

The Austrian strategy for adaptation to climate change

Part 2 – Action Plan

Updated Version, January 2017



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THE AUSTRIAN STRATEGY FOR ADAPTATION TO CLIMATE CHANGE

PART 2 – ACTION PLAN

This English translation of the action plan focuses merely on the overarching objectives and the recommended actions for the respective sector. Compared to the German version Austrian specific content (general description of the sector and its vulnerability assessment) is not included in this translation.

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1 INTRODUCTION

The Austrian Strategy for Adaptation to Climate Change was adopted by the Council of Ministers in October 2012 and was endorsed by the Provincial Governors' Conference in May 2013. Austria was thus one of the first EU member states to link a strategic concept for adaptation to climate change with a comprehensive action plan for implementing concrete recommendations for action.

The implementation of measures listed in the plan has been under way since then. In 2015, an initial evaluation of the level of implementation was published in accordance with the government program mandate. This progress report was also adopted by the Federal and by the Provincial governments.

In fulfillment of the mandate of the Council of Ministers, the existing 2012 adaptation strategy has been updated. Its structure has been preserved; the overall document is divided into a strategic part (context¹) and this document, the action plan, with concrete recommendations for action. In this revised version of the strategy, in which among other things all relevant ministries, the states, representatives of special interest groups, stakeholders and NGOs were involved, key findings from the 2015 progress report have been integrated. Particular focus in this updated action plan was given to the new results from the Austrian Assessment Report 2014 (AAR14²) and the project COIN (Cost of Inaction – Assessing the Costs of Climate Change for Austria³) as well as relevant scientific results from the Austrian Climate Research Programm (ACRP⁴) and StartClim⁵.

Due to organizational changes within the ministries after elections in the fall of 2018 the responsibilities of ministries referred to under “actors” in this document has changed. To allow consistency between the German version of the action plan which was published in the fall of 2017 the original acronyms were kept. In the table below you find the changes of acronyms and names of the respective Austrian Federal Ministries between 2017 and 2018:

Table 1: Changes of acronyms and names of the respective Austrian Federal Ministries between 2017 and 2018

Changes acronyms and names of the respective Austrian Federal Ministries between 2017 and 2018	
2017	2018
BMLFUW - Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (Federal Ministry of Agriculture, Forestry, Environment and Water Management)	BMNT – Bundesministerium für Nachhaltigkeit und Tourismus (Federal Ministry for Sustainability and Tourism) www.bmnt.gv.at
BMWF – Bundesministerium für Wissenschaft, Forschung und Wirtschaft	BMBWF – Bundesministerium für Bildung, Wissenschaft und Forschung (Federal Ministry of Education, Science and Research) www.bmbwf.gv.at

¹ Austrian Strategy for adaptation to climate change, Part 1, Context:

<https://www.bmnt.gv.at/service/publikationen/umwelt/austrian-strategy-adaptation-to-climate-change.html>

² Austrian Assessment Report (AAR14): <https://ccca.ac.at/wissenstransfer/apcc/apcc-aar14/austrian-assessment-report-2014-aar14>

³ Cost of Inaction (COIN): <https://coin.ccca.ac.at/>

⁴ Austrian Climate Research Programme (ACRP): <https://www.klimafonds.gv.at/call/austrian-climate-research-program/>

⁵ StartClim: <http://www.startclim.at/>

Changes acronyms and names of the respective Austrian Federal Ministries between 2017 and 2018	
2017	2018
(Federal Ministry of Science, Research and Economics)	BMDW – Bundesministerium für Digitalisierung und Wirtschaftsstandort (Federal Ministry for Digital and Economic Affairs) www.bmdw.gv.at
BMASK - Bundesministerium für Arbeit, Soziales und Konsumentenschutz (Federal Ministry of Labour, Social Affairs and Consumer Protection)	BMAGSK - Bundesministerium für Arbeit, Soziales, Gesundheit und Konsumentenschutz (Federal Ministry of Labour, Social Affairs, Health and Consumer Protection) www.bmasgk.gv.at (www.sozialministerium.at)
BMG – Bundesministerium für Gesundheit (Federal Ministry of Health)	
BMLVS – Bundesministerium für Landesverteidigung und Sport (Federal Ministry of Defence and Sports)	BMLV – Bundesministerium für Landesverteidigung (Federal Ministry of Defence) www.bmlv.gv.at
BMEIA – Bundesministerium für Europa, Integration und Äußeres (Federal Ministry for Europe, Integration and Foreign Affairs) www.bmeia.gv.at	
BMF – Bundesministerium für Finanzen (Federal Ministry of Finance) www.bmf.gv.at	
BMI – Bundesministerium für Inneres (Federal Ministry of the Interior) www.bmi.gv.at	
BMOEDS – Bundesministerium für öffentlichen Dienst und Sport (Federal Ministry for the Civil Service and Sport) www.bmoeds.gv.at	
BMVRDJ - Bundesministerium für Verfassung, Reformen, Deregulierung und Justiz (Federal Ministry of Constitutional Affairs, Reforms, Deregulation and Justice) www.bmvr dj.gv.at	
BMVIT – Bundesministerium für Verkehr, Innovation und Technologie (Federal Ministry for Traffic, Innovation and Technology) www.bmvit.gv.at	

2 SECTORS AND RECOMMENDATIONS FOR ACTION

In the following 14 sectors and their recommendations for actions are described in detail.

- Agriculture
- Forestry
- Water resources and water management
- Tourism
- Energy
- Construction and Housing
- Protection against natural hazards
- Disaster Management
- Health
- Ecosystems and biodiversity
- Transport infrastructure including aspects of mobility
- Spatial planning
- Business/Industry/Trade
- Cities – urban green and open spaces

2.1 AGRICULTURAL SECTOR

2.1.1 OVERARCHING OBJECTIVE OF THE SECTOR

OVERARCHING OBJECTIVE: Securing a sustainable, resource-conserving and climate-friendly (agricultural) production, as well as the maintenance and improvement of the ecosystem services of agriculture under changed climatic conditions.

2.1.2 RECOMMENDATIONS FOR ACTION FOR THE AGRICULTURAL SECTOR

GENERAL PRINCIPLES FOR ACTION IN THE AGRICULTURAL SECTOR

- For the development of robust adaptation measures that are flexible and support rapid reactions, an integrative view of the entire soil – plant – water (irrigation) system and the corresponding ecosystems is necessary.
- The guiding principle of a resource-conserving and sustainable use of materials and the natural basis of production must be followed in the development of adaptation measures in the agricultural sector.
- Adaptation to changed boundary conditions as a result of global change – such as increasing prices for production factors (energy, fertilisers, water) and changes in the international agricultural market, such as changes in the global demand – must be taken into consideration.

2.1.2.1 SUSTAINABLE SOIL COMPOSITION AND PROTECTION OF SOIL FERTILITY, STRUCTURE AND STABILITY

Objective

Safeguarding natural soil functions; build-up and long-term stabilization of optimal humus content in soils; conservation of aggregate stability; promotion of soil life and safeguarding of adequate water intake and water retaining capacity.

Prevention of damage (especially soil compaction and erosion) and conservation of soil productivity through sustainable and site-adapted land use and a soil-conserving tillage method.

Significance

The soil together with the climate is the most important location-specific factor. Through temperature and precipitation, the climate directly influences the physical, chemical and biological processes in the soil but it also indirectly influences the vegetation. Humus or the organic content of the soil is a central element for soil fertility and a significant factor inter alia for the soil structure, the storage of nutrients and nutrient dynamics during the course of the year. Through the storage functions, soils rich in humus reduce the losses of nutrients and pesticides into groundwater and surface water. A good soil structure also reduces the risk of soil erosion. The humus turnover of a location is dependent on the climate or weather, the soil characteristics, (e.g. clay content) and the cultivation practices (e.g. crop rotation, soil cultivation, addition of nutrients, addition and removal of organic matter, such as harvested produce, remains after harvesting, interim crops). In this respect, the soil can be both a source of and a sink for climate-relevant gases (CO₂, N₂O, CH₄). Changes of the humus content not only affect climate change, but also, for example, water protection and biodiversity.

Through the warming as a result of climatic change, some soils used for grassland could be used for cropland. However, this is only possible if the strict regulations within the framework of the Common Agricultural Policy regarding the ploughing up of grassland are taken into account.

Through sustainable soil use, damages such as soil compaction and soil erosion can be avoided. Customised forms of cultivation and measures to build up and maintain the humus content improve the soil quality and the maintenance of the aggregation stability and also support soil life. The surface-water flow – especially in the case of extreme precipitation events - is reduced and soil erosion is drastically reduced or even eliminated. Through large-scale application of conserving soil cultivation, the water retention capacity of the soil can be increased.

In addition, adapted cultivation methods can increase the binding of carbon and nitrogen in the soil and in the vegetation, relieving pressure on the atmosphere by reducing the concentration of greenhouse gases such as CO₂ or N₂O.

This recommendation for action therefore contains, in particular, measures such as site-adapted crop rotation, optimised fertiliser management, humus-building intercrops, between-crop greening, greening of crop areas, mulch- and direct-sowing and further soil-conserving cultivation methods.

Connections to other sectors

There is a close connection in particular to the following sectors: water, ecosystems/biodiversity; protection against natural hazards; spatial planning (see 2.12.2.13) and health.

Connections to existing instruments

In Austria, soil protection is a cross-cutting issue in a multitude of federal government and federal state laws. Relevant regulations are included, for example, in the laws on fertilisers, forests, water rights, waste treatment (in connection with the Federal Waste Treatment Plan (BMLFUW 2011e)), chemicals, the Business and Trade Code and, in particular, the soil protection laws of the federal states.

Further laws and legal guidelines which provide connections are: the Alpine Convention (Soil Protection Protocol), spatial planning laws of the federal states, nature protection laws of the federal states, various guidelines of the Advisory Board on soil fertility and soil conservation (e.g., guidelines for correct soil cultivation (BMLFUW 2012), guidelines for correct fertilisation (BMLFUW 2006b)).

In the directive on direct payments within the framework of cross compliance⁶, there are also regulations for soil protection.

Within the framework of the Austrian programme for support for an environmentally friendly, extensive agriculture that protects natural habitats (ÖPUL), there are measures in particular for soil-, climate-, and water protection.

⁶ In European Community law, Cross Compliance (CC) means the coupling of the provision of Direct Payments with compliance with obligatory environmental and other legal standards.

State of implementation

In particular with reference to the building up and maintenance of soil fertility, there are already many measures (e.g. mulch covering, mulch tillage and direct sowing with no tilling). These should – depending on evaluation results – be improved if necessary or complemented by further measures and included in subsequent programmes with particular attention to soil fertility, soil structure and soil quality.

For agricultural actors there is a comprehensive and established advisory, training and information system, which must be safeguarded. The consideration of topics relevant to adaptation, knowledge transfer from research and practical implementation must be further expanded and provided with the necessary support.

Currently in the area of environmental management within the framework of an international project, the norm ISO 14055 (Environmental management - Combatting land degradation and desertification - Part 1: Guidelines and general framework) is being developed.

The suggested measures are partially covered by existing programmes.

In 2014 the measures “Greening of crop areas” and “Mulch tillage and direct sowing with no tillage” were implemented over 408,979 and 134,163 ha respectively. In vineyards and orchards and other sloping areas, for example embankments, the risk of erosion was significantly reduced through planting mixtures of ground-cover plants (9,964 ha orchards; 31,758 ha vineyards).

These examples demonstrate that Austrian agriculture already takes precautions – even if the measures are not explicitly carried out under the heading of “Adaptation to Climate Change! .

Organic agriculture contributes with its environmentally protective production methods to increasing the soil fertility and the humus content. In 2013 there were 21,737 organic farms in Austria. The share of agricultural area used for organic farming is about 20% (BMLFUW 2015).

Broad, horizontal measures contribute to nationwide environmental effects through the support measures that are offered. Main elements are, for example, the preservation of landscape features, the preservation of permanent grassland, requirements for crop rotation, as well as the reduction of the use of fertilisers and pesticides.

With the Carbon Calculator (Austrian Carbon Calculator funded by the Austrian Climate and Energy Fund within the framework of the Austrian Climate Research Programme) farmers have access to a simple calculation model that shows how cultivation measures affect the provision of humus to the soil. Influencing factors such as crop rotation, fertilisation, soil cultivation, irrigation and intercrop greening of the agricultural areas and the local soil type, as well as current and future climatic conditions, are considered. The Carbon Calculator was developed first for the Mühlviertel (Upper Austria) and then for the Marchfeld (Lower Austria).⁷

Relevant research questions are dealt with in research programmes (e.g., Austrian Climate Research Programme of the Climate and Energy Fund⁸, StartClim⁹, European Territorial Cooperation ¹⁰).

Recommended further steps

Consolidation of available data regarding the effect of soil improvement and energy efficient cultivation practices;

Targeted evaluation of existing measures and regulations and their implementation, in particular with respect to soil fertility, structure and quality, in order to improve them or to add further measures in subsequent programmes;

⁷ Link to local model of the Carbon Calculator: http://www.umweltbundesamt.at/umweltsituation/landnutzung/acc/acc_lokal/

⁸ Link: <https://www.klimafonds.gv.at/foerderungen/aktuelle-foerderungen/2016/austrian-climate-research-programme-3/>

⁹ Link: www.startclim.at

¹⁰ Link: <http://www.oerok.gv.at/eu-kooperationen/>

	<p>If necessary, evaluate the need for a legal anchoring of soil conservation in other policy areas at the federal government and federal state level;</p> <p>Determine the research needs in particular with respect to humus formation and carbon sequestration, but also with respect to water retention capacity and soil structure;</p> <p>Evaluation and continuation of long-term experiments and, where necessary, adaptation to take new questions into account;</p> <p>Strengthened consideration of topics relevant to adaptation in existing, comprehensive and established offers for consultation, training and information supply;</p> <p>Secure existing support and measures for soil conservation;</p> <p>Awareness-raising and education within and outside of the sector to emphasise the significance of comprehensive soil protection. The goal would be to have societal consensus on the measures and their support;</p> <p>Review the selection of plants at locations with high risks of erosion;</p> <p>Integration of the valuation of soil function into spatial planning processes to improve soil conservation.</p>
Possible resource requirement	<p>Measures in the Agricultural Environment Programme (ÖPUL 2015) are financed to about 50% by the EU and about 50% from national sources. For the Programme (ÖPUL 2015) an annual total of 438.3 million Euros are foreseen. Alternatively, raising minimum standards for agricultural production in response to climate goals could be considered.</p>
Possible potential conflicts	<p>Use conflicts for soil and ground could arise through needs in sectors other than agriculture. In particular, conflicts are expected with settlement development and transport. Through the competition for land, the possible consequences of an intensification of agricultural production cannot be excluded. A valuation of the soil function should also be included in spatial planning processes.</p>
Actors	<p>Federal and state governments, interest groups (advice, information), academic and non-academic research institutions, farmers, Bio-Austria, b4 Corporate Soil Competence (Austrian Agency for Health and Food Safety (AGES), Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW), Environment Agency Austria, Federal Office of Water Management (BAW)), agricultural schools, rural training institutes, apprenticeship and specialized training units.</p>
Time horizon	<p>Within the framework of education, as well as the extensive existing advisory services and further education offers, more content about climate change consequences and adaptation needs could be integrated in the short term. Necessary research on the complex topics of soil cultivation systems as well as crop rotation suitable for local conditions can be tackled in the short term. The measures will take effect in the medium to long term.</p>

2.1.2.2 ENHANCED ESTABLISHMENT AND PROMOTION OF WATER-SAVING IRRIGATION SYSTEMS AND IMPROVEMENTS IN IRRIGATION PLANNING

Objective	<p>Efficiency improvements in irrigation and water use through the introduction of modern technological developments permitting the optimization of irrigation in terms of timing and amount of water.</p>
Significance	<p>As a result of adaptation to climate change an expansion of irrigated areas in different areas will take place. This development has to be managed with attention to the long-term regional situation and water availability. The amount of water in the soil available for plants plays a central role for the water budget of a crop. The water availability is determined in particular by the precipitation distribution. Cultivation areas with a low water retention capacity, an unfavourable water balance and/or high summer temperatures will be particularly affected. For some crops, irrigation will be essential to ensure the quality and amount of the harvest. This is particularly the case for the agricultural areas that are already the driest areas in eastern and southern Austria</p>

Connections to other sectors	<p>(APCC 2014). Experts assume, however, that the potential savings through the accelerated application of efficient irrigation systems are higher than the additional water demand as a result of climate change. Since artificial irrigation represents a significant cost factor, water-saving systems have been increasingly introduced recently and they will play a significant role in the future. Special attention must be paid to efficient and sustainable water use. In addition, modern irrigation systems are energy-saving and protect the soil. Also, exact temporal and areal planning and documentation of irrigation, paying attention to precipitation and to the water demand of the plants, can improve the efficiency of irrigation.</p> <p>Overall, it is to be noted that the economic feasibility of irrigation systems crucially depends on the energy prices, the selected irrigation technology (investment costs), potential costs of providing the water and the prices of the cultivated products.</p> <p>There is a close connection to the water resources and water management sector. As a result of the interactions with ecological aspects or, respectively, to competing uses (water supply, use for energy conversion), it is important to take a systemic approach. For the implementation, basic data for water withdrawal from groundwater or from surface water through agriculture (see the corresponding measures in the water resource and water management sector) are needed across the whole of Austria. Further connections are found with the energy, ecosystems/biodiversity and economy sectors.</p>
Connection to existing instruments	<p>Water extraction, for which permission has to be obtained, is regulated through the Austrian Water Act. Basic information on water extraction from groundwater or surface water with reference to the installations permitted according to water law are to be found in the water information systems of the federal states.</p>
State of implementation	<p>Artificial irrigation is coupled with considerable costs, which is one reason why water saving systems have become increasingly popular in the recent past. It can be assumed that efficient irrigation will have a special priority in the future.</p>
Recommended further steps	<ul style="list-style-type: none"> – Survey of the actual water use, since in some areas the sum of all legal permits is higher than the supply; – Regulation of the extraction of water from public water bodies. Consideration of a potentially existing need for adaptation in the granting of permits; – Creation of incentives for changing to water-efficient irrigation systems (e.g., investment support); – Research on the long-term regional water extraction capacity of an area and the development of demand using regional climate scenarios, as well as on the efficiency of irrigation systems with respect to energy and water consumption; – Information and advice initiatives within the framework of the extensive, existing education offers.
Possible resource requirements	<p>For the development of an Austrian basic data set on actual water extraction from groundwater and surface water, financing will be required. Research programmes should anticipate the need for resources for tackling relevant questions.</p>
Possible potential conflicts	<p>Conflicts over the use of water resources (drinking water and water for industrial use, water use for energy conversion etc.) are to be expected in particular in the regions that are already at risk of dry periods.</p>
Actors	<p>Federal and state governments, municipalities, interest groups, academic and non-academic research institutions, farmers, industry.</p>
Time horizon	<p>At best, the required research activities on the long-term regional water extraction capacity could be implemented in the short term. Strengthened and targeted information and advice campaigns within the framework of the existing supply could be implemented in the short term. In the medium term financial incentives for the development of water-efficient irrigation systems are conceivable.</p>

2.1.2.3 BREEDING AND TARGETED USE OF WATER-SAVING, HEAT-TOLERANT PLANTS (SPECIES/ VARIETIES) FOR REGIONALLY ADAPTED MANAGEMENT

Objective	Use of species and new varieties of plants that can tolerate changing climatic conditions. In particular, heat-tolerant and water-saving crops and grasses and species with low susceptibility to pests should be favoured.
Significance	<p>To cope with future warmer climatic conditions and increasing climate variability, the demands for plant breeding are increasing. Changing conditions for vegetation have always influenced the selection process of the existing species and varieties; however, an increased adaptation of the spectrum of varieties to climate extremes will be necessary. In particular, adaptation in the face of an unusual distribution of annual precipitation is a major challenge.</p> <p>The optimal adaptation of the spectrum of varieties of crops in the face of changed temperature and precipitation conditions is of pressing importance. Additional requirements include further improvement of heat and drought tolerance, as well as the tolerance towards other factors that often appear in combinations, such as ground level ozone (elevated ozone concentrations in hot spells have a possibly negative effect on photosynthesis, leaf aging and the yield). Furthermore, climate change is connected with the appearance of new pests and diseases. Thereby, the requirements for breeding for resistance are changing through the consideration of new genetically determined resistances to plant diseases and pests.</p> <p>Furthermore, breeding goals include a well-developed root system and an improved capacity for root penetration. All of the factors together significantly determine the stability of yield of a variety in a particular location.</p> <p>Varieties that are regionally established today will have to be replaced by better adapted species in the medium to long term. For the development of new and adapted species a corresponding lead time must be taken into account. The need for action is urgent and strong. For new breeds it is necessary to consider the plant genetic resources that are an enrichment of the gene pool through their tolerance of drought and pests. An increasingly specific offer of varieties increases the demands on farmers to select the optimal variety for their location. In the description of the varieties in future it will be necessary to include characteristics such as water demand, heat tolerance and vulnerability to new organisms or those that profit from climate change (provided that they are not yet included in the testing scheme), as well as product quality, agronomic measures etc.</p> <p>Independent from the demands for breeding of new varieties, the production of high quality seeds is essential, in order to realise the genetically determined performance characteristics in practice. For this, the location of the seed propagation plays a significant role.</p>
Connection to other sectors	There is a connection in particular to the ecosystems/biodiversity sector, as well as to the water resources and water management and economy sectors.
Connection to existing instruments	<p>The Austrian Agency for Health and Food Safety publishes the Austrian List of Varieties annually (AGES 2016). This provides information on the permitted agricultural varieties in Austria and provides the basis for the correct variety selection in crop and grassland farming.</p> <p>Journals and existing advisory systems also contribute to awareness-raising and the dissemination of relevant information.</p> <p>In the opinion of many experts, research programmes such as the ERA-Net CORNET¹¹ do not provide enough resources.</p>
State of implementation	From the development of a new variety to its introduction to the market there is a time span of 8 – 13 years depending on the breeding process and the species. Adaptation to

¹¹ Link: <https://www.cornet.online/>

	<p>climate change is currently not a top priority in breeding research. Relevant projects are currently only being prepared.</p> <p>70% of grasslands are on southern slopes, which lose their sod grass (low rooting depth) and degenerate with reduced precipitation and high temperatures in summer. To support the vegetation in such areas, the Austrian Association of Grassland and Livestock Production (ÖAG) has developed reseeded mixtures for meadows and pastures. For years drought-resistant species and varieties have thus been introduced to endangered meadows and pastures to make them more resistant to droughts and hot spells.</p> <p>At the Agricultural Research and Education Centre (HBLFA Raumberg-Gumpenstein) a breeding programme for drought-resistant grasses is being carried out.</p>
Recommended further steps	<ul style="list-style-type: none"> – Stronger provision of targeted information and advisory initiatives, especially within the framework of interest groups and existing capacity building possibilities. In general, communication about the significance of plant breeding, which is at the beginning of the food, fodder, commodity chain and contributes significantly to maintaining volumes and security of the products of the sector, must be supported and under no circumstances restricted; – Further development of new practical breeding methods (e.g. marker-supported breeding¹²) for the Austrian breeders to accelerate breeding success; – Identification of breeding priorities within the framework of international programmes (European Territorial Cooperation), in particular in central, southern and eastern Europe; – Continuation of research programmes for plant breeding; – Continuation with sufficient resources of existing breeding programmes for drought-resistant grass species and drought-tolerant grass mixtures for new areas and for water-saving renovation of degraded grassland without ploughing; – Increased consideration of plant genetic resources that expand the gene pool as a result of their drought- and pest-tolerance.
Possible resource requirements	<p>It is necessary to provide sufficient capacities and resources in research on plant breeding. Likewise for knowledge transfer, for example in education and advisory services, sufficient resources must be provided.</p>
Possible potential conflicts	<p>Climatic changes have impacts on the range of cultivated species and crop rotation in the long term. These can have effects on the range of beneficial organisms and pests. In turn this can have undesirable consequences for biodiversity and plant and animal communities.</p>
Actors	<p>Federal government (research funding), building and use of national and European networks, plant breeders, academic and non-academic research institutions, AGES, LFZ Raumberg-Gumpenstein, federal state experimental institutes, agricultural training institutes, farmers (implementation – changes in varieties).</p>
Time horizon	<p>In order to have adapted varieties in time, it is necessary to start now, because of the long lead time in breeding and optimisation of new varieties.</p> <p>Breeding a new variety takes on average 8 – 13 years, so short-term changes of breeding goals are not possible.</p>

¹² The marker-supported breeding or smart breeding scans plants or animals with the support of a DNA-marker to find gene-variants that are advantageous for breeding so that the examples that are found can be used specifically for further breeding. In contrast to transgenic plants, in this process the vertical gene transfer is influenced.

2.1.2.4 ADJUSTMENT OF FERTILIZER MANAGEMENT TO SEASONAL WEATHER PATTERNS

Objective	Need-based and site-specific plant nutrition as a contribution to plant quality, plant health, and yield security.
Significance	<p>Fertilisation measures that make sense economically and environmentally must be oriented towards the supply from the soil and the nutrient demand of the plant, as well as the crop rotation, general soil conditions, climate and irrigation. A loss of nutrients into the groundwater or through emissions – for instance, incorrect fertilisation and/or irrigation – represents a reduction of efficiency and should be avoided.</p> <p>Both extreme drought and more frequent intense rainfall events can affect the use or the efficiency of fertilisers. In regions, in which more winter and less summer precipitation are projected, the nutrient supply must be adapted. On the other hand, drought reduces the nutrient uptake. Catch crops or winter greening can contribute to an optimal nutrient use.</p> <p>The timing and the type of fertilisation, assessed from the needs of the plants and the nutrients available in the soil, have to be adapted to the changed weather conditions. A targeted application can subsequently lead to a reduction of fertiliser use. For this, there is a need for research regarding the timing of fertilisation and the amount of fertiliser under future climatic conditions. In the sense of a closed-loop economy, the use of nutrients from planting of legumes, farm manure, as well as compost and biogas slurry should be optimised and further stepped up.</p> <p>Given changing conditions, the washing out of unused nutrients and contaminants from the soil into the groundwater and thereby into the drinking water is considered to be highly relevant.</p>
Connection to other sectors	<p>In the Agricultural Environment Programme (ÖPUL 2015) the improvement of water management including the handling of fertilisers and pesticides is a focal point. Through the available ÖPUL-measures water-protecting methods of management are supported and nutrient leaching is reduced. Efforts should be made to increase the number of participants pursued, since the goal set by the EU Water Framework Directive has not been achieved. Measures are particularly needed for sloping cropland and alongside water bodies.</p> <p>An optimised fertiliser application makes an additional positive contribution to climate protection. It contributes <i>inter alia</i> to a reduction of greenhouse gas emissions from fertilisers and livestock farming.</p>
Connection to existing instruments	<p>There is a close connection in particular to the water resources and water management sector (see action recommendation 2.3.2.6 Achieving and ensuring the good ecological and chemical status of water bodies (including groundwater)); further connections are with the health and ecosystems/biodiversity sectors.</p> <p>Existing legal regulations, such as the EU Water Framework Directive, Water Rights Act, EU Nitrates Directive with implementation in the Action Programme for Nitrates, voluntary measures and measures in the Agricultural Environment Programme (ÖPUL), direct payments and the related requirements (Greening, Cross Compliance) and the guidelines for correct fertilisation, are important steps.</p> <p>Furthermore, research in particular within the framework of PFEIL 20 (Programme for Research and Development for a liveable Austria 2016 -2020, BMLFUW 2016b) as well as through the evaluation of the available measures under the Agricultural Environment Programme (OPÜL) deals with questions related to fertiliser management.</p>
State of implementation	<p>Within existing legal regulations important steps have already been taken in the direction of environmentally and economically appropriate fertilisation measures. A continuous review of the effectiveness of these measures, or measures derived from them, is undertaken (e.g. Action Programme for Nitrates, national Water Management Plan).</p>

Recommended further steps	<p>With respect to fertilisation and cultivation, numerous measures have been implemented for grasslands.</p> <p>The advisory services of the Chambers of Agriculture increasingly include soil and water protection in their activities, such as the Soil-Water-Protection advisory service of the Chamber of Agriculture in Upper Austria¹³.</p> <p>Research on measures to reduce material discharges into groundwater and surface water, as well as consideration of the results of statutory and voluntary measures;</p> <p>Continuous evaluation and further development of measures in the Agricultural Environment Programme;</p> <p>Further development of the direct payments with regard to adapting fertiliser management in the face of climate change;</p> <p>Securing and continually adapting of good practice (guidelines for correct fertilisation);</p> <p>Intensification of the cooperation between science, consultancy and agriculture, as well as increased information dissemination and awareness-raising for farmers within the framework of existing advisory, education and further education services.</p>
Possible resource requirements	<p>It is necessary to provide sufficient capacities and financial resources for research in existing research programmes, as well as in the area of education and advisory services. Similarly, sufficient funding is necessary for environmental measures (e.g. for water conservation). Standards must be further developed or raised in response to climate policy requirements.</p>
Possible potential conflicts	<p>Sub-optimal fertilisation can lead to a high potential for conflict through the leaching of unused nutrients into groundwater and thereby into the drinking water system.</p>
Actors	<p>Federal government, academic and non-academic research institutions, interest groups, AGES, HBLFA Raumberg-Gumpenstein, Committee for Soil Fertility and Soil Conservation, farmers.</p>
Time horizon	<p>Required research activities can be started in the short term.</p>

2.1.2.5 PROVISION OF SCIENTIFIC ADVICE ON POTENTIAL NEW AGRICULTURAL DISEASES AND PESTS

Objective	<p>Improvement in the state of knowledge regarding emerging diseases, to enable a quick and efficient response.</p>
Significance	<p>As a result of plant diseases, weeds and pests, climatic changes will put an increasing pressure on agricultural production around the globe. In addition to small and/or large areal shifts, there is also the risk of increased migration and spreading of new species. Furthermore, the climate-related prolongation of the vegetation period is expected to lead to increased flying times of harmful insects. A longer flying time and the resulting longer infestation time are already observed for the western corn rootworm (<i>Diabotrica virgifera virgifera</i>) (BMLFUW 2011f).</p> <p>The continuing climate change encourages certain invasive species (harmful organisms). This is a threat for both agricultural production and biodiversity. Regarding new pests and diseases in arable farming or cattle farming, knowledge is generally insufficient to be able, for example, to estimate the potential scale of damages.</p> <p>An increasing risk is the introduction through imported goods, such as seeds and plants or animal food, as well as through vehicles. In addition to climate change, factors such as land use and cultivation (crop rotation, soil cultivation and plant protection) are significant for the spreading of harmful organisms (Eitzinger et al. 2009).</p>

¹³ Link: <http://www.bwsb.at>

Connection to other sectors**Connection to existing instruments****State of implementation****Recommended further steps**

To be prepared for newly arising problems and able to react quickly, targeted research is necessary (e.g., with respect to potential new diseases, pests and invasive species, as well as to geographic spreading and expansion patterns of known and also new diseases, harmful organisms for animals, weeds, etc.).

The application of technical measures and plant protection products is also relevant in this case, both because of the changing environmental conditions and also because of the changed demands of society regarding food security and food safety.

In particular there are connections to the forestry, health and ecosystems/biodiversity sectors.

At European level, the topic of climate change and new or invasive harmful organisms is dealt with through participation in the ERA-Net EUPHRESKO (European Phytosanitary Research Coordination)¹⁴ and in der JPI-FACCE “Joint Programming Initiative: Agriculture, Food Security and Climate Change”¹⁵ In already existing research programmes, such as PFEIL 20 (BMLFUW 2016b), the Austrian Climate Research Program (ACRP) of the Climate and Energy Fund, or in the national climate research program StartClim, relevant research questions can be taken up. Efforts are being made to intensify the cooperation between advisory services and science.

Risks for plants and their health through new harmful organisms are estimated within the framework of PRA (pest risk analysis) of the European Food Safety Authority (EFSA) and the European and Mediterranean Plant Protection Organization (EPPO), based on the current climate. In the PRA a systematic analysis is made of the risk arising from a specific harmful organism for agriculture, forestry and the environment. Thereafter, a decision is made whether this risk is acceptable. Otherwise, in the risk management part of the PRA phytosanitary protection measures to reduce risks are identified and evaluated. This evaluation provides decision-makers with a basis for determining legal protection measures.

With regard to the relevant dangers, especially those resulting from climate change, there are few risk assessments except for the PRA in order to specify the need for action (risk management measures) and at least to some extent to include a cost-benefit estimate. A connection with socio-economic research has not been made so far in most cases.

- Intensify the cooperation between science, advisory services and agriculture;
- Consideration of relevant research questions in existing research programmes in particular concerning potential new diseases, pests and invasive species, geographical spread and expansion patterns of known or new diseases, harmful organisms for animals, weeds etc. ;
- Selection of the parameters that need to be studied with reference to climate change and plant health, as well as the setting up of databanks for such parameters for long-term comparisons;
- Capacity building for experts as well as provision of better tools for carrying out risk assessment;
- Capacity building for professionals in operational consultancy, who ensure the knowledge transfer to the agricultural operations;
- Development of relevant plant protection measures and establishment or adaptation of warning services for pests;
- Provision of suitable, environmentally acceptable plant protection products;
- If necessary, strengthen the network of and provide long-term commitment to the warning services for the collection and analysis of data.

¹⁴ Link: <https://www.euphresco.net/>

¹⁵ Link: <http://www.faccejpi.com/>

Possible resource requirements	<p>Sufficient financial support must be provided in existing research programmes, e.g. PFEIL 20 (BMLFUW 2016b), the Austrian Climate Research Programme (ACRP) of the Climate and Energy Fund or in StartClim.</p> <p>For knowledge transfer, e.g. in the education and advisory services, sufficient resources must be planned.</p>
Possible conflict potential	<p>There could be conflicts with biodiversity targets through the development and use of new plant protection products.</p>
Actors	<p>Federal and state governments, interest groups, AGES, academic and non-academic research institutions, farmers, industry (producers of plant protection products).</p>
Time horizon	<p>Necessary research activities should begin immediately or in the medium term for some thematic areas.</p>

2.1.2.6 ENVIRONMENTALLY SOUND AND SUSTAINABLE USE OF PLANT PROTECTION PRODUCTS (PESTICIDES)

Objective	<p>Optimisation of plant protection measures through changes in the timing and method of application and/or spectrum of pesticides, and establishment of systematic monitoring, with the goal of fostering environmentally friendly and sustainable agricultural practices.</p>
Significance	<p>In addition to the immigration of invasive species as a result of rising temperatures, ecological measures such as no-tilling cultivation, border biotopes and edge strips lead to changes in plant protection. Here, there is an urgent need for research to close knowledge gaps.</p> <p>Possible control methods include preventive plant cultivation measures, such as crop rotation. The selection of robust plant varieties, a wide-ranging mixture of varieties as well as location-adapted cultivation have positive effects. For these measures, suitable framework conditions are necessary.</p> <p>For plant protection is important to recognize the risks posed by new harmful organisms early (see also Chapter 2.1.2.5 Provision of scientific advice on potential new agricultural diseases and pests). Increased pressure due to harmful organisms leads to the conclusion that in the future the application of plant protection products could be more intensive. An increasing introduction of materials into the environment should, however, be avoided in order to protect health, nature and the environment. Therefore, targeted support of an environmentally friendly and sustainable use of plant protection products is urgently needed.</p> <p>Possible adaptation measures include a changed spectrum of plant protection products, as well as changed time of application and control measures. The application technology should be further developed with the goal of improving the effectiveness of plant protection products. Above all, the effectiveness during droughts must be ensured. The effect of plant protection products is reduced by high temperatures and dryness. For example, leaf herbicides work less well during dry periods through the development of a strong wax layer on the targeted plant. Furthermore, an application during dry conditions increases the danger of phytotoxicity.</p> <p>Overall, an improvement and expansion of projections of the emergence of harmful organisms are necessary, in order to optimise the timing, amount and type of plant protection product application.</p> <p>Furthermore, the expansion of organic plant protection measures and research on beneficial organisms should be supported.</p>
Connection to other sectors	<p>In particular, there is a connection to the ecosystem/biodiversity, health, water resources and water management and economy sectors.</p>

Connection to existing instruments

In 2009 the EU regulation concerning the placing of plant protection products on the market was agreed, consisting of a regulation on the use of plant protection products together with guidelines for the sustainable use of pesticides. The guidelines should provide uniform rules for the use of plant protection products and supplement the regulation on plant protection products. The EU Member States must produce national action plans to reduce the risks and amounts of as well as the dependence on plant protection products.

The guidelines *2000/29/EG* cover measures to protect against the importation of harmful organisms of plants and plant products into the Member States from other Member States or from other countries.

Further connections are provided by the law on changing agricultural legislation (2010) and the plant protection laws of the federal states.

The official plant protection services of the federal states have the responsibility to coordinate and carry out plant protection measures and control strategies, as well as the related inspection and monitoring tasks. This includes the supervision and monitoring of control measures, measures to reduce the spread of quarantine pests, supervision of export and operation monitoring, the plan passport and the registration of firms.

The plant protection warning service uses models to provide projections and thus gives an overview of regional disease and pest pressures and serves as an efficient and modern tool for an environmentally friendly and cost-effective plant protection. It aims to reduce the use of plant protection products and is thus a significant measure to protect the health of humans, animals and the environment. Since the warning service system was built up differently for the different crops, the Austrian Chamber of Agriculture developed a concept for a unified system. This project created a unified warning service across the federal states. This allows synergies between individual production branches and avoids duplication.

State of implementation

Comprehensive legal regulations exist.

Since the Spring of 2015 a nationwide warning system for all crop types for arable farming, fruit, vegetables and viticulture is available. The warning system is provided by the Austrian Chamber of Agriculture through the rural further education institute, supported by the EU, the Federal Ministry for Sustainability and Tourism, the federal states and their Chambers of Agriculture.

Recommended further steps

- Planning of possible national flexible use regulations and development of related recommendations;
- Intensification of the cooperation between science advisory services, agriculture and industry, as well as strengthened information provision and awareness-raising for farmers within the context of the existing advisory services and (further) education provision. The latter requires additional training courses and specialisation of the advisers. The university teaching on the topic of plant health must be strengthened;
- Further development of research programmes and international research cooperation;
- Extension of the methods for monitoring of new and potentially dangerous harmful organisms as well as the use of plant protection products;
- Further development of the technology for application to improve the effectiveness of plant protection products;
- Support of environmentally friendly plant protection including preventive measures for plant protection (e.g. appropriate crop rotation, organic plant protection measures) and/or support for doing without the use of plant protection products;
- Establishment and continuation of field trials to test the effectiveness of available plant protection products and control mechanisms;
- Acceleration of research on beneficial organisms.

Possible resource requirements	Within the framework of existing research programmes sufficient resources must be provided. In addition, sufficient resources are needed for the relevant training of advisers, as well as for a strengthened information provision. For continual field trials and other projects relevant for practice, the required resources must be secured.
Possible conflict potential	Through their implementation the measures can reduce conflicts with nature conservation and with water management. Strengthened regulations for plant protection measures can lead to competitive disadvantages with respect to other countries.
Actors	Federal and state governments, interest groups, AGES, academic and non-academic research institutions, Committee for Soil Fertility and Soil Conservation, agricultural trade, farmers, industry.
Time horizon	Required research and measures for awareness-raising and information can begin in the short term.

2.1.2.7 REVIEW OF SITE SUITABILITY BASED ON CHANGING CLIMATIC CONDITIONS AND DEVELOPMENT OF RECOMMENDATIONS FOR THE SELECTION OF A SITE-ADAPTED CROP

Objective	Selection of suitable crops for the respective site conditions.
Significance	<p>Cultivation of suitable varieties is a significant prerequisite for profitable and environmentally friendly agriculture (AGES 2016). A review of site suitability with regard to changing climatic conditions aims to enable the selection of suitable crops and secure the yield potential over the long term.</p> <p>Through the cultivation of location-adapted, drought- and heat-tolerant varieties with appropriate ripening behaviour, an important contribution can be made to responding to changed location characteristics. Especially in locations that are threatened by droughts, the planting of varieties with a well-developed root system, high robustness in the face of droughts and hot spells and sufficient winter-hardiness should be supported. Furthermore, with increasing drought-stress relatively thin stocks with strong individual plants should be planted, in order to use the available water and nutrient supply effectively. In addition, the amount of seeds and the timing of seeding can be adapted to suit the location. An earlier start of the vegetation period makes an earlier start of sowing possible, so that the winter moisture of the soil can be used better. For wintering crops a later sowing is possible.</p> <p>Location-appropriate cultivation can contribute on the one hand to the development of passive flood protection and on the other hand to potential biodiversity networks. A strengthened passive flood protection will most likely take place through the use of agricultural or forestry land. A strengthened cooperation and networking of the actors from the impacted sectors is needed for the implementation.</p> <p>These recommendations for action present a close connection to the recommendations from Chapter 2.1.2.1 Sustainable soil composition and protection of soil fertility, structure and stability, Chapter 2.1.2.3 Breeding and targeted use of water-saving, heat-tolerant plants (species/ varieties) for regionally adapted management, Chapter 2.1.2.4 Adjustment of fertilizer management to seasonal weather patterns, Chapter 2.1.2.6 Environmentally sound and sustainable use of plant protection products (pesticides).</p>
Connection to other sectors	In particular, there are connections to the forestry, water resources and water management, spatial planning and ecosystems/biodiversity sectors.
Connection to existing instruments	<p>One connection is the annual Austrian List of Varieties of the Austrian Agency for Health and Food Safety (AGES). This provides information on the permitted agricultural varieties and is the basis for the correct selection of varieties for cropland farming in individual regions.</p> <p>An additional connection is provided by the various journals and existing advisory services for awareness-raising and information dissemination for farmers.</p>

State of implementation	The Austrian List of Varieties contains information about the suitability and performance of the varieties in the various cultivation regions.
Recommended further steps	Strengthened consideration of site suitability with respect to heat, drought etc. in the Austrian List of Varieties; Awareness-raising and integration of all involved actors and subject material through the creation of a network between research, official variety testing, seed providers and agricultural practice; Research on changes of site conditions through climatic changes; Recommendations for the cultivation of agricultural crops under new climatic conditions; Integration of relevant research results in existing education and training programmes and advisory services; Development and maintenance of a gene pool for further advances in breeding.
Possible resource requirements	Additional resources could be needed for the adaptation and expansion of the advisory services and for research.
Possible conflict potential	Conflicts over land use (area) are possible with respect to settlement and transport developments as well as with nature conservation.
Actors	Federal and state governments, water management authorities, AGES, HBLFA Raumberg-Gumpenstein, interest groups, natural hazard insurers, academic and non-academic research institutions.
Time horizon	Research initiatives can start immediately or in the short term.

2.1.2.8 RISK MINIMISATION AND THE DEVELOPMENT AND EXTENSION OF RISK-SHARING INSTRUMENTS

Objective	Reduction of weather-related production risks and the development and extension of additional insurance models.
Significance	<p>Agriculture has always had to deal with production risks associated with weather. These risks will increase as a result of the expected climatic changes, especially through the increased occurrence of extreme events. Despite adaptation, there will be residual risks for climate-related damages to crops and animals. The risks are dealt with through general insurance products that should be further developed. Insurance and similar instruments are external risk management tools that serve to reduce the risk for individuals. A variety of insurance products, such as yield loss insurance, insurance based on a weather index and multiple risk insurance, is available.</p> <p>For example, grain can be insured against ten risks (hail, drought, frost, flooding etc.). The multiple risk insurance system is subsidised by the state in Austria for hail and frost insurance. Within the framework of a change to the law covering funds for disasters and the law supporting hail insurance, it was decided that the existing state support for insurance should be extended to further risks – in particular, drought.</p> <p>In cooperation with the insurance sector (e.g. the Austrian Hail Insurance) additional or new insurance models are to be developed, to spread risks depending on the proven adaptation efforts. Approaches that are already available (multiple risk insurance) offer important methods that could be further developed. Particular attention needs to be given with respect to grassland. In the meantime, an index-based insurance for grassland using precipitation deficit and heat days in particular time periods has been developed and is offered (drought risk index).</p> <p>To reduce risks, certain areas that are threatened by flooding could be removed from cultivation or at least planted with site-suitable species. This also provides passive flood protection and supports biodiversity networks</p>
Connection to other sectors	There is a strong connection to the economy sector (insurance sector).

Connection to existing instruments	The Austrian Hail Insurance insures agricultural crops within the framework of a multiple risk insurance for hail and other basic risks such as drought, flooding, frost, waterlogging etc.
State of implementation	The insurance against weather-related risks is widely implemented in Austria (multiple risk insurance). In 2015 insurance (drought risk index) was offered for the first time for grasslands. Grassland farmers participated in the first year with 30,000 hectares. In the drought year 2015 many operations received compensation. This type of model was offered for corn for the first time in 2016 (Drought-Index Corn). An expansion to winter grains (wheat) is being considered by the Austrian Hail Insurance.
Recommended further steps	<p>Many unavoidable risks – such as frost on apricot blossoms – are not insured due to the high production risk.</p> <ul style="list-style-type: none"> – Awareness-raising and integration of all stakeholders and relevant materials through the creation of a network between insurance companies, research and agricultural practice; – Regular review and further development or extension of insurance products; – Development of insurance models that spread risks depending on the proven adaptation efforts; – Further development of existing approaches (multiple risk insurance).
Possible resource requirements	Costs arise <i>inter alia</i> for advisory services and research. The federal government and the federal states contribute substantial resources to support insurance, since they cover 50% of the insurance premiums. Within the framework of rural development there is the possibility of co-financing through the EU (Regulation (EU) No 1305/2013). Currently Austria does not make use of this possibility.
Possible conflict potential	With regard to a public subsidy of insurance premiums, there is a difference of opinion as to whether the agricultural establishment or other economic actors or private persons profit from them.
Actors	Federal and state governments, water management authorities, AGES, HBLFA Raumberg-Gumpenstein, interest groups, natural hazard insurers, academic and non-academic research institutions.
Time horizon	Research initiatives can start immediately or in the short term.

2.1.2.9 INTEGRATED LANDSCAPING FOR SOIL PROTECTION AND THE IMPROVEMENT OF AGRICULTURAL ECOLOGY, INCLUDING THE CONSERVATION AND MAINTENANCE OF LANDSCAPE FEATURES

Objective	Improvement of the agro-ecological situation and conservation of natural biodiversity by reducing wind-exposed areas/wind speed and soil erosion, and improving water retention.
Significance	<p>Climatic changes such as higher temperatures will influence agricultural production through, among others, increasing water demand and higher evapotranspiration. Furthermore, phenological events change and increasing heat- and drought-stress are expected. This affects the water budget and demand and thereby the yields of agricultural crops especially in locations that are already dry (e.g. in eastern Austria).</p> <p>Landscape elements, such as agroforestry systems¹⁶ or windbreak hedges can change the landscape and the microclimate in a positive direction and can provide multiple positive effects for agricultural production.</p>

¹⁶ Form of land-use in which perennial woody plants (trees, bushes etc.) are planted in the same area that is used for agricultural crops or animals. In agroforestry systems there are both ecological and economic interactions between the various components.

They contribute to a reduction of the wind speed and thus reduce unproductive evaporation. This leads to an improved water balance and increased water and nutrient availability. Landscape elements increase biodiversity and can increase the survival of various species through creating networks of biotopes. A landscape with hedges and other elements can mitigate the impacts of extreme weather events.

Landscape elements also contribute to the improvement of soil characteristics and prevent soil degradation and erosion (in particular of dry soils). An increasing share of ground-covering permanent cultivation (e.g., hedges) builds up humus and stores carbon over the long term.

In eastern Austria, climate change is tending to lead to increased water losses in arable land, which can be reduced by landscape elements such as hedges. Through wind protection, wind erosion can be reduced particularly in the case of dried soils. Considering higher temperatures and perhaps increasing windy conditions, wind protection should be reviewed and improved where necessary. The use of landscape elements can also bring financial gains (e.g. wood for energy or timber), which compensate for the loss through land usage and the maintenance requirements.

A study of various landscape elements shows that hedges in particular have positive environmental (high biodiversity, habitat for fauna, support of beneficial organisms, regionally adapted domestic species etc.) and socio-cultural (landscape scenery, acceptance) effects. The low yield, high costs of planting and short rotation time can, however, be discouraging from a short-term economic perspective. With respect to the economic assessment, planting with herbaceous or perennial species is more advantageous (Brandenburg et al. 2009).

In Austria, as in other central European countries, it is assumed that there is a decrease of landscape elements (Teufelbauer 2015, Teufelbauer et al. 2015). In 2012 and 2013 a registration of particular landscape elements on parts of the agricultural land of Austria was carried out for the first time (Agrarmarkt Austria 2012).

If the landscape is designed to be attractive, the combination of tourism and agriculture (e.g. holidays on the farm) could become more popular in the Alps as a result of the warmer days and cooler nights.

Connection to other sectors

There is a close connection to the water budget and water management, protection against natural hazards, forestry, ecosystems/biodiversity and tourism sectors.

Connection to existing instruments

Landscape elements are basically well protected in various legal instruments of the federal states, although there are gaps in implementation. In addition, the implementation of the Flora-Fauna-Habitat guidelines and the bird protection guidelines within the framework of the nature protection laws of the federal states provide for wide-ranging protection of habitats (among others, also of landscape elements).

Furthermore, within the Austrian programme for an environmentally friendly, extensive and nature-protecting agriculture (ÖPUL) and within the framework of the direct payments, measures for soil, climate, water and landscape protection are included.

The Austrian programme for rural development supports measures for landscape design and landscape development. There is compensation for maintenance of landscape elements and nature protection measures include specific requirements for care of landscape elements.

State of implementation

The Austrian Agricultural Environment Programme (ÖPUL) supports the maintenance of landscape elements and of sensitive habitats. Key measures are, for example, environmentally friendly and biodiversity-supporting cultivation, organic cultivation, nature conservation, as well as alpine shepherding and pasturing.

Agrarmarkt Austria (AMA) has created a databank of defined landscape elements in Austria on the basis of aerial photographs¹⁷.

¹⁷ Link: <https://www.ama.at/Fachliche-Informationen/Oepul/Aktuelle-Informationen/2014/Landschaftselemente-ab-2015>

Recommended further steps	<p>Network Land provides information material such as brochures, a collection of questions and a briefing document about the diverse ecological functions of landscape elements (Netzwerk Land 2014).</p> <ul style="list-style-type: none"> – Support for measures to develop new and to maintain and care for landscape elements through the further development or extension of existing programmes such as the Agricultural Environment Programme or direct payments; – Strengthened advisory services and awareness-raising both within and outside of the agricultural sector with respect to the positive effect of landscape elements; – Cooperation with other areas (nature conservation, forestry spatial planning, tourism etc.) to secure the public goods of landscape, biodiversity, soil and water; – Review and potential adaptation of measures for wind protection; – Scientific accompanying research and evaluation.
Possible resource requirements	<p>For the continuation or the extension of existing support measures sufficient resources are required. Further resources are needed for awareness-raising and training of advisers. For farmers, the introduction of landscape elements requires additional land area and resources to buy the plants. They also need to take the working time for the care and maintenance or the use of the elements into account.</p>
Possible conflict potential	<p>Through the additional surface area requirement, agreements have to be made with other sectors in order to avoid use conflicts. In addition, the higher amount of work associated with these measures could negatively influence the level of acceptance by farmers.</p>
Actors	<p>Federal and state governments, interest groups (advice, information), farmers, nature conservation associations, tourism associations.</p>
Time horizon	<p>In education as well as the wide-reaching, existing advisory services and further education provision, it is possible in the short term to strengthen the content about the positive impacts of the measures. Research, in particular scientific accompanying research and evaluation, can also be started in the short term.</p>

2.1.2.10 PRESERVATION OF EXISTING PASTURES AND REVITALISATION OF ABANDONED PASTURES

Objective	<p>Maintenance of the protective and recovery function, of feed production and the targeted revitalisation and rehabilitation of abandoned pastures under consideration of nature conservation aspects.</p>
Significance	<p>The functions of alpine pastures are manifold: firstly, they are an important resource for fodder production and contribute to improvement of animal health. Secondly, their protection and recreational functions are becoming increasingly significant. Abandoned alpine pastures mean an increased avalanche and landslide risk, since the vegetation cover only remains stable, when the plant community that is adapted to the grazing of animals is not changed. A well cared-for alpine pasture also improves the water retention capacity, which is especially significant given increasing heavy rain events.</p> <p>As a result of warming due to climatic change the tree-line is moving higher, which reduces the overlying living space. This reduction increases the pressure on alpine farming.</p> <p>For the preservation of alpine pastures and their productive function in the future, their cultivation with consideration of nature conservation is significant, in order to avoid or reverse weed infestation and scrub encroachment. Through the preparation of an alpine pasture revitalisation plan, landscape-ecological and tourism-related aspects that are relevant for climate change adaptation could be taken into consideration. In order to take advantage of possible synergies, a stronger inclusion of “soft tourism” in alpine farming should be considered.</p>

Connection to other sectors**Connection to existing instruments**

The heat stress experienced by livestock in lower altitude regions as a result of increasing temperatures could also make alpine farming attractive.

Alpine pastures are at a high risk of being abandoned and this can only be avoided through the combined effects of support and measures (e.g. Direct Payment supplementary compensation). Their preservation is recognized as a societal goal (Natura 2000, Austrian national strategy plan LE 07-13 – Austrian Programme for Rural Development 2014-20 – and the Alpine Convention). Only a sustainable cultivation of the alpine pastures with livestock can maintain the surfaces in the desired condition and prevent dangers such as increased surface flows, snow slides, landslides, slope erosion¹⁸ or changes of the composition of the vegetation (with negative consequences for biodiversity). Sustainable alpine pasture management is anchored in the Austrian Agricultural Environment Programme (ÖPUL) through prescribed requirements regarding plant protection, livestock numbers, supplementary feed and fertilisation.

Above all there are connections to the ecosystems/biodiversity, tourism and protection against natural hazards sectors.

For sustainable management of alpine pastures support is available, such as the coupled premium within the Direct Payments framework for bringing cattle up to mountain pastures, pasturing and shepherding premiums, credits for agricultural investments etc. The measure “Modernising agricultural operations“ includes, for example, the support of investments for buildings in the alpine pastures including support of construction of technical equipment necessary for alpine cultivation (e.g. for energy and water supply, fencing, protective measures for the buildings and paths/roads), as well as measures for revitalisation of the alpine pastures.

The Alpine Convention – an international agreement to protect the Alps – views alpine management as an important component for securing various societal interests in the alpine region. In the implementation protocol the maintenance and support of site-appropriate and environmentally friendly mountain agriculture are the most important goals.

A register of alpine pastures is kept by the inspectorate of the federal state governments. It contains each alpine pasture and their most important characteristics, such as the name of the pasture, the persons responsible, the distribution of crop species, the use, the altitude, personnel, livestock numbers, soil type, rights and expenses, credit standing, grazing period and number of buildings.

State of implementation

With ALP Austria (programme to secure and develop the alpine cultural landscape) the basis for political decisions was established. The programme provides strategies and options for Austrian alpine pastures and their management. This should ensure a sustainable, financially viable, ecological and socially acceptable management of the alpine pastures.

The educational initiative on a multifunctional alpine pasture management provides a comprehensive further education programme. Results from further projects, such as “Biodiversity monitoring in alpine pastures” or “Alm Waal” should contribute further to a sustainable alpine pasture management.

Recommended further steps

- Maintenance of existing alpine pasture management, as well as site-suited and ecologically compatible revitalisation of abandoned pastures to ensure a sustainable, financially viable, environmentally friendly and socially acceptable management of alpine pastures;

¹⁸ In particular, erosion on alpine pastures in which there is slipping of large meadow areas together with the root horizon, especially after long periods of rain.

Possible resource requirements	<ul style="list-style-type: none"> – Research on the possible impacts of climatic change on alpine pasture management on the basis of existing data and projects (e.g., B. Alp-Austria¹⁹, EVALM²⁰); – Development of a revitalisation plan for alpine pastures that considers aspects relevant to climatic change adaptation, landscape ecology and tourism; – Advisory activities and, if necessary, provision of incentives to support alpine pasture management; – Stronger inclusion of soft tourism in alpine pasture management.
Possible conflict potential	In particular, resources are required for relevant research.
Actors	The implementation of the measures can lead to both synergies and conflicts with sectors such as nature conservation, tourism and forestry. Federal and state governments (funding of pasture management), interest groups, Almwirtschaft Österreich (Austrian Pasture Management), potentially tourism associations, farmers.
Time horizon	The time for implementation of the measures depends on the current state of the alpine pastures as well as the intensity of use – here it is particularly important to consider the high sensitivity of these regions.

2.1.2.11 OPTIMISATION OF GREENHOUSE CULTIVATION IN TERMS OF ENERGY, WATER AND COOLING SUPPLY STRATEGIES

Objective	Efficiency improvements in energy and water consumption in greenhouse and plastic-sheet cultivation, in particular with regard to increasing heat stress in the summer and potentially more frequent natural disasters.
Significance	<p>Vegetable cultivation in greenhouses and plastic tunnels is a particular area of activity in agriculture and should be considered as a special category. This branch is highly productive and increasingly affected by climatic change – in particular with respect to energy supply and extreme events. Hail and storms in particular can give rise to significant damages. The winter storms Paula and Emma damaged more than 150,000 m² of greenhouse and tunnel area (BMLFUW 2009a).</p> <p>The increasing trend of more hot spells in some regions will lead to over-heating, above all in greenhouses that are difficult to regulate. This can be mitigated through measures for sufficient ventilation and modern installations for shading. Air conditioning systems are not discussed, because a certain level of yield loss due to heat in the summer months is accepted.</p> <p>The timing and amount of irrigation have to be adapted to the changing conditions in order to increase efficiency. Modern technological developments with consideration of the largest possible soil protection are necessary for sustainable water use. These days, closed cultivation systems are widespread and for some of them rainwater is already used for irrigation.</p> <p>The combination of higher temperatures on average and increased watering creates a warm, moist microclimate, which is advantageous for the multiplication of pests and diseases. Humidity above 70% also leads to a noticeable reduction of the quality of the product. As a result of the high surface productivity, there is a high potential for damage.</p>

¹⁹ Link: <http://www.almwirtschaft.com/alp-austria.html>

²⁰ Link:

http://www.almwirtschaft.com/images/stories/neuigkeiten/2012/der_alm_und_bergbauer_inhaltsverzeichnis/Evaluierung_zur_Laendlichen_Entwicklung_im_Bereich_der_Almen.pdf

	<p>Use of waste heat from industrial facilities can contribute to a reduction of environmental pressures and to energy cost savings. During hot spells the use of alternative cooling technologies is to be preferred in order to avoid additional CO₂ emissions. A further reduction of CO₂ emissions can be achieved through recovery of CO₂ for fertiliser.</p> <p>New production areas can be located in the future in locations with a temporal heat surplus, for example as a by-product from industrial facilities or the availability of alternative energy sources.</p> <p>A further greening of the production can make a significant contribution to Austrian environmental performance.</p>
Connection to other sectors	There are connections to the following sectors: energy, water resources and water management, construction and housing, spatial planning and urban green areas.
Connection to existing instruments	European building standards cover the building of greenhouses. In the current Austrian programme for rural development, investments for the building of greenhouses, including the facilities and technical equipment for production, storage and sale, are supported.
State of implementation	Currently, heating constitutes, next to watering and regulation of the greenhouse climate, the largest cost factor. In the past, only isolated measures to improve the thermal efficiency, such as energy use reduction through changing the heating system or adding thermal insulation, were carried out. A nation-wide implementation could not be achieved. The use of renewable energy is currently rare as is the use of surface water from recent precipitation and groundwater.
Recommended further steps	<ul style="list-style-type: none"> – Collection of basic data on the current state of greenhouse cultivation and assessment of the development potential; – Creation of incentives to increase thermal efficiency; – Promotion of the use of renewable energy; – Promotion of the use of rainwater, e.g. through construction of water storage facilities under greenhouses; – Adaptation of the investment guidelines to meet the requirements of modern, environmentally friendly operations; – Research on technological development of greenhouses towards low-energy greenhouses, to optimise the regulation of greenhouse climate, as well as heating and irrigation technologies and fertilisation measures; – Development of alternative cooling technologies to reduce CO₂ emissions; – Awareness-raising among stakeholders; – Orientation of new production facilities towards the availability of alternative energy sources.
Possible resource requirements	To increase the thermal efficiency together with a noticeable reduction of energy use, financial support for research is necessary. For a nationwide implementation of the research results, incentives must be created within the framework of existing support programmes, for example through investment support.
Possible conflict potential	To keep transport distances low, the creation of closed production areas with optimal transport connections at a tolerable distance from urban areas is appropriate. This can lead to conflicts between land use for settlements or recreation and land use for horticultural production.
Actors	Federal and state governments, academic and non-academic research institutions, interest groups, Austrian Vegetable Growers Association, municipalities, producer associations, industry, farm managers.
Time horizon	In particular, research activities to increase thermal efficiency could be started in the short to medium term.

2.1.2.12 PROMOTION OF ANIMAL WELFARE AND ANIMAL HEALTH UNDER CHANGING CLIMATIC CONDITIONS

Objective	Expansion of knowledge and evaluation of the effects of climate change on animal health, and the development of preventative measures and, if need be, necessary veterinary measures as a basis for decision-making of authorities and farmers.
Significance	<p>Direct and indirect impacts of climatic change will affect farm animal health. An increase of heat stress and new infectious diseases with related production losses are to be expected. Increasing heat stress can strain the immune system of the animals and thereby increase the susceptibility to pathogens and parasites. In the case of dairy cattle, high temperatures lead to an increased water uptake and a decreased fodder uptake, which have a negative impact on milk production. With higher temperatures, farm animals need sufficient cooling possibilities – in particular pigs, since they cannot sweat. In the case of poultry, heat stress leads to a reduction of egg size and production. Therefore, water supply will gain importance in animal husbandry.</p> <p>Changes of the ingredients of fodder crops resulting from climatic change can require changes of the feed ration. An adapted management of feeding could be economically relevant, if feed has to be bought during hot summer months.</p> <p>Reliable statements about the emergence of new infectious diseases for farm animals cannot be made given the current state of knowledge. However, it is assumed that especially pathogens that are transferred by intermediate hosts such as mosquitoes will increasingly spread.</p> <p>The integration and intensification of monitoring systems (including already existing systems) and the monitoring of animal diseases must guarantee the early recognition of animal disease epidemics.</p> <p>These recommendations for action are closely connected to Chapter 2.1.2.13 Consideration of the future requirements for the cooling of stables due to increasing thermal stress.</p>
Connection to other sectors	There is a close connection above all to the health sector.
Connection to existing instruments	<p>The EU Animal Health Strategy (2007-2013) aims to protect public health, ensure food quality, protect animal health through the prevention of epidemics, as well as protect animals.</p> <p>The Commission has already set up a task force of epidemiological experts for the monitoring of animal health epidemics (TFADS), which should provide information about improvements of the existing monitoring system and new monitoring strategies (for example, for West Nile Fever). To assess the risks of the emergence of vector-borne diseases connected with weather events and climatic change, weather forecasts and analyses must be included in the early warning systems.</p> <p>The Austrian animal protection law governs key animal protection issues across the entire country. For agricultural animal husbandry there is a relevant animal husbandry ordinance.</p> <p>The veterinary administrations of the federal states are responsible for the implementation of all affairs that arise from Austrian animal protection law and related regulations (except criminal matters). This provides a uniform regulatory framework for agricultural livestock for the whole country, which successively replaces the laws and other agreements of the federal states. All existing stables and other facilities have to adhere to the Federal law by January 2020. All facilities built since January 1st 2005 must also adhere to the legal requirements without a transition period.</p> <p>The regulations for animal husbandry in organic agriculture go further. The guiding principle is a species-appropriate animal husbandry, which is monitored through the “animal – appropriateness index”. In accordance with the EU regulation for organic animal husbandry, for all animal species, a species-appropriate husbandry concerns ventilation, light requirements and the need for space and comfort. Thus, sufficient</p>

State of implementation

space must be foreseen, so that every animal has the necessary freedom to move and the natural social behaviour can develop.

The animal health regulation of 2009 governs the recognition and operation of animal health services in the areas of the animal medication law, as well as the rights and responsibilities of the participating veterinarians and farmers.

Current crisis plans for combating animal health epidemics are available for all relevant epidemics, but also for diseases were not found so far in Austria, and can be viewed on the website of the Federal Ministry for Labour, Social Affairs, Health and Consumer Protection (BMGF²¹). These plans should support the fastest possible response to a crisis situation through making use of all possibilities and resources of the federal government and the federal states to eliminate the source of the epidemic and to prevent a further spreading. The plans also include information for farmers, veterinary doctors related sectors and the general public.

In the Austrian Agricultural Environment Programme (ÖPUL), pasturing of animals is supported, which supports animal health and can contribute to reducing emissions.

One of the three key goals of the EU research programme Horizon 2020 is to find solutions to societal challenges. The programme supports research and innovation that should lead to concrete implementation of measures. One of the seven thematic areas covers food security, sustainable agriculture and forestry and organic agriculture. The projects supported in this area should contribute to the provision of safe and high quality food and other biological products. Projects along the entire production chain for food, including primary production, are supported²².

First suggestions for the evaluation of the impact of climatic change on animal health and productivity were developed in a StartClim project (Hörtenhuber & Zollitsch 2015).

Recommended further steps

- Further improvement of knowledge with respect to diseases that must not be reported, which could become more significant with climatic change;
- Further development and optimisation of diagnostics in cooperation with national and international reference laboratories;
- Use of (regional) climate scenarios in particular for epidemiological clarification;
- Use of regional climate scenarios for better estimation of the risk of epidemics; ;
- Where necessary, extend the existing monitoring systems for new disease vectors and infectious diseases;
- Review and where necessary establishment of a nationwide animal protection competency centre based on existing structures. This could be done within the context of building a European network of centres;
- Awareness-raising among all stakeholders with respect to their responsibility in general for animal health, food security and human health;
- Rapid information exchange and close cooperation with veterinary agencies of EU Member States, in order to react promptly to animal health crises and combat them;
- Development of an adapted management of feeding;
- Inclusion of weather forecasts and analyses in early warning systems to evaluate the risks of emergence of vector-borne diseases;
- Support of particularly species-appropriate animal husbandry and further sensibilisation of consumers regarding the high Austrian animal protection standards.

Possible resource requirements

For these recommended actions, financial support from existing research programmes would be necessary. The involved actors and stakeholders already have a strong network and sufficient human resources are available. For awareness-raising and

²¹ Link:

<https://www.verbrauchergesundheit.gv.at/tiere/krisenplaene/krisenplaene.html>

²² Link: further information on Horizon2020: <https://www.ffg.at/europa/h2020>

	increased attention to this topic in advisory services, as well as the continuous integration of the topic in education and training, adequate resources must be planned. Currently, significant resources are already being invested in disease- and epidemic-screening and precautionary measures.
Possible conflict potential	The implementation of the recommended measures can lead to increased demands in animal husbandry.
Actors	Federal and state governments, research, veterinary authorities, AGES, interest groups, HBLFA Raumberg-Gumpenstein, farmers, Austrian Animal Health Service (TGD), and animal health services of the federal states.
Time horizon	Research initiatives and measures for awareness-raising can be started in the short term.

2.1.2.13 CONSIDERATION OF THE FUTURE REQUIREMENTS FOR THE COOLING OF STABLES DUE TO INCREASING THERMAL STRESS

Objective	Reduction of thermal stress on farm animals, appropriate and stress-free livestock rearing, and reduction of harmful pollutants in stables.
Significance	<p>Meteorological extremes such as temperature, precipitation, storms, global radiation, UV-radiation, ozone and dust will lead to new challenges for animal husbandry. Measures for ventilation, air conditioning, UV-protection and dust protection will be necessary. Reduced precipitation amounts and a lower air humidity could lead to a higher dust exposure and thus to the spread of microorganisms.</p> <p>Poultry are particularly sensitive to heat stress, since they have a low capacity to regulate temperature. Rising temperature, a long period of sunshine and high radiation intensity reduce the fodder uptake of cows. Depending on the husbandry system, the milk productivity and health of the animals are negatively affected by high temperatures (Auer et al. 2015). Pigs also respond to heat with a reduced fodder uptake and the fodder is also converted less efficiently. Further, an increased temperature in combination with stronger pressures can lead to reduced fertility.</p> <p>Corresponding technical adaptations of animal shelters will be required, in order to avoid stress, possibly reduced growth rates or losses of animals, as well as possible spreading of diseases and pathogens. In this case, it is particularly important to support operations that conform to the goals of climate change mitigation. The necessary air conditioning and ventilation systems must be as fail-proof as possible (technically elaborate air-conditioned husbandry systems are vulnerable to longer loss of electricity or technical defects). The energy required for ventilation can be provided by renewable energy. Solar energy can also be used for the cooling of animal husbandry installations (solar cooling). Through the use of appropriate building and insulation materials, the heat loss in winter and overheating in summer can be avoided and in this way both climate change mitigation and adaptation can be achieved. Open husbandry systems with free movement possibilities for the livestock should provide the highest safety. A challenge for the implementation is above all the expected high investment costs.</p> <p>Construction measures must be carried out with attention to providing safety from storm damages, especially hail and windstorms (more massive construction, cold roofs etc.).</p> <p>Animal protection must be taken into account for all measures.</p> <p>For some of the potential problems (reduced growth rates, heat stress etc.) there are only a few research results.</p>
Connection to other sectors	<p>These recommendations for action are closely connected to animal protection and animal health (see Chapter 2.1.2.12 Promotion of animal welfare and animal health under changing climatic conditions).</p> <p>There is a close connection to the health, construction and housing, energy and economy sectors.</p>
Connection to existing instruments	The federal law on the protection of animals regulates key animal protection legal requirements uniformly across the country (see also Chapter 2.1.2.12).

<p>State of implementation</p>	<p>The regulations for animal husbandry in organic agriculture go further. The guiding principle is species-appropriate husbandry, which is monitored via the “animal appropriateness” index. In accordance with the EU regulation for organic animal husbandry, all animals should have species-appropriate conditions with respect to ventilation, light requirements, space and comfort needs. Accordingly, sufficient space must be provided so that each animal has the necessary freedom of movement and can develop its own natural social behaviour.</p> <p>Further connections are to the laws and regulations of the federal states governing building construction. The building sector is subject to the laws of the federal states.</p> <p>Spatial planning is subject to regulations of the federal government, the federal states and the municipalities. All spatial planning issues that are not explicitly accorded to the federal government are the responsibility of the federal states. The laws of the federal states provide the legal basis for local spatial planning.</p> <p>To carry out the assessment and classification of standard husbandry systems and installations, a specialised department for species-appropriate husbandry and animal protection was established in accordance with the animal protection law. This should contribute to increased legal certainty in animal husbandry and facilitate the implementation of animal protection.</p>
<p>Recommended further steps</p>	<ul style="list-style-type: none"> – Review and possible adaptation of building regulations for animal husbandry; – Further development of recommendations for action for buildings for animal husbandry, feeding, animal husbandry management, liquid manure management; – Support for awareness-raising and advisory services for farmers; – Basic research on potential hazards (poor growth rates, stress); – Scientific cooperation with testing and introduction of new animal husbandry systems; – Provision of incentives for systems that conform to the goal of climate change mitigation; – Secure support for investment costs; – Construction of protection against failure of ventilation and air-conditioning systems; – Increased use of renewable energy sources in ventilation and air-conditioning systems.
<p>Possible resource requirements</p>	<p>Possible additional resources for research should be covered in existing research programmes through a stronger focus on political objectives regarding climatic change. For awareness-raising and advisory services within the framework of existing programmes for further education and training, additional resources could be necessary. Where necessary, adaptation or new construction of animal husbandry buildings can be supported by existing programmes and possibly by investment support.</p>
<p>Possible conflict potential</p>	<p>The implementation of the recommendations for action can lead to higher costs for the construction of animal husbandry buildings.</p>
<p>Actors</p>	<p>Federal and state governments, interest groups (funding for stable adjustments), farmers, academic and non-academic research institutions (in particular, HBLFA Raumberg-Gumpenstein, BOKU, VMU), municipalities.</p>
<p>Time horizon</p>	<p>Research and measures for awareness-raising can start immediately.</p>

2.1.2.14 OPTIMISATION OF ADAPTATION AND COMBAT STRATEGIES FOR NEW DISEASES AND PESTS

<p>Objective</p>	<p>Further optimisation and, if needed, extension of existing warning systems, improvement of information and data transfer (e.g., between meteorological units, science, and farmers), and nationwide monitoring of potentially harmful organisms;</p>
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Significance

Designation of particularly endangered areas and the development and adjustment of decision-making aids for measures.

The increasing globalisation of trade favours the introduction, further expansion and establishment of harmful organisms for plants, plant products, or livestock, also in regions in which they were not found so far. Under changed climatic conditions, these new invasive harmful organisms can become serious threats for agricultural and horticultural production in Austria.

Efficient warning systems and a nationwide monitoring system for harmful organisms, as well as corresponding decision support allow the timely implementation of appropriate measures and reduce or avoid yield reduction or even harvest losses. An improvement of the monitoring systems would include tracking changes of the emergence of various harmful organisms.

Connection to other sectors

There are connections in particular to the health and ecosystems/biodiversity sectors.

Connection to existing instruments

There are connections to the warning services of the agricultural chambers of the federal states and the Austrian Agency for Health and Food Safety (AGES), the weather service of the Austrian Hail Insurance company, storm warning from the Meteorological Office etc. and regulations regarding monitoring (e.g., Monitoring Programme Regulation 2010).

State of implementation

Warning and monitoring systems are available but there is a need to check whether they can be used under changed climatic conditions and, if necessary they need to be adapted and optimised.

Examples are the vine protection service²³ and the plant protection warning services of the agricultural chamber²⁴.

Recommended further steps

- Study and development of adapted legal instruments where necessary;
- Support and expansion of existing warning services and monitoring systems;
- Intensification of the cooperation between those persons involved in agricultural advisory services, research, business and agriculture;
- Designation of areas particularly endangered by harmful organisms;
- Elaboration of appropriate forms or adaptation of forms of cultivation (plant protection, selection of species, crop rotation etc.).

Possible resource requirements

Sufficient resources are needed for research and the expansion and improvement of warning services and monitoring systems, as well as for advisory services for farmers.

Possible conflict potential

With respect to the selection of the type and method of pest control, conflicts with nature conservation can arise.

Actors

Federal and state governments, academic and non-academic research institutions, interest groups, AGES, HBLFA Raumberg-Gumpenstein, insurers, farmers.

Time horizon

The research activities that are needed could be started in the short term.

²³ Link: <https://rebschutzdienst.at/>

²⁴ Link: <https://warndienst.lko.at/>

2.2 FORESTRY SECTOR

2.2.1 OVERARCHING OBJECTIVE OF THE SECTOR

Overarching objective: Maintenance of the multifunctional effects of the forest through sustainable cultivation adapted to climatic changes.

2.2.2 RECOMMENDED ACTIONS FOR THE FORESTRY SECTOR

GENERAL ACTION PRINCIPLES IN THE FORESTRY SECTOR

- In forestry in particular, as a result of the long rotation intervals²⁵ (in commercial forests mostly 80 to about 120 years) considerably long lead times must be taken into account before measures take effect. Based on well-founded analyses of the impacts of climatic change, appropriate forest cultivation strategies must be established for timely adaptation.
- Rapid climatic changes have a direct effect on the vitality and stability of the forest. Since it is not possible to adapt the forests to hypothetical changes in a tailor-made way, it is necessary to support the natural self-regulation mechanisms and thus the adaptive capacity of the forests. Measures with that goal are considered to be robust.
- The departure from homogenous towards heterogeneous forest structures (increased diversity of species, structure and inventory) is an important element of adaptation strategies, since homogenous structures are found to be more vulnerable to disturbances. With a heterogeneous structure an increased stability is found in most cases (e.g. each tree species reacts differently to changes of temperature and precipitation as a result of its own specific ecophysiological characteristics and extensive damage due to bark beetles is usually strongly correlated with homogenous tree assemblies). There are, however, also natural pure stands in Austria and here the respective physiological and genetic spectrum of possibilities should be considered and used for adaptation to climatic change. On the other hand, studies show that specific functions of the forest habitat (protection, timber supply, welfare and recreation functions) are tied to particular places and stand criteria, which are not always correlated with a heterogeneous forest structure. It is therefore necessary to take a regional, functional and location-appropriate perspective.
- The forest and in particular the forest soil are by far the largest carbon sink in Austria. Climatic change can have an impact on the carbon stored in forests. It is therefore important to develop a connected set of measures that contribute to climate change mitigation and to stable, multifunctional forests.
- For the development of potentially successful adaptation measures, it is useful to take advantage of synergies, in particular with the Austrian Forest Dialogue and the Forest Strategy and other existing instruments (e.g. the federal protection forest platform and the regional protection forest platforms). In addition, existing spatial planning instruments can be used to ensure sufficient forest areas, while taking into account expected land use pressures from other sectors and actor groups.

2.2.2.1 MODIFICATION IN THE SELECTION OF TREE SPECIES AND PROVENANCE INCLUDING TARGETED PROMOTION OF DIVERSITY THROUGH APPROPRIATE SILVICULTURAL MANAGEMENT

Objective

Increase of stability and reduction of vulnerability of forest ecosystems to pests and diseases; Increase in diversity at all levels (genetic, species-specific, structural, diversity of habitat, etc.) adapted to the respective site-specific conditions;

²⁵ Time period from the establishment of the stand until the final use through chopping down the trees.

Significance

Increase of stability and reduction of susceptibility to disturbances, e.g., through the timely introduction of rejuvenation measures.

The use / support of location-appropriate tree species and origins should lead to a stable forest ecosystem in the long term. Forest with a rich mix of species and broad genetic amplitude, as well as a diverse stand texture and structure, appear to have the best prerequisites for stability and increased adaptive capacity of forest ecosystems given the expected climatic changes.

Tree species that are not appropriate for the location and monocultures often have a lower tolerance with respect to long-term changes and are more vulnerable to disturbances. Strengthened consideration of the ecological demands and ranges of tree species is very significant for rejuvenation. The search for further appropriate origins of tree species in other countries to complement the local spectrum, considering all ecological aspects, can help to avoid negative effects.

In selecting tree species that are adapted to climatic change, in addition to ecological and economic factors, the possibilities for processing and use (downstream industry) should be considered. Nationwide location mapping can significantly support silvicultural decisions and should be produced – also considering climate scenarios.

In this case, research on forest ecosystems, in particular considering appropriate tree species and their origins, will play a significant role. In addition, corresponding forest advisory capacities in forest administrations and interest groups must be supported.

Forest rejuvenation in harmony with nature leads, on the one hand, to a higher adaptive capacity of the forest stands and on the other hand to natural selection towards populations adapted to climatic change. Over-aged stands are more vulnerable than younger stands to the combination or a rapid succession of unfavourable biotic or abiotic factors. Especially in the case of forests that protect objects, it is important to watch out for over-aging of the forest and its structure, in order to maintain the protective function. Particularly in hilly and mountainous areas, because of the difficult harvesting and recovery conditions, there is low interest in using the forest, while hunting is more attractive. The consequence of this is that there are often excessive numbers of hoofed game animals, which make difficult or prevent the natural rejuvenation. A rejuvenation of the stands can, however, contribute significantly to increasing the stability and reducing risks.

Connection to other sectors

There is a close connection to the protection against natural hazards, disaster management, ecosystems/biodiversity and the economy sectors.

Connection to existing instruments

There are connections to:

- The Forestry Act 1975, which states that the sustainable cultivation, care and protection of the forest are the bases for ensuring its multifunctional effects with respect to use, protection, welfare and recreation;
- The work programme of the Austrian Forestry Programme and the Austrian Forest Strategy 2020+ of May 2016;
- Support and forest monitoring strategies and programmes (Austrian forest inventory, monitoring of the effects of wild animals, intensive monitoring areas (EU programme));
- The forest development plan (WEP) and the forest plan are the most important forestry spatial planning instruments. The forest development plan is a comprehensive presentation and description of all of the forests in Austria. It is the most important basis for the assessment of forest functions. The forest plan is a flexible forestry planning instrument on operational and regional levels;
- (Further) education programmes, journals, advisory programmes and advisory services on origins (www.herkunftsberatung.at).

State of implementation

The support of diversity and rejuvenation is at various stages of implementation. Within the framework of the Austrian forest ecology programme (ÖWÖP), which is the forestry part of the EU support programme LE 2014-2020, measures are prescribed for the maintenance and support of forest biodiversity (including changing stands with an

Recommended further steps	<p>orientation towards natural forest communities). Success and acceptance of this programme will have to be evaluated.</p> <p>The handbook on forestry in Austria on the basis of ecological principles from the Austrian Agricultural Chamber (LK 2013) provides practical guidance. It has been digitalised and is also available as an App that uses GPS to support decisions appropriate for the location.</p> <ul style="list-style-type: none"> – Intensification of forestry advisory services for forest owners with respect to climate resilience of the forest ecosystems (oriented towards the natural forest community, increasing diversity, rejuvenation, reduction of the pressures due to damage by wild animals etc.); – Initiation of and support for a nationwide location mapping to support forestry decision making; – Further development and widespread use of forestry handbooks, in which recommendations are made about suitable tree species in the face of climate change; – Strengthened consideration of forestry genetics, e.g., through the targeted search for drought-resistant origins for the main tree species found in Austria; – Adaptation of the forestry education, further education and advisory programmes through interest groups and forest administrations, further education for the agriculture and forestry teachers; – Awareness-raising within and outside of the sector; – Cooperation in particular with sectors with which there are common potential interests but where conflicts are also possible; – Expansion of research, especially in the areas forest management under changed climatic conditions and forest genetics; – Ensuring the rejuvenation of protective forests through ecologically appropriate management of wild animals.
Possible resource requirements	<p>The dynamics of implementation depend <i>inter alia</i> on incentives and support. The resources required will differ according to the measure but some of the costs can be covered by reallocation of resources. In the short term, increased resources and additional qualified personnel will be needed for effective implementation.</p>
Possible conflict potential	<p>The measures must be agreed with actors involved in nature protection, tourism, alpine pasture agriculture and hunting.</p>
Actors	<p>Forest owners, interest groups, academic and non-academic research institutions, federal and state governments, EU (responsibility lies with all those listed).</p>
Time Horizon	<p>Recommendations for forest owners can be disseminated in a targeted way in the short term through advisory services and journals. Research can start immediately and in the short term. Forestry measures can be implemented in the short to medium term, their impacts will be seen in the medium to long term (decades).</p>

2.2.2.2 SOIL-FRIENDLY MANAGEMENT

Objective	<p>Preservation of the physical and ecological functions of the soil, in particular in terms of water retention and nutrient supply.</p>
Significance	<p>A soil-conserving management of forests avoids soil compaction, contributes <i>inter alia</i> to stabilisation of nutrient cycles, as well as to erosion prevention, and supports the water storage capacity. These factors increase the stability of forest ecosystems and have positive impacts on carbon storage (climate change mitigation). Furthermore, the maintenance and improvement of soil fertility is supported.</p> <p>The use of machines for wood harvesting can, particularly if attention is not paid to the weather conditions, lead to soil compaction.</p>

Connection to existing instruments

The Forestry Act (1975) includes among others the goal to maintain the forest soil and its productivity. This includes the requirement that the machinery used to remove wood from forests must be planned, constructed and maintained in a way that, while considering technical and economic aspects, the forest soil and vegetation are damaged to the least extent possible and in particular that forest encroachment is not more than exploitation requires.

