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# THE AUSTRIAN STRATEGY FOR ADAPTATION TO CLIMATE CHANGE

Part 1 – Context

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# THE AUSTRIAN STRATEGY FOR ADAPTATION TO CLIMATE CHANGE

Part 1 – Context

Adopted by the Federal Government in October 2012
and by the Federal States in May 2013

Vienna, May 2012

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# Introduction

# 1 Introduction

Climate change as a global phenomenon represents one of the greatest environmental challenges of the twenty-first century. There is scientific consensus that climate change can no longer be prevented, but only mitigated in its impacts. In almost all regions of Europe, adverse effects are expected that will pose considerable problems for many socio-economic and natural systems.

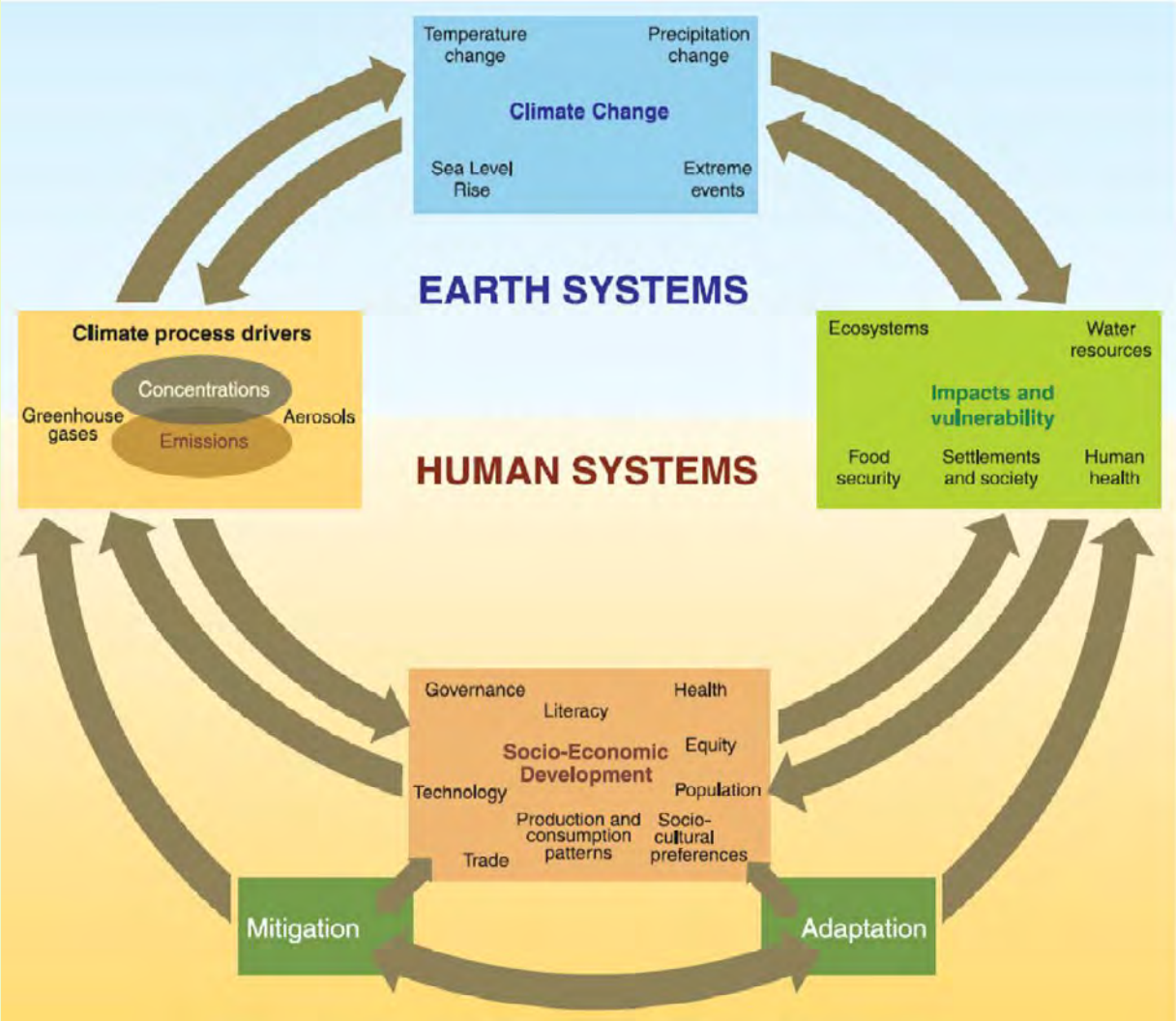
Even an immediate significant reduction of greenhouse gas emissions or a stabilization of emissions at current levels would entail a continuing temperature increase over the coming decades. This is due in part to the existing contamination from pollution since the beginning of industrialization and in part to the inertia of the climate system.

The European Union has set the goal of limiting the increase in average global temperature to less than 2°C above the pre-industrial level (EC 2007a). It is projected that compliance with this 2°C limit would, through the application of appropriate and timely adaptation measures, curb the negative effects of climate change and avoid serious consequences. Should this upper bound of temperature increase be exceeded, significant damages must be expected.

Therefore, in addition to essential measures to reduce greenhouse gas emissions, adaptation strategies must be developed and implemented. Adaptation as the second pillar in climate policy represents a necessary and indispensible complement to climate mitigation. The causal fight against climate change – i.e., the further reduction of greenhouse gasses – remains the top priority. A critical element of prevention in the coming years is thus the achievement of climate change mitigation objectives.

For Europe, the far-reaching effects of climate change have already been documented, such as the retreat of glaciers, longer growing seasons, and negative effects on public health resulting from heat waves (IPCC 2007). Figure 1 illustrates the anthropogenic drivers and effects of climate change, as well as reactions to climate change-induced shifts. The relationships and interactions between these components are presented schematically.

**Figure 1:**
**Schematic framework representing anthropogenic drivers, impacts, and responses to climate change, and their linkages.**




*Source: IPCC (2008)*

Climate change is affecting a number of sectors, systems, institutions, and individuals, with widely varying effects at the local and regional levels. Currently, adaptation initiatives are primarily focused on addressing short- and medium-term effects and are set up individually in response to already occurring climate change impacts (reactive). To date, these initiatives have mainly concentrated on the reduction or (in the best case) avoidance of losses and damages from extreme weather events (e.g., flood protection, drought-resistant crops). The consideration of long-term effects (proactive measures) has only been rudimentary, due in part to uncertainty about the future effects of climate change. There is no doubt that global warming will continue, while the average temperature in the Alps – in comparison to the global increase – is rising faster and to a greater extent. For this reason, the forward-looking planning and implementation of flexible adaptation measures on the basis of current knowledge is crucial.

# Political Environment

# 2 Political Environment

In recent years, at both the international and European levels, the issue of climate change adaptation has become a major focus of attention. The obligation to develop a national adaptation strategy can be found in the United Nations Framework Convention on Climate Change[1] (UNFCCC 2007, ratified by Austria), as well as in Art. 10 (b) of the Kyoto Protocol, which came into force in 2005. These agreements require the signatory parties to develop, implement, and update national and (where appropriate) regional programmes that facilitate adequate adaptation to climate change. In addition, at the international level, the Nairobi Work Programme (NWP)[2] of the UNFCCC has contributed to a better understanding of the impacts of climate change and adaptation options by combining the knowledge and experiences of individual countries with planning and implementing adaptation measures[3]. The array of potential adaptive responses available to human societies is very large, ranging from purely technological, through behavioural, to managerial and to policy. Although many early impacts of climate change can be effectively addressed through adaptation, the options for successful adaptation diminish and the associated costs increase with increasing climate change (IPCC 2007). In the Bali Action Plan, which was adopted by the 13th Conference of Parties (COP) of the UNFCCC, adaptation to climate change was established as one of the four key pillars[4] of global climate policy.

With its Green Paper on adaptation to climate change in Europe (EC 2007b), the European Commission established the foundation for adaptation initiatives at the EU level. In early April 2009, a White Paper on adapting to climate change: Towards a European framework for action (EC 2009a) was presented by the Commission. This White Paper sets out an action framework outlining how the European Union and its Member States should prepare for the consequences of climate change. In its first phase (through 2012), the foundations for a Europe-wide adaptation strategy should be established, to be in place by 2013.

The White Paper encourages efforts in on four pillars of action:

1. Building a solid knowledge base on the impact and consequences of climate change for the EU;
2. Integrating adaptation into EU key policy areas;
3. Employing a combination of policy instruments (market-based instruments, guidelines, public-private partnerships) to ensure effective delivery of adaptation; and
4. Stepping up international cooperation on adaptation.

[1] "United Nations Framework Convention on Climate Change", Art. 4.1 b and e; p. 6f; *http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf*

[2] UNFCC, Nairobi Work Programme: A 5-year programme of the UNFCCC, established in 2005.

[3] Link: *http://unfccc.int/adaptation/sbsta_agenda_item_adaptation/items/3633.php*

[4] The four pillars of the Bali Action Plan are emission reduction, adaptation to climate change, technology transfer, and financial support (UNFCCC 2007).

To facilitate implementation of the first pillar of the White Paper, in March 2012 the web-platform Climate-ADAPT (European Climate Adaptation Platform)[5] became publicly accessible. This platform provides users with information in the following areas:

- Expected climate change in Europe;
- Current and future vulnerability of regions and sectors;
- National and transnational adaptation strategies;
- Adaptation case studies and potential adaptation options;
- Mainstreaming at the European level;
- Tools that support adaptation planning;
- Profiles of adaptation-related research projects, guidance documents (e.g., for the management of uncertainty), reports, additional information sources, links, and announcements of events.

In addition, the European Commission has taken first steps towards the implementation of the second pillar and presented, inter alia, guidance on river basin management in a changing climate (EC 2009b). Furthermore, with the implementation of the White Paper, the Commission has established new structures: the so-called “Adaptation Steering Group” and the “Working Group on Knowledge Base on Climate Change Impacts, Vulnerability and Adaptation”. Austria is represented in both groups. For matters related to climate change, a new DG Climate Action[6] has been established.

In order to identify possible ways to improve Europe’s resilience to the effects of climate change, a separate working group (Working Group II, “Impacts and Adaptation”) has been established within the framework of the European Climate Change Programme[7]. However, the European Environment Agency (EEA) and the OECD are also devoting greater attention to matters of climate change impacts and adaptation. The European Environment Agency has published The European environment – state and outlook 2010 report in which climate change and adaptation are highlighted (EEA 2010).