The Austrian forest programme includes measures that can contribute to soil conservation in forests and thus to a comprehensive forest protection:

- Reduction of introduction of harmful substances,
- Minimisation of nutrient losses and sources of acidification,
- Avoidance of soil compaction and soil damage,
- Soil improvement measures within the framework of a forest cultivation comprehensive plan. Reduction of anthropogenic soil acidification (but not of naturally acid soils, humus conversion and humus development),
- In addition, the preparation of advisory information sheets for forestry – in particular for ecologically sensitive locations – and an intensification of respective advisory services are foreseen,
- Appropriate motivating incentives for these measures are already provided in existing instruments and support mechanisms. Further specific strategies should be integrated in future support programmes.

Connection to other sectors

There are connections above all to the water resources and water management, as well as ecosystems/biodiversity sectors; furthermore to the area of protection from natural hazards.

State of implementation

Soil-conserving forest management is state-of-the art in numerous places; however, further implementation steps are necessary.

The Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW) studied the nutrient sustainability of wood harvesting according to the wood processing method (Englisch & Reiter 2009). This showed that different soil types react differently to nutrient removal through the removal of whole trees. For about half of the forest soil areas the wood processing method did not seriously affect nutrient cycles; on primarily barren mountain soils processing should be avoided.

Recommended further steps

- Implementation of a forest soil monitoring and further development in the direction of a nationwide soil monitoring system;
- Further development of soil-conserving, cost-effective wood-harvesting systems;
- Optimisation of the organisation of wood-harvesting operations;
- Promote location-mapping as a basis for the optimisation of wood-harvesting methods;
- Further research on soil compaction due to wood-harvesting machinery;
- Selection of tree species that improve the soil;
- Support for soil restoration in order to improve the condition of degraded soils to the extent that they can be used sustainably without fertilisation (ARGE Waldveredelung und Flurholzanbau 2001);
- Awareness-raising and optimisation of education and further education (especially the employees in wood-harvesting companies), as well as forestry advisory services;
- Development and use of criteria that test the practicality of fine and coarse developments (building of forest roads) with respect to soil and nature protection.

Possible resource requirements

For the development and implementation of soil-conserving wood-harvesting systems (research, felling companies) there is a need for resources/investment. Additional incentives are necessary, for example, for use of cable cranes in steeper areas.

Possible conflict potential

The implementation of the measures can lead to higher wood-harvesting costs.

Actors	Forest owners, logging companies, public agencies, interest groups, research institutions, federal and state governments, EU, water management authorities, forestry workers, municipalities, leaseholders.
Time horizon	The measures can be implemented in the short term (up to 10 years) or medium term (a few decades).

2.2.2.3 REDUCTION OF DAMAGE CAUSED BY WILDLIFE

Objective	Reduced damage caused by game animals in order to safeguard rejuvenation and stock stability.
Significance	<p>Damage to the forests as a result of hooved wild animals can arise, for example, through browsing of shoots and young trees or through removal of bark. In addition cattle can also cause local damage through grazing or trampling. Not every impairment of the vegetation by wild animals or livestock can be seen as damage.</p> <p>Above a given level of intensity, the impairment can lead to serious ecological and economic damages. There are multiple reasons for this. In addition to the overpopulation for hunting purposes, there is also a lack of consideration of the needs of the wild animals in forest management (extensive one-age-cohort forests without corresponding grazing supply), as well as disturbance and displacement of wild animals through tourism and recreation, settlements or transport. Through the increasing utilisation of nature by people, the habitat for wild animals becomes increasingly narrowed down. This also leads, when the alternatives are not available, to regional overpopulation of wild animals (BMLFUW 2011b).</p> <p>A higher browsing by game and trampling endanger the regeneration capacity (rejuvenation) and stability of forest ecosystems. The increasing significance of mixed stands and the rejuvenation of overaged stands require a strengthened avoidance of browsing by game. Browsing damage to certain preferred tree species (deciduous trees, firs) leads to the segregation of (natural) forest communities, to the loss of ecologically valuable tree species and strong rejuvenation deficits in particular in protective forests.</p> <p>The report on damage due to wild animals (BMLFUW 2015f) reports a continued problematical impact of hooved game on forest vegetation: in almost two-thirds of the districts of Austria, more than half of the area shows strong impacts of game. The trend is increasing compared to the survey of 2007 – 2009.</p>
Connection to other sectors	There is a connection to the ecosystems/biodiversity and protection against natural hazards sectors.
Connection to existing instruments	<p>There is a natural close connection to hunting laws of the federal states, as well as to spatial planning (game-ecological spatial planning).</p> <p>The federal government, federal states, interest groups of the forest owners and hunters have jointly established a monitoring system for the impact of game (WEM). The goal is to collect data about the intensity and development of game impacts.</p> <p>The work programme of the Austrian Forest Programme includes a measure on interdisciplinary awareness-raising among those with permits to hunt and forest owners. A further instrument is the training of hunters.</p> <p>The Declaration of Mariazell signed in 2012 by high-ranking representatives of the forestry and hunting sectors has the most urgent goal, based on the knowledge gained through the monitoring of game impacts (WEM) and the Austrian Forest Inventory, to regulate the numbers of game, to the extent that the rejuvenation of the tree species that typically grow in a location can achieve their natural potential.</p>
State of implementation	The monitoring system for the impact of game (WEM), coordinated by the Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW), has been used for three survey periods with three-year intervals. The results of the survey between 2010 and 2012 shows a continued upward trend of game impacts in forests (see

Recommended further steps	<p>above). According to the progress report (BMLFUW, 2015a) almost 60% of the forest area is in need of rejuvenation.</p> <ul style="list-style-type: none"> – Coordination of the forestry sector with the hunting management and with the inclusion of all affected users of land (agriculture, tourism, transport, spatial planning); – Intensified and ambitious continuation of the dialogue between representatives from forestry and hunting within the framework of the Mariazell declaration; – Support for and implementation of game-ecological spatial planning in all federal states; – Adjustment of the density of game to the available habitat through strict implementation of federal state game laws or through adoption of corresponding federal state legal requirements for hunting; – Strengthened consideration of the problem of damage by game in the education / training of hunters; – Awareness-raising and education of forest owners, hunters and the public (in schools); – Development of guidelines to limit the feeding of the wild animals, which allows undisturbed overwintering in appropriate habitats, give priority to the natural food supply and reduce damages as far as possible; – Give priority to measures for protective forests.
Possible resource requirements	<p>Through the implementation of the recommendations, cost savings from the perspective of hunting and food provision can be expected in the medium to long term through renovation of (protective) forests, rejuvenation (protection against browsing) and building of protective barriers. Financial losses through loss of growth and value can be significantly reduced.</p>
Possible conflict potential	<p>Through the implementation of the measures, conflicts with the hunting community and possibly with animal protection can be expected.</p>
Actors	<p>Hunters, forest owners, federal states (laws pertaining to hunting and spatial planning), federal government, interest groups of all affected land use sectors.</p>
Time horizon	<p>The proposed further steps for implementation can be tackled in the short to medium term. The knowledge needed for rapid implementation of the measures is available.</p>

2.2.2.4 DEVELOPMENT OF AN ADVISORY SERVICE FOR FOREST OWNERS AS CONCERNS ADAPTATION OF FOREST TO CLIMATE CHANGE

Objective	<p>Improvements in consulting, training, and further education of forest owners taking into account latest research results.</p>
Significance	<p>Almost three-quarters of the Austrian forest are privately owned and are managed by private owners. Only about 1% of the operations have a forest area of 200 ha or more. Given this structure of ownership, advisory services are needed to disseminate more knowledge and experience, as well as information about research results. In addition, the advisory services relating to local conditions and forestry measures to increase the resilience of forest ecosystems should also lead to the development of a databank with good practice examples.</p>
Connection to other sectors	<p>Basically the recommendations for action have positive effects for all other sectors. There are connections in particular to the ecosystems/biodiversity sector.</p>
Connection to existing instruments	<p>There are connections to the Work Programme of the Austrian Forestry Programme and the Austrian Forest Strategy 2020+ (BMLFUW 2016c).</p> <p>There is a good system for forest education and further education as well as advisory services (Agricultural Chambers, Austrian Research and Education Centre for Forests, Natural Hazards and Landscape (BFW), Association of Forest Owners, forest education centres).</p>

State of implementation	<p>Relevant content from research results are already included in education and training. A coordinated Austrian strategy with defined implementation steps for the range of topics related to climatic change and forests to be covered in education and awareness-raising is not available.</p> <p>Brochures about selection of tree species are available in Upper Austria for the foothills of the Alps, the mountains and the Mühlviertel.</p>
Recommended further steps	<ul style="list-style-type: none"> – Development of a coordinated forest/climatic change education strategy at federal and state levels (e.g. within the framework of the forest dialogue); – Further development of adapted concepts and advisory services considering new and validated research results and specific issues; – Support for further education of teaching and advisory personnel; – Intensification of the cooperation between research and practice.
Possible resource requirements	<p>Research needs the corresponding funding in order to obtain relevant knowledge to be integrated into education and advisory systems. Forest owners would need more time and have additional costs for further education and making use of advisory services.</p>
Possible conflict potential	<p>Possible conflicts could arise with nature protection regarding the content of adapted education and advisory services.</p>
Actors	<p>Federal government, forest authorities, Chamber of Agriculture and other advisory institutions, academic and non-academic research institutions.</p>
Time horizon	<p>Development of relevant concepts and the adaptation of advisory instruments have already started and can be adapted in the short term when validated research results become available.</p>

2.2.2.5 ADJUSTMENT AND IMPROVEMENT OF CRISIS AND DISASTER MANAGEMENT

Objective	<p>Mitigation of damage from harmful events such as windfalls or bark beetle disasters.</p>
Significance	<p>Biotic and abiotic disturbances, above all as a result of pests and storms, are already a significant factor in forestry. It can be assumed that disturbances will increase as a result of climatic change. This requires an improved crisis and disaster management, consisting of multiple integrative single measures. This includes the development of specific action plans and the introduction and further development of efficient warning and information systems to prepare for extreme events. Successful disaster management requires an evaluation of the forest exploitation systems and forest protection routines. Furthermore, when damage occurs, transport, storage and processing should be assured. In particular, temporary wet storage areas could become more important as a complement to permanent wet storage areas, in order to store larger amounts without loss of quality and to minimise financial losses.</p>
Connection to other sectors	<p>There is a close connection to the protection from natural hazards, water resources and water management, ecosystems/biodiversity and business sectors.</p>
Connection to existing instruments	<p>The further development of appropriate management systems should be carried out in close cooperation with the Austrian Forest Programme.</p>
State of implementation	<p>A network of wet storage areas is partially established. Bark beetle monitoring is carried out throughout Austria (www.borkenkaefer.at); a consolidation and the extension to other harmful insect species has not yet taken place.</p>
Recommended further steps	<ul style="list-style-type: none"> – Development of specific action plans, in particular for dealing with bark beetle disasters or after storm damages; – Establishment of efficient warning and information systems and monitoring for harmful insects; for forest protection monitoring, the definition of nationally uniform minimum standards is recommended; – Development of logistic plans in particular for the transport and storage of increased amounts of damaged wood;

	<ul style="list-style-type: none"> – Review of the current wet storage network and where necessary proactive planning and preparation of a sufficiently dense network of temporary wet storage areas or a denser network of wet storage areas for rapid removal and storage that maintains quality of large amounts of wood in the case of disasters as a result of climatic change; – Development of uniform guidelines for legal permits for water for wet storage; – Securing the rapid access to forest areas and rapid removal possibilities in the case of disasters through a sufficiently dense system for removal of wood from the forest; – Further development of knowledge with regard to wood storage (wet storage; covered storage);
Possible resource requirements	Financing of the monitoring systems and provision of resources for research. After review and where necessary, further wet storage areas may be necessary.
Possible conflict potential	Possible conflicts with water management and nature protection could arise because of increased water demand, pollution through wet storage etc.
Actors	Federal and state governments, forest authorities, other authorities (e.g., water authorities), interest groups, forest owners, forestry federations (forest management collaborations (WWGs), forest associations), transport industry, wood and paper industries, EU.
Time horizon	The proposed steps can be taken within 10 years.

2.2.2.6 ESTABLISHMENT OF PREVENTATIVE MEASURES IN VIEW OF THE POTENTIAL INCREASE IN FOREST FIRES

Objective	Development of preventive measures and systems for elaboration or revision of emergency plans to combat forest fires.
Significance	<p>Forest fires change the composition of the vegetation and the forest structure. Fire leads to landscape changes and influences material cycles over the long term. Through the possibly resulting soil erosion there is a danger of a deterioration of soil quality.</p> <p>So far, the Austrian forest ecosystem was not widely threatened by forest fires. As a result of climatic change, however, the risk of forest fires can increase – especially during longer dry periods. An evaluation of the years between 2002 and 2015 shows that forest fires increased significantly. In 2015 the maximum so far (281 events) was recorded (http://fire.boku.ac.at/public/). Besides lightning strikes, most forest fires are due to human negligence. The efficiency of fighting forest fires is strongly dependent on logistical factors (forest roads, personnel and technical resources such as availability of extinguishing agents).</p>
Connection to other sectors	There is a close connection to the sectors of disaster management, protection against, natural hazards, water resources and water management, tourism and the economy.
Connection to existing instruments	Research programmes, such as the Austrian forest research strategy in particular, and other relevant research areas within the Austrian Climate and Energy Fund consider relevant questions.
State of implementation	<p>An information service on forest fire risk is provided by the Austrian meteorological office (ZAMG).</p> <p>The Austrian forest fire databank (Waldbrand-Datenbank) is online since March 2013. Those who are interested can raise questions about forest fire events using an interactive map and can produce statistics and charts. Forest fire events can also be reported quickly and simply.</p>

Recommended further steps	<p>Within the framework of the Austrian Forest Fire Research Initiative (AFFRI²⁶) the frequency, distribution and risk of forest fires in Austria were studied. In a follow-up project, ALP FFIRS²⁷, the development of a fire hazard model should make it possible to predict forest fires better and more exactly. The “Fire Risk and Vulnerability of Austrian Forests under the Impact of Climate Change – FIRIA” project, funded by the Austrian Climate and Energy Fund within the Austrian Climate Research Programme, studies the risk of fire in Austrian forests under current conditions and with future climatic change. Endangered areas were identified with respect to their current and future potential for forest fires in order to estimate possible negative developments and develop response measures.</p> <p>Several Austrian insurance companies offer insurance against forest fires.</p> <ul style="list-style-type: none"> – Evaluation of the existing forest road network with respect to the accessibility in the event of forest fires; harmonisation and revisions of available data; – Specification of differentiated precautionary measures and plans of action; – Public relations and awareness-raising campaigns for forest visitors; – Information and awareness-raising for forest owners; – Production of local maps for various fire risk categories; – Creation of fire ponds in particularly sensitive regions; – International cooperation (e.g. European Forest Fire Information System (EFFIS)).
Possible resource requirements	The research needs adequate funding in order to obtain relevant knowledge to be used in risk maps, early warning systems and action plans.
Possible conflict potential	During extended drought periods conflicts over water resources can arise.
Actors	Federal and state governments, municipalities, interest groups, forest owners, forest management collaborations (WWGs), forest associations, academic and non-academic research institutions, EU.
Time horizon	Research on relevant questions could be commissioned in the short term. The results can be used in the medium to long term, for instance in risk maps and in corresponding early warning systems and action plans, regulation of the behaviour of forest users etc.

2.2.2.7 FOREST POLLUTION CONTROL – INTEGRATED FOREST INVENTORY AND MONITORING OF IMMISSIONS

Objective	Nationwide inventory of Austrian forests by combining the forest inventory with remote sensing methods (laser scanning, multi-spectral satellite imagery) for enhanced system knowledge, and the establishment of an immissions-monitoring system.
Significance	Since 1961, the Austrian forest inventory carries out a systematic survey of the Austrian forests using a sampling network. In this way, on the one hand the wood and forest stand resources are determined, while on the other hand the condition and changes in the forest ecosystem are described. The results of the forest inventory provide the basis for forest and environmental policy decisions and are used for numerous scientific studies. Beginning in 2016, the forest inventory was changed to a permanent survey. Since the end of 2018, the annual results of the forest inventory are published by the Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW). Through the permanent survey it is possible to respond more quickly to questions and problems. The advantages are in the better spatial density of information,

²⁶ Link: <http://www.wabo.boku.ac.at/waldbau/forschung/fachgebiete/bewirtschaftungskonzepte/waldbewirtschaftung-und-klimaaenderung/waldbrand/waldbrand-forschung/affri/>

²⁷ Link: <http://www.alpffirs.eu/>

	<p>annual results, as well as nationwide and regional maps for forest and environmental policy.</p> <p>Air pollution and deposition measurements²⁸ show that forests are still polluted despite a reduction in emissions. In Austria the forests are affected above all by ozone, nitrogen oxide, sulphur dioxide, nitrogen or acid and sulphur deposition, as well as locally hydrogen fluoride, ammonia, heavy metals and dust. For emissions monitoring, it is necessary to evaluate the existing monitoring networks as the basis for establishing a comprehensive monitoring system. The current legal regulations do not provide a comprehensive protection of forest vegetation against emissions. No regulation considers the synergetic effects or the fact that concentrations that are below the toxic level can have indirect negative impacts (BMLFUW 2006a).</p> <p>Moreover, sound scientific threshold values to protect the forest ecosystem are not available.</p>
Connection to other sectors	There are connections to ecosystems/biodiversity and protection against natural hazards.
Connection to existing instruments	<p>Coordination with the goals of the work programme of the Austrian Forest Programme, environmental monitoring and the climate strategy;</p> <p>Legal regulations to protect forest vegetation against air pollutants.</p>
State of implementation	<p>The forest inventory was changed to a permanent survey in 2016, which makes an annual publication of the results possible since 2018. The data are to some extent the basis for reporting within the framework of the Kyoto Protocol and for the EU Flora – Fauna regulation.</p> <p>The emissions measurements for monitoring the compliance with the thresholds and targets to protect human health and vegetation are carried out at selected locations by agencies of the federal state governments and through the Austrian Environment Agency. Criteria for the location and number of measuring sites are determined by an ordinance.</p>
Recommended further steps	<ul style="list-style-type: none"> – Legal embedding of thresholds to protect the forest ecosystem; adaptation of the regulation on forest-damaging air pollution based on relevant scientific knowledge; – Legal consideration of the synergistic impacts and subtoxic concentrations; – Full implementation of existing laws and regulations; – Evaluation of existing monitoring networks as the basis for setting up a comprehensive monitoring of emissions; – Development of a close-knit forest-emissions information system that has the goal to provide a clearly understandable and user-friendly description of the emissions situation/risks for Austrian forests; – Establishment of an integrated forest inventory including an emissions information system.
Possible resource requirements	For the extension of the forest inventory, additional resources are necessary.
Possible conflict potential	Conflicts with respect to thresholds for transport and industry cannot be excluded.
Actors	EU, federal and state governments, Federal Research and Training Center for Forests, Natural Hazards, and Landscape (BFW), Environment Agency Austria (EAA).
Time horizon	These actions can be implemented in the medium term.

²⁸ Deposition of solid, liquid and gaseous pollutants of all kinds from the atmosphere onto surfaces

2.2.2.8 DEVELOPMENT OF MODIFIED AND INNOVATIVE TECHNIQUES FOR WOOD PROCESSING TAKING INTO ACCOUNT POTENTIAL CHANGES IN WOOD QUALITY AND TREE SPECIES

Objective	Development of innovative efficient technology for processing wood in order to increase the value creation of wood usage.
Significance	<p>The branches of industry that depend on Austrian forestry (sawmills, wood and paper industry, as well as electricity production) are, after tourism, the second most important sector in the external trade balance. Disturbances and changes in the supply of wood (qualitative, quantitative), as well as climate-related changes in forest stands can affect the industries that use and process wood. On the one hand, changes in the wood quality – for example, through weather impacts or changed tree species – are likely, while on the other hand new logistical challenges can be expected. Given the long lead time for the wood-processing industry, timely development of measures is necessary.</p> <p>Through the development of innovative, efficient technology for wood processing, the value creation is improved and optimally adapted to future supply.</p> <p>General support for wood also has positive consequences for climate change mitigation: the long useful life, increased use of wood and energy-efficient processing techniques make a significant contribution to mitigation.</p> <p>For the development of innovative technologies, it is important to consider what changes in the composition of tree species will take place as a result of climatic change.</p>
Connection to other sectors	There is a close connection to the economy, construction and housing and energy sectors.
Connection to existing instruments	Research activities, especially those of Wood Research Austria (HFA) and other relevant research areas of the Austrian Climate and Energy Fund, consider relevant questions.
State of implementation	Wood Research Austria (HFA) looks at the entire production – consumption chain, beginning with wood storage in the forest, through wood processing, to various products. The research is oriented towards practice and cooperates closely with business and industry.
Recommended further steps	<ul style="list-style-type: none"> – Research on relevant questions, whereby a close cooperation with the wood-processing industry is necessary; – Consideration of innovative technologies in wood research; – Development of smart technologies for wood use; – Consideration of the changed composition of tree species in the development of innovative technologies; – Awareness-raising for those responsible in the processing industry; – Feedback to the forest owners; – Development of new marketing concepts.
Possible resource requirements	Adequate resources for research are necessary. In the long term, investment costs for the processing industry can be expected.
Possible conflict potential	Use conflicts regarding wood can arise between the material and energy usage.
Actors	Academic and non-academic research institutions, wood-working and -processing industry, interest groups, Cooperation Platform Forestry-Wood-Paper (FHP), federal government, EU (Forest Technology Platform).
Time horizon	Research on relevant questions (especially regarding changes of wood quality through changing precipitation amounts and temperature) can be carried out in the short term in cooperation with the wood-processing industries.

2.3 WATER RESOURCES AND WATER MANAGEMENT

2.3.1 OVERARCHING OBJECTIVE OF THE SECTOR

Overarching objective: Sustainably securing water resources as the basis of life and habitat, as well as ensuring the provision of high quality drinking water, environmentally friendly cleaning of waste water and strengthening the protection of the population against natural hazards as a result of climatic change.

2.3.2 RECOMMENDED ACTIONS FOR THE WATER RESOURCES AND WATER MANAGEMENT SECTOR

GENERAL ACTION PRINCIPLES IN THE WATER RESOURCES AND WATER MANAGEMENT SECTOR

- Planning and implementation of no-regret strategies and robust measures: Given existing uncertainties (especially at the regional level), it is important to support so-called robust adaptation measures. These include not only those measures that are developed in response to projected changes (e.g. lowering of the groundwater level in eastern Styria) but also measures that would in any case support the sustainable development of water management. In this context, it is important to emphasise, for example, renaturalisation measures for flowing water and the creation or expansion of retention areas that have multiple very positive effects.
- The best possible support for adaptation in the water resources and water management sector requires additional research.
- In studies of the impacts of climatic change, the focus should increasingly be on the analysis of which mechanisms the changes cause, instead of only estimating the size of the changes (Blöschl & Montanari 2010, Montanari et al. 2010). This would make it easier to find robust measures.
- Analyses of the impacts of climatic change should, in particular, be clear about the level of uncertainty for certain projections. For example, the calculated changes of air temperature are considerably more reliable than those of the seasonal precipitation, which are more reliable than calculated changes of extreme events (heavy precipitation) (Böhm 2008).
- The interaction with multiple sectors is essential for climate change adaptation in the water management sector, especially with agriculture, ecosystems/biodiversity and protection against natural hazards. Regional planning, as an interface between the various demands for water, should be used more strongly as a management tool. This is particularly the case for flood risk management and water protection (groundwater and surface water). Within the framework of the projects FloodRisk I+II recommendations were already made for integrated flood protection, which should be taken into account. With regard to the acceptance, awareness-raising for the general population and other stakeholders is a significant measure. In the evaluation of the FloodRisk I+2 recommendations in 2014-2015, some implementation steps could already be identified, such as the precipitation forecasts and the expansion of alarm chains. Nevertheless, in many areas there is a further need for action. An important measure with respect to risk reduction that has only been partially implemented is, for example, the improvement of individual responsibility (FloodRisk E, Habersack et al, 2015).
- To make action recommendations systematic, an “integrated water management” approach is used. This attempts to deal with the three main goals of water management - water use, water protection and protection against water – in an integrated way. Below, the recommended actions are presented for the three main goals. Detailed recommendations for protection against water are described in the chapter on protection against natural hazards.

	<i>Recommended action</i>	<i>Water Use</i>	<i>Water Protection</i>	<i>Protection against water</i>
1.	Analysis of existing data and promoting collection of further data on water resources	X	X	X
2.	Improving coordination / information concerning water consumption and water demand	X	X	
3.	Guarantee of future water supply	X	X	
4.	Responsible use of water resources	X	X	
5.	Increased consideration of low water in the management of water resources	X	X	
6.	Achieving and securing the good ecological and chemical status of water bodies (including groundwater)	X	X	
7.	Proactive water management planning for groundwater resources	X	X	
8.	Adaptive flood risk management with robust measures			X
9.	Greater emphasis on water temperatures in water management measures		X	
10.	Installation of industrial water management instruments	X		

2.3.2.1 ANALYSIS OF EXISTING DATA AND PROMOTING COLLECTION OF FURTHER DATA ON WATER RESOURCES

Objective	Reduction of knowledge deficits regarding the effects of climate change on water resources and their use.
Significance	<p>Reliable statements about the impacts of climatic change on water resources and water use in the past or the future are not available. In the past, the anthropogenic changes in this sector and the natural variability of the climate were often more pronounced than the changes of climate due to the greenhouse effect.</p> <p>A homogenisation, analysis and combination of available data and further data collection are a necessary basis for improving knowledge about the system. The inclusion of information about changed climatic conditions is of great significance. This would allow an improved estimation of potential difficulties and shortages in water supply and other water management practices and the planning of pro-active adaptation measures would be made easier.</p> <p>The increasing climatic warming is already having noticeable impacts in the mountains through, for instance, the melting of glaciers and permafrost (danger of rock slides). The Austrian block glaciers are also affected and these are an important source of water for drinking and for other purposes in the tourism areas of the high alpine areas. For this, there is now monitoring of water storage and the dynamics of discharge including qualitative and quantitative changes with possible impacts on groundwater and ecosystems.</p> <p>Currently, a broad set of data on aspects of the water balance and water quality is being collected. A strict continuation of all of these measurements is necessary. The state of knowledge regarding evaporation – which is particularly important for estimation of the</p>

water supply – is not sufficient at the moment. In addition, there is a particular need for data on the changes resulting from climatic change in high alpine areas.

To measure the groundwater there is already a network of measuring stations, which should be maintained at this size in the future or increased in areas that are used intensively. The heat budget of groundwater also deserves particular attention. With respect to surface waters, the priority is the systematic analysis of temperature changes and discharge amounts at representative locations.

In future monitoring programmes, long-term, consistent data sets can show the impact of climatic change on the condition of surface- and ground-water so that the various influencing factors can be determined more clearly.

The existing programme for monitoring of lakes can also be adapted for the observation of potential climate impacts on mixing.

Many water supply companies have good records of water withdrawal, but there are hardly any data for water use by agriculture, energy conversion, industry or tourism (see recommended action Chapter 2.3.2.2: Improving coordination / information concerning water consumption and water demand). Therefore, improved information about water use and water demand is necessary.

Parallel to continuous data collection, homogenisation and analysis of existing and new data are very important. In order to derive trend changes from the data, high quality data are required. The Histalp data set (Auer et al. 2007) and the data from the Austrian Hydrography are examples of how this quality can be achieved. The digitalisation of data that are currently only recorded on paper permits the extension of the datasets, which means that climate-induced trends can be better identified. Interesting insights can be found through the combination of data sets on temperature, precipitation, discharge and groundwater amounts, as already shown by hydrological modelling. In a further step, a detailed study of the impacts of a changed availability of water resources on water usage will be necessary.

However, it is important to note that the need for additional data collection in response to particular questions should be carefully checked in order to avoid unnecessary costs.

There are connections to all other sectors, in particular to the economy, energy, agriculture, ecosystems/biodiversity and tourism.

For Austria as a whole, the Ministry for Sustainability and Tourism (formerly BMLFUW) is in charge of the development of the Water Information System Austria (WISA). This system contains, among others, the reporting data for the EU Water Framework Directive and information on the national water management plan (NGP, 2015). Further data on water are found in the geoinformation systems of the federal states.

The Austrian hydrographic service runs the measuring network on the components of the water cycle (water cycle data collection ordinance). This network provides useful information on the amount of water in Austria. Water quality information is also collected nationwide within the framework of the water quality monitoring ordinance.

Existing water information systems encompass a large amount of data, but to date climate-related changes have not been considered sufficiently.

Currently, the topic of climatic change and the impacts on water management is considered in studies in specific regions, such as the study on climate change adaptation strategies for Austrian water management (BMLFUW, 2011g), projects funded by StartClim in 2013, and projects funded within the framework of the Austrian Climate

Connection to other sectors

Connection to existing instruments

State of implementation

Recommended further steps	<p>Research Programme (e.g., CILFAD24²⁹; SeRAC-CC25³⁰; DSS_KLIM:EN26³¹; Aqua-Stress27³², DynAlp28³³).</p> <ul style="list-style-type: none"> – Strengthened integration of climatic and water data (hydrological modelling); – Further research on the impacts of climatic change on water management; – Digitalisation of hydrographic data currently only available on paper to extend existing data sets; – Homogenisation of existing long-term data sets to improve identification of trends (especially precipitation, discharge, evaporation, water temperature); – Evaluation of the possible introduction of additional monitoring stations for precipitation, snow amounts and discharge in the alpine region, in order to test the results of climate models for the alpine regions of Austria more comprehensively; – Where necessary, expansion and optimisation of the monitoring network for groundwater amounts and temperature in intensively used areas; – Strengthened measurement and monitoring of surface water temperatures; – Adaptation of the monitoring strategy for lakes (regular recording of depth profiles with temperature and oxygen measurements); – Installation of measuring stations for evaporation in connection with the water supply; – Focus on long-term, consistent data sets in the monitoring of the state of surface- and groundwater; – Data collection on water use of individual water use groups (industry, agriculture and households).
Possible resource requirements	<p>In order to derive trends from the monitoring data, the data must be of high quality. This cannot be achieved with the currently available financial and personnel resources. Additional resources would be necessary.</p>
Possible conflict potential	<p>No conflicts are expected.</p>
Actors	<p>Federal and state governments, districts, municipalities, academic and non-academic research institutions, water suppliers (water consumption/use and demand).</p>
Time horizon	<p>Data collection should be carried out continuously. The digitalisation and homogenisation, analysis and integration of existing data can start immediately after the resources are provided.</p>

2.3.2.2 IMPROVING COORDINATION / INFORMATION CONCERNING WATER CONSUMPTION AND WATER DEMAND

Objective	<p>Data collection, as complete as possible, on actual water consumption by various user groups as a basis for managing and safeguarding the water supply.</p>
Significance	<p>Many water supply companies have good records on the amount of withdrawal, but there are hardly any generally available or centrally collected data about the water consumption of individual user groups, such as agriculture (for crop watering), electricity companies, industry or tourism. The use of water that goes beyond the demand from households and the economy requires a permit from the water authority</p>

²⁹ Link: [CILFAD - Climate Impact on Low Flows And Droughts](#)

³⁰ Link: [SeRAC-CC - Sensitivity of the Runoff Characteristics of Small Alpine Catchments to Climate Change](#)

³¹ Link: [Entwicklung eines Decision Support Systems zur Beurteilung der Wechselwirkungen zwischen Klimawandel - Energie aus Wasserkraft & Ökologie](#)

³² Link: [Aqua Stress - Water resources under climatic stress. An integrated assessment of impacts on water availability and water quality under changing climate and land use](#)

³³ Link: [DynAlp - Dynamic Adaptation of Urban Water Infrastructure for Sustainable City Development in an Alpine Environment](#)

	<p>and is entered in the Water Register. For the issue of the required permit, information is required regarding the location, the amount and the type of water use. Because of the generally high availability of water in Austria, the amounts of water actually consumed are not centrally recorded. At least in areas where periodic drought events in the past have affected user groups, it would make sense to have an annual data survey regarding the actual amounts of water consumption by various user groups. As an example, we can look at the tourism industry: in the Austrian Alps about 66% of the skiing runs can be provided with artificial snow. Before the snow-making machinery is installed, the maximum amount and quality of the required water is determined within the framework of the permit process. For snow-making, water is used that is mostly collected in storage ponds. The actual amount of water withdrawn for making artificial snow in winter sport regions is, however, not known. Exact numbers can also not be found in specialist literature, since they vary strongly according to the snow-making system, climatic conditions and location. Studies in Switzerland conclude that in winter sports regions the water consumption for artificial snow-making can amount to between 20% and 36% of the annual regional water consumption (Teich et al. 2007).</p> <p>The goal, therefore, is to provide information on the actual water consumption of various user groups on the basis of structured data collection. This measure is particularly relevant for regions that seasonally reach the limits of supply capacity due to high water consumption.</p> <p>On the basis of transparent records on water consumption, planning for the management and security of water supply can be carried out.</p> <p>The aim is that in regions with a low water regime in summer, consumption is adapted to the possible lower water supply.</p>
Connection to other sectors	There is a connection to the economy, energy, agriculture, construction and housing, as well as tourism.
Connection to existing instruments	There are connections to legal regulations, such as, for example, the permit processes for artificial snow-making and to the Water Law, Furthermore, in the federal states there are databanks and for Austria as a whole there is the Austrian Water Information System (WISA).
State of implementation	Many water supply companies have good records regarding the amount of withdrawals; however, there are hardly any data on the consumption of individual user groups with respect to facilities and planning.
Recommended further steps	<ul style="list-style-type: none"> – Provision of actual withdrawal data by water associations; with reference to facilities and planning on the national and regional/community levels; – Introduction of these data into existing information systems, in order to enable a wider access;
Possible resource requirements	<p>Consideration of the possible decreasing water supply in regions with low water regimes in new permit processes and, where necessary, adaptation of existing permits.</p> <p>The collection and updating of data require considerable time and resources.</p>
Possible conflict potential	There are potential conflicts with all user groups (e.g., energy providers, agriculture and industry).
Actors	Federal and state governments, interest groups, regions, municipalities.
Time Horizon	The collection of data is a long-term process that can be started immediately.

2.3.2.3 GUARANTEE OF FUTURE WATER SUPPLY

Objective	Increasing qualitative and quantitative security of the water supply in areas threatened by water scarcity by means of planning and technological measures.
Significance	Since Austria is a country with plentiful water, no widespread scarcity of water is to be expected in coming years. Nevertheless, in some regions of Austria there could be

Connection to other sectors	<p>problems with the quality and quantity of the water supply. Meteorological extreme events in recent years (e.g., floods and droughts, erosion and the indirect effects of storms) led to disturbances in water supply. As a result of changed intensity and frequency of extreme events, such disturbances could increase (see Perfler et al. 2006, BMLFUW 2011g). On the other hand, higher temperatures and reduced precipitation amounts in summer lead to an increased removal of water stored in soil and plants. This can lead to a reduction of the accumulation of groundwater and thereby to a sinking of the groundwater level.</p> <p>The results of some studies show that this could occur in the south of Austria and in the drier regions in the east. Possible impacts of climatic change must, therefore, in particular in these dry regions, be integrated into planning and considered in the construction of water management infrastructure (e.g. development of new, additional water bodies considering ecological factors). Furthermore, the risk of failure can be reduced through interconnecting the existing supply structure (e.g. through the creation of superregional water associations or water pipes), as well as through safeguarding the quality and quantity of significant groundwater sources (systematic identification of priority groundwater areas and regulation of these areas as protected areas) or through the establishment of infiltration areas.</p>
Connection to existing instruments	<p>There is a close connection in particular to the health, energy, construction and housing, agriculture, tourism, economy, protection against natural hazards sectors, as well as to urban open and green spaces.</p> <p>In Austria, the development of measures to increase the reliability of supply is the responsibility of the federal states or the municipalities. The individual federal states select very different strategies (e.g. the Carinthian Water Foundation and the Drinking Water Supply Concept of Carinthia, Water Supply Plan of Styria, the Lower Austria Drinking Water Plan or the Upper Austrian strategy “Future Drinking Water”).</p> <p>The EU Water Framework Directive provides a framework for the protection of inland surface water, transferred water, coastal water and groundwater.</p> <p>For groundwater the directive supports a good chemical state and quantity as an environmental goal.</p> <p>The minimum requirements for the quality of drinking water in Austria, which is taken 100% from groundwater, are set by the food security and consumer protection laws and set out in detail in the Austrian drinking water regulation.</p> <p>The assistance guidelines for communal residential water management in 2016 provide, among others, measures for supply security (BMLFUW 2015k). This includes, for example, networks with other suppliers.</p>
State of implementation	<p>In 2009, the European Commission published guidelines for the consideration of climatic change in the development of national water management plans (BMLFUW 2009). The member states must integrate relevant aspects regarding climatic change in the second and third round of the development of the national water management plan. A chapter on climatic change was already included in Austria’s first national water management plan. In the national water management plan of 2015 climatic change is considered in the chapter on the impacts of climatic change on the Austrian water sector.</p>
Recommended further steps	<ul style="list-style-type: none"> – Where necessary, expansion of the existing instruments of the federal states for security of water supply to include aspects related to climatic change; – Development and implementation of regional strategies to safeguard the water supply, in particular in vulnerable regions: Possible strategies include limiting the risk of failure through building networks of existing supply structures or defining the supply possibilities for plants for which a connection to central installations is not economically feasible; – Implementation of a risk management instrument by water suppliers considering disturbance of supply (e.g. floods or landslides); – Further safeguarding of existing protected areas and precautionary protection of potential water sources (wells and springs);

	<ul style="list-style-type: none"> – Avoidance of risk areas during the renovation or planning of installations; – Survey of the weak points and dangers in the water supply system. The experiences from the extreme summers of 2003 and 2015 should be evaluated with respect to the bottlenecks in use and supply, in order to draw conclusions for increasing water supply security (such as measures to create redundant systems); – Development of suitable precautionary measures in case of use conflicts when there are shortages; – In cases where it appears to be appropriate for water management, strengthened implementation of measures for areal water retention to support the accumulation of groundwater; – Reduction or maintenance of paved areas and further development of infiltration areas, as far as this is appropriate for water management; – Use of deep groundwater primarily for emergency supply.
Possible resource requirements	Resources could be required for the inclusion of climatic change considerations in existing planning instruments or in the analysis of the vulnerability of existing water supply infrastructure. Subsequently, resource requirements could arise for planning and possibly for technical measures, such as, for example, the creation of superregional water pipes.
Possible conflict potential	Through the construction of technical measures (e.g. water withdrawal from groundwater), conflicts with, for instance, agriculture and nature protection could arise as a result of climatic change. An expansion of water protection areas could be in conflict with the interests of other land users. This poses great challenges for spatial planning and the detailed technical planning.
Actors	EU, state governments, municipalities, water suppliers.
Time horizon	The first step is to determine planning measures; technical measures can be implemented in the medium term, whereby the developments must be monitored and this information must be used to support further decisions.

2.3.2.4 RESPONSIBLE USE OF WATER RESOURCES

Objective	Protection of water resources in areas threatened by water shortages by encouraging increased use of efficient water-saving technologies and targeted awareness raising.
Significance	<p>Through the further development and use of efficient technologies, there is a great potential for water saving in many areas; for example, in private households or industry. Repair of leaks and technical improvement of protection against evaporation (e.g. in irrigation systems) play an important role. This is very significant above all in regions with water supply problems.</p> <p>In parallel to technological measures, awareness-raising and provision of information for water users should support a more conscious use of water resources. However, it should be noted that a reduction of water consumption can lead to stagnation and thereby to hygiene problems.</p>
Connection to other sectors	There is a connection to health, agriculture, tourism and the economy.
Connection to existing instruments	<p>Already in the past in periods with water scarcity it was necessary for municipalities to mandate careful use of water. In the Austrian federal states there are already various campaigns to raise awareness with respect to responsible use of water.</p> <p>Through financial incentives the implementation of water-saving technologies can be supported.</p>
State of implementation	<p>Examples for campaigns on responsible use of water are provided by Vienna, Salzburg and the Hohe Tauern National Park.</p> <p>Financial incentives for the implementation of water-saving technologies are found in the tourism sector. 50% of investments in such measures were refunded.</p>

Recommended further steps	<ul style="list-style-type: none"> – Further support for awareness-raising and clarification about water consumption; – Provision of further financial incentives for the implementation of water-saving technologies (e.g. in industry and agriculture) considering hygienic framework conditions (drinking water provision).
Possible resource requirements	Additional resources are required for further awareness-raising measures and for financial incentives.
Possible conflict potential	Conflict potential can be expected with those companies that sell water.
Actors	State governments, municipalities, water suppliers, water users, academic and non-academic research institutions.
Time horizon	Water-saving technologies can be developed and implemented in the short to medium term. Awareness-raising measures could be carried out immediately.

2.3.2.5 INCREASED CONSIDERATION OF LOW WATER IN THE MANAGEMENT OF WATER RESOURCES

Objective	Ensuring the achievement of water management objectives in periods of low water.
Significance	<p>Low water situations are of significance for both the protection of surface waters and (to a lesser extent) for water use and water ecology (e.g. through groundwater accumulation). Climatic change could have a strong impact on low water flows – with different effects in different regions. In regions with low water regimes in winter (above about 900m above sea level), reduced freezing could increase the water flows in the coming decades. From the perspective of water management, this would have positive effects (e.g., more water for artificial snow-making and hydropower). In regions with low flows in summer (below about 900m above sea-level), higher evaporation in the coming decades (with regional differences) is expected to lead to a reduction of discharge during low water periods (Weinviertel, northern Burgenland, parts of southern Styria and Carinthia, parts of the alpine foothills in Lower Austria).</p> <p>Low-water situations could be problematical for the discharge of waste water, because as a result of the low discharge of the surface water, the contents of the waste water are less diluted and therefore seasonal quality targets are exceeded. This is particularly significant since in 2010 the quality target ordinance for chemicals in surface waters introduced permitted maximum concentrations. Furthermore, low water situations can be problematical because as a result of the low reference water volumes (e.g., Q95, MJNQ³⁴) the permitted concentrations could be lowered in permit processes.</p> <p>The low-water years of 2003 and 2015 are very useful from a hydrological point of view in the evaluation of low-water situations in summer as a result of climatic change, since these extremely dry and hot summers are also expected to occur more frequently in the future (ZAMG 2015a). In addition, a recent study (Haslinger et al. 2016) has shown that the dry summer of 2015 corresponds with scenarios from global climate models, which project drier conditions in southern Europe and moister conditions in northern Europe in the coming decades.</p>
Connection to other sectors	There is a connection in particular to agriculture, economy, energy and ecosystems/biodiversity.
Connection to existing instruments	There is a close connection to the EU Water Framework Directive, which entered into force in Austria in 2003 and the related national water management plans (NGP 2009 (BMLFUW 2010e) und NGP 2015 (BMLFUW 2015c)). The water levels are regularly monitored within the framework of the water cycle survey and the water quality is monitored within the framework of the water status monitoring regulation.

³⁴ Q95: Discharge that is exceeded on 347 days of the year, or is not reached on 18 days of the year. MJNQ: mean annual low water

State of implementation	European guidelines were published for the inclusion of climatic change considerations in national water management plans. In the Austrian water management plan of 2015 climate change is included in one chapter.
Recommended further steps	<ul style="list-style-type: none"> – The following adaptation measures are particularly for Austrian regions with a low-water regime in the summer: – Check whether measures that are already planned with regard to low water in these regions should have a higher priority and whether they should be implemented earlier; – Continuous review of the impacts of low-water situations and their consequences for water management in the face of climatic change through analysis of extreme years (e.g., 2003 and/or 2015); – Where necessary, implementation of water management measures, such as storage management, to increase discharge during low-water situations; – Development of emergency measures (emergency plans) for extreme events; – Support for local infiltration and reduction of sealed surfaces in endangered regions.
Possible resource requirements	Many of the proposed measures can be implemented through existing instruments. New research and additional measures (e.g. early warning systems) require resources.
Possible conflict potential	Conflicts could arise between different water uses.
Actors	Federal and state governments, municipalities, academic and non-academic research institutions.
Time horizon	Inclusion in existing instruments and further research can start immediately.

2.3.2.6 ACHIEVING AND ENSURING THE GOOD ECOLOGICAL AND CHEMICAL STATUS OF WATER BODIES (INCLUDING GROUNDWATER)

Objective	Achieving and ensuring the good ecological and chemical status of water bodies (including groundwater) or the good ecological potential.
Significance	<p>The natural functional capacity of Austrian water bodies is strongly disturbed by human use in some places. The impacts of climatic change could put additional pressure on the ecological and chemical conditions of water bodies. For example, temperature changes could lead to shifts of the boundaries of fish species. In particular, it is expected that the spatial boundaries for trout and grayling will move upwards with increasing temperature, which would reduce the potential habitat for these fish species. It is not clear whether the hydromorphological conditions in these areas are suitable for fish species from lower regions (e.g., the barbel region). This aspect should be considered in the definition of fish-ecological guidelines and the subsequent evaluation of the ecological conditions.</p> <p>The Water Framework Directive provides a regulatory framework for the protection of inland surface water, water transfer, coastal water and groundwater. To achieve the goals of the Directive despite climatic change and the resulting impacts on water bodies and groundwater, an increased awareness of the problem is necessary.</p> <p>When the pressures on surface waters and groundwater intensify (e.g., through reduction of discharge and increased water temperature), measures must be taken in order to avoid a deterioration of the water body, as well as to guarantee the achievement of goals. This includes measures such as reduction of chemical inputs at point sources and through diffuse sources in agriculture, but also through renaturalisation measures and restoration of natural aquatic habitats. Possible impacts of climatic change on bathing water quality should also be considered (first results are provided by Dokulil 2009 and BMLFUW, 2011g).</p>

Connection to other sectors

There is a close connection to the economy, ecosystems/biodiversity, energy, agriculture, forestry, tourism and health.

Connection to existing instruments

There is a close connection to the EU Water Framework Directive, which was implemented in Austria in 2003 through the Water Rights Act Amendment which requires the development of national water management plans.

Further connections are through

Water Conditions Monitoring Ordinance and the Quality Goals Ordinances for chemicals in groundwater, ecology of surface waters, chemicals in surface waters, as well as the definition of areas where measures or monitoring are needed;

The Action Programme for Nitrates that is in the Water Rights Act, which is relevant for the chemical state;

For safeguarding significant groundwater sources, the definition of protected areas as well as water protection agreements with the agricultural sector;

Support for measures and projects that contribute to an improvement of water ecology (through environmental grants since 2009);

Within the framework of the Austrian Agricultural Environment Programme (ÖPUL), agricultural management forms are supported that focus in particular on protection of surface waters and groundwater.

State of implementation

European guidelines for consideration of climatic change in the development of national water management plans have been published. In the Austrian national water management plan of 2015, one chapter deals with the impacts of climatic change on Austrian water management.

Between 2009 and 2014, support was provided for 528 measures that contribute to an improvement of water ecology.

Recommended further steps

- Strategic planning of industrial and power plant locations considering changes of water resources;
- Reflection of climate change (adaptation of the natural state) in guidelines of the Quality Goals regulations. Since the adaptation process is slow, this constitutes a medium- to long-term perspective;
- Consideration of hydromorphological conditions for fish species of the lower fish regions in the definition of ecological guidelines for fish;
- Further measures to improve water ecology (such as renaturalisation and renovation of natural aquatic habitats);
- In the case of quality problems, reduction of the dissolved organic carbon, ammonia and nitrate loads from diffuse and point sources; Planning and construction of treatment plants;
- Supplementation of the emissions law with increased requirements for removal of ammonium and phosphorous that require no construction measures and which have to be complied with when certain dilution conditions are not met during periods of low water;
- Reduction of chemical inputs from point and diffuse agricultural sources;
- Continuation and further development of support programmes for agricultural environment measures.

Possible resource requirements

To a large extent, these actions can be implemented using existing instruments.

For measures to improve the ecological state of water bodies through reduction or removal of existing hydromorphological pressures (reinforced channels, obstructing constructions), the environmental support law provides support.

Financial support for projects to naturalise water bodies can be requested from the EU LIFE programme.

Possible conflict potential

Measures that lead to an ecological improvement of water bodies and require land can lead to conflict with other user groups, such as agriculture, energy and industry.

Actors	Federal and state governments, municipalities, EU, and other actors such as power suppliers, water suppliers, industry, flood associations, AGES, etc.
Time horizon	Since 2009 a national water management plan, in which adaptation measures to deal with climatic change must be addressed, is produced every 6 years. The conclusions or the action requirements from the plan are implemented through legal regulations or in addition through voluntary measures.

2.3.2.7 PROACTIVE WATER MANAGEMENT PLANNING FOR GROUNDWATER RESOURCES

Objective	Reducing the risk of the consequences of climate change affecting groundwater bodies and groundwater-dependent ecosystems, in order to contribute to the preservation of a good quantitative, chemical, and hygienic status of groundwater bodies.
Significance	<p>Since Austrian water use is almost entirely from groundwater, water management planning is particularly important. The maintenance of good conditions (amounts and chemistry) of groundwater reserves is a central goal of water management and is stipulated in the Water Framework Directive.</p> <p>In southern Austria, where a reduction of winter precipitation is projected, a reduction of the accumulation of groundwater over the coming decades must be taken into account. In some regions, however, high levels of groundwater (as in the first decade of the 21st century) could lead to water management problems (e.g. water in cellars). Since an exact forecast of future groundwater levels is not possible, the risk of negative impacts of climatic change on groundwater bodies must be reduced. As a result of climatic change, the demand for using groundwater reserves could increase.</p> <p>Ecosystems that depend on groundwater (e.g., fens) influence the amounts and chemistry of groundwater bodies. On the other hand, the ecological functions of ecosystems could be disturbed by changes of groundwater quality and levels. As a result, these sensitive areas must be considered in adaptation measures.</p>
Connection to other sectors	There is a close connection to economy, ecosystems/biodiversity, agriculture, tourism, construction and housing, health and spatial planning.
Connection to existing instruments	<p>There is a close connection to the EU Water Framework Directive, which came into force in Austria in 2003 with the Water Rights Act Amendment.</p> <p>Safeguarding of groundwater reserves and ecosystems that depend on groundwater is realised through the designation of protected areas.</p> <p>The water management framework plans according to the Water Rights Law provide another connection.</p> <p>Close cooperation with nature protection institutions (e.g., with the designation of Natura 2000 areas or the establishment of a LIFE project) can support the protection of ecosystems.</p> <p>The minimum requirements for the quality of drinking water, 100% of which comes from groundwater and springs in Austria, are provided by drinking water regulations, as well as laws covering food safety and consumer protection.</p>
State of implementation	<p>European guidelines for the consideration of climatic change in the development of national water management plans were published. In the Austrian national water management plan of 2015 climatic change is addressed in one chapter.</p> <p>The areas where measures will be carried out and the monitoring areas for groundwater are defined every 6 years in the national water management plan.</p> <p>Protected areas, sanctuaries and Natura-2000 areas exist for the protection of ecosystems that depend on groundwater.</p>

Recommended further steps

- Continuation or reorganisation/improvement of water management planning for the use of groundwater reserves, particularly in the areas with low precipitation in eastern and southern Austria;
- Check whether regional strategies for meeting the expected increased demand for water from groundwater are necessary;
- Review of building regulations and inclusion in regional spatial planning in regions with rising groundwater levels and low depth to groundwater;
- Continuous monitoring of ecosystems that depend on groundwater, in order to determine changes resulting from climatic change;
- Where necessary, further safeguarding of ecosystems that depend on groundwater, e.g. through nature protection programmes;
- Support for measures that increase the area of groundwater accumulation, to the extent that this makes sense for water management.

Possible resource requirements

These recommendations can mostly be implemented with existing instruments.

Possible conflict potential

Through land use pressures water management planning for groundwater reserves can lead to conflict with other sectors, such as agriculture.

Actors

Federal and state governments, municipalities, EU, nature conservation organisations.

Time horizon

Since 2009, a national water management plan is produced every 6 years, in which adaptation measures in response to climate change must be considered. The conclusions or requirements for action in the plan are implemented through legal regulations and/or voluntary measures.

2.3.2.8 ADAPTIVE FLOOD RISK MANAGEMENT WITH ROBUST MEASURES

Objective

Prevention of an increase in peak flows and damage.

Significance

The protection of society against the impacts of floods is a central task of Austrian water management. A combination of different methods of integrated flood risk management methods is used (e.g., increasing retention, space provision in development of areas, technological protective measures including the protection of objects, flood projections, increasing awareness of the population).

The current state of knowledge does not allow definitive statements about the possible impacts of climatic change on flood discharges, because it is not possible to calculate the future development of climatic or hydrological extreme events sufficiently reliably. The results of the study “Climate change adaptation strategies for Austrian Water Management“ (BMLFUW 2011g) show, however, that future changes in floods should be within the range of the high natural variability of decades in which there were many flood events. Given the current state of knowledge, a nationwide change to the rating of floods is not considered to be necessary, as long as assessments are carried out using the widest possible range of information (building on statistical data on floods, regional information, historical information and precipitation-discharge modelling). In the past, the increase of the flood damage potential as a result of anthropogenic causes (building of protection areas, increasing value of impacted objects) was mostly significantly higher than the change of probability of extreme events as a result of climatic change. WETRAX (Hofstätter et al. 2015) comes to the conclusion that in the future a potential increase in danger due to floods can be expected. This conclusion is based on an analysis of weather situations associated with floods. Possible changes in the spatial and temporal occurrence of widespread heavy precipitation in the Danube region until 2100 were studied. Particularly in the summer (May to October) a decrease of 10% to 30% of weather situations relevant to heavy precipitation was found. For the Danube region in Austria and Bavaria, the cyclone path (Vb) that is relevant for flooding would not, according to this study, occur more frequently. However, the potential for heavy

precipitation could increase due to higher temperatures. In winter (December to February), in contrast, an increase of 5% to 15% in weather situations that lead to more widespread heavy precipitation was found for some regions.

In any case, it makes sense to implement robust flood risk management measures that are adapted to the particular conditions. Although there are large uncertainties about the extent of climatic changes and the impacts on flood development (especially at the regional level), this approach can provide environmental and economic benefits for society. Management measures include the creation, extension and maintenance of retention areas, flood projections, as well as the improvement of the data basis. Since, particularly in the case of heavy rainfalls that are relevant with respect to flooding in small areas, the influence of climatic change is not known, the creation of a forecasting system for such areas would be important (forecast of the probability of flooding instead of the forecast of the water level).

Connection to other sectors

There is a close connection to the protection against natural hazards, disaster management, construction and housing, spatial planning, as well as urban open and green spaces, agriculture, tourism, energy and transport infrastructure.

Connection to existing instruments

The EU Floods Directive requires the development of flood risk management plans. Both regional spatial planning and local spatial planning contain appropriate measures to safeguard retention areas.

There are possible connections to the EU Water Framework Directive, which requires the integrated management of river areas.

Further instruments are the Water Rights Act of 1959, the Hydraulic Structures Support Law and, in connection with torrents and avalanche control, forestry law.

State of implementation

In the implementation of the EU Floods Directive, in the first step a preliminary assessment of flood risk and the designation of areas with potentially significant risk were carried out. Furthermore, maps of flood danger and risks were produced. These results are the basis for the flood risk management plan, which also envisages the securing of areas suitable for flood retention and in which aspects of climatic change should be considered in the second stage of implementation.

In Austria, integrated flood risk management is the conventional strategy for reducing flood risk. The changes resulting from climatic change have not yet been taken into account due to the difficulties described above.

The third pillar of the Austrian Spatial Development Concept (ÖROK 2011) considers climatic change, adaptation and resource efficiency. Measures are presented, such as reserving areas for flood discharge or expanding plans for endangered areas.

Existing internet platforms, such as www.naturgefahren.at or HORA 2.0 (www.hora.gv.at) provide an information service to raise awareness.

Recommended further steps	<ul style="list-style-type: none"> – Review of the rated values with respect to climatic changes in regions in which, as a result of increasing temperatures, a partial shift of flooding from summer to winter is expected (e.g., Innviertel and Mühlviertel); – Determination of the rated values of floods (in the range of existing discharges) on the basis of as much information as possible (combination of flood statistics, regional information, historical information and precipitation-discharge modelling) in other regions of Austria; – Continuation of the hydrological monitoring service and increasing the density of measurement points in small catchment areas; – Investigation of whether a flood forecast for small catchment areas (warning about the possibility of flooding) makes sense. Measures are recommendations from the projects FloodRisk I und FloodRisk II, as well as the results of FloodRisk-E(valuation) (Habersack et al. 2004, 2009, 2015); – Adoption of new or use of existing legal instruments, in order to reserve suitable areas for flood retention and discharge, as well as for emergency relief; – Continuation of coordinated forest management in high areas and management and safeguarding of protective forests; – More intensive cooperation with agriculture to achieve more sustainable forms of management; – Indication of the uncertainties in climatic impact analyses, separated according to the mechanisms that cause the changes. This provides support for robust decisions in flood risk management; – International research regarding experience with floods in other EU Member States and review of the usefulness for Austria.
Possible resource requirements	<p>Many of the proposed measures could be implemented using existing instruments. Resources are needed for adding to the knowledge base, flood forecasts for small areas and the reserving of areas.</p>
Possible conflict potential	<p>Safeguarding of areas for water retention could lead to conflicts with settlement development, construction companies or with farmers.</p>
Actors	<p>EU, federal and state governments, municipalities, academic and non-academic research institutions.</p>
Time horizon	<p>The inclusion in existing instruments and further research can start immediately. The national flood risk management plan was produced in 2015 (BMLFUW 2016a). It is reviewed every 6 years and adapted where necessary.</p>

2.3.2.9 GREATER EMPHASIS ON WATER TEMPERATURE IN WATER MANAGEMENT MEASURES

Objective	<p>Reduction of the influence of higher water temperatures on the use and protection of water bodies.</p>
Significance	<p>In general, the temperatures of surface water and groundwater have increased in recent decades, especially in summer. This trend is significantly more pronounced than for other variables of the water budget and therefore considered to be certain. It will probably increase in the coming decades, although the absolute value of the increase will vary depending on local conditions (Dokulil 2009, BMLFUW, 2011g). Increased water temperatures have an impact on the possible use of the water but the extent of thermal stress cannot be estimated due to a lack of data.</p> <p>According to the Water Framework Directive, the higher water temperatures should be considered as “natural”. They will lead to an adaptation of aquatic biocenoses and thus to shifts of the spectrum of species in water courses.</p> <p>The increase of water temperatures as a result of climatic change also affects the quality of surface water and groundwater. The temperature of the groundwater close to the</p>

Connection to other sectors	banks follows that of the water source, so the biological and biochemical processes take place faster and more completely.
Connection to existing instruments	As a result of the higher water temperatures, the use of surface water for cooling can be limited by the permitted heat discharge (power plants, industry).
State of implementation	In the case of new permits for heat discharge into water bodies (surface water and groundwater), the higher water temperatures as a result of climatic change must be considered. Through the development of thermal load plans, data on the variations, discharges and other relevant thermal pressures (shadows, river flow etc.) can be collected. These data make it possible to use models to calculate all pressures and their interactions. Through targeted studies regarding shifts of the species spectrum in water courses, the direct impacts on biocenoses can be determined.
Recommended further steps	<p>There are connections above all to ecosystems, biodiversity, energy and the economy.</p> <p>There is a close connection to the EU Water Framework Directive, which came into force in Austria with the Water Rights Act Amendment in 2003 and which requires the development of national water management plans. Support is available since 2009 for measures and projects to improve water ecology within the framework of environmental support.</p> <p>European guidelines for the inclusion of climatic change impacts in the development of national water management plans were published. In the national water management plan of 2015 the impacts of climatic change on Austrian water management are covered in one chapter.</p> <p>Between 2009 and 2014 environmental funding (from the funding programme for improvement of ecological conditions) was provided for 528 measures that contribute to the improvement of water ecology. Of these, 65% contribute to the improvement of passage and 35% to the removal of morphological pressures.</p> <ul style="list-style-type: none"> – Strengthened review of the impacts on the thermal budget of groundwater; – Consideration of expected higher surface water temperatures in the future for existing and future thermal discharges; – Inclusion of alternative methods for cooling and the study of variants; – Creation of possibilities for exceptional permits from administrations in extreme situations; – Examination of whether in individual cases the development of thermal load plans is necessary (collection of data on thermal loads and other parameters relevant for the temperature along water courses); – Implementation of the national water management plan regarding ensuring the unobstructed passage for fish through corresponding measures to improve water ecology; – Studies regarding the shifts of species spectrum in water courses, in order to determine direct impacts on biocenoses.
Possible resource requirements	The proposed measures can be implemented in existing instruments.
Possible conflict potential	Conflicts are possible between the use and the protection of water.
Actors	Municipalities, federal and state governments, EU, and other actors such as energy suppliers, water companies, fisheries, industry.
Time horizon	Further implementation steps should be taken in the short to medium term.

2.3.2.10 INSTALLATION OF INDUSTRIAL WATER MANAGEMENT INSTRUMENTS

Objective	Ensuring industrial water supply for the various areas of action: agriculture (irrigation), energy/industry (cooling), irrigation of golf courses and football fields, lumber yard sprinkling, industry and commerce, and in air conditioning and cooling systems.
Significance	<p>Service water is used for technical, business or agricultural purposes and its use contributes to a conservation of drinking water resources.</p> <p>Service water is not for human consumption but after use, e.g., for irrigation in agriculture, it must meet certain hygiene standards.</p> <p>For industry, the costs for service (process) water in connection with modern heat and material flow management are already significant. In this area, there is a strong trend towards circular management and thus to a reduction of water demand.</p>
Connection to other sectors	In particular, there is a connection to the economy, agriculture, tourism, energy and construction and housing.
Connection to existing instruments	<p>There are some instruments that support the implementation of measures, such as the support for drip irrigation (e.g., for vineyards) or the “Alarm Bell” groundwater programme.</p> <p>European guidelines for the reuse of cleaned waste water for irrigation and groundwater accumulation were published.</p> <p>Rule sheet 407 on recommendations for irrigation³⁵ of the Austrian Water and Waste Management Association (ÖWAV) summarises the most important quality criteria for the assessment of irrigation water for agriculture. In addition, quantitative aspects are discussed and examples provided. A revised new edition was published in March 2016.</p>
State of implementation	See “Connection to existing instruments”.
Recommended further steps	<ul style="list-style-type: none"> – Definition of the requirements and regulation of the use of service water and percolation water for agriculture, energy, industry and business; – Support for surveys of the demand for and resources of service water; – Introduction of water-saving technologies (e.g., drip irrigation, artificial snow-making); – Collection and dissemination of suitable support measures for the use of different water qualities; – Monitoring of the flawlessly hygienic implementation.
Possible resource requirements	An estimation of possible resource requirements is not possible at present.
Possible conflict potential	If water use is forbidden or limited, use conflicts could arise.
Actors	EU, federal and state governments, managers.
Time horizon	Implementation must be continuous.

³⁵ Link: <https://www.oewav.at/Page.aspx?target=196960>

2.4 TOURISM SECTOR

2.4.1 OVERARCHING OBJECTIVE OF THE SECTOR

Overarching objective: Safeguarding Austria as an attractive and sustainable location for tourism through the use of potentials arising from climatic change and supporting environmentally friendly adaptation measures.

2.4.2 RECOMMENDED ACTIONS FOR THE TOURISM SECTOR

GENERAL PRINCIPLES FOR ACTIONS IN THE TOURISM SECTOR

- The planning and implementation of “no-regret strategies” should be supported given the large uncertainties (particularly at the regional level). Measure should be kept flexible, to allow rapid adaptation to changing conditions.
- Using a holistic approach, the planning of measures should consider their consequences for nature protection, climatic change mitigation and other sectors (e.g., through the development of concepts for sustainable tourism/regional development). In doing this, the complex interactions must be presented and the measures that have positive consequences for multiple sectors are to be preferred.
- Because of the different temporal perspectives (e.g., with respect to investments) and scale levels (e.g., at the level of individual operations or of a region), the differentiation of strategies is necessary.
- The provision of comprehensive information (e.g., the analysis of the climate sensitivity of tourism destinations) and knowledge transfer are a basic prerequisite for avoiding spontaneous maladaptation and lead to an increase of adaptive capacity in the tourism sector.
- For regions, in which decreasing value added from the tourism sector is expected as a result of climatic change, scenarios for shifting priorities (e.g., development of offers that do not depend on the weather or support for other economic activities) should be considered. To support such regions, it makes sense to implement forward-looking structural measures to support other fields of economic activity.
- In principle, a diversification of tourism (with respect to target groups, seasons, and attractions) has a lower potential risk than a one-sided supply. Great potential is seen in Austria for the creation of sustainable options with a clear positioning and high quality (APCC 2014).

2.4.2.1 TAKING ACCOUNT OF CLIMATE CHANGE IN TOURISM STRATEGIES

Objective	Intensification of strategic consideration of issues of climate change and tourism as framework conditions for the implementation of adaptation measures.
Significance	<p>The federal system in Austria determines that the responsibility for tourism is with the federal states. As a result, the cooperation between the federal government and the federal states is voluntary.</p> <p>Strategies that pro-actively include future stress factors such as climatic change make an important contribution to safeguarding tourism locations. A strategy should provide a framework for a tourism destination so that it can react optimally to changes resulting from climatic change by developing and implementing the necessary adaptation measures.</p> <p>Considering the wide-ranging impacts of global warming and the adaptation measures that are relevant for other sectors and responsible actors, a close cooperation between the federal government and the federal states, as well as with further relevant actors should be supported. Through the coordination of individual strategies (including a clear distribution of competences and responsibilities for further implementation steps) and through a collective approach, the success of implementation can be increased and the vulnerability of the tourism sector to climatic change can be reduced.</p>

Connection to other sectors	Essentially there are connections to all other sectors.
Connection to existing instruments	<p>In most federal states tourism strategies have been prepared: Upper Austria³⁶; Lower Austria³⁷; Vorarlberg³⁸; Salzburg³⁹; Carinthia⁴⁰; Styria^{41 42}; Vienna⁴³; Burgenland⁴⁴; and Tyrol⁴⁵.</p> <p>The nationwide strategy⁴⁶ was published in February 2010 (BMWFJ 2010) and was produced jointly by the federal government and the federal states. This nationwide strategy process concludes that one of the most important steps in the future is better coordination of all tourism partners.</p> <p>There are also connections to spatial planning instruments both on the local level and on the regional level. Under the leadership of the Austrian Spatial Planning Conference, the Austrian Spatial Development Concept was produced (ÖREK 2011; ÖROK 2011). This is a strategic management instrument for spatial planning and development over all of Austria. Aspects related to climatic change should receive more attention in strategic environmental assessments.</p> <p>Existing funding programmes and funding guidelines are further instruments, which have a certain steering possibility with respect to consideration of climatic change and could support measures that lead to a better adaptive capacity.</p>
State of implementation	<p>In contrast to most of the previous tourism strategies of the federal government and the federal states, it can be seen that in most of the recent strategies/concepts, climatic change is presented as a challenge. Even when climatic change and adaptation are not explicitly referred to, all tourism concepts of the federal states refer to aspects relevant to adaptation (e.g., expansion of whole-year tourism, development of offers that do not depend on the weather or season) (BMLFUW 2015a).</p> <p>The Austrian Spatial Development Concept (ÖREK 2011) includes the theme area “Environment – Climatic Change – Resources”, which provides a connection to the use of free space and to tourism.</p>
Recommended further steps	<ul style="list-style-type: none"> – Integration and analysis of existing data on tourism, climate including climate scenarios, environment etc. on the level of destinations and carrying out a gap analysis with regard to those data that are necessary for the development of adaptation measures and can be used further in corresponding strategy documents. Where possible, commission research projects to close the gaps (see

³⁶ Link: [https://www.land-oberoesterreich.gv.at/Mediendateien/Formulare/DokumenteAbt_Ge/ENDFASSUNG-KURSBUCH\(180211\).pdf](https://www.land-oberoesterreich.gv.at/Mediendateien/Formulare/DokumenteAbt_Ge/ENDFASSUNG-KURSBUCH(180211).pdf)

³⁷ Link: http://www.noe.gv.at/noe/Wirtschaft-Tourismus-Technologie/NOe_Unternehmensbedarfserhebung.html

³⁸ Link: http://www.vorarlberg.at/vorarlberg/tourismus_kultur/tourismus/tourismuspolitik/neuigkeiten_mitbild_tourismusstrategie2020.htm

³⁹ Link: https://www.salzburg.gv.at/tourismus_/Documents/strategieplan_2020_-_internetversion.pdf

⁴⁰ Link: <https://www.ktn.gv.at/Themen-AZ/Details?thema=6&detail=560>

⁴¹ Link: http://www.verwaltung.steiermark.at/cms/dokumente/11721185_74836018/8a137681/Tourismusstrategie%202015-2020.pdf

⁴² Link: <http://www.verwaltung.steiermark.at/cms/ziel/74836018/DE/>

⁴³ Link <http://www.tourismusstrategie2020.wien.info/>

⁴⁴ Link: http://www.burgenland.info/static/files/bgld_strategie_final.pdf

⁴⁵ Link: http://www.ttr.tirol.at/sites/default/files/upload/311_15%20Strategie%20Tiroler%20Weg%202021.pdf

⁴⁶ Link: http://www.bmwfw.gv.at/Tourismus/Documents/Strategie_Neue%20Wege%20im%20Tourismus.pdf

	<p>also the recommended action on development, delivery and improvement of regional data as a basis for decisions on adaptation measures);</p> <ul style="list-style-type: none"> – Further integration of the topic of climatic change into tourism strategies; – Review of all recommendations in the tourism strategies with regard to their impact in reducing climate risks, climatic change mitigation and their compliance with climate protection goals, as well as the preparation of guidelines for the development of adaptation measures in tourism that are climate friendly; – Coordination of the individual strategies and clear distribution of responsibilities for implementation; – Detailed preparation of information to meet the needs of relevant actors in order to make decisions on as broad a basis as possible; – Support cooperation between the federal government and the federal states and between the federal states themselves (establishment of “Climate Regions” for tourism); – Adaptation of funding guidelines with regard to activities that support adaptation to climatic change.
Possible resource requirements	<p>Through the use of existing, established instruments (e.g., strategies, concepts, master plans) and networks, no additional resources would be needed.</p> <p>Costs would arise for awareness-raising measures and for networking and cooperation.</p>
Possible conflict potential	<p>Tourism is a cross-cutting theme and therefore often affects actors from other sectors. This can give rise to conflict potential. The inclusion of all significant actors and transparent knowledge transfer contribute to reducing possible conflicts.</p>
Actors	<p>State governments, federal government, actors such as mobility providers, international actors, etc.</p> <p>Furthermore, extensive networking between the various administrative levels (vertical) and between the areas of action (horizontal) is desirable.</p>
Time horizon	<p>The goal should be a stepwise adaptation of existing instruments in the short term.</p>

2.4.2.2 DEVELOPMENT OF CLIMATE-FRIENDLY ADAPTATION MEASURES BASED ON TOURISM STRATEGIES

Objective	<p>Increased consideration of adaptation measures that best contribute to the reduction of greenhouse gas emissions and provide added value for businesses, besides minimizing climate risk.</p>
Significance	<p>This recommendation is closely connected to the recommended action on consideration of climatic change in tourism strategies. However, this measure goes a step further and puts the focus on the development and implementation of climate-protecting adaptation measures.</p> <p>The tourism possibilities of a region are closely connected to the climatic conditions. On the one hand, climatic change can influence the weather situation directly (e.g., more very hot days) and the seasonal pattern (e.g., later start of the winter season through lack of snow in ski resorts without artificial snow-making). On the other hand, there can be indirect impacts through changes of the landscape (e.g., rising tree line) and ecosystems (e.g., decline of sensitive animal and plant communities in alpine ecosystems). In this way, the prerequisites for tourism in a region can change dramatically.</p> <p>Winter tourism is particularly sensitive to climatic changes. These days 65% of the ski-slopes can be provided with artificial snow. For current climatic conditions, a solid base of snow in autumn can allow a punctual start to the winter season in most cases. Furthermore, with the aid of artificial snow-making in the majority of the areas, a continuous snow cover can be maintained until March. Through higher temperatures as a result of climatic change, however, the conditions for artificial snow-making will deteriorate.</p>

For this reason, the affected winter sport regions – but also all other tourism regions in Austria, depending on the climate risks they face – need to accelerate the planning and implementation of measures, which should not have a negative impact on climate change mitigation or, in the best case, should contribute to a reduction of greenhouse gas emissions. Conventional measures in the tourism branch (e.g., increased artificial snow-making, wellness facilities, amusement parks) can have a considerable resource demand with respect to energy, water and surface area etc. In such cases, it is important to ensure that adaptation measures have no negative impacts on climate change mitigation and, in the best case, contribute to a reduction of greenhouse gas emissions.

The tourism sector is the source of about 5% of the global greenhouse gas emissions. 4% is a result of transportation for tourism and about 1% for accommodation and other tourism activities (UNWTO 2011). Tourism offers and possibilities for climate-protecting transportation to and from resorts, as well as mobility within the resorts themselves, are not only relevant from the point of view of climatic change mitigation but also support adaptation in the broadest sense.

Guidance for climate-protecting adaptation measures should be provided in the tourism strategies of the federal government and the federal states (See also Chapter 2.4.2.1: Taking account of climate change in tourism strategies). To support the implementation of climate-friendly and environmentally friendly adaptation measures, existing support measures and funding guidelines could be adapted. New construction of guest accommodation using tourism funding from the federal government can only be supported if the plan meets the quality standard “klimaaktiv silber” set out in the building standards for new construction and renovation of hotels and lodging (production of a planning declaration).

Adaptation measures should be developed in the following areas:

- Development of additional offers for alpine winter (ski) tourism that depends on snow in the sense of making the offers more flexible and diverse in the direction of all-year tourism; i.e., the measures should strengthen the pre-season and post-season;
- Development of offers that do not depend on weather and season, e.g., in the area of education, culture and health;
- Emphasis on regional specialities, such as cuisine, culture, handicrafts and landscape, as well as the development of regionally specific solutions;
- Spread the dates of holidays in order to reduce the temporally concentrated flows of tourists;
- Strengthened efforts to attract new target groups (e.g., older people, families with small children), who can participate in the low season.

The positive image of climate-friendly adaptation measures increases the attractiveness of holiday destinations and the quality of holidays, as well as the quality of life of the local population. In addition, a climate- and environmentally friendly orientation of tourism support can contribute to a reduction of costs or the energy dependence of businesses.

Connection to other sectors

Essentially there are connections to all other sectors. For the implementation of the recommended actions a close cooperation is recommended with transport infrastructure, construction and housing, spatial planning, agriculture, forestry, energy, ecosystems/biodiversity.

Connection to existing instruments

The existing tourism strategies provide certain linkages for the adaptation to climatic change. In future the strategies should provide the boundary conditions for the development and implementation of adaptation measures and also provide information about the sensitivity to climatic change of various tourism destinations.

Funding is available through the Austrian Climate and Energy Fund, as well as support for tourism from the federal government and the federal states and support for economic development.

State of
implementation

The fundable investment priorities identified by the federal government include investments for the establishment of environment- and safety-related facilities, as well as for saving energy and water. Furthermore, investments in the optimisation of internal processes towards economic and environmental sustainability are fundable (BMFWF 2015).

The need to develop climate-friendly adaptation measures can also be communicated through existing advisory services (e.g., environmental advisory services), networks (e.g., Climate Alliance Austria or e5⁴⁷), as well as through awarding of prizes and information campaigns.

In most tourism strategies, climatic change is recognised as a challenge. However, the current versions of the strategies do not provide an adequate framework and guidelines for the development and implementation of climate-friendly adaptation measures (BMLFUW 2015a).

The Austrian Climate and Energy Fund supports the development of new and innovative pathways for climatic change mitigation and a sustainable energy transition and supports, amongst others, activities in the areas of electric mobility, transport, energy efficiency, building and renovation, which are also relevant for tourism.

Information relevant for adaptation measures in the tourism branch can be found, for example, in the climate change adaptation data bank ([Datenbank Klimawandelanpassung](#)) or can be provided by existing advisory services and networks.

The klimaaktiv programme includes mobility management for leisure activities and tourism and provides innovative and practical solutions, partially connected to adaptation.

The Federal Ministry for Digital and Economic Affairs (formerly BMFWF) published a study in 2012 on climatic change and tourism in Austria in 2030, covering impacts, opportunities and risks, options and strategies (Fleischhacker et al. 2012)⁴⁸. Three main areas of action were identified for adaptation to climatic change in the tourism branch:

- Development of offers: Support for innovation, diversification of tourism research, safeguarding and further development of winter sports requiring snow;
- Risk reduction: Strengthening of hazard prevention using technical measures, risk minimisation through organisational measures;
- Communication: Clear positioning, targeted marketing, awareness-raising for the general public.

The Ministry also provides information measures (e.g., events about energy efficiency in hotels and restaurants or about sustainable mobility in the tourism branch) and publishes guidelines, such as those on energy management in hotels and restaurants and sustainable mobility in the tourism branch and guidelines for practitioners on sustainable mobility in tourism regions.

The Austrian environment label for tourism businesses (Österreichische Umweltzeichen für Tourismusbetriebe⁴⁹) is a joint initiative of the Ministries for environment and for education, science and research. It distinguishes accommodation and restaurants for their engagement in environmentally friendly management and social responsibility. Environmental labels for green meetings and events and for travel offers⁵⁰ are also relevant.

The initiative “Hotel of the Future”⁵¹ was developed by the professional association of the hotel industry and the federal department on tourism and leisure of the Austrian

⁴⁷ Link: e5 – Programme for energy-efficient municipalities: <http://www.e5-gemeinden.at/>

⁴⁸ Link to the summary: [Klimawandel und Tourismus in Österreich 2030 – Auswirkungen, Chancen & Risiken, Optionen & Strategien](#)

⁴⁹ Link: <http://www.umweltzeichen.at/cms/de/tourismus/content.html>

⁵⁰ Link: <http://www.umweltzeichen.at/cms/de/tourismus/content.html>

⁵¹ Link: <http://www.hotelderzukunft.at/>

Recommended further steps	<p>Economic Chamber and aims to raise awareness among hotel operators about environmentally friendly and climate-friendly possibilities.</p> <p>The initiative “Event of the Future” of the professional association of leisure and sport operators and the federal department on tourism and leisure of the Austrian Economic Chamber aims to stimulate the event business sector to integrate environmental protection, resource conservation and climatic change mitigation, as well as corporate social responsibility.</p> <ul style="list-style-type: none"> – Evaluation of funding measures using fixed criteria, in order to undertake necessary changes of the guidelines on a solid basis and thus to be able to use them for steering adaptation in the tourism sector; – Adaptation of tourism support with respect to climate-relevant themes; – Measures to increase awareness of responsible persons in the tourism branch with regard to the need to change the supply or develop new offers for different target groups. Here, new opportunities should be promoted (e.g., making summer tourism attractive, strengthening all-year tourism, offering sustainable mobility); – Training of personnel during the implementation of new offers; – Development of climate-friendly regional adaptation measures with inclusion of the general public in regional participatory processes; – Orientation of investments in the mobility sector towards sustainable measures, in order to minimise the share of greenhouse gas emissions with inclusion of regional and supra-regional transport and infrastructure operators; – Prioritisation of those climate-friendly adaptation measures that make use of existing infrastructure; – Evaluation of the existing tourism offers in the regions with respect to possible adaptation; – More intensive research regarding further possibilities for adaptation in climate-sensitive regions (e.g., alternative offers for low-lying winter tourism destinations); – Research to analyse potential (new) target groups and development of climate-friendly offers; – Strengthened use of advisory services and networks to disseminate information about adaptation to climatic change.
Possible resource requirements	<p>Through the use of existing institutions and support programmes, no additional financial resources are required.</p> <p>Financial resources are needed for the increased need for research on climate-friendly adaptation measures. Further resources are required for awareness-raising measures, training of people in the tourism sector and setting up networks.</p>
Possible conflict potential	<p>There is possible conflict potential with agriculture or settlement development with respect to land use requirements.</p>
Actors	<p>Federal and state governments, regions, municipalities, local tourism organizations, Association of Towns and Municipalities, interest groups, individual entrepreneurs, advisory institutions and services, incoming & outgoing trade, networks (e.g., RegioNext (Styria) and Planning Association, Tyrol), LEADER regions.</p>
Time horizon	<p>Sufficiently long time periods must be foreseen. The development can begin immediately. The aim is a step-wise adaptation and further development.</p> <p>Adaptation of funding instruments can be done in the short term, while the effects are over the long term.</p>

2.4.2.3 DEVELOPMENT, PROVISION AND IMPROVEMENT OF REGIONAL DATA AS THE BASIS FOR DECISION-MAKING FOR ADAPTATION MEASURES

Objective	<p>Minimising existing uncertainties and preparing robust bases for decision-making, especially by integrating regional climate change scenarios.</p>
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Significance	<p>On the basis of regional climate scenarios it is possible to analyse the climate sensitivity of specific locations. This provides a well-founded basis for future decisions and planning. In addition to meteorological data, regional economic and tourism (demand and supply) information must be gathered.</p> <p>A deeper analysis is needed for the following topics:</p> <ul style="list-style-type: none"> – Correlation of the demand (booking) behaviour with climate / weather data; – Influence of changes (e.g., reduced guarantee of snow) resulting from climatic change on the behaviour of tourists; – Influence of climatic change on tourism in protected areas; – Impacts of climatic change on summer tourism; – Studies of possible adaptation measures with regard to reduction of greenhouse gas emissions (APCC 2014); – Regional studies that include questions regarding economic and business aspects of tourism (APCC 2014).
Connection to other sectors	Essentially there are connections to all sectors, in particular to water management, ecosystems/biodiversity, as well as protection against natural hazards.
Connection to existing instruments	<p>The tourism strategies of the federal states are useful and they could be extended with information on regional climate scenarios and further relevant regional data.</p> <p>Research programmes (e.g. the Austrian Climate Research Programme of the Austrian Climate and Energy Fund, StartClim, the Austrian Academy of Sciences, Ministries etc.) are important for the generation of new information.</p>
State of implementation	<p>New regional climate scenarios for Austria are available since the summer of 2016 and can be used by the tourism sector.</p> <p>First steps towards the analysis of the climate sensitivity of destinations were taken with a study of the vulnerability of Austrian winter tourism destinations to climatic change (Halbertschlager et al. 2008). Further, within the framework of a range of Austrian funding programmes, some aspects of climatic change and tourism have been studied. The consideration of already existing results for individual regions and for the whole of Austria is essential. The assessment report on climatic change in Austria (APCC 2014) summarises the relevant literature on this topic and provides detailed information for decision makers. Both the impacts of climatic change on tourism and possible measures for mitigation and adaptation are covered in the report.</p>
Recommended further steps	<ul style="list-style-type: none"> – Pooling and provision of already existing information for decision makers – in particular, at the regional level – and examination of the results from the Austrian Assessment (APCC 2014) to demonstrate their practical relevance; – Use of media (e.g., newsletters or online platforms) for an active information dissemination and awareness-raising in the tourism sector; – Inclusion of significant regional information in (regional) tourism strategies; – Establishment or rigorous use of funding programmes for relevant research questions that target the needs of regional decision makers; – Consideration of data relevant for tourism decisions at the regional level – in particular in the case of investments that are designed to last for a long period of time (e.g., ski slopes, mountain huts) or that relate to safety concerns (e.g. nets along mountain paths). Web-based tools can support decision processes.
Possible resource requirements	<p>Human resources are available for the translation of natural science data into information that is useful for regional decision makers.</p> <p>Financial resources from funding programmes (including the Climate and Energy Fund, StartClim, the Austrian Academy of Sciences, Ministries etc.) are important for the generation of information.</p> <p>The analysis of existing data and the collection of further relevant information require financial resources. A detailed research agenda in cooperation with all funders could contribute to increased efficiency.</p>

Possible conflict potential	<p>Conflict potential exists with those tourism operations/branches that are identified as particularly vulnerable on the basis of regional climate scenarios, as well as tourism and socio-economic data.</p> <p>In the case of further installation of artificial snow-making and creation of ponds for snow-making, an increase of the potential of danger can occur (possible dam breaching and flash floods).</p>
Actors	Alpine clubs, vacation destinations. The input of both the federal government and the federal states is required with regard to the creation of new underlying data (e.g., regional climate scenarios, information on new offers).
Time horizon	The elaboration and synthesis of information is already taking place but must be strengthened. The use of these data can already begin step-by-step.

2.4.2.4 SUPPORT FOR CLIMATE CHANGE-ENDANGERED WINTER SPORT REGIONS BY CREATING OFFERS NOT DEPENDENT ON SNOW

Objective	Securing value creation from tourism long-term by diversifying offers.
Significance	<p>Winter tourism in Austria strongly depends on good snow conditions that make alpine skiing, snowboarding and cross-country skiing possible (APCC 2014). The guarantee of snow is the most important decision criterion in the selection of the ski resort (Unbehau et al. 2008). In many places in Austria, skiing operations would not be possible without artificial snow-making. Of the investments made in 2015-2016 by the Austrian lift operators (€570 million), €154 million were foreseen for artificial snow-making⁵². Currently around 65% of the piste area in Austria has artificial snow-making facilities (WKO 2015), but the future use is limited unless technical adaptations are implemented (APCC 2014). A further increase of snow production may lead to economic and environmental problems in many ski resorts (APCC 2014).</p> <p>Because of the differing characteristics, it is not possible to make general recommendations for responses to climatic risks. Offers that do not depend on snow should therefore be developed together with regional actors. It is necessary to ensure that they do not have any negative impacts with respect to climatic change mitigation and environmental protection, e.g., increase emissions or water use and land use.</p>
Connection to other sectors	Essentially there are connections to all sectors, in particular to ecosystems/biodiversity, economy, forestry, agriculture, water management and energy.
Connection to existing instruments	Tourism can adapt to climatic changes in multiple ways. In the study of tourism and climatic change in Austria in 2030 (Fleischhacker et al. 2012), adaptation measures are presented for the nine most important areas of demand, including winter tourism. The proposed measures have, however, not been assessed with respect to their environmental impacts.
State of implementation	<p>According to a study of the Naturfreunde in 2011, winter sport resorts already advertise alternatives to skiing. Tobogganing and snow-shoeing are possible when there is only a thin layer of snow. Frozen lakes offer opportunities for ice-slating and curling. In addition, resorts already provide all-year offers that do not depend on the weather, such as indoor swimming pools, saunas and climbing gyms. So far, regions have turned to offers that do not depend on snow for economic reasons.</p> <p>A StartClim study on tourism offers that do not depend on the weather focussed on offers for nature adventures (Pröbstl-Haider & Melzer 2015). The research project ClimAlpTour (Research programme Alpine Space)⁵³ developed an online tool to</p>

⁵² Link: <https://www.wko.at/Content.Node/branchen/oe/TransportVerkehr/Seilbahnen/Factsheets.html>

⁵³ Link: http://www.alpine-space.org/2007-2013/projects/projects/detail/ClimAlpTour/show/index.html#project_outputs

Recommended further steps	<p>support the selection of adaptation measures using evaluation criteria (e.g., environmental impacts, long-term sustainability, innovative).</p> <ul style="list-style-type: none"> – Make best practice examples from winter sport regions accessible for persons responsible for tourism (e.g., brochures, events); – Training of actors and those with political responsibility on the topic of climatic change and provision of expert support and process support for the development of offers that do not depend on snow; – Further development of cultural offers (concerts, exhibitions, lectures, readings), as well as offers to emphasise regional specialities (with regard to landscape and cuisine); – Further development and implementation of concrete strategies for sustainable winter tourism including the general public and considering adaptation and mitigation measures; – Evaluation using suitable criteria of support instruments for adaptation to climatic change.
Possible resource requirements	<p>Through the use of established institutions and funding programmes, there are no additional funding requirements.</p> <p>In the short term, financial resources could be necessary in winter sport regions that develop offers that do not depend on snow, but in the long term these costs should be recovered.</p>
Possible conflict potential	<p>There is possible conflict potential with agriculture or settlement development with regard to demand for land area, as well as with climatic change mitigation goals, if proposed measures increase emissions.</p>
Actors	<p>Federal and state governments, regions, municipalities, local tourism organizations, Association of Towns and Municipalities, interest groups, individual entrepreneurs, advisory institutions and services, incoming & outgoing trade, networks (e.g., RegioNext (Styria) and Planning Association, Tyrol), LEADER regions.</p>
Time horizon	<p>Sufficiently long time periods must be foreseen. The development can begin immediately. The aim is a step-wise adaptation and further development.</p> <p>Adaptation of funding instruments can be done in the short term, while the effects are over the long term.</p>

2.4.2.5 STRENGTHENING ALPINE SUMMER TOURISM

Objective	<p>Protecting alpine infrastructure and taking up opportunities due to climate change in summer tourism.</p>
Significance	<p>In recent years, summer tourism in Austria has been declining or stagnating and, compared to winter tourism, the lower average expenditures of tourists have led to a decline of the economic significance of summer tourism (APCC 2014). For summer tourism, climatic change provides opportunities and risks, which must be addressed by adaptation measures.</p> <p>Opportunities include the earlier start and later finish of the summer season, as well as an increase of periods with comfortable temperatures for leisure and sport. The frequency of precipitation in the summer months is projected to decrease, which leads to a better “weather guarantee”. Locations above 1000 – 1200m will not experience extreme heat or humidity and have the advantage of a pleasant “cool” climate (Fleischhacker et al. 2012). There is the possibility that alpine summer tourism will become more significant as a result of extreme heat in southern Europe. In the case of increasingly unattractive conditions in the Mediterranean region, every sixth beach holidaymaker would take his/her holidays somewhere else, e.g., a hiking or mountain holiday instead of a beach holiday (Fleischhacker et al. 2009).</p> <p>An important consideration for summer alpine tourism is the wide-reaching network of paths and mountain huts. In 2014, the Austrian Alpine Club invested 25.2% of the</p>

Connection to other sectors	<p>budget (€9.48 million) in the maintenance of the 235 mountain huts, the maintenance of the 26,000 km of paths and the more than 200 climbing facilities in the alpine area (Österreichischer Alpenverein 2014). These investments in the mountain areas and the work associated with them cannot be considered in isolation from a tourism point of view, since they are closely connected with tourism economy in the valley areas. Risks related to climatic change have been observed in recent years in high mountainous areas. Above all, the increases of rock falls and landslides, as well as subsidence of buildings, lead to problems. The retreat of glaciers and thawing of permafrost can lead to further instability of tourism infrastructure in high alpine locations (APCC 2014). An increase of potential dangers can negatively affect tourism demand (Pröbstl und Damm 2009). In addition, the retreat of glaciers can significantly change the landscape (Fleischhacker et al. 2012).</p> <p>For these reasons, the investments to maintain and adapt, in response to climatic change, the network of paths and mountain huts will increase further in the coming years and decades. Safeguarding the alpine infrastructure must have highest priority.</p> <p>In particular, there are connections to protection against natural hazards, health, ecosystems/biodiversity and the economy.</p>
Connection to existing instruments	<p>In 2011, the Alpine Club published a handbook⁵⁴ on paths, which also considers the impacts of climatic change.</p>
State of implementation	<p>As a result of increasing danger of rock falls, new construction of alpine climbs and paths has been necessary, for example on the Dullater Nock (Alpenverein 2011).</p> <p>More research is needed. In the StartClim project AlpinRiskGP⁵⁵, the current and future potential risks for alpine tourists and infrastructure as result of glacier retreat and permafrost changes were studied in the Großglockner area (Lieb et al. 2010). The result of this project showed how strongly individual paths and sections of routes could be affected and what measures could be taken, e.g., abandonment or new development of paths, installation of an information system for paths, improved training.</p> <p>Another study in the StartClim research programme estimated safety aspects and the development of visitor management approaches in high mountains using the example of the Tux valley (Pröbstl und Damm 2009⁵⁶).</p> <p>A further study looked at three regions (the Glockner region, the Venediger region and a section of the mountains in the Ötz valley) to identify the need for action with regard to pathways and mountain huts (Braun 2009⁵⁷).</p>
Recommended further steps	<ul style="list-style-type: none"> – Provision of advice and support in the development of sustainable and environmentally friendly tourism offers to strengthen summer tourism. In this case, environmental niche products should be developed and nature experience should be a priority (e.g., national park experiences, nature hotels); – Strengthened efforts to identify new target groups (e.g., the 50+ age group, young people interested in sport, people focussed on health); – Research on the level of acceptance among holiday-makers of a renaissance of summer resorts and the underlying conditions for potential demand; – Use of information systems for paths based on GIS to identify danger spots and to develop targeted measures in the network of paths; – Evaluation, using suitable criteria, of support instruments for adaptation to climatic change.

⁵⁴ Link: [Wegehandbuch der Alpenvereine](#)

⁵⁵ Link: http://www.startclim.at/fileadmin/user_upload/StartClim2009_reports/StC109F.pdf

⁵⁶ Link: http://www.startclim.at/fileadmin/user_upload/reports/StC108F.pdf

⁵⁷ Link:

https://zidapps.boku.ac.at/abstracts/download.php?dataset_id=7618&property_id=107&role_id=NONE

Possible resource requirements	In the short term, financial resources could be necessary to develop offers, but in the long term these costs should be recovered.
Possible conflict potential	There is possible conflict potential in the case of land use through the creation of new offers and also with climate mitigation goals, if the proposed measures increase emissions.
Actors	Federal and state governments, regions, municipalities, local tourism organizations, Association of Towns and Municipalities, interest groups, individual entrepreneurs, advisory institutions and services, incoming & outgoing trade, networks (e.g., RegioNext (Styria) and Planning Association, Tyrol), LEADER regions.
Time horizon	Sufficiently long time periods must be considered. The development can begin immediately. A step-wise adaptation and further development are needed. Adaptation of the support instruments can begin in the short term, while the effects will be seen over the long term.

2.4.2.6 EXPANSION OF CITY TOURISM IN AUSTRIA

Objective	Creating urban tourism offers adapted to climate change and strengthening the establishment of year-round offers.
Significance	<p>Societal trends, such as the increase of single-person households or the increasing level of education of those who travel, are increasing the number of city tours. Warmer conditions in spring and autumn can have positive impacts on this trend.</p> <p>At the height of summer, increased heat stress can be expected. However, the highest number of tourists also occurs in July and August. In particular, the heat-sensitive population over 60 years of age is affected by the increase of the heat island effect. A survey in Vienna on days following a hot day showed, however, that only one-third of those surveyed had changed their programme and instead frequented parks (Allex et al. 2011). Adaptation measures are required in city tourism with regard to increased heat stress.</p> <p>In this case, it is important to ensure that the expansion of city tourism is designed to be as climate-friendly as possible. In particular, travel for city tours is mostly undertaken with aeroplanes. Offers for climate-friendly travel to and from the destination should be provided as an alternative to flying, as well as travel offers, accommodation and hotels, restaurants etc. that have the Austrian Ecolabel.</p>
Connection to other sectors	Essentially there are connections to all other sectors, in particular to spatial planning, urban spaces, transport infrastructure, economy and energy.
Connection to existing instruments	The study on climatic change and tourism in Austria in 2030, examining impacts, opportunities and risks, options and strategies ⁵⁸ (Fleischhacker et al. 2012) also presents concrete adaptation possibilities for city tourism.
State of implementation	<p>City tourism adaptation measures are already being implemented for some aspects. The city of Vienna, for example, has increased the number of water fountains in places frequently visited by tourists. The locations can be found using an online city map. In Linz, on the other hand, a reduction of the heat island effect was achieved through greening of the tram tracks (Allex et al. 2011). Graz has created a network of green and open spaces that has contributed to an improvement of the local climatic situation.</p> <p>The study “Hot Town, Summer in the City”⁵⁹ explored the impacts of an increased heat island effect on city tourism (Brandenburg et al. 2010). In the resulting “management letter”, strategies for city tourism were presented, which should support responsible persons in the tourism branch, city administration and city planning in developing and implementing adaptation options.</p>

⁵⁸ Link: [Klimawandel und Tourismus in Österreich 2030 – Auswirkungen, Chancen & Risiken, Optionen & Strategien](#)

⁵⁹ Link: http://www.startclim.at/fileadmin/user_upload/StartClim2010_reports/StC110F_mitAnhang.pdf

Recommended further steps	<ul style="list-style-type: none"> – Measures in city, spatial and landscape planning, in particular: greening of roofs and façades; use of light-coloured building materials; reserving green spaces and fresh air corridors; use of evaporative cooling through moving water; opening of “cooling rooms” on days with extreme heat etc.; – Provide information for guests regarding days with extreme heat, showing where water fountains and cool locations can be found, suggesting suitable tours for hot days; – Promote easy access to high quality drinking water and emphasise this speciality and the picture of a cool city in a hot summer in marketing.
Possible resource requirements	Technical measures are associated with high costs. So-called “green” adaptation measures (e.g., promotion of parks), on the other hand, can be implemented cost-effectively.
Possible conflict potential	Conflict potential can possibly arise with regard to demands for land area in the creation of new offers.
Actors	Federal and state governments, tourism industry, municipal governments, urban planning, tourists.
Time horizon	Development can start immediately. A step-wise adaptation and further development are needed.

2.5 ENERGY SECTOR – FOCUS ELECTRICITY SECTOR

2.5.1 OVERARCHING OBJECTIVE OF THE SECTOR

Overarching objective: Safeguarding energy supply in general and in particular in the electricity sector under consideration of the consequences of climatic change; diversification of energy sources and decentralisation of the energy system⁶⁰, as well as reduction of energy consumption in order to reduce the vulnerability to the impacts of climatic change.

When the share of renewable energy sources is increasing, the safety of supply can be guaranteed more easily if measures are taken to reduce energy consumption.

2.5.2 RECOMMENDED ACTIONS FOR THE ENERGY SECTOR

GENERAL PRINCIPLES FOR ACTION IN THE ENERGY SECTOR

- The effects of climate adaptation and mitigation measures are closely connected to each other in this sector⁶¹. The numerous synergies should be taken into account as far as possible in all cases.
- The secure supply of electricity is not an entirely national matter. Failures of power plants or breakdowns in the distribution system of the European integrated grid can be a problem for Austrian supply (and vice versa). In addition, the influence of the international energy markets (price and demand developments) must be considered and robust measures must be developed that can cope with these global developments.
- Because in many cases it takes a long time for measures to become effective – in particular in this sector - different observation periods (short term: 1–10 years; medium term: 10–20 years; long term: 20 years and longer) and a differentiation between transition and long-term solutions makes sense. It makes sense in the short term to analyse the possibilities for adapting existing generating structures and at the same time consider the long-term aspects (impacts).
- In the assessment of adaptation measures in the electricity sector, ecological, nature protection and societal aspects must be considered. Also for the expansion of the use of renewable energy sources, environment, nature and landscape considerations must be taken into account.
- Energy saving, energy efficiency and the avoidance of supply shortages can be supported by both technical as well as awareness-raising measures (such as the climate mitigation initiative *klimaaktiv*).
- In this sector there are numerous relevant EU legal regulations and European norms. The development of norms is supported by a committee on energy management of Austrian Standards. A strengthened consideration of the impacts of climatic change in the development and revision of the European norms would be advisable. For this, active participation of all relevant actors in the Austrian Standards committee would be important.

2.5.2.1 OPTIMISATION OF THE NETWORK INFRASTRUCTURE

Objective	Avoidance of foreseeable supply shortages and overcapacities and reduction of vulnerability to extreme weather events.
Significance	Security of supply requires efficient and reliable transmission and distribution grids. In the future, energy suppliers and network operators will be confronted by more

⁶⁰Definition of decentralised energy supply: the decentralised generation includes those generating facilities, which are connected to public medium- or low-voltage grids and close to the consumption, as well as all generating facilities that are for self-supply (Energie-Control 2005).

⁶¹Therefore in this sector, several of the proposed recommendations for action are closely connected to measures for climatic change mitigation (e.g. the diversification of the energy supply).

decentralised generation, increased flow volumes and increasing demands for security of supply. In addition, climatic change could increase the vulnerability of the Austrian electricity network to failures as a result of weather. Large-scale interruptions as a result of snow and ice load, as well as wind, such as experienced in the winters of 2013/2014 and 2014/2015, or mudslides demonstrate the vulnerability of the supply network. Adaptation measures for network operations are therefore necessary and can be most simply and cost-effectively implemented, if they are taken into account in the planning of new sections of cable or the renovation of existing networks. It should be noted, however, that Austria, also in comparison with other European countries, has a high level of security of supply (CEER 2015).

The expansion of the network should also consider the possible increase of extreme weather events and the future regional distribution of supply and demand, particularly with regard to the increasing significance of decentralised feeding-in of renewable energy.

An increase of small decentralised energy suppliers (see the chapter on supporting decentralised energy generation and feed-in) will require adaptation of management of the electricity networks. An optimal electricity supply using renewable, decentralised energy sources requires an “intelligent” infrastructure: so-called “smart grids” provide the technological basis for an active control and distribution network. In addition to technology and infrastructure, corresponding market mechanisms are needed, which allow the development and utilisation of flexibility in generation, consumption, network management and storage (including synergies that are cross-sectoral across energy sources) through suitable exchange, valorisation and compensation mechanisms.

In the case of new power plants, the aim should be a minimisation of the network lengths (and thus the transportation losses and the susceptibility to disturbance). In this context, it also makes sense to carry out a comprehensive impact assessment for new power plants, considering the impacts on transport and distribution networks, safeguarding a long-term security of supply and minimising the dependence on foreign sources. Decisions regarding location selection should optimise the yield through cogeneration (district heating). The expansion of an effective European grid in connection with the expansion of adequate storage capacity will benefit the integration of renewable energy carriers that have fluctuating generation (e.g., wind and sun). With respect to the increased use of renewable energy sources, cogeneration to produce both electricity and heat is considered to be a flexible compensation for electricity generation from fluctuating sources.

Connection to other sectors

There are close connections in particular to construction and housing and to spatial planning.

Connection to existing instruments

At the European level, the regulation (EU Nr. 347/2013) for trans-European energy infrastructure has entered into force. On the basis of this regulation the energy infrastructure of the EU should be upgraded in order to prevent technical failures and to strengthen the resilience of the infrastructure in the case of failures, natural or anthropogenic disasters, negative impacts of climatic change and threats to their safety.

The implementation or the formalisation of the regulation was carried out in Austria through the Energy Infrastructure Law (BGBl. I Nr. 4/2016).

Die EU internal energy market directive (*DIRECTIVE 2009/72/EC*) states that ensuring electricity supply is decisive for responding to climatic change and requires that 80% of electricity meters should be “smart meters” by 2020 (to the extent that these have positive economic evaluations in the country).

The framework strategy for the Energy Union (COM/2015/080 final) has, amongst others, the goals of security of energy supply and of energy efficiency (see also the chapter on avoiding overheating of buildings in summer through reduction of electricity consumption and increasing the final energy efficiency), but puts priority on technological and market solutions and lower priority on a real reduction of demand.

A further related instrument is the Master Plan 2030 Austrian Power Grid AG (APG) for the development of the transmission grid in Austria for 2013 – 2030 with a

<p>State of implementation</p>	<p>perspective to 2050 (Austrian Power Grid AG 2013). In addition ENTSO-E, the European Network of Transmission System Operators for Electricity, has plans for the development of supra-regional grids.</p> <p>In the Austrian Smart Grids Technology Platform (Smartgrids Austria) founded in 2008, partners from industry, the energy sector and research are working together to prepare the grid infrastructure for the increased use of renewable energy and the increasing decentralisation. The Technology Roadmap Smart Grids Austria (Technologieplattform Smart Grids Austria 2015)⁶² and the strategy process (Smart Grids 2.0) initiated by the Austrian Ministry for Transport, Innovation and Technology (BMVIT) will make a significant contribution to the implementation of smart grids.</p> <p>The Energy Infrastructure Law and the APG Master Plan are the basis for medium- and long-term planning.</p>
<p>Recommended further steps</p>	<p>Within the strategy process Smart Grids 2.0 the results of previous research and demonstration projects were evaluated together with relevant actors and medium-term strategies and concrete action plans for Austria were developed. A research programme, funded by the Austrian Ministry for Transport, Innovation and Technology and the Austrian Climate and Energy Fund, identifies relevant questions for strategy development and commissions necessary research. Further relevant research results are provided by the programme on city of the future of the Austrian Ministry on Transport, Innovation and Technology and the energy research programme of the Austrian Climate and Energy Fund.</p> <ul style="list-style-type: none"> – Strengthened consideration of adaptation in future expansion and planning of transmission and distribution grids on the basis of uniform criteria; – Where necessary, implementation of a legal framework and further support for smart grids; – Continuation of the existing research on smart grids, on the impacts of decentralised feed-in and active distribution grids and on the development of the grid and generation structure until 2050, as the basis for strategy development and decision making; – Strengthened provision of incentives to support innovative technologies and the introduction of smart grids; – Inclusion of the general public; – Analysis of the efficiency of existing support systems for infrastructure considering climate goals.
<p>Possible resource requirements</p>	<p>On the basis of current knowledge, the resource requirements for the development of the basis for a uniform planning of the grid cannot be estimated.</p>
<p>Possible conflict potential</p>	<p>It cannot be excluded that expansion of the grid could lead to conflicts with the population or land owners.</p>
<p>Actors</p>	<p>Federal and state governments, electricity industry, e-control, network operators, EU, academic and non-academic research institutions.</p>
<p>Time horizon</p>	<p>The implementation can take place in the long term, because of the long lead times.</p>

2.5.2.2 PROMOTION OF DECENTRALISED ENERGY PRODUCTION AND FEED-IN

<p>Objective</p>	<p>Use and optimization of regional renewable resources to enhance security of supply and raising awareness of the general public with respect to energy topics.</p>
<p>Significance</p>	<p>A widespread decentralised and fluctuating feed-in from renewable energy sources will make it necessary for operators of the distribution grid to adjust the protection system in</p>

⁶² Link to Technology Roadmap: <https://nachhaltigwirtschaften.at/de/e2050/highlights/fti-strategie-smart-grids-2-0/technologie-roadmap-smart-grids-2020.php>

Connection to other sectors	<p>the grid and introduce a new operational management system. Currently, energy generated from renewable sources has feed-in priority. The balance between generation and consumption can be maintained through compensation possibilities, such as cogeneration plants, storage and expansion of the grid and through the support for intelligent transport and distribution grids (smart grids). Smart grids together with the appropriate institutional framework allow feed-in of large amounts of electricity from decentralised generation. One possibility for decentralised energy generation is provided by biomass, since this can be immediately deployed.</p> <p>This measure also supports the reduction of CO₂ emissions from fossil fuels.</p>
Connection to existing instruments	<p>In particular, there are connections to agriculture, forestry, water management, construction and housing, and spatial planning. Further connections exist with tourism and ecosystems/biodiversity.</p> <p>The EU directive to support the use of energy from renewable sources (<i>DIRECTIVE 2009/28/EC</i>) sets the goal for the share of renewables in Austria of 34% in 2020 (with reference to the gross final energy consumption) in comparison to the baseline of 23.9% in 2005. In 2014 the share was already 33.0%.</p> <p>The energy efficiency directive (<i>DIRECTIVE 2012/27/EU</i>) was implemented in Austria through an energy efficiency law (<i>BGBL. I Nr. 72/2014</i>) and the energy efficiency guidelines decree (<i>BGBL. II Nr. 394/2015</i>). The latter has already been updated. The main goal of the EU directive was to achieve a significant contribution towards reaching the EU energy efficiency goal for 2020 (20% saving of primary energy in the EU as a whole). The Austrian law implemented the directive with support for energy efficiency measures to achieve an improvement of energy efficiency of 20% by 2020. At the same time, indirectly, this should improve security of supply, increase the share of renewables in the energy mix and reduce the emissions of greenhouse gases.</p> <p>The law on climate protection regulates the preparation and implementation of effective climate protection measures.</p> <p>The green electricity act of 2012 (<i>BGBL. I Nr. 75/2011</i>) set targets for the period 2010-2020 for the expansion of the use of hydropower, wind power, biomass, biogas and photovoltaic energy. By 2015, electricity from green generation plants was to achieve a share of 15%.</p> <p>Further related instruments include the cogeneration law (<i>BGBL. I Nr. 111/2008 i. d. F. BGBL. I Nr. 27/2015</i>), energy and climate strategies of the federal states, master plans of the federal states etc.</p>
State of implementation	<p>Relevant research results are provided by the research programmes of the Austrian Ministry for Transport, Innovation and Technology (City of the Future, House of the Future, Energy Systems of the Future). Within the framework of energy research of the Austrian Climate and Energy Fund, topics are covered, such as energy efficiency, energy saving, renewable energy, smart grids, mobility and transport technology for optimised energy efficiency and climate protection, and storage. Strengthened efforts will be needed in the future to develop integrated regional energy systems. For this, in addition to the integration of the energy systems, including energy sources and infrastructure, integration of the sectors (mobility, industry, agriculture etc.) must also be considered and the relevant “innovation ecosystems” must be taken into account.</p> <p>On the level of the federal states, for example, within the DEZENT project in Styria an implementation plan for decentralised energy supply was developed⁶³.</p>
Recommended further steps	<p>The state of implementation of decentralised feed-in is very variable. Particularly in the case of small-scale generation units there is a need for knowledge and development.</p> <ul style="list-style-type: none"> – Further adaptation of the national legal framework in coordination with legal developments at the level of the EU;

⁶³ Link: <http://www.politik.steiermark.at/cms/beitrag/12387873/121400860/>

	<ul style="list-style-type: none"> – Creation of further incentives for providing buildings with their own generating facilities (using renewable energy): “House as power plant” with the possibility of feeding excess electricity into the grid; – Research into appropriate expansion of decentralised systems⁶⁴, with particular attention to regional characteristics and to optimisation of the feed-in and decoupling of decentralised facilities (households); – Support for research, technology, innovation and demonstration projects on micro-technologies for electricity generation; – Strengthened cooperation between energy supply businesses, grid operators and administration regarding questions related to decentralised energy supply; – Inclusion of corresponding content in education and training programmes for apprenticeships, schools and universities; – Awareness-raising in the general public; ; – Where necessary, creation of public facilities that can be used as energy self-sufficient rooms in the case of power failure (e.g., schools, hospitals); – Increased use of spatial planning instruments to improve energy efficiency. <p>Note: The implementation of measures in the electricity sector and research, technology and innovation policy is connected with the recommendations in the chapter on optimisation of the interaction between generation (from diverse sources) and consumption in an energy supply system with fluctuating supply and demand.</p>
Possible resource requirements	It is necessary to continue to provide sufficient resources for research and especially for the support of demonstration projects. For the implementation, financial incentives could be provided.
Possible conflict potential	Conflicts over the use of space are possible with nature protection and agriculture and in particular with settlement development. The introduction of smart meters can be rejected on the basis of concerns about grid safety, data protection or health.
Actors	Federal government (BMWFJ, BMNT (formerly BMLFUW), BMVIT, BMF), state governments, electricity industry, e-control, network operators, EU.
Time horizon	Feed-in possibilities could be created quickly through the design of the funding system to conform to climate policy goals, providing sufficient investment support and good accompanying support.

2.5.2.3 INCREASED RESEARCH ON POTENTIAL METHODS OF ENERGY STORAGE

Objective	Balancing out supply shortages or excess capacities.
Significance	<p>The objective of a future energy system is a sustainable supply primarily from renewable sources. While the volume of biomass, geothermal energy and hydropower can be planned over the long term, solar and wind power fluctuate strongly. An increased share of fluctuating energy sources requires effective, decentralised and economically attractive storage technologies. In addition, the use of cogeneration plants can contribute through compensating for fluctuating energy sources.</p> <p>For a successful further expansion of renewable energy, energy storage plays a key role, in order to bridge times when generation is weak and guarantee security of supply despite variable generation.</p>

⁶⁴ Decentralised generation structures are advantageous (because they are robust) in many cases but do not make sense everywhere. Aspects such as costs, strong demands for the grid, and – compared to large power plants – a lower efficiency of decentralised generation units must be considered.

Connection to other sectors	<p>For each application, storage technologies (materials, methods) must fulfil a very specific profile of requirements. The areas of application of storage range from the smoothing out of load fluctuations in the grid and of consumers to seasonal compensation of energy flows. Accordingly, the technical requirements differ with respect to energy and power density, efficiency, reaction time, cycle stability, storage capacity, self-discharge and other characteristics. Numerous storage technologies are technically mature and already being used or tested in pilot projects (e.g., pumped storage or district storage⁶⁵). Parallel to the development of technology, in the coming years practical testing of new storage solutions will be important. In order to support the use of storage technologies, an Action Programme could be established. For this, research and development are important and should be supported through specific funding programmes and other incentives for innovation. This can give Austria a lead in this internationally very important innovation area.</p>
Connection to existing instruments	<p>In particular, there is a connection to construction and housing, economy and agriculture.</p> <p>Austrian research and development in the International Energy Agency (IEA). The International Energy Agency is an international platform for various cooperations including the research, development, market introduction and use of energy technologies.</p> <p>The energy research programme of the Austrian Climate and Energy Fund supports the implementation of “Towards an Integrated Roadmap” of the Strategic Energy Technology Plan (SET-Plan) of the European Commission. The main focus is on energy efficiency, energy saving, renewable energy, smart grids, mobility and transport technologies for optimised energy efficiency and climate protection and storage.</p> <p>The energy research and innovation strategy for Austria (BMVIT 2017) provides suggestions for measures in research, technology and innovation.</p>
State of implementation	<p>Nationally and internationally a range of research support mechanisms and incentives exists. Several initiatives and pilot projects are running, e.g., the solar electricity storage packet of the Energie AG in Upper Austria⁶⁶, Sonnenplus-Storage of Kelag⁶⁷ and Power-to-Heat facility of the Salzburg AG⁶⁸.</p> <p>Relevant questions are addressed in particular in the research programme funded by the Austrian Ministry for Transport, Innovation and Technology “City of the Future”, as well as in the energy research of the Austrian Climate and Energy Fund. Among others, the development of innovative technologies for energy storage and prototypes are tested.</p> <p>In 2015 the Austrian Climate and Energy Fund started a storage initiative, which aims to provide potential market participants with information about storage technologies and their areas of use, to make exchange of experience easier and to identify support needs. The first step was to develop concrete recommendations for research and implementation activities (Klima und Energiefonds 2016b).</p> <p>Within the framework of the Austrian programme for centres of competence, COMET, support was provided for the “GSG-GreenStorageGrid“ project, The goal of COMET is to strengthen cooperation between industry and science, to build joint research competences and to support their exploitation.</p>
Recommended further steps	<p>Continuation of existing research programmes and activities;</p>

⁶⁵ Definition: District storage is a central community storage, in a regionally differentiated area (usually corresponding to a grid line), which can act as an interim storage for local feed-in and buffer in the case of shortages in the grid.

⁶⁶ Link: [Sonnenstrom-Speicherpaket der Energie AG Oberösterreich](#)

⁶⁷ Link: [Sonnenplus-Speicher der Kelag - Kärntner Elektrizitäts-Aktiengesellschaft](#)

⁶⁸ Link: <https://www.salzburg-ag.at/presse/aktuelle-meldungen/salzburg-ag-nimmt-zweite-power-to-heat-anlage-in-betrieb-2942/>

	<p>Strengthened implementation of pilot plants and detailed environmental assessment of new storage technologies with increased consideration of the impacts of climatic change;</p> <p>Coordination between the federal government and the federal states of the research programmes and research activities, to avoid duplication and support an effective use of resources for achieving climate policy goals.</p>
Possible resource requirements	For research and implementation of the results, further provision of adequate resources is necessary.
Possible conflict potential	No potential conflicts could be identified.
Actors	BMVIT, BMBWF (formerly BMWFW), state governments, Climate and Energy Fund, academic and non-academic research institutions, energy industry.
Time horizon	Initiatives have started and could be expanded rapidly. It is not possible to identify the timing of implementable findings and successful innovations from research projects. The implementation of research results is expected to be rapid given the strong economic interest.

2.5.2.4 STABILISATION OF THE TRANSPORT AND DISTRIBUTION NETWORK THROUGH APPROPRIATE CLIMATE-ADAPTED SYSTEM PLANNING

Objective	Reduction of the susceptibility of transportation networks to interference and the prevention of overload or supply shortages arising from the expected climatic changes.
Significance	<p>Reliable supply of electricity is of fundamental significance for society (see the introduction to this sector).</p> <p>This measure serves to provide precautionary consideration of meteorological risks in the planning and construction of transmission grids.</p> <p>Assuming both increasing basic loads as well as seasonal peak loads with more extreme weather events (e.g., storms, wet snow, thunderstorms, ice, mudslides) at the same time, the electricity sector faces enormous challenges. Supply disruptions – for example, through overload or damages due to weather – can be avoided through adapted routes and construction.</p> <p>The Austrian grid operators have many years of experience with the fast repair of weather-induced disruptions of the grid. Nevertheless, unforeseen extreme weather (e.g., wet snow in Carinthia in February 2014) can cause large, widespread disruptions to supply. Exchange of experience and cooperation between operators and (climate) research can, in this case, have preventive effects.</p>
Connection to other sectors	There is a connection in particular to spatial planning.
Connection to existing instruments	<p>The function and tasks of the transmission grid operators are set down in the law governing the management and organisation of the electricity sector. They are responsible for the operation and maintenance of their grids, as well as safeguarding the long-term capacity of the grid to satisfy an appropriate demand for transmission of electricity.</p> <p>Building on these fundamental tasks, the law (or the corresponding implementation laws at federal state level) prescribes a range of rights and duties for (transmission-) grid operators. These include above all the public service obligations to treat all customers without discrimination, to build and maintain a sufficient infrastructure, as well as the acceptance of electricity from generation plants.</p> <p>The transeuropean energy networks (TEN-E) play a significant role in safeguarding supply security and diversification of the supply. The development and expansion of transeuropean networks, in particular in the energy sector, was foreseen in the contract founding the European Union. Guidelines for the transeuropean energy infrastructure</p>

	<p>(REGULATION (EU) No 347/2013) identify energy infrastructure projects that are important for the energy sector, "Projects of Common Interest", which should have preferential treatment together with a simultaneous strengthening of public participation and environmental protection and limits on the maximum length of the process.</p> <p>The implementation of the transeuropean energy infrastructure regulation in Austria is done through the Energy Infrastructure Law (BGBl. I Nr. 4/2016). The process handbook that has to be developed according to the EU regulation refers to licensing provisions for all "Projects of Common Interest" and is not legally binding (BMWFV 2016a)⁶⁹.</p> <p>According to the European renewable energy directive (DIRECTIVE 2009/28/EC), by 2020 Austria must increase its share of renewable sources in the gross final energy consumption⁷⁰ to 34%. The expansion of renewable energy sources, which achieves diversification and a long-term safeguarding of energy supply, brings new challenges for the transmission and distribution networks. The legal basis for the permission to expand the network is provided, among others, by the law on the right of way of power lines and the electricity laws of the federal states. The Austrian Power Grid Master Plan for 2030 defines the necessary expansion steps of the transmission grid until 2030 and provides a perspective on possible further developments in the electricity until 2050 (Austrian Power Grid AG 2013). In the grid development plan of 2015 (NEP, Austrian Power Grid AG 2015) the necessary and planned transmission infrastructure projects are described.</p> <p>Furthermore, the law on assessment of environmental impacts must be taken into account for power lines with a voltage of at least 220 kV and a length of at least 15 km.</p>
State of implementation	<p>According to the law governing the management and organisation of the electricity sector, electricity businesses are obliged to build and maintain a sufficient grid structure in the interests of all. Transmission grid operators are obliged to keep the operating system safe, reliable, effective and to use it under consideration of environmental protection.</p>
Recommended further steps	<ul style="list-style-type: none"> – Increased implementation of loops to reduce the susceptibility of the electricity grid to disturbance under consideration of the impacts of climatic change; – Development of regional development concepts for grids; – Development of national and regional emergency plans and adapted crisis management in the case of grid interruptions due to weather events and natural disasters; – Carrying out of crisis practices; – Regular checking and, where necessary, revision of existing legal foundations and of planning instruments (technical and organisational rules for operators and users of grids, Master Plan 2030, network development plan for transmission grids); – Strengthened cooperation between the federal government, federal states, energy suppliers, grid operators, businesses, amongst others with emergency services.
Possible resource requirements	<p>For the adaptation of the grids to new demands resulting from increased energy consumption, especially in summer, and for the integration of renewable energy, further investments are necessary.</p>
Possible conflict potential	<p>Conflict potential could arise through: a lack of acceptance in the general public of the costs of the measures; an increased demand for land area, in particular with nature protection; but also with spatial planning (development of settlements).</p>
Actors	<p>Federal and state governments, energy industry, local residents.</p>

⁶⁹ Link: http://www.bmwfw.gv.at/EnergieUndBergbau/Documents/03_2016_PCI-Verfahrenshandbuch_Aktuell.pdf

⁷⁰The gross final energy consumption is the final energy consumption plus the transport losses and the internal consumption for electricity and district heating generation.

Time horizon | Loops can be realised in the medium term. Crisis management can be adapted in the short term.

2.5.2.5 OPTIMISATION OF THE INTERACTION BETWEEN GENERATION (FROM VARIOUS SOURCES) AND CONSUMPTION IN THE POWER SUPPLY SYSTEM UNDER VARYING SUPPLY AND DEMAND

Objective	Avoiding critical peak loads in the case of shortages; relieving the transmission system during peak loads; optimisation of the decentralised network feed-in.
Significance	<p>Basically, energy efficiency and energy saving should have priority. Through exchanges accompanied by corresponding support programmes (e.g., from the public sector), the number of inefficient electric appliances can be reduced and exchanged with more efficient appliances that correspond to the current state of the art. Through appropriate measures, it should be ensured that some of the saved energy is not lost through an expansion of energy services (rebound effect).</p> <p>To compensate for shortages in times of extreme demand for electricity, measures for load management are useful. These should flatten out the demand peaks, e.g., during periods of extremely hot weather. It is assumed that good load management can contribute to reducing the burden on the grid infrastructure. Through targeted use of storage and inertia effects, as well as through new forms of coordination of consumers through digital technology and new business models, the energy services can be kept on the highest level.</p> <p>Whilst electricity grids with central electricity generation dominate so far, the trend is towards decentralised generation plants, in particular for generation using renewable energy sources (such as, photovoltaic systems, wind power facilities and biogas plants). This leads to a significantly more complex structure, primarily in the area of load regulation and in maintenance of the grid stability. Attention must be paid, amongst others, to the possibility of generation using biomass, since this could be implemented in the short term. Therefore, electricity grids must be adapted to future challenges through a coordinated management using timely and bidirectional communication between the grid components, generation, storage and consumers and an energy- and cost-effective operation of the system (smart grids). Smart meters are considered to be a building block for the conversion to smart grids.</p> <p>They should contribute, given fluctuating supply and demand, to the optimisation of the interaction between generation (from diverse sources) and consumption. Electricity use that is not absolutely necessary during times of peak demand could be shifted to times with lower electricity consumption (at lower prices). A better load distribution can thus be achieved using meters and price incentives. Corresponding agreements exist generally with large-scale consumers but could be made with small-scale consumers. However, there are concerns about the installation of smart meters with respect to the high costs of the equipment and the conversion, the low savings effects and data protection. Studies conclude that the savings effects that can be realised in the household sector are comparatively small at about 2-4% (Kollmann & Moser 2014). The results of a pilot experiment on the introduction of smart meters suggest that for an optimisation of use in society as a whole as well as for individuals and in order to achieve long-lasting savings, a scientific accompanying study is recommendable (Renner et al. 2011).</p>
Connection to other sectors	In principle, there are connections to all other sectors.
Connection to existing instruments	<p>The connections include:</p> <p>The national technology platform Smart Grids Austria;</p> <p>Legal requirements are covered by the EU Directive on the internal market, which requires that by 2020 at least 80% of all customer systems are equipped with a smart meter. The legal basis for the introduction of smart meters in Austria is provided by the</p>

State of implementation	<p>Austrian electricity management and organisation law (2010) with three relevant regulations^{71 72 73}. Accordingly, by the end of 2019 95% of all metering points must be equipped with smart meters.</p> <p>The strategy process of the Austrian Ministry for Transport, Innovation and Technology - Smart Grids 2.0 – aims to assess the available results from research and demonstration projects and develop medium term strategies and concrete plans for action. Within the framework of the "Smart Grids Accompanying Research", funded by the Austrian Ministry for Transport, Innovation and Technology and the Austrian Climate and Energy Fund, questions relevant for the strategy development are identified and corresponding research is commissioned (Strategieprozess Smart Grids 2.0).</p>
Recommended further steps	<p>Energy research of the Austrian Climate and Energy Fund aims to support energy efficiency, energy saving, renewable energy, smart grids and storage.</p> <p>In 2015, about 300,000 smart meters were installed by the grid operators.</p> <ul style="list-style-type: none"> – Establishment of framework conditions for load management; – Creation of investment incentives for energy suppliers, grid operators and consumers to optimise the interaction between generation and consumption; – Further research in particular on increasing energy efficiency, on renewable energy sources, on energy storage or energy storage systems, as well as on optimisation of grids and systems (Smart Grids, Smart Metering); – Creation of exchange programmes as an incentive to change to efficient electric appliances; – Carrying out scientific accompanying research on the individual and societal benefits of smart meters, as well as data communication, transmission and processing; – Awareness-raising and advisory services for consumers; – Inclusion of appropriate content in training and education programmes for apprenticeships, schools and universities.
Possible resource requirements	<p>Research must continue to tackle relevant questions in existing research programmes. The basis for this is the Austrian energy research and innovation strategy (BMVIT 2017).</p>
Possible conflict potential	<p>The introduction and, in particular, the analysis of the data from smart metering can lead to reservations. Customers could reject the introduction of smart metering because of the costs.</p>
Actors	<p>Network operators, EU, federal and state governments, municipalities, energy industry, e-control, industry (producers/generators of devices), customers.</p>
Time horizon	<p>First steps can be implemented in the short to medium term, effects will be observed shortly after implementation. The introduction of smart grids has already started and should be continued.</p>

⁷¹ Regulation of E-Control, with which the requirements for smart meters are set out (Intelligente Messgeräte-AnforderungsVO 2011 – IMA-VO 2011)

⁷² BGBl. II Nr. 323/2014, regulation of the Federal Government on the introduction of smart meters (Intelligente Messgeräte-Einführungsverordnung – IME-VO StF: BGBl. II Nr. 138/2012)

⁷³ Regulation of the board of E-Control, which sets out requirements for data transfer from the grid operator to supplier and the consumption information to the end-user (Datenformat- und VerbrauchsinformationsdarstellungsVO 2012 – DAVID-VO 2012)

2.5.2.6 FACTORING IN THE EFFECTS OF CLIMATE CHANGE WHEN MAKING DECISIONS ON ENERGY AND RESEARCH ACTIVITIES, SUCH AS FROM THE POINT OF VIEW OF FURTHER DIVERSIFICATION

Objective	Increasing security of supply through more diversified energy sources structures and far-reaching avoidance of negative consequences for other areas and their adaptive capacity.
Significance	<p>Climatic change with its consequences (temperature rise, more intensive hot periods, changes of precipitation, extreme events) will have a direct effect on electricity generation or operation of power plants. In Austria the sources of renewable energy include, hydropower, biomass in various forms, wind and solar energy, ambient heat, as well as gas from landfill and water purification plants.</p> <p>As a result of changes of climate and weather, longer periods of low water could occur, in particular in summer, which would reduce the effectiveness of both run-of-river plants and also the provision of cooling water. A regional perspective is, however, necessary. If the frequency and intensity of extreme weather events increase, both the power lines and, for example, photovoltaic systems and the production of biomass will be affected. On the other hand, the operation of power plants (in particular those using renewable energy sources) will influence other sectors that are sensitive to climatic change (e.g., protective water management, biodiversity) and could further increase their vulnerability. This requires further research, for example with respect to the environmental consequences of the use of geothermal energy for energy generation. Therefore, it is necessary to evaluate planned strategies for diversification and decisions with respect to their compatibility with goals relevant for adaptation and to close existing knowledge gaps through research.</p> <p>Possible sub-measures:</p> <ul style="list-style-type: none"> – Hydropower: System optimisation for storage management, with consideration of the consequences for river ecology as well as the protection against flooding; analysis of the water availability for run-of-river plants; – Wind energy: Updating or definition of areas suitable for wind power (priority and reserved areas, in some cases also taboo zones) for each federal state with consideration of aspects regarding nature protection and spatial planning, to ensure reasonable planning and integration; – Geothermal energy: Research on the benefits and potential of geothermal energy in Austria and possible consequences for the soil ecosystem; – Photovoltaic energy: Consideration of wind loads in specifications and norms for new systems; – Regional use of biomass including the cascading use of residues and waste materials. <p>Despite the high significance of renewable energy sources for the energy sector, in particular hydropower⁷⁴, the relevance of thermal power plants for a continuous supply is still high⁷⁵, especially considering the increasing need for cooling in the future. For this, given the need for climate protection, attention should be paid to the coupled production of electricity and (district) heat with a good connection rate in the heating network, as well as the use of primarily sustainably produced biomass (in biomass power plants).</p> <p>In cogeneration plants electricity and heat are produced simultaneously, which leads to a reduction of the primary energy usage and the CO₂ emissions. Various energy sources can be used in cogeneration, including renewable sources (biogenic materials, waste).</p>

⁷⁴ The significance of storage power plants – to compensate the differences between supply and demand – will increase with the increasing expansion of wind power.

⁷⁵ One advantage of thermal power plants (but also storage power plants) is the flexibility (fast switching on and off) and suitability as a balancing mechanism.

Connection to other sectors	<p>Cogeneration technology continues to have a high significance, because of the goal of increasing energy efficiency.</p>
Connection to existing instruments	<p>An increased use of renewable energy sources is not only a significant goal because of climate protection. Diversification is also an important aspect with respect to climate change adaptation. To ensure security of supply, a balanced energy mix using flexible generation units is necessary.</p> <p>Through proactive consideration and planning, bad investments and climate-damaging adaptation measures can be avoided.</p> <p>Basically there are connections to all other sectors, in particular to agriculture, forestry and water management.</p> <p>According to the European renewable energy directive (<i>DIRECTIVE 2009/28/EC</i>), by 2020 Austria must increase its share of renewable sources in the gross final energy consumption to 34%. Connections are to the Green Electricity Law of 2012 (<i>BGBl. I Nr. 75/2011</i>), the energy efficiency law (<i>BGBl. I Nr. 72/2014</i>), the national law on the promotion of the installation of district cooling pipelines (<i>BGBl. I Nr. 113/2008 i.d.F. BGBl. I Nr. 72/2014</i>), the environmental support law (<i>BGBl. Nr. 185/1993 i.d.g.F.</i>) and the law on cogeneration (<i>BGBl. I Nr. 111/2008 i. d. F. BGBl. I Nr. 27/2015</i>), as well as the climate protection law, the energy and climate strategies of the federal states and business strategies.</p>
State of implementation	<p>Businesses implement possible preventive measures to avoid damages, when the economic framework conditions are suitable, and these measures are also included in long-term strategic decisions.</p> <p>Relevant results are delivered through research programmes, such as those of the Austrian Ministry of Transport, Innovation and Technology and the Austrian Climate and Energy Fund.</p>
Recommended further steps	<ul style="list-style-type: none"> – Coordination of existing instruments with regard to their objectives, and measures, in order to avoid possibly contradictory proposed measures in the strategies (e.g., between the climate change adaptation strategy and the energy strategy); – Continual adaptation of existing strategies and policy instruments according to new information and results; – Creation of a basis relevant for decision making for the development of long-term strategies and determination of the economically feasible options and framework conditions; – Knowledge transfer into the various levels of decision making (targeted transfer of new information to individual actors); – Development of emergency measures (emergency plans) for extreme events, such as the occurrence of longer low-water periods in summer; – Awareness-raising and information with regard to the need for measures at all levels.
Possible resource requirements	<p>No reliable estimates of possible resource requirements can be made at present.</p>
Possible conflict potential	<p>Conflicts with other sectors depend on the type of measure to be implemented. For example: Water management (measures towards expansion of hydropower), nature protection (e.g. power lines), air pollution and agriculture (type of biomass used) and land requirements or negative impacts on flora, fauna and landscape through wind power installations. During the implementation of the measure, non-technical barriers can occur, for instance objections from the general public or a lack of consensus between impacted stakeholder groups regarding the financing of measures, but also lack of clarity regarding responsibilities. Furthermore, legal obstacles can block the implementation.</p>

Actors	Energy suppliers, federal government (BMBWF (formerly BMWFW), BMVIT, BMNT (formerly BMLFUW), BMF), state governments, municipalities, energy service providers, interest groups, NGOs (e.g., Austrian Biomass Association, photovoltaics).
Time horizon	The implementation depends on the dynamics at the level of decision making (e.g., strategic decisions in business can be made quickly, while on the level of regional authorities they require a longer process).

2.5.2.7 REDUCTION OF INTERNAL LOADS TO AVOID OVERHEATING IN SUMMER IN BUILDINGS BY REDUCING POWER CONSUMPTION AND INCREASING FINAL ENERGY EFFICIENCY

Objective	Improvement of thermal comfort in buildings during heat waves in the summer by increasing efficiency to reduce both internal heat loads ⁷⁶ and energy consumption.
Significance	<p>Climatic change will lead to higher temperatures on very hot days and to an increase of heat-waves. This can have negative impacts on the thermal comfort both in homes and other buildings and lead to impacts on health (see also the chapter on the health sector). In addition to the heat coming from outside, heat is also added from inside the building. The reduction of the internal sources of heat, necessary from the point of view of climate change adaptation, is generally connected to an increase of the energy efficiency of appliances (e.g. lighting, computer systems etc.) and thus with a reduction in greenhouse gas emissions.</p> <p>In general, the reduction of energy consumption should be supported by awareness-raising measures, such as the climate protection initiative “klimaaktiv”, which also supports adaptation to climatic change</p> <p>In addition, further measures will be necessary, which reduce the demand for heating and cooling energy, as well as the electricity demand (see also the recommendations in the chapter on the construction and housing sector and the chapter on alternative, energy-saving technologies in the economy sector).</p> <p>About one third of energy use is in the building sector: for heating or cooling of rooms, heating water and lighting.</p> <p>A conscious use of energy-consuming equipment saves energy and reduces the heating inside buildings. Examples of undesirable heat sources are consumer electronics or inefficient / badly placed refrigerators.</p>
Connection to other sectors	There is a close connection to construction and housing, tourism, economy and health.
Connection to existing instruments	<p>The action plan for energy efficiency of the European Commission (<i>COM(2006)545</i>) aims to reduce electricity consumption by 20% by 2020 and proposes a packet of measures at the EU level to achieve this goal. The EU regulation on final energy efficiency (<i>DIRECTIVE 2006/32/EC</i>) has the general goal to reduce the average annual final energy consumption by 9% in each Member State between 2007 and 2016 (baseline values from 2001 – 2005). A further EU regulation (<i>DIRECTIVE 2012/27/EU</i>) aims to make a substantial contribution to achieving the 20% reduction of energy consumption by 2020. The latter regulation was implemented in Austria through a federal law on energy efficiency (<i>BGBl. I Nr. 72/2014</i>); Lower Austria adopted a corresponding law at the federal state level. The Austrian achievements with respect to energy efficiency are evaluated and documented within the framework of the annual progress report to the EU, as well as the national energy efficiency plan</p> <p>The EU framework strategy for a stable Energy Union (<i>COM(2015) 80 final</i>) focuses on the energy efficiency of the transport and space-heating sectors, but less on effective measures to reduce demand and more on technological and market-based changes.</p>

⁷⁶ Internal loads include heat or moisture emissions from users, appliances and machines (heat and draughts, odour emissions, pollutants) as well as activities (washing, taking a shower and cooking) that increase the air humidity.

State of implementation

The EU Building Directive (*DIRECTIVE 2010/31/EU*) requires, amongst others, the presentation of an energy pass for the construction, sale or renting of buildings, which is not valid after 10 years. The obligation to present an energy pass within the framework of this regulation should have the effect that more buildings, apartments and business premises with improved energy efficiency are on offer. Within the framework of the national implementation, the calculation of the primary energy demand will be included in the energy pass, which will include the internal loads.

Through the Austrian action plan for sustainable public procurement, as well as the green design regulation, more energy efficient appliances must be installed and thereby the heat emissions into the room would decrease, thus reducing the internal loads.

Further connections are provided by the building standards and norms.

Another connection is with the financial support for building homes, which should consider the primary energy demand as the basis of calculation.

In recent decades in Austria, many efforts have been made to reduce the energy consumption in buildings. The federal states are responsible for the building regulations. The federal government has the responsibility for the civilian legal system. The guidelines⁷⁷ of the Austrian Institute for Construction Engineering that are relevant for the building regulations of the federal states were updated in 2015.

Since 2001 in the EU energy-efficient appliances are identified on a voluntary basis with the Energy Star label. The goal of Energy Star is to support consumers and those responsible for procurement in businesses and the public sector in the selection of energy-efficient products. The Energy Star programme in the EU covers information technology, printing, copying and office equipment.

In Austria, within the framework of klimaaktiv, businesses, municipalities and households are supported in areas such as building and renovating, energy saving, and use of renewable energy sources. The information platform <https://www.topprodukte.at> supports consumers looking for energy-efficient products. The platform provides information on the most efficient product in each category available in Austria and permits a comparison between individual products. The platform includes the categories of lighting, office, household, heating/ warm water, communication, mobility and entertainment.

The monitoring platform for energy efficiency ([Monitoringstelle Energieeffizienz](#)) calculates final energy savings and analyses and documents the development of energy efficiency in Austria.

The Austrian catalogue for environmental and energy technology (www.ecolinx.com) provides links to businesses that work, in particular, on energy efficiency. The information supplied is for potential purchasers, customers and partners. The Austrian Climate and Energy Fund supports the market penetration of climate-friendly energy.

Recommended further steps

- Checking and, where necessary, adaptation of, building standards and norms, in particular rapid adoption of the OIB guidelines in building regulations of the federal states;
- Joint planning of heating, warm water, emergency electricity, lighting and air flow. The goal is to support buildings with low primary energy demand and CO₂ emissions, building on guidelines updated in 2012;
- Support for the use of energy-efficient appliances and lighting (low loss and standby-power) through awareness-raising, incentives etc.;
- Optimisation of the operating times of appliances (e.g., regulation of lighting depending on daylight);
- Virtualisation of computing systems (Green information technology; server is not in the office but in an energy-efficient computing centre);

⁷⁷ Link: OIB-RL 6: *Energietechnisches Verhalten von Gebäuden. Richtlinien des österreichischen Instituts für Bautechnik*, März 2015. URL: http://www.oib.or.at/sites/default/files/leitfaden_richtlinie_6_26.03.15_0.pdf

	<ul style="list-style-type: none"> – Support for energy audits for small and medium enterprises; – Support for introduction of energy management systems in business; – Increasing energy efficiency in operating activities; – Further development of energy advisory services and awareness-raising; – Where necessary, support for the Top-Runner approach⁷⁸.
Possible resource requirements	For awareness-raising and support for the exchange of inefficient appliances, additional costs could occur. In the long term, however, the recommendation for action would lead to a reduction of energy costs.
Possible conflict potential	Switching to energy-efficient appliances can lead to objections because of the costs involved.
Actors	Federal and state governments, EU, building users, real estate developers, building technology planners, IT planners, device developers, academic and non-academic research institutions.
Time horizon	Measures can be implemented in the short to medium term. Concept development and research, for instance to demonstrate effectiveness using simulations, implementation of demonstration projects and monitoring etc., could start in the short term.

2.5.2.8 CONSIDERATION OF THE IMPACT OF CLIMATE CHANGE ON ENERGY DEMAND AND ENERGY SUPPLY IN ENERGY STRATEGIES

Objective	Consideration of the energy required for heating and cooling as well as the changed supply of renewables due to climate change in energy strategies, policies, or action plans.
Significance	<p>In the energy sector, the need for adaptation to climatic change is above all to be found in the dependence of renewable energy sources on climate, shifts of energy demand as a result of changed needs for heating and cooling and the protection of electricity generation and distribution against extreme events (APCC 2014).</p> <p>Both at the level of federal states and of regions, municipalities or businesses, strategic documents for the energy sector are available (Climate and Energy Model Regions, e5 municipalities, Climate Alliance Austria etc.). At the federal level, an integrated energy and climate strategy for the implementation of the Paris Agreement is planned.</p> <p>Measures for climate change adaptation and mitigation are closely connected in the energy and building sectors. Measures in these areas cannot be easily separated and their impacts are interconnected. In order to take best advantage of synergies and because of the long leads times of some measures in the energy sector, the challenges of climatic change must be integrated into energy strategies at various different levels (federal government, federal state, region, city, municipality and business). As a basis, comprehensive and regionalised electricity and heat demand forecasts and estimates of the future availability of renewable energy sources are useful.</p>
Connection to other sectors	There are connections in particular to agriculture, forestry, water management, tourism, construction and housing, ecosystems/biodiversity, transport infrastructure, spatial planning and the economy.
Connection to existing instruments	Connections are, in particular, with the Energy Status Austria of 2015, the Energy Report of the Federal Government in 2003, the climate protection law, the green electricity law, the federal energy efficiency law, the climate and energy strategies of the federal states, as well as programmes that support regions, municipalities and

⁷⁸ The Top Runner approach is an environmental approach focussing on products, which aims to support market penetration of the most environmentally friendly (resource and/or energy efficient) technology within a particular product group. The Top Runner approach sets a target value for the energy consumption of products within a specific product group. The target is determined on the basis of the efficiency level of the most energy-efficient product in each product group available at the times of setting the target.

State of implementation	<p>businesses to set energy policy objectives (Climate and Energy Model Regions, e5 Municipalities etc.).</p> <p>The available energy strategies and programmes focus on measures on measures for climate protection and a sustainable energy supply.</p> <p>Aspects relevant for adaptation are partially considered. For example, one quarter of the measures in the catalogue of the e5 programme are closely connected to climatic change adaptation.</p>
Recommended further steps	<ul style="list-style-type: none"> – Production of comprehensive regionalised projections of electricity and heat demand; – Revision of existing strategies, guidelines and programmes of measures with regard to expected impacts of climatic change; – Development of crisis management plans that consider the consequences of climatic change; – Creation of incentives to produce registers of waste heat from industrial areas; – Awareness-raising, in particular in regions, municipalities and businesses, on the impacts of climatic change on energy demand and supply.
Possible resource requirements	<p>For the incorporation of scientifically validated information about the impacts of climatic change and the development of corresponding measures, there is a certain need for resources.</p>
Possible conflict potential	<p>Depending on the measures that are proposed, conflicts with agriculture, forestry water management and settlement development, but also with nature protection and tourism, cannot be excluded.</p>
Actors	<p>Federal and state governments, regions, municipalities, energy suppliers, network operators, Climate and Energy Fund, klimaaktiv, e5 program, Climate Alliance, energy agencies, agriculture and forestry, academic and non-academic research institutions.</p>
Time horizon	<p>Long-term strategic plans are needed as soon as possible.</p>

2.6 CONSTRUCTION AND HOUSING SECTOR

2.6.1 OVERARCHING OBJECTIVE OF THE SECTOR

Overarching objective: Ensuring quality of living through implementation of planning, building and use-related adaptation measures for buildings and their surroundings.

2.6.2 RECOMMENDED ACTIONS FOR THE CONSTRUCTION AND HOUSING SECTOR

GENERAL PRINCIPLES FOR ACTION IN THE CONSTRUCTION AND HOUSING SECTOR

General consideration of the criteria for sustainability during the construction and renovation of buildings and particular in the selection of building materials.

Sustainable construction has the goal that buildings contribute to minimising energy and resource consumption, reducing environmental pressures and improving the total cost-effectiveness over the entire life cycle, beginning with the production of building materials, through the construction, use and dismantling or disposal of buildings. At the same time, the safeguarding of health and comfort aspects that contribute to an increased quality of life of the users must be considered. Sustainable construction can contribute to resource protection, reduce the life-cycle costs and simultaneously improve cost-effectiveness (BMVBS 2011).

Especially the choice of building materials and the quality of the components can extend the service life of the building, lead to a reduction of the maintenance costs and renovation expenses, but also have a positive effect on quality of life. The building materials to be used with priority should be environmentally friendly, have a long service life, and compounds should be fully separable during disposal and consist of raw materials that can either be recycled or at least disposed of without problems. In addition, they should be sourced with short transportation distances. Sustainable building can make a significant contribution to reducing CO₂ emissions and, therefore to achieving climate protection goals. Building materials from renewable raw materials, such as wood, store carbon from CO₂ over a long period of time. In addition, through using plant-based materials as building or insulation materials, further CO₂ can be saved, which would have been emitted during the production of other materials (material substitution effect). Wood products can be recycled or used to make energy at the end of the life-cycle, in line with a cascading use of materials. This replaces the use of fossil fuels (fossil substitution effect). In this way, sustainable building contributes to both pillars of climate policy – mitigation of and adaptation to climatic change.

2.6.2.1 IMPLEMENTATION OF STRUCTURAL MEASURES (IN NEW BUILDINGS AND RENOVATION) TO ENSURE THERMAL COMFORT

Objective	Ensuring thermal comfort indoors through structural measures, especially with regard to the increased incidence of hot days.
Significance	<p>The construction design of buildings in the case of both new construction and renovation largely determines the thermal comfort conditions in interior spaces. Particularly in summer, increasing heat stress and thus an increasing demand for cooling are expected. For the use of passive cooling strategies, construction measures are also required.</p> <p>In order to ensure thermal comfort, evidence for the optimal orientation of the building should be required for new construction. For this an annual cycle calculation should be sought.</p>
Connection to other sectors	There is a close connection in particular to energy, health and spatial planning. There are also connections to tourism and the economy. The recommendations for action show a close connection to the chapter on adapting building standards and norms with consideration of climatic change.

Connection to existing instruments

In particular, there are connections to building standards and norms, which must be checked and, where necessary, adapted with respect to further implementation.

The guidelines on energy saving and insulation of the Austrian Institute for Construction Engineering (OIB 2015) envisage insulation in the summer. Summer insulation for homes is achieved when sufficient storage mass (simplified proof according to Austrian norm B 8110-3) is available, regardless of the locally valid ambient air temperature with an exceedance frequency of 130 days in 10 years. For non-residential buildings, the externally induced cooling demand must be met. The explanatory notes state that a further revision is necessary to take climatic change and the resulting changes of climate in specific locations into account. The revision considering all available climate data is currently being carried out.

There is also a connection to the land-use plans according to spatial planning laws of the federal states. Municipalities have the possibility to implement some of the suggestions through land-use plans already. Checks should be made whether further legal adjustments are necessary.

For the integration of comfort parameters, support is provided by programmes, such as the residential building support provided by the federal states, federal support for renovation and quality standards, advisory services and information dissemination, such as those provided by klimaaktiv, but also competitions and calls for tender. For such support, quality criteria for the construction of the outer shell of the building should be defined.

The “Dialogue Forum Building – together for clear and simple building regulations” initiated by the Austrian Standards Institute in cooperation with the Federal Guild of Construction of the Austrian Economic Chamber aims to include practical experience into the further development of Austrian norms with the participation of all concerned persons. The impacts of climatic change should be considered in this activity.

Further connections are found in the existing education and training services provided by experts and stakeholders (universities, universities of applied sciences etc.).

In the process of environmental impact assessment, a climate and energy concept is already required, which must include measures for energy efficiency and has led to progressive standards with respect to thermal insulation and energy sources in urban development projects.

State of implementation

The EU Directive on the energy performance of buildings from 2010 (*DIRECTIVE 2010/31/EU*) aims for an optimal-cost achievement of energy efficiency levels of buildings. By 2018 all new buildings owned and used by public authorities and by 2020 all new buildings are to be lowest energy buildings. Furthermore, efforts should be made to increase the total number of lowest energy buildings through renovation.

Further connections are provided by the Austrian energy efficiency law (BGBl. I Nr.72/2014), the climate protection law (BGBl. I Nr. 106/2011 i.d.g.F.), the guidelines for environmentally exemplary renovation and the energy and climate strategies of the federal states.

Measures to ensure thermal comfort are already defined within the framework of thermal renovation and supported by the federal government, federal states and the Austrian Climate and Energy Fund and the suitability for summer is increasingly considered.

Brochures, such as that on building suitable for summer (Upper Austria) provide information on how buildings can be protected from overheating through planning and operation (Oberösterreichischer Energiesparverband 2009).

Recommended further steps

- Many technical possibilities are available that can be used individually or in combinations, such as:
- Further reduction of the share of glass in façades. The indoor climate is strongly influenced by the type of window, protection against the sun and the amount of area covered by windows. The largest heat input is through the windows, even if they have a very good U-value⁷⁹. In particular for converted attics with slanting roof windows, the protection against heat depends to a significant extent on the area of windows and amount of shading. In addition to the amount of glass in the building envelope, the orientation of the building, the quality of the glass, the use of the building, the shape of the building and the location of the building are decisive for the cooling and heating energy demand. Appropriate use of triple glazing makes an important contribution to the energy balance of a building. **Sun protection films and sun protection glass** can also have positive effects, but the latter reduce the solar input during winter, which must be taken into account in the total energy balance (development of sun protection glass with variable transmission characteristics should be supported);
- **Shading equipment:** Consideration of shading during architectural design and planning of buildings is an effective measure to reduce solar heat input. Shading equipment can also be added to existing buildings. For façades facing east, south and west, shading equipment must be sufficiently resistant (e.g., to wind);
- **Rain- and storm-safe** positioning of windows or ventilation openings as a prerequisite for the use of passive cooling strategies;
- **Comfort ventilation systems** contribute significantly to a well-balanced interior climate. They guarantee a continual introduction of fresh air, provide high quality of air in interior spaces, remove pollutants, odours and excess humidity and help to avoid damage from mould. In lowest-energy and passive houses, the use of comfort ventilation systems is standard practice. Their use in renovation is particularly recommendable when, for example, the airtightness of a building is improved and damages through higher air humidity and thermal bridges are possible. In addition, the support of comfort ventilation systems – in particular in locations with high exposures to, for instance, noise and pollution – makes it possible to improve the climate in living spaces. Professional planning and implementation are important for success in this regard. Unprofessional or irregular maintenance can lead to hygienic and technical problems;
- **Avoidance of overheating** through appropriate orientation of buildings /rooms, for which a proof of the optimal building orientation should be presented;
- **Insulation:** A widespread and supportive measure to avoid heat input into buildings is provided by insulation. However, it is important to note that the largest heat input into a building can be through the windows and not through the walls;
- Component activation⁸⁰ can only have a positive effect in buildings that have enough shading mechanisms and possibilities for night-time ventilation;
- **Information and awareness-raising** including the health aspects of climatic change;
- Expansion of advisory services on support considering summer suitability;
- Strengthened public relations on exemplary projects (e.g., of the Austrian Climate and Energy Fund, klimaaktiv, Austria Solar etc.);

⁷⁹ The U-value (previously k-value) is a measure for the heat flow through a building component and is given in W/m²K. The U-value describes how much power per m² of the building component is required to maintain a temperature difference of 1 Kelvin.

⁸⁰ Use of building components (e.g., walls, ceilings) to actively influence the interior climate.

	<ul style="list-style-type: none"> – Support for the use of the BIM-Tools⁸¹ to avoid construction flaws; – Acceleration of the rate of renovation through incentives, energy advisory services, accompanying renovation advisory services with strong consideration of the different social groups.
Possible resource requirements	Existing funding programmes should continue or be expanded to promote measures to support thermal comfort. In the long term the recommended actions can lead to a reduction of energy costs.
Possible conflict potential	With regard to increased costs for new construction and renovation, opposition can be expected.
Actors	Federal and state governments, architectural firms, planning firms, building owners, real estate developers, academic and non-academic research institutions.
Time horizon	Measures can be introduced in the short to medium term. Development of concepts and research, e.g., testing the effectiveness through simulation, implementation of demonstration projects and monitoring projects, can be commissioned in the short term.

2.6.2.2 ENCOURAGED USE OF PASSIVE AND ACTIVE COOLING WITH ALTERNATIVE, ENERGY-EFFICIENT AND RESOURCE-SAVING TECHNOLOGIES

Objective	Ensuring thermal comfort inside new buildings, in renovations, and in existing buildings by means of passive and alternative (“active”) cooling strategies.
Significance	<p>Passive cooling, when appropriately applied, is an effective way to avoid overheating of interior spaces. It involves using the cooling potential of the spaces with little or no technical intervention. During the day, the input of heat through radiation (windows) and air exchange should be reduced and the outside temperature should be used at night to cool the rooms.</p> <p>To increase the use of passive cooling there are several prerequisites that must be fulfilled during the architectural planning and design phase for the buildings in question (for examples see the chapter on construction measures in new construction and renovation to ensure thermal comfort).</p> <p>Façade- and roof-greening contribute, on the one hand, via evaporation to a reduction of the surface temperature and in doing so they improve the microclimate inside and around the building. In summer they act as a natural air-conditioning system and in winter as insulation. On the other hand, the reduction of the area sealing of the building, e.g., through roof-greening, and around the building, e.g., paths, parks and open spaces, benefits rainwater storage and minimises the local warming.</p> <p>Alternative (“active”) cooling technologies should only be introduced when passive cooling is insufficient or cannot be used. In house construction, buildings with active cooling demand should be avoided. For the deployment of alternative technologies, an appropriate planning and construction method for new construction should allow subsequent measures to be integrated with minimum effort. The boundary between passive cooling and some technologies is sometimes hard to define.</p>
Connection to other sectors	There is a close connection to energy and health, as well as to tourism and the economy. The recommended actions show a close connection to the chapter on adapting construction standards and norms to climatic change.

⁸¹ *Building Information Modelling (BIM) is a smart digital building model that allows an optimised planning and execution of buildings.*

Connection to existing instruments

There are connections in particular to building standards and norms, which should be checked and, where necessary, adapted with regard to further implementation.

There is also a connection to the land-use planning according to spatial planning laws of the federal states. Municipalities already have the opportunity, through their land-use plans, to implement some of the proposals. Legal adaptations that might be necessary should be evaluated.

In addition, support programmes, competitions and calls for tender provide opportunities to accelerate the use of passive or alternative cooling.

Integration in the education of professionals and stakeholders (universities, universities of applied sciences etc.).

State of implementation

The use of district cooling systems increased strongly in recent years in urban areas. The delivery of district cooling in Austria in 2013 amounted to about 320 TJ (89 GWh), which was four times as much compared to previous years. A further growth is expected (Klima- und Energiefonds 2015). For example, in Vienna around 100 Megawatt of installed district cooling was available in 2015 and the goal for 2020 is 200 MW (Wien Energie 2016).

In 2012 the Austrian Ministry for Transport, Innovation and Technology published a technology roadmap for solar-thermal cooling in Austria. This provides an overview of the technologies being used, the cost-effectiveness and the possible market for solar-thermal cooling. In recent years, comprehensive know-how in the area of solar-thermal cooling has developed in Austria. Research results and information about solar-thermal cooling are provided by the website www.nachhaltigwirtschaften.at or Austria Solar (www.solarwaerme.at).

Guidelines for roof- and façade-greening (“die umweltberatung”Wien 2009, ÖkoKauf Wien 2013), as well as the guide on green building methods for cities of the future (Pitha et al. 2014), give tips for implementation.

Recommended further steps

In order to accelerate passive cooling, some prerequisites must be fulfilled for the buildings in question, which must be considered during the design and planning stages (see also the chapter on thermal comfort):

- The spatial arrangement of ventilation openings / windows must allow cross-ventilation;
- The external night-time temperatures cannot be too high (see recommended actions to avoid the heat island effect);
- The arrangement of ventilation openings / windows must take safety with respect to rain and storms into account, because, for example, in service buildings there are usually no people present at night. In addition, protection against burglary must be ensured;
- Partial automisation makes ventilation at night possible in service buildings even when no people are present;
- The development of a databank on good practice with examples that prevent overheating of buildings without a high technical effort. For this, experience could be used from those countries that already experience high summer temperatures and have developed corresponding building methods and constructions.

It must be noted that an efficient passive cooling depends on low night-time temperatures and a corresponding design of the external space to reduce the heat island effect.

	<p>For buildings, in which passive cooling is not sufficient or not possible, despite implementation of the recommended actions in the chapter on thermal comfort, numerous alternative (“active”) cooling technologies are available, for example:</p> <ul style="list-style-type: none"> – Use of district cooling; – Solar-thermal cooling; – Ventilation systems can be used for cooling if they are designed accordingly (cooling of the air through the ground); – If necessary, additional utilisation of thermoactive masses; – Geothermal cooling technologies (ground as heat sink); – Acceleration and creation of incentives for roof- and façade-greening. As well as measures for passive cooling; – Expansion of advisory services on support for passive and active cooling with alternative, energy-efficient and resource-protecting technologies.
Possible resource requirements	It is not possible to quantify resource requirements at present. In the long term the recommended actions can lead to a reduction of energy costs.
Possible conflict potential	In general it is important to ensure that the use of active cooling technologies does not have negative effects with respect to climate protection.
Actors	Federal and state governments, (energy consultants), environmental consultants, architectural firms, planning firms, building owners, real estate developers, research, technology companies.
Time horizon	<p>Measures for passive cooling can be introduced in the short to medium term; those for alternative cooling can be implemented in the medium to long term. Measures for new constructions can be implemented immediately, while those for renovation measures are only possible in the medium to long term.</p> <p>The development of concepts and research, e.g., proof of effectiveness using simulation, implementation of demonstration projects and monitoring etc., can be commissioned in the short term.</p>

2.6.2.3 CLIMATOLOGICAL IMPROVEMENT OF URBAN SPACES, WITH PARTICULAR EMPHASIS ON MICRO- AND MESO-CLIMATIC CONDITIONS IN URBAN AND OPEN SPACE PLANNING

Objective	Optimisation of living conditions and conditions of human and wind comfort, as well as reduction in the heat-island effect through urban and open space planning.
Significance	<p>The micro- and meso-climate in urban areas are influenced in particular by building development, sealing of the surface, traffic, waste heat and emission of pollutants. These changes characterise the urban climate, which is distinguished through higher air annual average temperatures, lower cooling at night, a lower relative humidity, and lower wind speeds, as well as a longer vegetation period of up to 10 days (Stiles et al. 2014). In some places in the city, however, high-rise buildings can give rise to a significant increase in wind speeds. The impacts of climatic change will be strengthened through these urban characteristics and lead to a deterioration of living conditions, which can have significantly negative health impacts, especially for susceptible people or groups at risk.</p> <p>The heat island effect, i.e., the increased temperature in urban areas in comparison to the surroundings, can be effectively reduced through a number of open-area and urban planning measures. Through stronger consideration of micro- and meso-climatic</p>

Connections to other sectors**Connection to existing instruments****State of implementation**

conditions in urban and open-area planning, a significant contribution to adaptation to climatic change can be made. The possible increase of heavy rain events must also be considered. As an important side-effect, which is of particular interest here, the conditions for the use of passive cooling strategies are thereby improved.

There is a close connection in particular to spatial planning, urban free and green areas. There are also connections with tourism, economy and health.

Climatological questions should be more strongly integrated in urban development, regional planning and local spatial planning, in particular at the local level in the zoning plans according to the regional planning laws.

Micro- and meso-climatic aspects can already be taken into account in local spatial planning using existing instruments, a legal requirement to do so could be implemented within the framework of regional planning laws (goals and basic principles). In addition, requirements for municipal spatial planning would be necessary in instruments for regional spatial planning, in particular for conurbations.

The Austrian Spatial Development Plan 2011 (ÖREK; ÖROK 2011) is a non-binding instrument. The plan presents a common objective and strategic management instrument for nationwide regional planning and development.

Within the framework of environmental impact assessments, both micro- and meso-climate are considered, since local climatic conditions can be influenced by a project. Negative effects on the microclimate as a result of construction projects should be kept as small as possible. Environmental impact assessments for urban construction projects (that require an assessment because of their size) should consider a wider range of aspects related to climatic change adaptation.

Both microclimate and mesoclimate as considered in environmental impact assessments. In some cases simulation tools are used for the planning or projects are carried out within the framework of basic research.

Within the framework of the Smart Cities initiative of the Austrian Climate and Energy Fund, demonstration projects are being implemented. The focus is on the design of energy and mobility systems with respect to sustainability principles. Action areas are buildings, energy, municipal supply and disposal, mobility, communication and information and green and open spaces.

The guidelines on green construction methods for the future (Pitha et al. 2014) show how the urban climate can be improved and how paved surfaces that allow infiltration contribute to regulating the water budget. Relevant results have and will come, among others, from the Austrian Climate and Energy Fund (e.g., Focus-I – Zuvela-Aloise 2013⁸², Urban fabric types - Stiles et al 2014⁸³, STOPHOT - Arnberger 2014⁸⁴) and from the research programme of the Austrian Ministry for Transport, Innovation and Technology.

An urban heat island strategy is available for Vienna (UHI-STRAT Wien)⁸⁵ with measures to reduce the urban heat islands (Stadt Wien 2015). The strategy for Vienna provides exact information regarding the effectiveness of 37 individual measures and discusses the advantages of and possible barriers to the implementation of measures, as well as the expected expenses for construction and maintenance.

⁸² Link [Future Of Climatic Urban heat Stress Impacts:](#)

⁸³ Link: [Urban Fabric Types and Microclimate Response - Assessment and Design Improvement](#)

⁸⁴ Link: [Cool towns for the elderly – protecting the health of elderly residents against urban heat](#)

⁸⁵ Link: <https://www.wien.gv.at/umweltschutz/raum/uhi-strategieplan.html>

Recommended further steps

- The reduction of the heat island effect can be achieved, in particular, by the following measures:
- Consideration of the local wind and environmental situation during the building planning and proof of improved climatic conditions after construction (micro-simulations);
- Change of the radiation balance, e.g. through the use of light colours, through appropriate surface design;
- Shading in outdoor spaces using, for example, trees, canopies, roofed passages etc.;
- Use of façade- and roof-greening. With appropriate planning and implementation, these contribute to an improvement of the interior climate and the urban climate. Technical solutions are available in order to avoid potential risks resulting from natural disasters, which should be taken into consideration during planning and implementation;
- Changes of the water budget, for example, through creation of evaporation surfaces for cooling and/or ensuring the watering of green spaces;
- Avoidance of further sealing of the ground surface, as well as the creation and maintenance of green open spaces and small structures that provide shading, filter out harmful substances, reduce noise etc.;
- Maintenance and creation of air- and climate-corridors to use the cooler air of the surroundings;
- Development of registers for human and wind comfort, as well as for heat island and surface sealing, in order to be able to implement greening and other measures where hotspots are identified;
- Consideration of micro- and meso-climatic conditions during the development of strategic instruments (regional planning, building planning, urban development plan etc.) through strengthened use of digital prototyping based on microsimulation tools in urban planning and development;
- Further needs for research and development regarding implementation;
- Creation or adaptation of a legal basis for implementation and for incentives (e.g. financial support);
- Education and training regarding technical and meteorological questions;
- Complete consideration of the microclimate (heat island, human comfort etc.) as the basis for the adequate evaluation of different impacts;
- Increased implementation of relevant research results;
- Information and awareness-raising for the general public;
- Increase the share of water in the town/city (rainwater management, increase the share of water surfaces, uncovering formerly channelled watercourses).
- Many of the steps presented here can also be taken by individuals.

Possible resource requirements

With regard to an accelerated implementation, resources for awareness-raising and creation of incentives (e.g. financial support) are necessary.

For the adaptation of teaching material (changing priorities and restructuring) little or no additional financial resources are necessary.

Possible conflict potential Actors

Conflicts with the protection of historical monuments cannot be excluded.

BMNT (formerly BMLFUW), BMVIT, federal states, municipalities, Climate and Energy Fund, real estate planning firms, planning firms, microclimate experts, academic and non-academic research institutions, real estate developers.

Time horizon | The implementation of individual steps can start immediately. Concept development and necessary basic research and research projects, e.g. to prove the effectiveness through simulation (some results already available), the implementation of demonstration and monitoring projects etc., could be commissioned in the short term. In the long term, appropriate steps in education are particularly important.

2.6.2.4 IMPLEMENTATION OF STRUCTURAL MEASURES ON BUILDINGS TO PROTECT THEM FROM EXTREME WEATHER EVENTS

Objective | Structural adaptation of buildings (new and existing buildings) for protection from extreme weather events.

Significance | In Austria a large number of buildings are threatened by natural hazards. 118,089 buildings are in the danger zones for torrents and avalanches. 82,600 buildings are in the risk areas for 100-year floods and 154,000 buildings for a 300-year flood (as of 2013). The possible increase of extreme weather events (heavy rain, local flooding, wind, hail, heavy snow loads) requires measures to adapt construction for new buildings but also – with limited possibilities – for existing buildings.

If floods cannot be avoided or occur periodically (e.g. Steyr), building types and materials that cannot be damaged should be selected. Electrical cabinets, heating systems etc. should be installed above the expected high water level. Oil tanks should be secured against floating up. Furnishing in flooding areas should be easily dismountable and transportable.

In existing buildings the possibilities to intervene are limited and expensive.

Connection to other sectors | There are connections to spatial planning, protection against natural hazards, disaster management, health, economy and tourism.

Connection to existing instruments | There are connections to zoning plans, building plans, existing building regulations, tax bases and norms.

State of implementation | Examples for the state of implementation:

The Austrian Spatial Development Concept of 2011 pays considerable attention to protection against flooding in relevant definitions of targets, action programmes (in particular, priority areas to protect against natural hazards) and areas of responsibility (in particular, reserving flood retention and flood discharge areas).

All spatial planning laws, except in Vienna, ensure that zoning of construction land is not allowed in areas threatened by flooding. In Vienna this regulation is in the building code. Most federal states have changed their spatial planning laws and building codes to improve preventive flood protection. In legal bases or regional planning, some federal states have improved the safeguarding of areas vulnerable to 100-year floods, retention areas and flood discharge areas through appropriate goals and measures to limit building land (Flood-Risk-E BMLFUW 2015b, Habersack et al. 2015; see also the recommended actions in the chapter on spatial planning).

Individual building codes explicitly authorise requirements for particular protective measures in the external area (e.g. walls, dams) to be included in the building explanation or the building permit.