[5] Link: *http://climate-adapt.eea.europa.eu/*

[6] Link: *http://ec.europa.eu/dgs/clima/mission/index_en.htm*

[7] ECCP (European Climate Change Programme): *http://ec.europa.eu/environment/climat/eccpii.htm*

For several years, the majority of European countries have been concentrating on the elaboration of national adaptation strategies (NAS). The development of adaptation strategies is often the first step for a coordinated adaptation approach at national level and represents the first milestone in a long-term process. The different approaches and procedures of various countries provide valuable information, both for the development of strategies and for their implementation.

In December 2008, the federal government in **Germany** enacted the **German Strategy for Adaptation to Climate Change (DAS)**. The fundamental objective of the DAS is to strengthen the adaptive capacity of ecosystems and individual groups so that they are prepared for the future. The adaptation strategy emphasizes the contribution of the federal government, thereby providing an orientation for other actors.

In addition to describing the current state of knowledge on expected climatic changes (worldwide and for Germany) and the associated potential impacts, the DAS outlines adaptation options for 13 human environmental, and economic areas, as well as for civil protection and land use. Furthermore, the international context and the German contribution to adaptation in other parts of the world are defined, and the next steps for the further development of the German adaptation strategy are described.

The essential next step in the further elaboration and specification of the strategy involved federal cooperation with the German states and other socially relevant actors in the development of an “Adaptation Action Plan”, which was adopted in August 2011. This plan includes the activities of the federal government in the coming years and identifies links with other national strategy processes. The Adaptation Action Plan covers activities in four areas: “Providing knowledge, informing, enabling”, “Creation of frameworks by the Federal Government”, “Activities for which the Federal Government is directly responsible”, and “International responsibilities”.

Link to the DAS (German): *www.bmu.de/N42783/*
Link to the DAS (English): *www.bmu.de/N42841-1/*

Link to the action plan (German): *www.bmu.de/N47641/*
Link to the action plan (English): *www.bmu.de/N48464-1/*

Further information:
*www.bmu.de/P216-1/*
*http://www.anpassung.net/cln_349/nn_1467980/DE/Anpassungsstrategie/anpassungsstrategie__node.html?__nnn=true*

In **Switzerland**, in March 2012 the first part of the **Adaptation Strategy** to climate change in Switzerland was adopted by the Federal Council. This strategy defines objectives, challenges, and action areas. The first part of the adaptation strategy highlights adaptation in the sectors of water management, natural hazards, agriculture, forestry, energy, tourism, biodiversity management, health, and spatial development. For these sectors, a total of 48 fields of action are set out, adaptation goals and principles are formulated, and bases for implementation are outlined by which these goals can be achieved. In addition, interfaces between the sectors are described. This should enable the best possible use of existing synergies in efforts to adapt to climate change, avoiding or resolving conflicts between objectives.

In the next step, the second part of the strategy, the **Action Plan**, will be drawn up. This plan should outline how Switzerland seeks to achieve its adaptation goals and deal with the challenges identified. The Action Plan should be in place by the end of 2013.

In addition, a **Climate Adaptation Information Platform** has been established to compile information on adaptation to climate change in Switzerland and support networking among the actors involved. The platform provides information on the Federal Council's strategy and the activities of the cantons, as well as an overview of research programmes, projects, and practical adaptation measures.

Link to part 1 of the strategy:
*http://www.bafu.admin.ch/publikationen/publikation/01673/index.html?lang=en*

Information platform:
*www.bafu.admin.ch/klimaanpassung*

**Finland's** Ministry for Agriculture and Forestry was the first in Europe to adopt a **Strategy for Adaptation** to Climate Change. The aim of this strategy is to increase the adaptive capacity of the Finnish society.

The strategy identifies climate impacts and adaptation measures in 15 sectors with a time horizon of 2080. The following action areas are identified as priorities through 2015: (i) mainstreaming climate change impacts and adaptation into sectoral policies, (ii) addressing long-term investments, (iii) coping with extreme weather events, (iv) improving observation systems, (v) strengthening the research and development base, and (vi) international cooperation.

In 2009, a first evaluation of the strategy was published, in which the implementation of the strategy's measures were rated on a 5-point scale (from 1 *little activity* to 5 *measure implemented*). On the basis of this evaluation, the strategy will be revised and adjusted by 2013.

Link to the strategy:
*http://www.mmm.fi/attachments/ymparisto/5h0aZ7Iid/Finlands_national_adaptation_srtrategy_julkaisu.pdf*

Further information:
Evaluation:
*http://www.mmm.fi/attachments/mmm/julkaisut/julkaisusarja/2009/5IEsngZYQ/Adaptation_Strategy_evaluation.pdf*

The **United Kingdom** is to date the only European country in which adaptation has been legally regulated through the **Climate Change Act** of 2008. This act requires a UK-wide Climate Change Risk Assessment (CCRA) that must take place every five years. Among other things, the law provides the mandate giving Her Majesty's Government (HMG) and the Welsh Government the power to require 'bodies with functions of a public nature' and 'statutory undertakers' (e.g. water and energy utilities) to report on their adaptation efforts to address the risks posed by climate change to their work. An indicator system for performance monitoring should become available in 2012. Furthermore, an Adaptation Sub-Committee (ASC) of the independent Climate Change Committee has been established. The role of the ASC is to provide advice, analysis, information and other assistance in relation to the implementation of the Act. The Climate Change Act 2008 also requires HMG to create a National Adaptation Programme (to be reviewed every five years) to address the most pressing climate change risks to England and reserved matters.

In addition to its activities under the framework of the Climate Change Act, with the establishment of the UKCIP (**United Kingdom Climate Impact Programme**) in 1998, the UK took a leading role in Europe in terms of information provision on adaptation. UKCIP offers programmes and information on climate change and impacts, helping private and public organizations to evaluate the potential effects of climate change. In addition, an online adaptation tool is available to support organizations as they systematically deal with necessary adaptation.

Link to the strategy:
*http://www.defra.gov.uk/environment/climate/government/*

Further information:
*http://www.ukcip.org.uk/*

In the **Netherlands**, on the initiative of the national government, the **National Programme for Spatial Adaptation to Climate Change** (ARK) was launched in 2006. For this programme several ministries worked closely with the umbrella organisations of the provincial authorities, municipal authorities and water boards. This programme is based on the assumption that spatial planning, in combination with other affected areas, should be the starting point for adaptation and thus represents the top priority.

One product of this collaboration is the **National Strategy for Adaptation in Spatial Planning**, adopted in 2007. This strategy formulates the actions necessary to climate-proof spatial planning in the Netherlands (over a time horizon of the next 100 years).

A new Delta Commission had been formed in 2008, as the current approach taken to coastal defense may no longer be viable in future and the approach needed to be scaled-up. On September 3rd, 2008 the Delta Commission presented their advice to the Dutch Cabinet. The Delta Commission formulated twelve recommendations for the short and medium term. The Dutch government responded to the advice of the Delta Commission with the start of the Delta Programme in 2009/2010. With the Delta Programme the Dutch government formulated new priorities in the field of adaptation to climate change.

Link to the strategy:
*http://www.climateresearchnetherlands.nl/gfx_content/documents/documentation/National_Adaptation_Strategy_The_Netherlands.pdf*

Further information:
*http://www.climateresearchnetherlands.nl/climatechangesspatialplanning/programme/adaptation*
*http://www.climateresearchnetherlands.nl/gfx_content/documents/documentation/ARK_make_room_for_climate.pdf*
*http://promise.klimaatvoorruimte.nl/pro1/publications/show_publication.asp?documentid=657&GUID=%7B4507E506%2DABC4%2D49E4%2DB0B6%2D4C75516AE8F2%7D*

In the Alps, the signatories of the Alpine Convention (BGBl. Nr. 477/1995) took the initiative to elaborate and adopt an Action Plan on Climate Change in the Alps in 2009. Its aim is to offer concrete measures that are specific to the Alps by promoting, both in terms of mitigation and adaptation, themes and measures that could be the subject of regional co-operations in the frame of the Alpine Convention, and by taking into account actions that are already in place on a national, regional and local level. The Alpine countries have committed themselves to pursuing the implementation of the climate action plan, using concrete measures to fight climate change, and to providing the necessary resources for this purpose.

At the national level, the **process of developing an Austrian adaptation strategy** was launched in 2007 (see Chapter 4: Development of the Austrian Adaptation Strategy). The current government programme of the federal government for the 24$^{th}$ legislative period (Republic of Austria 2008) has provided for the formulation of a national adaptation strategy with the involvement of all relevant stakeholders and the consideration of international good practices. The objective is to prepare the population and the economy for the coming changes and to offer options for protection against negative consequences.

**Infobox:**

European Commission's Green Paper on Adaptation to Climate Change:
*http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0354en01.pdf*

European Commission's White Paper on Adaptation to Climate Change:
*http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:DE:PDF*

ECCP (European Climate Change Programme):
*http://ec.europa.eu/environment/climat/eccpii.htm*

DG Climate Action
*http://ec.europa.eu/dgs/clima/mission/index_en.htm*

European Environment Agency:
*http://www.eea.europa.eu/de/themes/climate/eea-activities*

OECD:
*http://www.oecd.org/env/cc/adaptation.htm*

Nairobi Work Programme der UNFCC:
*http://unfccc.int/adaptation/sbsta_agenda_item_adaptation/items/3633.php*

Action Plan on Climate Change in the Alps:
*http://www.alpconv.org/de/ClimatePortal/Documents/20120220_AC_X_B6_fin_fin_de.pdf*

# Objectives

# 3 Objectives

The objective of the Austrian adaptation strategy is to avoid the adverse effects of climate change on the environment, society, and the economy and to fully utilize any opportunities that may arise. The adoption of an adaptation strategy should strengthen natural, social, and technological adaptive capacities. Adaptation measures should thus involve no social downsides; rather, they should minimize risks to democracy, health, security, and social justice.

The need for adaptation affects different decision-making levels, from public administration units with their various responsibilities over different economic sectors to individual people. Adaptation is a challenge that involves the entire society, requiring a well-coordinated approach that mediates between affected areas and between actors.

As a nationwide framework for the alignment of necessary adaptation measures, the strategy aims to bring together relevant actors, support cooperative action and facilitate the use of synergies through cooperation whenever possible. It seeks to provide recommendations for each of the various areas and to identify linkages for all the actors challenged with implementation. In accordance with the precautionary principle, the strategy attempts to lay a foundation for forward-looking action with regard to future climate change impacts and to foster successful implementation. A proactive approach is recommended, because as climate change progresses, the opportunities for successful adaptation diminish and the associated costs increase.