Brochures such as that on living with natural hazards (BMLFUW 2015h), on protecting buildings against flood and groundwater damages (BMLFUW 2007d), guidelines on water risks for buildings and protective measures (ÖWAV 2013), flood safety advice (ÖZSV 2008) etc. provide comprehensive information. The centre for prevention of

	<p>elementary damages, supported by some federal states, provides information sheets and advisory services.</p> <p>A guide produced by the Federal Ministry for Land, Forestry, Environment and Water and the University of Natural Resources and Life Sciences (Hübl & Tscherner 2015) aims to raise the awareness of home owners and planners regarding natural hazards before they begin building, so that possible effects can be considered in the planning stage.</p> <p>Currently, Austrian norms and regulations for preventive, temporary or permanent measures to protect against natural hazards are being prepared⁸⁶.</p> <p>The Dialogue Forum on clear and simple building regulations, initiated by the Austrian Standards Institute in cooperation with the Chamber of Commerce aims, with the participation of all stakeholders, to reflect practical experience in the further development of Austrian norms. The impacts of climatic change should be considered in this process.</p>
Recommended further steps	<ul style="list-style-type: none"> – Consideration of construction measures to protect against extreme weather events and natural hazards in support measures and creation of incentives (e.g., insurance); – Adaptation of construction elements and extensions (such as solar systems) with regard to higher wind and snow loads; – Promotion of by and large hail-resistant construction elements; – Promotion of water-proofing and protective measures, non-return flaps, as well as water-resistant construction materials with as little hollow space as possible; – Promotion of electrical installations and heating systems that are safe in the case of floods; – Expansion of advisory services and information activities on construction measures in new construction and renovation of buildings; – Review and, where necessary, adaptation of norms and standards, as well as tax bases and building codes; – Risk evaluation of locations; – Further research on concrete requirements and on technical and constructive solutions, e.g., particularly with respect to building materials, renewable energy sources integrated into buildings etc.
Possible research requirements	<p>Resources are needed in particular for strengthened awareness-raising with regard to prevention. Relevant research questions can be covered in part by existing research programmes and an adequate budget must be provided.</p> <p>Retrospective adaptation of buildings can be expensive.</p>
Possible conflict potential	<p>Opposition can be expected from building owners, if the adaptation results in additional or high expenses.</p>
Actors	<p>Federal and state governments, architectural firms, planning firms, building owners, real estate planning firms, technology firms, academic and non-academic research institutions, microclimate experts.</p>
Time horizon	<p>Measures can be implemented in the short to medium term. Necessary research on concrete requirements and on technical and constructive solutions can be started in the short term.</p>

⁸⁶ Link: <https://committees.austrian-standards.at/detail/19570>

2.6.2.5 INCREASE OF WATER RETENTION

Objective	Prevention of local flooding through structural measures around buildings.
Significance	<p>Clear statements on the development of floods in Austria cannot be made with certainty, since future developments of extreme weather events (e.g. heavy rain) cannot be calculated with sufficient reliability (BMLFUW 2011g). Small-scale (convective) heavy rainfalls and thunderstorms could increase in intensity and frequency and cause increased local flooding (APCC 2014). Changes of precipitation, discharge regimes and flood events will differ regionally and this requires a regionally differentiated consideration.</p> <p>In built-up areas, an increase of the potential damage due to heavy rainfall is expected, also because of temporary overloading of the canalisation (APCC 2014). In particular, the building stock is considered to be affected, unless sufficient safety measures have been taken. Penetrating water can not only destroy inventory, but also endanger the building fabric. In addition to moisture penetration into the building shell, heavy rain can affect the base area and the cellar, where water penetration and flooding can occur (Haas et al. 2010a).</p> <p>An increase of water retention can effectively reduce or avoid local flooding, since the capacity of available water discharge installations is not (or less) exceeded.</p>
Connection to other sectors	<p>There is a close connection. In particular, to water management, protection against natural hazards, and spatial planning. There are connections to agriculture, tourism, energy, disaster management, health, transport infrastructure, economy and urban open and green spaces.</p> <p>The recommended actions must be coordinated with those from the chapters on adaptive flood management, promotion of risk transfer mechanisms, and spatial planning for water retention and water discharge areas.</p>
Connection to existing instruments	There are connections to spatial planning laws and regional planning.
State of implementation	See Chapter 2.12.2.2: Establishment and protection of flood retention and drainage zones and clear regulation of zoning prohibitions and restrictions (Spatial Planning).
Recommended further steps	<p>Strengthened consideration of possible flooding in the planning phase;</p> <p>Reduction and delay of water discharge (e.g., promotion of rain retention);</p> <p>Review and, where necessary, removal of surface sealing (easing the burden on canalisation through local infiltration of water);</p> <p>Creation of incentives to unseal areas;</p> <p>Creation of retention areas (reduction of the discharge volume);</p> <p>Collect data on the current amount of sealing in municipalities and ideally keep this level constant (i.e. new surfaces can only be permitted when old ones are broken up);</p> <p>Adoption or strengthened use of existing legal instruments, in order to protect flood retention and discharge areas as well as suitable areas for emergency relief.</p>
Possible resource requirements	Safeguarding the long-term functional capacity of facilities for rain retention requires maintenance expenses.
Possible conflict potential	Implementation will require financial investments from owners, which can be expected to lead to conflicts.
Actors	Federal and state governments, municipalities, planning firms.
Time horizon	The measures are, depending on the region, implementable in the short to medium term.

2.6.2.6 ADAPTATION OF BUILDING STANDARDS AND NORMS TO CLIMATE CHANGE

Objective	Consideration and integration of adaptation requirements in construction standards and norms.
Significance	<p>Existing building standards assume a continuation of the environmental conditions observed so far and thus reflect the past. Forward-looking building and renovation, however, requires consideration of expected future developments. Through climatic change and its impacts on buildings, adaptation is necessary. In particular, microclimatic changes are to be expected.</p> <p>Climatic change and adaptation to the impacts should be integrated into the revision of the federal state building codes and considered by the standardisation bodies. Further, support measures should be adapted accordingly and additional support incentives should be provided.</p> <p>The adaptation requirements should be developed separately for new construction and renovation.</p>
Connection to other sectors	There are connections in particular to spatial planning and protection against natural hazards.
Connection to existing instruments	There are connections to building standards and Austrian norms as well as to the building codes of the federal states.
State of implementation	<p>The European Committee for Standardisation (CEN) carried out a first review of European norms with regard to adaptation requirements in the areas of construction and housing, transport infrastructure and energy. Together with CENELEC (European Committee for Electrotechnical Standardisation), CEN published guidelines on consideration of adaptation to climatic change in norms (CEN & CENELEC 2016).</p> <p>Guidelines from the Austrian Institute for Construction Engineering (OIB) on energy saving and thermal protection envision thermal protection in summer (OIB 2015). Summer insulation for homes is achieved when sufficient storage mass (simplified proof according to Austrian norm B 8110-3) is available, regardless of the locally valid ambient air temperature with an exceedance frequency of 130 days in 10 years. For non-residential buildings, the cooling demand induced by external conditions must be met. The explanatory notes state that a further revision is necessary to take climatic change and the resulting changes of climate in specific locations into account. The revision considering all available climate data is currently being carried out.</p> <p>In all federal states, special requirements for construction technology with regard to flood risk are prescribed. These are based on guidelines from the OIB and refer almost always to 100-year floods. In Upper Austria, these requirements are in force since 2013 additionally also in so-called residual risk areas, which are not in the 100-year flood areas because technical flood protection measures were installed (Giese 2015).</p> <p>The building pass in Vorarlberg considers all aspects (energy, ecology and societal) of buildings. As with the energy pass, it is required in the application documentation for buildings that are to be built with support of housing subsidies. Likewise it is required for support for advice on renovation, if the housing subsidy is to be used for a comprehensive renovation.</p> <p>Currently, Austrian Norms and ON-rules (quickly available normative documents) on preventive, temporary or permanent measures to protect against natural hazards are being prepared.</p> <p>The Dialogue Forum on clear and simple building regulations, initiated by the Austrian Standards Institute in cooperation with the Chamber of Commerce aims, with the</p>

Recommended further steps

participation of all stakeholders, to reflect practical experience in the further development of Austrian norms. The impacts of climatic change should be considered in this process.

- Review and, where necessary, adaptation of the tax bases for climate change adaptation on the basis of the results from current regional climate scenarios;
- Calculation of summer suitability on the basis of future temperature levels (adaptation climate data sets);
- Calculation of heat loads (avoidance of oversizing of heating systems);
- Calculation of structural components (gutters, waste water systems, flood safety of cellars etc.);
- Consideration of the adapted tax bases and the resulting impacts in the planning and assessment of buildings;
- Building on the above measures, review and, where necessary, adaptation of building standards and Austrian norms, in order to make a resource-efficient, climate-friendly and adapted building sector possible.

In addition, as an example, measures for new construction and renovation are needed in the following areas:

- Adaptation of quality requirements for building components of the building shell (plaster, glass, roof tiles etc.);
- Adaptation of building components and extensions (such as solar systems) to higher wind and snow loads;
- Regular review of buildings by independent institutes;
- Review and, where necessary, adaptation of support mechanisms, as well as development of additional support incentives.

Possible resource requirements

The resource requirements for the implementation of the recommended actions cannot be quantified at present.

Possible conflict potential

If compliance with stricter building standards and norms in new construction and renovation leads to higher costs, opposition from the general public could occur.

Actors

Federal and state governments, Austrian Institute of Construction Engineering (OIB), Austrian Standards International.

Time horizon

Implementation can be carried out in the short to medium term.

2.6.2.7 EVALUATION AND FURTHER DEVELOPMENT OF FUNDING INSTRUMENTS FOR TAKING INTO ACCOUNT OF CLIMATE CHANGE ASPECTS IN NEW CONSTRUCTIONS AND RENOVATION

Objective

Increased emphasis on adaptation needs in the funding of new construction and the renovation of residential and non-residential buildings.

Significance

The implementation of adaptation measures can be significantly supported through the review, further development and accelerated use of various instruments.

The existing housing subsidies aim to provide needs-based, affordable and high quality living space. Currently climate protection measures are supported above all, e.g., measures to increase energy efficiency and the use of renewable energy sources. Many adaptation measures are closely connected to climate protection measures. For example, measures to increase energy efficiency (thermal insulation) are also relevant for adaptation (reduced heat loading). Construction measures to protect against extreme weather events and natural hazards receive little support at the moment.

Connection to other sectors

An accelerated rate of renovation, a significant goal within the Austrian climate and energy strategies, is also a prerequisite for a successful penetration of adaptation measures in the building sector. New construction and renovation are equally important in this case.

To determine the renovation measures with respect to adaptation, buildings must be assessed individually, in order to identify and implement the most appropriate measures from an ecological, economic and technological point of view.

The goal should be the embedding in a comprehensive, overall concept.

Over the long term, the benefits for owners and residents are an increase of living comfort, energy savings, health aspects, increased value, long-term lower costs through avoided damages etc.

In particular there is a connection to the energy sector. The recommended actions in the chapter on adaptation of building standards and norms to climatic change are a basic prerequisite for these measures. There are also connections to tourism, protection against natural hazards, health, spatial planning and the economy.

Connection to existing instruments

There are connections to the subsidies for homes, environmental support for inland operations, the Austrian Climate and Energy Fund, special programmes of the Federal Government and the federal states (e.g. renovation campaign), the financial compensation mechanism, municipalities, towns and cities and the economy (e.g., insurance companies).

Further connections: review of measures for further development of framework conditions with respect to tenancy laws, property laws and leasehold rights for better integration of adaptation to climatic change, in which the interests of both tenants/users and owners must be considered equally.

State of implementation

In Austria, climate-friendly and environmentally friendly new buildings and renovation are supported by a multitude of support measures. Efficient energy use, thermal renovation of buildings (including shading systems) and cooling of buildings are all relevant for adaptation.

Overall, the connection to climatic change impacts and adaptation is rarely made in the support measures that have been studied. Aspects relevant to adaptation are, however, indirectly represented in many support measures. Preventive measures to protect buildings from heavy rainfall, flooding and other natural hazards are currently rarely considered in support for either new construction or renovation.

There is no specific support programme/advice on adaptation measures or support in the construction and housing sector.

Adaptation to climatic change is currently hardly considered. The emphasis is on climate mitigation measures.

Recommended further steps

- Awareness-raising and further education, as well as information for the professional groups, but also for the general public. Among others, insurance should be included in education measures;
- Review and, where necessary, simplification or better coordination of the support instruments for both new construction and renovation;
- Strengthened cooperation and coordination between insurance companies, banks and the construction sector;
- Proof of the future summer suitability as a prerequisite for allocating support (at least for comprehensive renovation of buildings), among others to avoid the use of energy-intensive, active cooling;
- Support for building methods and the use of building materials that are not damaged by extreme weather events;

<p>Possible resource requirements</p>	<ul style="list-style-type: none"> – Support for building methods and the use of building materials that contribute to local infiltration or retention of surface water flows (e.g., green roofs, unpaved house driveways and private paths, rainwater storage); – Support for environmentally friendly and sustainable building materials in connection with adaptation to climatic change; – Adaptation or introduction of quality standards for renovation (synergies between adaptation and mitigation; renewable energy sources; environmentally friendly and sustainable building materials etc.) The different characteristics of the building to be renovated must be considered and taken into account in the planning of the renovation measures. This should ensure that the most suitable (environmental, technical, financial) measures are selected. <p>Additional costs can be expected for the implementation of better standards (e.g., hail protection, thermal insulation, passive elements etc.), for example to increase the threshold for summer suitability by 1.5°C. Further resources could be required for the support of measures from a catalogue of measures.</p>
<p>Possible conflict potential</p>	<p>Potential opposition from the general public can be expected, in particular in locations where buildings must be renovated. It is necessary to clarify how to proceed with buildings that are located in the areas of 30-year floods.</p>
<p>Actors</p>	<p>Federal and state governments, in part interest groups, municipalities, public-private partnerships, BMJ, BMWFJ.</p>
<p>Time horizon</p>	<p>Efforts should be made to implement the measures in the short to medium term. The rate of renovation should be maintained or increased.</p>

2.6.2.8 RESEARCH ON ADAPTATION TO THE CONSEQUENCES OF CLIMATE CHANGE IN THE AREA OF CONSTRUCTION AND HOUSING

<p>Objective</p>	<p>Improvement of the knowledge base with the goal of optimized adaptation to the effects of climate change and improvement of underlying data.</p>
<p>Significance</p>	<p>A well-founded knowledge basis is the foundation for all further steps. The further improvement of the state of knowledge is given high priority. The results of current research activities should be continually brought in to processes and for the review and adaptation of existing instruments.</p> <p>Further research activities are needed for the successful implementation of adaptation measures. For example, despite improvements of the data situation, in some areas the effects of climatic change are still very uncertain. These recommendations for action should be closely connected to those from Chapter 2.6.2.9: Pilot projects “climate change-adapted architecture” and 2.6.2.10: Public information and raising awareness of the issue of adaptation to the consequences of climate change in the area of construction and housing).</p> <p>An inter- and transdisciplinary research approach, in which in addition to technical and biological, the social and environmental medicine aspects are considered, is recommended.</p>
<p>Connections to other sectors</p>	<p>Research activities with an interdisciplinary approach should be coordinated and carried out together with, in particular, the spatial planning, energy, protection against natural hazards and health sectors.</p>
<p>Connection to existing instruments</p>	<p>There are connections to existing research support programmes (e.g., the European Commission, the Austrian science fund (FWF), the Austrian Research Promotion Agency (FFG), the Austrian Climate and Energy Fund, research programmes of the</p>

State of implementation	Federal Ministry for Transport Innovation and Technology) and commissioned research on concrete topics.
Recommended further steps	<p>In the research programmes “City of the Future” and “House of the Future” of the Austrian Ministry for Transport, Innovation and Technology, as well as “Energy Research” and the Austrian Climate Research Programme of the Austrian Climate and Energy Fund relevant research questions are addressed.</p> <ul style="list-style-type: none"> – Strengthened consideration of relevant questions in and better coordination of research support programmes (e.g., EU, FWF, FFG, Austrian Climate and Energy Fund, House of the Future, City of the Future, Energy Systems of the Future), additional commissioned research on concrete topics; – There is demand for research on numerous topics that relate to different action areas. As a starting point, a targeted survey of demand is recommended, in order to avoid duplication. The research demand and the orientation of questions should be continuously surveyed and updated as necessary: – Regional impacts of climatic change (e.g., improvement of models, regionalisation of the results, data bases for norms); – Interdisciplinary basic research on the effects of climatic change, in particular in urban areas, on, for example, buildings, groundwater, noise, air quality and social aspects. Based on research results, development of recommendations for the optimal surface area, type of design, and perhaps also the types of plants; – Bioclimatology and microclimate (e.g., comfort levels in interior spaces, heat island effects, development of simulation tools, concept development to improve the microclimate, analysis of the effects on microclimate of different kinds of planting), with a focus on urban and regional development; – Building research (e.g., building concepts and methods adapted to climatic change, materials research, identification of critical existing buildings, energy economy analyses, cost-benefit analyses, increasing the energy efficiency); – Implementation research (e.g., the effectiveness of policy instruments, barriers to implementation); – Political, legal and socio-economic framework conditions and trends (analysis of likely political, legal and socio-economic trends and their effects as a basis for sustainable decisions); – Research on the use of various building materials (health aspects, recycling, resource efficiency, development of evaluation systems, economic effects, impacts on different economic sectors, life-cycle analyses, global perspectives etc.); – Maintenance and, where necessary, expansion of funding programmes with reference to climate policy goals; – Development of tools to estimate the impacts of climatic change on buildings considering the average useful life.
Possible resource requirements	The need for additional resources for research can be partially satisfied by reallocation of resources. In particular for the necessary virtual networking of existing research results resources will be required.
Actors	EU, federal government, research funding bodies (Climate and Energy Fund, FWF, FFG), academic and non-academic research institutions.
Time horizon	Efforts should be made to implement the measures in the short to medium term.

2.6.2.9 PILOT PROJECTS “CLIMATE CHANGE-ADAPTED ARCHITECTURE”

Objective	Demonstration of the feasibility and advantages of “climate change-adapted architecture.”
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Significance	<p>Successfully implemented projects have much stronger powers of persuasion than political appeals or mere information. Therefore, for the implementation of a strategy to adapt to climatic change, it is important to demonstrate the feasibility and also the benefits of corresponding architecture. This concerns concrete technical or constructive solutions, which should cover as many areas (thematic and spatial) as possible.</p> <p>The first step is to clarify and define what is meant by architecture adapted to climatic change. Factors such as the orientation, shading, wind conditions, logistics etc. and also other (e.g., sociological) aspects should be considered.</p> <p>These recommendations are closely connected to those in Chapter 2.6.2.8: Research on adaptation to the consequences of climate change in the area of construction and housing and Chapter 2.6.2.10: Public information and raising awareness of the issue of adaptation to the consequences of climate change in the area of construction and housing.</p>
Connection to other sectors	<p>There are connections in particular to forestry, energy, protection against natural hazards, economy, health and spatial planning.</p>
Connection to existing instruments	<p>Connections are offered by existing research programmes, such as House of the Future and City of the Future of the Federal Ministry for Transport, Innovation and Technology, as well as the smart cities initiative of the Austrian Climate and Energy Fund.</p>
State of implementation	<p>The publication on sustainable building in Austria in 2015 documents monitoring results from demonstration buildings, which were planned and built within the framework of the “House of the Future” funding programme. In the publication, particular attention is paid to the summer suitability of buildings. Further flagship examples are presented in a magazine of the Austrian Climate and Energy Fund and in the databank of klimaaktiv. The focus is on thermal renovation, increasing the energy efficiency and, partially, the summer suitability.</p>
Recommended further steps	<ul style="list-style-type: none"> – Development of practical adaptation solutions that can be upscaled, in particular to protect against extreme weather events and for increased constructional stress; – Interdisciplinary development (sociology, logistics, consideration of further environmental factors, such as emissions from transport) and evaluation of pilot projects, as well as accompanying research (monitoring, cost-benefit analyses, social science accompanying research); – Presentation of the microclimatic effects and derivation of measures from the results using simulation tools (digital prototyping on the scale of a town/city); – Implementation of information campaigns: strengthened public dissemination of pilot projects; – Creation of a legal framework for the implementation of pilot projects.
Possible resource requirements	<p>For the implementation of interdisciplinary pilot projects, resources will be required. In the long term, the adapted building forms will provide savings.</p>
Actors	<p>EU, federal and state governments, research funding bodies (Climate and Energy Fund, FWF, FFG), academic and non-academic research institutions, innovative real estate developers/building developers, municipalities, microclimate experts, medical doctors, sociologists, psychologists, logistics specialists.</p>
Time horizon	<p>Corresponding flagship examples with inter- and transdisciplinary development could be started in the short to medium term.</p>

2.6.2.10 PUBLIC INFORMATION AND RAISING AWARENESS OF THE ISSUE OF ADAPTATION TO THE CONSEQUENCES OF CLIMATE CHANGE IN THE AREA OF CONSTRUCTION AND HOUSING

Objective	Raising awareness and dissemination of knowledge on the subject of adaptation to the effects of climate change and the necessary adaptation measures.
Significance	As a new and complex topic, adaptation to the impacts of climatic change, in contrast to mitigation of climatic change, does not receive the necessary level of attention.
Connection to other sectors	Public relations and awareness-raising on the topic of adaptation to climatic change are found to be essential in all sectors, in order to cope with the consequences of climatic change.
Connection to existing instruments	There are connections to existing national and regional programmes and public relations activities (e.g., klimaaktiv, Klimarettung, e5 Gemeinden) and through cooperation with NGOs.
State of implementation	<p>A well-established and nationwide advisory service for the building sector exists with a focus on energy efficiency and the increased use of renewable energy sources. Protection against natural hazards and extreme weather events are rarely considered.</p> <p>Brochures such as “Living with Natural Hazards” (Leben mit Naturgefahren, BMLFUW 2015h), “The power of water – correct protection of buildings against floods and groundwater” (Die Kraft des Wassers – Richtiger Gebäudeschutz vor Hoch- und Grundwasser, BMLFUW 2007d), the “Safety Guidebook – Flooding” of the Austrian Civil Defence Association etc. provide comprehensive information on protecting buildings against floods and natural hazards. The centre for the prevention of elemental damage (Elementarschaden Präventionszentrum), supported by Upper Austria, Lower Austria, Styria and Burgenland, provides information sheets and advisory services.</p> <p>A guide produced by the Federal Ministry for Land, Forestry, Environment and Water and the University of Natural Resources and Life Sciences (Hübl & Tschärner 2015) aims to raise the awareness of home owners and planners regarding natural hazards before they begin building, so that possible effects can be considered in the planning stage. .</p>
Recommended further steps	<p>To create appropriate awareness and the necessary knowledge, various steps are necessary, for example:</p> <ul style="list-style-type: none"> – General information and awareness-raising on climatic change and on adaptation to the impacts of climatic change, as well as to positive interactions with respect to climate protection; – Public relations and awareness-raising on necessary adaptation measures for buildings and in their surroundings; – Advisory services on planning and construction measures and behavioural change; – Initiation of interdisciplinary knowledge platforms, as well as strengthened thematic coordination with already tried-and-tested initiatives on climate protection; – Development of public relations campaigns for target groups. This measure requires a close cooperation with research, which provides the necessary information and results.
Possible resource requirements	To a large extent, the development of appropriate information materials and targeted information campaigns can be carried out through reallocation of resources. For the expansion of advisory services additional resources might be necessary.
Actors	Federal and state governments, municipalities, NGOs, interest groups.

Time horizon | Appropriate activities can be started in the short term, in order to achieve the goal in the long term.

2.6.2.11 TRAINING AND FURTHER EDUCATION ON ISSUES OF ADAPTATION TO THE CONSEQUENCES OF CLIMATE CHANGE IN THE AREA OF CONSTRUCTION AND HOUSING

Objective	Creation of a sound knowledge base for the implementation of measures for adaptation to the consequences of climate change.
Significance	For a broad implementation of adaptation measures, appropriate qualifications must be widely secured. For this, the tertiary education sector (universities, universities of applied sciences) plays a key role, but the contents must also be integrated into education and training programmes for relevant professional persons (e.g., builders) and in general into school curricula. This measure also requires close cooperation with research, which provides the necessary information and results.
Connection to other sectors	There is a close connection, in particular, to the protection against natural hazards, health, disaster management, spatial planning and energy.
Connection to existing instruments	There are connections to existing curricula and the education and training programmes for professionals.
State of implementation	Adaptation to climatic change is currently not covered comprehensively in education and training.
Recommended further steps	<ul style="list-style-type: none"> – Adaptation of curricula for architecture students, urban and regional planning, building construction sector, open space planning, real estate agents, as well as property developers; – Support for training of professionals; – Adaptation of school curricula; – Strengthened cooperation and interaction between researchers and the building professionals.
Possible resource requirements	The necessary adaptation of teaching content on the basis of new knowledge can be carried out within the continual adaptation of teaching content.
Actors	Federal government, training and education institutions, interest groups (chambers), academic and non-academic research institutions.
Time horizon	Efforts should be made for implementation in the short to medium term.

2.7 PROTECTION AGAINST NATURAL HAZARDS

2.7.1 OVERARCHING OBJECTIVE OF THE SECTOR

Overarching objective: Strengthening the precautionary principle through areal precautions, personal precautions and behavioural precautions, in order to reduce the negative consequences of natural hazards resulting from climatic changes.

2.7.2 RECOMMENDED ACTIONS FOR PROTECTION AGAINST NATURAL HAZARDS

GENERAL PRINCIPLES FOR ACTION IN THE AREA OF PROTECTION AGAINST NATURAL HAZARDS

Despite the uncertainties in projecting possible regional impacts of climatic change in the area of protection against natural hazards, it is necessary to continue along the path that has been taken of a “permanent adaptation” to continually changing boundary conditions (not only climate, also societal values, global change etc.). This should make it possible, on the basis of the often century-long experience with dangerous natural processes in the alpine area and the resulting tradition of coping with natural hazards, to prepare better for future events of unknown extent. An important part of this task will always be communication and clarification of the limits to protection against natural hazards: a completely comprehensive and unlimited protection against natural hazards is not possible for technical, financial and resource-related reasons. The realistic goals of the protection against natural hazards must be oriented towards limiting the dangers and thereby the risk to an acceptable level. The important goals of natural hazard management are the protection of human life, the protection of the life-support system, the reduction of material damage, the review and facilitation of reconstruction, as well as the sustainability of the measures. To achieve these goals, a series of regulatory, social and economic measures are necessary, which are connected to the following principles for action:

- National and international cooperation and knowledge/information exchange regarding the impacts of climatic change on the protection against natural hazards are basic prerequisites for successful adaptation measures.
- Adaptation to climatic change in the area of protection against natural hazards requires a broad range of measures, so a combination of non-structural (no construction) and structural measures is necessary.
- Strengthening the general resilience and capacity to regenerate in society according to the Sendai Framework for Disaster Risk Reduction 2015-2030 with the aim of reducing the negative consequences of natural extreme events.
- Following the principles of integrated natural hazard and risk management: this is understood as the forward-looking development of a comprehensive set of options and measures. For this it is necessary to include and work with all affected persons – within communities and across institutions – with various means in different phases of natural hazard management.
- Further use of the precautionary principle in adaptation to climatic change:
 - Promotion of
 - Area precaution,
 - Personal precaution and
 - Behavioural precaution.

The precautionary principle builds on the active support of the actors in natural hazards management.

- Promotion of the principle of proportionality in dealing with natural hazards: the necessary measures must be in a reasonable relationship to the protection goal (with respect to efficiency and effectiveness). That is: no protection at any price.
- Promotion of knowledge, experience and data transfer (which should be considered separately for each recommended action where specifically needed).
- Promotion of awareness-raising, the possibility of individual initiative and more extensive learning, teaching and training processes.

2.7.2.1 DEVELOPMENT (EDUCATION) AND PROMOTION OF DANGER AND RISK AWARENESS AS WELL AS INDIVIDUAL RESPONSIBILITY IN THE POPULATION

Objective	Anchoring and strengthening awareness of self-reliance when dealing with risks from natural hazards.
Significance	<p>The best measure to protect against natural hazards is always the avoidance of any danger and then of threatened areas. In many valleys and mountainous regions, however, as a result of intensive use (building land, business and industry, transportation routes, tourism, agriculture and forestry) on the one hand, and the effect and superimposition of natural hazards, on the other hand, there are hardly any areas left that provide a high level of safety with respect to natural hazards. This restriction of safety from a spatial point of view has impacts on the basic functions such as housing, work, provisioning, education, recreation, transport and communication. Given the growing needs for protection of the population, the state provides public services. However, the state cannot guarantee absolute safety in the case of natural hazards, which is why the concept of individual responsibility for one's own safety is still very important in dealing with natural hazards. Precaution within the framework of individual responsibility assumes responsible behaviour in dealing with the risks of natural hazards. Generally this includes awareness of danger, perception and acceptance of risks of natural hazards, as well as a responsible handling of these dangers. The perception of this individual responsibility in a society founded upon solidarity is a necessary contribution of the individual to the common good and helps to cope with the negative consequences of natural hazards.</p> <p>The possibilities for (individual, communal, regional) adaptation to climatic change in the area of protection against natural hazards are manifold. However, the very complex interconnections and interdependencies can in many cases only be judged and estimated by professional experts. Here, the specialised services of the federal government and the federal states, as a first source of information, provide unbureaucratic support, which is appreciated and used by the general public. With respect to adaptation to climatic change, however, numerous new challenges arise regarding information transfer, including the topics of financial support, legal liabilities, possibilities for self-protection, but also estimating the danger at a particular location. This amount of additional advisory activity cannot be carried out to the desired extent with the current resources of the departments of the federal government and federal states.</p> <p>Providing purely digital information will become increasingly important, but there are limits to the availability and possibilities for use for some of the population (e.g., remote settlements, differing practical implementation etc.). Thus, the possibility for direct provision of advice is still important in the digital age and should be maintained. Thereby, the increased needs of the population for safety and information must be taken into account. At the same time, the advisory activities should cover, in addition to the technical and non-structural possibilities, all variations of financial, organisational and coordination support that appear to be necessary for adaptation to climatic change.</p>
Connection to other sectors	There is a close connection in particular to disaster management, spatial planning and construction and housing.
Connection to existing instruments	The EU Floods Directive strengthens the obligation of the authorities to provide information to the general public in the area of flood management and requires the

Member States to identify areas with a potentially high risk of flooding. For these areas, maps of dangers and risks must be produced and programmes of measures for flood risk management should be developed on that basis.

The instrument of hazard zone planning is an important part of the existing supply of information of the specialised departments of the federal government and federal states. These departments offer unbureaucratic advice, help and information on the topic of protection against natural hazards. However, the additional work associated with adaptation to climatic change is difficult to carry out with the current level of personnel. In general, however, the available information structure for natural hazards could serve as a model for advisory services.

Furthermore, existing internet platforms are a source of information with respect to awareness-raising on prevention, for example www.naturgefahren.at or www.hora.gv.at. For children and young people, initiatives, such as “Biber Berti”(hazard zone planning for children) or www.generationblue.at, provide information on the topic of natural hazards.

In the area of civil protection, there are institutions such as the National Crisis and Disaster Protection Management (SKKM), the Federal Geological Office and the Central Institution for Meteorology and Geodynamics (ZAMG) or also state institutions in the area of disaster protection (e.g., KAGIS⁸⁷). There is a connection to the recommendation of the Austrian Conference on Spatial Planning (ÖROK) on preventive handling of natural hazards in spatial planning (ÖROK 2005a), as well as to the ÖROK recommendation on risk management for gravitational natural hazards in spatial planning (ÖROK 2016).

The hydrographic units in the federal states use elaborate computational models to warn the population about the danger of flooding. While 100 years ago it was only the Danube region that was considered important for flood warning services, currently forecast models are used for almost all large water bodies in Austria and continuously calculate the current discharge situation and make forecasts of the discharge for up to 2 days.

Each hydrographic unit provides up-to-date information and data online on the water balance in the area for which they are responsible. The data from almost all monitoring stations that have remote data transmission capabilities are transmitted to the Federal Ministry for Sustainability and Tourism and presented on the eHYD (www.ehyd.gv.at) webpage. This online presentation provides a nationwide overview of the current situation of all surface water bodies and is linked to the hydrographic services of the federal states.

When a flooding situation occurs, the corresponding hydrographic service establishes a team. The Federal Ministry for Sustainability and Tourism is informed about this and all warnings and reports on the situation are summarised and presented for the public on the eHYD webpage.

The national weather service (ZAMG) and private weather services provide warnings via internet for wind, storm, hail etc. The warnings are also provided in some case via text-messaging.

To date, climatic change and adaptation were not a focus of attention but were partially integrated in existing instruments (such as electronic access to the hazard zone plans of the Federal Water Construction Administration and the Forest Technical Service for Torrent and Avalanche Control, or ensuring the unrestricted access to information about natural hazards and risks etc.).

FloodRisk II, ClimChalp, AdaptAlp, ERA-Net CRUE, FloodRisk E, as well as the project “KLARA-Net” (Research project “Network for adaptation to climatic change in the Starkenburg region”, Germany, 2008)

State of
implementation

Source of
recommendations

⁸⁷ Link: http://www.kagis.ktn.gv.at/19948_DE

Recommended further steps	<ul style="list-style-type: none"> – Further interlinking of information on the community level (e.g., hazard zone plans, flood zones etc.); – Investigation of the level of risk-awareness and the awareness regarding individual precaution/responsibility in the general public as a basis for targeted public relations; – Promotion of hazard-awareness in regions intensively used for tourism through targeted information campaigns, such as the (obligatory) provision of information folders about natural hazards in the region when guests register at their holiday location; – Strengthened engagement to establish the topic of natural hazards and climatic change in schools and kindergartens (e.g., as a module during school trips or school skiing courses, but also as a measure of the flood risk management plan); – Continual targeted risk communication or information, amongst others to promote individual responsibility, with the support of communications experts; – Strengthened networking and cooperation of all involved levels (federal government, federal states, municipalities), as well as between the specialised departments, in public relations work; – Where necessary, creation of incentives (e.g. awards, financial support) to strengthen risk-awareness and individual precaution.
Possible resource requirements	Resources are necessary for the networking and for the preparation of data for various target groups or for the ongoing operations.
Possible conflict potential	No conflict potential has been identified.
Actors	Federal government (departments), state governments (departments), municipalities, tourism organizations, individuals, National Crisis and Disaster Protection Management (SKKM), ZAMG, Geological Survey of Austria, ÖROK, state school authorities.
Time horizon	The inclusion in existing instruments can start immediately. Efforts are made to provide hazard zone plans for the entire country.

2.7.2.2 PROMOTION OF SUSTAINABLE SPATIAL DEVELOPMENT STRATEGIES, INCLUDING INCREASED CONSIDERATION OF PLANNING IN HAZARD AREAS AND IDENTIFICATION OF RISKS

Objective	Keeping areas potentially affected by natural hazards free from use for residential, commercial, or infrastructure purposes, or risk-oriented control of such use.
Significance	<p>The analysis of past catastrophic flooding and torrent events in Austria has shown that the increasing concentration of buildings and infrastructure in exposed areas and in some cases in areas also designated as dangerous have had a proven effect on damage and subsequent costs. This has occurred despite extensive protective measures through public money (e.g., analyses and results from the project FloodRisk I, Habersack et al. 2004 und FloodRisk II, Habersack et al. 2009; Keiler 2005, FloodRisk-E). Similar situations exist for avalanches, landslides or areas threatened by rockfalls in the Austrian Alps.</p> <p>In general the measures protect the existing settlement and economic areas against natural hazards to the limit of the design event (currently in most cases this is an event with a probability of recurrence in 100 years).</p> <p>The effectiveness above all of technical protective measures – in addition to the effects of damaging events – also depends on the service life of the product and declines over time. The documented increase of the value of buildings, as well as the related increase of the number of threatened people in areas already threatened, qualify and minimise the level of safety after protective measures have been implemented. The mere</p>

existence of protective measures is no guarantee of long-term safety of a particular location. Their functionality can only be judged in combination with accompanying measures and instruments (hazard zone planning, local zoning, individual precaution, awareness-raising etc.). This is also true for all considerations of residual risk.

Given these technical limitations, the possibility of direct prevention of hazards through targeted management of the supply of areas for settlements, business and infrastructure is one of the most effective and efficient solutions for dealing with natural hazards. This includes restrictions on sealing of the soil surface, and the creation of near-natural open spaces. Regional – but most significantly local – spatial planning in cooperation with the hazard zone planning of the Federal Department of Hydraulic Engineering and the Forest Technical Service for Torrent and Avalanche Control is particularly important. In this connection, spatial planning is a cross-cutting activity that must find a balance between the natural hazard potential and the demands for use of available space. A stronger use of the results of hazard zone planning in regional and local spatial planning can contribute to an optimal exploitation of the possibilities for areal precaution and in some cases to minimise the use of very expensive precautionary and protective measures (e.g., through the identification of settlements that are particularly exposed to hazards, for which, because of the foreseeable inefficiency of protective measures, abandonment (relocation) should be considered; see also the Chapter on Spatial Planning). The legally binding inclusion of hazard zone planning into spatial planning and building laws of the federal states, as well as possible resulting reserved areas and areas to be kept free, has not yet been carried out.

This recommended action supports climate protection goals, since as a rule no accompanying construction measures or subsequent measures (e.g. reconstruction) are needed.

Connection to other sectors

There are close connections to many sectors, since they affect regional and spatial planning to a greater or lesser extent. There is a close connection to recommended actions in spatial planning.

Connection to existing instruments

Adaptation of regional planning and building laws of the federal states (e.g. of regional and local spatial development concepts or plans) is necessary. The development of concrete measures must take into account the recommendations of the Austrian Conference on Spatial Planning (ÖROK) regarding preventive measures with respect to natural hazards (ÖROK 2005a Nr. 52), the ÖROK recommendation on risk management for gravitational hazards in spatial planning (ÖROK 2016), the spatially relevant recommendations in flood management plans, relevant recommendations from the projects FloodRisk I (Habersack et al. 2004), FloodRisk II (Habersack et al. 2009) und FloodRisk-E (BMLFUW 2015b), as well as relevant aspects from the forestry programme.

State of implementation

To date, climatic change and adaptation were not a focus of attention but were partially integrated in existing instruments.

In the hazard zone plans and discharge studies of the Federal Department of Hydraulic Engineering, the areas of flood discharge for different probabilities (30-year, 100-year and 300-year, according to the Austrian Water Rights Act) are presented. These provide the technical basis (including residual risk areas) for the legal implementation in the regional planning and building laws of the federal states.

For example: The regional planning law of Lower Austria forbids zoning measures in the discharge area of a 100-year flood. (See also the recommended action in spatial planning 2.12.2.2: Establishment and protection of flood retention and drainage zones and clear regulation of zoning prohibitions and restrictions).

Sources of recommendations

FloodRisk I-II, FloodRisk-E, ÖREK2011, ClimChAlp, AdaptAlp, national studies.

Recommended further steps

- Establishment of risk-oriented spatial planning: a risk-oriented use of space should contribute to a situation in which there is no significant increase of potential damage or a reduction of possible damages due to natural hazards, as

	<p>well as an early consideration of natural hazards in planning processes leading to no unacceptable risks;</p> <ul style="list-style-type: none"> – Orientation of future settlement development towards existing, well developed locations, in order to avoid further urban sprawl; – Discussion of an organised retreat and support for abandonment and changes of use of threatened areas; – Legally binding embedding of designated inundation areas, hazard zones and functional areas in spatial planning laws; – Enforcement of the accumulation principle (summation effect) in all building permit processes that are in hazard zones of the Federal Department of Hydraulic Engineering or the Forest Technical Service for Torrent and Avalanche Control; provision for the whole country of hazard zone plans of the Federal Department of Hydraulic Engineering or the Forest Technical Service for Torrent and Avalanche Control.
Possible resource requirements	The resource requirement cannot be quantified at present.
Possible conflict potential	A potential conflict could arise because making hazard zone planning legally binding requires agreement between the federal government and the federal states. In the case of changes of land use in threatened areas, conflicts could perhaps arise through necessary changes in existing legal rights.
Actors	Federal government (hazard zone maps, GZP), state governments, municipalities.
Time horizon	Inclusion in existing instruments can start immediately. The countrywide development of hazard zone plans has already begun. A countrywide expansion of the hazard zone plans to include other alpine natural hazards (e.g. rock falls, slide processes etc.) requires around 10-20 years (collection of data, homogenisation, linking, plausibility checking etc.).

2.7.2.3 PROMOTION OF WATER RETENTION IN CATCHMENT AREAS AND REACTIVATION OF NATURAL FLOODPLAINS (AND AREAS), PARTICULARLY AS A CONTRIBUTION TO PROVISION OF ADDITIONAL INUNDATION AREAS

This recommendation corresponds to that of Chapter 2.3.2.8: Adaptive flood risk management with robust measures. Because of its particular importance for a sustainable and effective adaptation to climatic change from the perspective of protecting against natural hazards, it is also included here.

Objective	Reduction of peak flows by ensuring water retention in the catchment area.
Significance	<p>Between 2009 and 2012, the total daily use of land area (areas for buildings and transport, sports facilities, infrastructure) was 22.4 ha/day. About 5 ha of this are sealed each day (Umweltbundesamt 2013). The increasing sealing competes with the abiotic (e.g. buffering) and biotic (e.g. habitat for flora and fauna) functions of the soil. With respect to the water budget, these changes lead to a reduction of storage capacity and therewith to increased discharge speeds and large discharge peaks.</p> <p>Both in the regional (e.g., in the development plan) and the local spatial planning (e.g., local development concepts, zoning plan or building plan), appropriate measures to ensure water retention in the area must be included. Experience shows that further intensive awareness-raising on the necessity to reserve areas for flood discharges rather than for competing uses is particularly important, since here synergies exist between measures to improve ecological conditions and measures flood protection (integrated measures).</p>
Connection to other sectors	There is a close connection in particular to water management, ecosystems/biodiversity, regional planning (in particular Chapter 2.12.2.2: Establishment and protection of flood retention and drainage zones and clear regulation of zoning prohibitions and

Connection to existing instruments	<p>restrictions), construction and housing, transport infrastructure, economy, and agriculture.</p> <p>Also, in the forestry sector, the high importance of forests in storing water is discussed (see Chapter 2.2.2.2: Soil-friendly management).</p> <p>During the development of concrete measures the recommendations from the projects FloodRisk I (2004), FloodRisk II (2008) und FloodRiskE (2015) must be included.</p> <p>Possible connections are provided by the EU Water Framework Directive and the EU Flood Directive, in which the integrated management of river areas is laid down. According to the implementation of the Flood Directive, the first step is to carry out a preliminary risk assessment. Further, these results are used in the development of flood hazard and risk maps and the flood risk management plan, which amongst others foresees the safeguarding of water retention areas. Furthermore, improved planning instruments were produced (water body development and risk management concepts, regional programmes for water management), which strengthen the awareness of the hazards and provide incentives to support water constructions, hydromorphological measures, ecological measures etc., to maintain or reserve areas for natural flooding.</p> <p>There is also a close connection to the ÖREK (Austrian spatial development concept) 2011, which considers climatic change, adaptation and resource efficiency and formulates measures such as preserving flood discharge areas.</p>
State of implementation Recommended further steps	<p>Step-wise implementation is carried out during the development and implementation of the flood risk management plans.</p> <ul style="list-style-type: none"> – Strengthened safeguarding, through regional planning, of natural (designated or potential) inundation areas within the framework of a nationwide register of inundation areas; – Mobilisation of reserves of building land (e.g. town centre) rather than new zoning of agricultural areas; – Promotion of the renaturalisation of rivers and wetlands (e.g. reactivate and reconnect cut-off meanders, maintain existing river meadows and moors).
Possible resource requirements	<p>For further recommended steps see Chapter 2.12.2.2: Establishment and protection of flood retention and drainage zones and clear regulation of zoning prohibitions and restrictions).</p> <p>Resource requirements cannot be quantified at present.</p>
Possible conflict potential	<p>There is possible conflict potential with agriculture, since most of the areas and plots of land necessary for successful implementation are agricultural and therefore corresponding compensation mechanisms will be required.</p>
Actors	<p>Federal and state governments, municipalities, infrastructure managers, land owners, water boards, ÖROK.</p>
Time horizon	<p>The inclusion in existing instruments can be carried out immediately. Possible purchase or exchange of plots of land can, however, require a longer period of time.</p>

2.7.2.4 PROMOTION OF FORECASTING, (EARLY) WARNING AND MEASUREMENT SYSTEMS

Objective	<p>Expansion of the scope of data and information on hazardous natural processes and the resulting possibility of (early) warning.</p>
Significance	<p>An effective management of natural hazards requires a wide set of methods, data, technologies and groups of measures. Each of these and their results are connected with more or less high levels of uncertainty, which must be considered in each decision about the appropriateness of a selected measure to protect against natural hazards.</p>

	<p>Uncertainty can be reduced through intensive observations, measurements and data collection with respect to natural hazard processes, but also through continual scientific and technological developments. Measuring systems for continual observation (monitoring) of natural phenomena make an important contribution to analysing and evaluating the hazard processes and developing appropriate strategies to cope with natural hazards on this basis.</p>
Connection to other sectors	<p>Warning and early-warning systems contribute to the avoidance or minimisation of potential damages and have proven their worth in particular in medium and large river catchments. In these areas, an effective warning and advance information for the population is possible due to the longer timespan of processes (e.g. floods). In areas subjected to torrents and avalanches, as well as in small catchments, there is still a need to catch up, because of the faster development of the processes and the resulting, usually very short, time for advanced warnings. In this case, there is an urgent need for further development of the technological prerequisites, in order to extend the advanced warning time and reduce false alarms.</p>
Connection to existing instruments	<p>Basically, there are connections to all other sectors but in particular to water management (see Chapter 2.3.2.1: Analysis of existing data and promoting collection of further data on water resources) and disaster management (see Chapter 2.8).</p>
State of implementation	<p>Austria has a well-organised and functioning network of monitoring stations for observing precipitation, water and air temperature, discharge, groundwater level etc. (e.g., through the Central Institution for Meteorology and Geodynamics (ZAMG), the Hydrographic Service, the Austrian portal for hydrographic data (eHYD)). In Austria, the hydrological discharge forecasts are the responsibility of public services and are made by the hydrographic units of the federal states. The demand for hydrological forecasts has changed strongly over the last 100 years due to the spread of settlements into the valley areas and the resulting increase of damage risk. While 100 years ago it was only the Danube region that was considered important for flood warning services, currently forecast models are used for almost all large water bodies in Austria. The model structure has changed significantly, particularly in the last 15 years. More or less simplified correlation models based on events have been replaced by water budget models that are permanently in operation. The related demand for input data and for data management has increased dramatically. Furthermore, there are numerous alarm and warning systems (e.g. the Federal Warning Centre (BWZ) and State Warning Centres (LWZ) and particular systems for avalanche warnings). Various institutions (e.g. ZAMG or some insurance societies) offer early warning announcements via text messaging.</p>
Basis of recommendations	<p>The information for small catchment areas is, however, not always sufficient. The further provision of appropriate monitoring stations in small catchment areas would provide a valuable data and information basis for a better understanding of natural hazard processes and further technological development in the area of forecasting and warning systems.</p>
Recommended further steps	<p>To date, there has been no focus on climatic change and adaptation but this could be integrated into some existing instruments. Furthermore, political decisions that provide guidance for the implementation are necessary.</p>
Basis of recommendations	<p>ERA-Net CRUE (2009) und AdaptAlp (2009b), FloodRisk-E (2015)</p>
Recommended further steps	<p>As a rule, warning systems are only effective when the affected population has been included from the start in the design and implementation. This is particularly important in the starting phase of such systems, since at this stage there are often false alarms, which lead, if there are many of them, to distrust regarding the capability of the system. The planning of emergency approaches and plans of action is necessary as an accompanying measure, in order to be able to coordinate and manage appropriate behaviour of all persons involved when an event occurs.</p>

	<ul style="list-style-type: none"> – Qualitative expansion of monitoring systems and further development of the technological prerequisites for early recognition of danger (especially in small catchment areas); – Further development of forecasting models and tools; – Further research on risk communication, in order to better understand and consider the connections between information, understandability and acceptance of the information, risk-awareness etc.; – As early as possible, inclusion and training of the general public in the design and implementation of warning systems; – Planning and training for emergency approaches and plans of action, in order to ensure appropriate behaviour of all people involved when an event occurs.
Possible resource requirements	Resources are necessary for the qualitative expansion of monitoring systems and further development of forecasting models.
Possible conflict potential	No conflict potential has been identified.
Actors	BMLFUW, BMVIT, federal states, municipalities, interest groups, scientific institutions, infrastructure operators, ZAMG, Geological Survey of Austria, emergency response organizations.
Time horizon	Research on relevant questions can be commissioned in the short term. In this case, because of the complexity of monitoring and warning systems, it is important to ensure that as many specialised disciplines as possible are brought together in a research initiative. Reliable results can be expected within the next 10 years. The expansion of the monitoring systems can be undertaken in the next 5 years. The monitoring results can be included in hazard zone plans and corresponding early warning systems, emergency plans etc. in the medium to long term.

2.7.2.5 PROMOTING RESEARCH INTO THE IMPACT OF CLIMATE CHANGE ON EXTREME EVENTS, ON CHANGES IN THE NATURAL ENVIRONMENT, ON HUMAN USE AND ON HOW TO DEAL WITH UNCERTAINTIES IN DECISION-MAKING

Objective	Provision of decision-making bases using the state of the art in science and technology.
Significance	Further intensive research and development of climate modelling and hydrology/meteorology are necessary, in order to be able to provide necessary information and boundary conditions (e.g. climate scenarios, design events, dimensioning etc.) for planning in natural hazard management with high temporal and spatial resolution (e.g., WETRAX - Weather Patterns, CycloneTracks and related precipitation Extremes – Hofstätter et al. 2015). Furthermore, the influence of extreme events on natural areas and the resulting possible changes of human use of these areas are very important for the best possible adaptation of responses to future increased extreme events as a result of climatic change.
Connection to other sectors	In line with an interdisciplinary approach, research should be coordinated with regional planning, forestry, energy, construction and housing and health.
Connection to existing instruments	The research topics are covered by existing and future national (e.g. Austrian Climate Research Programme of the Austrian Climate and Energy Fund) and international research programmes (e.g., Alpine Space) and initiatives.
State of implementation	Continual implementation in regional, national and international research and development projects.
Basis of recommendations	FloodRisk I (2004), FloodRisk II (2008), FloodRisk-E (2015), ClimChAlp (2008), AdaptAlp (2009), national and international research projects.

Recommended further steps	<ul style="list-style-type: none"> – Consideration of interdisciplinary and transdisciplinary principles in research; strengthened attention to the topic in national and international research programmes; – Increased research with respect to climatic change and hydrology/meteorology for better planning in natural hazard management; – Take up the treatment of uncertainty in decision making as a research topic; – Research on the connections between information, understandability, and acceptance of the information, risk-awareness and (potential) behavioural changes at the individual and group levels.
Possible resource requirements	Resource requirements cannot be quantified at present.
Possible conflict potential	No conflict potential has been identified.
Actors	EU, federal and state governments, academic and non-academic research institutions, university cooperation arrangements, national research programs.
Time horizon	Consideration in current/future research initiatives can be included or expanded rapidly. The validation and implementation of the research results will take a longer time.

2.7.2.6 PROMOTING ADOPTION OF MEASURES FOR REDUCING RISK WHILE TAKING ACCOUNT OF APPROPRIATE RISK TRANSFER MECHANISMS

Objective	Raising awareness about the need for complementary insurance-based preparedness measures.
Significance	<p>An appropriate risk transfer mechanism can provide an additional protection of livelihood. This mechanism relies, besides precaution organised by the state and the potential of private individual precaution, additionally on a private basic insurance against damage through natural hazards. Such an insurance scheme must cover the common natural hazards in Austria, would relieve the pressure on the Disaster Fund significantly and simultaneously ensure a uniform processing of damages across Austria. In other EU countries this kind of insurance system is available. In order to be able to offer such a system, some political steps are necessary. It would also be conceivable that this system would require, as an incentive to take preventive measures, a higher own-risk deductible in areas with greater potential hazards.</p> <p>Risks cannot be fully avoided, so a residual risk remains. This consists of an accepted risk (for a protection goal using the 100-year flood, it is accepted that less frequent events could cause damage), unknown risk (within the risk analysis not all possible scenarios can be considered and evaluated) and risk through unsuitable measures or bad decisions (human aspect). Therefore, particularly when considering climatic change, besides technical, regional planning, informative and organisational possibilities to deal with natural hazards, private risk precaution plays a significant role, which is currently only used in a small number of cases. Private risk precaution means, in the case of damages through natural processes, being able to access sufficient (financial) reserves, in order to avoid a situation in which livelihood is threatened.</p>
Connection to other sectors	There is a connection in particular to the economy (insurance business), agriculture, construction and housing, as well as disaster management.
Connection to existing instruments	Currently insurance against damages through storms or hail events is possible, damages through, for example, floods are only covered to a certain limit (about EUR 7,000.-).
State of implementation	The model for the inclusion of further natural hazards in the existing basic insurance against natural hazards was already developed and scientifically evaluated for Austria. For the implementation, there is currently no political consensus.

Basis for recommendations	<p>In addition, research is currently developing possible reform approaches for risk transfer mechanisms in Austria on the basis of international trends and models. This includes discussions about public-private partnerships, supplementary insurance solutions that can be seen as complementary to the Disaster Fund etc. Natural hazard damages are, however, only covered up to a limit of 5,000 to 10,000 EUR by the private fire and household insurance schemes (Hanger & Riegler 2015).</p>
Recommended further steps	<p>FloodRisk I + II, FloodRisk-E</p> <ul style="list-style-type: none"> – Strengthened cooperation with the insurance branch, for example, for a platform to promote risk-conscious behaviour of owners of threatened property (perhaps in connection with the development of models of certification of the level of protection of buildings); – Review and where necessary adaptation of the legal framework for promoting individual precaution supported by insurance; – Review and where necessary adaptation of the insurance contract law in Austria.
Possible resource requirements	<p>Resource requirements cannot be quantified at present.</p>
Possible conflict potential	<p>No conflict potential has been identified.</p>
Actors	<p>Federal and state governments, municipalities, insurance industry, individuals.</p>
Time horizon	<p>The amendment of the insurance contract law is possible at any time but requires consensus between the state and the insurance branch.</p> <p>According to the insurance association, the lead time for a new insurance model is about 18 months.</p>

2.7.2.7 PROMOTION OF PROPERTY PROTECTION MEASURES (PERMANENT AND TEMPORARY) TO ENCOURAGE INDIVIDUALS TO TAKE SAFEGUARDING MEASURES

Objective	<p>Prevention of damage to buildings and property related to the effects of natural hazards.</p>
Significance	<p>Because of the limited availability of appropriate areas, residential and business areas often spread into regions that are only partially or not at all suited for these purposes because of potential threats of natural hazards. This leads to an accumulation of values that are particularly exposed to damage in the case of an event. Despite enormous efforts by public authorities to protect against natural hazards, it is impossible to cover all possible risks related to natural hazards through state measures alone. Therefore, within the framework of integrated risk management, it is expedient to promote special concepts to protect single objects through construction measures (technical protection of objects) or adapted use of this object. Studies in Austria (e.g., Holub 2008, Fuchs et al. 2007, and the guidebook on natural hazards produced by the University of Natural Sciences and Life Sciences (BOKU) and the Federal Ministry of Sustainability and Tourism (Hübl & Tscharner 2015)) have shown that such measures are best suited to reduce the damage potential of buildings and infrastructure with regard to natural hazards or to achieve an increased resistance of the buildings and infrastructure to the impacts of natural processes.</p> <p>The following basic principles for the implementation of measures to protect objects should be considered (Holub 2008):</p>

Connection to other sectors	<p>Need for knowledge about the interactions of all potential hazard processes in the area under consideration (multiple-hazard and multiple-risk approach);</p> <p>Permanent measures (fixed installation) are to be preferred over temporary (mobile) solutions. The arguments for this are the usually high speeds of alpine natural hazards and the related very short advanced warning time;</p> <p>Damages to third persons should be avoided, which means that technical object protection should have no negative effects on adjacent plots or those downstream.</p> <p>In the meantime there are multiple solutions for the protection of new buildings (e.g., Holub 2008, BMLFUW 2010a, c), but also for retrofitting existing buildings that can be carried out using various building materials depending on the natural hazard in question. There can be synergy effects. For example, technical measures to protect objects can be implemented at the same time as planned measures to increase energy efficiency of a building, the design of premiums for basic insurance against natural hazards, but also in the possible consideration of regionally specific building norms and requirements (available for earthquakes, storm, lightning and snow load; floods, rock falls, avalanches, mudslides and landslides are not considered).</p> <p>As an incentive system, the following are conceivable: consideration of technical measures to protect objects as a requirement for claiming public subsidies (e.g. housing subsidy) or as a required adaptation measure for applications to make modifications or add an extension to a building that is currently situated in a “red danger zone”.</p> <p>Furthermore, the introduction of a legally binding transfer, by a certified agency, of a certificate for the level of protection of an object with respect to natural hazards (analogous to the energy pass) should be promoted for the sale or new purchase of an object.</p> <p>The recommended actions have a direct connection to those on construction and housing (see Chapter 2.6.2.4: Implementation of structural measures on buildings to protect them from extreme weather events). A consideration of corresponding approaches for developing norms for technical protection measures for buildings in building law and various building codes is recommended (see Chapter 2.6.2.6: Adaptation of building standards and norms to climate change). There is also a connection to the economy (insurance branch), water management, tourism and transport infrastructure.</p>
Connection to existing instruments	<p>Standards and norms for the consideration of earthquakes, storms, lightning and snow load are available. Furthermore, an Austrian norm (ON-R⁸⁸ 24800 ff) regulates the impact models for hazards related to torrents, mudslides, avalanches and rock falls.</p>
State of implementation	<p>Instructions and guidelines for the implementation of technical measures to protect objects used for business or residential purposes are provided, for example, by the Federal Ministry for Sustainability and Tourism (BMLFUW 2010a, c). These are considered in local spatial planning and in the building branch.</p>
Basis for recommendations	<p>To date, there has been no focus on climatic change and adaptation but this could be integrated into some existing instruments. Furthermore, political decisions that provide guidance for the implementation are necessary.</p>
Recommended further steps	<p>FloodRisk II, ERA-Net CRUE, ClimChAlp, FloodRisk-E</p> <ul style="list-style-type: none"> – Strengthened information and awareness-raising to increase individual precaution of property owners; – Establishment of a working group on individual precaution between the federal government, federal states and municipalities to coordinate various interests;

⁸⁸ ONR are quickly available normative documents that must not fulfil all of the requirements for a classical norm. A later introduction into a norm (ÖNORM) can be prepared.

	<ul style="list-style-type: none"> – Adaptation of the legal basis with regard to the consideration of and development of norms for technical measures to protect buildings in the processing of building procedures or the approval (Kollaudierung⁸⁹) of completed new buildings or conversions. Corresponding norms could be included in the guidelines of the Austrian Institute for Construction Engineering (OIB); – Establishment of an overarching institution in the federal states that, similar for example to the Fire Prevention Agency in Upper Austria, provides advisory services and specialised research and development tasks; – Taking ranges of process intensity (Prozessintensitätsbandbreiten⁹⁰) into account in the planning of protective measures for objects from the hazard zone plans of the Federal Water Construction Administration and the Forest Technical Service for Torrent and Avalanche Control; – Creation of incentive systems for obligatory consideration of protective measures for objects when public subsidies are used in endangered areas; – Review of different scenarios (e.g., development of certificates for properties and objects in connection with insurance solutions) and consequences (e.g., transfer of the risk for property also leads to higher pressure on municipalities).
Possible resource requirements	The resource requirements depend on the selected solution.
Possible conflict potential	No potential conflict has been identified.
Actors	Federal and state governments, municipalities, association of insurers, science, developers, individuals, OIB (Austrian Institute of Construction Engineering), certification body.
Time horizon	<p>The planning and implementation of technical measures can be undertaken at any time.</p> <p>The inclusion in existing instruments of building law and building codes, as well as the public support measures, can be carried out in the short term. For implementation in a law, a time horizon of 5 years can be expected.</p>

⁸⁹ *Kollaudierung: an official assessment by an authority of whether a building was built according to the plan and legal requirements.*

⁹⁰ *Ranges in which a particular process can realistically occur for a selected annuality.*

2.8 DISASTER MANAGEMENT SECTOR

2.8.1 OVERARCHING OBJECTIVE AND IMPORTANT FINDINGS FROM THE PROGRESS REPORT

Overarching objective: Fast and professional management of disasters through better linkages and preparation of all concerned actors, in particular with regard to changing climatic conditions.

2.8.2 RECOMMENDED ACTIONS FOR THE DISASTER MANAGEMENT SECTOR

GENERAL PRINCIPLES FOR ACTION IN THE DISASTER MANAGEMENT SECTOR

- For the development of sustainable adaptation measures, an integrated consideration of the whole system of disaster management in Austria with increased attention to risks is needed;
- Changes of the frequency and intensity of natural disasters as a result of climatic change require adaptation and the creation of additional prerequisites;
- For the implementation of complementary activities, a comprehensive and forward-looking networking of the relevant actors in disaster management on the basis of existing instruments is essential;
- Efforts must be made to strengthen cooperation between research, authorities and emergency response organisations and continually include new scientific knowledge into the practice of disaster management;
- Strengthened inclusion of the economy, as well as awareness-raising of the general public, is necessary in order to be adequately prepared for unusual damaging events.

2.8.2.1 CONTINUOUS IMPLEMENTATION OF THE OBJECTIVES OF THE SKKM STRATEGY 2020, WITH GREATER CONSIDERATION OF THE EFFECTS OF CLIMATE CHANGE

Objective	Timely and forceful implementation of the SKKM Strategy.
Significance	<p>There are numerous reasons for the increase of damages as a result of natural disasters. On the one hand there are factors such as increasing values and concentrations, more vulnerable infrastructure and increasing demands for mobility and communication. On the other hand, factors such as climatic change and changed risk behaviour increase the probability of occurrence and the amount of damage.</p> <p>The National Crisis and Disaster Management Plan (SKKM) from 2009 (BMI 2009) responds to national and international developments and trends. The strategy defines ten challenges and the related need for action. The following areas are seen as challenges but also as potential areas for development:</p> <ul style="list-style-type: none"> – Increasing efficiency through technical innovations; – Intensification of cross-organisation training and drills; – Optimisation of the coordination structure and the legal framework; – Intensification of risk analysis as the basis for disaster management planning; – Maintenance of nationwide supply with primarily voluntary institutions; – Concept for strategically important resources; – Design and use of European and international boundary conditions; – Stronger inclusion of research and development; – Optimisation of the use of financial resources; and – Inclusion of the general public and the economy.

	The implementation of the SKKM-strategy should deal comprehensively with natural hazards and anthropogenic threats and also consider climatic change and the possible consequences.
Connection to other sectors	There is a close connection to the protection against natural hazards and connections should be made to this area in the implementation of the SKKM strategy. There are also connections to transport infrastructure and energy (critical infrastructure).
Connection to existing instruments	The most important instruments include the SKKM strategy, the Austrian safety strategy (Republik Österreich 2013b), the Austrian programme to protect critical infrastructure (Republik Österreich 2015), disaster support/management laws and plans of the federal states as well as the national research programme on safety (KIRAS).
State of implementation	The implementation of the SKKM strategy is at different stages in each area. The greatest progress has been made in cross-organisation education.
Recommended further steps	<ul style="list-style-type: none"> – Periodic new priority-setting for the needs for action in the SKKM strategy considering knowledge about the impacts of climatic change; – Further implementation of concrete projects, which work on the implementation of the SKKM strategy and include the important stakeholders; – Pursuit of the SSKM goals, which could be adapted, after 2020 should be carried out while ensuring a systematic connection or coordination with other strategies (e.g., the strategy for flood protection) (BMLFUW 2015b).
Possible resource requirements	Resource requirements cannot be quantified at present.
Possible conflict potential	No conflict areas have been identified.
Actors	Federal and state governments, municipalities, science, industry, emergency response organisations.
Time horizon	The analysis of the current situation and validated scientific knowledge should be continually introduced into the implementation of measures (Staudinger 2015).

2.8.2.2 ESTABLISHMENT OF A NATIONAL RISK REDUCTION PLATFORM

Objective	Comprehensive exchange between and networking of all relevant institutions, improvement of knowledge transfer from research, dissemination of information on technical innovations and product developments as well as support for a broad dialogue.
Significance	<p>In March 2015 at the third World Conference of the United Nations for Disaster Risk Reduction, the Sendai Framework for Reducing Disaster Risks 2015-2030 was adopted (UNISDR 2015). It provides instruments for forward-looking risk management in order to reduce the impacts of disasters significantly by 2030. The aim is to reduce the risks due to natural disasters, to avoid the emergence of new risks and to strengthen the resilience of the population and institutions to disasters. Climatic change and the connected risks are explicitly included and thus build an international link to the Framework Convention on Climate Change.</p> <p>For Austria, particularly relevant targets of the new action framework are the stronger emphasis on the local level of disaster avoidance, the inclusion of civil society and the work with volunteers. Furthermore, Austria has shown advances in disaster avoidance, such as improvement of early warning systems and the recording and mapping of dangers. For the full implementation of the Sendai action plan, further efforts are required.</p> <p>A significant contribution could be made through a national platform for risk reduction and the establishment of a platform is also supported by the European Council.</p> <p>The increasing number of disasters as a result of climatic change requires a better and closer networking of all relevant actors and facilitation of the access to technical innovations and product developments.</p>

Connection to other sectors	Cooperation between authorities, science, emergency response organisations, the economy (e.g. operators of critical infrastructure, media, insurance branch) and the general public is an essential prerequisite.
Connection to existing instruments	Basically there are connections to all other sectors. Coordination and cooperation are necessary with protection against natural hazards, water management, health, transport infrastructure and energy (electricity).
State of implementation	Besides the National Crisis and Disaster Management Plan (SKKM), the instruments include the Austrian Safety Strategy (Republic Österreich 2013b) and the Austrian Programme to Protect Critical Infrastructure (Republik Österreich 2015). Models such as the Swiss national platform on natural hazards (PLANAT) and the German committee on disaster precaution (DKKV) could be taken as examples for the implementation of a platform in Austria.
Recommended further steps	<p>First preparatory steps for the establishment of a national platform have been taken. Awareness of the relevant actors needs to be strengthened. In the StartClim project SNORRE on screening of weather conditions (Matulla et. al. 2015) a concept was developed to link individual authorities and emergency response and aid organisations and to bring together available data in a data-, communications- and information-platform. A further feasibility study for a nationwide databank for damages is currently being carried out⁹¹.</p> <ul style="list-style-type: none"> – Strengthened awareness-raising and sensitisation for necessary actors and those responsible for actions, for example through events (such as Understanding Risk Austria 2016) and targeted information campaigns; – Detailed determination of the structure, definition and formulation of the goals; – Identification of the responsible actors to be included; – Delimitation and identification of interfaces to other initiatives and instruments; – Review and evaluation of possible financing mechanisms.
Possible resource requirements	For the establishment and long-term maintenance of such a platform, resources are required but cannot be quantified at present. Efforts should be made to keep resource requirements low through the use of existing structures and networks.
Possible conflict potential	The establishment of such a platform requires the networking and inclusion of all relevant actors on different levels. With respect to the responsibilities or the division of work conflicts could arise.
Actors	Authorities at the federal level (Ministry of the Interior, BMI, Ministry of Defence, BMLV (formerly BMLVS), BMVIT, BMNT (formerly BMLFUW), BMASGK (formerly BMG)) and at the state and municipal levels, emergency response organizations (fire departments, Red Cross, etc.), industry (e.g., insurance, operators of critical infrastructure), science, general public.
Time horizon	Establishing such a platform takes time and could require several years. The prerequisites for this are political will, awareness-raising, active engagement and early integration of the relevant actors.

2.8.2.3 PRESERVATION AND, IF NECESSARY, IMPROVEMENT OF THE CONDITIONS FOR VOLUNTEERING IN THE FIELD OF DISASTER MANAGEMENT

Objective	Maintaining and improving suitable framework conditions as well as maintaining the attractiveness of volunteering as one of the important pillars of disaster management in Austria.
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⁹¹ DAMAGE.AT: Enabling the development of an Austria-wide databank on damages; (Joanneum Research, commissioned by the Austrian Climate and Energy Fund)

Significance

According to the second report on volunteers, in 2012 around 360,000 volunteers were engaged in disaster support and rescue services. They contributed more than 1.3 million working hours per week in fire brigades and rescue services (BMASK 2015). In comparison, at the time of the first report more than 413,000 volunteers were engaged, with almost 1.6 million working hours per week (BMASK 2009). The maintenance of voluntary work is a question of overriding importance, since the emergency response organisations, such as the voluntary fire brigade and rescue services are an important pillar of disaster response. Maintaining the nationwide provision of voluntary activities is a key strategic question, in order to be able to respond to more frequent and extreme events and disasters in the future.

The level of voluntary activity in Austria is constantly high for many years, but there is a trend towards irregular and less frequent engagement. This can threaten the future commitment of trained personnel, particularly in remote areas (Seebauer 2013).

Besides climatic change, societal developments (e.g., increasing demands in the workplace, demographic change, outmigration from rural areas, migration, an increasing trend towards spontaneous voluntary engagement with no long-term commitment) also lead to a need for appropriate adaptation measures. These cover various areas (e.g., compatibility of voluntary engagement with the demands of the workplace, ensuring the availability of the daily response team, value of training in connection with voluntary engagement etc.) and should secure voluntary engagement in disaster management over the long term and maintain its attractiveness.

Connection to other sectors

The engagement of volunteers is also important for protection against natural hazards, water management and health.

Connection to existing instruments

The Austrian federal law to support voluntary engagement (*Freiwilligengesetz*) is in force since June 2012 and regulates the framework conditions for formal voluntary activities in the interests of the common good with the aim to support such activities and participation. This should strengthen the solidarity between social groups, generations and cultures, as well as societal and social responsibility. It provides the legal basis for the structures and framework conditions for the support of voluntary activities in Austria, for the voluntary social service year, the voluntary environmental protection year, Austrian Holocaust Memorial Service and peace and social services abroad

Further connections exist to the law for the protection of workers (*Arbeitnehmerinnenschutzgesetz* (ASchG BGBl: Nr. 450/1994 i.d.g.F.)), the general social insurance law (*Allgemeine Sozialversicherungsgesetz* BGBl. Nr. 189/1955 i.d.g.F.) and the pension insurance laws of the insurance providers.

State of implementation

The Austrian federal law to support voluntary engagement provides an important basis for voluntary work. Various emergency response organisations, such as the fire brigade, the Red Cross, mountain rescue and water rescue, work above all with volunteers. In addition there are initiatives like “Team Austria” cooperation between the Austrian Red Cross and a radio station – underlining the trend towards project-oriented voluntary work with no long-term commitment. Initiatives to support voluntary action are currently mostly based on campaigns run by the organisations and public authorities.

Recommended further steps

- Continual analysis of the current situation, needs and challenges of volunteer work in disaster protection;
- Review and possible further development of the law on voluntary engagement with respect to the following exemplary points;
- Consider relief and incentives for businesses that support voluntary engagement of their employees and that are directly connected to the voluntary engagement of their employees,
- Examine the possibilities of leave of absence or additional vacation days or special vacation days for emergency responders,
- Recognize specialised training in disaster protection as an additional professional qualification in public service and possibly in businesses;

	<ul style="list-style-type: none"> – Definition, implementation and evaluation of packets of measures to maintain and support voluntary work in disaster protection; – Establishment of structures for the integration of spontaneous voluntary helpers; – Coordination and integration with on demand (analogous to “Team Austria”) with initiatives like “Team ÖBB” of the Austrian train service, in order to improve the interfaces between businesses and volunteers in disaster situations; – Continuous awareness-raising and public relations regarding the significance of voluntary engagement in disaster protection.
Possible resource requirements	A possible expansion of the framework conditions for volunteer work is possible without substantial resource demands. For individual packets of measures and public relations work there are no estimates of resource requirements at the present.
Possible conflict potential	There can be conflict potential in particular with employers who have to grant leave to employees engaging in disaster response.
Actors	EU, federal and state governments, municipalities, emergency response organizations, humanitarian organizations, volunteers, industry, trade unions.
Time horizon	Measures that demonstrate and support the significance of voluntary engagement should start immediately and be carried out continually over the long term to provide protection (especially in remote regions with weak infrastructure).

2.8.2.4 INCREASING THE FLEXIBILITY OF FINANCING AND FUNDING INSTRUMENTS IN THE FIELD OF DISASTER MANAGEMENT

Objective	Creation of a financing mechanism for short-, medium- and long-term activities of an integrated disaster management on the basis of defined criteria.
Significance	<p>The current version of the Disaster Relief Fund (Katastrophenfonds) was established to provide additional financing for measures to avoid future and to deal with arising disaster damages. Furthermore, resources from the Fund were used to purchase equipment for fire brigades, to co-finance warning and alarm systems and support hail insurance premiums. About three-quarters of the resources are for torrent and avalanche control.</p> <p>Support for dealing with damages to the assets of natural and legal persons after disasters is the responsibility of the federal states. The federal government refunds 60% of the aid money that the federal states have provided to victims.</p> <p>As a result of climatic change, extreme weather events and the resulting floods, mudslides, landslides etc. could become more frequent and more intense in the future. For a modern disaster management, it appears to be useful to examine the financing mechanisms on the basis of the risk analyses currently being carried out.</p> <p>In doing this, measures could be considered, such as risk communication (information campaigns), expansion and further development of warning and alarm systems, provision of specialised equipment for emergency response organisations (e.g., communication and transport resources), as well as support for measures of individual precaution (see the Chapter on protection against natural hazards).</p>
Connection to other sectors	There is a connection in particular to protection against natural hazards. There are also interfaces to agriculture, forestry, construction and housing, transport infrastructure, regional planning and economy (insurance branch).
Connection to existing instruments	Instruments include the Austrian Disaster Relief Fund, as well as the law on the disaster relief fund (1996) and the law on support of water constructions (1985).
State of implementation	The current form of the disaster relief fund concentrates primarily on avoidance and damage compensation. An expansion/ provision of more flexibility of the financing instruments cannot be foreseen at present.

Recommended further steps	<p>Research is currently developing possible reform approaches for risk transfer mechanisms in Austria on the basis of international trends and models. This includes discussions about public-private partnerships and supplementary insurance solutions, which can be seen as complementary to the Disaster Relief Fund. Damages as a result of natural disasters are already covered by private fire and household insurance schemes, but only to a level of €5.000 to €10.000. An extension of coverage could be considered (Hanger & Riegler 2015).</p> <ul style="list-style-type: none"> – Evaluation of the Disaster Relief Fund on the basis of the examination and adaptation of the action needs of the National Crisis and Disaster Protection Management (SKKM) strategy 2020; – If necessary, restructuring of existing or creation of additional financing and support instruments for disaster management; – Consideration of research results on insurance solutions, which can be seen as complementary to the Disaster Relief Fund; – Examination and, where necessary, optimised use, on the basis of risk criteria, of the resources of the Disaster Relief Fund for targeted equipping of emergence response services; – Examination and, where necessary, creation of incentives for individual precaution and risk avoidance, as well as, where necessary, combining the payment of insurance claims or of resources from the disaster relief fund with measures for prevention (BMLFUW 2015b); – Creation of incentives to consider disaster protection during planning and construction of new settlements or buildings; – Creation of incentives to integrate climatic change and natural hazards in disaster protection plans.
Possible resource requirements	Resource requirements cannot be quantified at present.
Possible conflict potential	In the case of regionally strong occurrence of disasters, conflicts can arise with regard to the distribution of resources from the Disaster Relief Fund.
Actors	Federal and state governments, emergency response organizations, (insurance) industry, science.
Time horizon	The discussion and, where necessary, adaptation of the Disaster Relief Fund or of public-private partnerships considering recent research results can be started in the short term.

2.8.2.5 RISK COMMUNICATION AS A CONTRIBUTION TO STRENGTHENING INDIVIDUAL PROVISION IN THE AREA OF DISASTER MANAGEMENT

Objective	Exposure to natural disasters is recognized by the general public and appropriate precautionary measures are carried out.
Significance	<p>Widespread heavy precipitation events have increased in frequency and intensity since the 1980s. A further increase of both widespread and also local heavy precipitation events and thunderstorms is considered possible (APCC 2014).</p> <p>The risk-awareness of people is significantly influenced by the knowledge of which dangers and risks can be expected in the area where they live and work and by previous experience with disaster events.</p> <p>In recent years the focus of disaster precaution in Austria was on construction or technical measures to protect the population against natural disasters. In the meantime, it has become clear that such measures are only part of an optimal protection of the population.</p>

Connection to other sectors	<p>Surveys confirm that protection against natural disasters is seen to be, above all, the responsibility of the state. With the expectation of state support, private protective and precautionary measures and private insurance solutions are essentially neglected (Hanger & Riegler 2015, Seebauer 2015, Kräutler 2015). A nationwide, generally accessible supply of information regarding the threats of natural disasters is the basic prerequisite for strengthening individual precaution (BMLFUW 2015b).</p> <p>Optimal and targeted forms of risk communication must be defined in order to strengthen individual precaution. Risk communication requires clear framework conditions, is the task of all institutional levels (federal government, federal states, and municipalities) and should transmit a clear message to the population. It requires methods, resources and expert knowledge to make the limits of protection, the residual risk and the responsibilities of those involved understandable (BMLFUW 2015b).</p> <p>Risk communication should be carried out in close cooperation in particular with the national risk analysis for Austria (see national progress report on the implementation of the Hyogo Framework for Action (2013-2015); Staudinger 2015), the flood risk management plans, hazard zone plans and further relevant instruments and institutions.</p>
Connection to existing instruments	<p>Basically there are connections to all other sectors. In particular, there is a close connection to the protection against natural hazards (see 2.7.2.1 and 2.7.2.4), health and transport infrastructure.</p> <p>In Austria various actors are involved in different forms of risk communication (e.g., the Federal Ministry for Sustainability and Tourism (formerly BMLFUW), the civil protection association, the Central Institution for Meteorology and Geodynamics (ZAMG), insurance companies). A harmonisation of the communication strategies can help to avoid redundancy and provide the basis for various activities in the area of risk communication.</p>
State of implementation	<p>Currently, for example, the Federal Ministry for Sustainability and Tourism, federal states, the civil protection association and various emergency response organisations are active in the area of risk communication.</p> <p>There are numerous sources of information on natural hazards in different formats, such as websites, printed media, Apps, events etc. In addition, early warning systems (e.g., storm and heat warnings from the Austrian weather service (ZAMG) or from the insurance branch) and innovative information systems, such as warning systems via mobile telephone in endangered areas, play an important role. In the StartClim project REInvent⁹² various methods and approaches to strengthen individual precaution were analysed and recommendations for improvement were developed.</p>
Recommended further steps	<p>Within the safety research programme KIRAS, a project was carried out that aimed to improve the communication between the civil protection authorities and the general public. Using an interdisciplinary approach, a new, systemic alarm concept for Austria (PASA: Public Warning and Alert System for Austria)⁹³ is being developed.</p> <ul style="list-style-type: none"> – Strengthened cooperation and clustering of the activities of the federal government, federal states, emergency response organisations and insurance companies in risk communication for strengthening individual precaution; – Survey of all institutions and their offers, which are active in the area of risk communication in Austria, to obtain a complete overview of what is offered. This can be used as a basis for the strengthened cooperation, the coordination of all activities and the development of a comprehensive communication plan; – Evaluation of available risk communication activities; – Further development of methods for risk communication, especially considering public participation;

⁹²REInvent <http://www.startclim.at/startclim2015/>

⁹³ Link: http://www.kiras.at/geoerderte-projekte/detail/?tx_ttnews%5Btt_news%5D=569&cHash=51aced1549798ec6e639a8e448768a2

	<ul style="list-style-type: none"> – Development of generally valid communication guidelines for authorities and emergency response organisations regarding use of conventional and new media; – Promotion of innovative and participatory approaches in the area of risk communication, in order to reach various target groups; – Cross-sectoral and cross-institutional development of suitable communication concepts and documentation (protection against natural hazards, health, black-outs, transport infrastructure); – Development of communication strategies for specific target groups with particular needs (older people, children, people with a migration background etc.); – Increasing the risk-awareness through consideration of relevant content in the education system.
Possible resource requirements	Additional resources are necessary for any necessary research and the increased use of innovative and participatory approaches in risk communication as a contribution to individual precaution. This can be partially achieved through reallocation of research resources.
Possible conflict potential	Strengthened cooperation and coordination in the area of risk communication could lead to questions regarding responsibilities and tasks.
Actors	Federal and state governments, municipalities, emergency response organizations, insurers, Civil Defence Association, ZAMG, Austrian Storm Centre, industry, the media, academic and non-academic research institutions.
Time horizon	The implementation of communication activities that reach all necessary target groups appropriately should be based on the results of the national risk analysis and take place continually.

2.8.2.6 INCREASE IN TRAINING OFFERS IN THE FIELD OF DISASTER MANAGEMENT

Objective	Improving training and increasing competencies of the actors in disaster management with respect to natural hazards and climate change.
Significance	<p>Currently authorities at the federal and state level offer seminars. Emergency response organisations provide further education for their leaders. In the tertiary education sector various specific educational events are available. A complementary extension or a clustering of offers from various organisations in the area of disaster management in Austria would appear to make sense.</p> <p>This should provide decision makers in Austrian disaster management with a comprehensive, multidisciplinary supply of educational possibilities, in order to ensure an integrated and comprehensive treatment of the processes of disaster management. The priority is the focus on the whole system of disaster management in order to derive the largest possible benefit for society.</p> <p>To date, there is no description of the whole system of educational possibilities in the area of disaster management in Austria. Interlinking the supply of educational possibilities and where necessary the addition of further content are needed. This can be achieved through a new overall educational system in the tertiary sector or through an expanded supply of seminars (e.g. those of the Safety Academy regarding the National Crisis and Disaster Protection Management (SKKM)), courses (e.g., the course on risk prevention and disaster management at the University of Vienna), workshops and similar events for education, training and further education for the target groups involved in disaster management.</p> <p>Key competences are required for sustainable disaster precaution and thus for sustainable disaster management as a whole and would provide a model for Austria.</p>
Connections to other sectors	There is a close connection above all to protection against natural hazards and health.

Connection to existing instruments	There are connections to the National Crisis and Disaster Protection Management (SKKM), as well as to the educational programmes of the relevant authorities and emergency response organisations, universities and universities of applied sciences.
State of implementation	Education on key questions across the organisations, such as the leading of operations and organisation of disaster operations staff, could lead to large advances with the inclusion of authorities and emergency services. This is also the case in the practical implementation. At present, the impacts of climatic change are not covered separately in education and training. There is a need for action with regard to the interconnecting treatment of various topics over all phases of the disaster cycle and forward-looking risk management. The existing education supply provides a good basis, into which the impacts of climatic change and further scientific knowledge should be regularly introduced.
Recommended further steps	<p>Since the autumn of 2015, the University of Vienna in cooperation with the Federal Ministry of the Interior offers a further education course on risk prevention and disaster management⁹⁴. Climatic change is offered as an elective module.</p> <ul style="list-style-type: none"> – Analysis of the current state of education provision regarding inclusion of climatic change and natural hazards in Austria; – Where necessary, development of adequate educational offers considering international solutions; – Implementation of supplementary educational offers on climatic change and natural hazards in cooperation with authorities, emergency response organisations and educational institutions.
Possible resource requirements	Resources will be required for a systematic analysis of the current state of education provision and the adaptation of the educational content.
Possible conflict potential	No conflict potential has been identified.
Actors	Actors in disaster management, educational institutions of disaster management, tertiary educational institutions.
Time horizon	A continual expansion and deepening of education about disaster management requires continual analysis, planning and implementation. Besides content preparation (such as climatic change and natural hazards), administrative preparations are viewed as a main activity.