Despite considerable scientific knowledge, the effects of climate change in many areas are still subject to uncertainty. A primary focus in the design of the strategy was therefore the development of flexible and robust recommendations for action that can easily be adjusted to diverging requirements and serve secondary benefits. No-regrets and win-win measures are worthwhile in any case, as they provide further social, ecological, or economic benefits regardless of the extent to which climate change is accelerating.

Another important objective is to identify linkages between the areas for action and related recommendations in order to avoid negative impacts in other areas and possible conflicts in the implementation process. Adaptation activities that conflict with other key objectives – such as environmental protection or climate change mitigation – or that disadvantage social groups should also be precluded. Spontaneous maladaption is particularly to be avoided; this includes measures that seem promising in the short term to combat adverse effects but prove to be counterproductive in the long run.

Another key objective is to increase awareness at all levels in order to sensitize actors and make the complex issue of adaptation to climate change more tangible.

## What do we mean by adaptation?

The term adaptation refers to initiatives and measures enacted to "*decrease the sensitivity of natural or human systems to the actual or expected effects of climate change*" (IPPC 2007).

Adaptation activities seek to reduce vulnerability to climate change, to increase resilience, and to take advantage of potential opportunities presented by changing climatic conditions. Adaptation can be brought about in many ways and at various levels of action: forward-looking (proactive) or in response to specific climatic effects (reactive), on the public or private level, autonomously or planned.

Generally speaking, a wide range of adaptation options are available. They can be broadly classified into three categories (EC 2009c):

1. *"Grey"* infrastructure approaches, corresponding to physical interventions or construction measures and using engineering services to make buildings and infrastructure essential for the social and economic well-being of society more capable of withstanding extreme events (such as technological systems for flood protection or slope stabilization),
2. *"Green"* structure approaches are contributing to the increase of ecosystems resilience and, while addressing goals such as halting biodiversity loss, degradation of ecosystem or restoring water cycles, at the same time use the functions and services provided by the ecosystems to achieve a more costs effective and sometimes more feasible adaptation solution than relying solely on grey infrastructures alternatives. Increasing the resilience of green infrastructures therefore can be considered as synergy and no regret actions,
3. *"Soft"* non-structural approaches, corresponding to design and application of policies and procedures, and employing i.a. land-use controls, information dissemination, and economic incentives to reduce or prevent disaster vulnerability. They require more careful management of the underlying human systems.

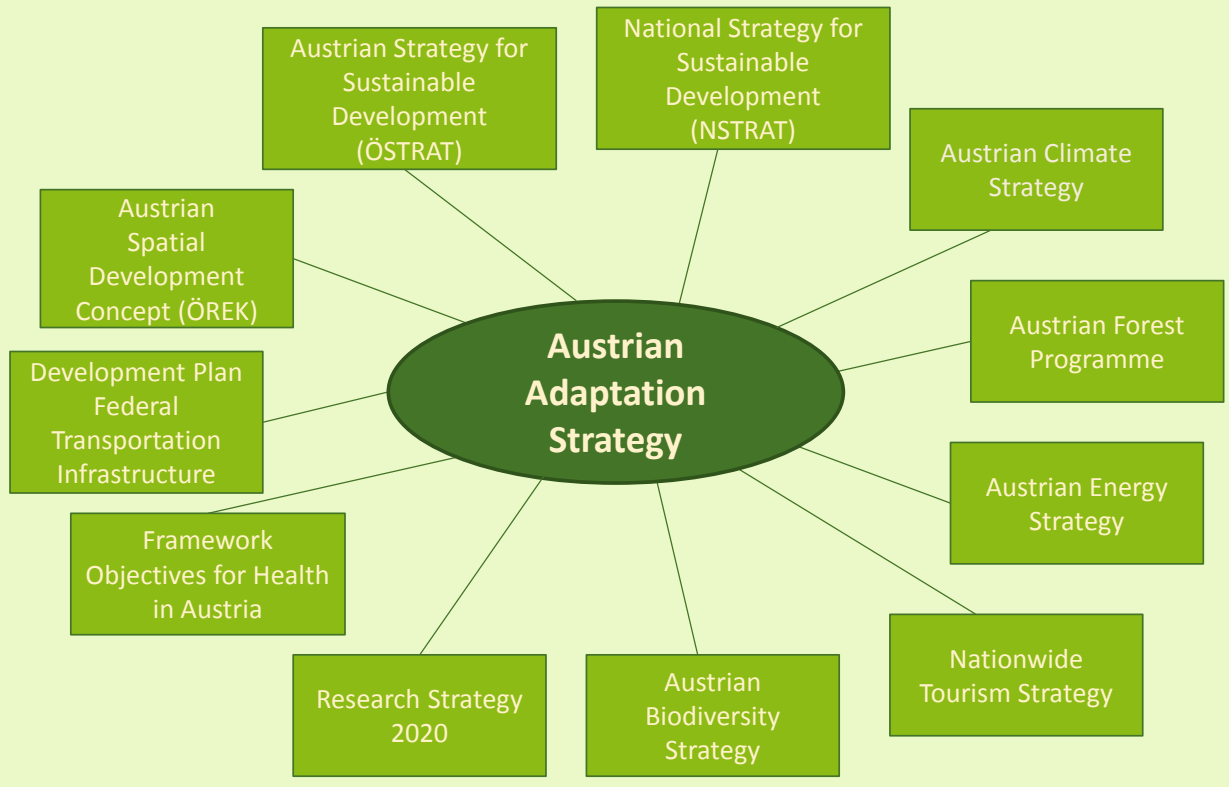
Although the definition of adaptation seems clear, in practice there are often difficulties in drawing distinctions. For example, measures aimed at the sustainable use of land and water are useful and necessary even without explicit consideration of the effects of climate change. However, climate change will increase the pressure on natural resources, such that these types of measures will also contribute to adaptation to climate change. Therefore, it is not always possible, nor is it expedient, to differentiate adaptation to climate change from measures that serve to protect the climate, the environment, or sustainable development.

# Interfaces with relevant national strategies

Climate change adaptation is a cross-cutting issue related to a wide range of policy fields, from flood protection to the security of agricultural production to public health. Due to the cross-cutting nature of adaptation, a number of interfaces exist between the adaptation strategy and other relevant national strategies, processes, and programmes. Sustainable development and adaptation are particularly closely related and complementary. The Austrian adaptation strategy is to be seen in the context of sustainable development, aiming to ensure the country's economically efficient, socially equitable, and ecologically sound future development.

In addition, certain areas for action have already created their own strategies, offering important points of linkage; here, close cooperation and coordination in order to take advantage of synergies is advisable. The graphic below shows an example of interfaces in the adaptation strategies of existing strategies and programmes.

**Figure 2:**
**Adaptation to climate change as a cross-cutting issue.**




*Graphic: Environment Agency Austria*

# Development of the Austrian Adaptation Strategy

# 4 Development of the Austrian Adaptation Strategy

The development process of the Austrian adaptation strategy began in September 2007. The initiative arose from the Kyoto Forum – a body tasked with discussions and arrangements on climate mitigation measures between representatives from the Austrian Ministry of Agriculture, Forestry, Environment, and Water Management (also referred to as the *Lebensministerium*) and the federal states (also referred to as the *Länder)*. The Ministry took the lead role in the development of the Austrian adaptation strategy.

The starting point for the development of recommendations for actions on adaptation was the outcome of the "Survey of the Current State of Adaptation to Climate Change in Austria" (Gingrich et al. 2008), in which the development of an Austrian adaptation strategy was recommended.

Between June 2008 and November 2011 recommendations for adaptation in 14 areas for action were successively developed from a scientific perspective, commissioned by the *Lebensministerium* and the Austrian Climate and Energy Fund. Conclusions regarding sectoral and regional climate impacts as well as a first qualitative evaluation of vulnerabilities supported the development of draft adaptation measures. On the basis of a literature review and a written survey involving numerous experts, concrete recommendations for the following 14 areas for action were formulated:

1. Agriculture
2. Forestry
3. Water Resources and Water Management
4. Tourism
5. Energy – Focus on the Electricity Industry
6. Construction and Housing
7. Protection from Natural Hazards
8. Disaster Risk Management
9. Health
10. Ecosystems/Biodiversity
11. Transportation Infrastructure and Selected Aspects of Mobility
12. Spatial Planning
13. Business/Industry/Trade
14. Cities – Urban Green and Open Spaces.

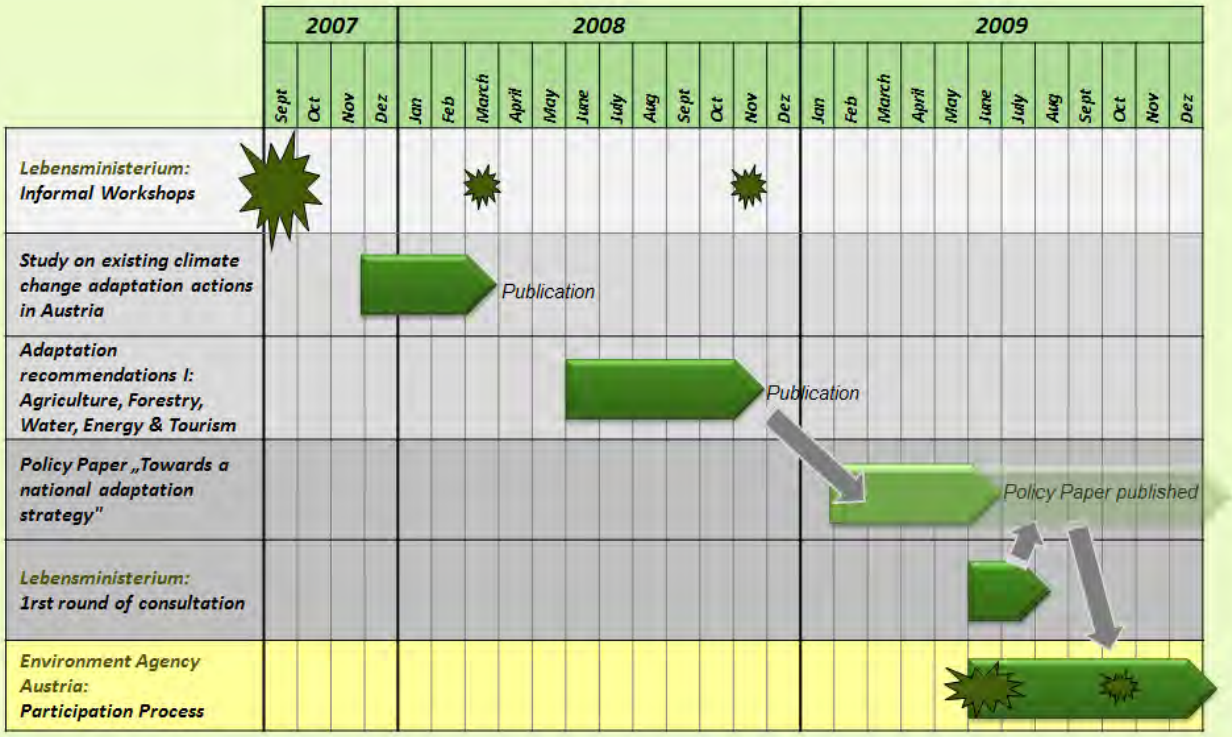
In order to specify the recommendations with a view to their implementation, an accompanying participatory process including some 100 organizations was undertaken between the summer of 2008 and July 2011.