2.8.2.7 CONTINUATION OF THE NATIONAL RISK ANALYSIS AND DEVELOPMENT OF A UNIFORM METHODOLOGY FOR CARRING OUT RISK ANALYSES

Objective	Further development of the current uniform method for assessing disaster risks as the basis for coordinated, integrated, risk-based, and cost- and benefit-oriented planning of measures in Austria.
Significance	<p>Currently, Austrian disaster management does not use a uniform method for risk analysis. From the EU there are specifications such as the EU Guidelines for Risk Assessment and Mapping (EK 2010), which are based on the ISO 31000 for the development of risk analysis processes for disaster protection management. A specialised group of the National Crisis and Disaster Protection Management (SKKM) is currently working on the development of a methodology for Austria.</p> <p>The basic pattern of the majority of the processes in use in risk analysis is the determination of the size of the risk as objectively as possible for concrete disaster events or particular areas (see, for example, the Swiss National Platform on Natural Hazards; PLANAT 2008). This includes both the assessment of the starting situation</p>

⁹⁴ Link: <https://www.postgraduatecenter.at/weiterbildungsprogramme/gesundheit-naturwissenschaften/risikopraevention-und-katastrophenmanagement/>

	<p>and also the effects of measures. Following the objective, systematic and transparent assessment of the existing risks in the risk analysis, the risk evaluation checks whether society can cope with these risks or whether they must be reduced. This evaluation is on the one hand the basis for the planning of measures, but on the other hand, only the planning of measures can show whether the risks can be reduced with a commensurate effort to achieve the targeted level of protection. In this context, the targeted level defines a measure of the level of effort put into protection for individuals and society.</p> <p>In Austria, such risk analyses in the area of natural hazards should (at least) be made uniform across the country. On the basis of this, further measures for reduction of risk should be planned and implemented. As a result, a coordinated, integrated, prioritised implementation of measures oriented towards costs and benefits can be achieved across Austria. This requires training of actors in the carrying out of risk analyses, risk evaluation and the treatment of the resulting planning of measures (see Chapter 2.8.2.6: Increase in training offers in the field of disaster management).</p> <p>Possible impacts of climatic change must be considered in the risk analyses.</p>
State of implementation	<p>Austria submitted the first national risk analysis to the European Commission in 2015. On the basis of the EU guidance for risk assessment, adequate provisions/framework conditions for risk analysis are proposed for Austria by the Federal Ministry of the Interior.</p> <p>Further examples: In the Interreg project RiMaComm a comprehensive risk analysis in municipalities in Tyrol (Survey of hazard situation and hazard estimation) was carried out.</p>
Connection to other sectors	<p>Basically, there are connections to all other sectors. Close cooperation is necessary with protection against natural hazards (especially Chapter 2.7.2.4: Promotion of forecasting, (early) warning and measurement systems and Chapter 2.7.2.7: Promotion of property protection measures (permanent and temporary) to encourage individuals to take safeguarding measures - Promotion of property protection measures (permanent and temporary) to encourage individuals to take safeguarding measures).</p>
Connection to existing instruments	<p>There are connections to the implementation of the EU Flood Directive, flood risk management plans, hazard zone plans from torrent and avalanche control, basic concepts of water protection management, water body development concepts, zoning plans, local development plans, building standards and the flood risk zoning in Austria.</p>
Recommended further steps	<ul style="list-style-type: none"> – Development of a methodology for risk analysis on various administrative levels; – Evaluation and, where necessary, revision considering international developments and specifications; – Prioritisation of action areas on the basis of the national risk analysis; – Identification and presentation of examples of good practice in Austria, e.g. on the national platform (see Chapter 2.8.2.2: Establishment of a national risk reduction platform).
Possible resource requirements	<p>Resource requirements cannot be quantified at present.</p>
Possible conflict potential	<p>No conflict potential has been identified.</p>
Actors	<p>Federal and state governments, municipalities, infrastructure managers, research institutions, insurance industry.</p>
Time horizon	<p>Strengthened cooperation of actors in the further development of the national risk analysis and prioritisation of the action areas is possible in the short term.</p>

2.8.2.8 PROMOTING PARTICIPATORY APPROACHES TO THE INTEGRATION OF ALL PLAYERS IN DISASTER MANAGEMENT

Objective	Promotion of the inclusion of all actors in opinion formation, decision, and implementation processes and involvement of civil society, as well as use of new communication platforms (social media) to achieve integrated disaster management.
Significance	Participatory processes are useful for all stakeholders. Civil society engagement depends on their role in the process. Besides a deeper integration of science and the economy, citizens should participate more in participatory processes so that their needs and interests can be better considered. As a rule, citizens have local expertise – a detailed knowledge of problems in the world that they live in - and often they also have concrete ideas about solutions for these problems. If the knowledge and perspectives of different actors are included in planning processes, creative and durable solutions can generally be found, which have been developed on a broad basis and thus are accepted by all stakeholders. The possibility to participate in planning also supports a feeling of responsibility for communal issues and a balancing between different interests and interest groups. Public participation thus strengthens democratic processes at the local level and supports the development of a civil society. Decisions are improved from a content point of view and are transparent and more robust, which can also accelerate the implementation. Politics, the administration and the general public all benefit from this.
Connection to other sectors	Basically there are connections to all other sectors, in particular to protection against natural hazards and health.
Connection to existing instruments	The standards for public participation from 2008 (BKA & BMLFUW 2008) and the handbook of public participation (ÖGUT & BMLFUW 2005) provide administrative assistants with advice and support for implementing participatory processes. Public participation in the area of disaster management can build on experience such as that with the drafting of the flood risk management plan of 2015 or with the Round Table on Public Participation.
State of implementation	There is currently no discussion process regarding adaptation or transfer of existing systems for public participation in the area of disaster management.
Recommended further steps	<ul style="list-style-type: none"> – Analysis of existing participatory approaches (national and international) in disaster management and collection of best practice examples; – Development of a tool box with various methods for citizen participation especially for disaster management on the basis of the standards for public participation; – Training of stakeholders in the use of these participatory approaches, for example within the framework of education and training of responsible persons in disaster protection.
Possible resource requirements	For strengthened implementation of participatory processes, higher investments of time and a need for coordination can be expected.
Possible conflict potential	During participatory processes conflicts can arise as a result of different interests.
Actors	EU, federal and state governments, municipalities, industry, academic and non-academic research institutions, the general public.
Time horizon	Implementation should take place in the medium term over several years.

2.8.2.9 CONTINUATION AND NETWORKING OF RESEARCH ACTIVITIES AND DEVELOPMENT OF INNOVATIONS RELATED TO DISASTER MANAGEMENT

Objective	Promotion of inter- and transdisciplinary research activities, provision of bases for decision-making, and development of technical innovations derived from the SKKM strategy 2020 or its implementation.
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Significance

Efficient planning of disaster protection and disaster aid is not possible without knowledge of the hazards and threats that have to be managed.

The need for integrated research activities and the dissemination of important findings with the inclusion of all relevant actors becomes obvious through the worldwide increase of extreme events as a result of climatic change and resulting damages, which are also evident in Austria (APCC 2014, Steininger et al. 2015). This trend underlines the need for a continual further development and optimisation of disaster management, in order to reduce risks.

Currently, results are not broadly accessible to the interested public and experts and are seldom available for education and training. Research activities dedicated to a systematic treatment of questions relevant for Austria and the broad communication of answers are the basis for planned implementation of disaster management activities. These research activities must be multidisciplinary, in order to have a systemic approach in the area of disasters with consideration of climatic change.

Connection to other sectors

Basically, there are connections to all other sectors, in particular to protection against natural hazards, health, water management and transport infrastructure.

Connection to existing instruments

Connections are the research programme KIRAS (Austrian Funding Programme for Safety Research of the Federal Ministry for Transport, Innovation and Technology (BMVIT)), the Austrian Climate Research Programme (ACRP) of the Austrian Climate and Energy Fund und the national climate research programme StartClim, SKKM working groups and Austrian Space Application Programme of BMVIT.

State of implementation

The impacts of climate change are the focus of the Austrian Climate Research Programme (ACRP) of the Austrian Climate and Energy Fund⁹⁵ and the research programme StartClim⁹⁶. Research projects such as the VOICE project (Voluntary work in disaster management - Challenges for adaptation to climate), supported by the Austrian Climate and Energy Fund provide practical recommendations for various actors in disaster management (Seebauer 2015, Balas et al. 2015). In the research programme KIRAS the impacts of climatic change are not explicitly covered at present.

Recommended further steps

- Determination of the thematic coverage of research programmes with the participation of all relevant actors (e.g., emergency response organisations, civil society, business);
- Integration of as many specialised disciplines as possible into research activities;
- Presentation of the research results in journals of the target groups as well as publication of results for specific target groups via internet;
- Collection of all research results in one place (e.g., the national platform for risk reduction, see recommended action 2.8.2.2) to make results accessible, in particular for decision makers at all levels, for the emergency response organisations and also for the interested general public;
- Implementation of “Quick Response Research” immediately after the occurrence of events (e.g., as in Upper Austria after the flood event in 2013);
- Regular observation and presentation of innovations and product developments, for example, using the national platform for risk reduction (see Chapter 2.8.2.2), which can be taken up in practice for disaster management;
- Research on risk communication, on the status of risk-awareness and risk behaviour of affected persons, analysis of the relationships between information, comprehensibility and acceptance of the information and the risk-awareness, as well as behavioural changes of individuals and groups.

Possible resource requirements

The prerequisite for the implementation of research programmes is sufficient funding. This can be provided from both public and private sources.

⁹⁵ Link: <https://www.klimafonds.gv.at/foerderungen/projektberichte/forschung/>

⁹⁶ Link: www.startclim.at

Possible conflict potential	No conflict potential has been identified.
Actors	SKKM working groups, federal and state governments, municipalities, industry (particularly operators of critical infrastructure), academic and non-academic research institutions, emergency response organizations.
Time horizon	The content orientation of research activities and, where necessary, additional research programmes should be systematic, long-term and sustainable. Research activities on current open questions can be commissioned in the short term and should, in particular, support the implementation of the SKKM strategy 2020.

2.9 HEALTH SECTOR

2.9.1 OVERARCHING OBJECTIVE

Overarching objective: Management and avoidance of direct (e.g., through heat waves) and indirect (e.g., through the spread of allergenic plants and animals) effects of climatic change on health through suitable measures when needed and through early implementation of precautionary measures.

2.9.2 RECOMMENDED ACTIONS FOR THE HEALTH SECTOR

GENERAL PRINCIPLES FOR ACTIONS IN THE HEALTH SECTOR

- A climate-conscious and sustainable lifestyle, which on the one hand reduces the impacts of and on the other hand makes a contribution to the adaptation to climatic change, has positive effects on human health.
- Further promotion of a balanced, appropriate diet as part of a healthy lifestyle. A significant basis is provided by the national Nutrition Action Plan (BMG 2011, BMG 2013). Nutrition plays a significant role in the development of chronic illnesses (WHO & FAO 2003). The promotion of healthy nutrition and lifestyle supports the health of the population and subsequently the resilience with respect to possible relevant impacts of climatic change, such as heat stress.
- Continual awareness-raising about the causes and consequences of climatic change is a prerequisite for the preparation, implementation and effectiveness of measures.
- Many recommendations for action to protect human health from the impacts of climatic change are the responsibility of other sectors or require a close cooperation with other sectors, such as construction and housing, regional planning, protection against natural hazards or agriculture. It is important to strengthen the linkages between all concerned actors and ensure better coordination and cooperation of various disciplines.
- Strengthened cooperation and linkages between actors in the health sector are necessary to support a resource-friendly and effective development and implementation of measures. For this, priorities are an increase of the authority to act, strengthening of the public health service and the avoidance of duplication.
- Furthermore, a continual exchange of knowledge and new information between the responsible and involved institutions is essential.
- Contacts and exchange at the EU and international levels are extremely important, since new research results continually become available, recommendations for action are developed and new areas of action are identified.

2.9.2.1 GENERAL PUBLIC RELATIONS AND SPECIFIC WORK ON PREPARING FOR EXTREME EVENTS OR OUTBREAKS OF INFECTIOUS DISEASES

Objectives	Raising awareness, informing the public and improving the capabilities of coordinated emergency services and the responsible institutions in order to prevent or minimize health risks and lower fatal casualties in cases of extreme events or outbreaks of infectious diseases.
Significance	<p>An appropriate awareness-raising for the population is the basis for all recommended actions on the topic of adaptation to climatic change. Climatic change is one of the few topics that affect all age groups and for which they are interested in education and training (children, youth, adults). Targeted information for specific groups with concrete recommendations for action is required.</p> <p>Measures for climate change mitigation and adaptation must be considered together. The population must have the capacity to deal with apparent contradictions, in order to develop environmentally friendly and sustainable measures. For example, adaptation</p>

Connection to other sectors**Connection to existing instruments****State of implementation**

measures such as air-conditioners have negative effects with respect to climate change mitigation through the increased energy demand for cooling.

Adaptation relevant to health involves many individual behavioural changes either for a majority of the population or for those in particular risk groups (APCC 2014).

“Prevention and healing” should be simultaneously integrated into daily life.

Furthermore, in communication it is important to focus on a positive approach and demonstrate alternatives; the negative aspects and limitations should not be in the foreground (future-oriented measures).

The World Health Organisation defines health support as the process that aims to allow all people a larger amount of self-determination with respect to their health and thus to give them the capacity to improve their health. An important instrument for supporting health is the explanation of and information about avoidable illnesses and about mental and social factors that influence health. Climatic change and the resulting consequences are considered rarely or not at all in established health support.

There is a close connection in particular to protection against natural hazards, economy (see Chapter 2.13.2.7: Raising public awareness about preventing damage and reinforcing the individual responsibility of insured people), disaster management, ecosystems/biodiversity, urban planning and construction and housing.

In 1998 Austria established a legal basis for a stronger embedding of health support and prevention in the health sector with the Health Support Act and the establishment therein of the “Healthy Austria Fund”.

The Health Support Act contains measures and initiatives for maintenance support and improvement of the health of the population and education and information about avoidable illnesses and the mental and social factors that influence health.

The 10 health goals (BMG 2012)⁹⁷ aim to improve the health of all persons living in Austria, regardless of their educational status, income or personal circumstances. The health support strategy adopted in 2014 supports the implementation of the goals. It aims, through strengthened implementation of broadly agreed, high quality, effective and efficient health support measures, to contribute to a situation where all people in Austria have a long, self-determined healthy life (BMG 2014a).

Connections to corresponding content are provided by existing initiatives, communication systems (hotlines etc.), media (newspaper, television, radio etc.), schools and further education such as the “Healthy Community”. The network of “Healthy Community” in the federal states supports health-consciousness of the population and increases awareness about living conditions that support health.

Within the framework of CEHAPE (Children’s Environment Health Action Plan for Europe)⁹⁸, a new focus on protecting health and environment against the impacts of climatic change was introduced at the conference of health ministers in Parma in 2010. A significant characteristic of CEHAPE is the active participation of children and young people; this is mirrored in Austria with the Young Persons Environment Platform (Jugend-Umwelt-Plattform JUMP).

Further connections are provided by klimaaktiv mobil (climate friendly mobility and movement support health), ÖKOLOG – Schools, Environment Labels for Schools, Climate Alliance for schools etc.

Heat: Information for dealing with heat waves is distributed when necessary by the authorities. The Federal Ministry for Health, as well as some of the federal states (e.g., Styria, Vienna), insurance companies, the Red Cross, the Chamber of Labour, the Federal Environment Agency etc. provide information, guidebooks and concrete instructions for actions with regard to heat.

Brochures on dealing with **allergies and infectious diseases** (including ticks) are available.

⁹⁷ www.gesundheitsziele-oesterreich.at

⁹⁸ https://www.bmlfuw.gv.at/umwelt/luft-laerm-verkehr/verkehr-laermschutz/internet_koop/CEHAPEAT.html

Recommended further steps

Styrian plan for **epidemics** – In addition to measures for sickness due to rare imported, very infectious pathogens, the plan includes measures for diseases that must be reported and other relevant infectious diseases, including a chapter on hygiene after disasters using the example of flooding (Feenstra 2010).

Bathing water: the Federal Ministry of Labour, Social Affairs, Health and Consumer Protection published information on bathing outdoors⁹⁹ and, in cooperation with the Austrian Agency on Health and Food Safety (AGES) a folder on non-cholera Vibrios (AGES 2016).

For dealing with **floods** there are brochures from the federal government, the federal states and civic protection associations (health aspect not integrated at present).

Publications regarding health precautions in the case of hazards and emergencies (Generic Public Health Preparedness in Europe) are available at the European level. These include basic knowledge and instructions on how Member States should prepare their emergency plans. A series of EU projects on public health and current health threats (epidemics, terrorism, chemical and physical risks, data collection and information management) were the basis for the publication (EU 2011).

General

- Integration of existing information and development of a website for Austria, which provides general information and, in particular, recommendations for action, which are linked to monitoring and early warning systems, and where all relevant information can be retrieved;
- Knowledge management and education on the connection between health and climate as a prerequisite for individual competence to act (building the competence to take individual responsibility to act in certain situations);
- Identification of the different target groups and development of material appropriate for these different target groups on a variety of topics, such as:
- Strengthened integration of climatic change adaptation into curricula;
- Young people via internet, social networks, creative actions;
- Adults possibly through radio and television programmes;
- Expansion of the supply of information on the topic via internet;
- Particular measures for “hard-to-reach” groups of people;
- Sensitisation of multipliers in the health sector regarding adequate measures and behaviour.
- Support for research on risk communication. Care must be taken that communication does not lead to panic, but on the other hand the risks should not be played down. What is needed is realistic and well-founded information that enables action;
- Optimisation and evaluation of existing instruments (e.g., teaching plans and educational standards);
- Education of multipliers in schools and elsewhere. They should be enabled to demonstrate connections and not just focus on individual aspects. This guarantees that the participants discover their own possibilities for action (education for sustainability).

Heat and extreme events

- Preparation and implementation of action-oriented public relations about behaviour during extreme events (e.g., heat waves, floods) – for example, indication of local, easily accessible, alternative spaces for recreation and holidays during hot summer days.

Infectious diseases

⁹⁹ Link: http://www.bmgf.gv.at/home/Gesundheit/VerbraucherInnengesundheit/Baden_in_der_Natur

	<ul style="list-style-type: none"> – Awareness-raising regarding possible new and already existing infectious diseases that are expected to become more frequent as a result of climatic change (e.g., West Nile fever), for which the area of distribution is changing (e.g. tick-borne encephalitis) or whose period of activity is extended; – Support of knowledge transfer from research to doctors; – Review and, where necessary, new regulation of the responsibilities regarding risk communication (federal ministries, Public Health Service (ÖGD), federal states, AGES); – Further development and continual improvement of cross-border communications; – Support for research.
Possible resource requirements	<p>Education requires sufficient financial resources; more recognition of the value of awareness-raising and its long-term benefits is needed. Sufficient resources are required for coordinated and early information campaigns.</p> <p>For the implementation of the recommended actions, existing communication systems and initiatives (such as “Health Community”) can be used.</p>
Possible conflict potential	<p>Within science and also within the responsible authorities, it is necessary to clarify which threats are most relevant. In doing this, both the potential damages and the probability of occurrence must be considered.</p>
Actors	<p>BMG, BMASK, state governments (technical authorities), ÖÄK (Austrian Medical Chamber), Gesundheit Österreich GmbH, ÖGD, ÖGB, Chamber of Labour, the media, AGES, universities, schools, Adult Education Centres, national and EU-wide networking, BMNT (formerly BMLFUW), BMBWF (formerly BMFWF), tourism organizations.</p>
Time horizon	<p>Short- to medium-and long-term. Attention to strengthened awareness-raising activities in the short term is recommended.</p>

2.9.2.2 DEALING WITH HEAT AND DROUGHT

Objective	<p>Reducing heat stress and preventing additional climate change-related negative health effects in the population in especially heat-prone areas (e.g., urban areas affected by the heat-island effect).</p>
Significance	<p>Climatic change will lead to an increasing heat stress – in particular in urban areas. In summer, in addition less precipitation and thus longer dry periods are expected. The probability of longer-lasting heat waves is thus considerably higher.</p> <p>In Austria, a significant increase of very hot days is already observed. This is shown by the comparison of the two climatic periods 1961-1990 and 1981-2010 (ZAMG 2015a, b). In Vienna, the average numbers of days with 30 °C and more has increased from 9.6 (1961-1990) to 15.2 (1981-2010), in Innsbruck from 9.0 to 16.6 and in Klagenfurt from 6.2 to 13.9 (ZAMG 2012). Besides overheating during the day, higher night-time temperatures must be expected.</p> <p>Heat can lead to dehydration, make various illnesses worse, and also cause heat cramps, sunstroke and heat stroke. The risk is high for older people, people with relevant underlying diseases (cardiovascular diseases, respiratory diseases, metabolic disorders etc.) and for babies and children. In addition, performance can be impaired. In particular, people who work outdoors or at hot working places are affected.</p> <p>As a result of increased temperature of surface waters, both reduced microbiological water quality through faecal bacteria and increased occurrence, for example, of bathing dermatitis through Zerkarien species and occurrence of algae can be expected.</p> <p>Furthermore, hot periods have stronger effects for inhabitants of urban areas. About 2/3 of the Austrian population live in towns and cities and this fraction is expected to increase. Fresh air corridors and high share of green space, but also public drinking water fountains make a considerable contribution to reducing heat stress.</p>

Connection to other sectors

Connection to existing instruments

State of implementation

Recommended further steps

Because of the expected temperature increase and the expansion of urban areas, this recommended action is considered to be very important. Likewise, the World Health Organisation recommends the development of strategies, plans and packets of measures to prepare the population for heat-stress days and for the public health service.

Infections from food, through Salmonella und Campylobacter bacteria and other microorganisms, occur particularly in the summer. These are multi-factor events that depend on biosafety and hygiene of humans and animals. Through continuing warming and insufficient hygiene, the danger for more frequent occurrence of food-related stomach and intestinal infections increases.

There is a close connection to construction and housing, regional planning, spatial planning, disaster management, energy, transport infrastructure, economy and tourism.

Connections to the integration of appropriate aspects are provided by the 10 framework goals and the health strategy, collective agreements, Working Hours Act, School Education Act, Workers Protection Act, Volunteer Act etc.

Heat protection plans are available in Styria and Carinthia. Vienna and Lower Austria have a heat warning system. Vienna published a heat guidebook¹⁰⁰ in 2015. A heat protection plan is foreseen.

In May 2016, on the initiative of the Federal Ministry of Labour, Social Affairs, Health and Consumer Protection, a working group was set up to develop a nationwide heat warning system. The federal states, the weather service and the Federal Ministry of Sustainability and Tourism (formerly BMLFUW) and other relevant institutions are included in the working group.

The state capitals, such as Graz, Salzburg, Linz, Innsbruck and Vienna provide drinking water fountains for the population, including tourists.

Teleworking solutions are offered in some places, and regulations are foreseen in the law for protection of workers.

- Development of a national heat action plan (based on a risk analysis of sensitive persons) including measures to reduce health effects, including:
- Continual awareness-raising and information when events occur regarding the risks of heat (e.g., also regarding changes of bathing water quality), as well as motivation for correct behaviour during heat waves during daily life and during recreation (including information about the risk of skin cancer and ozone exposure);
- Strengthened support /creation of extramural¹⁰¹ care facilities and evaluation of the interlinkages;
- Targeted prevention measures for particularly vulnerable groups, particularly care-dependent people.
- Consideration of making working hours more flexible and strengthening of work protection measures, as well as strengthened sensitisation of work protection with regard to high temperatures in interior rooms and in outside areas. This is also to be considered in schools and kindergartens;
- Support of voluntary work and neighbourhood help (e.g., in the form of call services), in order to take care of elderly people during heat waves;
- Organisation or provision of cool, generally accessible spaces/rooms;

¹⁰⁰ Link: [Wiener Hitzerratgeber](#)

¹⁰¹ Extramural care refers to the range of services for care and help at home. It is a segment of social services. It covers, besides care and medical activities, all services to support daily life, such as home help, mobile meal services (“meals on wheels”), cleaning services, laundry services, as well as visiting and accompanying services etc. (Schaffnerberger & Prochobradsky 2004).

	<ul style="list-style-type: none"> – Development of medium- and long-term strategies to reduce heat exposure in buildings (especially in hospitals, care homes etc.) and increasing the summer suitability of buildings (renovation); – Consideration of heat waves in long-term urban planning, including building structures, energy and transport strategies (see the Chapters on spatial planning and construction and housing); – Development and maintenance of fresh air corridors and the share of green spaces in urban areas; – Increased horizontal and vertical greening of buildings; – Developing of shading solutions for public spaces, for stops of the public transportation system, children’s playgrounds etc., planting of trees; – Strengthened provision of drinking water fountains in public buildings (schools etc.) and in public squares (e.g. transport hubs of the public transportation system); – Support of research, e.g., regarding changed time patterns during the normal day and on behavioural changes.
Possible resource requirements	The resource requirements for logistical measures are estimated to be small. Additional resources are required for the development of new technologies. Relevant research topics can be included in existing research programmes.
Possible conflict potential	During implementation conflicts with urban planning (settlement development) and with respect to the financing of new technologies are possible.
Actors	BMG, BMASK, ÖGD, BMWA, BMUKK, federal state governments, Gesundheit Österreich GmbH, ÖGB, cities, municipalities, infrastructure providers, public transportation, aid organizations, trade unions, Chamber of Labour, Chamber of Commerce, Association of Towns and Municipalities, urban planners, ÖÄK, the media, NGOs, academic and non-academic research institutions.
Time horizon	With short-term implementation, the results of the measures should be observable in the medium term.

2.9.2.3 DEALING WITH FLOODS, MUDSLIDES, AVALANCHES, LANDSLIDES AND ROCK FALLS

Objective	Maintaining supply functions of central services in cases of disaster and preventing fatal casualties, and acute and chronic as well as physical, and mental health effects.
Significance	<p>Security of supply can only be maintained when appropriate structures and emergency plans for disaster events (e.g., floods, mudslides) are in place. This can also protect the helpers during their work (e.g. by shortening distances within or to a disaster area). Maintenance of the supply function can also be achieved through coordination of the emergency service providers. This would avoid duplication of efforts and increase efficiency through using synergies.</p> <p>Furthermore, priority must be given to the supply of drinking water of sufficient quantity and quality to maintain the minimum supply and thus protect human health. The implementation by water suppliers is in line with the legal requirement (ÖVGW-Richtlinie W 74) on providing drinking water.</p> <p>In addition to the obvious acute health effects of disasters (e.g., injuries), “invisible” chronic effects must also be considered. Attention must be paid, in particular, to long-term and widespread contamination of water, soil and food after floods and the flooding of contaminated sites, industrial areas, oil storage facilities, petrol stations etc. and prevention must be strengthened in this area. Follow-up damages, such as growth of mould, are also relevant with respect to health. Moreover, chronic complaints in the shape of post-traumatic stress disorder, the size and frequency of which can be reduced through fast professional treatment, must be considered.</p>

Connection to other sectors

Extreme weather events are mostly connected with social and economic consequences. It is, therefore, necessary to develop strategies in the health sector that can minimise these effects.

The possibility of the occurrence of very cold spells or extremely cold weather should also not be ignored. These events can lead to an increase of injuries, frostbite and mortality.

This recommended action contributes to the protection and maintenance of the long-term health of the population and has great economic significance.

There is a connection to disaster management and protection against natural hazards, spatial planning and tourism. There are further connections to the following recommendations for action:

Chapter 2.6.2.1: Implementation of structural measures (In new buildings and renovation) to ensure thermal comfort;

Chapter 2.6.2.5: Increase of water retention ;

Chapter 2.3.2.3: Guarantee of future water supply

Chapter 2.3.2.8: Adaptive flood risk management with robust measures

Connection to existing instruments

There are connections to the flood centres and civil protection associations of the federal states.

Civil protection provides protection for the population through actions taken by the authorities, the emergency response organisations and in the private sector. In close cooperation with the federal government, federal states, municipalities and emergency response organisations, the Austrian civil protection organises humanitarian measures to deal with crises.

The federal states already have good emergency plans.

Existing initiatives, such as “Helfer Wiens (Helpers in Vienna)”¹⁰² (previously the Vienna Civil Defence Association) can be considered as examples of good practice. The goal of “Helfer Wiens” is knowledge dissemination, on how to help, safely and deliberately, oneself, one’s family and neighbours in emergencies until emergency response organisations arrive.

To safeguard the quality of drinking water, obligatory tests must already be carried out at present: Every water supplier must, according to the drinking water regulation, have the water tested and the responsible authority (indirectly federal administration, regional administration authorities or the state) checks whether the supplier is meeting the obligations. Monitoring systems of the Federal Ministry of Labour, Social Affairs, Health and Consumer Protection and the Austrian Agency for Health and Food Safety (AGES) are also available.

The national flood risk management plan (BMLFUW 2016a) aims to reduce the negative consequences of floods on human health, the environment, cultural heritage and economic activities.

Possible connections can also be found in the EU Water Framework Directive, which prescribes the integrated management of river areas.

Further instruments are the Water Rights Act of 1959, the Water Construction Support Act, and in connection with torrent and avalanche control the Forestry Act.

The ERA-Net CRUE is a European network to improve the connections between national programmes with the goal of harmonising and integrating the research on flood risk management on the levels of policy and financial strategies.

State of implementation

Early warning systems and a comprehensive supply of information on floods and further natural hazards are available. Impacts on human health are not considered with priority.

Civil protection associations and initiatives such as “Helfer Wiens” provide valuable connections.

¹⁰²Link: www.diehelferwiens.at

Recommended further steps	<p>With the initiative “Team Austria” a movement started, which supports professional helpers when disasters occur. This form of citizen engagement is based on voluntary action and provides a diversity of possible applications through the many capabilities of the volunteer helpers.</p> <ul style="list-style-type: none"> – Nationwide coordination and communication, as well as strengthened networking of the emergency response organisations; – Definition of central service areas in the communities and forward-looking planning of capacities (considering overarching scenario exercises); – Review and, where necessary, improvement of existing emergency plans or coordination and integration of emergency plans; – Provision of crisis intervention teams on site for the first help when a disaster occurs; – Increase the capacity of the rescue teams in an emergency situation; – Further creation of incentives to obtain more voluntary helpers (e.g. through legal means) and corresponding preparation and training of rescue teams; – Organisation of an early intervention as well as long-term psychological care for victims with post-traumatic stress disorder; – Safeguarding drinking water supply and maintenance of hygienic sanitary removal of faecal matter after extreme events; – Continual monitoring of drinking water quality to prevent and avoid contamination, especially in the case of extreme events (pathogens that lead to diarrhoeal diseases, chemical pollution etc.) and safeguarding of access possibilities; – Consideration already at the planning and implementation stage of keeping the vulnerability of the water supply to extreme events as low as possible; – Implementation of the water security plan of the World Health Organisation by operators of water supply systems; – Research on post-traumatic stress disorder.
Possible resource requirements	<p>Additional resources for preventive measure in risk areas are required. For the provision of specially trained personnel during or after emergency situations additional resources could be required.</p>
Possible conflict potential	<p>In the planning stage, conflicts are possible with respect to the different responsibilities for action (federal government, federal states, emergency response organisations etc.).</p>
Actors	<p>Cooperation between federal and state governments, municipalities, aid organizations, health care, disaster protection management, hospital operators, BMI, psychosocial services, emergency services, the army, ÖÄK, psychotherapy associations, hospitals, insurers, water suppliers, BMG, ÖGD, BMNT (formerly BMLFUW), state governments, Gesundheit Österreich GmbH, AGES, ÖWAV, ÖVGW, NGOs, universities.</p>
Time horizon	<p>A short-term implementation is urgently required.</p>

2.9.2.4 ADVANCEMENT OF KNOWLEDGE AND PREPARATION FOR HANDLING PATHOGENS/INFECTIOUS DISEASES

Objective	<p>Improving the knowledge base on climate change-related alterations in the establishment and spread of pathogens and infectious diseases; Suppression of the establishment and spread of pathogens, infectious diseases, and disease carriers (vectors);</p>
Significance	<p>Improving early recognition, diagnosis, and therapies for “new and emerging diseases.” The establishment of a complete infection cycle of vector-borne diseases in humans requires the presence of the pathogen, the host and the vector at the same place and</p>

same time. A human can be the sole host or a secondary host. The vector must be infected and able to transfer the pathogen. Important vectors are, for example, insects, ticks and rodents. Since the majority of the vectors belong to the ectotherm¹⁰³ animals, the expected temperature increase provides an improvement of their living conditions. Distribution areas will expand northwards and to higher altitudes, the activity phase will be longer during the course of the year. Amount of precipitation, air humidity and food supply are also relevant.

As a result of the changed habitat for disease vectors, an increase of infectious diseases must be expected. Already existing vectors can transfer additional diseases. If imported vectors find suitable conditions they can multiply and enable the spread of new diseases. Potential vectors, such as the Asian tiger mosquito (*Aedes albopictus*), which transfer numerous disease pathogens such as dengue-, Chikungunya-, yellow- and West-Nile-fever, were found in Austria for the first time in 2012 (mosquito monitoring of the Austrian Agency on Health and Food Safety (AGES)¹⁰⁴). Further factors such as travel and global trade likewise contribute to the spreading of new vectors and are a significant element in the establishment of new infectious diseases. To manage these new challenges, a strengthened cooperation and use of existing systems and instruments at national, European and international levels are essential.

Currently, the state of knowledge and the data situation regarding the importation and establishment of vector-borne diseases is poor. Awareness-raising and precautionary measures, as well as information regarding the connection to climatic change, are not available. In addition, adaptation measures in the area of vector-borne diseases are relatively limited. For some diseases there are no possibilities for vaccination, therapies are often lengthy and do not always bring success (e.g., in the case of Lyme disease).

The lack of knowledge and the potentially high risk call for more research to create the basis for suitable preventive measures. Furthermore, a continual monitoring with regard to the establishment of new vectors or pathogens is strongly advisable.

In Austria a series of laws regulates the monitoring and control of infectious diseases. In addition, a reliable collection and transfer of information about the spatial and temporal occurrence of infectious diseases is necessary. This provides the basis for the planning of preventive measures or the implementation of targeted control mechanisms. Within the framework of the current reporting system, possible new infectious diseases that could become established in Austria as a result of climatic change are increasingly recorded. Since 2015 West Nile fever must be reported and since 2016 dengue and Chikungunya fever, Hanta-virus infections and Zika-virus infections must also be reported. A corresponding preparation and training of doctors and diagnostic personnel is recommended.

High quality and fast clinical and laboratory diagnosis of pathogens is the prerequisite for adequate prevention and control measures, as well as for therapy for patients. Efforts should be made to further expand the relevant expertise and necessary infrastructure and to safeguard them over the long term.

There is a connection in particular to ecosystems/biodiversity, agriculture, forestry, water management, tourism and urban planning.

Monitoring and control of contagious diseases is a central task of the Federal Ministry of Labour, Social Affairs, Health and Consumer Protection. The reporting requirements are covered by a law on epidemics (*BGBI. Nr. 186/1950*) amended in 2016 (*BGBL. I Nr. 63/2016*).

The monitoring of and exchange of information about zoonoses and zoonotic agents are also legally required.

Within the framework of reporting requirements for infectious diseases of the EU Surveillance Systems TESSy, the establishment of electronic reporting systems was

Connection to other sectors
Connection to existing instruments

¹⁰³ Ectotherm refers to animals, whose body temperature is fully dependent on the surroundings and normally not influenced by their metabolism.

¹⁰⁴ Link: <http://www.ages.at/themen/ages-schwerpunkte/vektoruebertragene-krankheiten/gelsen-monitoring/>

State of implementation

necessary. The epidemiological reporting system (EMS) monitors infectious diseases in Austria. The electronic reporting requirement for laboratories is legally regulated (BGBl. II Nr. 184/2013). The reporting system has interfaces to extract data and report them regularly to TESSy.

There is also a connection to the European Network for Diagnostics of Imported Viral Diseases (ENIVD)¹⁰⁵.

A series of EU projects have been supported in this topic area, such as: the European Network for Highly Infectious Diseases, the Integrated Decision Support System for HEALTH THREATS and crisis management. SIDARTHa: European Emergency Data based Syndromic Surveillance System created, within the framework of a European project, the foundation for improving the information to recognise epidemics and to deal with them. These activities are connected with the European Emergency Data Research Network.

On the basis of the results of EU projects and activities, a publication was produced to prepare the public health service with respect to threats and emergencies¹⁰⁶.

On the EU level (especially the European Centre for Disease Prevention and Control, ECDC) integrated research has been carried out for more than 10 years, in which Austria also participates. In addition, Austrian institutions (University of Veterinary Medicine, Department for Virology of the Medical University of Vienna, Austrian Agency on Health and Food Safety etc.) carry out research.

Within the framework of the EU decision 1082/2013 there is a reporting requirement for serious cross-border health threats and thus for many infectious diseases.

It is possible to introduce *ad hoc* new legal requirements for reporting newly occurring diseases or pathogens and integrate them into the electronic epidemiological reporting system.

The Styrian epidemics plan (Feenstra 2010) provides regional recommendations for action based on national and international knowledge. The contents range from measures for diseases through rare imported, highly infectious pathogens and infectious diseases relevant for Styria that must be reported, to measures for disasters and terrorist attacks. It provides doctors and medical personnel with structured information about relevant infectious diseases and information about process organisation, checklists, information sheets, explanatory material and addresses for further information.

Reports of the Austrian Agency on Health and Food Safety (AGES) on monitoring of zoonoses in Austria: The annual reports provide information on the occurrence of zoonotic agents along the entire life-cycle. This provides the basis for targeted measures to break transfer chains and protect people from diseases.

The project VectorBorneDiseases¹⁰⁷ (funded by the Austrian Climate Research Programme; project end in 2017) aimed to record invasive species of mosquitoes in Austria, to identify new human and animal disease pathogens and to develop systemic strategies to control their spread.

Recommended further steps

- Continual examination and, where necessary, amendment of legal framework conditions (e.g., laws on epidemics and on zoonoses);
- Support for research, in particular on the following topics:
 - Which pathogens must (still) be considered? What risk potential exists?
 - Dispersion models for vectors;

¹⁰⁵ Link: <http://www.enivd.de/index.htm>

¹⁰⁶ Link: http://ec.europa.eu/health/preparedness_response/docs/gpp_technical_guidance_document_april2011_en.pdf

¹⁰⁷ Consequences of climate change for the spread of invasive vectors and vector borne diseases in Austria (and neighbouring regions). Link: <https://www.klimafonds.gv.at/assets/Uploads/Projektberichte/ACRP-2014/20170612VectorBorneDiseasesACRP7ZBB464781KR14AC7K11954.pdf>

	<ul style="list-style-type: none"> – Characterisation of critical threshold values for the establishment of pathogens/infectious diseases. – Further support of interdisciplinary research at national and EU; – Development of an adequate laboratory structure (with international linkages); – Preventive control of vectors, above all in risk areas; – Integration of required reporting of new diseases/pathogens into the electronic reporting system when necessary; – Sensitisation of professionals and inclusion of appropriate content in the education and training of doctors, nurses, nursing scientists and other multipliers (guidelines for action).
Possible resource requirements	Financial resources are needed for further national research projects, the development of an adequate laboratory structure and for education and training measures for medical personnel, as well as for a general extension of existing vector monitoring (as preparation and basis for plans for measures).
Possible conflict potential	Participation in EU-Programmes or the use of the results saves resources.
Actors	No potential conflicts have been identified.
Time horizon	BMASGK (formerly BMG, BMASK), BMBWF (formerly BMWFW), BMLV (formerly BMLVS), BMNT (formerly BMLFUW), state governments, academic and non-academic research institutions, AGES, Gesundheit Österreich GmbH, ÖÄK, EU (ECDC ¹⁰⁸).
	The implementation of the results can take place in the medium to long term.

2.9.2.5 RISK MANAGEMENT WITH REGARD TO THE SPREAD OF ALLERGENIC AND TOXIC SPECIES

Objective	Prevention/reduction of adverse health effects due to allergenic and toxic plants and animals.
Significance	<p>Allergens are substances that lead to an immune reaction and thus to an allergy. Allergens trigger hypersensitivity reactions and are found almost everywhere in the environment and can be found, for example, in pollen and in animal hairs.</p> <p>Higher temperatures and the resulting lengthening of the growing period of vegetation lead to a strengthening and extension of the exposure to allergens. Allergies have very different systems and can be manifested in mucous membranes, the respiratory tract, and the skin or in the gastro-intestinal tract.</p> <p>Various studies show that the pollen season in recent decades has begun earlier and sometimes lasted longer than in periods before. With allergenic plants, there can be interactions with other pressures, such as air pollution (ozone, nitrous oxide, particulate matter etc.). More frequent high pressure situations in summer can favour the development of air pollution. An increase of air pollution increases the allergenic capacity of pollen. Recent studies show that ozone exposure leads to the development of highly allergenic complex proteins as a result of stress reactions in plants.</p> <p>The spreading of imported species with a high allergenic potential (e.g., common ragweed) is particularly significant. For particularly sensitive people 5-10 pollen per m³ of air can cause allergic symptoms. Usually this is hay fever, but around a quarter of the people with an allergy to ragweed develop bronchial asthma. Furthermore there is cross-reactivity with mugwort and foodstuffs such as bananas or melons.</p> <p>A strict control of strongly allergenic plants can save considerable expenses for treatment. However, the knowledge about the potential spreading of allergenic plants is</p>

¹⁰⁸ European Centre for Disease Control and Prevention, <http://ecdc.europa.eu/en/Pages/home.aspx>

Connection to other sectors
Connection to existing instruments

still at a low level. In addition, the effects and interactions between air pollutants, allergens and changing conditions as a result of climatic change have not yet been studied enough and more research is needed.

Allergic reactions can also occur through an increased number of insect pests that thrive in warm conditions. For years, the northward spread of the oak processionary (*Thaumetopoea processionea*) has been observed (Eis et al. 2010). The stinging hairs lead to irritation of the skin, eyes and the mucous membranes of the respiratory tract.

Many allergenic plants and insect pests like ragweed and the oak processionary prefer to settle close to humans. This must also be taken into account in urban planning.

As a result of climatic change, the immigration of poisonous species that prefer warm conditions and were originally found in the Mediterranean region can be observed. For example, the northward spread of the yellow sac spider (*Cheiracanthium punctatorium*) has been observed. This is the most poisonous central European species of spider; the poisonous effect is stronger than that of wasp or hornet stings. As a result of climatic change, the importance of mycotoxins produced by mould is increasing in Europe (Miller 2008). This is particularly critical, because the daily tolerable intake of some mycotoxins is already reached.

There is a close connection to agriculture, forestry, ecosystems/biodiversity, tourism, transport infrastructure and spatial planning.

Connections are given to, among others, the federal act amending the agricultural law of 2010.

The official Austrian plant protection service regulates measures against the import and spreading of quarantine pests. The higher authority for the official plant protection service is the Federal Ministry of Agriculture, Forestry, Environment and Water Management (now Federal Ministry for Sustainability and Tourism). The Austrian Authority for Food Safety and the Austrian Research Centre for Forests have tasks as authorities in the first instance regarding import. At the regional level, the provincial governor is responsible for the implementation of plant protection law with regard to introduction of plants, plant products and other objects within the community.

Further connections are to the plant protection warning centres and information provided by the Austrian Agency for Health and Food Safety and the Agricultural Chambers.

Some federal states already provide information about ragweed (e.g., Lower Austria, Styria, Vorarlberg).

The website www.pollenwarndienst.at provides, in cooperation with the Austrian weather service (ZAMG), information about current pollen counts and fungal spores. Likewise, the federal states have pollen warning services, mostly in cooperation with ZAMG and with www.pollenwarndienst.at.

The Austrian Agency for Health and Food Safety has a mosquito monitoring system to monitor vectors of pathogenic viruses, such as West-Nile fever, dengue or Chikungunya. In cooperation with the University of Veterinary Medicine in Vienna, vectors that are found are investigated with respect to bacterial diseases transferred by mosquitos such as tularemia (“rabbit fever”) and parasitic diseases such as leishmaniosis spread by sand flies.

On the EU-level the project HIALINE (Health Impact of Airborne Allergen Information Network) aims to study the impacts of climatic change on exposure to allergens and to establish a Europe-wide early warning system.

State of implementation

Invasive species are not currently covered by laws for phytosanitary or quarantine pathogens.

	<p>With the official Austrian plant protection service and the plant protection services of the federal states, measures have been introduced to prevent the import and spread of quarantine pests¹⁰⁹.</p> <p>The oak processionary regulation in Vienna provides measures for the local police to remove any threat to human health connected with the occurrence of the oak processionary spider.</p> <p>Within the Austrian Climate Research Programme of the Austrian Climate and Energy Fund relevant research is carried out (CLIMAllergy¹¹⁰, RAG CLIM¹¹¹, Aliens Health¹¹² etc.).</p>
Recommended further steps	<ul style="list-style-type: none"> – Further research on the spreading of allergenic and toxic species, on possible interactions with other factors etc.; – Systematic monitoring to determine and present the spatial and temporal spread of invasive, allergenic species; – Where necessary, development of a management strategy to contain existing populations, including the establishment of a coordination agency including all relevant actors and the municipalities; – Promotion of targeted control measures (e.g., mowing or weeding before the ragweed goes to seed) to prevent a further spreading or the import and spread of new allergenic plants and animals; – Active public relations and information campaigns through the public health system to create awareness about the problem; – Prophylaxis for those affected; – Strengthening of phytosanitary import controls.
Possible resource requirements	<p>Enough resources must be provided for research and monitoring within existing research programmes.</p> <p>Additional resources will be required for targeted information campaigns and the revision of existing information material.</p> <p>Sufficient financial resources must be available for necessary control measures (e.g. ragweed).</p>
Possible conflict potential	<p>Depending on the type of control or suppression measures after importation has occurred, conflicts with nature protection could arise. Wetlands, in particular, are an important habitat for insects/vectors.</p>
Actors	<p>BMASGK (formerly BMG), AGES, BMNT (formerly BMLFUW), state governments, Chamber of Agriculture, Gesundheit Österreich GmbH, academic and non-academic research institutions, municipalities, gardeners, ÖÄK, the media.</p>
Time horizon	<p>The implementation of the measures can begin in the short to medium term.</p>

2.9.2.6 DEALING WITH POLLUTANTS AND ULTRAVIOLET RADIATION

Objective	<p>Prevention/reduction of adverse health effects due to changes in exposure to pollutants resulting from extreme events and climate change.</p>
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¹⁰⁹ Quarantine pests are legally regulated pathogens, which can cause significant economic damage.

¹¹⁰ Climate change induced invasion and socio-economic impacts of allergy-inducing plants in Austria. Link: <https://www.klimafonds.gv.at/assets/Uploads/Projektberichte/ACRP-2009/20130903ClimAllergyEndberichtSven-FollakACRP2.pdf>

¹¹¹ Climate effects on the recent range expansion of ragweed in Central Europe. Link: <https://www.klimafonds.gv.at/assets/Uploads/Projektberichte/ACRP-2010/02052014RAG-ClimStefan-DullingerEBACRP3.pdf>

¹¹² Emerging public health risks from alien species under climate change: A systematic review of threats and an evaluation of mitigation measures. Link: <https://www.klimafonds.gv.at/assets/Uploads/Projektberichte/ACRP-2013/20160713Aliens-HealthACRP6B368636KR13AC6K11141ZB2.pdf>

Significance

As a result of increased exposure to ultra-violet radiation, allergens and pollutants, health effects can be expected. This is the case for long-term changes and for acute problems after extreme events.

Floods in sensitive areas (contaminated sites, industrialised areas, petrol stations, sewage plants etc.) can lead to contamination. In such cases, acute threats to health are paramount, but long-lasting effects on groundwater and drinking water, food, water bodies and soils can present risks to health.

According to the WHO, as a result of more UV-radiation (due to the depletion of the ozone layer) there will be an increase of certain forms of skin cancer (squamous cell carcinoma and basal cell carcinoma) in connection with the cumulative exposure to the sun (WHO 2010a). A further expected consequence of increased UV-exposure is the increased occurrence of cataracts.

More frequent summer high pressure situations can favour the development of air pollution. Increased pollutant loads in the air lead to an amplification of health effects, as well as an increase of the prevalence¹¹³. Increased concentrations of air pollutants (nitrogen oxides, ozone) lead to direct damaging effects on the respiratory tract and to stress reactions in plants, which produce highly allergenic proteins in response. In addition, fine dust particles and diesel soot particles are also very damaging to health – especially with respect to inflammatory, carcinogenic and allergy-causing processes.

As a result, people with allergies are particularly vulnerable: both through the damaging and irritating effect of the pollutants and also through more aggressive pollen and an extended pollen season.

The impact of climatic change on fine dust loading and the behaviour of persistent organic compounds cannot be estimated at present.

Indirect effects of climatic change, which lead to a changed or increased accumulation of pollutants (release of pollutants from melting ice and glaciers, increased concentrations as a result of dry periods, increased use of pesticides because of changed conditions), can also have negative health effects.

The contamination of groundwater and drinking water and food has significant implications for health.

Reports of experience and studies show that groundwater pollution can persist for decades and long-lived, bioaccumulating materials can also be found for decades in food and organisms.

One topic that is increasingly important is the exposure of humans to a multitude of chemical materials with different or similar effects over various paths of exposure (air, water, food, interior spaces, products). The exposure of humans in inside spaces is increasingly important for a number of reasons: As a rule, today people spend more than 90% of their lifetime indoors. The quality of indoor air is, however, often inadequate. On the one hand, pollutants from outside and chemicals from building materials and furniture are found in the air inside a building and on the other hand the level of pollution is influenced by the behaviour of those living in the building. Air exchange is often not enough to guarantee an adequate quality of the inside air, as a result of strengthened draught-proofing and energy-saving measures, which contribute to climatic change mitigation.

Connection to other sectors

There are connections in particular to disaster management, construction and housing, water management, agriculture, transport infrastructure and economy.

Connection to existing instruments

There are connections to the EU Floods Directive, the ozone warning service, and air quality monitoring; the working group on inside air of the Federal Ministry of Sustainability and Tourism (formerly Federal Ministry of Agriculture, Forestry, Environment and Water Management), the panel on Contaminants in the Food Chain

¹¹³ Prevalence or frequency of illness is a key figure in health care and pathology (epidemiology) and indicates how many people in a particular group of a defined size suffer from a particular illness.

State of implementation

(CONTAM), the Stockholm Convention of UNEP¹¹⁴, the European directive REACH, the EU strategy for environment and health and the EU environment and health action plan.

The EU strategy for environment and health and the action plan for environment and health aim to identify health risks that are a result of the environment and measures to reduce them.

The framework health goals consider, in goal 4, which calls for the safeguarding and sustainable development, also for future generations, of natural resources such as air, water and soil as well as all habitats, that the environment is an important resource for health.

The national flood risk management plan (RMP 2015 (BMLFUW 2016a)) aims to reduce negative consequences of floods for human health, the environment, cultural heritage and economic activities.

At the EU level the project MASH (Mass casualties and Health care following the release of toxic chemicals and radioactive material) was supported. The aim of the project is to increase the capacity of the health sector to act in the case of a widespread occurrence of toxic and radioactive substances.

The topic of contamination of food is taken up by an expert body of EFSA¹¹⁵, the panel on Contaminants in the Food Chain (CONTAM).

Persistent organic pollutants are regulated and monitored within the framework of the Stockholm Convention. REACH contains some instruments to limit dangerous chemicals.

The ACRP project UVSkinRisk (Simic 2014) dealt with the health risk of skin cancer through uv-radiation in connection with climatic change.

The European Commission made recommendations for action to improve the quality of indoor air (EC 2011) and developed regulations for healthy schools (EC 2015). The working group at the Federal Ministry of Agriculture, Forestry, Environment and Water Management (now Federal Ministry for Sustainability and Tourism) is responsible for this topic for the past 15 years at the national level and produces position papers on relevant topics¹¹⁶.

Recommended further steps

- To identify regions with above average uv-radiation, the exposure should be measured. On this basis, targeted recommendations for behaviour to protect threatened population groups can be derived;
- Support for research regarding the indirect effects (temperature, humidity, dryness etc.) on pollution levels in air, groundwater, water bodies, soils and food;
- Review and, where necessary, adjustment of the framework conditions to reduce exposure to pollutants;
- Awareness-raising regarding pollution and uv-radiation, in particular on changed pollutant concentrations in urban areas when temperatures are high and wind speeds low, as well as information for the general public regarding appropriate behaviour to reduce air pollutants.

Possible resource requirements

For the risk assessment and the implementation of preventive measures, additional resources will be required but an exact estimate is not possible at present. Furthermore, resources are required for research and awareness-raising.

Possible conflict potential

During implementation, as a result of stricter requirements conflicts are possible with agriculture, the economy and transport.

¹¹⁴ The Stockholm Convention, which came into force in 2004, also the Persistent Organic Pollutants Convention, is an agreement about legally binding measures to ban or limit certain long-living organic pollutants.

¹¹⁵ European Food Safety Authority <http://www.efsa.europa.eu/de>

¹¹⁶ Further information: <https://www.bmlfuw.gv.at/umwelt/luft-laerm-verkehr/luft/innenraumluft/positionspapiere.html>

Actors	BMNT (formerly BMLFUW), BMASGK (formerly BMG, BMASK), state governments, Chamber of Agriculture, Gesundheit Österreich GmbH, ÖÄK, AGES, ÖGB, Chamber of Labour, municipalities, the media.
Time horizon	The implementation should take place between the short and the long term.

2.9.2.7 LINKING IN AND FURTHER DEVELOPMENT OF MONITORING AND EARLY WARNING SYSTEMS

Objective	Preparation of the general public, health care, and aid organizations for climate change-related effects and emergency situations in order to reduce/prevent health consequences through the development of a common, coherent monitoring structure, in particular by linking existing systems. This structure should be adjustable to the respective risks (e.g., floods, heat, cold, pathogens/infectious diseases).
Significance	<p>To avoid and reduce damage, injuries, deaths or panic in the general public, it is important to have prepared adequate monitoring and early warning systems. The development of early warning systems is also very important in view of the expected increase of heat waves, the spreading of allergenic plants or new diseases.</p> <p>Monitoring systems allow the systematic and measurable detection of changes. The continual collection of data is necessary, in order to be able to make statements about relevant changes with certainty and to deduce the necessity for introducing measures. This is true for all areas (groundwater, drinking water, food inspections, infectious diseases, species observation, pollutants, water level and floods, weather and climate).</p> <p>With the monitoring systems, hotspots should also be recognised and observed. In the case of heat, hotspots are those places at which particularly high temperatures occur (high exposure) and those where risk groups are often found (high sensitivity). They provide information for spatially explicit and target-group specific early warning systems and serve as the basis for their development.</p> <p>The implementation of monitoring and early warning systems is the basis for several recommended actions in the health sector:</p> <p>Chapter 2.9.2.2: Dealing with heat and drought</p> <p>Chapter 2.9.2.3: Dealing with floods, mudslides, avalanches, landslides and rock falls</p> <p>Chapter 2.9.2.4: Advancement of knowledge and preparation for handling pathogens/infectious diseases</p> <p>Chapter 2.9.2.5: Risk Management with regard to the spread of allergenic and toxic species</p> <p>Chapter 2.9.2.6: Dealing with pollutants and Ultraviolet radiation</p> <p>The World Health Organisation has published recommendations for dealing with uv-exposure, heat waves, extreme weather events, disasters and epidemics, as well as health risks resulting from climatic change (WHO 2010a, b, c, 2011a, b). These provide an important basis for implementation in Austria and should be considered.</p>
Connection to other sectors	Basically there are connections to all other sectors. Monitoring and early warning systems should be developed and implemented in close cooperation with agriculture, ecosystems/biodiversity, water management, disaster management and protection against natural hazards.
Connection to existing instruments	The Earth Observation System of the European Union, Copernicus, formerly known as Global Monitoring for Environment and Security (GMES), is a programme founded in 1998 by the European Commission and the European Space Agency (ESA). On the basis of earth-observation and information technologies, Copernicus provides an independent European observation system, which has been in operation since 2014. It provides current information regarding questions about the environment and security. The services comprise land observation, disaster and crisis management, security, observation of the marine environment, observation of the atmosphere, as well as adaptation to climatic change and reducing its consequences.

State of implementation

The Central Institution for Meteorology and Geodynamics (ZAMG) provides information on the weather conditions and their development, as well as relevant meteorological data.

The warning centres of the federal states serve the emergency response services as the centre for coordination across the state and operational leadership and they serve the citizens through provision of services and information.

The digital hazard maps HORA (Natural Hazard Overview & Risk Assessment Austria) informs about possible dangers through natural hazards such as floods, storms, hail, lightning or snow loading. Furthermore, current weather warnings for floods, hail and heavy rain, earthquakes etc. are available.

The Hydrographic Service in Austria has a basic network for observing the important components of the water cycle. Current water levels, data on precipitation amounts (6 to 72 hours) and discharge are available for all of Austria via eHyd.

The Pollen Warning Service provides information about the current pollen load in the air and forecasts for the coming period. The Plant Protection Service provides information on plants that require a passport, export of plants and harmful organisms.

The mosquito-monitoring system of the Austrian Agency for Health and Food Safety (AGES) monitors vectors of human-pathogenic viruses, such as the West-Nile virus.

There are connections to existing monitoring and warning systems, such as the ozone observation system (the Austrian Ozone Act regulates measurement of the ozone concentration and provision of information to the general public). In general, the air quality monitoring, as well as monitoring programmes in the framework of the EU Water Framework Directive and the Directive on monitoring water conditions, are established instruments that also serve to make observations of changes over time.

A series of monitoring and early warning systems has been established for various areas and sectors (including natural hazards, health, agriculture and forestry).

Scientific foundations are available from the IPCC, as well as specific projects, e.g., ACRP projects, StartClim projects, WHO publications, general adaptation strategies from EU Member States.

Recommended further steps**Monitoring**

- Synthesis and analysis of existing data considering the comparability and generation of data regarding the starting situation and presentation of trends as an important part of a comprehensive monitoring system and as an important basis for early warning systems for targeted groups;
- Mapping, presentation and characterisation of areas/regions with a high risk with respect to floods, as well as high sensitivity with respect to heat, infectious diseases etc.;
- Evaluation of the interaction between heat and other influencing factors (air pollutants, uv-index, noise, stress etc.);
- Description of risk groups according to risk- residential areas within urban areas etc.;
- Examination and, where necessary, connection or adaptation of existing monitoring systems considering their usability under changed climatic conditions;
- General consideration regarding the development or expansion of monitoring systems for illness associated with climate, including:
 - Heat-related illness and mortality (cardiovascular illnesses);
 - Infectious diseases;
 - Allergenic loads;
 - UV-radiation.
- Modelling of the possible future spreading of vectors (simulation models).

	<p>Early Warning Systems</p> <ul style="list-style-type: none"> – Establishment of an interdisciplinary support institution as the basis for an interlinked monitoring and early warning system; – Adaptation, combination and extension of existing instruments for early warning to provide early warning with temporally and spatially specific warnings and rules of conduct; – Designation of a central coordination point, which cooperates with participating institutions and is able to act directly when there is an emergency, and creation of communication channels; – Regulations on who, when there is a heat warning, must give which information to whom and who must implement which measures; – Development of educational measures to prepare actors (see Chapter 2.9.2.8: Incorporation of climate-relevant topics in the training and further education of doctors and personnel in medical, therapeutic and diagnostic health professions (MTDG)) <p>Possible resource requirements</p> <p>In the area of infectious diseases, personnel resources and laboratories are available, but it is felt to be important to set and weight new priorities. For high-risk pathogens no suitable facilities are available. For this, considerable financial resources would be required.</p> <p>An interlinking of existing information could be carried out with limited resource requirements. It would be advantageous to set up a website, which brings together all of the relevant information or which is linked to all existing specific websites (see also Chapter 2.9.2.1: General public relations and specific work on preparing for extreme events or outbreaks of infectious diseases). This should contain links to monitoring and early warning systems, as well as concrete recommendations for action.</p> <p>Possible conflict potential</p> <p>Regarding the question of responsibilities and thus of financing, conflicts could arise between the federal government and the federal states.</p> <p>Actors</p> <p>BMG, BMLVS, BMASK, state governments, academic and non-academic research institutions, Gesundheit Österreich GmbH, ÖÄK (Austrian Medical Chamber), ÖGB, insurers, Statistics Austria, ZAMG, cities/municipalities, care services, retirement homes, nursing homes, hospitals, psychosocial services, Chamber of Labour, disaster protection management, emergency services, civil defence associations, the media.</p> <p>Time horizon</p> <p>The implementation should take place in the short to medium term. More time is needed for the description of the risk groups (long term).</p>
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2.9.2.8 INCORPORATION OF CLIMATE-RELEVANT TOPICS IN THE TRAINING AND FURTHER EDUCATION OF DOCTORS AND PERSONNEL IN MEDICAL, THERAPEUTIC AND DIAGNOSTIC HEALTH PROFESSIONS (MTDG)

<p>Objective</p>	<p>Increasing the competence of doctors and health care personnel in handling climate-relevant health topics.</p>
<p>Significance</p>	<p>As discussed in the previous recommendations for action, new health risks will occur as a result of climatic change. Through educational measures, health-care professionals should be prepared. For this, it is necessary that enough teaching personnel familiar with the topic are available. Targeted training and further education of medical personnel and the preparation of information material are important factors in managing the new challenges and thus reducing or avoiding as far as possible the negative consequences for individuals.</p> <p>In the area of infectious diseases, structured, clustered information about core data, main characteristics and differential diagnosis are necessary in order to prevent disease outbreaks and limit their spreading.</p>

Connection to other sectors**Connection to existing instruments****State of implementation****Recommended further steps**

To guarantee a frictionless process when an event occurs, e.g., a heat-wave, it is necessary to produce checklists, fact sheets, explanatory material with further addresses etc. and to undertake more training of persons active in the health sector.

Furthermore, the occurrence of psychological health consequences such as Post-Traumatic Stress Disorder (PTSD) after existence-threatening events (e.g., deaths in the family, destruction of basic needs such as the home or business as a result of flooding) must be considered more and therapy options should be offered.

There is a close connection to disaster management.

An example in this area is the Styrian epidemics plan (Feenstra 2010), which provides a basis for doctors, hospitals and all of the coordinating emergency response services.

The Styrian plan for heat events contains a strategy, plans and measures to ensure the best possible attitude of the population with respect to heat-stress days and effective managing of tasks of the public health service (ÖGD).

Within the framework of the ordinance on the training of doctors (*ÄAO 2015, BGBl. II Nr. 147/2015*), the relevance of changes as a result of climatic change was already considered and was referred to as one of the basic goals in the building of specialised medical competences especially regarding illnesses due to the environment (§ 16 Abs. 2 Z 4. ÄAO 2015).

Furthermore, in certain specialised disciplines of human medicine the definition of the specialised disciplinary competences includes competences related to the environment (see the definitions of competences for pharmacology, toxicology or clinical microbiology and hygiene).

Further, within the professional work in health psychology, according to the law covering the work of psychologists (*Psychologengesetz 2013, BGBl. I 182/2013*), the influence of environmental factors that make people ill have a particular significance in diagnosis and findings, as well as in advice and treatment.

At the national level 10 framework health goals were developed as a cross-sectoral process covering a range of policy areas. One of the goals concerns the environment (Goal 4: for the safeguarding and sustainable development, also for future generations, of natural resources such as air, water and soil as well as all habitats). The aim is to generate synergies and cooperation, but also to emphasise and use them. The framework health goals aim to operate where it is possible to have a positive influence on the maintenance and development of the health of the population.

The EU project “Climate change adaptation by Training, Assessment and Preparedness – CLIMATE TRAP” (2009–2012)¹¹⁷ developed training materials for the health sector to deal with various challenges as a result of climatic change.

- Consideration of climate-relevant topics in the training and further education of doctors and care staff;
- Diagnostics and treatment of tropical illnesses that could occur in Austria as a result of climatic change (dissemination of possibilities for acute and chronic interventions, for example during training weeks on climate data);
- Prevention of heat stress with particular attention to different risk groups (older people, chronically ill persons, children etc.);
- Improvement of precautionary measures and follow-up care and early recognition/diagnosis and treatment of post-traumatic stress disorder (PTSD).
- Inclusion of the topics in educational requirements and curricula;
- Creation of problem-awareness in hospitals, of doctors and in the public health service (ÖGD) regarding post-traumatic stress disorder after disasters;
- Educational work in health services using various communication channels.

¹¹⁷ Link: https://webgate.ec.europa.eu/chafea_pdb/health/projects/20081108/summary

**Possible
resource
requirements**

It is expected that additional resources will be required for increased educational work. There is an urgent need for knowledgeable educational personnel, who are familiar with these topics.

Actors

BMGF, state governments, ÖÄK (Austrian Medical Chamber), training academies, hospital operators, academic and non-academic research institutions, Gesundheit Österreich GmbH, public health services, psychosocial services, the media.

Time horizon

It is recommended that this work start in the short term, so that, given the lead times for preparation and adaptation of the material to be taught, there will be an effect in the medium to long term.

2.10 ECOSYSTEMS AND BIODIVERSITY SECTOR

2.10.1 OVERARCHING OBJECTIVE OF THE SECTOR

Overarching objective: Maintenance and support of biodiversity and ecosystems and their functions through protection of species that are vulnerable to climatic change, interlinking habitats, sustainable land use and adaptation of nature protection plans to changes resulting from climatic change.

2.10.2 RECOMMENDED ACTIONS FOR THE ECOSYSTEMS/BIODIVERSITY SECTOR

GENERAL PRINCIPLES FOR ACTION IN THE ECOSYSTEMS/BIODIVERSITY SECTOR

- In the ecosystems/biodiversity sector there is a large number of adaptation measures closely connected to climate change mitigation measures. These are above all measures that reduce the release of carbon from ecosystems or increase the carbon storage by ecosystems. In this document, the focus is on measures for adaptation to climatic change.
- To achieve an integrated approach, above all, measures should be selected that use synergies between adaptation, mitigation and nature protection and maintain ecosystems and biodiversity. For example, in wetlands when the buffering function for the consequences of extreme events on the water budget is supported, this also has a positive effect on the carbon storage function of this ecosystem.
- Adaptation measures refer to actions that create the required framework conditions for adaptation (e.g. risk analyses should improve the knowledge basis for adaptation measures in a way that supports action) or that lead directly to the desired effect (improvement of resilience¹¹⁸ of species or habitats, improvement of ecosystem services etc.). These can be nature protection measures (e.g. adjustments in protection strategies), but also measures from other policy sectors that influence aspects relevant to nature protection (e.g. land use, protection against natural hazards).
- The adaptive capacity of species or ecosystems with respect to the impacts of climatic change can be significantly increased when other negative pressures (e.g. habitat destruction, eutrophication, use of biocides, fragmentation, surface sealing etc.) are reduced or avoided and through this the buffering capacity of species and habitats are increased. Care must also be taken that other negative effects on ecosystems that can be influenced by humans are kept small. Particular attention should be paid to the reduction of those negative effects that could be further strengthened as a result of climatic change (e.g., drainage of wetlands). A dynamic adaptation to changed conditions that protects the value of the habitat and considers possible risks for biodiversity (e.g., the composition of tree species in forests) must be enabled.

2.10.2.1 IMPROVING THE KNOWLEDGE BASE THROUGH RESEARCH ON THE EFFECTS OF CLIMATE CHANGE ON ECOSYSTEMS/BIODIVERSITY

Objective	Advancement of knowledge on the impacts of climate change on ecosystems and biodiversity as a basis for and support of the implementation of potential measures.
Significance	In addition to already existing anthropogenic pressures, climatic change presents a further factor that will exceed the adaptive capacity of many biological systems and species. Effects that are already observed, such as shifts of the distribution areas, loss of habitat and species, phenological changes and invasion of thermophilic species, will increase. This leads to a fundamental change of living conditions, but also of the interactions between species. An improved understanding of the impacts of climatic change is necessary, to provide bases for the further orientation and prioritisation of recommendations for action. In particular, regionalised information about vulnerability

¹¹⁸ *Robustness/tolerance of a system with respect to disturbances.*

	<p>of species, habitats and ecosystem services are important for the development of solutions appropriate for particular regions.</p>
	<p>The effectiveness of adaptation measures for the protection of nature (within and outside of protected areas) is very context-dependent, among others depending on the particular natural conditions, on the object that is to be protected and on the available resources. Therefore, comparative studies to identify the most effective adaptation measures under specific conditions are very important in the area of nature protection.</p>
Connection to other sectors	<p>An interdisciplinary approach is necessary to identify the interfaces with other sectors, to find synergies and to use this information to develop overarching measures.</p>
	<p>To do this, it is very important to connect together and include further institutions or infrastructure facilities that are active in researching the impacts of climatic change, in order to have better connections between national activities and to ensure international connectivity.</p>
Connection to existing instruments	<p>For a systemic and interdisciplinary treatment of relevant questions, there is a need for coordination with research questions from agriculture, forestry, water management, energy and health, in particular.</p>
	<p>Connections exist to existing research programmes and infrastructure facilities, such as:</p> <ul style="list-style-type: none"> – The Austrian Climate and Energy Fund with the Austrian Climate Research Programme (ACRP), – The forestry research strategy of the Federal Ministry for Sustainability and Tourism (formerly BMLFUW), – Pfeil 20 (BMLFUW 2016b), – FTP (Forest Technology Platform at the EU level), – K1-Competence Centre alpS, – International programmes of the Austrian Academy of Sciences (ÖAW), – StartClim (national climate impact research programme), – LIFE programme (EU and national financing), – Horizon 2020 (EU research programme).
State of implementation	<p>Existing focus areas and projects of universities and other research institutions provide significant foundations (GLORIA¹¹⁹, water body monitoring, SHIFT-alpS¹²⁰). Current and completed research projects particularly of the Austrian Climate Research Programme (e.g., RagClim¹²¹, ClimAllergy¹²², BIO_CLIC¹²³, RIPCLIMA¹²⁴, Monitoring of selected indicator species¹²⁵, SpecAdapt¹²⁶) and EU projects (LEGATO¹²⁷).</p>
Recommended further steps	<ul style="list-style-type: none"> – Analysis of needs based on available knowledge as the basis of integration of relevant questions in national research programmes; – Strengthened networking and use of existing infrastructures; – For groups of species and habitats that are important for nature protection or presumed to be particularly affected by climatic change, vulnerability assessments and adaptation measures should be developed;

¹¹⁹ Link: <http://www.gloria.ac.at/>

¹²⁰ Link: <http://www.alp-s.at/cms/de/strategische-projekte/aktuelle-projekte/shift-ii/>

¹²¹ Link: [Climate effects on the recent range expansion of ragweed in Central Europe \(RAG-Clim\)](#)

¹²² Link: [Modelling the invasion potential and socio-economic impact of allergy-inducing plants in Austria in relation to climate change \(ClimAllergy\)](#)

¹²³ Link: [BIO_CLIC - Das Potential der Ufervegetation zur Minderung von Effekten des Klimawandels auf biologische Lebensgemeinschaften kleiner bis mittelgroßer Fließgewässer](#)

¹²⁴ Link: [RIPCLIMA Risk assessment and management of Riparian ecosystems in condition of Climate Change in Austria](#)

¹²⁵ Link: [Klimawandel und sein Einfluss auf die Biodiversität - Grundlagen für ein Monitoring ausgewählter Indikatorarten](#)

¹²⁶ Link: [SecAdapt - Climate change driven species migration, conservation networks, and possible adaptation strategies](#)

¹²⁷ LEGATO "LEGumes for the Agriculture of TOMorrow", supported by the FP7 Programme of the EU, Link: <http://www.legato-fp7.eu/>

Possible resource requirements	<ul style="list-style-type: none"> – Socio-economic scenarios (e.g., changes of land use, population density, and transport infrastructure) should be integrated into the scenarios and mapped out. The processing should be carried out in cooperation with existing national and international initiatives; – Development of concepts, modelling, long-term studies and monitoring (to provide data basis and check plausibility); – Implementation of model projects and case studies; – Clarification of the significance of genetic diversity for the adaptive capacity of species with respect to climatic change.
Possible conflict potential	Conflicts can arise in discussions about topic leadership.
Actors	Federal government (BMBWF (formerly BMWF), BMNT (formerly BMLFUW), state governments, academic and non-academic research institutions, ZAMG, Austrian Academy of Sciences, FWF, Climate and Energy Fund (ACRP, Austrian Climate Research Program).
Time horizon	Implementation should take place in the short to medium term.

2.10.2.2 INCREASED CONSIDERATION OF CLIMATE CHANGE IN EXISTING MONITORING SYSTEMS AND FURTHER ESTABLISHMENT OF MONITORING AND EARLY WARNING SYSTEMS

Objective	Continuation, adjustment, extension, and consolidation of existing or evolving environmental monitoring networks with the overall aim of identifying the effects of climate change on species, habitats, and ecosystem services and applying this information in early-warning systems.
Significance	<p>Monitoring with systematic collection of, for example, variables relevant for biodiversity is important and provides the basis for general measures and in particular for the establishment of early warning systems. Some existing monitoring systems are not sufficiently able to determine how functions and structures will change as a result of climatic change.</p> <p>It would be important for strengthening awareness to include farmers and forest owners in monitoring programmes.</p> <p>In particular, alien (thermophilic) species, species that endanger health and potential pathogens could profit as a result of climatic change. In total, these developments mean that in the future these species will present a higher threat than today for biodiversity, but also for agriculture and human activities and health. For frequent and widespread invasive species, control measures and the prospect of success are mostly very limited. Therefore, the focus of action must be on prevention, early detection and rapid implementation of measures.</p> <p>European coordination of the activities is particularly important for this recommended action.</p>
Connection to other sectors	Basically, there are connections to all other sectors, in particular to agriculture, forestry, water management, health and protection against natural hazards.
Connection to existing instruments	To ensure natural diversity in Europe, the EU has enacted two nature protection directives – the Habitats Directive and the Birds Directive. On the basis of these directives, all Member States must implement a series of legal regulations to protect species and habitats. Both directives foresee the establishment of protected areas, in which selected species and habitats should be maintained for the future (Natura 2000).

State of implementation

There is a connection to the Austrian Biodiversity Strategy 2020+, which covers the recording and observation of biodiversity as an important aspect.

The integration and coordination with monitoring and early warning systems that already exist or are being established is essential (e.g., the national biodiversity monitoring system MOBI, Natura 2000 monitoring (*FFH-RL* Art. 11 on monitoring the conservation status of habitats and species), Water Framework Directive monitoring, Austrian forest inventory, warning services of the plant protection services, breeding bird monitoring of BirdLife Austria, GLORIA, LTER Long-term Ecological Research Zöbelboden, national water body management plan). Furthermore, the further development of expandable data collections (e.g., Zobodat¹²⁸, EMaRT¹²⁹, GBIF Austria-Portal¹³⁰) for monitoring purposes should be investigated. There are also connections to the Austrian action plan on alien species (Neobiota). It contains a set of measures in order to keep future negative effects of problematic neobiota as small as possible. It was enacted in 2004 in cooperation with the national biodiversity commission.

In 2015, the EU Directive 1143/2014 on the prevention and management of the introduction and spread of invasive alien species entered into force^{5F131}. Member States are required to undertake research, monitoring and observation of such species.

Article 7 of the Convention on Biological Diversity (CBD) requires the implementation of biodiversity monitoring by all parties and requires the observation of components of biological diversity. This is particularly the case for components that urgently require conservation measures and those that offer the greatest potential for sustainable use. In parallel, activities that have a significant impact on the conservation and sustainable use of biological diversity must be monitored. The implementation at the national level is provided by the Austrian Biodiversity Strategy 2020+.

A concept for biodiversity monitoring in Austria is available and part of it is being implemented (MOBI). The monitoring aims to have an early warning function, which should also demonstrate the effects of climatic change. During the development of the concept, attention was paid to including existing relevant activities, such as the forest inventory, Natura 2000 monitoring, Water Framework Directive monitoring, LTER Zöbelboden, GLORIA and the breeding bird monitoring of BirdLife.

A proposal for a regulation of the European Parliament and the European Council for European Environmental Economic Accounting contains a requirement to include ecosystem services in environmental accounts.

Recommended further steps

- Ensuring the continuation of existing monitoring systems (e.g., MOBI, forest inventory, GLORIA);
- Review of existing monitoring systems with regard to their relevance for adaptation to climatic change and, where necessary, further development of monitoring and early warning systems to use synergies and increase the efficiency with strengthened use of geo-information systems;
- Strengthened consideration of genetic diversity, establishment or expansion of a genetic monitoring system;

¹²⁸ ZOBODAT (Zoological-Botanical Data Bank, formerly ZOODAT) is a digital bio-geographical databank, including analysis, documentation and communication facilities. ZOBODAT is operated by Upper Austria and is located in the Upper Austrian State Museum. At present, not all of Austria is covered. Link: <http://www.zobodat.at/>

¹²⁹ To develop the Natura 2000 monitoring system according to legal requirements (*FFH Richtlinie* Art. 11) the nine federal states commissioned a project in 2010 on the basic survey of habitat types and species of common importance in Austria. During the course of the project a web-based GIS-tool (EMaRT -Expert Monitoring and Reporting Tool) was developed as the basis for long-term monitoring. EMaRT is seen as an integrative, permanent web-based GIS-tool for the collection and evaluation of protected goods found in Austria based on the annexes of the EU Habitats Directive (animal and plant species, habitats). <http://emart.sbg.ac.at/emart/index.html> (password protected)

¹³⁰ The international Initiative **Global Biodiversity Information Facility** provides data on the global biodiversity via internet. <http://www.gbif.at/>

¹³¹ Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species.

	<ul style="list-style-type: none"> – Review and, if necessary, further development of the environmental inspection report; – Development of an early warning system for selected alien species (neobiota) with special consideration of those species that lead to high health and economic costs for society.
Possible resource requirements	For the possible development of monitoring systems for more detailed examination of these questions additional resources will be required.
Possible conflict potential	Conflicts can arise between the federal government, the federal states and interest groups, in particular with regard to economic use.
Actors	BMBWF (formerly BMWF), BMNT (formerly BMLFUW), state governments, NGOs, BFW, ÖAW, FWF, universities, Environment Agency Austria, Austrian Climate Research Program (ACRP), Long Term Ecological Network (LTER), museums (e.g., Zobodat).
Time horizon	Implementation should take place in the short to medium term.

2.10.2.3 INTEGRATION OF CLIMATE CHANGE INTO NATURE PROTECTION

Objective	Consideration of the impacts of climate change and representation of potential needs for action in nature conservation concepts.
Significance	<p>Nature protection concepts, strategies or plans are comprehensive instruments for the presentation of specialised foundations and requirements for nature protection in a regionally specific and transparent manner. They provide guidelines for the implementation of necessary nature protection measures. As the basis for projects and other sectoral plans, they ensure that nature protection perspectives are introduced as early as possible into planning processes.</p> <p>Climatic change provides new challenges for concepts, strategies or plans for nature protection, which will change their goals and value structure. A reassessment covers, amongst others, the relationship between dynamic and conservative nature protection, handling of new immigrant species, safeguarding ecosystem services, management of protected areas, the relationship between perpetuating existing habitats and communities of species and newly developing habitats. In addition, the protection of biodiversity as the basis for functioning under climatic change will become more significant, while at the same time the requirements (e.g., food production, provision of renewable raw materials) will increase.</p> <p>The possibilities for a flexible nature protection with anticipatory elements should be discussed more. Areas that are considered insignificant today from a nature protection point of view could become suitable for protected areas in the future as a result of climatic change. This could be essential for the survival of species and a high genetic variability, as found in particular in correspondingly large populations and habitats. Implementation could be difficult to achieve.</p>
Connection to other sectors	There is a connection in particular to agriculture, forestry, water management, energy, tourism and spatial planning.
Connection to existing instruments	One instrument of nature protection is site protection. In addition, with the Austrian programme for rural protection ¹³² measures are supported with the goal of restoration, conservation and improvement of biological diversity. On average more than 70 million Euros per year are foreseen for this. On the one hand, this is for projects such as management plans or development concepts for Natura 2000 areas and other areas with a high priority for nature protection, projects to improve or restore valuable habitats, investments in objects that support the valorisation of areas with high natural value, public relations and awareness-raising or the design of tourism facilities, such as nature

¹³² Link: https://www.bmlfuw.gv.at/land/laendl_entwicklung/leprogramm.html

<p>State of implementation</p>	<p>trails, thematic paths, adventure paths, etc. Furthermore, nature protection measures and the implementation of Natura 2000 in agricultural areas are covered by the programme. The forest environment measures also have this goal.</p> <p>According to the nature protection laws of the federal states, parts of nature and the landscape can be declared through regulation as protected areas.</p> <p>Further examples of concepts, strategies and plans for nature protection are the Austrian strategy for national parks or the management plans for the Austrian national parks and the Natura 2000 areas. Guidelines are foreseen for biosphere parks.</p> <p>Currently, the impacts of climatic change are not sufficiently considered in the instruments for nature protection. In the nature protection concept of Lower Austria climatic change and its impacts are discussed as future challenges in a general description. In the Austrian strategy for national parks, climatic change is discussed many times. In several management plans for national parks aspects relevant to adaptation are included. In three of them (National park Thayatal, National park Gesäuse and Guidelines National park Kalkalpen) climate change is directly mentioned (BMLFUW 2015a).</p>
<p>Recommended further steps</p>	<ul style="list-style-type: none"> – Review and, where necessary, further development of existing nature protection concepts, strategies and plans or development of new concepts; – Strengthened consideration of nature protection in regional planning.
<p>Possible resource requirements</p>	<p>The integration of the topic of climatic change in nature protection instruments requires an investment of time.</p>
<p>Possible conflict potential</p>	<p>Conflicts could arise during the implementation of nature protection in particular with agriculture, forestry, water management, energy, regional planning, urban planning, tourism and the economy.</p>
<p>Actors</p>	<p>State governments, BMNT (formerly BMLFUW).</p>
<p>Time horizon</p>	<p>Implementation should take place in the short to medium term.</p>

2.10.2.4 STRENGTHENING OF KNOWLEDGE TRANSFER ON THE IMPORTANCE OF BIODIVERSITY AND ECOSYSTEMS FOR CLIMATE CHANGE ADAPTATION IN TRAINING, AND INCREASED PUBLIC RELATIONS EFFORTS

<p>Objective</p>	<p>Increased integration of the importance of biodiversity for the adaptation of society to climate change in education and accelerated public relations efforts.</p>
<p>Significance</p>	<p>Intact ecosystems are less sensitive to climatic change and therefore in a better position to continue providing ecosystem services, upon which our prosperity and well-being depend. For this, the protection of biological diversity of the cultural landscapes and the managed landscapes play a particularly significant role.</p> <p>The conservation of natural resources under climatic change is therefore very important for every adaptation policy and an essential prerequisite for the success of adaptation measures in other sectors. Knowledge transfer to decision makers and the general public must be further promoted to increase understanding. For this, a strengthened integration of the significance of biodiversity in education (schools, universities, agricultural colleges) and an aggressive knowledge transfer to the general public regarding the connections are necessary. The public relations efforts should be carried out in cooperation with representatives of interest groups (e.g., land use, fishing, hunting, beekeepers, tourism), who are directly dependent on an intact ecosystem and therefore, despite existing differences, represent interested partners for nature protection.</p> <p>The inclusion of social science approaches is of particular importance in order to identify barriers to implementation (e.g., fears, motivations), to be able to manage negotiation processes in a targeted manner and to improve the acceptance of adaptation measures.</p>

Connection to other sectors	Public relations work and the integration of the topic of adaptation to climatic change in education are extremely important for all sectors and build the foundation for meeting the challenges and taking advantage of opportunities.
Connection to existing instruments	Connections exist, for example, to the campaigns “vielfaltleben ¹³³ ” and National Parks Austria ¹³⁴ of the Federal Ministry for Sustainability and Tourism (formerly BMLFUW), as well as “Natur im Garten ¹³⁵ ”, “Biodiversität in der Stadt ¹³⁶ ” and initiatives such as www.naturbeobachtung.at ¹³⁷ , www.muttererde.at ¹³⁸ etc.
State of implementation	In addition to the above-named initiatives, there is, for instance, the biodiversity monitoring with farmers that is supported by the federal government, the federal states and the EU. In this project, farmers observe and report the biodiversity in their meadows. Currently, the project on biodiversity monitoring for foresters and for alpine pastures is being prepared. Strengthened awareness-raising and information about the value of biodiversity and the influence of humans on it are fixed components of public relations work and educational opportunities of the agricultural chambers.
Recommended further steps	<ul style="list-style-type: none"> – Integration in training of professionals and stakeholders (schools, agricultural colleges, universities etc.). Support for the networking of actors; – Development of concepts, educational material and information material; – Strengthened targeted public relations work and awareness-raising on the systemic significance of biodiversity and of ecosystems; – Strengthened motivation for behavioural change in the general public towards a sustainable and climate-friendly way of life.
Possible resource requirements	The development of suitable information and educational materials, as well as the implementation of campaigns, will possibly require additional financial resources that cannot be quantified at present.
Actors	State governments (nature conservation departments), land users, biodiversity research institutes, NGOs, Ministry of Science, universities, training facilities for the relevant interest groups (e.g., agricultural and forestry training institutions), nature park academies, associations.
Time horizon	The implementation should start in the short term and be continued so that the effects will be seen in the medium to long term.

2.10.2.5 MAINTENANCE OF EXTENSIVE LAND USE IN MOUNTAINOUS AND ALPINE ELEVATIONS AND IN SELECTED LOCATIONS

Objective	Protection of the traditional cultural landscape as a sanctuary for its species.
Significance	Extensive land use refers to the use of soils with low intervention in natural cycles by the people who work on the land and retention of the local vegetation. The term is thus relative and to be seen in the corresponding temporal and geographical context. The term always refers to a comparison with forms of use that are customary today. Extensively used areas in a landscape provide buffering and balancing elements and

¹³³ The campaign *vielfaltleben* (living diversity) is carried out by the Federal Ministry for Sustainability and Tourism (formerly BMLFUW) together with the *Naturschutzbund* (Association for nature conservation) and many other partners.

¹³⁴ Publishers are the Association of National Parks Austria together with the Federal Ministry for Sustainability and Tourism (formerly BMLFUW) (www.nationalparksaustria.at)

¹³⁵ Association “Natur im Garten” (Nature in the garden) und “Natur im Garten“ GmbH (www.naturimgarten.at)

¹³⁶ Wiener Umweltschutzbund (Vienna Environmental Prosecutor's Office) (<http://wua-wien.at/images/stories/newsletter/umweltstadt-09-01.pdf>)

¹³⁷ [naturbeobachtung.at](http://www.naturbeobachtung.at) is a cooperation project of the *naturschutzbund* and science4you

¹³⁸ Austria's leading environmental and nature conservation organisations joined together with the Austrian public service broadcaster ORF for the charity initiative MUTTER ERDE (Mother Earth).

	<p>can, for example, reduce soil erosion, positively influence the capacity to absorb water, positively change the microclimate, regulate fluctuating water levels or take on a protective function for water bodies. Furthermore, extensively used elements of a landscape, such as meadow orchards, can shape the landscape and thus should be conserved for aesthetic reasons.</p> <p>Cultural landscapes (especially grasslands and alpine meadows) at medium to high altitudes in Austria are mainly extensively used compared to other landscapes, so these areas are important refuges for many species of the cultural landscape. This is also true for low-lying areas in Austria such as nutrient-poor grassland, meadow orchards, marshes etc.</p> <p>As a result of climatic change, the role of these special locations as retreat areas for species that are adapted to cooler conditions will increase. Therefore, the conservation and extension of extensive land use is very important. This can be achieved through corresponding strategic plans, which amongst others encompass support and awareness-raising.</p>
Connection to other sectors	There are connections in particular to agriculture, forestry, water management and protection against natural hazards. Furthermore, there is a close connection to tourism.
Connection to existing instruments	There is a connection to the Austrian programme for rural development 2014-2020.
State of implementation	Within the framework of rural development, between 2007 and 2013 agricultural environment measures relevant for biodiversity were supported (e.g., M28 nature protection measures, M15 mowing of steep slopes, M16 management of mountain meadows, AZ – compensatory allowances). In the programme for rural development that started in 2014 ¹³⁹ measures for the agricultural environment that are relevant for biodiversity are further supported (e.g., environmentally-friendly and biodiversity-supporting cultivation (10.1.1), restriction of yield-increasing operating materials (10.1.2), alpine pasturing and shepherding (10.1.15), precautionary groundwater protection (10.1.16) or the nature protection measure (10.1.19)). The compensatory allowances are still provided for mountainous areas and other areas that are disadvantaged for substantial reasons related to nature.
Recommended further steps	<ul style="list-style-type: none"> – Implementation of pilot projects and support of project proposals; – Consideration in research, support and nature protection programmes; – Support for public relations work, integration into training of experts and stakeholders (agricultural colleges, universities etc.).
Possible resource requirements	The resource requirements cannot be quantified at present.
Possible conflict potential	During the implementation of the recommended action, conflicts with agriculture are possible.
Actors	EU, BMNT (formerly BMLFUW), state governments (nature conservation departments), land users, land owners, NGOs, interest groups, agricultural authorities, municipalities, HBLFA Raumberg-Gumpenstein, tourism associations.
Time horizon	The implementation should take place in the medium to long term.

2.10.2.6 ADAPTING LEISURE AND VACATION ACTIVITY OFFERS

Objective	Management and adjustment of leisure activities that threaten biodiversity in favour of sustainable leisure activities.
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¹³⁹ Link: https://www.bmlfuw.gv.at/land/laendl_entwicklung/leprogramm.html

Significance	<p>As a result of climatic change, there will presumably be changes in leisure and vacation behaviour; this includes the spatial relocation of activities (such as into higher lying regions), the temporal extension of activities (such as the bathing season) and the decline of current activities (such as winter tourism in lower lying areas) with a simultaneous increase of possible new activities.</p> <p>Therefore, negative damages to biodiversity as a result of leisure and vacation activities must be managed, reduced and avoided where possible. This is particularly the case for negative effects in protected areas, particularly endangered species and habitats and leisure activities that will become more difficult to perform when the climatic conditions have changed.</p>
Connection to other sectors	There are close connections to tourism. In addition there are connections to health, forestry, water management, transport infrastructure and spatial planning.
Connection to existing instruments	<p>There are connections to the regional development plans and the tourism strategies (on local and regional levels).</p> <p>In Austria, there are some initiatives to provide certificates for sustainable tourism. These certifications do not contain criteria relevant to biodiversity as a top priority, but they contribute at least indirectly to tourism that is more protective of biodiversity (e.g., through the supply of organic products). Examples are the environmental label for tourism and leisure businesses, the Alpine Pearls network, the initiative of mountain climbing villages or the association of Austrian hiking villages.</p>
Recommended further steps	<ul style="list-style-type: none"> – Leisure and vacation activities that affect sensitive habitats must be designed so that the negative impacts are minimised (e.g. winter tourism, see also the Chapter on tourism); – Leisure and vacation activities that will be made increasingly more difficult as a result of climatic change (e.g., skiing in low-lying locations) must be adapted to the fluctuating conditions. This should be done in a way that additional tourism offers that are sustainable under changing climatic conditions are developed together with the affected municipalities; – Development of concepts and implementation of pilot projects; – Consideration during the implementation and further development of tourism and leisure facilities, support for public relations work, support for project proposals; – Inclusion in future communal plans for energy and climate protection.
Possible resource requirements	Resource requirements cannot be quantified at present.
Possible conflict potential	There is possible conflict potential with tourism and cable-car businesses.
Actors	Associations, businesses, and professionals in the tourist industry, cable-car industry, land owners, protected area administrations, educational institutions, NGOs, interest groups, general public.
Time horizon	Implementation should be carried out in the short to medium term.

2.10.2.7 ADJUSTMENT IN THE DESIGN OF PUBLIC AND PRIVATE OPEN SPACES IN RESIDENTIAL AREAS TO THE OBJECTIVES OF NATURE CONSERVATION AND THE EFFECTS OF CLIMATE CHANGE

Objective	Creation of areas of retreat for animal and plant species (including rare and threatened species), improvement of the local climate in populated areas, increase in water retention, adjustment of the design of green spaces to climate change (e.g., selection of species and varieties).
Significance	During hot periods, widely sealed, built-up areas have a particularly hot climate with low humidity (heat island effect). Through suitable measures this heat effect can be

	<p>reduced and in this regard vegetation is particularly significant, since it positively influences the local climate through evaporation and shading.</p> <p>Coordination is necessary with spatial planning and in particular with urban development as well as with the sectors “Cities - Urban Green and Open Spaces” and transport infrastructure.</p>
Connection to other sectors	<p>There is a close connection to spatial planning, Cities - Urban Green and Open Spaces, construction and housing and transport infrastructure. Increasing water retention is also important in the water management sector and protection against natural hazards.</p>
Connection to existing instruments	<p>There are connections to the zoning plans and buildings plans with respect to maintaining green and open spaces, as well as the design of concepts for green and open spaces.</p> <p>Within the framework of the Interreg IV C Project GRaBS (Green and Blue Space Adaption for Urban Areas and Eco Towns), measures were collected for Graz and these are already being implemented (e.g., the “Grüne Netz Graz”, standards for planning of open spaces, the revival of inner courtyards in Graz or the sectoral programme on streams in Graz).</p>
State of implementation	<p>Currently, climatic change is rarely considered in the planning and design of public and private open spaces.</p>
Recommended further steps	<ul style="list-style-type: none"> – Design of green spaces keeping nature conservation in mind, unused brownfields such as industrial brownfields etc. as retreat areas; – Unsealing of areas within residential areas (relief of canal systems, increasing the infiltration into the ground), rainwater management; – Greening of roofs and façades; – Increase the number of trees in public areas (e.g., along urban roads, squares etc.); – Preferred selection of heat- and drought-resistant woody plants for planting; – Support for near-natural design of gardens and public green areas; – Acceptance of spontaneous greenery in areas that are hardly used or unused; – Concept development, implementation and monitoring of pilot projects; – Integration in the training of professionals (universities, universities of applied sciences etc.); – Establishment in competitions and calls for tender; – Support for public relations work; – Consideration in the requirements for garden authorities.
Possible resource requirements	<p>Early consideration of climatic change in the design of public and private open spaces can save costs for maintenance efforts over the long term. In the short term higher costs can be expected for the design and implementation.</p>
Possible conflict potential	<p>The safeguarding of areas for open and green spaces can lead to conflicts with the development of residential areas.</p>
Actors	<p>Building owners, municipalities, architectural firms, garden owners, real estate developers, parks departments, educational institutions, environmental consultants, “Action Nature in Gardens”, BMASGK (formerly BMGF), BMNT (formerly BMLFUW).</p>
Time horizon	<p>Implementation should take place in the short to medium term.</p>

2.10.2.8 STRENGTHENING OF THREATENED POPULATIONS AND SPECIES

Objective	<p>Reducing the hazardous situation of species threatened by climate change through restocking or ex-situ conservation (including seed and gene banks).</p>
Significance	<p>To reduce the hazardous situation of species threatened by climatic change through targeted conservation projects, the necessary measures must be designed for specific</p>

<p>Connection to other sectors</p> <p>Connection to existing instruments</p>	<p>species, accompanying studies must examine the efficiency of the measures and, where necessary, the measures must be further developed. The range of important activities extends from care and renovation of habitats to targeted support of populations (e.g., planting of individual plants propagated ex situ). Only when there are no alternatives and after detailed consideration of possible risks is the support of migration through translocation of threatened species/populations to be carried out.</p> <p>A prioritisation of particularly threatened species and of species with high displacement effects is necessary for the protection of other species.</p> <p>In the Austrian Assessment of Climate Change (2014), there is an overview of the knowledge about the impacts of climatic change on species and ecosystems in Austria as well as their adaptive capacity. This shows that there are knowledge gaps in many areas but for some specific species/ecosystems (mostly based on single studies and research projects) there are first results (APCC, 2014).</p> <p>There are connections in particular to agriculture, forestry, water management, spatial planning, tourism and transport infrastructure.</p> <p>To safeguard natural diversity in Europe, the EU has enacted two nature protection directives – the Habitat Directive and the Birds Directive. On the basis of these directives, all Member States must implement a series of legal regulations to protect species and habitats. Both directives prescribe the establishment of protected areas, in which threatened species and habitats should be conserved for the future (Natura 2000).</p> <p>Further connections are to the Austrian Biodiversity Strategy 2020+ and the nature protection laws of the federal states.</p>
<p>Recommended further steps</p>	<p>The Austrian strategy for river meadows published in 2015 (BMLFUW 2015i)¹⁴⁰ defines the principles for the long-term safeguarding of domestic species and river landscapes. This strategy also serves as the implementation of the Ramsar Convention (<i>BGBI. Nr. 225/1983 i.d.g.F.</i>) for the conservation and sustainable use of wetlands.</p> <ul style="list-style-type: none"> – Concept development (including national prioritisation, nature protection research, implementation of pilot projects and monitoring; – Consideration in research, support and nature protection programmes, support of pilot projects; – Review or further development of existing support measures and development of new measures for compensation of management difficulties as a result of the requirements of habitats that should be protected.
<p>Possible resource requirements</p>	<p>The resource requirements cannot be quantified at present.</p>
<p>Possible conflict potential</p>	<p>Regarding the need for areas, conflicts can arise with agriculture, forestry, regional planning (settlement development), water management, tourism, energy and transport infrastructure.</p>
<p>Actors</p>	<p>Land users, associations, conservation departments, protected area administrations, universities, botanical gardens, Environment Agency Austria.</p>
<p>Time horizon</p>	<p>The implementation should take place in the short to medium term.</p>

¹⁴⁰ BMLFUW (2015a): Pühringer, Ch.; Mair-Markart, B.; Krainer, K.; Lazowski, W.; Mühlmann, H.; Pleschko, D.; Schwach, G.; Schwarz, U & Zinke, A: Auenstrategie für Österreich 2020+. Wien.

2.10.2.9 MAINTAINING AND IMPROVING THE EMBEDDING AND NETWORKING OF PROTECTED AREAS AND HABITATS

Objective	Facilitating the networking of habitats and protected areas through the integration of buffer zones and corridors to increase the probability of survival of populations and species, and conservation of the natural value of protected areas under conditions of climate change.
Significance	<p>Numerous species have particular requirements, for example with respect to their nutrition or other circumstances in their habitat.</p> <p>Habitats are changing at a high speed at present. Through the diverse ways in which humans are interfering with nature, such as continuing urban sprawl and dissection of the landscape, surface sealing etc., habitats are increasingly becoming isolated islands. And these are becoming increasingly small and constantly move further apart. At the same time, climatic changes are increasing with the effect that certain species have to exploit areas that have a more suitable climate.</p> <p>In addition, the high speed of this development makes it more difficult for the species to keep up with the changing conditions. This ultimately leads to changes in the biotic communities and the interactions between the species, since these have different adaptive capacities.</p> <p>The networking of habitats is particularly important, since the impacts of climatic change are not just at selected points but have an overall effect. Through the conservation of existing and the promotion of further potential exchange possibilities between individuals of neighbouring populations, it should be possible to make them more resistant to environmental impacts and thus improve their capacity to survive. In the best case, the implementation of the measures that should lead to an ecologically interconnected system must be planned and carried out by all actors in close cooperation.</p> <p>The legally prescribed protected areas have a central role as an instrument of nature protection. The value of protected areas, but also of habitats outside of protected areas that are valuable for nature protection, depends strongly on their spatial distribution, the level of connections between the habitats and protected areas and on the integration in the surrounding landscape. These factors determine significantly (together with the area size of the habitat islands or protected areas) the probability of survival of species and the conservation of protected areas under a changing climate.</p> <p>In order to maintain the conservation value of protected areas and habitats relevant to biodiversity, an effective networking is particularly important.</p> <p>In particular circumstances, however, an improved interconnectedness of protected areas can be a threat for target species and is therefore counterproductive (e.g., improved possibility of North American crayfish to spread, which transmit crayfish plague to domestic crayfish).</p>
Connection to other sectors	There is a connection above all to agriculture, forestry, water management, tourism, energy, health, transport infrastructure, spatial planning, economy and City – urban open and green spaces.
Connection to existing instruments	There are connections to the EU Directives on habitats and birds, the nature protection laws of the federal states, the Strategic Environmental Assessment, the EU Water Framework Directive, regional planning concepts and programmes (e.g., protecting corridors for wild animals, habitat connectivity, green infrastructure etc.).
State of implementation	Within the framework of regional nature protection plans, the planning and execution of the nature protection area payment is made in line with the measure on nature protection of the Agricultural Environment Programme (ÖPUL). This ensures that protection of habitats is well-coordinated at the regional level. Similarly, within the agriculture environment programme (ÖPUL), but also within the ecological priority areas for direct payments, nationwide retreat areas (biodiversity areas) are created, which lead to a broad environmental effect and a wide interconnected system.

A good-practice example is the “Green Band”, which was developed and maintained where the Iron Curtain used to be and is now the largest interconnected system of biotopes in Europe. For 40 years along the borders, the area became a retreat space for many rare animal and plant species and is an integrated functioning ecosystem consisting of various habitats. It runs through 23 countries over a distance of more than 12,500 km through the whole of Europe from North Cape on the Barents Sea to the Black Sea and the Adriatic Sea. Austria has a share of almost 1,300 km (Upper Austria, Lower Austria, Burgenland, Styria and Carinthia). In addition to the cross-border national parks of Böhmerwald, Thayatal and Neusiedler See, there are many small natural treasures along the borders.

Almost half of the “Green Band” consists of different forest types, a quarter consists of arable land and special crops, meadows and pastures, wetlands, moors and heaths – the rest is mostly water areas, rocks and bushes.

Another good example is the Alpen-Karpaten-Korridor (Alpine-Carpathian Corridor). With international support from the IUCN, UNEP and the Alpine and Carpathian Conventions, the federal state of Lower Austria is leading a large cross-border project. The goal is to make the Alpine-Carpathian corridor passable again for wild animals and thereby restore an ecologically functional landscape. Nature protection and regional planning organisations in Austria and Slovakia together with partners from the transport, agriculture, forestry, hunting and tourism sectors and above all with the participating municipalities are developing concrete measures to ensure the network of habitats and will implement them as demonstrations.

In the Alpine Space project ECONNECT – Improving Ecological Connectivity in the Alps¹⁴¹ innovative methods were developed to achieve cross-border protection of alpine areas, which allow an effective, cross-border cooperation and the harmonisation of the approach to restoring ecological connections in the whole alpine area. In addition to the necessary analytical and planning steps on the level of the whole alpine area, in six pilot regions within the project first implementation measures should be carried out, which are adapted to the specific regional needs and conditions of the individual areas.

The project Lebensraumvernetzung.at¹⁴² commissioned by the Federal Ministry for Sustainability and Tourism (formerly BMLFUW) contributes to the implementation of the Austrian Biodiversity Strategy 2020+.

Likewise, measures in transport planning can contribute to improved connectivity, e.g., “green bridges”(wildlife crossings) or tunnels. Coordinated planning is, however, essential. This is the case not only for measures on the land, but also for those to restore the passability of water bodies (see also Chapter 2.3.2.6).

Recommended further steps

- Habitats and protected areas should be connected as far as possible through suitable structures that create an effective network of habitat corridors;
- During the design of corridors and stepping stones care must be taken that they are developed in a way that they can be used well by the targeted species (e.g. distance between stepping stones, suitable structures) and that in general they connect protected areas, particularly those that are similar;
- Corridors along climate or altitude gradients are particularly suitable for networking;
- Strengthening of the supervision of protected areas in Austria and adaptation of the management of protected areas with regard to climatic change;
- Other negative impacts on protected areas as a result of human activities should in addition be reduced as far as possible
- Concept development, implementation of pilot projects, long-term studies and monitoring;

¹⁴¹ Link: http://www.econnectproject.eu/about_the_project.php?lang=de

¹⁴² Link: <http://www.lebensraumvernetzung.at/>

	<ul style="list-style-type: none"> – Complete implementation of the EU nature protection directives and the Water Framework Directive; – Consideration in research, support and nature protection programmes.
Possible resource requirements	Resource requirements cannot be quantified at present. Additional resources will be needed for the possible land requirements.
Possible conflict potential	An additional need for land area for corridors, buffer zones and further protected areas can lead to conflicts with all other sectors that use space.
Actors	BMNT (formerly BMLFUW), BMBWF (formerly BMWFW), state governments (nature conservation departments), protected area administrations, land owners, NGOs, interest groups, district agricultural authorities, ÖAW, academic and non-academic research institutions, Environment Agency Austria, NGOs, spatial planning authorities.
Time horizon	The implementation should take place in the short to medium term.

2.10.2.10 PROTECTION OF WETLAND HABITATS BY ENSURING THE QUALITY AND QUANTITY OF GROUNDWATER AND BY RAISING THE WATER STORAGE AND RETENTION CAPABILITY OF LANDSCAPES

Objective	Protection of wetland habitats by ensuring adequate groundwater quality and quantity under conditions of climate change, and increasing water storage and retention capability through runoff-retarding measures.
Significance	<p>As a result of climatic change, the pressure on groundwater bodies can increase regionally, since in hot and dry periods the water demand will increase. Declining groundwater levels could threaten numerous water-dependent ecosystems. In addition, in some places the water storage and retention capability of the landscapes has significantly declined as a result of drainage, upgrading of flowing waters or construction measures (e.g., surface sealing).</p> <p>Therefore, measures that protect groundwater bodies, support the accumulation of groundwater and improve water retention are very important, in order to reduce the increasing pressure on habitats and biological diversity resulting from climatic change. Furthermore, the protection of wetland habitats makes a significant contribution to climate protection, since in many cases they store large amounts of carbon.</p>
Connection to other sectors	There are connections above all with the water resources and water management sector (see, for example, Chapter 2.3.2.7: Proactive water management planning for groundwater resources), agriculture (see Chapter 2.1.2.2 Enhanced establishment and Promotion of water-saving irrigation systems and improvements in Irrigation planning), as well as forestry and protection against natural hazards.
Connection to existing instruments	<p>The Ramsar convention provides, as an intergovernmental agreement, the framework conditions for international cooperation for the conservation and balanced use of wetland habitats. With the entry into force of the convention, Austria is obliged to support the conservation of the wetlands. In total, Austria has 19 Ramsar areas with a total area of 138,259 hectares.</p> <p>In 1983 the Austrian parliament approved the Austrian federal law on the agreement on wetlands, in particular as a habitat for water and wading birds. The Ramsar areas added since 1983 are found in later legal regulations (<i>BGBl. 153/2004</i> and <i>BGBl. 12/2006</i>).</p> <p>Further connections are provided by the nature protection laws of the federal states and laws regarding national parks. Furthermore, the Austrian strategy for river meadows (BMLFUW 2015i) contains targets for the conservation and restoration of ecologically intact and near-natural water bodies and river meadows.</p>
State of implementation	Projects such as the cross-border MoRe (Revitalisation of the March river) project supported through European Territorial Cooperation (ETC) and LIFE projects contribute to ecological improvements of rivers. Between 1996 and 2020, resources for LIFE-Nature funded or fund 49 nature protection projects in Austria. The majority (i.e.,

Recommended further steps	<p>34 of the 49) of projects (e.g. Mostviertel- Wachau, Auenwildnis Wachau) aim to give rivers a more natural appearance.</p> <ul style="list-style-type: none"> – Support for extensive ground cover in agriculture (see also Chapter Fehler! Verweisquelle konnte nicht gefunden werden.: Sustainable soil composition and protection of soil fertility, structure and stability; – Support for measures that delay discharge, the range of which can be from opening of former flooding areas to the establishment of new retention areas; – Targeted rewatering of drained wetlands and adaptation of the use to local conditions – where possible, development of concepts, implementation of pilot projects, monitoring and long-term studies; – Further measures to improve the ecology of water bodies, such as, in particular, renaturalisation and passability of flowing water with the opening of sealed water beds; – Where necessary (regional review necessary) increase groundwater accumulation in areas with declining groundwater levels through targeted reversal of drainage and avoidance of further drainage. In areas where there are locations with large water withdrawal, groundwater formation could be supported by targeted groundwater recharge; – Full implementation of the Water Framework Directive, the Groundwater Directive and the EU nature protection directives; – Strengthened establishment of and support for water-saving irrigation systems and improvements in irrigation planning (see Chapter 2.1.2.2: Enhanced establishment and Promotion of water-saving irrigation systems and improvements in Irrigation planning); – Consideration in research, support and nature protection programmes.
Possible resource requirements	The resource requirements cannot be quantified at present.
Possible conflict potential	Conflicts can develop in existing residential areas with regard to cellars becoming wet.
Actors	BMNT (formerly BMLFUW), state governments, land owners, energy producers, water suppliers, interest groups, agricultural authorities, spatial planning, NGOs, ÖBf, academic and non-academic research institutions.
Time horizon	The implementation should take place in the short to medium term.

2.10.2.11 PROMOTION OF RESTORATION OF WATERS, REINFORCEMENT OF INTEGRATED WATERSHED MANAGEMENT, AND PREVENTION OF SUBSTANTIAL WARMING OF WATER BODIES

Objective	Combined flood and biodiversity protection through restoration and a comprehensive view of water bodies, as well as the prevention of their substantial warming.
Significance	<p>As a result of climatic change, the discharge conditions of rivers will change overall and seasonally, although there are large uncertainties, in particular regarding the development of extreme events. However, there are clear signals that extreme flooding could increase in some regions. In addition, the promotion of hydropower projects will put additional pressure on natural water bodies.</p> <p>Water ecosystems are already threatened by observed regionally increasing water temperatures as a result of climatic change, whereby maximum values during heat waves are particularly problematic. In the case of sustained warming, it can be assumed that fish species that prefer cool conditions, such as brown trout and grayling, will retreat to the upper reaches and species that thrive in warm conditions will increase. However, constructions and natural barriers limit the upstream migration.</p>

	Human interference with water bodies – above all in flowing water – can additionally augment the temperature increase, e.g., through water abstraction, the introduction of warmed water, clearing of bushes on the banks. Therefore, such human interference should be done in a way that it prevents too strong a warming in vulnerable water bodies.
Connection to other sectors	There are connections to energy, water management, spatial planning, protection against natural hazards, disaster management, construction and housing, transport infrastructure, agriculture, tourism and the economy.
Connection to existing instruments	Connections are given to the EU Water Framework Directive (implemented in Austria through the national water management plan NGP) and the EU Floods Directive.
State of implementation	Partially considered in the implementation of the EU Water Framework Directive (approval procedure).
Recommended further steps	The development of hydropower and necessary flood and water protection measures should consider the following guidelines or contain the following steps: <ul style="list-style-type: none"> – Continuation of activities to expand or maintain flooding areas and flood retention areas; – Designation of risk zones and areas where no building is allowed considering the increasing risk of flooding; – Ensuring a sustainable use and holistic treatment of water bodies; – Attenuation of discharge peaks during heavy precipitation; – Development of the energetic use of hydropower only with attention to the ecological consequences and inclusion of aspects of nature protection; – Implementation of pilot projects, monitoring and long-term studies; – Full implementation of the Water Framework Directive and the Floods Directive; – Consideration in the national energy strategy; – Adaptation of water management and regional planning; – Comprehensive review and, where necessary, limiting of the introduction of warmed waste water; – Development and introduction of suitable measures and processes to avoid adding warmed water (see Chapter 2.3.2.9: Greater emphasis on water temperature in water management measures).
Possible resource requirements	The resource requirements cannot be quantified at present.
Possible conflict potential	Through the increased demand for land area and limitations to the introduction of warmed water, conflicts with agriculture, spatial planning (settlement development), energy and the economy could arise during the course of implementation.
Actors	BMNT (formerly BMLFUW), BMVIT, state governments (nature conservation departments), land owners, energy producers, water management associations, industry, interest groups (e.g., fisheries), NGOs, BOKU, Environment Agency Austria, state hydraulic engineering departments, Via Donau.
Time horizon	Implementation should take place in the short to medium term.

2.10.2.12 CONSERVATION OF ECOSYSTEM SERVICES IN SUSTAINABLE LAND USE AND NATURE CONSERVATION

Objective	Raising awareness about ecosystem services (e.g., contribution to water retention, flood control, biodiversity, drinking water generation, CO ₂ fixation, etc.) to promote sustainable land use supporting sustainable development, including improvement of biological diversity.
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Significance	<p>Intact ecosystems provide numerous services that are essential for the functioning of our society. As a result of climatic change these services are, however, threatened (e.g., through the loss of biodiversity), although they are increasingly important (e.g., carbon storage, flood protection, biodiversity).</p> <p>In order to conserve ecosystems with their functionality, concrete contributions to their safeguarding must be made. It must be noted that consideration of conflicts and setting of priorities between aspects of climatic change, the conservation of biodiversity and risk prevention must be made. Safeguarding of ecosystem services must be considered across sectors.</p>
Connection to other sectors	In particular there are connections to agriculture, forestry, water management, tourism, energy, protection against natural hazards, spatial and urban planning.
Connection to existing instruments	There are connections to nature protection laws, as well as legal requirements in agriculture, forestry and water management.
State of implementation	In the agricultural sector, within the framework of the Common Agricultural Policy, extra expenses and lower yields for cultivation that supports biodiversity are compensated.
Recommended further steps	<ul style="list-style-type: none"> – Raising the awareness of all relevant actors and the general public (see also Chapter 2.10.2.4: Strengthening of knowledge transfer on the importance of biodiversity and ecosystems for climate change adaptation in training, and increased public relations efforts); – Concept development, implementation of pilot projects, long-term studies and monitoring; – Consideration in research, support and nature protection programmes; – Promotion of ecosystem services in Austria, which make a positive contribution to climate protection and adaptation to climatic change.
Possible resource requirements	The resource requirements cannot be quantified at present.
Possible conflict potential	Basically, conflicts are possible with all sectors that use or require land area.
Actors	Federal and state governments (nature conservation departments), interest groups/associations, land users, NGOs, agricultural and forestry authorities.
Time horizon	The implementation should be carried out in the short to medium term.

2.10.2.13 CONSIDERATION OF ECOSYSTEMS/BIODIVERSITY ISSUES IN A GLOBAL CONTEXT

Objective	Reduction of indirect negative effects on biodiversity worldwide.
Significance	<p>National adaptation to climatic change inherently has a significant global dimension. National adaptation policies should consider the external consequences, in order to prevent the externalisation of negative or even counterproductive effects on global biodiversity and its ability to adapt to climatic change. National adaptation to climatic change must aim to have positive effects on similar efforts in other countries.</p> <p>For the implementation of this recommendation for action, the inclusion of as many actors as possible is required. A step-wise approach, beginning with particularly important matters that are urgent, and sufficient political support would support achieving the goal. This measure has a particularly significant cross-cutting character.</p>
Connection to other sectors	In particular, there are connections to agriculture, forestry, tourism, energy and the economy.

Connection to existing instruments

There are connections to:

- The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization, which entered into force in 2014 as an additional agreement to the Biodiversity Convention. With the EU Directive (Nr. 511/2014) on compliance measures for users from the Nagoya Protocol, the implementation of the Protocol in Austria is obligatory.
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
- Austrian Development Agency.

The Austrian Development Agency (ADA) is responsible for the implementation of all bilateral programmes and projects in the partner countries of the agency and manages the budget for these activities. A further focus is on education and information provision in Austria.

- Economic programmes (especially energy and other resources);
- Partnerships of cities, federal states, Climate Alliance;
- Certification systems with regard to imports (e.g., Forest Stewardship Council – FSC, Programme for the Endorsement of Forest Certification Schemes – PEFC);
- Legal instruments (e.g., Forest Law Enforcement, Governance and Trade FLEGT);
- National Action Plan for Sustainable Procurement;
- Contributions of Austria in the form of support for projects to conserve biodiversity in developing countries (Life-Web-Initiative of the CBD).

State of implementation

Within the international context, the Austrian development cooperation aims to reduce poverty, secure peace and preserve the environment. In 2011, 17% of the Austrian development cooperation projects made a concrete contribution to protecting biodiversity (BMLFUW 2014).

Recommended further steps

- Review of the significant Austrian programmes with regard to the effects on global biodiversity or, when necessary, adaptation;
- Review of the effects of imports and, where necessary, adaptation (strengthening of positive initiatives, weakening of negative practices);
- Consideration of climate change adaptation and of biodiversity standards in development cooperation, integration in legal and procedural material, as well as in the elaboration of international research programmes;
- Promotion of the use of sustainably produced, domestic renewable raw materials to reduce imports and thereby the related possible negative effects on, for example, biodiversity in the countries from which Austria imports goods;
- Criteria and monitoring should be developed or adapted so that the requirements that must be met are comparable to those for national activities;
- Strengthened international cooperation and strengthened participation of Austria in relevant international institutions (e.g., IPCC, IPBES, EU policies) and Conventions (e.g., CBD, CITES, Ramsar, UNEP, Cartagena Protocol etc.);
- Integrate adaptation and mitigation as cross-cutting topics at the national level and support this at the international level;
- For the implementation of global biodiversity standards in climate change adaptation processes, the aim should be that Austria takes on the operational execution of projects. Concept development and the development of criteria and standards must be carried out in advance;
- Integration of the topic of global responsibility in education and training;
- Governance support in environmental projects;
- Demonstrate good practice examples.

Possible resource requirements	The resource requirements for specific projects can, for example, be covered by reallocation of multilateral development cooperation payments into bilateral payments.
Possible conflict potential	There is a possible conflict potential in as much as developing countries could interpret the support as interference in their sovereignty.
Actors	Federal and state governments, ADA, municipalities, industry, Global Responsibility – Platform for Development and Humanitarian Aid, ANRICA (Austrian Natural Resources Management and International Cooperation Agency).
Time horizon	The implementation should take place in the medium term.

2.11 TRANSPORT INFRASTRUCTURE SECTOR INCLUDING ASPECTS OF MOBILITY

2.11.1 OVERARCHING OBJECTIVE AND SIGNIFICANT FINDINGS FROM THE PROGRESS REPORT

Overarching objective: Safeguarding a functioning, safe and climate-friendly transport system through a transport system adapted to climatic change.

CORE FINDINGS FROM THE PROGRESS REPORT

The instruments of transport planning do not explicitly cover adaptation to climatic change, but they contain several goals and measures that match recommendations for action in the national adaptation strategy. According to experts¹⁴³ some of them are implemented to a large extent, such as the “Expansion of information and Early Warning Systems”.

Surface sealing by transport surfaces continued to increase during the last 10 years. Since 1950 the modal split has changed very strongly. Motorised private transport increased strongly in the 1960s and continues to increase today (considering 10-year averages). The distribution of the person-kilometres over the different means of transport has hardly changed during the time period between 2005 and 2012. The traffic volume (according to distance covered) has, however, increased markedly in the relatively short period of time.

Note: Compared to data available at the time of the production of the progress report, more recent values are now available for 1995 – 2013/14¹⁴⁴.

A nationwide cataloguing of infrastructure damages as the basis for vulnerability assessments and planning of measures is currently not available. In some federal states, damages to the network of highways through landslides, mudslides wet snow or storms (e.g. Styria) or floods, undercutting and rock falls (e.g., Salzburg) are recorded.

2.11.2 RECOMMENDED ACTIONS FOR THE TRANSPORT INFRASTRUCTURE SECTOR

GENERAL PRINCIPLES FOR ACTIONS IN THE TRANSPORT INFRASTRUCTURE SECTOR

- The recommended actions are structured according to, on the one hand, directly operational measures and, on the other hand, instruments that create beneficial framework conditions for the implementation of measures. In the planning of new infrastructure, as well as in reconstruction and renovation, the changed risk situation must be strictly taken into account. Construction in potential hazard zones should be avoided when possible. Also, alternatives in the case of interruptions are essential for important transport routes (and in the case of proven vulnerability).
- The increase of average and extreme temperatures, especially in urban heat islands with their simultaneous dense transport networks, requires suitable measures to ensure driving ability and safety and comfort of use of all means of transport. Furthermore, comfort is a key factor for the acceptance of climate-friendly public transport. The expected higher temperatures must also be considered in the planning and building of transport infrastructure. Especially in urban areas, contributions to the

¹⁴³ According to responses from experts during the evaluation of the national adaptation strategy.

¹⁴⁴ Link: [Österreich unterwegs 2013/2014](#)

reduction of the heat island effect are necessary (e.g., removal of sealed transport surfaces through measures to reduce traffic).

- There is also need for adaptation with regard to the increasing risk of heavy rain, above all for constructional infrastructure. In addition, measures in the surroundings of transport routes can reduce or avoid the impacts of heavy rainfall (see Chapter 2.3 Water resources and water management and Chapter 2.7 Protection against natural hazards).
- Numerous adaptation measures in this sector are closely connected to mitigation measures. For instance, increased efficiency of land use can in many cases support effective adaptation (e.g., planting trees after dismantling, reducing parking spaces, cycle paths instead of parking lanes etc.). The use of area efficiency is supported by the COIN project (Cost of Inaction – Assessing Costs of Climate Change for Austria, Steininger et al. 2015), since the significant control parameter for future direct costs is the growth of the transport network. In the adaptation strategy, the emphasis is on adaptation measures. However, it is generally recommended that the goals of climate protection and adaptation to climatic change should be considered together, i.e., measures should be developed that support achieving both goals.

2.11.2.1 FURTHER EXPANSION OF INFORMATION AND EARLY WARNING SYSTEMS

Objective	Implementation of the precautionary principle for transportation infrastructure in the case of extreme weather events.
Significance	<p>Despite the expected increased frequency of extreme weather events, the time and place of specific events can only be forecasted in the short term. The expansion of information and early warning systems therefore depends on all other recommendations for action in this sector, particularly with recommendation 2.11.2.8 (Research on adaptation to the consequences of climate change in the area of transportation infrastructure).</p> <p>To avoid or reduce damages to transport infrastructure and protect people, a timely preparation before extreme weather events is necessary from several points of view. This includes knowledge about the possible impacts, organisational and technical measures, as well as the qualified training of the relevant actors, provision of sufficient resources and broad inclusion of the general public. The content and significance of the information and early warning systems must be sufficiently conveyed. For this it appears to be important, in particular, to develop regional threshold values, above which traffic interruptions or damages to infrastructure can be expected. This pertains to duration and intensity of precipitation with regard to slides, peak wind speeds, wet snow or ice loads with regard to wind throw or branches and trees falling, as well as temperature or humidity with regard to surface damages.</p> <p>The effectiveness of information and early warning systems depends, on the one hand, on the recipients of the information and, on the other hand, on the clear regulation of tasks. In addition, the large surface extent (across administrative boundaries) of transport infrastructure requires coordination.</p>
Connection to other sectors	Basically there are connections to all other sectors, particularly to protection from natural hazards and disaster management.
Connection to existing instruments	Large transport operators, such as ÖBB or ASFINAG, have good information and early warning systems (e.g. the ÖBB in the case of floods and fires; the ASFINAG with a weather forecasting programme, in particular also for winter services, including an automatic alarm for extreme weather events).
State of implementation	Transport operators have information and early warning systems that are being continually expanded.

Recommended further steps	<p>The traffic information service¹⁴⁵ in Austria provides information on traffic events across the road network, including traffic news (traffic jams, accidents, slippery roads, building sites etc.). Users receive continual information about the current traffic situation, as well as a forecast of the traffic situation, and can thus plan individual trips (car, bicycle) more safely and efficiently.</p> <ul style="list-style-type: none"> – Development of a catalogue covering experiences with vulnerability in the past, which can be used to support decisions about new investments (partially available at ASFINAG and federal state governments or known in the ÖBB) for road sections; in Scandinavian countries, risk maps for roads are available and would be possible in Austria on the basis of new maps for landslide threats, An example for this was developed for Styria in the adapt2to4 project (König et al. 2014b); – Implementation of the existing foundations and further research in response to knowledge about the development of climatic change; – Development of a monitoring system for extreme weather events (including information about climate variables such as precipitation etc.) and continuous evaluation (costs of damages, uniform, nationwide direct and indirect electronic recording); – Implementation of technical and organisational measures in the case of extreme events (plans of action etc.); – Introduction of rules for responsibility and obligations for support; – Training of personnel of the infrastructure operators, also at the level of federal states and communities; – Information for the general public related to particular events; – Consideration of back-ups in extreme situations; – With respect to heat waves, an exchange with our southern neighbouring countries should take place.
Possible resource requirements	The provision of resources is required for continual monitoring and for merging data.
Possible conflict potential	No conflict potential could be identified.
Actors	Federal and state governments, municipalities, operators of transportation infrastructure, university and non-university research institutions, universities of applied science, meteorological institutions and companies (e.g., ZAMG, AustroControl).
Time horizon	The implementation should take place over the short (to medium) term.

2.11.2.2 SAFEGUARDING A FUNCTIONAL TRANSPORTATION SYSTEM

Objective	Adaptation of transportation infrastructure to secure a functioning and climate-friendly transportation system and to secure the provision of supplies to the general public under changed climate conditions (in particular extreme precipitation events and changed potentials for natural hazards) as well as avoidance of disruptions/interruptions of services and the resulting follow-on effects (losses of time in passenger traffic, interruptions of production due to disruptions of freight traffic).
Significance	Transport infrastructure must be adapted to changed climatic conditions (e.g., increase of very hot days and of the temperature on the hot days, increase of heavy rain events). Numerous technical possibilities are available to support transport infrastructure that is more robust to climatic change, which ultimately also have lower vulnerability. Especially transport requires, however, the best possible coordination between adaptation and mitigation goals. The reasons for this are:

¹⁴⁵Link: <http://www.verkehrsauskunft.at>

- Transport infrastructures react very slowly and determine the selection of means of transport over a long period of time;
- Cleverly combined adaptation and mitigation strategies for transport infrastructure (e.g., expansion of the environmental alliance) promise, especially in urban areas, higher additional benefits for human quality of life given the projected increase of heat stress.

The form of the transport infrastructures significantly determines the framework conditions for settlement areas and regions. The current very low transport costs increase the distances that are travelled. In addition, the expansion of the network increases the risk of damages as a result of climatic change.

In the design of transport infrastructure, spatial planning laws play a significant role through interventions, e.g. making the life functions that are spatially relevant (living, working, supply, recreation etc.) better connected (principle of short distances) and reachable with public transportation.

Connection to other sectors

There is a close connection in particular to health, spatial planning, construction and housing, ecosystems/biodiversity, economy, tourism, protection from natural hazards and disaster management.

Connection to existing instruments

There are connections to the framework plan of the ÖBB for 2017-2022, the ASFINAG infrastructure investment programme 2016 for the next six years and Zielnetz 2025+ for the ÖBB railway track infrastructure, instruments of regional planning, building regulations; regional transportation concepts and the Connecting Europe Facility (formerly TEN-T policy) of the EU. The catalogue of measures in the national flood risk management plan (BMLFUW 2016a) refers to the consideration of hazard zone plans also as a measure for transport infrastructure planning with simultaneous positive impacts with respect to adaptation to climatic change¹⁴⁶.

State of implementation

Relevant national framework plans do not pay any special attention to adaptation to climatic change (in contrast to mitigation of climatic change)¹⁴⁷.

The European Connecting Europe/TEN-T Guideline¹⁴⁸ focuses on seamless east-west and north-south connections (nine corridors), as well as intermodality and compatibility in rail transport in particular, while the impacts of climatic change and adaptation are implicitly considered under safety aspects.

The European Committee for Standardization (CEN) carried out a first review of European norms with regard to adaptation requirements in the transport infrastructure, construction and housing and energy sectors. Together with CENELEC (European Committee for Electro-Technical Standardization) CEN published guidelines regarding the consideration of adaptation to climatic change in norms (CEN & CENELEC 2016).

The significance of shade provision in public (transport) space has been well studied. An example is the ACRP project STOPHOT (Arnberger 2014)¹⁴⁹. Topics of the study included possible improvements of the living conditions of older people during hot periods in Vienna. Older people appear to be doubly threatened in this regard: not only with respect to physical health but also because participation in social life is more difficult during hot periods.

From many proposed measures, those affected found that shadow-providing objects in public spaces were the most important. For this, among several alternatives, the preference was for an appropriate stock of trees.

Recommended further steps

Freight and passenger traffic on the local to supra-regional level

¹⁴⁶ Link: <https://www.bmnt.gv.at/wasser/wasser-eu-international/Nationaler-Hochwasserrisikomanagementplan.html> .

¹⁴⁷ Generalverkehrsplan, Rahmenplan ÖBB 2016–21, Ausbaustrategien Bundesverkehrsinfrastruktur 2013–18, Evaluierung ASFINAG Autobahnen/Schnellstraßen, ASFINAG Investitionsprogramm

¹⁴⁸ Link: https://ec.europa.eu/transport/themes/infrastructure/ten-t-guidelines/legal-basis_en

¹⁴⁹ <https://www.klimafonds.gv.at/wp-content/uploads/sites/6/03032015STOPHOTArne-ArnbergEBACRP3-B068678-K10AC1K00025.pdf>

Effective measures for the creation of transport infrastructure that is more resistant to climatic change are the reduction of the amount of traffic, the use of surface-efficient modes of transport and the more efficient use of existing transport infrastructure and thus the reduction of demand for additional transport infrastructure. The reduction depends in the long term both on building regulations and on the fiscal framework conditions.

- Development of reference cards on all relevant risks of interruption or damage (mud slides, wind throw, storms etc.);
- Assessment of the indirect effects of interruptions in transport networks, show especially important artery connections and access roads relevant for supply, for which circumvention is impossible or would take a long time; from that develop regional adaptation priorities;
- Production of emergency plans for road interruptions considering clearing, supply and management of diversions;
- Connection of public institutions (e.g., hospitals, public authorities, schools) to the public transportation network;
- Integration of aspects of adaptation (and also climate change mitigation) into all investments in transport infrastructure and review of investment plans with regard to inconsistencies with adaptation requirements and climate protection goals;
- In the case of proven vulnerability: maintenance or expansion of alternative structures (e.g., rail tracks, waterways, cycling, walking, public transportation);
- Development of infrastructure for multimodal transport;
- Strengthened interconnections between modes of transport to reduce vulnerability (establishment of multimodal transport nodes in accordance with the EU White Paper “Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system”¹⁵⁰);
- Public relations efforts on climatic change and transport/mobility;
- Integration of climatic change and transport/mobility in the training of experts and stakeholders (universities, universities of applied sciences, public authorities etc.);
- Proof of the effectiveness through simulations, implementation of demonstration projects and monitoring.

Local and regional passenger transport

- Adaptation of the infrastructure to improve public transportation;
- Preferential treatment of the selection of climate-friendly means of transport through local measures to reduce transport;
- Promotion of the principle of the shortest distance;
- Develop and improvement of footpaths and cycle paths through elements that shade or otherwise protect from weather (e.g., trees, arcades, drinking fountains);

Regional and supra-regional passenger transport

- Strengthened use of technical possibilities, e.g., for the establishment of teleworking or video conferences (considering social aspects), in order to reduce traffic volume.

¹⁵⁰ WHITE PAPER Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system

Possible resource requirements	The amount of resources differs according to the measures. For example, the planning of infrastructure adapted to climatic change requires a significant effort by professionals with the relevant expertise. The resource intensity for the implementation of the recommendations differs according to the measure, but some recommendations can be implemented without using a lot of resources.
Possible conflict potential	The development of infrastructure can lead to conflicts with nature protection but there are continual efforts to minimise them. Further conflicts of interest can arise, for example, through the sharing of the adaptation costs or additional personnel resources.
Actors	Federal and state governments, Federal Transport Agency, municipalities, operators of transportation infrastructure, planning firms, developers, businesses.
Time horizon	Some points could be implemented in the short term (e.g., public relations work); medium to long term/permanently (e.g., embedding in spatial planning instruments).

2.11.2.3 ENSURING THERMAL COMFORT BY REDUCING THERMAL LOADS IN PUBLIC TRANSPORT STATIONS AND THEIR VICINITY

Objective	Reduction of thermal loads in built-up areas and modes of transport, as well as public transport stations and industrial and commercial buildings.
Significance	Means of transportation (especially those using fuels) release large amounts of waste heat from propulsion, air conditioning and lighting. This adds to the heat burden of densely built-up areas that have poor ventilation. In addition, it is necessary to reduce the expected increase of heat stress as a result of climatic change through measures in the surroundings of the transport stations and means of transport using greening and shading. The reduction of thermal loads is thus a further significant building block in ensuring thermal comfort.
Connection to other sectors	There is a connection to energy, construction and housing, health, spatial planning, economy and tourism.
Connection to existing instruments	There are connections to building regulations and regional transport plans.
State of implementation	Measures to reduce thermal loads from transport are not included in the framework plans of BMVIT or in regional planning instruments.
Recommended further steps	<ul style="list-style-type: none"> – Development and support of technologies that protect climate (e.g., low emissions), that release less waste heat and are less dependent on weather conditions (e.g., use of airflow cooling in vehicles, surfaces that allow infiltration in ancillary facilities); – Shading and, where possible, greening of waiting areas in public transportation and operations buildings; – Greening of tram lines and the surroundings to improve the microclimate; – Support of protection against weather for public transportation passengers through the construction of shelters; – Reduction or calming of motorised private traffic in densely built areas to reduce thermal loads; – Lighting of equipment, airports, stations etc. depending on the availability of daylight; – Development of infrastructure for e-mobility, electricity from solar systems; – Development of concepts: demonstration of effectiveness using simulation, implementation of demonstration projects and monitoring; – Implementation and use of the eco-design directive (e.g., for street lighting);

	<ul style="list-style-type: none"> – Use of energy efficiency criteria in the planning of transport infrastructure and transport stations; – Development of corresponding requirements for the construction of transport stations and operations buildings.
Possible resource requirements	Individual measures have differing resource requirements and these cannot be defined at present.
Possible conflict potential	Measures for reducing transport or also thermal loads can lead to conflicts due to a lack of acceptance by the general public.
Actors	Transportation service operators, real estate developers, IT planners, device developers, federal and state governments.
Time horizon	The implementation should take place in the short to medium term.

2.11.2.4 REDUCTION OF POTENTIAL HEAT STRESS FOR PASSENGERS AND PERSONNEL IN PUBLIC TRANSPORTATION THROUGH APPROPRIATE AIR CONDITIONING

Objective	Maintaining operational safety and comfort of use in public transport under heat loads.
Significance	<p>The increase of the speed and the increased use of tunnels for rail transport mean that train windows that can be opened are being replaced by full air-conditioning of the carriages. A failure of the air-conditioning can endanger the health of passengers and personnel, as was seen in the summer of 2010.</p> <p>Also in local public transport – with the numerous occasions where the doors are opened – the effectiveness of air conditioning is limited. As a result, besides the reduction of waste heat inside and passive, architectural cooling strategies, further measures to avoid heat are advisable. However, attention must be paid to the avoidance of conflicts with climate protection.</p>
Connection to other sectors	There is a connection to health, energy, economy and tourism.
Connection to existing instruments	The requirements for air-conditioning in public transportation are regulated by EU standards (e.g., <i>EN 13129-1:2002</i> for trains).
State of implementation	Public transport vehicles are often air-conditioned (independent of type of transport or operator); the European standards are partially adapted to the increase of temperatures (e.g., in trains).
Recommended further steps	<ul style="list-style-type: none"> – Further development of the air-conditioning of public transportation vehicles while minimising the resulting emissions of greenhouse gases and thermal loads for the surroundings, i.e., through smart use of insulation and ventilation techniques; – Timely and needs-oriented air-conditioning of vehicles before departure through training the personnel; – Further development of the reliability of air-conditioning systems; – Development of rules of conduct for fleet operators when air-conditioning fails; – Development of emergency systems; – Provide long-distance traffic with emergency air-conditioning; – Ensure sufficient availability of drinking water in vehicles and at transport nodes; – Research for the development of cooling systems that are environment- and climate-friendly; – Simulation of operational conditions under high temperatures; – Promotion of adaptation through individual responsibility through awareness raising (e.g., taking your own drinking water, clothing suitable for the weather

	<p>conditions) – supplementary to tried and tested emergency plans of the transport companies;</p> <ul style="list-style-type: none"> – Development of appropriate requirements for vehicle equipment in tenders or direct award of contracts for transport services of the federal government or federal states; – Consideration of climatic change in new calls for tender, so that the producers can react to the new requirements; – Creation of alternative offers through development of public transportation.
Possible resource requirements	Costs and/ or energy demand are high for both changes of infrastructure and in operations.
Possible conflict potential	Conflicts with climate protection goals could arise, because air-conditioning is connected with high energy consumption. However, it should be kept in mind that any loss of comfort while using public transportation could lead to a switch to using motorised private transport, which would significantly increase the emissions of greenhouse gases overall. For this reason, a small increase of energy demand for the cooling of public transport vehicles or the transport infrastructure for public transportation (e.g., stations) can nevertheless lead to a reduction of the total emissions.
Actors	Federal government, public transport operators, infrastructure providers, educational institutions, state governments, municipalities, manufacturers of public transport vehicles.
Time horizon	The implementation should take place in the medium term.

2.11.2.5 REVIEW AND, IF NECESSARY, ADAPTATION OF LEGAL STANDARDS FOR THE CONSTRUCTION AND OPERATION OF TRANSPORT INFRASTRUCTURE UNDER CHANGED CLIMATIC CONDITIONS

Objective	Adaptation of laws, norms, and guidelines on the impacts of climate change in order to avoid damage to transport infrastructure.
Significance	<p>To be efficient the starting point of every adaptation should be an evaluation of existing instruments (e.g., standards, guidelines, laws, strategies, working groups). In many cases, existing mechanisms can be very effective for adaptation, if small adjustments are made. The existing building standards assume constant environmental conditions and largely reflect the past situation. Forward-looking building, operating and renovating of transport infrastructure requires, however, consideration of expected future developments. As a result of climatic change and its impacts on buildings and operation of transport infrastructure, adaptations are necessary.</p> <p>In order to align existing legal norms with the possible impacts of climatic change, research (see Chapter 2.11.2.8: Research on adaptation to the consequences of climate change in the area of transportation infrastructure) and the expansion of the basis of information (see Chapter 2.11.2.1: Further expansion of information and early warning systems) must be further accelerated.</p>
Connection to other sectors	For the construction of operations buildings there is an important connection to the recommended action of Chapter 2.6.2.6: Adaptation of building standards and norms to climate change (construction and housing sector).
Connection to existing instruments	There are connections to the guidelines and directives for the rail and road sectors, to the technical specifications for interoperability (TSI), as well as to further technical guidelines such as Austrian norms, European norms etc.
State of implementation	In some standards/regulations at the EU level aspects regarding adaptation to climatic change were introduced (e.g., TSI).
Recommended further steps	<ul style="list-style-type: none"> – Legal introduction of a nationwide registry of damage for all transport infrastructures;

	<ul style="list-style-type: none"> – Making available a uniform list of all bridges in Austria with all construction information to estimate the risk of log/debris jams and backwater formation; – Calculation of the summer suitability of transport infrastructure on the basis for future temperature levels (adaptation of climate datasets); – Calculation of heat loads (avoidance of over-dimensioning of heating systems); – Adaptation of the requirement norms to the higher physical pressures through, for example, more frequent floods, larger flood peaks or extreme heat impacts; – Make planting, care and management of tree populations along transport routes more resistant to storms, e.g., through the selection of tree species and the height of growth, especially for protective forests around objects; – Address the topic of climatic change and adaptation to its impacts in amendments to the building regulations of the federal states and in the standardisation bodies; – Development of adaptation requirements separately for new buildings and renovation. <p>The adaptation of existing legal norms should cover the following areas:</p> <ul style="list-style-type: none"> – New assessment of physical structures (water inlets, canals, infiltration areas, flood safety of transport facilities etc.) in specifically defined cases; – Dimensioning of the fortifications (anchoring) of transportation facilities (e.g., traffic lights, signposts, street lighting); – Structural regulations for critical constructions (power lines, network configuration, overhead signposts etc.).
Possible resource requirements	The implementation of adapted norms inherently requires significant resources and long periods of time.
Possible conflict potential	Possible over-regulation because of limited (also local) certainty of assumptions contradicts the long period of use of transport infrastructure facilities.
Actors	Federal and state governments, standardization authorities, Austrian Institute of Construction Engineering (OIB), Austrian Association for Research on Road – Rail – Transport (FSV).
Time horizon	The implementation should take place in the medium to long term.

2.11.2.6 CONSIDERATION OF MICRO- AND MESO-CLIMATIC CONDITIONS IN URBAN AND OPEN SPACE PLANNING

Objective	Ensuring thermal comfort through adapted infrastructure planning as part of urban and open space planning.
Significance	Since transport areas are 20-40% of the total area, they have a very decisive influence on the micro- and meso-climate. A stronger consideration of micro- and meso-climatic conditions in the planning of infrastructure can make a significant contribution to adaptation to climatic change.
Connection to other sectors	There is a connection in particular to spatial planning and cities – urban green and open spaces. There are also interfaces to health, construction and housing, water management, tourism and the economy.
Connection to existing instruments	Local spatial planning (zoning and development plans), ÖREK 2011 - Austrian Spatial Development Plan 2011(ÖROK 2011).
State of implementation	The third pillar of the Austrian Spatial Development Plan 2011 (ÖREK 2011) covers the topic of climatic change, adaptation and resource efficiency. Measures are proposed (e.g., creating or maintaining open spaces).

Recommended further steps

The EU project “GRaBS” (financed by INTERREG IVC) provides good practice examples for planning that considers local climatic conditions (the city of Graz is involved as a partner).

- Development of urban climate concepts (perhaps obligatory in the long term for towns/cities with a resident population of 50,000 or more) considering the following aspects:
- Development of microclimate cadastres (e.g., heat islands, fresh air corridors, wind comfort);
- Simulation of traffic volume, climatic trends;
- Implementation of adaptation measures, above all in “hotspots” (e.g., greening, water areas);
- Development of a catalogue of measures (e.g. on the share of green, on building materials) for affected urban areas.
- Use of brighter surface materials that absorb less radiation to reduce the heating that leads to weakening of material (ruts in the road) and pressure on the surroundings (heat release);
- Consideration of human behaviour in the development and zoning plans with regard to later use of infrastructure and the energy consumption for mobility;
- Consideration of micro- and meso-climatic conditions in the regional planning laws of the federal states and in the development of urban development plans;
- Traffic reduction in motorised private vehicles and removal of parking spaces to improve the microclimate and reduce the heat load and creation of alternative offers through the expansion of public transportation;
- Basic research; concept development.

Possible resource requirements

It is not possible to estimate resource requirements at present.

Possible conflict potential

Conflicts could arise due to economic interests in particular within the framework of urban development.

Actors

State governments, municipalities, planning firms, meteorologists, traffic participants.

Time horizon

The implementation should take place in the short to medium term.

2.11.2.7 REDUCTION OF THE INCREASE IN PERMANENTLY SEALED SURFACES FOR TRANSPORT INFRASTRUCTURE AS FLOOD PROTECTION

Objective

Reduction of excessive sealed surfaces in transportation infrastructure to reduce/prevent local flooding.

Significance

Oversized transport surfaces (e.g., oversized highways next to motorways) provide a considerable potential for removing the surface sealing. Often the areas remain sealed after the loss of their function, because there is no legal requirement to remove the sealing. However, removing the sealing would increase the water retention of the surface and avoid or effectively reduce local flooding.

Therefore, the avoidance of further surface sealing and the removal of sealing should be prioritised. Only afterwards should alternatives (e.g. the use of permeable materials) be used. Compensation measures should be used as a final option.

Land consumption and sealing continue at a high level. In Austria, the daily drawdown of the land surface through settlement and transport areas during the period 2012-2014 averaged 19.1 ha/day. The daily use for building and transport areas was 6.3 ha/day during this period (Umweltbundesamt 2015b, 2016). If one calculates the sealing, which is the covering of the soil with a layer that is impermeable for water, the average level of sealing in Austria is 56% of the area used until 2014 for settlement and transport (Umweltbundesamt 2016).

Connection to other sectors	There is a close connection above all to spatial planning, construction and housing, protection from natural hazards and disaster management.
Connection to existing instruments	There are connections to transport planning instruments and the third pillar of the Austrian Spatial Development Plan (ÖREK 2011).
State of implementation	In new construction projects of the ASFINAG, extensive water protection systems are included, which make retention of collected surface water possible. Also in the area of the existing road network of ASFINAG extensive renovation projects are currently being carried out with regard to water regulations, which lead to an improvement of the situation.
Recommended further steps	<ul style="list-style-type: none"> – Review and, if necessary, adaptation of existing instruments (e.g., determination of maximum levels of sealing in building regulations); – Development of incentives for keeping surfaces open (e.g., compensatory measures for sealed transport and building surfaces in settlement areas); – Preference for infiltration areas rather than sealing in the new development of parking areas; – Efforts should be made to allow the infiltration of rainwater that has fallen on roofs and transport surfaces after required cleaning when permeable ground is available; – Development or consideration of climate policy goals in support programmes, to promote the removal of sealing and adaptation of the road infrastructure; – Limitation of further urban sprawl, since this both directly (construction of settlements) and indirectly (demand for transport infrastructure) leads to surface sealing.
Possible resource requirements	Resources could be required for financial support for renaturalisation of sealed surfaces, support measures and financing of roads.
Possible conflict potential	Because of the demands for land area, conflicts are possible with spatial planning (settlement development).
Actors	Federal and state governments, municipalities, operators of transportation infrastructure, developers, land owners.
Time horizon	The implementation should take place in the short to medium term.

2.11.2.8 RESEARCH ON ADAPTATION TO THE CONSEQUENCES OF CLIMATE CHANGE IN THE AREA OF TRANSPORTATION INFRASTRUCTURE

Objective	Improving the knowledge base with the goal of optimised adaptation to the consequences of climate change.
Significance	<p>Scientific findings close knowledge gaps with regard to the development of adaptation and mitigation measures.</p> <p>Research is needed on numerous topics. To achieve the best possible results, dual research is needed (i.e., the further development of existing systems, but also pilot projects with future technologies).</p>
Connection to other sectors	Research activities with an interdisciplinary approach should be coordinated in particular with protection from natural hazards, disaster management, spatial planning, health and ecosystems/biodiversity.
Connection to existing instruments	Research support programmes (e.g., EU, Austrian Science Fund (FWF), Austrian Research Promotion Agency (FFG), Austrian Climate and Energy Fund), CEDR (Conference of European Directors of Road), commissioned research on particular topics, scholarships, performance agreements with universities.

State of implementation

Relevant research projects were and are carried out within the framework of the Austrian Climate Research Programme of the Austrian Climate and Energy Fund (e.g., adapt2to4, COIN). However, the introduction of scientific findings into practice is usually delayed and/or limited.

Relevant research findings are also provided by EU projects, such as EWENT¹⁵¹ and WEATHER (Weather Extremes: Impacts on Transport Systems and Hazards for European Regions)¹⁵², ECCONET (Effects on climate change on the inland waterway networks)¹⁵³ und MOWE IT¹⁵⁴, which looks at the adaptation of various modes of transport to climatic change and extreme weather events.

Furthermore, the following research was commissioned by CEDR (Conference of European Directors of Roads): ROADAPT (Roads for today, Adapted for tomorrow)¹⁵⁵ and CLipDaR (Design guideline for a transnational database of downscale Climate Projection Data Road impact models)¹⁵⁶. Within the framework of the previous organization ERA-NET ROAD¹⁵⁷ the following projects were carried out: IRWIN (Improved local Winter Index to assess Maintenance Needs and Adaptation Costs in Climate Change Scenarios), P2R2C2 (Pavement Performance and Remediation Requirements following Climate Change), RIMAROCC (Risk Management for Roads in a Changing Climate) und SWAMP (Storm Water prevention – Methods to Predict Damage form the Water Stream in and near Road Pavements in lowland Areas).

Recommended further steps

- Promotion of research and development, amongst others in the following areas:
- Regional consequences of climatic change (e.g., improvement of models, regionalisation of results, data bases for norms);
- Indirect economic consequences of traffic interruptions, including, for instance, traffic simulations of the costs of loss of time and interruptions in supply chains/ production interruptions;
- Bioclimatology and microclimate (e.g. comfort conditions in vehicles, heat island effects, improvement of the microclimate);
- Building methods and materials adapted to the consequences of climatic change, identification of critical operating conditions, energy economic analyses, cost-benefit analyses;
- Implementation and social questions (e.g., effectiveness of policy instruments, networking of infrastructure operators, barriers to implementation, behaviour of those affected);
- Traffic infrastructures and technologies;
- Opportunities through climatic change.
- Development and practical testing of transnational systems in particular for rivers with floodplains that cross country borders (e.g., March) ;
- Simulation of extreme weather scenarios with and without adaptation measures;
- Optimisation of acceptance of (and compliance with) early warning systems;
- Implementation of innovative technologies (e.g. sensors in or in the surroundings of infrastructure) in order to take advantage of digital possibilities and increase the resilience of the infrastructure;
- Promotion of national and international exchange of experience.

¹⁵¹ Link: <http://ewent.vtt.fi/>

¹⁵² Link: <http://www.weather-project.eu/weather/index.php>

¹⁵³ Link: <https://www.danube-navigation.eu/projects/econet-effects-of-climate-change-on-the-inland-waterway-networks>

¹⁵⁴ Link: http://cordis.europa.eu/project/rcn/104378_de.html

¹⁵⁵ Link: <http://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2012/call-2012-climate-change-road-owners-adapting-climate-change/roadapt-project-results/>

¹⁵⁶ Link: <http://www.cedr.eu/?s=CLipDaR>

¹⁵⁷ Link: <http://www.cedr.eu/era-net-road/>

Possible resource requirements	For research on open questions, existing support sources could be used.
Possible conflict potential	Research can contribute to the finding and solving of conflicts.
Actors	EU, CEDR (Conference of European Directors of Road), federal government, research funding agencies (e.g., Climate and Energy Fund, FWF – Austrian Science Fund, Austrian Research Promotion Agency (FFG)), academic and non-academic research institutions.
Time horizon	Implementation should take place in the short to medium term.

2.11.2.9 PILOT PROJECTS ON TRANSPORTATION INFRASTRUCTURE ADAPTED TO CLIMATE CHANGE

Objective	Demonstration of the feasibility of climate-change adapted transportation infrastructure.
Significance	Successfully implemented projects are much more convincing than political appeals or just information. It is therefore important to demonstrate the feasibility and also the advantages of relevant concepts. This concerns concrete technical or structural solutions, which spread as widely as possible (thematically and spatially). In this connection, it is important that the experience from these pilot projects is also widely accessible. This can be achieved through reports in the internet or newsletter, information campaigns etc.
Connection to other sectors	There is a close connection to protection from natural hazards, disaster management, spatial planning, Cities – urban green and open spaces, construction and housing, health and ecosystems/biodiversity. This recommended action is closely connected to Chapter 2.11.2.8: Research on adaptation to the consequences of climate change in the area of transportation infrastructure and Chapter 2.11.2.10: Improved public information methods.
Connection to existing instruments	Initiatives such as klimaaktiv show numerous examples with great effect in the area of climate protection. Within the framework of klimaaktiv the topic of mobility is also discussed.
State of implementation	klimaaktiv focusses on climate change mitigation; adaptation was not considered so far.
Recommended further steps	<ul style="list-style-type: none"> – Development of adaptation measures that are suitable for practice and can be transferred (e.g., settlement and transportation infrastructure); – Consideration of microclimatic conditions in the demonstration projects (consideration of the surroundings); – Addition of accompanying research (monitoring, cost-benefit analyses, social science accompanying research); – Strengthened cooperation of research, administration and infrastructure operators; – Implementation of information campaigns: The results of the demonstration projects must be prepared in a way that has a public affect and can be disseminated.
Possible resource requirements	Resource requirements cannot be provided at present.
Possible conflict potential	No conflict potential has been identified.
Actors	EU, federal and state governments, research funding agencies (Climate and Energy Fund, FWF – Austrian Science Fund, Austrian Research Promotion Agency (FFG)), academic and non-academic research institutions, innovative real estate developers/builders.

Time horizon | The implementation should take place in the short to medium term.

2.11.2.10 IMPROVED PUBLIC INFORMATION METHODS

Objective	Generating acceptance for necessary actions and dissemination of knowledge on the subject of adaptation to climate change in the transport sector.
Significance	<p>Even though climatic change and its consequences are covered by the media, the discussion about appropriate adaptation is new and not well established in public and political discourse. The two topics of climate change adaptation and climate change mitigation are still mixed up. Strengthened and targeted public relations work can remedy this.</p> <p>Symbols and “Ambassadors” can convey messages well, e.g., a tree instead of a car. Since people are mostly sensitised during an actual event (e.g., a heatwave), suitable campaigns should be prepared ahead, so that they are ready to be implemented when an event occurs.</p>
Connection to other sectors	Public relations work is enormously important for all sectors and should therefore be carried out with close cooperation and across sectors.
Connection to existing instruments	<p>National and regional programmes and public relations activities (e.g., klimaaktiv, Klimarettung, Climate Alliance etc.); Cooperation with NGOs.</p> <p>The existing newsletter of the Environment Agency Austria on climate change and adaptation can be used and made available to a wider circle (e.g., schools).</p> <p>Cooperation with educational institutions, media etc. serve as multipliers.</p>
State of implementation	The newsletter Klimawandelanpassung is an important communication tool, which deals with the fast-growing topic of adaptation to climatic change in Austria (https://www.klimawandelanpassung.at).
Recommended further steps	<ul style="list-style-type: none"> – Strengthened awareness-raising about climate change (e.g., the difference between weather and climate), about climate change mitigation and about adaptation to the consequences of climatic change; – Information about necessary planning and construction adaptation measures in the transport sector and about useful individual behavioural changes; – Development of targeted public relations campaigns that use various channels and address regional features and concerns. It is important to generate individual concern; – Development of information campaigns on particular topics before events occur (e.g., heat waves).
Possible resource requirements	Considerable financial, personnel and organisational resources are required, since the state of implementation is still very low.
Possible conflict potential	<p>When climate mitigation and adaptation are not considered together.</p> <p>The stimulation of societal and political rethinking fundamentally harbours conflict potential. Specifically, conflicts of interest with business and industry lobbies are possible.</p>
Actors	NGOs, NPOs, federal and state governments, municipalities, schools, universities, interest groups, the media, individuals.
Time horizon	The implementation should take place as soon as possible at the individual and societal levels.

2.11.2.11 TRAINING AND FURTHER EDUCATION ON ADAPTATION TO THE CONSEQUENCES OF CLIMATIC CHANGE IN THE AREA OF TRANSPORTATION INFRASTRUCTURE

Objective	Advancement of knowledge on adaptation to the effects of climate change through the inclusion of relevant information in training and further education.
Significance	For an efficient implementation of adaptation measures, corresponding qualifications must be firmly established as widely as possible. A key role is played here by the tertiary educational sector (universities, universities of applied sciences). However the teaching content must also be integrated into training and further education programmes of the relevant professional groups and in general into school curricula.
Connection to other sectors	Training and further education on the topic of adaptation to climatic change are important in all sectors in order to be able to deal with the consequences of climatic change. In the integration of relevant teaching content, interactions with other sectors and recommended actions must be considered.
Connection to existing instruments	The connections are to the existing curricula for training and further education.
State of implementation	In school curricula, certain foundations for the topic of climatic change are foreseen. Focus areas should be supplemented accordingly.
Recommended further steps	<ul style="list-style-type: none"> – Adaptation of the curricula for architecture, urban and spatial planning, civil engineering, transport planning, open space planning and others; – Support for further education for persons active in the transportation sector; – Adaptation of school curricula; – Active integration into international activities; – Provision of personnel and material resources.
Possible resource requirements	For the integration of relevant teaching content in curricula, training material etc. the resource demand is relatively low.
Possible conflict potential	Conflicts could arise through scepticism regarding the content changes in curricula or training material.
Actors	Federal government, training and further education institutions, interest groups (chambers).
Time horizon	The implementation should take place in the short to medium term.

2.12 SPATIAL PLANNING SECTOR

2.12.1 OVERARCHING OBJECTIVE OF THE SECTOR

Overarching objective: Coping with the challenges of climatic change to secure a sustainable spatial development through strict use and further development of existing planning goals and instruments, as well as the conservation of ecosystem functions.

2.12.2 RECOMMENDED ACTIONS FOR THE SPATIAL PLANNING SECTOR

General principles for action in the spatial planning sector

– Adaptation of the legal framework

Climate change adaptation should be explicitly included as a goal and task of spatial planning or as the principle for planning in the laws of the federal states for spatial planning (BMVBS 2010b, CLISP 2011a, b, d, Pütz & Kruse 2011). Through this, the goals of climate change adaptation can be made available for the balancing of interests, contents of plans that are relevant for adaptation can be subjected to obligatory review by the supervisory authority, and a legitimisation and buy-in effect for consideration of adaptation aspects in the planning instruments at the regional and local planning levels can be created. A legally established mandate reflects a corresponding political commitment. The distribution of responsibilities should be combined with the corresponding provision of resources. The spatial planning goals and planning principles have a stronger immediate relevance for decision-making at the local planning level in those federal states in which there is a comparatively low intensity of regional planning. During the inclusion in the catalogue of goals or principles, attention must be paid to the integration of issues regarding climate change mitigation (e.g., energy efficiency, renewable energy supply etc.), i.e., early consideration of spatial planning conflicts and potential synergies between the two climate policy streams.

– Consistent application of the existing planning instruments for implementation of a sustainable spatial development and further development of the existing set of instruments with regard to adaptation to climatic change

Available and established spatial planning guidelines and goals, as they are laid down in the goals and principles formulations of most federal state regional planning laws, and which aim for an organised and sustainable development of settlements (amongst others, clustering and concentration of infrastructure, avoidance of urban sprawl, precaution against risks), contribute in many cases to both mitigation of and adaptation to climatic change. This is true, for example, for existing spatial planning tasks that aim for a compact, inward-oriented settlement development, an economical use of soil and building land, and protection from natural hazards. For instance, closed settlement structures can be protected from natural hazards using technical measures more efficiently and are advantageous for efficient energy supply. At the same time, settlement structures that use less space and the reduction of new demands for surface area (e.g., through consistent use of the principle of “inward development before outward development”), the reuse of abandoned areas or the closing of building gaps (BMLFUW 2009c, 2011d) also contribute to the safeguarding and reserving of potential spaces for various climate-relevant functions – such as natural flood retention areas, cold air spaces and corridors, ecological habitat corridors or groundwater accumulation areas. Thus, spatial planning can make significant contributions to adaptation to climatic change within the framework of existing goals and instruments. In many cases, this concerns measures that are economically and ecologically advantageous independently from climatic change or can bring advantages from several points of view (Birkmann et al. 2011).

An effective exploitation of available potential for adaptation to climatic change depends largely on effective implementation of existing spatial planning goals and on using existing instruments more consistently. To increase the power of enforcement of formal planning, amongst others the more frequent setting of binding goals for spatial planning, e.g., through the designation of priority areas, can make a contribution (BMVBS 2013). Furthermore, continuous further development of the set of planning instruments as well as their orientation towards and use for meeting climate goals are necessary (BMVBS 2013; CLISP 2011a, b).

– **Enabling the adjustment of planning and the adaptive capacity of the planning system**

A stable and reliable legal and planning system is a prerequisite for societal and economic development. On the other hand, adaptation to climatic change and existing scientific uncertainties about its regional manifestations require increased room for flexibility. Firstly, when improved knowledge about climatic changes or their spatially significant effects becomes available, it should be possible to adjust planning and development goals. This could be achieved, for example, by considering a certain range of possible developments when formulating and implementing planning goals and measures and leaving several options for spatial use open. This can be done, for example, through fixed-term, staged and conditional specifications in the sense of precautionary planning (such as the designation of reserved areas, which can be upgraded to priority areas at a given time), but the possibility to introduce such a flexibilisation of planning specifications should be legally regulated (BMVBS 2013; Birkmann et al. 2010). On the other hand, the design of planning instruments, including their application practice, should itself be adjustable in the short term. Through a limited and moderate flexibilisation of the planning, the risk of maladaptation can be reduced.

– **Long-term planning beyond the review cycle**

In order to cope with the challenges of climatic change in the long term, it is necessary to plan beyond the usual planning horizons of spatial planning (intervals of planning revision about 10-15 years). In doing this, the spatial development goals and strategies should be designed so that they also consider the possible future impacts of climatic change and enable later adaptation measures (ARL 2010). For this, strategic planning instruments on the regional and local level thus have a greater significance.

– **Strengthened horizontal and vertical cooperation**

Because of the necessary holistic and cross-sectoral approach for adaptation to climatic change and the many interfaces between spatial planning and space-relevant planning in other sectors, there is a general need for coordination. This is particularly the case for cross-sectoral legal and planning materials, such as protection from floods and natural hazards, which are characterised by a strict division of responsibility and tasks between the federal government, the federal states and the municipalities. The horizontal cooperation and networking of spatial planning with planning in other sectors, such as water management, torrent and avalanche protection, urban construction, meteorology etc., must therefore be supported (ÖROK 2005a; Fürst 2006; Pütz & Kruse 2011). First and foremost, the existing interfaces between the individual sectoral policies, their measures and approaches must be clearly defined and a common orientation must be promoted. For this, the Austrian Spatial Development Plan 2011 (ÖREK 2011) recommends “Round Tables” on sectoral and spatial policy (ÖROK 2011), which could also be established for climate-relevant questions.

In addition to a strengthened horizontal cooperation, the coordination between the planners at different planning levels should be strengthened (vertical planning coherence) and the inclusion of regional and local actors and planners should be supported. Only in this way can the willingness to

act be increased in the long term and the necessary steps towards a successful implementation be secured.

2.12.2.1 DEVELOPMENT AND PROVISION OF PRACTICE-RELEVANT DATA AND INFORMATION BASES, RAISING AWARENESS AND IMPROVED NETWORKING OF ACTORS

Objective	<p>Generation, provision, and transfer of improved spatially relevant knowledge about climate impacts and adaptation that is useful and directly usable in spatial planning decision-making processes;</p> <p>Increasing the willingness and ability to act among spatial planning actors and affected citizens in coping with climate change.</p>
Significance	<p>Strengthening support for spatial development adapted to climatic change, raising awareness and the availability, accessibility and transfer of practice-relevant knowledge are a significant basic prerequisite for adaptation and its implementation. A lack of specific know-how is one of the most frequent reasons for limited institutional and individual implementation capacities and acts as a significant barrier to adaptation to climatic change in practice (EEA 2014; Clar et al. 2013). Above all for spatial planning as a cross-cutting theme with coordinating and forward-looking tasks, comprehensive information relevant for decision making and knowledge transfer are essential for the avoidance of maladaptation. An improved networking of the actors both within and outside of spatial planning and on all levels (from the municipality up to the federal government) can contribute significantly to increasing adaptive capacity.</p> <p>The consideration of the impacts of climatic change in spatial planning requires, on the one hand, reliable data and, on the other hand, the translation of climatic impacts and adaptation knowledge into spatially relevant actions. Data, information and knowledge about climatic change consequences, adaptation needs and possible actions in Austria are available to a significant extent, but they are often not in a useable form for spatial planning. The findings must be prepared so that they are applicable in planning both for local and regional decision-makers and also as directly as possible. To support the actors responsible for implementation, tools (guidelines, handbooks, checklists etc.) must be prepared and training and advisory offers must be developed.</p> <p>For efficient implementation, relevant qualifications must be widely established and transmitted. For this, the education sector plays a key role. The topic of adaptation must be more strongly integrated into university education, but also in training and further education programmes.</p>
Connection to other sectors	<p>Cooperation with actors from many or all sectors can be necessary or advantageous (in particular regarding measures on networking, raising awareness and cooperation).</p>
State of implementation	<p>The topic of adaptation to climatic change is included in some cases in specialised training and further education but in total not systematically enough. Regarding knowledge provision, better networking of actors and the promotion of exchange of experience, considerable advances have been made in the spatial planning sector (BMLFUW 2015a). Uniform regional climate projections on the level of the federal states (e.g., Gobiet et al. 2012) and regionalised climate impact assessments are increasingly available; in addition, since 2016 high-resolution climate scenarios for Austria, produced in a project (Project ÖKS 15) commissioned by the federal government and the federal states, are available as a basis for spatial planning.</p> <p>First results regarding guidelines and tools are available from pilot projects. For example, the results of the CLISP project include guidelines, criteria and a checklist for planners to evaluate planning instruments and processes with respect to their ability to deal with climatic change (climate change fitness) (CLISP 2011c). A transnational strategy for consideration of climatic change adaptation in planning developed in the CLISP project contains guidance for the implementation on the regional level (CLISP 2011a).</p>

In the FAMOUS project, funded within the Austrian Climate Research Programme (ACRP) of the Austrian Climate and Energy Fund, together with decision-makers a handbook was produced for federal states, regions and cities with methods and tools for adaptation to climatic change (Prutsch et al. 2014), which also contains specific tools for spatial planning. The communication guidelines produced in the ACRP project CC-Talk (Prutsch et al. 2014) can be used for information on climate change adaptation in all sectors. In further projects, decision support tools and information material are currently being developed for various target groups, including spatial planning, for instance for the community level.

The programme of the Austrian Climate and Energy Fund that started in 2016 on climate change adaptation model regions provides a suitable framework to support knowledge transfer, communication and the networking of actors in regions and municipalities (KLIEN 2016).

The strategies for adaptation to climatic change of the federal states of Tyrol (Tir. LR 2015) and Styria (Stmk. LR 2015) include measures that are directly relevant for this recommended action (Tyrol: “Raising awareness of planners and municipalities through knowledge transfer about spatial structures and building methods adapted to climatic change”; “Development and provision of a climate module in the Tyrolean spatial information system”; Styria: “Awareness-raising measures and communication for consideration of the topic of adaptation to climatic change at all levels of planning, in particular with respect to municipalities and politics”). The climate change adaptation strategy of Upper Austria (Oö. LR 2013) envisages horizontal measures, which aim to strengthen cross-departmental research activities, the provision of basic material about climatic change and for planning adaptation and the intensification of awareness-raising and further education on climate change adaptation.

Recommended further steps

Improvement of the knowledge base

- Improvement of the data bases and a uniform basis of knowledge on regionalised climate scenarios, climate change impacts that are relevant for spatial issues and spatial planning and vulnerability, as well as their consideration in spatial planning (Pütz & Kruse 2011);
- Improvement of the usability of information about the consequences of climatic change for decision-makers in spatial planning; improved interface between knowledge generation from research on climate and impacts of climatic change and the specific information needs of spatial planning through dialogues between research and practice;
- Provision of spatially relevant information and data on climatic change, impacts and adaptation options to spatial planning actors, e.g., using digital spatial planning platforms or geographic information systems of the federal states, and in which, for example, regional planning associations take on the function of hubs and intermediaries to the municipalities (Tir. LR 2015; CLISP 2011a, b);
- Development of spatial monitoring systems with indicators relevant for climatic change, in order to permit an adaptive management of spatially relevant climatic change consequences (CLISP 2011b);
- Implementation of transdisciplinary research and pilot projects (e.g., within the framework of support programmes) to consider spatial planning authorities and actors.

Knowledge transfer

- Development and provision of support for work, planning and implementation as well as decision support tools for planning authorities, supervisory and authorizing authorities, municipalities and planners (e.g., guidelines, handbooks, checklists, standards), which provide instructions and support on how the topic of climate change adaptation should be treated and presented in spatial planning at different planning levels (Stmk LR 2015; CLISP 2011a,b,c) (See Chapter 2.12.2.12 – “Climate Proofing” spatial plans, development concepts, and projects with spatial impacts);

	<ul style="list-style-type: none"> – Provision of good practice examples for consideration of climate change adaptation in spatial planning; – Generation of specific information, advisory and educational offers; Consideration of topics relevant to climate in specialised training and further education.
	<p>Communication and awareness-raising</p> <ul style="list-style-type: none"> – Awareness-raising measures and targeted communication to consider the topic of adaptation to climatic change on all planning levels, in particular with regard to municipalities and property developers (based on a long-term, systematic and uniform communication strategy on adaptation to climatic change at the national level); – Targeted awareness-raising measures, information and advisory activities for property owners and citizens to improve the individual risk-awareness and to increase individual risk precaution.
	<p>Networking of actors</p> <ul style="list-style-type: none"> – Improved networking, cooperation and inclusion of actors as well as promotion of exchange of experience within spatial planning and with other areas, e.g., through the introduction of regular network meetings at the level of the federal states or regions or within the framework of the climate change adaptation model regions of the Austrian Climate and Energy Fund (KLIEN 2016); – Development and expansion of models and structures for regional governance of adaptation to climatic change, e.g. within the framework of the climate change adaptation model regions of the Austrian Climate and Energy Fund (KLIEN 2016);
Possible resource requirements	For the development and networking of the databases and the development of action guidelines, resources are necessary. Further financial resources are needed in particular for comprehensive regional vulnerability assessments by the research community.
Possible conflict potential	No potential conflict has been identified.
Actors	Federal and state governments, ÖROK, municipalities, planning and regional associations, interest groups, research institutions, planning firms.
Time horizon	Implementation of the measures in the short term is recommended, so that the implementation in planning practice becomes effective in the medium term.