Based on the above mentioned studies, the first political position paper (**Policy Paper: The Path to a National Adaptation Strategy – First Draft**) was published in July 2009. A second draft was published in October 2010 (BMLFUW 2010a). The policy paper has been continuously revised and expanded and developed towards the Austrian adaptation strategy.

Informal workshops hosted by the *Lebensministerium* have accompanied the development process of the national adaptation strategy. Between September 2007 and November 2011, a total of six workshops were organized in which the current state of work was presented and discussed with a wide audience.

The recommendations for the 14 areas for action are elaborated in detail in Part 2, “Action Plan”, of the national adaptation strategy.

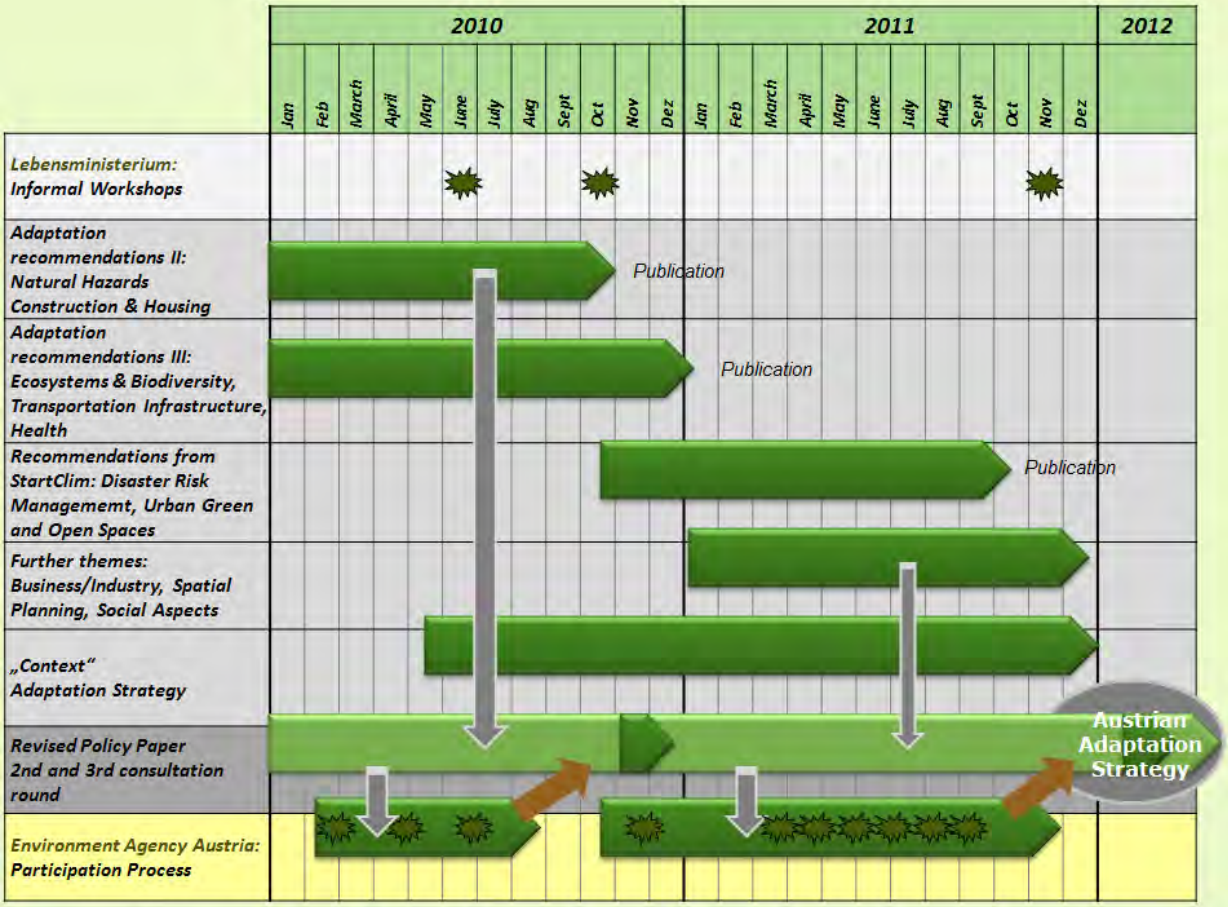
**Figure 3:**
**Illustration of the temporal sequence of activities and processes in the development of the national adaptation strategy, 2007–2009.**




*light grey = Ministry events, medium grey = substantive studies,*
*dark grey = strategic policy paper upon which the further development of the adaptation strategy is based,*
*yellow = concomitant participation process*

*Graphic: Environment Agency Austria*

**Figure 4:**
**Illustration of the temporal sequence of ongoing and planned activities and processes in the development of a national adaptation strategy, 2010–2012.**




*light grey = Ministry events, medium grey = substantive studies,*
*dark grey = strategic policy paper upon which the further development of the adaptation strategy is based,*
*yellow = concomitant participation process*

*Graphic: Environment Agency Austria*

# Climate Change in Austria

# 5 Climate Change in Austria

The results of numerous studies suggest that climate change has been influenced by human activities since the beginning of industrialization and that the process is already underway.

Since the mid-nineteenth century, records indicate an increase in the average annual temperature in Austria of about 2°C (ZAMG,[8] Auer et al. 2007). This increase is significantly above the global temperature rise of 0.76°C (IPCC 2007). Since the mid-1970s alone, the air temperature in Austria has risen by more than 1°C. With the exception of south-eastern Austria, annual precipitation has increased by 10–15% (Schöner et al. 2010).

The effects of climate change can be documented in many countries, Austria included: rapid melting of glaciers, thawing of permafrost, increasing numbers of hot days, etc. Of particular interest here is the question of how climate change will affect the human-environment system in the future – for example, by the increasing frequency and intensity of extreme weather events (e.g., heavy rainfall and the resulting floods).

## 5.1 Global Climate Scenarios

In order to capture the complexity of the climate system and to estimate past and future climatic trends, complex climate models have been established. These models describe the most important climate-related physical processes in the atmosphere, the oceans, and on the earth's surface, along with their mutual interactions.

For the calculation of climate scenarios, in addition to climate system models, further details regarding the future development of greenhouse gas concentrations are required; these are estimated by means of emission scenarios. Such scenarios are based on the assumption that future demographic, economic, and technological developments will have a direct influence on the further course of greenhouse gas emissions and can thereby variably enhance climate change. These so-called SRES scenarios (after "Special Report on Emissions Scenarios") include, among others, the "optimistic" B1, the moderate A1B, and the A2 scenario (IPCC 2008).

The climate scenarios in the IPCC report (2007) estimate a temperature increase of 1.1–6.4°C by the end of the 21st century relative to the 1980–1999 period, without taking future variations in natural forcings (e.g. large volcanic eruptions, solar activity) or external feedback processes into account. On the global level, warming of over 0.2°C per decade over the next two decades is expected. Even if atmospheric concentrations were held fixed at year 2000 values, a temperature increase of 0.1°C per decade must be anticipated.[9] However, between 2050 and 2100, the various emission scenarios exhibit significant differences in projected increases in global mean surface air temperature. Conclusions regarding precipitation are considerably less definite than those for temperature, since precipitation models are not as accurate as temperature models; a number of processes affecting precipitation patterns have not yet been effectively modelled.

[8] ZAMG: *http://www.zamg.ac.at/cms/de/klima/informationsportal-klimawandel/klimazukunft/alpenraum/lufttemperatur*

[9] ZAMG: *http://www.ipcc.ch/publications_and_data/ar4/syr/en/main.html*

In general, incomplete data, the lack of understanding of processes (in particular climate change feedbacks), and limited spatial resolution in the calculation of climate scenarios can lead to uncertain conclusions (Kromp-Kolb 2008). Models will only ever be approximations of reality and can never take into account all influencing factors. Model calculations for the global climate – and (especially) for regional climates – thus involve high levels of uncertainty; in addition, feedback effects have not yet been considered. Uncertainty in the assumptions also rises as the scenarios project further into the future. Nevertheless, the various models clearly indicate a potential range of climatic changes to be expected. Within this range, appropriate adaptation measures are needed that allow flexible readjustments and take account of existing uncertainties.

Despite existing uncertainties, climate models and scenarios constitute a crucial basis for the understanding of climate change and its potential impacts. However, it will be essential in the future for taking decisions on adequate adaptation actions to differentiate factors with varying levels of accuracy (e.g., estimated changes in air temperature are more reliable than estimates of changes in precipitation) and to show the whole spectrum of results.

## Tipping Points in the Climate System

The Earth's climate system is complex and non-linear, including certain regimes and processes that are particularly sensitive to climatic changes. These so-called "tipping points" could be disrupted by climate change in a way that they exceed a certain temperature threshold and subsequently "tip" into a fundamentally different state. An irreversible process that human actions could neither halt nor mitigate would be set into motion, accelerating the greenhouse effect. In addition, many of these processes are self-reinforcing, and therefore the effects are even more difficult to predict (Formayer 2009, Germanwatch 2010).

Scientists believe that many of these tipping processes will be triggered if the global mean temperature rises by more than 2°C relative to pre-industrial levels.