2.12.2.2 ESTABLISHMENT AND PROTECTION OF FLOOD RETENTION AND DRAINAGE ZONES AND CLEAR REGULATION OF ZONING PROHIBITIONS AND RESTRICTIONS

Objective	<p>Protection of built-up areas from floods by securing and recovering natural flood plains and water retention areas; improvement of water retention in the catchment areas of rivers;</p> <p>Protection from flood-related damage by reducing peak flows and slowing waves of floodwater.</p>
Significance	<p>The maximum annual flood discharges have increased in the last 30 years in about 20% of the catchment areas of Austria, above all in smaller catchments north of the Alpine main ridge and in winter. In virtually no area have the floods decreased during this time period. Extensive extreme precipitation has increased since the 1980s. In 2002, 2010, and 2013 central Europe and Austria experienced massive, extensive flood events.</p> <p>Concrete statements about future changes of floods cannot be made with certainty on the basis of the current state of knowledge, since the future developments of extreme weather events cannot be calculated with sufficient reliability (Nachtnebel et al. 2014;</p>

BMLFUW 2011g). However, model results suggest an increase of precipitation frequency and intensity in central Europe of about 10% in winter, while for the summer half-year an increase of intensity of 30-year precipitation events of 17-26% in the time period 2007-2051 was computed. In general, it should be noted that future changes of precipitation patterns, discharge regimes and flood events will differ according to region.

The tendency for flooding is influenced, in addition to climatological and hydrological factors, by land-use changes, whereby trends of changes in climate and land use can mutually interact and lead to stronger changes. It can be assumed that without precautionary measures the potential for damage and thus the flood risk will continue to increase as a result of increasing demands for land use, expansion of built-up areas and the increases of property values, independently of climatic change. The flood events of recent years have increasingly shown that measures to protect built-up areas and the infrastructure associated with them from floods are indispensable.

In addition to water protection and torrent and avalanche protection, spatial planning plays a significant role in precautionary flood-risk management. In order effectively reduce the flood risk and keep the risk and damage potentials low, it is necessary, in addition to protection of property, to promote the so-called passive, non-constructed flood protection.

For this, a central action strategy is the designation of natural flood discharge and retention areas as well as safeguarding them over the long term through priority areas that have the effect of keeping them free in spatial planning (e.g., BMLFUW 2015b; ÖROK 2011). In addition to their function as passive protection from flooding, these areas can also often fulfil further significant open space functions (e.g. for recreation, nature protection and biodiversity, adapted agricultural use). Flood area precaution requires a close cooperation of spatial planning with the specialised planning with regard to natural hazards.

Urgent need for action in this regard also arises from the fact that the use of flood plains for uses that are not compatible with flooding is continually increasing, which means that the current and the future flood risk also continually increases (BMLFUW 2015a, 2015b).

Connection to other sectors

There are connections to protection against natural hazards, water management, construction and housing, transport infrastructure, agriculture, forestry, ecosystems/biodiversity, economy, disaster management and urban development.

There is a close connection to the following recommended actions:

Chapter 2.3.2.8: Adaptive flood risk management with robust measures (Water resources and water management);

Chapter 2.7.2.3: Promotion of water retention in catchment areas and reactivation of natural floodplains (and areas), particularly as a contribution to provision of additional inundation areas (Protection against natural hazards);

Chapter 2.6.2.5: Increase of water retention.

Connection to existing instruments

Flood risk and natural hazard management are covered fundamentally in the Austrian spatial planning laws. The spatial planning goals of nearly all spatial planning laws contain, besides the general goals for protection of the population, specific goals that specifically refer to natural hazards. General legal foundations for the designation of open spaces (e.g. through zoning restrictions in regional spatial plans) are available in all federal states in various forms (BMLFUW 2015a, 2015b). Both the instruments for regional spatial planning (e.g., in regional development programmes) and local spatial planning (e.g., in local development concepts or in zoning plans) enable measures for safeguarding water retention areas. Differentiated statements and regulations regarding keeping areas open for flood protection exist but only in the legal bases of isolated federal states (BMLFUW 2015a). The spatial planning laws of the federal states refer in their planning regulations only to some extent explicitly to the 100-year flood level as a criterion for zoning (BMLFUW 2015b).

State of implementation

The EU Floods Directive regulates the management of flood risks. With the amendment to the Water Rights Act, the requirements of the Floods Directive were implemented in Austria and its instruments were taken up in water law. The flood risk management plan for Austria was published at the beginning of 2016 (BMLFUW 2016a) and provides the basis for the water management and water protection planning and implementation until 2021, at which time a review and, if necessary, an update should take place. The consideration of the possible consequences of climatic change for the occurrence of floods is explicitly foreseen

Concrete water management instruments, which have potentially high spatial impacts and whose use is also foreseen in risk areas in compliance with the Floods Directive, are in particular the flood lines and the hazard zone plans: from the Federal Waterways Administration (BWV) flood lines for 30-, 100- and 300-year floods are produced for running water within their area of responsibility. Building permits within the 30-year flood line are generally prohibited by building regulations and water law. Flood lines for the 100-year flood (as a demarcation criterion for flood discharge and flood retention areas) are not available for all areas in all federal states. In about one third of the designated risk areas in the risk management plan, complete and up-to-date hazard zone plans of the Federal Waterways Administration are not available for all affected municipalities (BMLFUW 2014).

Adaptation to climatic change is one of the goals of the Austrian Spatial Development Concept 2011 (ÖROK 2011). The designation of priority areas for protection from natural hazards and reserving areas for flood retention and flood discharge are defined in the concept as action areas and tasks. The ÖROK recommendation Number 52 on preventative handling of natural hazards in spatial planning (ÖROK 2005a) likewise recommends the designation and legally binding embedding of inundation areas (for 30- and 100-year floods) and risk zones in spatial planning and building regulations, as well as keeping them free through requirements or prohibition of zoning and use in spatial planning. Within the framework of the ÖREK-partnership "Risk Management Floods", the ÖROK recommendation 52 is currently being revised and should be adapted in particular to the requirements of the EU Floods Directive by 2017.

In recent years, regulations in spatial planning law relevant to floods were changed and improved in some federal states. The implementation of the EU Floods Directive has contributed to a strengthening of state responsibility for flood protection and the political commitment to safeguard areas and sustainable flood protection.

In almost all federal states there are general legal foundations for the integration of natural hazards in regional/sectoral spatial planning programmes. These are considered in various different instruments, such as the federal state spatial programmes of Upper Austria and Burgenland, the climate and energy programme of Lower Austria, the programme on future space of Tyrol or in individual sectoral programmes. A pioneering role with regard to the integration of natural hazard management is taken by the federal states of Salzburg (Integration into the state development programme and regional programme), Styria (development programme for flood safety of built-up areas and consideration in regional development programmes) and Vorarlberg (regulation of the federal state government on the designation of regional open areas for flood protection in the Rhine valley, so-called "blue zones"). In these programmes, natural hazard is referred to directly and considered with concrete measures (BMLFUW 2015a). In particular, the regulation on "blue zones" can be taken as a good practice example for a spatial development programme developed through cooperation between the federal state and the municipalities for river landscapes and for active and long-term provision of areas beyond the area of the 300-year flood (BMLFUW 2015b).

The designation of flood discharge and retention areas in regional spatial planning is directly a topic in the spatial planning law of the federal states of Burgenland, Carinthia and Tyrol.

According to explicit spatial planning law, land in the 100-year flood area cannot be classified as building land in Lower Austria, Burgenland, Styria and Upper Austria

(Meinharder & Dreiseitl-Wanschura 2014), although exceptions are, however, mostly approved. Building land prohibitions for “flood risk areas” that are not classified in more detail (with no reference to a concrete measurement event, such as the 100-year flood) can be found in all spatial planning laws (except for Vienna).

Through the implementation of the EU Floods Directive in Austrian law, significant steps were made towards integrated water management (BMLFUW 2015b). In 2011, 391 areas were designated as having a potentially significant flood risk, which in total covered 7.1% of the total length of the water bodies that were studied (BMLFUW 2016a). In 2013, hazard maps and risk maps were published for all risk areas, in which inundation areas for flood events with high, medium and low probability (return period on average 30, 100 and 300 years) are identified. The majority of the areas (88%) are at least partially protected against floods (up to 30-year flood) with constructional measures. A very high damage potential exists for floods with medium or low probability (BMLFUW 2016a). The implementation of the flood risk management plan of 2016 (BMLFUW 2016a) should take place through 22 measures in five action areas with active participation of the population. Many measures have components with a strong spatial impact and must be implemented in cooperation with spatial planning (Meinharder & Dreiseitl-Wanschura 2014). The priority of measures that do not involve construction rather than technical measures was set down in legal requirements, technical guidelines (RIWA-T, BMLFUW 2015j) and support mechanisms, although not as a target definition in water law. During the course of the amendment of the water law, inundation areas were legally anchored as protective measures: in the future, according to the water law, hazard zone plans should identify hazard zones which must be kept free in order to reduce flood risks or for later protective water management measures (BMLFUW 2015b).

Methods for assessing the natural retention and discharge effect, to provide a quantifiable legal and spatial planning basis for reserving inundation areas are increasingly available (Habersack et al. 2014), but they still require standardisation in technical guidelines.

The strategies for adaptation to climatic change of the federal states of Tyrol (Tir. LR 2015), Styria (Stmk LR 2015) and Upper Austria (Oö. LR 2013) contain measures that are directly connected to this recommended action (Styria: Further development of integrated flood risk management; Tyrol: Strengthening integrated flood management; Promotion of passive flood protection measures; Upper Austria: Improvement of the basic knowledge in the climate-water area and based on that adaptation in planning and processes; Systematic improvement in problem areas that regularly occur as a result of heavy precipitation events – Project “Extreme precipitation – programme of measures”).

Recommended further steps

- Investigation and identification of the significant flood discharge and retention areas using uniform, effect-oriented criteria within the framework of the water management specialised planning responsibilities of the federal government, e.g., through the production of an inundation area cadastre in order to prepare the specialised foundation for the safeguarding of areas through planning (BMLFUW 2015b);
- Generation and improvement of the legal basis for reserving flood discharge and retention areas through anchoring in spatial planning law of all federal states, in particular through (BMLFUW 2015b):
- Inclusion in the target definition as well as the creation of categories related to the protective function in regional spatial planning (such as priority, precautionary or reserved areas) and of corresponding zoning criteria for the zoning plans;
- Determination of clear limitations to and prohibitions of zoning in all spatial planning laws for building land and damage-sensitive buildings in green land in the area of the 100-year flood, as well as for uses that could adversely affect the effectiveness of discharge and retention (BMLFUW 2015b; ÖREK 2011, ÖROK 2005a,b, FloodRisk II Habersack et al. 2009, CLISP 2011a);

- Development of clear legal norms for exemption grounds in relation to zoning prohibitions and restrictions in flood discharge and retention spaces (FloodRisk II, Habersack et al. 2009, ÖROK 2005a, CLISP 2011a);
- Aim for a nationwide, harmonised procedure for the anchoring of keeping areas free in the spatial planning laws of the federal states, e.g., in the framework of federal cooperation instruments (Art. 15a B-VG-Vereinbarung);
- Strengthening of the legal regulations reserving inundation and retention areas and stronger restriction of building in these area in water law (BMLFUW 2015b):
- Inclusion of the priority for non-constructural measures as a target definition in water rights law;
- Extension of the water law so that authorisation must also be obtained to build in 100-year flood areas, for which several options are possible (BMLFUW 2015b), or the obligation to adopt regional programmes for water management.
- Identification of flood discharge and retention areas as priority or reserved areas in regional spatial planning (sectoral and regional spatial planning programmes), with the obligation to keep areas free in local spatial planning (amongst others BMLFUW 2015b; ÖROK 2005a); in this case, the regional water management programs foreseen in water law could provide a connection between protective water management and spatial planning, although the relationship between water and spatial planning legal instruments must still be clarified and organised accordingly (BMLFUW 2015b);
- Clear regulations and procedures for land within flood discharge and retention areas that has already been authorised for construction but no building has yet taken place (ÖREK 2011), e.g., through the strengthened use of regulatory approaches such as reallocation, building bans, designation of development areas etc. for unbuilt building land in discharge and retention areas (FloodRisk II 2009) (see Chapter 2.12.2.4: Regulations for handling existing zoning and building in hazardous areas).
- Making visible and strict implementation of designated flood areas and hazardous zones as well as the connected zoning and use restrictions in local spatial plans;
- Strengthened cooperation and coordination between the affected regional authorities in catchment areas, in particular between upstream and downstream municipalities, for reserving open spaces for flood discharge and retention (BMLFUW 2015b; ÖREK 2011, CLISP 2011a, FloodRisk II 2009) (see Chapter 2.12.2.5 – Promotion of intermunicipal cooperation);
- Intensified cooperation between spatial planning, building regulation, (protective) water management, torrent and avalanche prevention and disaster management, including strengthened institutionalisation of coordination processes; further promotion of integrated flood risk management during the implementation of the flood risk management plans (BMLFUW 2015b; FloodRisk II 2009, CLISP 2011a,e, ÖROK 2005b);
- Review of instruments (such as flood control agreements, reserved areas in spatial planning, civil contractual safeguards, area exchange, permanent servitude in the land registry, requirement for special management measures) and development of models for active management and the functional use of flood discharge and retention areas (BMLFUW 2015b; ÖREK 2011, Pretenthaler et al. 2009);
- Generation and improvement of the prerequisites in spatial planning laws and water laws, in order to consider more effectively the cumulative effects through the successive loss of inundation space; anchoring of the compensation for loss of inundation areas in relevant planning instruments and technical guidelines;

Possible resource requirements	<p>– Survey and evaluation of the implementation and execution practice for legal and regional requirements for reserving areas with a protective function at local level (BMLFUW 2015b; Kanonier et al. 2015).</p> <p>The implementation of the spatial planning and water legal measures can be carried out to a large extent within the framework of existing activities and processes (e.g. implementation of the risk management plan within the water rights law), which might, however, require extra resources for execution. For the provision of specialised planning bases, such as inundation area cadastre and hazard zone plans, costs for both the protective water management and the municipalities are expected, which are not, however, additional costs as a result of adaptation to climatic change. For securing land for retention and discharge space, there could be potentially considerable costs for purchasing areas, compensation or renaturalisation measures, which can be limited through appropriate implementation models. In all cases, it can be assumed that the regional and economic benefits through damage avoidance are significantly higher than the investment costs.</p>
Possible conflict potential	<p>Competition between the designation of flood retention areas and other demands for use, e.g., for residential areas or agricultural purposes, is likely (Prettenthaler et al. 2009).</p> <p>Reserving areas can be seen as interference with property and use rights; reallocation of existing but undeveloped building land in priority areas for flood protection can lead to compensation claims from property owners. The introduction of instruments that ignore compensation as far as possible generates conflict potential.</p>
Actors	<p>Asymmetrical distribution of burdens and benefits between upstream and downstream municipalities requires cross-municipality cooperation.</p> <p>ÖROK, state governments, municipalities, planning firms, protective water management (BMNT, formerly BMLFUW), torrent and avalanche control authorities (BMNT, formerly BMLFUW), Federal Waterways Authority (BMVIT), infrastructure operators, viadonau – Österreichische Wasserstraßen GmbH (BMVIT), land owners.</p>
Time horizon	<p>The determination of the important discharge and retention areas as well as the definition or specification of the respective regulations in spatial planning or water laws are possible in the short to medium term; their implementation can then take place continuously in the planning and authorisation processes, during the implementation of flood risk management plans or step-by-step during the new development of spatial plans. The implementation of retention areas can be delayed through participatory processes and private property rights. In the consideration of specialised planning bases in spatial plans, delays can arise, because the revision cycles of spatial planning (on average 10 years) and specialised planning (water management, torrent and avalanche control) are not coordinated with each other.</p>

2.12.2.3 REINFORCED LEGAL LINKS BETWEEN ZONING AND HAZARD-ZONE PLANNING

Objective	<p>Protection of built-up areas and infrastructure from natural hazards, taking changes in the potentials of natural hazards due to climate change into account;</p> <p>Reservation of areas threatened by natural hazards by banning construction and land uses involving high damage potential; Ensuring proactive hazard prevention.</p>
Significance	<p>Climatic changes, such as the expected increase of extreme weather events, changed precipitation and discharge regimes, thawing permafrost and glacier retreat, can influence natural hazard processes caused by floods and gravitation in various ways and also change the intensity and frequency of natural hazard events (Kromp-Kolb et al. 2014). Depending on the specific local circumstances, these can also be connected with a future increase of natural hazard potentials and the expansion of hazard areas. In mountainous regions, slides, mudslides, rock falls and other gravitational mass movements will significantly increase (APCC 2014). Built-up areas that are not</p>

threatened by natural hazards will decline as a result of the expansion of flood zones in valleys and the hazard zones on slopes threatened by mass movements (Kromp-Kolb et al. 2014). Independently from that, the spatial development of built-up areas and the related transport infrastructures lead to an increase of the hazard potential and the vulnerability of land uses.

The hazard zone plans of the Torrent and Avalanche Control (WLV) and the Federal Waterways Administration (BMV) are important instruments for federal specialised planning, providing area-related information about threats through floods, torrents and avalanches and the basis for planning and decision making for spatial planning, the building and the safety sectors. They are instruments with a high potential for managing risks, but their effectiveness in practice depends on the level of consideration in spatial planning. In formal legal terms, they are qualified reports from federal specialised planning with the character of prognoses, with no direct normative effect. The identification of natural hazards in hazard zone plans or risk maps in accordance with water law can lead to a binding effect within the authority; but it can only bind spatial planning activities of the federal states, if they make a voluntary commitment to do so (BMLFUW 2015b). All spatial planning laws envisage an obligation to include available hazard zone identification in zoning plans of the municipalities. A further legal anchoring of the hazard zone plans was seldom carried out in the spatial planning laws of the federal states. Many federal states orient their planning practice on the results of the WLV and BMV, but a stronger legal coupling of hazard zone plans and zoning plans is necessary, in order to avoid a further increase of damaging events, the related direct damage costs and the indirect following costs for active protective measures. The normative upgrading of hazard zone plans in spatial planning is a significant contribution towards a sustainable, climate-robust spatial development.

The Austrian Spatial Development Concept (ÖREK 2011) calls for legally binding anchoring of hazard zone plans and also an extension of their content to consider further natural hazard processes such as landslides and rock falls. In addition, the production and updating of hazard zone plans and data collection with regard to changes of discharge in the alpine area should be further stepped up (ÖROK 2011).

Possible future changes of natural hazard processes as a result of climatic change are a challenge for expert planning and spatial planning. Because of the high ranges of uncertainty of climate projections, future climatic changes are not considered at present in the basis of calculation. A continuous adaptation to changing natural hazard processes would also be possible through a regular review and, where necessary, an updating of the hazard zoning, in which most recent extreme events are considered in the statistics and a data base that is as broad as possible is used. The guidelines for development of hazard zone plans stipulate that when new changed conditions that affect the assessment are found, there is an obligation to change the plans. A considerable share of the existing hazard zone plans is, however, already more than 15 years old.

Connection to other sectors

There is a close connection above all to the recommended action of Chapter 2.7.2.2 – Promotion of sustainable spatial development strategies, including increased consideration of planning in hazard areas and identification of risks. There are also connections to construction and housing, transport infrastructure and the economy.

Connection to existing instruments

Connections are to the spatial planning laws, local development concepts, zoning plans, hazard zone plans of the Torrent and Avalanche Control (WLV) and the Federal Waterways Administration (BMV), flood risk management plans.

State of implementation

At present both the hazard zone plan of the WLV and the hazard zone plan of the BWV have a legally binding inclusion in spatial planning in only some of the federal states, but they must be taken into account according to the spatial planning laws of the federal states in zoning and building permission (Oberleitner 2006). In planning practice, hazard zone plans are taken into account in all federal states.

The majority of the spatial planning laws do not make an explicit connection to the content of hazard zone plans in the definition of hazard areas that cannot be used as building land. Also in the zoning prohibitions and restrictions for threatened areas,

reference is made to the content of the hazard zone plan only partially in an unambiguous and explicit way. An obligatory consideration of the hazard zone plan as a criteria for zoning decisions is only included directly in the spatial planning law of Upper Austria (§ 18 Abs. 7 Oö ROG), Styria (Development programme for flood-safe development of built-up areas) and Tyrol (§ 37 Abs. 2 TROG) (BMLFUW 2015a).

Gravitational natural hazards are included in the legal spatial planning material in most federal states in the form of general formulations (except for Vienna and Burgenland). In comparison to the flood risk, in the treatment of gravitational natural hazards (landslides, rock falls etc.) there are deficits with regard to hazard analysis, hazard zone planning and their use in spatial planning. For this, an ÖREK-partnership has made technical recommendations and produced a comprehensive collection of material (ÖROK 2015), which is the basis for ÖROK- Recommendation 54 “Risk management for gravitational natural hazards in spatial planning” (ÖROK 2016).

In recent years there was progress in the production, continuation and public availability of hazard zone plans; in particular in the area of responsibility of the WLW these are available nationwide for nearly all areas (Habersack et al. 2015). Through the consolidation and improvement of local and regional planning bases (flood lines, flood hazard and risk maps), hazard information is in part available nationwide (BMLFUW 2015b). Nevertheless, there are still clear differences with regard to whether the hazard zone plans are up to date, their quality and availability in digital form

For the consideration of the residual risk in areas protected through construction measures (in the case of failure or overloading), first steps have been taken in expert planning through the identification of the 300-year flood areas in risk areas according to the water law. Since 2014 it is possible to obtain information on the residual risk areas via a website (WISA). This, together with the digital hazard map HORA 2.0, contributes to increasing risk awareness. However, to date the residual risk areas are not considered in spatial planning or building laws and the treatment of residual risks in planning has not been fully clarified (Kanonier 2015 et al.; BMLFUW 2015b).

The national flood risk management plan (BMLFUW 2016a) includes two measures in the action area “Precaution” that are directly connected to the recommended action discussed here: production/ updating of hazard zone plans and consideration of hazard zone plans.

Recommended further steps

- Unambiguous and legally binding anchoring of hazard zone plans (WLW und BWV) in spatial planning and subsequent building laws, which aims for a strengthened coupling between zoning and the content of hazard zone plans in all federal states (ÖROK 2005a, 2011):
- Consolidation and clear determination of the legal consequences (zoning and use prohibitions or requirements) of the contents of hazard zone plans in spatial planning law and increased binding effect for zoning: clear regulation of the implementation of the contents within local planning (normative upgrading, mandatory requirement to take the contents into account) (BMLFUW 2015b; FloodRisk II 2009);
- Prohibition of building land zoning at all planning levels for areas within the limits of the 100-year flood (red and red-yellow zones in the hazard zone plans of the BVW) and in red zones and brown identified zones (geogenic hazards) in hazard zone plans of the WLW (BMLFUW 2015b ÖROK 2005a, 2011);
- Restriction and clear legal norms for exceptional facts of the case with regard to zoning prohibitions and restrictions in hazard zones (ÖROK 2005b, FloodRisk II 2009);
- Making hazard zones and identified flood discharge areas visible in regional and local spatial plans (Kanonier & David 2004);
- Stricter implementation of zoning and building prohibitions in hazard zones in zoning practice (ÖROK 2011, Kanonier & David 2004), amongst others, through strengthened review of the contents of zoning plans by the supervising authority;

- A nationwide harmonisation of spatial planning laws in this area would be worth considering (possible area of application of an agreement under Article 15a-B-VG) (BMLFUW 2015a).
- Stronger cooperation and coordination between spatial planning, torrent and avalanche control and protective water management;
- Provision by torrent and avalanche control and protective water management of comprehensive planning bases (hazard zone plans, flood lines) that are as up to date as possible; expansion of the content of the hazard zone plans of the WLW through obligatory presentation of areas exposed to geogenic processes (mudslides, landslides, rock falls and rockslides – currently in the brown identified areas); strengthened harmonisation of the hazard zone plans of WLW and BWV (BMLFUW 2015b; ÖROK 2005a, b, 2011);
- Harmonisation of the timing of the production of local spatial plans (development concepts, zoning plans) with the production or updating of the hazard zone plans or flood risk maps, to avoid overly long delays in the consideration of hazard information in spatial plans (Seher 2004; Kanonier 2004; Habersack et al. 2009);
- Clear communication and presentation of residual risks, protection goals and protection levels in zones with constructional protection to increase risk awareness; development of a thorough treatment of residual risks in spatial planning (e.g., questioning the removal of hazard zone designation after construction of protective measures, clarification of restrictions related to residual risks and their requirements) (BMLFUW 2015b; FloodRisk II, Habersack et al. 2009).

Possible resource requirements

For the production or regular updating of hazard zone plans, resources are required within the regular budgets of the relevant departments. Legal spatial planning measures can be integrated in existing instruments and processes.

Possible conflict potential

Hazard zone plans of the BWV are not available for all areas at present. The inclusion of the residual risk in spatial planning requires a societal and political negotiation process, in which protection goals and risk acceptance should be discussed. Possible restrictions on using residual risk areas for building could lead to tensions with economic development goals of municipalities and land property rights.

Actors

ÖROK, state governments, municipalities, planning firms, protective water management, torrent and avalanche control, land owners.

Time horizon

The extension of hazard zone plans of the WLW for all areas to include further alpine hazards would take about 10 - 20 years. The generation of legal framework conditions for spatial planning and the continual implementation in the instruments of local spatial planning are basically possible in the short to medium term. Since the revision cycles of (local) spatial plans (about 10 years) and the cyclical processing, reviewing and updating of hazard zone plans as the basis for planning can deviate from one another, delays of several years can occur in the consideration of hazard zones.

2.12.2.4 REGULATIONS FOR HANDLING EXISTING ZONING AND BUILDING IN HAZARDOUS AREAS

Objective

Lowering the damage potential of natural hazard events in risk zones; ensuring proactive hazard prevention.

Significance

The avoidance of developing settlements in risk-exposed areas is the priority and most effective measure for protection against natural hazards. Despite considerable efforts in spatial planning, valid building land zoning (zoned, but unbuilt building land) and existing buildings and facilities are also threatened by natural hazards. From the perspective of the mandate of spatial planning to protect against natural hazards, this poses an enormous challenge, not least because in both cases the existing rights of

Connection to other sectors**Connection to existing instruments****State of implementation**

property owners are affected. In addition, as a result of climatic change the potential for natural hazards could increase.

For zoned but still unbuilt building land within hazard zones, spatial planning has regulation approaches, such as rezoning, fixed-term building bans or the designation of development zones until the threatened area has been secured through technical measures. Reallocation during the revision of zoning plans can contribute, in line with sustainability goals, to a redimensioning of excessive building land reserves and thereby to a reduction of use of new areas. In addition, the potential of development plans should be used more strongly to minimize risks, e.g., through damage-limiting risk-differentiated usage allocation in the development plan.

In contrast, for already existing buildings, spatial planning has very limited possibilities to intervene. These are provided above all by downstream building law, which should make it increasingly possible to carry out retrospective prescription of safety measures for objects or properties (with close involvement of reports from the WLW through their activities as advisors and experts) (BMLFUW 2015b; FloodRisk II, Habersack et al. 2009).

As a final option, the relocation of endangered objects can reduce the damage potential. However, in this case spatial planning does not usually play a dominant role (perhaps in finding new locations for relocated objects) (FloodRisk II 2009).

In connection with rezoning, according to requirements of the relevant laws, corresponding compensation measures (compensation payments) must be considered.

In the national flood risk management plan (BMLFUW 2016a) the topic of endangered zoned areas and building stocks is addressed through two measures: Implement and adapt measures to protect objects; and Review and/or adapt relocation and reallocation.

There is a close connection above all to protection against natural hazards, water management, construction and housing and the economy. Chapter 2.7.2.6 – Promoting adoption of measures for reducing risk while taking account of appropriate risk transfer mechanisms.

There are connections to the spatial planning laws, zoning plans, development plans, building regulations, hazard zone plans (WLW, BWV), flood risk management plan according to the water law.

Unambiguous statements about the handling of threatened zoned areas and building stocks and clear regulation of rezoning requirements are still broadly unavailable. In most spatial planning laws the topic is addressed but not correspondingly clearly regulated or there are large differences regarding the intensity of regulation (BMLFUW 2015a, 2015b).

Clear regulations on this are found in particular in the spatial planning law of Lower Austria.

In the Carinthian municipal planning law of 1995 there is a special regulation, according to which, unbuilt grasslands that have been designated as building land but which are in flood hazard areas must, taking certain specifications into account, be reallocated as grassland (BMLFUW 2016a).

Furthermore, the possibility to set time limits for building on designated building land exists in Salzburg and Styria (Kanonier et al. 2015; BMLFUW 2016a).

The spatial planning law in Vorarlberg contains legal regulations for reallocation without compensation: in this case, there is no obligation to compensate, as long as the particular piece of land is not suitable as a building area as a result of the natural conditions (Kanonier et al. 2015).

Restrictions on the use of threatened building land are possible, for example, in Styria in the form of building prohibition, development and renovation areas, while in other federal states significantly fewer or no specific recommendations are foreseen (Kanonier et al. 2015).

The state and extent of reallocations of threatened building land in municipal planning practice are largely unknown. However, it can be assumed that reallocation in hazard

Recommended further steps

zones in municipalities in some federal states are being currently undertaken in the course of new development of zoning plans (Kanonier et al. 2015).

From a building law perspective, there is a good level of implementation of the required prescription of a flood-safe method of building and the definition of construction requirements for the design of flood-safe buildings (Kanonier et al. 2015). Individual building regulations foresee requirements for explicit authorisations in the building site declaration or building permit of particular protective measures in the outside areas of the building plot. In Tyrol, in addition to construction measures, organisational arrangements in the form of a “safety concept” can also be required (BMLFUW 2015b).

- Obligatory statements on the handling of threatened zoning areas and building stocks in the spatial planning instruments and development of guidelines for handling threatened zoning areas and building stocks (FloodRisk II 2009);
- Clear regulation of reallocation provisions for (unbuilt) building land in hazard zones in all spatial planning laws; in doing this, efforts should be made to reallocate, without compensation if possible, building land in hazardous areas and retention areas in all cases in which securing is not possible (BMLFUW 2015b), e.g., in the course of revision of zoning plans;
- Increased use of regulatory approaches such as building prohibitions, development and renovation areas, in order to guarantee safety of threatened objects and properties;
- Increased use of zoning and development plans for risk minimisation, above all through application of the principle of risk-differentiated zoning practice or use allocation (selective allocation of uses or building structures according to the damage potential and the degree of threat);
- Strengthened integration of measures to protect objects in outside areas and organisational arrangements for cases of floods (e.g., safety concepts, alarm plan) in all building regulations or in the development plans (Kanonier et al. 2015); Enable in particular retrospective requirements for threatened existing buildings (BMLFUW 2015b);
- Inclusion of the requirement for a flood-safe method of construction for residual risk areas in building regulations (Kanonier et al. 2015b);
- More consistent management and execution of legal requirements for buildings with respect to safety.

Possible resource requirements

Resources for the public sector could be required for reallocation, inasmuch as there is a requirement to compensate owners. Costs for the implementation of measures to protect objects fall in the area of private risk precaution. In both categories of measures there is potentially a very good cost-benefit ratio.

Possible conflict potential

Changes of zoning are connected with interventions in property rights (and are therefore preferably avoided by local planners); Value losses through changes of zoning (with possible compensation claims of affected owners).

In the case of safety measures related to objects, care must be taken that through relief changes (embankments) or protective devices at the edge of areas that discharge conditions are not changed in a way that leads to an increased risk for neighbours or those downstream.

Possible resettlements can hardly be executed using coercive measures and are connected with psycho-social stress for those affected.

Actors

State governments, municipalities, BMNT, formerly BMLFUW (protective water management, torrent and avalanche control (especially in the role of experts and consultants in individual expert reports)), land and building owners.

Time horizon

The inclusion in the existing spatial planning law can be tackled in the short term and implemented within the framework of existing instruments and processes; the strengthened application of available regulatory approaches is possible immediately.

2.12.2.5 PROMOTION OF INTERMUNICIPAL COOPERATION

Objective	<p>Protection of intermunicipal “solidarity” areas for flood retention and prevention of natural hazards;</p> <p>Introduction of compensation mechanisms and risk transfer models between municipalities or bodies under public law in accordance with the Water Rights Act (e.g., protective water cooperatives/associations) for balancing out burdens and benefits between upstream and downstream riparian communities.</p>
Significance	<p>The cooperation of several municipalities plays a significant role in flood area provision, since flood events often have regional dimensions. To achieve an approach to flood area provision in relation to the river or catchment areas, intermunicipal cooperation between upstream and downstream riparian communities must be promoted. In addition to dealing with floods, strengthened cooperation between municipalities also makes sense and could be necessary for securing areas to deal with other natural hazards. In doing this, the asymmetrical distribution of burdens and benefits between upstream and downstream communities is a particular challenge. Usually the upstream municipalities contribute to an improved flood protection for the downstream municipalities through keeping areas free or the provision of retention areas or technical measures, but in doing this they possibly have to sacrifice spatial development potentials, while in the downstream area new spatial development potentials are opened up. In this case, the connections must be clearly presented and corresponding agreements developed and implemented. Thereby, the municipalities, for which, for example, retention areas are available, can be compensated for the sacrifice of development opportunities through financial compensation for the loss of value of the areas. In this connection, the creation of compensation mechanisms for balancing burdens and benefits is important (BMLFUW 2015b; ÖROK 2011, FloodRisk II, Habersack et al. 2009, CLISP 2011a, b).</p> <p>Spatial planning has developed informal planning instruments for this, which can be used to different extents by municipalities in voluntary combinations (development or framework concepts for small regions). These concepts can provide a good basis for further intermunicipal cooperation.</p> <p>Intermunicipal cooperations are, in addition to dealing with floods, also useful and advantageous with respect to dealing in future with a range of other municipal tasks, in particular given stagnating public resources. Cross-municipal models of cooperation can contribute in different ways both to adaptation to climatic change and to a sustainable spatial development. This is the case, for example, for the safeguarding of extensive open spaces for various – also relevant to climatic change – functions, for cooperation in the development of business parks and industrial estates or infrastructure for tourism, which can also minimise land area usage, both for municipal and cross-regional water supply networks.</p>
Connection to other sectors	<p>There are connections in particular to protection against natural hazards, water management, construction and housing, agriculture, forestry and the economy.</p>
Connection to existing instruments	<p>There are connections to the instruments of the Water Rights Act (WRG) for implementation of the EU Floods Directive, in particular the flood risk management plan (BMLFUW 2016a); protective water management planning instruments and concepts; hazard zone plans of BWV and WLV; concepts for care of water bodies; regional spatial planning programmes; informal regional spatial planning instruments (e.g. development and framework concepts for small regions).</p>
State of implementation	<p>Cooperations between municipalities are generally increasing in the federal states (BMLFUW 2015b), ranging from informal municipal cooperation (e.g., in Lower Austria and Vorarlberg), to regional associations (e.g., in Tyrol and Salzburg) and merger of municipalities (Styria). Formal cooperations connected with flood protection are based above all on water law; cooperation models for nature protection, which reach beyond water rights associations, are rare so far in the area of spatial planning.</p> <p>Examples of intermunicipal cooperation and compensation mechanisms:</p>

Recommended further steps

- In Salzburg municipalities have joined together in associations or cooperatives on the basis of water law to implement flood protection measures together;
- Similarly in Austria in the area of torrent and avalanche control there are around 270 cross-municipal “protection associations”, that are predominantly in Salzburg (256 protection associations of the WLW in 2012) (BMLFUW 2015a);
- Within the framework of intermunicipal cooperation along the Aist river in Upper Austria, 29 municipalities are working together in the catchment of the tributaries to provide flood protection with retention areas and to keep surfaces open for flowing retention (Seher & Berger 2009);
- Water association for flood protection in the Aschach valley, Upper Austria: 28 municipalities are cooperating in the construction of retention basins, ecological renaturation measures and the installation of an early warning system for floods;
- Flood protection in the Triesting valley (Lower Austria);
- Compensation model Mittersill (Salzburg);
- In Tyrol the municipalities were reorganised into 36 planning associations and one planning association for Innsbruck and the surrounding region; these regional associations are a good starting point for organising cross-municipality cooperation, also for flood protection.
- Strengthened cooperation and improved coordination between the upstream and downstream riparian communities (ÖROK 2011), including institutionalised or formalised forms of cooperation;
- Review and, if necessary, adaptation of the legal framework conditions within spatial planning for the support of intermunicipal cooperation;
- Support for and creation of incentives and financing possibilities for municipalities or public bodies according to the Water Rights Law, e.g., support or financial incentives for cooperation, provision of model contracts for cooperation, organisational support, initiation of specific pilot projects, preparation and transfer of examples of good practice (BMLFUW 2015b; Floodrisk II 2009; ÖROK 2011);
- Linking the use of public support for protective measures with the formation of intermunicipal cooperation;
- Use of existing organisational structures and instruments, such as regional associations, flood protection associations, LEADER-regions, in the course of implementation of the flood risk management plan (Meinharter & Dreiseitl-Wanschura 2014);
- Development, testing and implementation of models for balancing burdens and benefits, balancing economic interests, risk transfer and for compensation measures in line with financial transfers between upstream and downstream riparian municipalities;
- Strengthened use of regional planning for investigating and identifying areas that are reserved and expected development areas.

Possible resource requirements

Resources will be needed for the creation or extension of support possibilities for intermunicipal cooperation for protection against floods and natural hazards. Through interventions in property rights, municipalities could have costs for compensation or the purchase of land. Further resources could be required in the form of additional time. When looking at the system as a whole, through synergy effects cost savings at the same time as optimisation of use are possible for municipalities, federal states and the federal government.

Possible conflict potential

Conflict could arise through different interests of the municipalities. However, ultimately intermunicipal cooperation should balance the interests and thus minimise conflicts between upstream and downstream relationships.

Actors

Federal and state governments, municipalities, planning firms, land owners.

Time horizon	Initiatives to develop and test intermunicipal cooperation models can start in the short term in order to enable a broader application in the longer term.
2.12.2.6 PROTECTION OF FRESH/COLD AIR PRODUCTION AREAS, VENTILATION PATHS, AND “GREEN” AND “BLUE” INFRASTRUCTURE WITHIN RESIDENTIAL AREAS	
Objective	Improvement of microclimates in densely populated areas, prevention of overheating and heat-island effects, and compensation for increased bioclimatic stress on human health; Securing the supply of fresh/cold air in built-up areas, avoidance of health risks due to heat.
Significance	<p>In recent decades, the average number of hot days (with a temperature above 30°C) per year has increased markedly in all federal state capitals and in some cases doubled (ZAMG 2015a, b). As a result of climatic change, temperature extremes, frequency, intensity and length of hot periods will increase even more (Kromp-Kolb et al. 2015). This leads to the risk of over-heating and heat island effects in densely built areas. Less favourable bioclimatic conditions in residential areas lead to increased heat stress for the population and to increased heat-related mortality, in particular for vulnerable groups of the population (see Chapter 2.9 – Health Sector).</p> <p>Keeping open and ensuring the function of suitable fresh/cold air production areas, i.e., unbuilt areas with an open structure and good air quality, can contribute strongly to reducing the consequences of heat. For this, suitable air circulation and ventilation corridors must be planned between “cool spaces” and urban spaces and their climatic functionality must be secured. Furthermore, bioclimatically effective green or open corridors can fulfil other valuable functions of open spaces (e.g., connecting habitats, recreation space, flood discharge corridors, ecological compensation areas). Microclimatic functions can be fulfilled by open spaces such as nature protection areas, agricultural and forestry areas, gardens, parks or green connections, but also by water areas (e.g., rivers, ponds, lakes or inundation areas).</p> <p>Within residential areas more structuring open, green and water areas that positively affect the local climate (“green” and “blue” infrastructure) should be planned and kept free. Unbuilt areas in suitable places and with appropriate orientation, which are connected to fresh/cool air production areas in the surroundings through ventilation corridors, ensure ventilation, while in addition green spaces and water areas bring cooling through evaporation and shading (BMVBS & BBSR 2009; ÖROK 2011; CLISP 2011a, b, c).</p> <p>Spatial planning is required to identify suitable spaces and corridors at the regional level, to label them as priority areas and to keep them free at the local level, and to structure and connect existing green and open spaces at the local and regional levels. This relates to areas within urban areas as well as the surrounding region.</p> <p>Urban and bioclimatic maps are required for information and as a planning basis for spatial planning (Kemper et al. 2011).</p> <p>For adaptation measures such as the greening and opening up of inner-urban areas, efforts must be made to find a suitable balance with the competing policy for residential areas, which is to aim for denser and more compact structures.</p> <p>There is a connection to Cities – Urban Green and Open Spaces, health, construction and housing, transport infrastructure, agriculture, forestry and ecosystems/biodiversity.</p> <p>There are particular connections to the following recommended actions: Chapter 2.6.2.3 – Climatological improvement of urban spaces, with particular emphasis on micro- and Meso-climatic conditions in urban and open space planning (Construction and housing sector);</p>
Connection to other sectors	

Connection to existing instruments

Chapter 2.11.2.6 – Consideration of micro- and meso-climatic conditions in urban and open space planning (Transport Infrastructure).

There are connections to spatial planning laws, federal state development programmes, regional spatial planning programme, sectoral spatial planning programmes (e.g. sectoral programme for air in Styria), local development concepts, urban development plans, zoning plans, green and open space concept, air quality laws, environmental impact assessments and strategic environmental assessment.

State of implementation

The spatial planning laws of most of the federal states contain general statements regarding priority areas with ecological functions. Amongst others, they specify that local (development) concepts/programmes should include statements about the conservation or development of open areas and/or nature. Clearer foundations for expedient implementation are, however only found in the spatial planning laws of some federal states, in particular in Upper Austria, Styria and Burgenland (BMLFUW 2015a). These specifications provide connections for planning and securing open zones that affect the local climate.

The Vienna urban development plan for 2025 (STEP 2025) stipulates that climate change mitigation and adaptation must be an integrated component of planning, implementation and further development of urban areas and that open areas must be considered (MA 18 2014a). Based on an EU project, Vienna has developed a strategy plan for urban heat islands (UHI), which contains a comprehensive portfolio of strategic and planning or project-related measures for climate-sensitive urban planning (MA 22 2015), some of which are already being implemented.

A guidebook for “green and blue spatial planning” from the federal state of Styria provides assistance for the increased use of green and blue infrastructure in local planning (Schwaberger 2012). The “Green Net” (“Grünes Netz”) in Graz is a concept for connecting existing and planned green and open spaces in the city from an ecological, transport and design point of view, which should also serve as a practice-oriented basis for zoning planning.

The recommendation for action discussed here is directly discussed in the climate change adaptation strategies with measures of the federal states of Tyrol (Tir. LR 2015) and Styria (Stmk. LR 2015) (Styria: Clear regulation of zoning prohibitions and requirements in designated fresh or cold air areas and corridors and strict implementation in zoning practice; Tyrol: Preserving and connecting multifunctional open spaces).

Recommended further steps

- Provision of basic climatological information (landscape and urban climate maps, register of urban heat islands etc.) and consideration of micro- and meso-climatic conditions in plan development (regional spatial plans, local development concepts, zoning plans, building plans, urban development plan etc.);
- Stocktaking of existing green, water and open areas and evaluation of their effects on local climate as the basis for identifying further needs for action under a changing climate;
- Specification of the legal basis in planning for the identification and preserving of priority areas that influence the local climate in all federal states (BMLFUW 2015a), e.g., through expansion of the functions of multifunctional (ecological) categories of priority areas such as “regional green zones”;
- Clear regulation of use prohibitions or restrictions in identified fresh/cold air spaces and corridors as a binding requirement for zoning practice;
- Strengthened identification of areas where fresh/cold air develops as well as ventilation paths as priority or preservation areas in regional spatial plans and in strategic planning instruments at the local level (local development concept, urban development plan, urban construction master planning); strict implementation of use restrictions in zoning and building planning or in urban planning instruments;

	<ul style="list-style-type: none"> – Safeguarding, development and networking of green and water areas in built-up areas (green and blue infrastructure); – Conversion or renaturalisation of urban derelict sites to climatically effective green or open spaces; – Upgrading and promotion of the spatial guideline, concepts of open space and landscape as a component of local development concepts.
Possible resource requirements	Financial resources are required for the provision of climatological technical foundations. The implementation can be carried out without high additional costs within the framework of existing instruments.
Possible conflict potential	Competing spatial or urban planning targets are possible, e.g., between population growth and compaction of built-up areas on the one hand and sufficient greening and opening up of residential areas on the other hand. The often low availability of properties for climatic compensation areas in residential areas and economic goals of the construction sector in the use of property are a challenge for planning.
Actors	State governments, greater urban regions, municipalities, planning firms, nature conservation (federal states), urban planning, landscape and open space planning, meteorology/microclimatology), land owners.
Time horizon	The increased consideration and implementation within existing instruments is immediately possible and should be carried out in the short term; the corresponding regulations in spatial planning law can be specified in the short to medium term.

2.12.2.7 REVIEW AND (IF NECESSARY) ADJUSTMENT OF BIOCLIMATICALLY ACTIVE MEASURES IN DEVELOPMENT PLANS

Objective	Improvement of microclimates in densely populated areas, prevention of overheating and heat-island effects, and compensation for increased bioclimatic stress on human health; Prevention of heat-related health risks.
Significance	In addition to the preservation of priority areas and the creation of green and blue infrastructure (see 2.12.2.6 – Protection of fresh/cold air production areas, ventilation paths, and “green” and “Blue” infrastructure within residential areas) bioclimatically effective measures can also be achieved through measures in development plans and building regulations, i.e., measures for properties and objects. These include the optimisation of the configuration of buildings, of building locations and building orientation, the avoidance of blocking constructions on slopes, determination of the amount of constructional use and share of green areas, building limits, minimum size of building lots, fresh air paths effective for the local climate or requirements for the orientation of window and roof surfaces. The object-related greening, such as courtyard-, roof- or façade-greening, support for passive cooling of buildings, the brightening of building and ground surfaces and the unsealing of surfaces also contribute to improving the climate in densely built areas and in the corresponding buildings, as well as improving bioclimatic conditions (MA 22 2015; Kemper et al. 2011). Furthermore, through both legal measures for construction and incentives, further effective adaptation measures are supported (e.g., to improve building resilience against extreme events (storm loads, floods, hail etc.), as well as the use of rainwater and grey water in buildings). These measures are, however, often in the area of responsibility of various owners (CLISP 2011a, b, CIPRA 2010, Hiess & Pfefferkorn 2010).
Connection to other sectors	There are connections to construction and housing, Cities – urban green and open spaces and health. There are close connections to the following recommendations:

Connection to existing instruments	Chapter 2.6.2.1 – Implementation of structural measures (In new buildings and renovation) to ensure thermal comfort to ensure thermal comfort (Construction and housing);
State of implementation	Chapter 2.6.2.6 – Adaptation of building standards and norms to climate change (Construction and housing). The connections are to the development plan, in building law and in the provisions for the development plan in spatial planning laws.
Recommended further steps	<p>Many micro- and meso-climatic aspects can currently be implemented with existing instruments of local spatial planning; a legal assignment could be implemented within the framework of the goals and principles of the spatial planning law. In addition, assignments for the municipal spatial planning in instruments of regional spatial planning particularly in conurbations would be necessary for support (see the construction and housing sector).</p> <p>In Vienna’s strategy plan on urban heat islands there is a comprehensive portfolio of adaptation measures, which can be implemented on the level of the development plan (MA 22 2015). Some of the measures are being or will be implemented.</p> <p>The guidebook on “Green and Blue Spatial Planning” of the federal state of Styria (Schwabberger 2012) provides concrete indications of how effective adaptation measures should be implemented in object and development planning.</p> <p>In Linz and Vienna there is support for roof-greening or corresponding requirements for new buildings.</p> <ul style="list-style-type: none"> – Identification of residential areas that are threatened by overheating; – Review and, if necessary, adaptation of provisions of the development plan, in order to enable measures that affect the bioclimate (horizontal and vertical greening, settlement form, design and orientation of building structure, constructional use of the plot and share of green areas, orientation of building façades, roofs and windows, roof greening etc.); – Optimised use of the development plan to improve the local climate through new designations and, as far as possible, structural improvements of the stock.
Possible resource requirements	There is a moderate resource requirement for the provision of meteorological or climatological technical foundations.
Possible conflict potential	In the area of the building process, there is a conflict potential between the introduction of strict requirements and the freedom, as set down in constitutional law, of the applicant to build. The scope of action of the development planning is more limited for structural improvements to existing stock than it is for new designations.
Actors	State governments (planning and building law, ROG), municipalities, planning firms, urban planning, building authorities, meteorology/microclimatology, developers, land and building owners.
Time horizon	The review of constructional requirements and the inclusion in building law and in the design of the development plan can start in the short term.

2.12.2.8 INCREASED PROTECTION OF WATER RESOURCES AND IMPROVED INTEGRATION OF SPATIAL PLANNING, WATER MANAGEMENT PLANNING, AND USAGE WITH WATER DEMAND

Objective	<p>Protection of groundwater and drinking-water resources and support for groundwater recharge;</p> <p>Ensuring continuous quantitative and qualitative security of water supply, especially in vulnerable regions.</p>
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Significance

The long-term increase of the average temperature as well as changes of the precipitation regime influence the quantity and quality of water resources and the supply of drinking water. Also in Austria, regions with dry and hot summers could experience declining groundwater levels and water shortages. While all groundwater bodies near the surface still have a good amount of water, the situation in eastern areas with low precipitation and also to some extent in the south/south-east of Austria is more critical and could deteriorate at least regionally as a result of climatic change (BMLFUW 2015a). In particular as a result of simultaneous occurrence of reduced water supply on the one hand and consumption peaks on the other during summer hot and dry periods, temporary supply shortages are more likely in future in some parts of Austria. From the perspective of security of supply, areas with a high degree of individual supply (low level of connection to the public supply grid) and smaller supply units of water suppliers are particularly affected.

Therefore, it is particularly important to adapt the withdrawal of water to the long-term requirements, to consider future possible changes of consumption and withdrawal amounts, and, in doing this, to pay attention to the interactions between the various land uses with water use requirements (e.g., agriculture, tourism, households, industry). Instruments of spatial planning and regional development should be coordinated more strongly with planning instruments in water management and integrated into them. In order to reduce or avoid future conflicts in the use of water resources, uses that require a large amount of water should be managed with a view towards the future, e.g., through strengthened review and considered approval of water-intensive planned projects in areas that are (sometimes) vulnerable to dryness. The need for a stronger coordinating and facilitating role of spatial planning in cross-sectoral coordination of spatially relevant water uses will probably increase in the future.

An increased climate sensitivity and vulnerability of the quality of the drinking water supply is already observed in some places. More frequent and more intense meteorological extreme events (especially heavy rain) could lead to more problems with the quality in the future as a result of the increased introduction of germs and pollutants in water catchment areas, the turbidity of springs or the flooding and contamination of water sources in areas affected by floods and lead to increased costs for the resulting renovation and cleaning. In this respect, near-surface aquifers and water sources and smaller water supply structures and individual suppliers are particularly vulnerable. Dry periods with reduced groundwater accumulation and increased withdrawal can reduce the dilution effect for nutrients and pollutants and lead to more frequent exceedance of health-relevant thresholds.

For the future guaranteeing of security of supply, it can therefore be necessary for water suppliers to develop additional or alternative water sources, to strive for redundancies in the raw water sources, and to engage in forward-looking planning of groundwater reserves. In order to manage various use demands more strongly, there is an increased need for close coordination the spatial planning.

Connection to other sectors

There are connections to water management, health, the economy, energy, tourism, agriculture, forestry, and urban planning.

There are connections in particular to the following recommended actions:

Chapter 2.3.2.3 – Guarantee of future water supply (Water resources and water management);

Chapter 2.3.2.7 – Proactive water management planning for groundwater resources (Water resources and water management).

Connection to existing instruments

Water management planning: With the amendment to the Water Rights Act of 2003, the EU Water Framework Directive and further EU requirements were legally implemented. Based on this, in 2016 the second national water management plan (NGP) was produced, which determines the status, goals and measures for the protection, sustainable use and improvement of surface waters and groundwater (BMLFUW 2015c). The NGP provides the framework for specific water management planning and concepts, such as water management framework plans, concepts for

State of implementation

drinking water supply, water supply plans and water management plans, including in plans for residential areas. Protection and conservation areas are based on legal regulations.

Spatial planning: regional spatial plans, local spatial plans, regional development concepts.

Review instruments: strategic environmental assessment, environmental impact assessment.

In 2009 the European Commission published guidelines for consideration of adaptation to climatic change in the production of national water management plans (Directive 2000/60/EC). In the Austrian national water management plan of 2015, the impacts of climatic change on Austrian water management are considered in one chapter (BMLFUW 2015c).

For the entire Danube catchment area there is a higher-level climate change adaptation strategy of the International Commission to Protect the Danube River (ICPDR 2013); this contains guiding principles on how climate change adaptation should be integrated into the implementation processes of the EU Water Framework Directive and the EU Floods Directive, as well as general recommendations for measures.

The climate change adaptation strategy of Styria (Stmk. LR 2015) provides measures to secure water resources within the water resources and water management sector, which also relate indirectly to spatial planning.

Recommended further steps

- Strengthened quantitative and qualitative securing of additional or alternative groundwater bodies, water sources and areas where drinking water originates and is extracted through designation of water management priority areas, protection and conservation areas etc. with suitable zoning and use restrictions in regional and local planning (e.g., BMVBS & BBSR 2009, CLISP 2011a, b);
- Intensification and strengthening of cross-sectoral cooperation with water management and development of integrated regional development and water supply concepts (CLISP 2011a, b);
- Strengthened consideration of possible changes of water use and withdrawal, particularly in regions with reduced water availability in the future, through stronger coordination of the water use demands of various sectors (e.g. agriculture, tourism, energy, industry);
- Increased review of water-intense usage plans with respect to climatic change (especially in areas that tend towards occasional water shortages), e.g., within the framework of strategic environmental assessment and environmental impact assessment (e.g., BMVBS & BBSR 2009, CLISP 2011a);
- Increased review of location safety of facilities of the water supply infrastructure with respect to meteorological extreme events and natural hazards (Prettenthaler et al. 2009);
- Promotion of compact structures of residential areas, in order to enable cost-efficient connection of households to the public water supply grid and to reduce the level of individual supply (CLISP 2011a);
- Accelerated use of existing spatial planning instruments for an area-protecting development of residential areas, in order support groundwater recharging, creation of infiltration areas, measures to support areal water retention.

Possible resource requirements

Resource requirements for increased consideration of forward-looking water management planning in spatial planning instruments require, above all, increased coordination efforts.

Possible conflict potential

An expansion of water management priority areas, protection and conservation areas can compete with other land uses.

Actors

State governments, municipalities, planning firms, water management (BMNT (formerly BMLFUW), state governments), agriculture, industry, energy industry, tourism and land owners.

Time horizon	Most measures to improve integrated planning between spatial planning and water management can be implemented at any time.
2.12.2.9 INCREASED PROTECTION OF ECOLOGICALLY IMPORTANT OPEN SPACES (UNDEVELOPED SEMI-NATURAL AREAS, HABITAT CORRIDORS, BIOTOPE NETWORKING) AND MINIMISATION OF FURTHER HABITAT FRAGMENTATION	
Objective	Maintenance and improvement of a functional (even under changing natural conditions) network of protected areas and habitats for animal and plant species; Establishment and maintenance of non-fragmented areas of retreat for animal and plant species, maintenance and improvement of ecological connectivity, and prevention of further habitat fragmentation.
Significance	Through changes as a result of climatic change, changes of locational and habitat factors in near-natural habitats are unavoidable. Thereby, the distribution areas of many animal and plant species shift. The increasing use of land areas and the fragmentation of landscapes and habitats are not only one of the main causes of loss of species (Zulka et al. 2015; Umweltbundesamt 2016), they hinder the autonomous adaptation processes of fauna and flora to climatic change through migration, shifts and spreading processes. Climatic change and continuing fragmentation and habitat loss threaten to accelerate further loss of biodiversity, but can also lead to gaps in regional and supra-regional connections between biotopes and endanger the functionality and coherence of existing protected areas (ARL 2009). The cross-regional securing of extensive habitat networks (especially between protected areas) and the minimisation of further habitat fragmentation are a central contribution to conserving biodiversity under conditions of climatic change. In addition, these open spaces can also fulfil other functions, such as fresh air paths, flood retention areas, recreational space etc. (e.g., BMVBS & BBSR 2009). The safeguarding and preserving of ecological corridors through spatial planning must therefore be accelerated and further fragmentation of remaining unfragmented habitats through high-profile, linear infrastructures and dispersed settlement development must be avoided as far as possible, independently of whether an area is a legally protected area or not.
Connection to other sectors	There are connections to ecosystems/biodiversity, transportation infrastructure, agriculture, forestry and urban planning. There are close connections to the following recommended actions: Chapter 2.10.2.2 – Increased consideration of climate change in existing monitoring systems and further establishment of monitoring and early warning systems (Ecosystems/Biodiversity); Chapter 2.10.2.9 – Maintaining and improving the embedding and networking of protected areas and habitats (ecosystems/biodiversity).
Connection to existing instruments	Spatial planning laws of the federal states, federal state development concepts or programmes, regional spatial planning programmes, local development concepts, zoning plans; strategic environmental assessment, EU biodiversity strategy, communication of the European Commission on green infrastructure, EU Directive on the conservation of natural habitats and of wild fauna and flora (Natura 2000), Austrian biodiversity strategy 2020+, nature protection laws of the federal states, legally protected natural areas.
State of implementation	In the Austrian regional development concept (ÖREK 2011) the development of open areas is highly valued in spatial development strategies and the report called for a close alliance between spatial planning and nature and water protection to combat the continuing decreasing availability of natural or near-natural areas. The creation,

anchoring and long-term safeguarding of highly valued open space functions and their consideration in zoning is defined as a task area (ÖROK 2011).

The spatial planning laws of most federal states contain general statements about priority areas with ecological functions. Clear foundations for implementation to achieve the goals are, however, only found in the spatial planning laws of some of the federal states. In Upper Austria, a grassland concept, which amongst others establishes priority zones for landscapes, is called for as part of the local development concept. In Burgenland, the spatial development that is aimed for must be defined in local development concepts and include natural areas and those areas that will not be built upon. In Styria, the natural prerequisites for connecting biotopes must be created through designation of green corridors within the framework of local spatial planning (BMLFUW 2015a). Through the designation of priority functional green or open zones, it is possible to consider supra-regional ecological corridors in regional development programmes. In addition, non-binding guidelines for development of ecological corridors in spatial planning are available (Griesser & Wieser 2010).

In the Austrian Biodiversity Strategy 2020+ (BMLFUW 2014) one goal is the consideration of biodiversity and ecosystem services in spatial planning and transport/mobility.

Connections, initiatives and expert foundations are increasingly available for the restoration or safeguarding of extensive green infrastructure, e.g., the European connected biotope system “Grünes Band” (Green Band).

This recommended action is also included in the climate change adaptation strategy of Styria (Stmk. LR 2015); significant aspects are discussed in the measure on preserving and connecting multifunctional open spaces in the adaptation strategy of Tyrol (Tir. LR 2015).

Recommended further steps

- Increased consideration and integration of relevant goals and instruments of nature protection (e.g. Biodiversity Strategy 2020+, coherent network of NATURA 2000 protected areas, legally protected natural areas according to the nature protection laws of the federal states etc.) into the instruments of regional and local planning;
- Increased generation of bases for spatial planning laws, which enable the allocation of ecological functions to the open or green space categories in regional planning, in all federal states; establishment of highly valued open space functions (including ecological functions) as a separate use category in zoning (ÖROK 2011); clear regulation of zoning or usage prohibitions or restrictions for designated ecological priority areas (BMLFUW 2015a);
- Increased identification of priority areas with ecological functions (habitats, ecological corridors, stepping stones, buffer areas) in line with a coherent, functional connection of biotopes in regional spatial planning (federal state development programmes, regional spatial development programmes) and careful consideration in local spatial planning (BMLFUW 2014; CLISP 2010a);
- Securing and strict preservation of ecological corridors /axes of habitat connections (e.g., in the form of multifunctional green zones) in spatial planning at all levels, including the further construction and ensuring the functions of ecological crossing supports (e.g., green bridging etc.) in linear transport infrastructure (BMLFUW 2014; CLISP 2010a);
- Accelerated implementation of guidelines for sustainable development of built-up areas (reduction of surface use and sealing, compact settlement structures; concentration of extension of settlements in existing, well- developed locations etc.) and increased use of strategic environmental assessment and environmental impact assessment to avoid further deterioration of ecological landscape connectivity (CLISP 2010a, BMLFUW 2011d);
- Development and implementation of models for forward-looking safeguarding of areas for compensatory measures; consideration of functional ecological connections in the development of compensatory areas;

	<ul style="list-style-type: none"> – Improvement of the cooperation and coordination between spatial planning, nature protection and spatially relevant sectoral planning with respect to biodiversity aspects (BMLFUW 2014).
Possible resource requirements	There is a requirement for resources and land (perhaps across the boundaries between federal states) for compensatory measures for interventions that lead to loss of habitat or deterioration of ecological connectivity.
Possible conflict potential	The conservation of ecological priority areas can be in competition with other (e.g., economic) development goals and demands for land use (e.g., settlement development, transport infrastructure planning or agriculture).
Actors	ÖROK, state governments, municipalities, planning firms, nature conservation (state governments), transport and infrastructure planning (BMVIT, state governments, ASFINAG, ÖBB), land owners.
Time horizon	Increased implementation within the framework of existing instruments can start directly; adaptation measures of spatial planning regulations that go further are possible in the short to medium term.

2.12.2.10 INCREASED COOPERATION BETWEEN SPATIAL PLANNING AND TOURISM TO PROMOTE A CLIMATE CHANGE-ADAPTED, SUSTAINABLE TOURIST INFRASTRUCTURE

Objective	Securing and supporting sustainable and climate change-adapted spatial development in tourism.
Significance	<p>Tourism is a significant economic factor in Austria. It is based largely on the natural and cultural attractiveness and therefore depends on the long-term conservation of these resources (ÖROK 2011).</p> <p>Developments in tourism are directly and indirectly connected to spatial structures and uses. Spatial consequences can arise through the construction of large facilities for tourism (e.g., lifts, spas etc.) and the resulting traffic and possible environmental impacts.</p> <p>Numerous consequences of climatic change affect tourism and the tourism infrastructure. In particular the decreasing guarantee of snow at medium and low altitudes threatens the economic survival of many winter sport locations. As a result of the increasing temperatures, a further decrease of the length of the snow season and snow depth is likely, although regional differences must be considered. Possible decreases of the economic gains through tourism fundamentally affect many aspects of spatial planning. Tourism is increasingly facing the challenge of developing additional sustainable alternatives to snow-based winter tourism and making existing offers more robust with respect to the climate through diversification, This includes expanding offers into the pre- and post-winter season and providing alternatives in the summer season as well as offers that do not depend on snow and weather. In addition, the safety of tourism facilities in the alpine area is increasingly threatened by extreme and natural hazard events (thawing of permafrost, landslides, rock falls etc.). However, besides negative effects, climatic change offer new opportunities for tourism in Austria, such as a longer summer season and increased attractiveness due to the more comfortable summer temperatures in comparison to, for instance, Mediterranean regions. Both the forward-looking dealing with negative consequences of climatic change and taking advantage of opportunities require a reorientation of tourism to new offers adapted to climatic change.</p> <p>Spatial planning can directly support the transformation process in tourism and is needed especially in the location planning for new or alternative infrastructure for tourism, the development of plans for subsequent usage for abandoned tourism offers, as well as in the evaluation of suitability for particular areas. For the expected pressure to develop in higher alpine locations, particularly for winter tourism, or the spatial expansion of individual strongly competitive tourism areas, timely development of</p>

	<p>strategies is as important as it is for regions with declining economic value-added from tourism. Integrated plans from tourism and spatial planning must therefore be promoted in the future.</p>
Connection to other sectors	<p>There are connections to tourism, transport infrastructure, ecosystems/biodiversity and protection against natural hazards.</p>
Connection to existing instruments	<p>There are connections to:</p> <p><u>Tourism</u>: National tourism strategy “New ways in tourism” (2010); Tourism strategies of the federal states; regional tourism plans, tourism support.</p> <p><u>Spatial planning</u>: Development plans of the federal states; sectoral spatial planning programmes for tourism; regional spatial planning programmes; regional development concepts; local development concepts.</p> <p><u>Assessment</u>: Strategic environmental assessment; environmental impact assessment; spatial suitability assessment.</p>
State of implementation	<p>The Austrian tourism strategy discusses climatic change as a challenge. The tourism strategies of most of the federal states also discuss climatic change, although the measures are only indirectly related to adaptation (BMLFUW 2015a).</p> <p>There are sectoral spatial planning programmes for tourism in some federal states, e.g. “Spatially suitable tourism” in Tyrol.</p> <p>Both the dimension of spatial structure of tourism activities and also the connection to climatic change are hardly discussed concretely at present in spatial planning instruments.</p>
Recommended further steps	<ul style="list-style-type: none"> – Better coordination of spatial planning and tourism strategies through the development of integrated concepts that consider climatic change; – Active role of spatial planning in the development of spatially suitable alternative tourism offers, finding locations for alternative tourism offers and the planning of subsequent uses for abandoned tourism infrastructure and locations (e.g., previous winter sports locations at low altitudes); – Supporting role of spatial planning in the development of sustainable, spatially and environmentally appropriate and climate-robust alternative tourism offers; development of strategies on how to deal with the expected increased pressure for tourism development or with the pressure on space in strongly competitive tourism areas; – Increased assessment of the safety of tourism infrastructure with respect to extreme events and natural hazards.
Possible resource requirements	<p>A strengthened cooperation can be implemented without significant additional resource use.</p>
Possible conflict potential	<p>Conflicts can arise through different interests of the involved actors.</p>
Actors	<p>ÖROK, state governments, municipalities, planning firms (tourism planning, regional development: BMWFJ, state governments, tourism associations, regions, municipalities, cable-car industry, torrent and avalanche control).</p>
Time horizon	<p>Measures and initiatives to improve the integration of tourism planning and spatial planning can be started at any time; the aim should be a step-wise adaptation and further development of instruments and procedures.</p>

2.12.2.11 PROMOTION OF ENERGY-OPTIMISED SPATIAL STRUCTURES

Objective	<p>Strengthening of the spatial dimension of the energy system; Reducing energy consumption and improving energy efficiency; Improved achievement of climate change mitigation objectives through reduction in greenhouse gas emissions; Increasing</p>
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Significance

the contribution of renewable energy sources in the regional fulfilment of energy demand.

Spatial planning measures for spatial and settlement structures, site planning and construction forms have a large and long-term influence on energy demand, energy efficiency, the possibility to satisfy demand through renewable energy, traffic volumes and the associated greenhouse gas emissions. In this connection, “energy spatial planning” is increasingly discussed as a cross-sectoral instrument for achieving an energy transition (ÖROK 2009, 2011, 2015; Stöglehner et al. 2013). Within the framework of an ÖREK partnership (ÖROK 2015) “energy spatial planning” was defined as an integral component of spatial planning that deals comprehensively with the spatial dimensions of energy consumption and energy supply (ÖROK 2015). An important goal is the promotion of energy-efficient and energy-saving, low-traffic, CO₂ neutral (as far as possible) spatial structures with a good supply system. This includes, amongst others, the avoidance of urban sprawl, the support of compact, sufficiently dense settlement structures and a mixture of functions, which benefit cost-efficient, central energy supply for heating and cooling and reduce traffic. A further important goal is the maintenance and full use of spatial potential for collecting and provision of renewable energy. This requires the safeguarding and mobilisation of suitable areas for the collection, storage and distribution of renewable energy and optimised mobility and energy concepts with a clear regional connection (ÖROK 2011, 2015), that is, with a short distance between production and consumption of electricity and with, as far as possible, regionally closed cycles (biogenic energy sources). An energy-efficient, integrated settlement and transport surface development contributes through the enabling of efficient cooling supply directly and indirectly to adaptation to climatic change.

Despite significant efforts in spatial planning, the existing trends in spatial development often work against the goals of energy-optimised spatial structures. This includes the increased use of land surfaces and the living area per person, continuing suburbanisation in core areas and in some cases dispersed settlement development in rural areas with a frequently high share of single-family housing and an increase of travel using cars (Umweltbundesamt 2016).

Furthermore, spatial planning plays an important role in the route support of electricity lines. Strategic planning of electricity lines and adaptation to decentralised feed-in must be promoted (ÖROK 2011).

In particular, integrated spatial and energy concepts are an important basis for decisions in zoning and infrastructure expansion (ÖROK 2011).

Connection to other sectors

There is a close connection to energy, transport infrastructure, agriculture, forestry and the economy.

Connection to existing instruments

Energy strategies and concepts of the federal states; the eco-electricity law; the e5 programme for energy-efficient municipalities; climate and energy model regions (Austrian Climate and Energy Fund); instruments of regional (sectoral programmes, regional spatial planning programmes) and local spatial planning (zoning plan, development plan); support for home building.

State of implementation

In the majority of the federal states, general foundations for producing integrated (spatial) energy concepts at the strategic level are available.

However, energy spatial planning is only partially integrated into spatial planning laws and regional instruments.

The ÖREK partnership on energy spatial planning developed and published action areas, instruments, measures and priority recommendations for action for the implementation of energy-optimised spatial structures (ÖROK 2015).

Standardised planning and decision support and examples of applications for energy spatial planning are increasingly available. A handbook published by the BMNT (formerly BMLFUW) covers many of these tools and provides advice on their selection and use in planning processes (Stöglehner et al. 2013).

Recommended further steps	<ul style="list-style-type: none"> – Inclusion of central aspects of energy-efficient spatial structures and renewable energy supply in the planning goals and principles of the spatial planning laws (ÖROK 2015); – Development of integrated spatial and energy concepts (ÖROK 2011), e.g., through step-wise inclusion of holistic energy planning or concepts in regional spatial planning programmes or sectoral programmes and subsequently in local spatial planning (ÖROK 2015); – Determination and application of energy efficiency criteria in zoning and development planning (ÖROK 2011); – Strategic planning of grid infrastructure considering decentralised feed-in; – Establishment of an energy guidance planning (ÖROK 2011); – Preservation and safeguarding of supply routes (ÖROK 2011); – Provision of a basis for planning through spatial planning for regional and local energy and mobility concepts (ÖROK 2015) and consideration and embedding of the transport mode of rail as a part of the economic development of space with the same intensity that is currently devoted to the transport mode of road; – Selection and application of available tools (planning and decision support) for energy-optimised spatial planning (Stmk. LR 2015); – Review and, where necessary, adaptation of spatially effective incentive systems, e.g., of energy efficiency criteria in relevant support instruments (e.g., support for home building).
Possible resource requirements	No substantial additional resource requirements have been identified. Usable tools for energy spatial planning are already available. For the nominal spatial planning an increased effort for execution could be required.
Possible conflict potential	Conflicts can arise through competing demands for land area, through area demand and through possible negative impacts on flora, fauna and the landscape for renewable energy sources.
Actors	Federal government, ÖROK, state governments, municipalities, planning firms, energy suppliers, energy agencies, energy institutes, regional associations, farmers, forest owners, regional management, Climate and Energy Fund.
Time horizon	The measures can be started at any time; the aim should be a step-wise adaptation and further development of instruments and procedures.

2.12.2.12 “CLIMATE PROOFING” SPATIAL PLANS, DEVELOPMENT CONCEPTS, AND PROJECTS WITH SPATIAL IMPACTS

Objective	Systematic consideration and review of the impacts of climate change and questions of adaptation in spatial development strategies, formal and informal planning instruments, projects, and planning processes; securing the long-term resilience and adaptability of spatial development in the face of current and future impacts of climate change.
Significance	The term “climate proofing” is not used uniformly in research on adaptation to climatic change and in spatial planning policy and expert discussions and it includes various dimensions. Generally the term “climate proofing” refers to the systematic consideration of adaptation questions and the development of risk minimisation strategies with regard to climate-related extreme events as well as gradual changes (ARL 2016; Birkmann et al. 2011). In the context of spatial planning it is basically understood in terms of methods, instruments and processes, which ensure that plans, programmes, strategies and concepts and the associated investments with regard to current and future impacts of climatic change are made resilient and adaptive (“fit for climate change”, “climate-resistant”, “climate-robust”) and furthermore that they contribute to achieving climate protection goals (BMVBS & BBSR 2013; Birkmann & Fleischhauer 2009). In a narrower understanding, this can be carried out through assessment processes (climate impact assessment, “climate check”), in which the

contents of plans and projects are assessed with regard to their susceptibility to and ability to withstand the consequences of climatic change. In a broader understanding climate proofing refers to creating the prerequisites in order to consider climate change impacts and adaptation questions in spatially relevant planning with a precautionary orientation, i.e. in the programmes, plans and informal instruments as well as in planning and decision processes. Both should ultimately contribute to keep the vulnerability of spatial structures and spatial development low over the long term (ARL 2016).

A central difference between climate proofing and existing assessment processes in planning is that the well-known assessment processes (environmental impact assessment, strategic environmental assessment) examine the effects on the environment of a proposed project or the contents of a plan, while in the climate proofing approach the consequences of changed environmental conditions for the projects and plans themselves are also assessed (BMVBS & BBSR 2013; Birkmann et al. 2010). In short, it is a matter of assessing whether development goals and plans still work under a plausible range of future climatic conditions. In this way, unsustainable pathways, which lead to expensive investments, increased risks of damage and negative external effects for the environment and society, should be avoided (maladaptation). For this, it would make sense, not only to expose concrete plans to a “climate change fitness check” but also planning instruments or the entire planning system (CLISP 2011c). This should guarantee that relevant impacts of climatic changes are considered systematically; when possible already when programmes, plans and projects are developed (Birkmann & Fleischhauer 2009).

So far two possible action areas have been identified for implementing climate proofing in spatial planning (CLISP 2011a, b):

- Integration of climate change adaptation in strategic environmental assessment and environmental impact assessment. In addition to the methodological operationalisation of climate impact assessment for these purposes, to improve effectiveness it would be necessary to strengthen the obligation for carrying out strategic environmental assessment in spatial planning at the regional and local levels;
- The systematic integration of climatic change and adaptation as subjects to be covered in plan development and approval processes (mainstreaming of climate change adaptation in planning systems). For this, practice-related research (case studies, pilot projects) and specific support for preparation, planning and execution are needed. In any case, a corresponding political or spatial planning legal mandate would be helpful.

Connection to other sectors

Basically there are connections to all other sectors.

Connection to existing instruments

There are connections to the spatial planning systems of the federal states (spatial planning laws, instruments, planning processes and procedures), strategic environmental assessment, environmental impact assessment and spatial suitability analysis.

State of implementation

In April 2014 the EU Directive on environmental impact assessment was changed (DIRECTIVE 2014/52/EU) and additions were made to the catalogue of objects to be protected. The Directive now envisages that, in addition to the impacts of projects on climate (e.g., greenhouse gas emissions), assessment must be made of their vulnerability to climatic change, the risk of serious accidents and/or disasters that according to scientific findings are a result of climatic change, and impacts relevant for adaptation. The implementation of the amended Directive in national law must be completed by April 2017 and is currently being prepared in Austria.

Recommended further steps

The project ENVISAGE-CC¹⁵⁸ developed guidelines for strategic support for project planning for the consideration of the consequences of climatic change (Dallhammer et al. 2015). These should help project applicants to consider the impacts of climatic change during the conception and development of large projects. Large projects that are obliged to carry out an environmental impact assessment usually have large spatial effects.

Scientific studies, model projects and experience with the integration of climate change adaptation into spatial planning are increasingly available, e.g., from Germany (model projects of BMVBS/BBSR: “Spatial development strategies for climatic change”, “Regional plan appropriate for climatic change”, “Transfer KlimaMORO”¹⁵⁹).

In the transnational project CLISP¹⁶⁰ with representatives from spatial planning in Austria, guidelines, criteria and a check-list for the evaluation of climate change fitness of planning instruments and processes were developed (CLISP 2011c). It can be assumed that this preparatory work cannot be directly transferred into the Austrian framework, but the systematic integration of the impacts of climatic change and adaptation will require more in-depth studies and a broad expert discussion, e.g. within the framework of an ÖREK implementation partnership. This is reflected in all of the recommended actions for spatial planning in this document.

“Climate Proofing” of spatial plans or proposals that have spatial implications using assessment instruments

- Implementation of the amended EU Directive on environmental impact assessment and preparation of guidelines for considering climate change impacts and the vulnerability of projects to climatic change (for project applicants, in the environmental impact assessment process);
- (Voluntary) integration of climatic change impacts and climate change adaptation in strategic environmental assessment (BMVBS 2013); extension of the obligation to carry out strategic environmental assessment for spatial planning;
- Implementation of case studies and pilot projects for the development and testing of concepts, methods, approaches and evaluation criteria for climate proofing of spatial plans or projects with spatial effects (BMVBS 2014; BMVBS & BBSR 2013).

Mainstreaming of climate change adaptation in spatial planning

- Examination of the spatial planning systems (spatial planning laws, instruments, processes) of the federal states with regard to their suitability for contributing to adaptation to climatic change (climate change fitness check);
- Case studies, pilot projects and practical experiments to study and test approaches on how climate change impacts and adaptation can be integrated in a suitable way at the level of legislation, instruments, processes and actors (BMVBS 2014);
- Systematic integration of climate change impacts and adaptation into plan development and approval processes (calls for proposals/tenders and awarding basic research projects and preparatory work, plan development, examination and permission by supervisory authorities etc.) (CLISP 2011a, b);
- Preparation and provision of support for work, planning and execution support for planners, supervisory authorities, municipalities etc. (e.g., information materials, (practical) guidelines, handbooks, check-lists, standards), which provide instructions and support on how climate change adaptation should be handled and presented in spatial planning (BMVBS 2014; CLISP 2001a, b);

¹⁵⁸ Research project “Environmental Impact Assessment Satisfying Adaptation Goals Evolving from Climate Change (ENVISAGE-CC)”. Funded by the Austrian Climate and Energy Fund within the framework of the Austrian Climate Research Program (ACRP).

Link: http://www.klimawandelanpassung.at/ms/klimawandelanpassung/de/kwa_news/kwa_forschung/kwa_envisage_cc/

¹⁵⁹ Link: www.klimamoro.de

¹⁶⁰ Climate Change Adaptation by Spatial Planning in the Alpine Space (CLISP). Co-financed by the Alpine Space Programme 2007-2013. Link: <http://www.alpine-space.org/2007-2013/projects/projects/detail/CLISP/show/index.html>

Possible resource requirements	<p>Collection and publication of good practice examples for “climate-sensitive” planning (see Chapter 2.12.2.1 – Development and provision of practice-relevant data and information bases, raising awareness and improved networking of actors).</p> <p>The integration of climate change impacts in the environmental impact assessment is carried out within the obligatory implementation of the amended EU Directive on environmental impact assessment. The financing of research and pilot projects on mainstreaming climate change adaptation in the spatial planning system can be carried out at least to some extent in existing support programmes. Further resource requirements cannot be quantified at present.</p>
Possible conflict potential	No conflict potential has been identified.
Actors	BMNT (formerly BMLFUW), ÖROK, state governments, municipalities, planning firms, academic and non-academic research institutions.
Time horizon	The implementation of the amended Directive on environmental impact assessment will take place by April 2017. It is recommended that case studies and pilot projects, the development of concepts, methods and tools for climate proofing and a corresponding sectoral and political discussion begin in the short-term, so that the implementation can take place in the medium to long term.

2.12.2.13 PROMOTION OF QUANTITATIVE SOIL PROTECTION AND CONSIDERATION OF SOIL QUALITY IN LAND USE DECISIONS

Objective	Consideration of functions of the soil in spatial planning procedures to secure the soil’s ecosystem services and to maintain adaptive capacity; reduction of soil losses and additional land use due to building and sealing for settlements and transportation.
Significance	<p>In addition to the safeguarding and improvement of soil quality (see Chapter 2.1.2.1 Sustainable soil composition and protection of soil fertility, structure and stability), the quantitative protection of soil is also very important. Unsealed soil has a central role in the natural system and, amongst others, in the agricultural production process and contributes numerous ecosystem services that are also highly relevant in the context of climatic change and adaptation. These include, for example, the significance for the water system (storage, filtering, discharge regulation, groundwater recharge), the storage of carbon, the function as the location for climate-regulating vegetation and food security through production of food and feed, but also of renewable energy sources (biomass). The soil and the ecosystem services that it provides are affected by climatic change in many ways. On the other hand, unsealed soils provide significant services for adaptation of nature and society to climatic change. The continuing intensive use, building development and sealing of soils for built-up areas and transportation purposes require measures that protect the amount of this resource, which also consider more strongly the different qualities of soil.</p> <p>In doing this, it must be taken into account that the available land in Austria that could potentially be used for building settlements (permanent settlement area) is limited to only about 37% of the area of the country as a result of natural and topographical factors. Despite moderate population growth, surface use and sealing in Austria continue at a high level. The daily consumption of land area by settlement and transportation area in the 2012-2014 period was in total 19.1 ha/day, which is 8 times higher than the goal in the sustainability strategy (maximum 2.5 ha/ day) (Umweltbundesamt 2015b, 2016). If one calculates the sealing, the covering of the surface with a layer impermeable to water, the result for Austria is an average degree of sealing of 56% of the surfaces used for settlement and transport in 2014 (Umweltbundesamt 2016). Between 1995 and 2012 the sealed surface in Austria increased by 50% (BMLFUW 2015d).</p> <p>Quantitative soil protection is also discussed increasingly at the European level. In Austria, the establishment of a working group by the federal states and the BMNT</p>

Connection to other sectors

(formerly BMLFUW) on evaluation of soil functions provided a significant justification for discussing soil protection more strongly during spatial planning processes.

There are connections in particular to agriculture, water management, protection against natural hazards, health, ecosystems/biodiversity, transportation infrastructure and urban planning.

Connection to existing instruments

The Austrian sustainable development strategy (ÖSTRAT, BMLFUW 2010d); Austrian spatial development concept (ÖROK 2011); Austrian biodiversity strategy 2020+ (BMLFUW 2014); soil protection laws of the federal states; spatial planning laws; regional and local spatial planning (instruments, processes); environmental impact assessment.

State of implementation

In the Soil Charter 2014 signed by the BMNT (formerly BMLFUW), the association of municipalities and further notable institutions, the federal government and the federal states are called to avoid, as far as possible, building on high value agricultural soils and to agree on a binding goal for soil consumption (Art. 15a B-VG Vereinbarung). Within the framework of the new Austrian spatial development concept (ÖREK 2011) the protection of soil is explicitly considered.