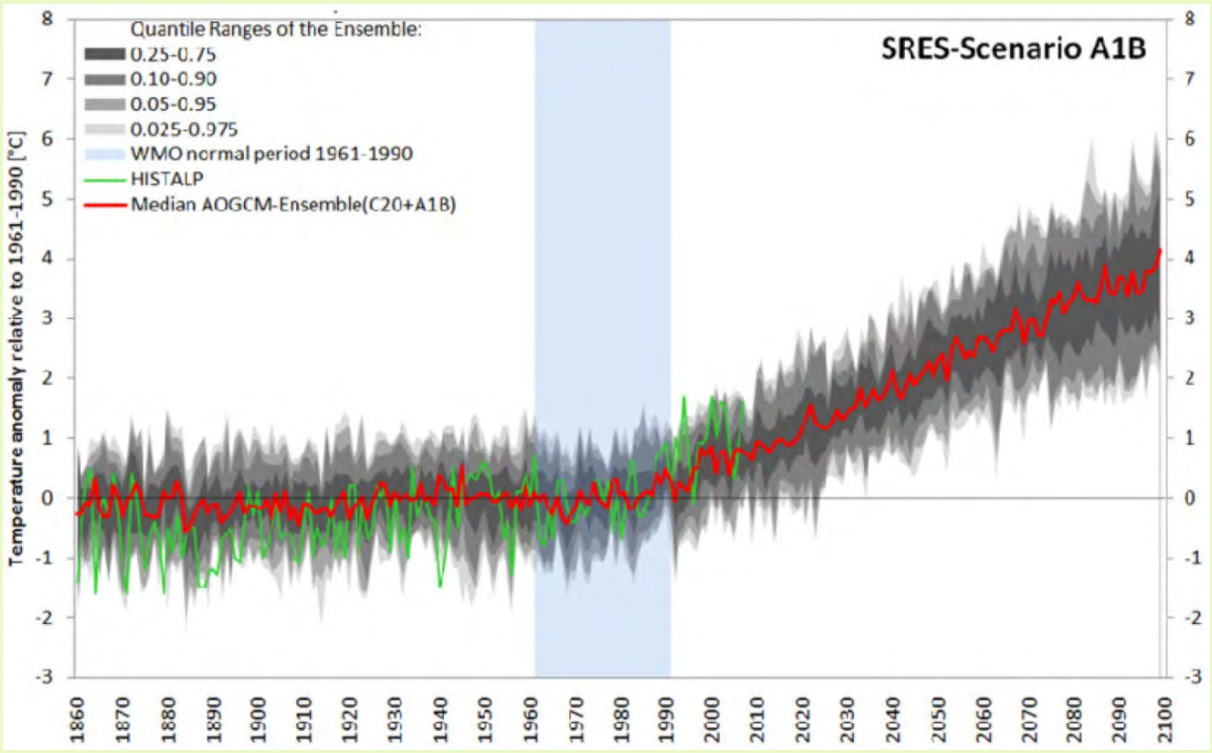
Eleven potential tipping points have been identified. One example of a self-reinforcing tipping point is the Arctic sea ice and the associated shrinking of the albedo (reflected radiation vs. total incident radiation). The less ice there is in the sea, the greater the visible surface area of dark water which absorbs more solar radiation than light ice surfaces do. This effect in turn fosters warming and simultaneously retards the process of new ice formation in winter.

Another influence on Europe's climate is the Gulf Stream and the extended North Atlantic currents. The currents in the Atlantic Ocean are controlled by water temperature and salt concentration. With increasing ocean temperatures and freshwater dilution (due to the melting of ice sheets in Greenland), this system of currents could change abruptly. The climatic consequences for Europe are not yet known; however, north-west Europe could become significantly colder.

## 5.2 Regional Climate Scenarios for Austria

Regional analyses of global climate models (GCMs) can only be performed for relatively large areas, such as the Alpine region. Fifteen different results from the latest GCM generation are available. By examination of this ensemble of model results, average trends can be projected and conclusions about the certainty of results can be drawn. For the Alpine region, the assumptions of the so-called “moderate” scenario A1B (entailing a further increase in emissions up to 2050, then marked reduction through technological progress) indicate an annual increase in temperature of about 4°C by 2100 relative to the period 1961–1990 (see Figure 5). In addition to this trend, the differences between the models are readily observable: 50% of all models fall within the dark grey area, and 80% within the medium-grey region. Here, it is evident that the uncertainties with regard to temperature changes are much smaller than the climate change signal.

**Figure 5:**
**Annual mean temperature relative to WMO normal period 1961–1990 in the Greater Alpine Region (GAR) up to 2100, based on 15 GCMs. The green line indicates measured values.**




*Information source: IPCC (2007); Source: Schöner et.al. (2010)*

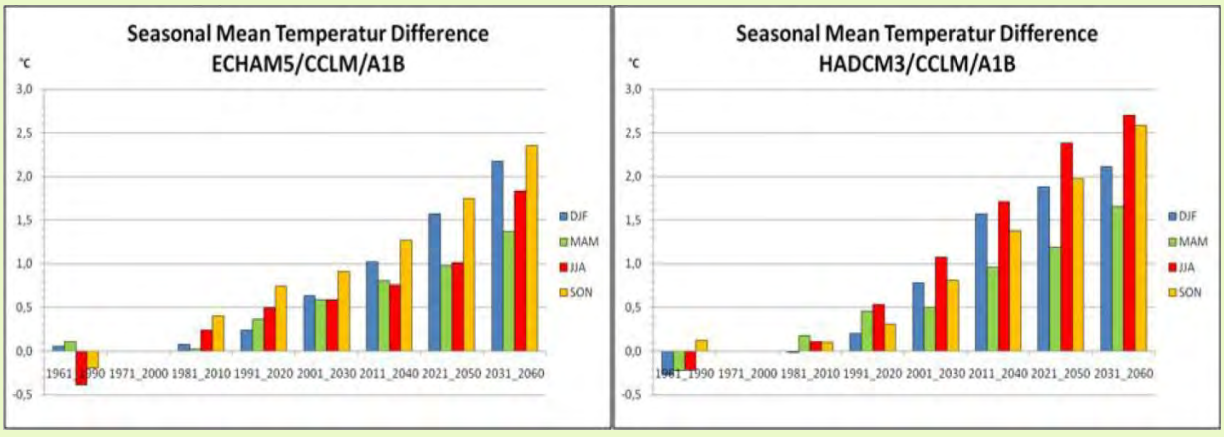
In order to derive the effects of climate change for Alpine regions, so-called “regionalization approaches” (consideration of regional conditions at a spatial resolution of 10 x 10 km) must be applied to the global climate models. However, regional changes are much more difficult to simulate than global average changes, and thus the conclusions for individual regions exhibit greater levels of uncertainty.

The Austrian research project *reclip:century* (Loibl et al. 2011) ran an ensemble of regional climate models with a spatial resolution of 10 km from the present to the middle of the twenty-first century. The climate change signals in these models are generally similar to those driving global climate models; however, due to the better representation of the Alps, they are significantly more robust.

With regard to **temperature**, all models for Austria show a continuous increase of about 1.5–2.5°C by the period 2031–2060 (relative to 1971–2000). Warming is particularly expected in summer and winter; the lowest level of warming is projected in spring (see Figure 6).

Comparison of the two model combinations employed indicates that in ECHAM5/CCLM (see Figure 6, left), the warming is somewhat more moderate than in HADCM3/CCLM.[10] ECHAM5/CCLM shows a maximum warming of 2.4°C in autumn, followed by winter with 2.3°C. In summer, there is warming of about 1.8°C, and in spring, 1.4°C. In the model HADCM3/CCLM, the differences between the seasons are similar in size. The most extreme warming is projected in summer, with an increase of 2.7°C; the lowest level of warming is seen in spring.

**Figure 6:**
**Regional scenarios for climate warming in Austria; each bar represents the difference between a 30-year average and the period 1971–2000. Left: based on the model ECHAM5/CCLM/A1B; right: based on HADCM3/CCLM/A1B.**



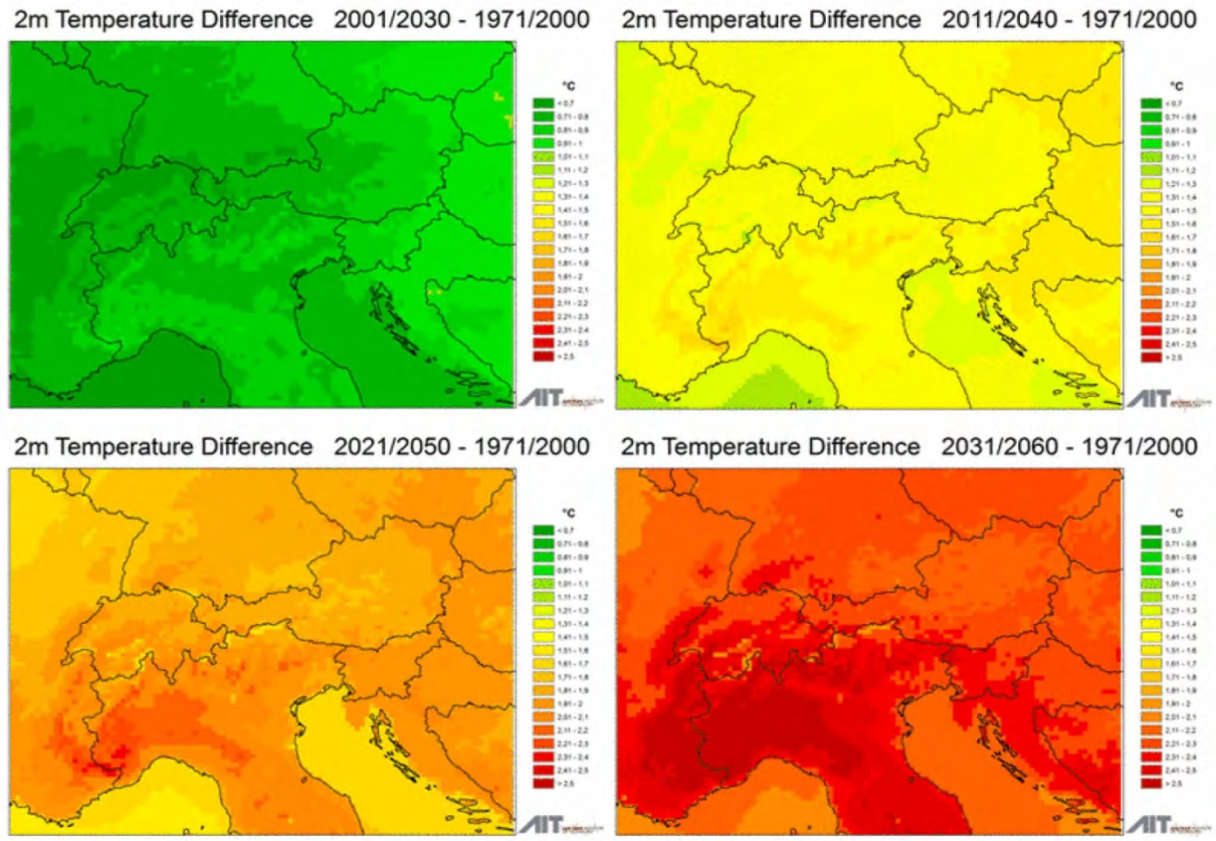

*DJF: December, January, February  MAM: March, April, May  JJA: June, July, August  SON: September, October, November*

*Source: reclip:century, Loibl et al. (2011)*

[10] ECHAM5 and HADCM3 are global climate models; COSMO CLM (CCLM) is a regional climate model.

Figure 7 presents the spatial distribution of temperature warming in the Alpine region for the periods 2001–2030, 2011–2040, 2021–2050, and 2031–2060 relative to the climate period 1971–2000. In general, the temperature increase is evenly distributed across the entire Alpine region, although the regions south of the main ridge of the Alps tend to warm somewhat more rapidly.

**Figure 7:**
**Regional scenarios for climate warming in the Greater Alpine Region (GAR), each showing the difference between a 30-year average and the period 1971–2000, based on the model GCM HADCM3.**



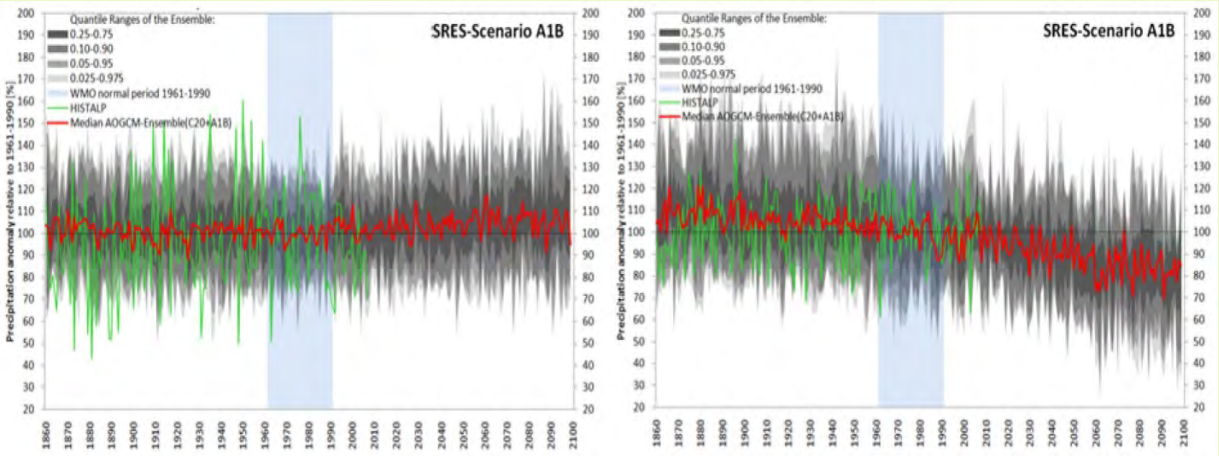

*Source: reclip:century, Loibl et al. (2011)*

Figure 11 shows an overview of climate change signals for 7 sub-regions and the three currently available *reclip:century* models. The regional differences in temperature in the transition seasons are minor, but in summer and winter they can amount up to half a degree.

Changes in **precipitation** are dependent on processes that are not adequately captured by global climate models (e.g., small-scale heat thunderstorms or large-scale extreme precipitation induced by orographic lift). The Alps act as a barrier for precipitation. Between 1860 and 2007, rainfall in the north-west Alpine region increased, while the south exhibited a long-term decrease. For the continental north-east, no changes have been observed (ZAMG 2009).

The precipitation scenarios downscaled from global climate models indicate that the total annual precipitation for the Alpine region should remain largely constant (see Figure 8), although the precipitation is expected to shift from the summer months to the winter months. The existing modelling results through the year 2100 predict an increase in precipitation in winter and a significant decrease in summer across all regions of Austria. According to the currently available studies, substantial changes in precipitation in summer are predicted after about 2040 (Schöner et al. 2010).

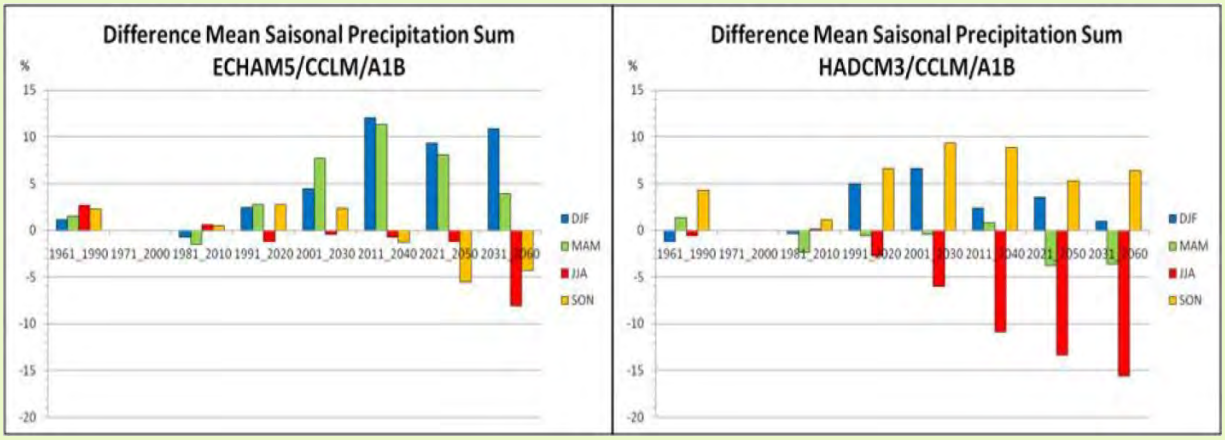
**Figure 8:**
**Changes in precipitation relative to the WMO normal period 1961–1990 in the Greater Alpine Region (GAR) through 2100, based on 15 GCMs. The green line indicates measured values. Left: winter; right: summer.**




*Data source: IPCC (2007); Source: Schöner et al. (2010)*

The results of *reclip:century* for precipitation are not as robust as those for temperature. In part, this is because global climate models generally show significant changes in seasonal precipitation in the Alpine region only in the second half of the century. In addition, for Austria, uniform developments in precipitation are not expected, since the topography of the Alps result in stark differences in precipitation regimes. All models indicate a decrease in precipitation in the summer (see Figures 8 and 9). The transition seasons, spring and fall, are assessed differently by the various models; however, all models predict an increase in precipitation in winter.

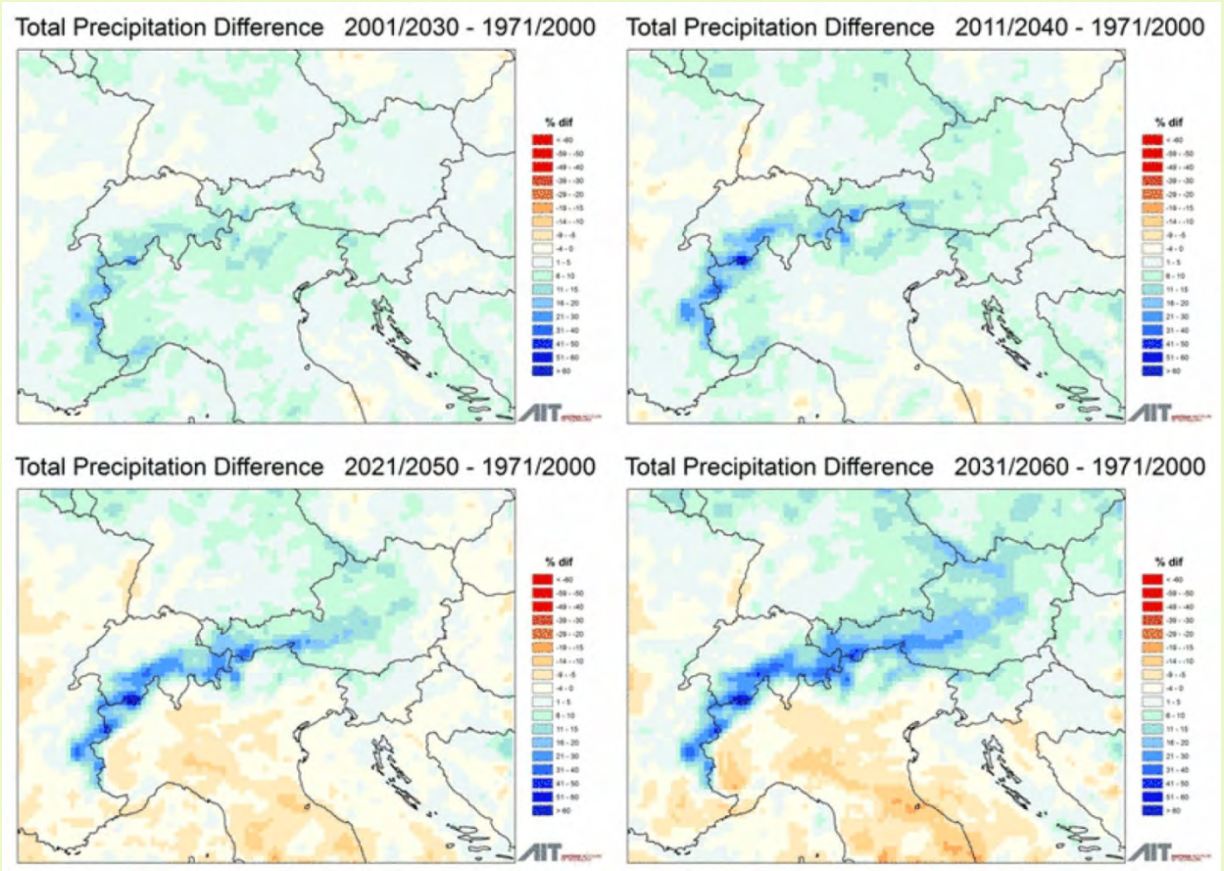
**Figure 9:**
**Regional scenarios for changes in precipitation in Austria;**
**each bar indicates changes for 30-year periods relative to the period 1971–2000.**




*DJF: December, January, February  March, April, May  JJA: June, July, August  SON: September, October, November*

*Source: reclip:century, Loibl et al. (2011)*

**Figure 10:**
**Precipitation changes in the Greater Alpine Region (GAR); each map indicates the relative difference between a 30-year period and the period 1971–2000, based on the model GCM HADCM3.**