Since 2013 an Austrian norm (ÖNORM L 1076) provides a uniform basis for evaluating soil functions. A joint working group of the advisory board on soil fertility and soil protection and the Austrian Standards Institute has developed a methodological guide for the implementation of evaluation of soil functions according to the Austrian norm (BMLFUW 2013). Upper Austria, Salzburg and Vienna provide state-wide maps of the evaluated soil functions as an internet service, which were produced using the digital map of agricultural soils and soil appraisal data; however, evaluations of soil functions are not available for the whole of Austria. In some federal states pilot projects have been carried out to integrate soil functions into local and regional spatial planning and in environmental impact assessments (BMLFUW 2013). Together with the guidelines for environmental impact assessment (Umweltbundesamt 2012) there are, therefore, significant foundations, tools and practical experience for considering soil functions in the instruments and processes of spatial planning.

In 2015 on behalf of the conference of state agricultural advisors (Landesagrarreferentenkonferenz - LARK) and the BMNT (formerly BMLFUW) a working group (federal government and federal states) of the advisory board on soil fertility and soil protection was set up, which has developed a comprehensive list of measures to reduce consumption of agricultural soil (BMLFUW 2015e). The working group recommended, amongst others, the following priority key measures: (i) comprehensive legal anchoring of quantitative soil protection (soil protection laws and spatial planning laws of the federal states, nationwide regulation); (ii) comprehensive application of soil functions evaluation in all federal states; (iii) an increase of the awareness regarding soil in municipalities, agriculture, the construction industry, schools and the general public; (iv) definition of soil conservation targets according to the area type; (v) further development of soil-protecting spatial development, amongst others, on the basis of quantifiable, regionalised targets in spatial planning laws; and (vi) measures to avoid compensatory measures on high-value agricultural areas (e.g. through pooled spaces) (BMLFUW 2015e; Umweltbundesamt 2016).

In June 2016 the conference of state agricultural advisors discussed the above measures (BMLFUW 2015e) and indicated that they are an important basis for the sectoral and political implementation. Amongst others, the spatial planning advisors of the federal states are requested to consider quantifiable goals for soil conservation more strongly in spatial planning laws.

Recommended further steps

- Comprehensive application of soil functions evaluation (on the basis of ÖNORM L 1076 and the complementary instructions from the BMNT (formerly BMLFUW) in all federal states (BMLFUW 2015e);
- Strengthening of the legal anchoring of quantitative soil protection (spatial planning laws, soil protection laws); Specification through binding regional targets for land area consumption (e.g., according to area type and soil quality) in spatial planning law of all federal states; strengthened integration of soil

	<p>functions in planning and testing instruments and processes (spatial planning, environmental impact assessment) (BMLFUW 2015e; Umweltbundesamt 2016);</p> <ul style="list-style-type: none"> – Implementation of the measures proposed by the working group of the advisory board for soil fertility and soil conservation to reduce the consumption of agricultural soils (on the basis of a decision of the state conference of agricultural advisors) (BMLFUW 2015e); – Promotion of quantitative soil protection through strengthened and optimised use of the available portfolio of instruments and measures (e.g., spatial planning laws and development planning instruments, incentives, fiscal, market-oriented and awareness-raising measures).
Possible resource requirements	For the comprehensive application of soil functions evaluation personnel resources are necessary.
Possible conflict potential	Land use conflicts can arise through competing interests and land use requirements in the context of limited development possibilities through lack of space. This is particularly possible with settlement development, transportation infrastructure planning and agriculture.
Actors	Federal and state governments, municipalities, ÖROK, b4 Corporate Soil Competence (AGES, Environment Agency Austria, BFW, BOKU (IBF), IKT), academic and non-academic research institutions, spatial planners.
Time horizon	The application of the available bases for soil function evaluation and the continual consideration of soil functions in spatial planning are possible immediately. Strengthening of quantitative soil protection in the relevant laws and the implementation of the measures proposed by the working group on soil protection could be started in the short term, whereby the implementation period depends on the specific measure.

2.13 BUSINESS/INDUSTRY/TRADE SECTOR

2.13.1 OVERARCHING OBJECTIVE OF THE SECTOR

OVERARCHING OBJECTIVE: Increasing the resilience of production and trade through minimisation of the climate-related risks and the development of climate-friendly products that support adaptation.

2.13.2 RECOMMENDED ACTIONS FOR THE BUSINESS/INDUSTRY/TRADE SECTOR

The overarching objective is to strengthen the resilience of businesses and economic sectors through careful management of climate-related risks and development of climate friendly products that support adaptation. In order to achieve this objective it is necessary, on the one hand, that suitable framework conditions, robust foundations for decisions and supporting offers are created through politics, administration, science and economic associations. On the other hand, businesses themselves must implement appropriate measures corresponding to their own risk profile. These can be of an organisational, planning, awareness-raising, ecological or technical kind.

– **Transformation** to a robust economy and society:

For a transformation to a climate-neutral economic system, a cross-sectoral, closely coordinated approach with new kinds of institutional cooperation in an integrated climate policy will be necessary. It requires a rethinking of lifestyles, consumption patterns, production structures etc. towards long-lived products and regional economic cycles.

– Systematic consideration of **climate change impacts** in the framework of business management processes:

The consequences of climatic change are multi-faceted and complex, as are the individual impacts on businesses. To date there are neither standards nor management instruments that explicitly address climatic change. However, within the framework of some initiatives, methodological approaches have been developed to integrate climate-related risks into existing structures and management systems (Fichter et al. 2013). How this can be carried out in individual cases depends on the management instruments that are established in the business. Possible starting points could be risk, quality, innovation, sustainability, environmental, safety, supply-chain or business-continuity management.

The individual climate-risk profile depends to a considerable extent on regional hazard potentials, sector-specific risks, value chains and the effectiveness of measures that have already been implemented.

It is important to consider climate risks in decision-making processes and also during the design of projects. Especially in planning of projects that will run for a long time, an early inclusion of climate change aspects is highly relevant, such as in decisions on location, new construction or renovation, production facilities, warehouses, transportation, water and energy infrastructure. In this way, the risk of damage can be substantially reduced and long-term use is supported.

For small and medium-sized enterprises (SME), which often have no institutionalised management system, it is recommended that the climate risks are identified and initially evaluated in a workshop with experts. Depending on the characteristics of the individual risk profile, one or more employees should be trained, who are then responsible for climate risk management in the business. The German Ministry of Economics published climate-check guidelines with an Excel-tool, designed for medium-sized businesses of the manufacturing industry in Germany, but which

is useful in parts for other businesses. The guidelines and tool are available on the website of the German Ministry of Economics (BMWi)¹⁶¹.

- Review and, where necessary, adaptation of relevant **legal framework conditions** and norms:

A screening of relevant legal and normative requirements with regard to their suitability for adaptation appears to be unavoidable for the ability to implement some adaptation measures. However, for those measures that have negative environmental effects, further attention will have to be paid to ensure that they do not contradict the political intentions (such as the protection of the environment in line with the environmental impact assessment) upon which the legal framework conditions are based.

- Further development and strengthening of the interface between the economy and research:

In future planning and product development, the findings of climate research must be considered and regularly evaluated. Through the cooperation with scientific institutions, economic competitiveness should be increased and socially and environmentally acceptable innovations should be supported.

- Strengthening the interface between authorities and businesses

A necessary prerequisite for the implementation of adaptation measure by firms is the interconnecting of measures from different sectors and the strengthening of the interface between authorities and businesses through the bringing together of competences regarding climatic change. The example of the food industry shows clearly that the future of the food and drink industry depends on the interconnection between different sectors (e.g., energy, water supply, land use, ecosystem services and biodiversity).

Focus Production and Trade

2.13.2.1 SECURING OF SUPPLY, TRANSPORT NETWORKS AND PRODUCTION THROUGH DIFFERENTIATED SUPPLY NETWORKS, REGIONAL CLUSTERS AND PRODUCTION CLOSE TO THE MARKET

Objective	<p>Ensuring security of supply, e.g., with agricultural products through regionally and seasonally differentiated supply networks; reducing the risk of failure in the supply chain;</p> <p>Reducing the risk of failure and/or fluctuations in price/amount (availability) in the supply chain through the regionalization and diversification of sub-supplier relationships;</p> <p>Securing the transportation routes in the supply and distribution networks, reducing the risk of interruptions along the transportation network, ensuring the quality of, for example, agricultural and forestry products or food.</p>
Significance	<p>Through regional clusters and production close to the market, transportation distances are shorter. This reduces, on the one hand, the risk of a disrupted supply or delivery chain through possible damages to transport infrastructure. If the production is close to large markets, on the other hand, the risk of interruption of operational or sales networks is reduced.</p> <p>Suppliers from different regions (broader distribution and reduction of the risk of a total failure) and seasonally different supplies (different harvesting times) secure the supply of agricultural goods and reduce additional sourcing and distribution risks, which could</p>

¹⁶¹<http://www.bmwi.de/Redaktion/DE/Publikationen/Industrie/klimacheck.html>

	<p>arise through negative impacts on the transportation infrastructure or as a result of damages to suppliers.</p> <p>Shorter transport distances for temperature-sensitive goods (e.g., food, chemicals, dangerous goods and medical products) reduce the danger of a loss of quality through transport or long temporary storage.</p> <p>Through regional clusters and production close to the market, transport distances are reduced and, as a result, there are cost savings and reduced greenhouse gas emissions.</p> <p>Regional clusters and production close to the market are very significant for regionally focussed sectors, such as food production, while these measures are less relevant for large-scale industrial and/or internationally oriented sectors.</p>
Connection to other sectors	<p>There is a connection to transport infrastructure, water management, energy (connection to decentralised energy supply), agriculture and spatial planning.</p>
Connection to existing instruments	<p>There are connections to business plans, instruments for location planning and testing, operational emergency plans, norms (e.g., ISO 31000 und ONR 49000 – risk management, ISO 14001 und EMAS – environmental management, ISO 22301 – business continuity management, etc.) and further business management instruments (supply chain management, safety management, process management etc.)</p>
State of implementation	<p>Regionality and regionalisation are increasingly discussed and are being promoted in many Austrian regions.</p> <p>Through increasingly responsible consumption, there is an increased demand for products from Austria or from the regions. This supports and encourages regional cooperation.</p>
Recommended further steps	<ul style="list-style-type: none"> – Simplification of the communication with authorities and strengthening of the interface between authorities and businesses through consolidation of competences regarding climate change (e.g., in a local contact person or specific institution); – Strengthening of regional economic structures, e.g., through more intensive interconnections between firms and agricultural and forestry operations in the region; – Development and establishment of sector-specific advisory services, also at the regional level, for sensitisation and awareness-raising with regard to climatic risks, to enable businesses to make their supply chains climate-fit and to diversify their supply networks correspondingly; – Include the topic of adaptation to climatic change or management of climatic risks in training and further education programmes; – Compile and disseminate available knowledge and available practice (good practice examples); – Support of pioneer projects and pilot experiments; – Awareness-raising in the general public and in the regions about the significance of regional production close to the market and consumption; – Promotion of research and development in order to improve the resilience (resistance and regeneration ability) of the economy, especially small and medium sized enterprises; – Include climatic risks in operational supply-chain management and business-continuity management.
Possible resource requirements	<p>For the possible adaptation of logistics systems, additional needs for investments by businesses are expected.</p>
Possible conflict potential	<p>A geographically wide distribution of suppliers can lead to additional greenhouse gas emissions as a result of the longer transport distances.</p>
Actors	<p>Businesses; federal and state governments (food authorities), AGES, municipalities, interest groups (Chambers, trade associations).</p>

Time horizon | The implementation is a long-term process that should be started immediately.

2.13.2.2 SECURING SUPPLY AND PRODUCTION THROUGH LONG-TERM CONTRACTS AND EXPANSION OF STOCKS HELD IN WAREHOUSES

Objective	<p>Maintenance of freight flow processes along the value chain through long-term contracts and the expansion of existing contracts, reducing the risk of losses, for example of agricultural delivery products, ensuring the quality of agricultural advance services;</p> <p>Reducing the risk of failure and/or fluctuations in price/amount (availability) in the supply chain by expanding inventory and avoiding supply shortages.</p>
Significance	<p>Extreme weather events and periods of weather such as droughts in agricultural areas can lead to loss of harvest. Supply shortages and rising prices are the result. Through other extreme weather events such as storms, the transport infrastructure can be damaged, which leads to interruptions in the supply chain. In order to reduce these risks, storage in warehouses is increased.</p> <p>However, especially in the case of food, this can mean that the need for cooling increases, which leads to increased energy demand and rising costs when conventional technologies are used.</p> <p>While for the food industry the above measures are a reasonable option, because of stronger fluctuations of agricultural raw materials as a result of climatic change, for sectors that are more internationally oriented such as the chemical industry climate-related price fluctuations are above all relevant for renewable raw materials. For sectors and businesses, whose business model relies on fossil raw materials and energy supply, such as coal, mineral oil (products) and gas, climate policy decisions and new regulations present a risk.</p>
Connection to other sectors	There is a connection in particular to transportation infrastructure, energy, agriculture and construction and housing.
Connection to existing instruments	Connections are to contract law (General Civic Law) and with regard to expanded warehouse capacity building law and its regulations (specific to particular federal states).
State of implementation	In the meat-processing industry, for example, long-term contracts with domestic farmers are being agreed or expanded, in order to guarantee the supply of meat.
Recommended further steps	<ul style="list-style-type: none"> – Review and, where necessary, expansion of the warehouse stock or increase of the storage capacity for important inputs to production; – Inclusion of the suppliers in the operational supply-chain management, e.g., in that the businesses request information from their suppliers on whether they know and manage their climate risks, or through appropriate design of supply contracts; – Securing of supply of raw materials through the review and, where necessary adjustment or closure of long-term supply contracts; – Examination of whether the required raw materials imply climate risks as a result of greenhouse gas emissions and if necessary development of a strategy to substitute CO₂-intensive raw materials with climate-friendly alternatives in the medium term; – Development and establishment of (regional) advisory services.
Possible resource requirements	The possibly required expansion of storage capacities can give rise to additional needs for investment for businesses (after a cost-benefit analysis). Relevant questions can be integrated into existing research programmes.
Possible conflict potential	The measure could lead to much higher costs of storage. An expansion of storage capacities is therefore only efficient, if the increased costs of storage are not higher than the avoided costs of supply failures and/or price rises for agricultural raw materials.

Actors	<p>Furthermore, an expansion of warehouse stocks can lead to more demand for land. If the expansion of warehouse stock leads to an increased use of conventional air-conditioning and cooling systems, the energy demand would increase in any case (the relevance for climatic change mitigation depends on the source of the electricity).</p> <p>Businesses; Chamber of Commerce, federal and state governments.</p>
Time horizon	<p>These actions can be implemented in the medium term.</p>

2.13.2.3 MEASURES TO INCREASE THE RESILIENCE OF PRODUCTION, SALES AND OPERATIONAL INFRASTRUCTURE

Objective	<p>Maintenance of the production process, ensuring adequate conditions for storage, preventing quality deterioration due to impaired storage, functioning logistics under conditions of higher outdoor temperatures and during periods of drought, and protection of operational infrastructure during floods and other extreme weather events (storms, hail, snow load).</p>
Significance	<p>Through increased outside temperatures, the inside temperatures also increase in warehouses, production halls and offices. This temperature increase can affect the quality of the products (e.g., food in trade), which is why production and storage facilities are already cooled today. An additional demand for cooling arises for office buildings. Through appropriate construction measures and the use of passive and alternative cooling methods for the air conditioning of production halls (insulation, air conditioning systems) these negative consequences can be avoided.</p> <p>When the outside temperatures are very high, cooling with water from water towers during the course of production cannot be used and it is necessary to use water that has been cooled using a large amount of energy.</p> <p>Through increased dryness, there are water shortages in some regions, since the public water grid cannot provide a sufficient supply. Therefore, waste water should be increasingly reprocessed. Furthermore, rainwater storage is an alternative for water-intensive production that should be promoted more strongly (e.g. in the chemical industry).</p> <p>In addition, buildings should be built so that they can better withstand natural disasters. Roofs and façades, which can be damaged above all by hail, storm and snow load) are particularly threatened.</p> <p>As a result of storms there is an increase of damage to glass, e.g., in retail spaces. During new construction and renovation, glass that can withstand higher pressures should be used.</p> <p>Through the direct proximity of production systems to rivers or water bodies that are often needed for cooling processes, the danger of flooding is increased.</p> <p>Through appropriate flood protection by public authorities (e.g., local and regional spatial planning, dams, retention areas) and measures for individual responsibility, damages can be averted.</p> <p>Businesses can protect themselves through building, technical, planning and organisational measures, through investments, for instance in emergency power generators or pumps, or together with other businesses through strengthening the local fire brigade.</p>
Connection to other sectors	<p>There are connections to energy, water management, construction and housing, transportation infrastructure, protection against natural hazards and ecosystems/biodiversity.</p>
Connection to existing instruments	<p>There are connections to, amongst others, water law (federal government), building law and regulations (federal states), instruments of spatial planning and the environmental impact assessment. On the business level there is a connection to operational early warning systems, safety concepts and emergency plans, norms (ISO 31000 and ONR</p>

State of implementation	49000 – risk management, ISO 14001 und EMAS – environmental management, ISO 9001 – quality management, ISO 22301 – business continuity management etc.) and further business management instruments (supply chain management, safety management, process management etc.).
Recommended further steps	<p>Protection of operational infrastructure against damages through extreme weather events such as storms, hail and snow load is being carried out in some cases during the course of renovation, e.g., through the use of suitable building materials and methods, as well as by taking out insurance.</p> <p>Flood protection is taking place autonomously in some cases.</p> <ul style="list-style-type: none"> – Embed the review of climate risks in business management systems and processes (e.g., consideration of climate risks as a criterion in the selection of suppliers, distribution and sales partners or business locations); – Increase the water (and energy) efficiency in production processes and review the relevant legal requirements in order to possibly promote rainwater storage; – Make process more flexible (supply, production, logistics, sales) through redundancy and substitution possibilities; – Development or adaptation of operational emergency plans and introduction of operational early warning systems; – Diversification of sales partnerships and sales regions; – Business investment in research and development, e.g., on cooling – such as analyses related to river areas, innovative cooling approaches, change of water quality with regard to biomass growth, deposits and germ contamination; – Adaptation of requirements in laws for commerce and promotion or facilitation of pilot projects; – Development of a climate-risk check tool for small and medium-sized enterprises that is easy to use; – Strengthened consideration of the experiences within pilot projects for the further development of legal framework conditions; – Interconnect measures from different sectors (for instance from energy management, water management and manufacturing).
Possible resource requirements	It will be necessary for businesses to invest in cooling systems, air conditioning, water reprocessing systems, rainwater storage, building and flood protection measures. In addition, climate risks must be considered in management and operational processes.
Possible conflict potential	There is a possible conflict potential with protection of nature and species through interference with ecosystems (in particular through flood protection).
Actors	Businesses, federal and state governments, municipalities, interest groups (Chamber of Commerce, trade associations, Federation of Austrian Industry).
Time horizon	If implementation takes place in the short term, the measures should be effective in the medium term.

2.13.2.4 INCREASED ENERGY SECURITY BY PROMOTING ALTERNATIVE/ ENERGY EFFICIENT TECHNOLOGIES TO INCREASE RESILIENCE TO THE IMPACTS OF CLIMATE CHANGE

Objective	Increasing energy security by saving energy, measures to increase efficiency, increased usage of renewables, diversification of energy sources, grid expansion, and businesses generating their own energy in order to reduce their vulnerability to the impacts of climate change.
Significance	The impacts of climatic change can affect the energy supply of businesses, especially through extreme weather events. Energy sources and energy infrastructure can be disturbed, damaged or destroyed, for example, by storms or ice loads. Measures that

<p>Connection to other sectors</p> <p>Connection to existing instruments</p>	<p>increase the security of supply, such as the reduction of energy demand, are not only relevant for adaptation but also significantly for climate protection.</p> <p>The energy demand is reduced through structural, organisational and technical measures (such as operational energy recovery). Through this reduction, supply risks and negative effects of price fluctuations are reduced.</p> <p>An additional benefit is the reduced use of fossil fuels, which contribute simultaneously to climate change mitigation.</p> <p>Examples: renewable energy sources (e.g., photovoltaic systems, alternative hydropower plants), fuel recovery (e.g., by-product gases), use of industrial waste heat (e.g., through feeding into district heating grids), thermal renovation of buildings, passive cooling and active cooling with alternative technologies (e.g., solar cooling), solar heating.</p> <p>Furthermore, decentralised energy supply reduces the dependence on energy grid infrastructure, which reduces the risk of a blackout.</p> <p>For energy-intensive sectors, such as the chemical industry or iron and steel production, a secure energy supply at globally competitive prices is a decisive production factor, since, for example, longer-running chemical processes can be disrupted by interruptions of the energy supply.</p> <p>If, as a result of electricity failures (e.g., through storms or heavy snow loads), systems that are usually always running have to be shut down, this can lead to sensitive loss of revenue.</p> <p>The planned ring closure of the Austrian electricity grid would increase the supply security of electricity in Austria.</p> <p>Lightning detection systems could help businesses, in the case of pending severe weather, to switch to their own emergency electricity system in order to avoid electricity and production failures.</p>
<p>State of implementation</p>	<p>There are connections above all to energy, construction and housing and ecosystems/biodiversity.</p> <p>There are connections to emissions trading, the cogeneration Directive of the EU, cogeneration laws, Austrian law on electricity generation from renewable energy sources, environmental impact assessment, energy efficiency law, electricity management and organisation law, law on district heating and cooling, climate protection law, Austrian environmental support, Austrian Climate and Energy Fund.</p> <p>Some alternative energy sources have long amortisation times and are therefore to some extent only implemented with support.</p> <p>To some extent efforts to improve energy efficiency are already made on economic grounds and the energy efficiency law will bring additional improvements in energy efficiency. However, support measures, such as support for energy audits for small and medium-sized enterprises and for the implementation of an energy management system, are also needed in the business sector.</p>
<p>Recommended further steps</p>	<p>A current barrier to the feed-in into the district heating grid is the spatial separation between industrial and residential areas (prescribed building and safety zones), which means that feed-in is often not profitable. In addition, organisational circumstances are a barrier to implementation.</p> <p>The ring closure in the Austrian electricity transmission grid is planned. Lightning detection systems are provided by ZAMG and insurance companies.</p> <ul style="list-style-type: none"> – Increase energy efficiency in the operational area; – Promotion of renovation of office and company buildings with regard to energy; – Promotion of renewable energy and energy recovery for companies; – Promotion of energy-efficient cogeneration plants (when sufficient renewable energy sources are available) for in-plant electricity generation and for waste recycling and feeding waste heat into the grid;

	<ul style="list-style-type: none"> – Review and, where necessary, creation of incentives for feeding-in to the district heating grid; – Possible use of regional waste heat potential through the introduction of regional waste heat associations; – Promotion of energy audits for small and medium-sized enterprises; – Promotion of the introduction of energy management systems; – Further development of advisory services and awareness raising; – Review and, where necessary, promotion of the Top Runner approach¹⁶²; – Research and development for energy optimisation of energy-intensive manufacturing.
Possible resource requirements	For the implementation of the recommended actions business investments are needed in the short and medium term, which will become profitable in the medium and long term.
Possible conflict potential	The ring closure in the Austrian transmission grid leads to a conflict potential with neighbouring residents and with nature protection.
Actors	Companies, federal and state governments, energy industry.
Time horizon	With short-term implementation, medium-term effects can be expected. In the case of the ring closure option, the implementation is over the long term.

2.13.2.5 DEVELOPMENT OF CLIMATE-FRIENDLY AND ADAPTIVE PRODUCTS, TECHNICAL PROCESSES AND SERVICES

Objective	Increasing resilience (ability to resist and regenerate) through innovative products, technical procedures, and services.
Significance	<p>In order to limit climatic change and make its consequences manageable, public and private actors must make their contribution to achieving climate goals and simultaneously prepare for changed climatic conditions. The range of measures extends from new regulatory requirements to risk-reducing construction measures. Therefore, there is a strong demand for climate-friendly and climate-fit products, processes and services.</p> <p>Businesses, as part of complex value chains, can react to these regulatory/market economy consequences. Examples are: alternative drive technologies and light construction in the automobile industry, insulation material from renewable raw materials, detergents from renewable raw materials, mobile flood protection elements, façade elements that are not damaged by hail and products that can be recycled without high energy requirements. However, there is a demand for new technical solutions and services, such as processes that aim to increase energy and resource efficiency, climate-friendly mobility concepts, building methods that protect against storms and floods, alternative financing models (e.g., to finance projects in the renewable energy sector).</p>
Connection to other sectors	There are connections in particular to water management, construction and housing, energy, protection against natural hazards, agriculture and forestry.
Connection to existing instruments	There are connections to the patent system and to the legal framework conditions for eco-design (EU Directive) and producer responsibility, energy efficiency law, climate protection law.

¹⁶² The Top Runner approach is an environmental approach focussing on products, which aims to support market penetration of the most environmentally friendly (resource and/or energy efficient) technology within a particular product group. The Top Runner approach sets a target value for the energy consumption of products within a specific product group. The target is determined on the basis of the efficiency level of the most energy-efficient product in each product group available at the time of setting the target.

State of implementation	The advancement of innovations is a continual process – on the one hand through the dominating competition and on the other hand through new regulations (e.g., climate protection requirements) by legislators.
Recommended further steps	<ul style="list-style-type: none"> – Creation of an environment that supports innovation and optimal framework conditions for research and development; – Promotion of research, development and innovation in the area of climate change adaptation to establish Austria as a lead market (e.g., in the area of innovative transport infrastructure); – Adaptation of norms and legal requirements (e.g., building regulations) to the demands of changed climatic conditions; – Systematic analysis of the environmental and climatic impacts (life-cycle analysis, environmental footprint, carbon footprint) for products and services along the value chain, as the basis for an environmentally friendly and climate-friendly product design; – Acceleration of patent processes; – Strengthening of initiatives such as repair networks, repair cafes, food cooperatives etc.; – Standardisation of the legal framework conditions in the European Union.
Possible resource requirements	Corresponding questions can be taken up in existing research programmes.
Possible conflict potential	Current legal and normative requirements as well as massive state support for energy forms that damage the environment and climate make the establishment of climate- and environment-friendly products, processes and services in the market difficult. On average in recent years the volume of environmentally damaging subsidies in Austria was 3.8 – 4.7 billion Euros (WIFO 2016).
Actors	Companies (supply and demand side), public sector (demand side).
Time horizon	Research activities can be started immediately and in the short term.

Focus Insurance

2.13.2.6 PROMOTION OF APPROPRIATE FUTURE SCENARIO-BASED RISK ASSESSMENTS, COOPERATION WITH R&D, MONITORING OF SCIENTIFIC RESULTS

Objective	Development of new risk assessment methods for the entire insurance industry taking climate scenarios and transformation risks into account; improved bases for risk assessment for companies.
Significance	<p>Risk assessment based on historical data (e.g., the return period of floods) is becoming more difficult and in some cases impossible as a result of climatic change. For future planning, product development and investments, findings from climate scenarios (especially with regard to extreme weather events) must be taken into account and regularly evaluated.</p> <p>The insurance sector is interested in learning about and understanding current scientific findings regarding climatic changes and their consequences as much as possible. The goal is, amongst others, to be better able to project risks as a result of weather events (e.g., hail). Through cooperation with scientific institutions reliable models should also be developed to enable more robust risk assessment.</p> <p>For future risk assessments, in addition to climate scenarios, economic, technological and societal developments as well as successes in climate protection should be considered.</p>

Connection to other sectors	<p>In general, businesses should be better informed about the current state of the climate problem, so that they can be better prepared or implement more robust adaptation measures.</p>
Connection to existing instruments	<p>Fulfilling the requirements of Solvency II, the new regulatory framework for insurance businesses, which came into full force on 1.1.2016, is a central challenge for the insurance sector. The insurance companies are now required to adapt their capital demands correspondingly and to take their own risk exposure as a result of climatic change more strongly into account. Thus it is important to have a robust basis of data for risk analysis and evaluation.</p>
State of implementation	<p>In addition to banks, investment companies etc., insurance companies are institutional investors. In connection with Solvency II it is advantageous to examine one's own investment strategy with regard to possible climatic risks and, where necessary, to re-evaluate the investments. Current studies show that investments in CO₂-intensive institutions hide substantial risks that could lead to appreciable value losses (Bank of England, 2015; BAFU, 2015; Economist Intelligence Unit, 2015; GEF – Green European Foundation, 2013; Prudential Regulation Authority, 2015). Globally, large investors are therefore already moving out of CO₂-intensive investment forms (divestment), in order to reduce the risk of stranded assets.</p>
Recommended further steps	<p>There are connections in particular to construction and housing, agriculture, forestry, transportation infrastructure, spatial planning, water management, disaster management and protection against natural hazards.</p> <p>There is a connection to the information platform HORA and the instruments of spatial planning; risk management – provided that appropriate methods for risk identification and evaluation are used (e.g., scenario analysis, Delphi methods).</p> <p>Some institutional investors already signed the international “Montreal Carbon Pledge”¹⁶³ and committed themselves to measure the carbon footprint of their capital investments every year, to publish the results and to continually reduce the footprint.</p> <p>Some large insurance companies have already developed strategies for withdrawal from climate-damaging investments and steer their capital investments towards sustainable and climate-friendly forms of investment.</p> <p>Monitoring of scientific research is already taking place in some cases.</p> <p>Insurance companies have excellent know-how in the evaluation of risks, especially with regard to the risks of natural hazards.</p> <p>Some companies already address climate-related risks and opportunities in operational risk management or in other established management instruments.</p> <ul style="list-style-type: none"> – Systematic measurement and presentation of climate risks of investments using carbon footprints or CO₂-balances; – Disclose the climatic impacts of investments to stakeholders and engage in international transparency initiatives such as the “Montreal Carbon Pledge”; – Perform stress tests on capital investments and, where necessary, develop strategies to withdraw from investment forms that contain high climate risks; – Targeted development of capacities in the area of climatic change and investments; – Identify opportunities as a result of climatic change, such as insurance products for renewable energy projects, awareness-raising initiatives and risk-transfer solutions to increase the resilience, investments in climate-friendly forms of investment etc. (Prudential Regulation Authority 2015); – Support for research and development.

¹⁶³ Link: <http://montrealpledge.org/>

Possible resource requirements	At most, resources are required for investments by insurance companies in research and development.
Possible conflict potential	No conflict potential has been identified.
Actors	Insurers, academic and non-academic research institutions.
Time horizon	Research initiatives can be started immediately and in the short term.

2.13.2.7 RAISING PUBLIC AWARENESS ABOUT PREVENTING DAMAGE AND REINFORCING THE INDIVIDUAL RESPONSIBILITY OF INSURED PEOPLE

Objective	Strengthening of private preparedness measures resulting from insurers proactively informing their customers as well as public institutions and the general public about risks and changed potentials for natural hazards due to climate change, so that they are in a position to take precautionary measures and avoid damage.
Significance	<p>The ability of society to deal with increased potential of natural hazards depends on various factors, such as the actions of water management administrations, disaster protection, those responsible for zoning plans, the political actors involved, as well as the risk awareness and individual precaution of the population. The resulting vulnerability is considerable in some cases, because within the general public there is a strong expectation that the state is responsible for their safety and a shallow awareness of their own responsibility.</p> <p>Knowledge about the consequences of climatic change, their chains of effects and the possible individual vulnerability is essential in order to be able to recognise and reduce damage potential. Often there are simple behavioural measures (e.g., closing windows during storms, informing oneself proactively about hazards) or construction measures, which – if they are planned early enough – often do not lead to considerable additional costs but bring large benefits (e.g., installation of backflow protection devices, protection of exposed building parts against increased wind and snow loads, using hail- and heat-resistant building materials and façade elements, protecting cellar entrances, sufficient sizing of rainwater gutters, ensuring infiltration possibilities in the premises).</p> <p>Possible instruments are information events and campaigns, competitions, distribution of brochures in the general public, conversations between insurance representatives and customers, design of premiums and deductibles depending on measures taken for individual precaution, online services (e.g., www.naturgefahren.at, www.hora.gv.at), GIS-applications on mobile telephones, hazard and risk maps for areas with significant natural disaster risks.</p> <p>In addition to a better communication of the fact that basically every person is responsible for the protection of his/her property, and a better communication of the risk and the residual risk, as well as the possibilities for protecting objects, the strengthening of individual precaution and object protection require a corresponding and incentivising form of risk-transfer mechanism (e.g., reduced premiums for insurance solutions, where necessary depending on the risk zones).</p> <p>Through the particularly large coverage of insurance in the population, this measure has great potential.</p>
Connection to other sectors	There is a close connection to protection against natural hazards (see Chapter 2.7.2.6 – Promoting adoption of measures for reducing risk while taking account of appropriate risk transfer mechanisms – and Chapter 2.7.2.7 – Promotion of property protection measures (permanent and temporary) to encourage individuals to take safeguarding measures –, disaster management, water management, construction and housing and health.

Connection to existing instruments	There are connections to customer service of the insurance companies and information campaigns of public institutions.
State of implementation	<ul style="list-style-type: none"> – Through information campaigns, strengthening of individual responsibility is already taking place in some cases. The insurance association and further insurance companies provide information material on natural disasters, protection against storm damages, floods etc. The first steps have been taken in the development of a natural hazard passport for various natural hazards such as storms, hail and floods on the basis of HORA data. – Both public institutions and the private sector have some approaches to solutions, in order to improve the current system. – In Vorarlberg, for example, insurable damages up to 7,200 Euros are not compensated by the public sector. – In Salzburg, damages in the red hazard zone are only compensated in exceptional cases. In Lower Austria, compensation is only paid under the condition of the correctness of government permits. – An interactive risk radar is provided by one insurance company for various natural hazards, such as storm, hail, flood and lightning, which is based on data from insurance cases available to this company.
Recommended further steps	<ul style="list-style-type: none"> – Design of communication formats for different target groups to show the necessity of and possibilities for individual precaution and increase risk awareness; – Strengthened cooperation of insurance companies and the administration in the development and execution of information campaigns. These should be, amongst others, participatory and carried out at the local level; – Connect payments from the disaster fund to requirements; this requires the development of a catalogue of preventive measures for businesses and households; – Tax relief for individual precaution; – Incentivising design of insurance products; – Strengthened cooperation between insurance companies, science, politics and administration.
Possible resource requirements	Financial resources must be provided for public relations and communication.
Possible conflict potential	One problem is that private persons believe that there is full insurance without paying for premiums through the disaster fund (in reality this is not the case), which strongly reduces the incentive for individual precaution (BMLUFW 2015b).
Actors	Insurers, public institutions.
Time horizon	Information campaigns can start immediately after their planning and preparation.

2.13.2.8 BETTER RISK DIVERSIFICATION FOR INSURERS, WITH RESULTING INCREASE IN THE INSURABILITY OF CLIMATE- AND WEATHER-INDUCED DAMAGE

Objective Significance	<p>Introduction of insurance against natural disasters (NatCat insurance).</p> <p>In the case of high damage potentials, insurers are limited in the extent to which they can provide insurance protection. Through the participation of other partners from the sector, both the risks and the premiums are shared, which means that it is easier to insure certain risks.</p>
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Connection to other sectors**Connection to existing instruments****State of implementation****Recommended further steps**

Currently in Austria there is no possibility to insure natural disasters above certain limits. The insurance of damages due to natural disasters, in contrast to the usual household or liability insurance, is not possible through a private sector solution. With disaster insurance, the potentially high damage claims due to a natural disaster must be considered. For this, insurance with an affordable premium is extremely difficult for a private insurance company. At the same time, there is the problem of adverse selection, i.e., the situation in which only the people who are exposed to a high risk voluntarily take out additional insurance against it. Therefore, in order to create a model that is achievable in the market economy, the general public must be directly or indirectly obliged to insure. For this reason a regulatory and/or supporting participation of the public sector is sensible or necessary.

Research projects and attempts in the past to identify the possibilities for an Austrian natural disaster insurance (NatCat insurance) show that there are no simple solutions. After the floods in 2002 and 2005 a comprehensive reform proposal for NatCat insurance in Austria was developed.

The scientifically evaluated NatCat-model includes a full insurance against natural disasters, made possible through an obligatory linking of the NatCat area to fire insurance. The model proposes that premiums are dependent on risk zone. Possible deductibles could be an incentive for preventive measures.

The research project InsAdapt – Insurance for Adaptation¹⁶⁴ evaluated the current situation in Austria together with representatives from the federal government, federal states, municipalities and the insurance sector (Hanger & Riegler 2016, Mechler 2016).

There is a connection in particular to protection against natural hazards, construction and housing and disaster management (see Chapter 2.8.2.4 – increasing the flexibility of financing and funding instruments in the field of disaster management).

There is a connection to the insurance contracts law.

Some important steps in the direction of public-private partnerships in the area of risk transfers have already been taken. However, a full implementation, e.g., in the form of the NatCat-model developed by the insurance sector, which proposes relief for the state disaster fund through a private sector obligatory insurance against natural disasters, has not yet been made (BMLFUW 2015).

- Review and where needed implementation of a NatCat-insurance for Austria considering current research results;
- Increase the public acceptance for a NatCat-insurance solution (and thereby its political feasibility) through broad information campaigns and awareness raising (Habersack et al. 2015);
- Insurance in existing insurance solutions to a maximum threshold, above which state compensation is provided from the disaster fund (such as the scheme already implemented in Vorarlberg with a limit of 7,200 Euros)(Hanger & Riegler 2015);
- Standardisation of the state support system for individuals who have suffered damage, in order to have a uniform damage compensation from the disaster fund across the country (BMLFUW 2015);
- Harmonisation of the settlement methods of the federal states following the respective best federal state model (BMLFUW 2015);
- Linking of damage compensation to corresponding implementation of measures for individual precaution (e.g., object protection) (BMLFUW 2015);

¹⁶⁴ Link: <http://pure.iiasa.ac.at/13003/1/WP-16-003.pdf>

Possible resource requirements	<ul style="list-style-type: none"> – Cross-sectoral and cross-departmental communication between the relevant groups of people, e.g., through setting up a regular discussion forum within the framework of the flood risk management plan (Hanger & Riegler 2015); – Review and, where necessary, adaptation of the insurance contract law. <p>Resource requirements can be expected for measures for information dissemination and awareness raising (public sector and insurance companies) and for insurance premiums (private persons).</p>
Possible conflict potential	<p>Possible conflicts could arise through different directives and guidelines of the individual federal states for settlement methods regarding the provision of support to deal with disaster damages (deadlines, payment and inspection aspects, social criteria, marginal wages threshold, damage estimation, data collection and recording) (BMLFUW 2015).</p> <p>To date there is no political consensus, so the necessary political steps for a NatCat solution have not been taken. Since a high penetration is necessary for the insurability of natural disaster risks, the obligatory extension of the coverage to fire insurance is a significant element. This requires a change of the legal framework in the insurance contract law (BMLUFW 2015b).</p>
Actors	<p>Insurers, federal government (lawmakers).</p>
Time horizon	<p>This recommended action can be implemented directly after changing the insurance contracts law.</p>

2.13.2.9 PROVIDING SERVICES TO CUSTOMERS AFTER CLAIMS

Objective	<p>Support for damage repair as well as professional damage management in order to limit follow-on damages and to strengthen the resilience to future events.</p>
Significance	<p>After damage it is difficult for victims to maintain an overview and take all of the steps in a coordinated way. To act correctly in such exceptional situations and limit follow-up damages, professional support is valuable.</p> <p>Since large damaging events often occur simultaneously during natural disasters, the necessary services after the event can run short. Through additional efforts on behalf of the insurance companies in the case of insured damage, there should not only be financial compensation but also organisational support, such as the searching for and identification of service providers to repair damages or to manage damages, coordination of all involved actors, such as further insurance companies, authorities, disposal companies, renovators etc.</p> <p>To provide these supporting services, insurance companies are making efforts “when things are quiet” to build up good relationships with qualified service providers, so that they are available in times when resources are short (e.g., from other regions).</p>
Connection to other sectors	<p>There is a connection to protection against natural hazards, disaster management, construction and housing, health and agriculture.</p>
Connection to existing instruments	<p>There are connections to disaster deployment plans.</p>
State of implementation	<p>The provision of services for customers is being continually expanded.</p>
Recommended further steps	<ul style="list-style-type: none"> – Development of customer services of insurance companies; – Strengthened cooperation and coordination with all relevant actors (federal government, federal states, emergency service organisations) in the development of joint services; – Strengthened cooperation and coordination with evaluators, experts, municipalities and emergency services when an event occurs.

Possible resource requirements	There is a need for additional personnel.
Possible conflict potential	No conflict potential has been identified.
Actors	Insurers, other service providers.
Time horizon	Implementation should take place in the short to medium term.

2.14 CITIES – URBAN GREEN AND OPEN SPACES

2.14.1 OVERARCHING OBJECTIVE OF THE SECTOR

Overarching objective: Safeguarding urban quality of life under changed climatic conditions through conservation and improvement of the multiple functions of urban open and green spaces.

2.14.2 RECOMMENDED ACTIONS FOR CITIES - URBAN GREEN AND OPEN SPACES

GENERAL PRINCIPLES FOR ACTION IN CITIES – URBAN GREEN AND OPEN SPACES

Adaptation in urban areas is a cross-cutting issue, which can only be successfully implemented, if it is planned and implemented in an integrated way. The success is only possible through the inclusion of all relevant persons in the city administration, but also users or private property owners.

2.14.2.1 ADAPTATION OF THE WATER MANAGEMENT STRATEGY FOR GREEN AND OPEN SPACES

Objective	Ensuring the water supply and retention functions of green and open spaces under changing climatic conditions.
Significance	<p>Urban ecosystems are especially affected by the impacts of climatic change. In the summer it is assumed that there will be increasing water demand as a result of higher temperatures, during heat waves and increasing dryness. At the same time, it can be assumed that there will be growing demands for the use of areas and for new green and open spaces for recreation.</p> <p>The possible increase of precipitation, in particular heavy rain events, also presents new challenges for water management in green and open spaces with regard to their retention function as well as their contribution to infiltration support. Convective heavy rain events in summer easily lead to small-scale flooding in urban areas with a high damage potential. Measures on the surface that allow the rainwater discharge to infiltrate, evaporate, be stored or diverted with a time delay will become increasingly important. These measures include green roofs and courtyards, permeable surfaces, unsealing of surfaces and rainwater storage. Various kinds of environmental technology with multiple functions include rainwater infiltration systems for roof drains and paved surfaces (including parking spaces for cars). High priority is given to the selection of purification possibilities for dirty rainwater (separators, settling ponds, filter, absorption systems).</p> <p>Closely connected with this are the dimensioning, operation and testing of purification systems for transportation and parking areas. The use of these cleaning systems (drainage of transportation surfaces) is limited to the purification of rain- or meltwater that comes in particular from transportation and parking surfaces, handling areas and storage areas and that are usually not polluted by light fluids. Major transportation areas such as motorways or highways are discussed in Chapter 2.11.2.7.</p> <p>There is increasing discussion of multifunctional surface use in residential areas as an option for avoiding small-scale inundation and floods.</p>
Connection to other sectors	<p>There is a close connection to the following sectors:</p> <p>Water Resources and Water Management (Chapter 2.3.2.2 – Improving coordination / information concerning water consumption and water demand; Chapter 2.3.2.3 – Guarantee of future water supply; Chapter 2.3.2.4 – Responsible use of water resources; Chapter 2.3.2.6 – Achieving and ensuring the good ecological and chemical status of water bodies (including groundwater); Chapter 2.3.2.8 – Adaptive flood risk management with robust measures);</p> <p>Construction and Housing (Chapter 2.6.2.5 – Increase of water retention);</p>

Objective	<p>Ensuring the water supply and retention functions of green and open spaces under changing climatic conditions.</p> <p>Protection from natural hazards (Chapter 2.7.2.3 – Promotion of water retention in catchment areas and reactivation of natural floodplains (and areas), particularly as a contribution to provision of additional inundation areas);</p> <p>Transport Infrastructure (Chapter 2.11.2.7 – Reduction of the increase in permanently sealed surfaces for transport infrastructure as flood protection).</p>
Connection to existing instruments	<p>The Austrian norms (ÖNORMEN B 2506 Part 1-3) cover all types of required construction for infiltration of rainwater. The Austrian norm (ÖNORM B 5102) on purification systems for rainwater from transportation and parking areas was updated in 2014.</p> <p>There are connections to the urban development plans, such as STEP in Vienna, spatial development concepts (such as REK Salzburg) and the care plans of the parks departments.</p>
State of implementation	<p>Example Salzburg: First basic considerations began with the climate study of the Salzburg parks department.</p> <p>Example Linz: The city supports the construction of rainwater-use installations with below-ground storage for watering all outside facilities in the urban area.</p> <p>Case study Innsbruck: during the course of the Dynalp project, supported by the Austrian Climate and Energy Fund, a web-based GIS platform was developed to provide decision makers with information about the degree to which various areas of the city are threatened by different developments (using, for instance, climate scenarios and urban development scenarios). Furthermore, the effectiveness of adaptation measures can be tested.</p>
Recommended further steps	<ul style="list-style-type: none"> – Review and, where necessary, adaptation of the irrigation management for urban green spaces; – Testing and promotion of the use of rainwater and installation of rainwater ponds (reservoirs); – Review and, where necessary, adaptation of open spaces for a multifunctional use to retain discharge peaks; – Promotion, increasing and improvement of the retention function of green and open spaces to avoid local inundation; – Increase the share of surfaces that permit infiltration; – Information and networking of the relevant actors in the city administration, in particular at the interface between water and land surface management; – Awareness raising and information for the general public (private green spaces, allotments, industrial estates) with regard to the selection of plants, use of rainwater etc.
Possible resource requirements	<p>For the implementation of measures, such as the accelerated use of rainwater and the installation of collecting ponds, an increase of financial expenditure can be expected.</p>
Possible conflict potential	<p>Through an increased demand for irrigation, a use conflict with drinking water supply cannot be excluded. More water surfaces in the city can support the development of disease vectors and thus be negative from a health perspective.</p>
Actors	<p>Municipal departments, parks departments, water suppliers.</p>
Time horizon	<p>The measures can be integrated into planning in the short term or existing care concepts can be adapted in the short term (lead times!).</p>

2.14.2.2 ADAPTATION OF SOIL MANAGEMENT IN URBAN GREEN AND OPEN SPACES

Objective	<p>Maintenance of soil functions, especially their water storage and water filtration functions.</p>
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Significance	<p>Soils play a special role in urban areas, since they can be seen as the hub of material and energy flows. Urban soils fulfil various functions: they are the basis of life for plants and animals. Together with vegetation they are responsible for a balanced urban climate through evaporation. Soil that is not sealed contributes through the infiltration of precipitation to relieving the urban waste water system, to protection against small-scale inundation after heavy rain events or floods and to the breaking down of organic pollutants and the buffering of harmful materials. Soil management measures have direct effects on quality of life in cities.</p> <p>For the positive effects to be realised, it is important to consider soils and surfaces holistically. The continual greening and unsealing of surfaces are important and here, in addition to green and open spaces (parks, courtyards, parking areas etc.), houses (façade greening, roof greening) are also considered. Equally important is a sustainable and soil-conserving care of the green and open spaces (e.g., careful use of fertilizers, herbicides and pesticides).</p>
Connection to other sectors	<p>There is a close connection to spatial planning and transport infrastructure (see Chapter 2.11.2.7 – Reduction of the increase in permanently sealed surfaces for transport infrastructure as flood protection), construction and housing and ecosystems/biodiversity.</p>
Connection to existing instruments	<p>According to constitutional law, soil is an environmental (protected) good. Soil conservation is covered, as part of environmental protection, in the federal law on sustainability, animal protection, security of food and water supply and research (BGBl. I Nr. 111/2013) and is the responsibility of the federal states. Protection of forest soils is covered by the Forestry Act (BGBl. Nr. 440/1975).</p> <p>There are connections to the instruments of spatial planning such as zoning plans and urban development concepts or local development concepts.</p> <p>Example Innsbruck: The environment plan of Innsbruck is understood as a holistic initiative to improve the quality of life and the environmental situation in Innsbruck and is a dynamic instrument for sustainable development. The topic of soil is one of the eleven sectors of the environmental plan.</p> <p>The Austrian Climate Alliance offers a nationwide training on soil conservation for representatives of municipalities. The contents range from zoning to settlement expansion, flood protection and soil quality, soil protection and soil rights.</p>
State of implementation	<p>Currently, the impacts of climatic change on soils are not covered sufficiently in soil conservation.</p>
Recommended further steps	<ul style="list-style-type: none"> – Where necessary, mapping of urban soils to evaluate soil functions; – Avoidance of further surface sealing. Where this is not possible, alternatives (e.g., through the use of permeable materials) should be used. Only when these two options are not possible, compensation measures should be taken; – Review of existing regulations and instruments (e.g., in spatial planning) and, where necessary, adaptation (e.g., determination of maximum degrees of sealing in building regulations, development of a biotope surface factor); – Creation of incentives for keeping areas open (e.g., through compensation for transportation and building areas); – Raising awareness of actors (public and private) and adaptation of education and training.
Possible resource requirements	<p>The increased development of areas that allow infiltration can be connected with higher costs.</p>
Possible conflict potential	<p>The avoidance of further surface sealing can lead to conflicts with settlement development and an increase of prices for building lots.</p>
Actors	<p>State governments, municipal departments, parks departments, planning firms, individuals.</p>
Time horizon	<p>The measures should be tackled in the short term.</p>

2.14.2.3 CONSERVATION AND PROMOTION OF BIODIVERSITY IN URBAN GREEN AND OPEN SPACES

Objective	Maintenance of ecosystem services and species diversity in urban green and open spaces.
Significance	<p>Urban activities and their infrastructure change the local plant and animal communities. The variety of types of activities and their intensity creates a multitude of different habitats as well as very different habitat structures. In addition there is the advertent and inadvertent introduction of numerous cultivated or non-cultivated plant and animal species (neobiota). As a result, urban areas have a high number of species and are ecological niches for specialised species. As a rule there is also a high number of domestic species in urban habitats (Werner & Zahrer 2009).</p> <p>Residents directly influence, through their own ideas about usefulness and attractiveness, the design of private green and open spaces and thus the biodiversity in urban areas. The offers of garden centres and horticultural businesses have a significant influence on the selection of plants and garden maintenance. Information and the creation of incentives for a suitable design to support biodiversity are necessary, in order to be able to use the bioclimatic advantages of green and open spaces under changed climatic conditions. These advantages include balancing the temperature, increasing air humidity, filtering of air pollutants, ventilation and shading</p> <p>Increasing heat and dryness in summer can lead to changes in plant and animal communities. In particular, the establishment of generalists that like warm conditions, especially neobiota, is made easier, which can lead to a displacement of specialised species. Suitable measures are needed for this.</p>
Connection to other sectors	There are close connections to almost all recommendations for ecosystems/biodiversity, and to health and tourism.
Connection to existing instruments	<p>Starting points are provided by the Austrian Biodiversity Strategy 2020+, the neobiota action plan, laws of the federal states for nature conservation and biotope mapping of the federal states and in urban areas.</p> <p>Example Vienna: The “Network Nature – Viennese Species and Habitat Conservation Programme” aims to achieve a long-term conservation of biodiversity. Through cooperation with districts, planners and city departments responsible for the green areas a sustainable implementation is supported.</p>
State of implementation	<p>The guidelines for roof greening produced for the City of Vienna (Die Umweltberatung Wien 2009) and for greening of façades (Magistrat der Stadt Wien 2013) demonstrate the options and how they can be implemented, explain the advantages and provide information regarding support possibilities.</p> <p>Further examples are the environmental programme of Dornbirn, the green network of Graz and the revitalisation of courtyards of Graz.</p> <p>Awareness-raising on neobiota in the biosphere park of the Vienna Woods, amongst others, the production of an information brochure on alien species from the garden with recommendations for responsible garden design¹⁶⁵ from the Austrian Federal Forestry company in cooperation with the Federal Environment Agency and the Biosphere Park Vienna Woods Management.</p>

¹⁶⁵ Link: http://www.bundesforste.at/uploads/publikationen/Folder_Neophyten_130x220_Auflage2_screen.pdf

Recommended further steps	<ul style="list-style-type: none"> – Creation of incentives and legal framework conditions for near-natural design of gardens, courtyards, roofs, façades etc.; – Installation of additional green and open spaces and extension of tree stocks in public areas (e.g., along urban roads, squares etc.); – Approval of spontaneous green in areas that are unused or hardly used; – Unsealing of areas within residential areas (relief of the canalisation system, increase of infiltration into the ground); – Avoidance of further sealing; – Development of concepts, implementation of model projects and monitoring; – Establishment of measures to support biological diversity in competitions and calls for tenders; – Monitoring with regard to the establishment and development of concepts for avoidance of the spreading of neobiota (especially allergenic plants); – Selection of locally adapted species when areas are newly planted or replanted (e.g., heat, drought, increasing or new pests); – Review and, where necessary, adaptation of nature protection measures and the development goals in nature protection laws of the federal states; – Maintenance and expansion of the migration possibilities for species (biotope network); – Adaptation of maintenance.
Possible resource requirements	For the expansion of green areas and the tree stock in public areas, costs will be incurred for both the installation and maintenance.
Possible conflict potential	With regard to the need for surface area for further green and open spaces, a conflict with settlement development is possible. The avoidance of further surface sealing can be in conflict with settlement development and lead to an increase of prices for building lots.
Actors	BMNT (formerly BMLFUW), state governments, municipal departments, parks departments, planning firms, urban planning, spatial planning, garden centres, horticulture.
Time horizon	The measures should be taken in the short term.

2.14.2.4 ADAPTATION OF PLANNING STRATEGIES FOR URBAN GREEN AND OPEN SPACES

Objective	Consideration of climate change in urban planning instruments.
Significance	<p>For the purpose of a strategic network of open spaces in an urban area, urban green and open spaces can reduce the urban heat island, provide ventilation corridors, regulate the water balance, relieve the waste water system, contribute to reducing air pollution and provide a habitat for domestic animal and plant species. To respect all of these tasks in planning, a close cooperation between all departments is necessary. Conflicts, but also negative impacts on other sectors, should be avoided. Different spaces have different use requirements. In order to respect these different needs and requirements, an early inclusion of user groups is advised.</p> <p>Within the framework of zoning and building planning, already during the purposeful initial analysis of potential areas, risks and – to some extent – conflicts can be avoided and optimal solutions for retroactive densification or zoning of building land can be found.</p> <p>Green connections (shading, ventilation, infiltration) must be considered and implemented to the appropriate extent in higher level planning. Urban planning can make a strategic contribution to develop the distribution of green and open spaces in a continuous, qualitatively valuable form.</p>

Connection to other sectors	There are close connections to spatial planning, construction and housing and transportation infrastructure.
State of implementation	Currently, climate change adaptation is not considered explicitly in existing planning strategies.
Connection to existing instruments	Example Vienna: The urban development plan (STEP 2025) is the instrument for forward-looking urban planning and urban development and determines in a broad outline the further orderly development of the city. It determines the distribution of usages and identifies development areas, higher level green and open spaces and higher level transportation infrastructure (underground trains, suburban trains, trams and highways). Furthermore, it demonstrates the spatial-functional connections between the city and the region. Example Graz: With the “Green Network Graz”, a catalogue of measures and strategies was created to maintain and develop quality of life in Graz. The green network is designed for the long term and serves as the basis for urban planning, zoning and for responses to building applications etc.
Recommended further steps	<ul style="list-style-type: none"> – Review and, where necessary, adaptation of the urban and spatial development plans, building / zoning plans with inclusion of the users, urban development, planning offices etc. and promotion of the implementation on the basis of scientifically based and comprehensive analysis of urban climate; – Avoidance of further surface sealing already at the zoning stage; – Interconnecting of biotope monitoring, risk assessment and zoning of building land; – Zoning and new installation of green and open spaces considering adaptation of urban structure to climatic change (distribution, connectivity, cooling, air filtering); – Determination of the required share of green space for an improvement of the urban microclimate; – Development of guidelines to support the consideration of climatic change in urban planning instruments.
Possible resource requirements	The consideration of the impacts of climatic change can be carried out within the framework of the periodic revision of urban development concepts.
Possible conflict potential	Conflicts can arise with regard to competing demands for land area.
Actors	State governments, municipal departments, urban development and planning, parks departments, spatial planning, planning firms, micrometeorologists.
Time horizon	The measures should be taken in the short term.

2.14.2.5 ADAPTATION OF OPEN SPACE PLANNING AND MAINTENANCE

Objective	Consideration of climate change in the design, implementation, and maintenance of urban green and open spaces.
Significance	Adaptation of the design and maintenance is necessary because of the stronger demand for land and the changing requirements of plants as a result of increasing temperatures. In addition, new/more infiltration structures are needed within urban areas. It is also necessary to consider that green and open spaces have various ownership states. Private individuals, housing cooperatives, owners of industrial plots etc. are equally required to take the necessary steps. Strengthened awareness raising and the creation of incentives are recommended.
Connection to other sectors	There are connections to ecosystems/biodiversity, water management and tourism.

Connection to existing instruments	There are connections to the biotope mapping and the tree cadastre and to existing management concepts of the cities. On the basis of experience and possible comparisons, these concepts could provide indications of the potential changes of the design of green and open spaces. Existing park examples (e.g., Vienna parks department) could be further developed with regard to adaptation to climatic change.
State of implementation	Approaches for the adaptation of green spaces are available, for example in the climate study in Salzburg.
Recommended further steps	<ul style="list-style-type: none"> – Review and adaptation of planning; – Review and, where necessary, adaptation of management concepts; – Avoidance of further surface sealing; – Review and, where necessary, adaptation of the plant selection to the climatic changes; – Increased use of surfaces that permit infiltration; – Improvement of the structures with respect to the increasing use pressure. Increased use of alternative irrigation systems and water collection systems (e.g., rainwater use); – Awareness raising and creation of incentives, especially for private land owners.
Possible resource requirements	For adaptation of management, resources are needed for training of the actors and for measures to provide information for private land owners. More efforts expected for management are connected with higher costs. Additional costs can be expected for overarching measures, e.g. increasing the infiltration capacity for neighbouring areas.
Possible conflict potential	Conflicts can arise with regard to competing demands for land and with regard to the distribution of costs.
Actors	Municipal departments, parks departments, planning firms, micrometeorologists.
Time horizon	The measures should be taken in the short term.

2.14.2.6 PROMOTION AND ADAPTATION OF GREEN AND OPEN SPACES FOR RECREATION AND LEISURE USES UNDER CHANGING CLIMATIC CONDITIONS

Objective	Conditions preservation and creation of green and open spaces as recreational and leisure area to promote human well-being under changing climatic conditions (especially during heat waves).
Significance	<p>Green and open spaces in urban areas increase the quality of life through their multiple functions. They are important areas for recreation and leisure and provide space for social contacts. A special role is the experience of nature and biological diversity for the social and psychological development of children and young people (Cervinka & Karlegger 2009, Sergel 2010).</p> <p>Particularly on hot days and during heat waves an increased usage is expected. Negative impacts in green areas (e.g., as a result of an increased number of visitors) can be avoided through forward-looking planning and adaptation of the management.</p> <p>With regard to climate protection, it is important to ensure that green and open spaces can be reached using public transportation.</p>
Connection to other sectors	There are connections to transport infrastructure (see Chapter 2.11.2.4 Reduction of potential heat stress for passengers and personnel in public transportation through appropriate air conditioning), tourism and health.
State of implementation	St. Pölten, for example, has created an initiative “City Trips with the City Bus LUP”, which offers resource-conserving local recreation and at the same time taps into the recreation areas close to the city.

Connection to existing instruments	There are connections to the urban planning concepts or specific concepts for green and open spaces of urban areas, such as “Grüne Netz Graz”, furthermore, also public relations efforts for the local recreation areas in the urban area (e.g. Biosphere Park Vienna Woods).
Recommended further steps	<ul style="list-style-type: none"> – Review of the existing green and open spaces regarding their climate suitability (increasing temperatures, decreasing precipitation in summer) or the expected increasing demands for use and, where necessary, redesign; – Ensure that the spaces can be reached using public transportation; – Consideration of sufficient green and open spaces in planning or urban expansion; – Renovation of urban areas with the aim to increase the thermal standards, e.g., through the relocation of parked cars into garages, the reclamation of public spaces or increasing of local supply; – Promotion of the Super-Block¹⁶⁶ concepts.
Possible resource requirements	Purchase of areas for the expansion of existing local recreation areas. Investments in public relations work for local recreation in urban green and open spaces. Costs for expanding the infrastructure of local public transportation to improve accessibility.
Possible conflict potential	Conflicts could arise regarding the competing demands for land area and perhaps with the ecosystems/biodiversity sector.
Actors	Municipal departments, parks departments, planning firms, micro-meteorologists.
Time horizon	The planning should be started in the short term. The implementation will follow in the medium to long term.

2.14.2.7 RAISING AWARENESS, IMPROVED NETWORKING, AND ADAPTATION OF THE TRAINING AND FURTHER EDUCATION OF ACTORS (PUBLIC AND PRIVATE)

Objective	Advancement of knowledge and improvement of networking among affected actors.
Significance	<p>The responsible people in the area discussed here (both in the public and private spheres) require, above all, easily accessible information and an overview of the planned measures in other affected sectors. Only a cross-sectoral networking of actors enables a coordinated, cross-sectoral approach in connection with the development and maintenance of urban open and green spaces.</p> <p>It is important to develop a structure that allows a continual exchange between the actors.</p> <p>In this way, strategies that have already been used successfully can be implemented faster in other places or other cities and this leads to a greater speed of adaptation of the instruments and operating procedures.</p> <p>Furthermore, all further land owners must be shown which options for action are available in order to preserve the quality of life in cities.</p>
Connection to other sectors	Awareness raising, training and further education on the topic of adaptation to climatic change are important in all sectors, in order to deal with the consequences of climatic change. Because of the enormous significance for all sectors, action should be across all of them.
State of implementation	The topic of adaptation to climatic change is not yet considered sufficiently in training and further education or existing information initiatives.

¹⁶⁶ A Super-Block has an area of 400 x 400m. Driving through with cars is not possible; access is possible for the residents and local businesses. Green areas and alternatives to private cars should be developed. This also includes support for bicycle transport. At the edge of the block public transportation is available.

Connection to existing instruments	<p>There are connections to existing training and further education programmes for urban planners, gardeners etc. as well as existing higher level coordination units in the administration (e.g., climate protection coordination in Vienna).</p> <p>Example Bregenz: The climate dialogues in Bregenz provide the general public, businesses and schools with practical support and the possibility to discuss and exchange opinions.</p> <p>Example Vienna-Lower Austria: Conferences for the city and the surrounding regions provide participants from politics, administration and sectoral planning with possibilities for information exchange and networking on topics relevant to adaptation (e.g., urban planning, green and open spaces, settlements and quality of life).</p>
Recommended further steps	<ul style="list-style-type: none"> – Development of an exchange platform for actors (public and private); – Information distribution to actors (public and private); – Introduction of good practice exchanges.
Possible resource requirements	Time resources in the administration for consultation and coordination of the relevant departments. Additional resources will be required for the preparation of information materials and provision of advisory services for private land owners.
Possible conflict potential	No conflict potential has been identified.
Actors	Municipal administrations, Association of Austrian Cities and Towns.
Time horizon	Corresponding activities can be started in the short term; the effects will be seen in the medium to long term.

2.14.2.8 IMPROVEMENT OF THE KNOWLEDGE BASE THROUGH INTER- AND TRANSDISCIPLINARY RESEARCH ON URBAN GREEN AND OPEN SPACES

Objective	With a view to adapting urban green and open spaces to climate change, issues must be explored at various levels and prepared in an interdisciplinary fashion for implementation.
Significance	<p>Research on the question of adaptation of urban free and green spaces must consider both the constructional design and also the urban planning connection and climatological significance of these spaces.</p> <p>Open questions include human health and the recreational function within the urban agglomeration.</p> <p>Close cooperation of science with city administrations is necessary to be able to deal with the relevant questions in a targeted and application-oriented way.</p>
Connection to other sectors	In line with an interdisciplinary approach, research activities should be coordinated with ecosystems/biodiversity, health, water management, protection against natural disasters and spatial planning.
Connection to existing instruments	There are connections to existing research programmes such as the Austrian Climate Research Programme (ACRP) or the national climate impacts research programme StartClim. A further funding line is the Smart Cities Demo programme, which amongst others also funds projects on the design of open and green spaces ¹⁶⁷ .
State of implementation	The Austrian Climate Research Programme (ACRP) and the national climate impact research programme StartClim cover questions on adaptation of urban areas to climatic

¹⁶⁷ 7th call for proposals 2015/2016 with a focus on “City oases – smart green and open space design in urban areas” with reference to heat and climatic change

Recommended further steps	<p>change. Current and completed research projects on this topic are, for example, DynAlp¹⁶⁸, StopHot¹⁶⁹, Urban Fabric Types¹⁷⁰, or FOCUS-I¹⁷¹.</p> <p>The following research areas should be dealt with for a successful adaptation of green and open spaces:</p> <ul style="list-style-type: none"> – Risk analyses for urban spaces; – Studies of meso- and microclimate; – Research on the suitability of plant species given increasing heat and dryness; – Research on reliable unsealed surfaces; – Development of optimised planning systems and planning instruments for cross-sectoral urban planning; – Development of implementation strategies for urban open space structures in view of adaptation to climatic change; – Support of the recreational function with regard to the significance of green and open spaces for human health; – Development of design strategies and evaluation criteria for already existing urban open and green spaces and those to be planned.
Possible resource requirements	Sufficient resources must be provided by research programmes for dealing with the relevant questions.
Possible conflict potential	No conflict potential has been identified.
Actors	Federal government (research programs), academic and non-academic research institutions, municipal administrations, planning firms, micrometeorologists.
Time horizon	The research can be started in the short term.

¹⁶⁸ Dynalp Dynamic Adaptation of Urban Water Infrastructure for Sustainable City Development in an Alpine Environment. 4. Call <https://www.klimafonds.gv.at/wp-content/uploads/sites/6/04012016DynAlpACRP4EBB175093KR11AC0K00206.pdf>

¹⁶⁹ STOPHOT Cool towns for the elderly – protecting the health of elderly residents against urban heat. 3. Call. <https://www.klimafonds.gv.at/wp-content/uploads/sites/6/03032015STOPHOTArne-ArnbergEBACRP3-B068678-K10AC1K00025.pdf>

¹⁷⁰ Urban Fabric Types and Microclimate Response – Assessment and Design Improvement (Urban Fabric + Microclimate). 3. Call <https://www.klimafonds.gv.at/wp-content/uploads/sites/6/20150716UFT-ADIACRP3EB.pdf>

¹⁷¹ FOCUS-I Future Of Climatic Urban heat Stress Impacts. Adaption and mitigation of the climate change impact on urban heat stress based on model runs derived with an urban climate model. 2. Call. <https://www.klimafonds.gv.at/wp-content/uploads/sites/6/03032015FOCUSZuvela-AloiseEBACRP2B060373.pdf>

3 INDEX OF ABBREVIATIONS

ACRP	<i>Austrian Climate Research Programme (Klima- und Energiefonds)</i>
ADA	<i>Austrian Development Agency</i>
AGES	<i>Austrian Agency for Health and Food Safety (Österreichische Agentur für Gesundheit und Ernährungssicherheit GmbH)</i>
AK	<i>Austrian Chamber of Labour (Arbeiterkammer)</i>
AKNZ	<i>Academy for Crisis Management, Emergency Planning and Civil Defense (Akademie für Krisenmanagement, Notfallplanung und Zivilschutz)</i>
ANRICA	<i>Austrian Natural Resource Management and International Cooperation Agency (Österreichische Agentur für Waldentwicklung, Waldbewirtschaftung und internationale Kooperation)</i>
APG	<i>Austrian Power Grid AG</i>
APP	<i>Application software (Anwendungssoftware)</i>
AZ	<i>Compensatory allowance (Ausgleichszulage)</i>
BAES	<i>Federal Office for Food Safety (Bundesamt für Ernährungssicherheit)</i>
BAW	<i>Federal Office of Water Management (Bundesamt für Wasserwirtschaft)</i>
BBK	<i>Federal Office for Civil Protection and Disaster Relief (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe)</i>
BFW	<i>Federal Research and Training Centre for Forests, Natural Hazards and Landscape (Bundesforschungs- und Ausbildungszentrum für Wald, Naturgefahren und Landschaft)</i>
BIP	<i>Gross Domestic Product (Bruttoinlandsprodukt)</i>
BMASK	<i>former Bundesministerium für Arbeit, Soziales und Konsumentenschutz (since 2018: Federal Ministry of Labour, Social Affairs, Health and Consumer Protection)</i>
BMB	<i>former Bundesministerium für Bildung (since 2018: Federal Ministry of Education, Science and Research)</i>
BMBF	<i>former Bundesministerium für Bildung und Forschung (since 2018: Federal Ministry of Education, Science and Research)</i>
BMF	<i>Federal Ministry of Finance (Bundesministerium für Finanzen)</i>
BMG	<i>former Bundesministerium für Gesundheit (since 2018: Federal Ministry of Labour, Social Affairs, Health and Consumer Protection)</i>
BMGF	<i>former Bundesministerium für Gesundheit und Frauen (since 2018: Federal Ministry of Labour, Social Affairs, Health and Consumer Protection)</i>
BMI	<i>Federal Ministry of the Interior (Bundesministerium für Inneres)</i>
BMJ	<i>Bundesministerium für Justiz</i>
BMLFUW	<i>former Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (since 2018: Federal Ministry of Sustainability and Tourism)</i>
BMLVS	<i>former Bundesministerium für Landesverteidigung und Sport (since 2018: Federal Ministry of Defence)</i>
BMUKK	<i>former Bundesministerium für Unterricht, Kunst und Kultur (since 2018: Federal Ministry of Education, Science and Research)</i>
BMVIT	<i>Federal Ministry of Transport, Innovation and Technology (Bundesministerium für Verkehr, Innovation und Technologie)</i>
BMWA	<i>former Bundesministerium für Wirtschaft und Arbeit (since 2018: Federal Ministry of Digital and Economic Affairs)</i>
BMWFJ	<i>former Bundesministerium für Wirtschaft, Familie und Jugend (since 2018: Federal Ministry of Digital and Economic Affairs)</i>
BMWF	<i>former Bundesministerium für Wissenschaft und Forschung (since 2018: Federal Ministry of Digital and Economic Affairs respectively Federal Ministry of Education, Science and Research)</i>

<i>BMFWF</i>	<i>former Bundesministerium für Wissenschaft, Forschung und Wirtschaft (since 2018: Federal Ministry of Digital and Economic Affairs respectively Federal Ministry of Education, Science and Research)</i>
<i>BOKU</i>	<i>University of Natural Resources and Life Sciences, Universität für Bodenkultur</i>
<i>BWV</i>	<i>Federal Department of Flood Control Management (Bundeswasserbauverwaltung)</i>
<i>BWZ</i>	<i>Federal Warning Center (Bundeswarnzentrale)</i>
<i>CBD</i>	<i>Convention on Biological Diversity</i>
<i>CC</i>	<i>Cross Compliance</i>
<i>CDP</i>	<i>Carbon Disclosure Project</i>
<i>CEHAPE</i>	<i>Children’s Environment Health Action Plan for Europe</i>
<i>CEN</i>	<i>European Committee for Standardization, europäisches Komitee für Normung</i>
<i>CENELEC</i>	<i>European Committee for Electrotechnical Standardization, europäisches Komitee für elektrotechnische Normung</i>
<i>CICES</i>	<i>Common International Classification of Ecosystem Services</i>
<i>CITES</i>	<i>Convention on International Trade in Endangered Species of Wild Fauna and Flora - Washingtoner Artenschutzübereinkommen</i>
<i>COIN</i>	<i>Cost of Inaction (Kosten des Nichthandels, ACRP-Projekt)</i>
<i>COP</i>	<i>Conference of the Parties (Vertragsstaatenkonferenz)</i>
<i>CSR</i>	<i>Corporate Social Responsibility</i>
<i>DAS</i>	<i>German Strategy for Adaptation to Climate Change (Deutsche Anpassungsstrategie an den Klimawandel)</i>
<i>DKKV</i>	<i>German Committee for Disaster Reduction (Deutsches Komitee Katastrophenvorsorge)</i>
<i>DOC</i>	<i>dissolved organic carbon (gelöster organischer Kohlenstoff)</i>
<i>EBP</i>	<i>Single Payment Scheme (Einheitliche Betriebsprämie)</i>
<i>ECDC</i>	<i>European Centre for Disease Prevention and Control (Europäisches Zentrum für die Prävention und die Kontrolle von Krankheiten)</i>
<i>EEA</i>	<i>European Environment Agency (Europäische Umweltagentur)</i>
<i>EFSA</i>	<i>European Food Safety Authority (Europäische Behörde für Lebensmittelsicherheit)</i>
<i>ElWOG</i>	<i>Electricity Sector Act (Elektrizitätswirtschafts- und –organisationsgesetz)</i>
<i>EMAS</i>	<i>Eco Management and Audit Scheme (freiwilliges europäische Umweltmanagement)</i>
<i>ENTSO-E</i>	<i>European Network of Transmission System Operators for Electricity</i>
<i>EPPO</i>	<i>European and Mediterranean Plant Protection Organization</i>
<i>ETS</i>	<i>Emission Trading System (Emissionshandel der Europäischen Union)</i>
<i>ETZ</i>	<i>European Territorial Cooperation (Europäische Territoriale Zusammenarbeit)</i>
<i>EU</i>	<i>European Union (Europäische Union)</i>
<i>EUR</i>	<i>International currencycode for Euro (Internationaler Währungscode für Euro)</i>
<i>EZA</i>	<i>Development Cooperation (Entwicklungszusammenarbeit)</i>
<i>FFG</i>	<i>Austrian Research Promotion Agency (Österreichische Forschungsförderungsgesellschaft)</i>
<i>FSME</i>	<i>Tic-borne encephalitis (Frühsommer-Meningoenzephalitis)</i>
<i>FTI</i>	<i>Research, Technology and Innovation (Forschung, Technologie und Innovation)</i>
<i>FWF</i>	<i>Austrian Science Fund (Fonds zur Förderung der wissenschaftlichen Forschung)</i>
<i>GAP</i>	<i>Common Agricultural Policy (Gemeinsame Agrarpolitik)</i>
<i>GLORIA</i>	<i>Global Observation Research Initiative in Alpine Environments</i>
<i>GMES</i>	<i>Global Monitoring for Environment and Security (Globale Umwelt- und Sicherheitsüberwachung)</i>
<i>GPS</i>	<i>Global Positioning System (Globales Positionierungssystem)</i>
<i>GZP</i>	<i>Hazard Map (Gefahrenzonenplan)</i>
<i>HBLFA</i>	<i>Higher-level secondary technical and vocational college (Höhere Bundeslehr- und Forschungsanstalt)</i>
<i>HFA</i>	<i>Austrian Forest Products Research Society (Holzforschung Austria)</i>

<i>HORA</i>	<i>Natural Hazard Overview & Risk Assessment Austria (HochwasserRisikoflächen Austria)</i>
<i>HQ100</i>	<i>100-year design flood (Abflusskenngröße: ein statistisch gesehen alle 100 Jahre auftretendes Hochwasserereignis)</i>
<i>IEA</i>	<i>International Energy Agency (Internationale Energieagentur)</i>
<i>ICD-Codes</i>	<i>International Statistical Classification of Diseases und Related Health Problems (internationale statistische Klassifikation der Krankheiten und verwandter Gesundheitsprobleme)</i>
<i>INTERREG</i>	<i>Interreg: European Territorial Cooperation (Regionalprogramm der Europäischen Union zur Förderung der grenzüberschreitenden Zusammenarbeit)</i>
<i>IGS</i>	<i>Institute for tested safety (Institut für geprüfte Sicherheit, seit 2015 EPZ Elementarschaden Präventionszentrum)</i>
<i>IPBES</i>	<i>Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services</i>
<i>IPCC</i>	<i>Intergovernmental Panel on Climate Change (Klimarat der Vereinten Nationen)</i>
<i>ISO</i>	<i>International Organization for Standardization (Internationale Organisation für Normung)</i>
<i>IT</i>	<i>Information Technology (Informationstechnologie)</i>
<i>IUCN</i>	<i>International Union for Conservation of Nature</i>
<i>JJ/CDM-Programm</i>	<i>Acquisition of Emissionreduction using Joint Implementation (JI) and Clean Development mechanisms (CDM) (Ankauf von Emissionsreduktionen aus Joint Implementation (JI) und Clean Development Mechanism (CDM))</i>
<i>KFV</i>	<i>Austrian Road Safety Board (Kuratorium für Verkehrssicherheit)</i>
<i>KIRAS</i>	<i>Astrian Security Research Programme (Österreichisches Sicherheitsforschungsprogramm)</i>
<i>KMU</i>	<i>Small and medium enterprises (kleinere und mittlere Unternehmen)</i>
<i>KWK</i>	<i>Power-Heat Coupling (Kraft-Wärme-Kopplung)</i>
<i>LARK</i>	<i>Landesagrarreferenten-Konferenz</i>
<i>LF</i>	<i>Land used for agriculture (landwirtschaftlich genutzte Fläche)</i>
<i>LFZ</i>	<i>Education and Research Center Raumberg Gumpenstein (Lehr- und Forschungszentrum Raumberg Gumpenstein)</i>
<i>LWZ</i>	<i>National Warning Center (Landeswarnzentrale)</i>
<i>MJNQ</i>	<i>Intermediate yearly low water (mittleres jährliches Niederwasser)</i>
<i>NAS</i>	<i>National Adaptation Strategy (Nationale Anpassungsstrategie)</i>
<i>NEP</i>	<i>Network Development Plan (Netzentwicklungsplan)</i>
<i>NGO</i>	<i>Non-Governmental Organization (Nichtregierungsorganisation)</i>
<i>NGP</i>	<i>National Water Development Plan (Nationaler Gewässerbewirtschaftungsplan)</i>
<i>NÖ</i>	<i>Lower Austria (Niederösterreich)</i>
<i>OECD</i>	<i>Organisation for Economic Co-operation and Development (Organisation für wirtschaftliche Zusammenarbeit und Entwicklung)</i>
<i>OEZA</i>	<i>Austrian Development Agency (Agentur der Österreichischen Entwicklungszusammenarbeit)</i>
<i>OIB</i>	<i>Austrian Institute for Construction Technology (Österreichisches Institut für Bautechnik)</i>
<i>ONR</i>	<i>ON-Regeln (rasch verfügbares normatives Dokument, erfüllt nicht alle Ansprüche einer klassischen Norm)</i>
<i>OÖ</i>	<i>Upper Austria (Oberösterreich)</i>
<i>ORF</i>	<i>Austrian Broadcasting Corporation (Österreichischer Rundfunk)</i>
<i>ÖÄK</i>	<i>Austrian Medical Association (Österreichische Ärztekammer)</i>
<i>ÖAW</i>	<i>Austrian Academy of Sciences (Österreichische Akademie der Wissenschaften)</i>
<i>ÖBf</i>	<i>Austrian Federal Forests (Österreichische Bundesforste AG)</i>
<i>ÖGB</i>	<i>Austrian Trade Union confederation (Österreichischer Gewerkschaftsbund)</i>
<i>ÖGD</i>	<i>Public Health Service (Öffentlicher Gesundheitsdienst)</i>
<i>ÖHV</i>	<i>Austrian Hotel Association (Österreichische Hoteliervereinigung)</i>
<i>ÖNACE</i>	<i>Austrian Classification of Economic Activities (Österreichische Klassifikation der wirtschaftlichen Tätigkeiten, NACE steht für für "Nomenclature générale des activités économiques dans les communautés européennes")</i>

ÖPNV	<i>Local Public Transport (Öffentlicher Personennahverkehr)</i>
ÖPUL.....	<i>Austrian Agri-Environment Programme (Österreichisches Programm zur Förderung einer umweltgerechten, extensiven und den natürlichen Lebensraum schützenden Landwirtschaft)</i>
ÖREK	<i>Austrian Spatial Development Perspective (Österreichisches Raumentwicklungskonzept)</i>
ÖROK.....	<i>Austrian Conference on Spatial Planning (Österreichische Raumordnungskonferenz)</i>
ÖVGW	<i>Austrian Association for Gas and Water (Österreichische Vereinigung für das Gas- und Wasserfach)</i>
ÖWAV.....	<i>Austrian Water and Waste Management Association (Österreichischer Wasser- und Abfallwirtschaftsverband)</i>
ÖZSV.....	<i>Austrian Civil Defence Association (Österreichischer Zivilschutzverband)</i>
PCI	<i>Projects of Common Interest (Vorhaben von gemeinsamem Interesse)</i>
PRA	<i>pest risk analysis</i>
PRTR.....	<i>Pollutant Release and Transfer Register (Europäisches Schadstofffreisetzungs- und Verbringungsregister)</i>
PTBS	<i>Post-traumatic stress disorder (Posttraumatische Belastungsstörung)</i>
QZV.....	<i>Quality Target Regulation (Qualitätszielverordnung)</i>
REK.....	<i>Spatial Development Concept (Räumliches Entwicklungskonzept)</i>
RIWA-T	<i>Technical guidelines for the Federal Water Management Engineering Administration (Technische Richtlinien für die Bundeswasserbauverwaltung)</i>
ROG.....	<i>Regional Planning Act (Raumordnungsgesetz)</i>
RMP.....	<i>Risk Management Plan (Risikomanagementplan)</i>
RVS.....	<i>Guidelines and Codes for the Transport Sector (Richtlinien und Vorschriften für das Verkehrswesen)</i>
SKKM	<i>Federal Civil Protection and Disaster Management (Staatliches Krisen- und Katastrophenschutzmanagement)</i>
SREP	<i>Schutzwasserwirtschaftlicher Raumentwicklungsplan</i>
STEP	<i>Urban Development Plan (Stadtentwicklungsplan)</i>
SUP.....	<i>Strategic Environmental Assessment (Strategische Umweltprüfung)</i>
TGD.....	<i>Austrian Animal Health Service (Österreichischer Tiergesundheitsdienst)</i>
THG.....	<i>Greenhouse gases (Treibhausgase)</i>
TSI.....	<i>Technische Spezifikationen für die Interoperabilität</i>
UFI.....	<i>Domestic environmental support scheme of the federal state (for corporations) ((betriebliche) Umweltförderung des Bundes im Inland)</i>
UNEP	<i>United Nations Environment Programme</i>
UNFCCC	<i>United Nations Framework Convention on Climate Change (Rahmenübereinkommen der Vereinten Nationen über Klimaänderungen)</i>
UNWTO.....	<i>World Tourism Organization</i>
UVP	<i>Environmental Impact Assessment (Umweltverträglichkeitsprüfung)</i>
VMU	<i>University of Veterinary Medicine, Vienna (Veterinärmedizinische Universität Wien)</i>
VVO.....	<i>Association of Insurance Companies of Austria (Verband der Versicherungsunternehmen Österreichs)</i>
WEM	<i>Game impact monitoring (Wildeinflussmonitoring)</i>
WEP.....	<i>Forest Development Plan (Waldentwicklungsplan)</i>
WFP.....	<i>Forest Management Plan (Waldfachplan)</i>
WHO.....	<i>World Health Organization (Weltgesundheitsorganisation)</i>
WIFO.....	<i>Austrian Institute for Economic Research (Österreichisches Institut für Wirtschaftsforschung)</i>
WIS.....	<i>Water Information System (Wasserinformationssystem)</i>
WISA	<i>Water Information System Austria (Wasserinformationssystem Austria)</i>
WKEV.....	<i>Water Cycle Assessment (Wasserkreislaufferhebung)</i>
WKO.....	<i>Austrian Economic Chambers (Wirtschaftskammer Österreich)</i>

- WLV..... Torrent and Avalanche Control (Wildbach- und Lawinenverbauung)*
WWF World Wide Fund for Nature
WWG Forestry Community (Waldwirtschaftsgemeinschaft)
ZAMG..... Central Institute for Meteorology and Geodynamic (Zentralanstalt für Meteorologie und Geodynamik)

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