*Source: reclip:century, Loibl et al. (2011)*

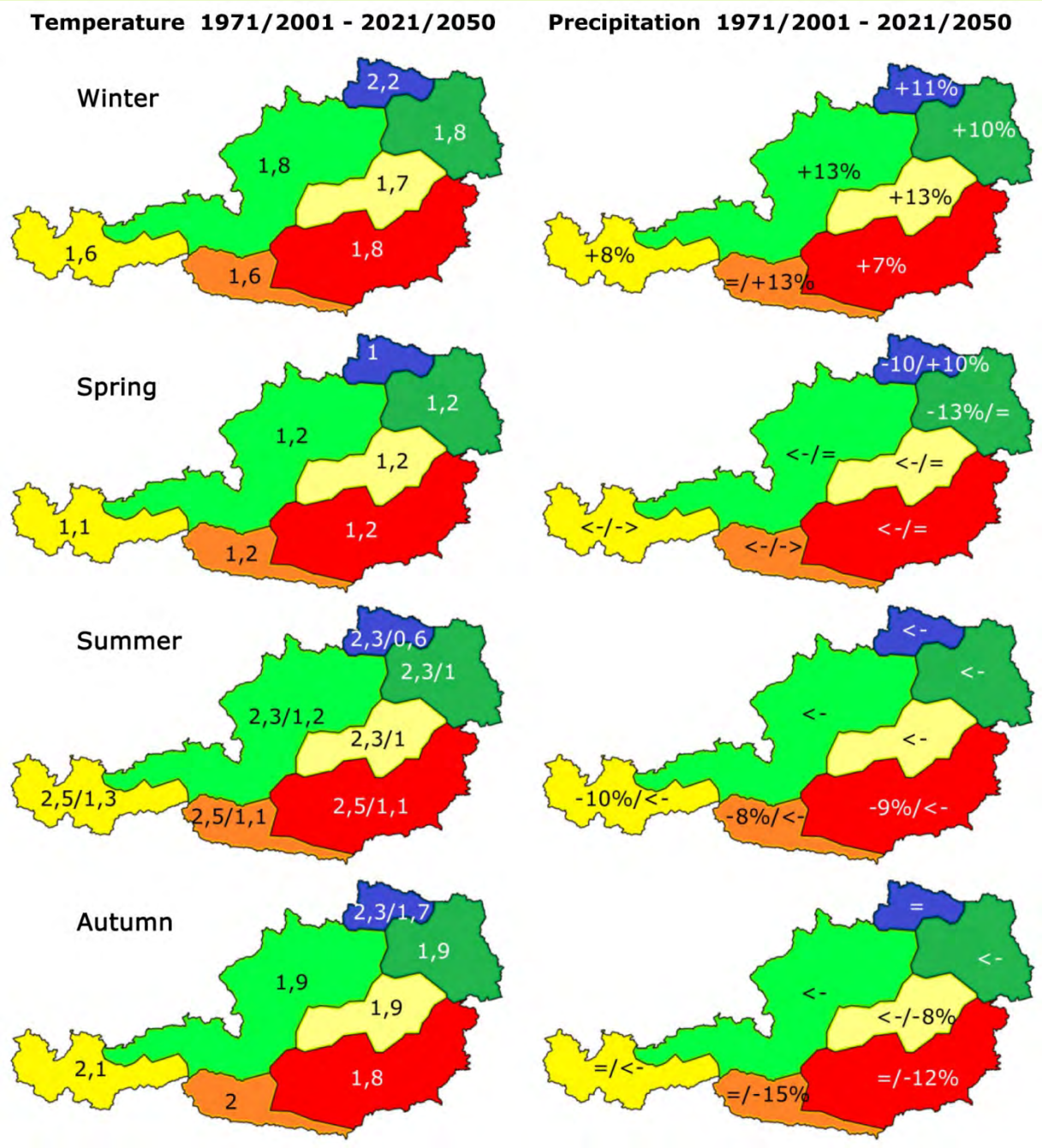
Regional differences can be seen in the increase in precipitation in winter (see Figure 11) for the period 2021–2050: In the north and east, there is an increase of just over 10%; in the west and south-west just under 10%. In spring, no consistent signals are apparent, except in the east, where a slight decrease in precipitation seems possible. In summer, a general decrease in precipitation is predicted, reaching 10% south of the main ridge and in the west. For autumn, no significant changes in precipitation are expected, but a decrease of about 10% is possible in southern and eastern Austria.

In addition to the above mentioned changes in mean precipitation, the possibility of increasing climate change-induced variability between years is also discussed. Consequently, the precipitation scenarios should be interpreted with caution.

For the investigation of current and past climate in Austria, in addition to the model calculations described above, measurement data sets have recently been compiled; of special interest are the homogenized sets developed and tested by the ZAMG (HISTALP). These data have been the subject of numerous detailed analyses and present a clear picture of climate change in Austria.

An unambiguous result gleaned from past data (which can be applied to the future as well) is that the year-to-year changes in climate (temperature, precipitation, duration of snow cover, etc.) are much larger than the long-term climate trends, as long as future scenarios consider a time horizon of a few decades. Thus, natural climate variability must always be taken into account in the interpretation of climate scenarios.

**Figure 11:**
**Summary of *reclip:century* results for temperature and precipitation in Austrian regions for the period 2021–2050 compared to the period 1971–2001.**




*Left: seasonal temperature means (according to HadCM3/CCLM/A1B; ECHAM5/CCLM/A1B, ECHAM5/CCLM/B1); right: relative change in precipitation in % (according to HadCM3/CCLM/A1B; ECHAM5/CCLM/A1B: explicit figures in % or – for small changes – indicated only as a trend, <-/->)*

*Source: reclip:century, Loibl et al. (2011)*

## 5.3 Anticipated Future Effects of Climate Change Based on Climate Scenarios for Austria

In addition to the previously described regional and seasonal changes in temperature and precipitation, the direct and indirect effects of these changes will also be significant. The following section will briefly present the expected future temperature- and precipitation-induced effects with respect to their importance for the 14 areas for action considered.

Within Austria, differing regional concerns are expected.

**Area for Action: Agriculture and Forestry**

- Prolongation of the growing season;
- Shift in precipitation from the growing season to the winter (regional differentiation is necessary here);
- Decrease in frequency of precipitation during the summer months;
- Increase in the variability of precipitation in summer from year to year;
- Increase in the frequency of droughts;
- Heat damage to plants, especially in combination with drought;
- Probable decrease in groundwater supply and thereby increased water stress in southern and eastern Austria;
- Increase in potential evapotranspiration[11] due to higher temperatures and longer growing seasons;
- Heat damage to plants and the increase in evapotranspiration can result in specific crops being abandoned in certain regions or overall. Increased risk of a decrease in biodiversity;
- Changes in species composition, including new invasive species;
- Emergence of mutated and new invasive pests causing damage to plants and plant products;
- Emergence of new pathogens in animal husbandry;
- No authoritative conclusions as yet regarding the effects of extreme weather events, such as increased frequency of storms and hail or erosion due to heavy rainfall; for effects of flooding, see the area for action “Water Resources and Water Management” (further research needed);
- Changes in physiological parameters of performance and quality for useful plants and crops due to changing patterns of precipitation and temperature conditions.

**Area for Action: Water Resources and Water Management**

- Tendency to shift the risk of flooding into winter and spring in northern Austria; increase in heavy rainfall possible (thus far, not clearly documented); a possible increase in local heavy precipitation of short duration is also discussed;
- Increase in evaporation;
- Decrease in precipitation in the form of snow and in the duration of snow cover; earlier onset of melting of snow;
- Increase in precipitation in winter (especially in the north), decrease in summer rainfall;
- Increased runoff in winter (with the exception of the south), decrease in summer runoff (varies by region);

[11] Evapotranspiration: Totality of soil evaporation, plant transpiration, and evaporation from interception (retention of rainfall on the "surface").

- Continuation of glacial retreat. Runoff from glacier melt should reach a maximum in 2040–2050;
- Increase in low-water runoff in the Alps in winter, possible reduction in the lowlands in late summer/autumn;
- General increase in low-water runoff in winter, decrease in summer;
- Increase in water temperatures (surface water – especially in summer – as well as groundwater);
- Locally, the bed load potential in areas of permafrost may increase; from a regional perspective, the increase could be rather small for large discharge systems;
- In southern and eastern Austria, a decrease in groundwater recharge is likely; in northern and western Austria, groundwater recharge could increase;
- Due to the potential increase in evaporation and the decrease in summer precipitation, a reduction in spring discharges from near-surface springs cannot be excluded;
- Possible reduced dilution potential in surface waters in south-eastern Austria could lead to raised concentrations of substances;
- Higher temperatures will lead to changes in aquatic biocenoses, altering the bioregions;
- On a small scale, existing bottlenecks in water supply in areas with unfavourable water resources could worsen.

**Area for Action: Tourism**

- Increase in annual mean temperatures (year-round tourism);
- Changes in precipitation and its seasonal distribution: a decrease in the frequency of precipitation during summer months and an increase in winter months;
- Decrease in snowfall in lower and middle elevations; reduced certainty of snow;
- Decrease in ice and frost days;
- Increase in the number of days without continuous snow cover in the mountains;
- Thawing of permafrost can lead to instability in infrastructural facilities and to risk of rock falls;
- Glacial retreat affects the landscape;
- Possible increased pressure on glaciers due to worsening conditions in ski areas at lower elevations;
- Increase in water temperatures (longer season for swimming outdoors);
- Possible adverse effects on water quality in lakes (e.g., due to algae) at higher temperatures;
- Relative climatic advantage of Alpine region in summer in comparison to Mediterranean destinations;
- More severe heat waves and an increase in the number of hot days (over 30°C) in summer (e.g., city tourism – escape from urban regions into the surrounding areas);
- Loss of biodiversity (flora and fauna) resulting in a change in the natural scenery.

**Area for Action: Energy – Focus on the Electricity Industry**

- Increase in low-water runoff in winter and earlier beginning of snow melt;
- In Prealps waters: increased occurrence of low-water periods in summer and autumn;
- In Alpine waters: potentially longer low-water periods in late summer; in glacial areas, summer and autumn flows could even increase in the short to medium term, as glacial melting contributes to the runoff. In the long term, however, the accelerated retreat of the glaciers is expected to result in decreasing water supply;
- Increase in water temperatures, above all during dry periods in summer;
- Retreat of glaciers and permafrost and thus increased areas of glacial till;

- Potential changes in wind conditions;
- Potential changes in solar radiation;
- Potential changes in the supply of biogenic materials for energy production;
- Decrease in energy consumption for heating and increase in energy demand for cooling; changes in the number of heating and cooling degree days;
- Potential changes in the supply of renewable energy sources (e.g., wind energy, solar energy, biomass).

**Area for Action: Construction and Housing:**

- Increasing average temperatures and maximum temperatures;
- Increased incidence of heat waves leads to an increase in heat stress; especially in urban areas, intensification of the heat-island effect is expected;
- Increase in temperature-related physical demands on buildings;
- Increase in night-time minimum temperatures of over 20°C;
- Regional differences in increases in intensity of precipitation;
- Shift of flood risk into winter and spring (note that a general prediction regarding changes in flood risk for all of Austria is currently not possible);
- Increased snow loads are to be expected at higher elevations and cannot be excluded for lower and middle elevations due to increasing climate variability;
- Currently, no robust conclusions can be drawn regarding extreme weather events such as for storm and hail frequency (further research needed);
- Regionally variable increases in heavy precipitation and the thawing of permafrost in Alpine regions can lead to increased mud flow, rock slides, rock falls, landslides, and (in winter) avalanches;
- Increased risk of forest fires and wildfires due to heat waves.

**Area for Action: Health**

- Increased incidence of heat waves leads to an increase in heat stress; especially in urban areas, the intensification of the heat-island effect is to be expected;
- New record high temperatures in low-lying areas of Austria;
- Increase in night-time minimum temperatures of over 20°C, particularly during hot spells;
- Increase in thermophysical burden on hot days and during heat waves;
- Increase in the mortality rate during heat waves, especially for high-risk groups;
- Possible performance impairment on hot days and during heat waves;
- Changes in the dispersion and transmission conditions of vectors and pathogens;
- Potentially wider dispersion of allergenic plants and animals;
- Robust predictions regarding the increase in extreme weather events (such as frequent storms and hail, heavy rainfall, and flooding) are currently not possible. Higher frequency of extreme events would raise the risk of spills, injuries, permanent disability, and fatal casualties;
- Secondary health effects of extreme weather events potentially include stress and psychological disorders, as well as mould and mildew in living spaces due to water damage;
- Summertime high-pressure fronts can contribute to the accumulation of air pollutants;
- Higher temperatures can favour the growth of microorganisms in food and thereby lead to an increase in food-borne infections;
- Possible bacteriological contamination of drinking water due to an increase in water temperatures.

**Area for Action: Ecosystem/Biodiversity**

- Increase in annual mean temperatures;
- Higher temperatures lead directly to a lengthened growing season and thus to an earlier beginning and a later end of plant transpiration;
- Increase in the frequency of droughts;
- Changes in the amount of precipitation and its seasonal distribution: a decrease in the frequency of precipitation during summer months and an increase in winter months (regional differentiation is required);
- Heat stress in plants, especially in combination with droughts;
- Probable decrease in groundwater supply and thereby increased drought stress in southern and eastern Austria;
- Increased risk of reduction in biodiversity;
- Changes in species composition;
- Decrease in amount of snow in lower and middle elevations; reduced certainty of snow;
- Decrease in ice and frost days;
- Increase in water temperatures, above all during summertime droughts;
- Shifts in area boundaries along elevation and moisture gradients;
- Changes in species composition in biotic communities and biotopes;
- Loss of habitats and species;
- Spread of new invasive species (alien species).

**Area for Action: Transportation Infrastructure**

- Increased heat stress can result in damage to materials and structures, as well as the deformation of pavement and rail infrastructure (road and rail buckling);
- During heat waves, there is a higher risk of failure for electronic equipment (signal systems);
- Changes in the amount of precipitation and its seasonal distribution: a decrease in the frequency of precipitation during summer months and an increase in the winter;
- Tendency for flood risk to shift to winter and spring in northern Austria;
- Increased runoff in winter (with the exception of the south), decreased runoff in summer (variable by region);
- Potential increase in heavy precipitation (thus far not clearly documented); a possible increase in local heavy precipitation of short duration is also discussed;
- Heavy precipitation can result in drainage system overloads and the flooding of underpasses;
- Erosion and washouts can threaten the stability of railroad embankments and road beds;
- Increasing risk of mass movements (landslides, mud flows);
- Decrease in precipitation in the form of snow and in the duration of snow cover; earlier onset of snow melt;
- Decrease in the amount of snow in lower and middle elevations; reduced certainty of snow;
- Increase in the amount of snow at elevations above 1800 m, potentially accompanied by a higher risk of avalanches in certain regions;
- Increase in the number of days without continuous snow cover in the mountains;
- Decrease in ice frost days;
- Thawing of permafrost can lead to instability in infrastructural facilities and increase the risk of rock falls;
- Robust predictions regarding storms are currently impossible; storms can cause damage to electronic infrastructure.

**Area for Action: Business/Industry/Trade**

- Higher temperatures and heat waves increase the cooling requirements for the storage and transport of various products;
- Higher temperatures and heat waves affect working conditions (decline in productivity, endangerment of worker health and safety);
- Changes in consumer behaviour due to rising temperatures and longer hot spells (e.g., beverage consumption);
- Decrease in the availability of cooling water during heat waves/droughts can affect cooling-intensive production as well as power generation;
- Potential changes in the availability of raw materials and intermediate products due to changes in temperature and precipitation conditions can have an impact on the entire value chain;
- Regional differences in water supply resulting from changes in the amount of precipitation and its seasonal distribution: a decrease in the frequency of precipitation during summer months and an increase in winter months;
- Potential increase in extreme events and extreme weather conditions can cause massive damage to operational infrastructure and production processes (risk of liquidity crises for enterprises and insurers);
- Precipitation- and temperature-induced extreme weather events (storms, hail, floods and landslides, heat waves in combination with droughts) can lead to bottlenecks in power generation and thereby interfere with production or result in production downtime;
- Impacts on internal logistics due to more frequent extreme weather events, impairment of transportation and storage infrastructure;
- Through globalisation, both the supply for production in Austria and the sales of Austrian products will be influenced by climate effects in other regions of the world;
- Both climate protection requirements and climate change can result in innovations in products and processes – for example, innovations in the insulation industry, in the development of coolants and new building materials, in renewable energy, or in terms of flood protection, slope stability measures, and other forms of adaptation.

**Area for Action: Cities – Urban Green and Open Spaces**

- Increased incidence of heat waves leads to an increase in heat stress; especially for urban areas, the intensification of the heat-island effect is expected.
- Increase in thermal extremes and new record high temperatures in low-lying areas of Austria;
- Increase in night-time minimum temperatures of over 20°C, particularly during hot spells;
- Increase in thermophysical load on hot days and during hot spells;
- Increase in the mortality rate during heat waves, especially for high-risk groups;
- Potential performance impairment on hot days and during heat waves;
- Reinforcement of the thermal urban climate effect by an increase in power demand during heat waves (increase in the use of air conditioning);
- Summertime high-pressure fronts can contribute to the accumulation of air pollutants;
- Shift of flood risk to winter and spring (more general predictions regarding changes in flood risk for all of Austria are currently not possible);
- Changes in the amount of precipitation and its seasonal distribution: a decrease in the frequency of precipitation during summer months and an increase in winter months;
- More frequent summer thunderstorms and heavy rainfalls with heavy peak rainfall flows;

- Making robust predictions regarding storms is currently impossible; storms can cause damage to electronic infrastructure;
- Changes in urban flora and fauna and the spread of thermophile plant and animal species, especially invasive alien species;
- Decrease in the evaporation capacity of vegetation;
- Lengthening of the growing season;
- Increased vulnerability of vegetation during dry periods or droughts.


# Challenges to Adaptation

# 6 Challenges to Adaptation

The planning and implementation of adaptation is a dynamic process that must allow for flexible adjustments to new conditions (e.g., further consequences of climate change, new research results). Adaptation to climate change is a complex task characterized by a wide range of challenges.

Finding a proper way to deal with **uncertainties** is undoubtedly a key challenge for the planning and implementation of any adaptation measure. Above all, uncertainty emerges from global and regional scenarios for the future evolution of the climate. A lack of understanding regarding meteorological processes (especially feedback processes), ambiguous development of greenhouse gas emissions, missing long-term data, and the limited spatial resolution in the calculation of climate scenarios all lead to uncertain conclusions. Climate scenarios are always merely approximations of reality and can never account for all influencing factors. They do not provide definite predictions about a specific future course of events, but rather show the wide range of plausible future developments. Despite these inevitable uncertainty factors, climate scenarios represent an essential basis for the understanding of climate change and its potential effects.

In addition to uncertainties linked to climate models, there are also uncertainties with regard to future developments in greenhouse gas emissions. This issue is dependent on many factors, such as population growth, economic growth, trends in energy prices, and changes in land use, as well as in how far technologies enabling reductions in greenhouse gas emissions gain worldwide acceptance.

Another challenge in adaptation results from the fact that adaptation is a classic **cross-cutting issue**: a multitude of areas for action (e.g., infrastructure, energy supply, water management, protection from natural hazards) and stakeholders from various fields all play a role. In addition, different levels and areas of responsibility are affected by taking action on adaptation, from public administration units (local up to national) to various economic sectors to individual people. Interdependencies also arise between the various levels and areas for action, such that benefits in one area can lead to undesirable consequences in another. A lack of cooperation and coordination between the different areas for action, actors, and decision-making levels can cause conflicts and potential synergies (including those of a financial nature) could possibly not be utilized. Therefore, a cross-sectoral perspective and the integration of adaptation in diverse policy areas should be pursued.

The third challenge arises from the inevitably close relationship between **climate change mitigation** and **adaptation**; the two issues should thus be considered together. Adaptation cannot replace climate change mitigation; however, achievements in mitigation efforts can help reducing the costs of adaptation. In the planning of adaptation measures, actions that simultaneously pursue the objectives of mitigating climate change should be prioritized. In turn, in the planning of mitigation measures, those that would be robust in a wide range of plausible future developments should be favoured.

However, all these challenges cannot be used as an argument for inaction! It is essential that every person involved in adaptation processes share a common understanding and the same level of knowledge, and are willing to proactively deal with open questions regarding planning and implementation. Furthermore, a cooperative approach and close collaboration between science, practice, and decision-makers is a prerequisite for successful adaptation.

# Social Aspects of Climate Change

# 7 Social Aspects of Climate Change

Human mankind is on one hand the main cause of climate change, but on the other hand increasingly feels its effects and investigates possibilities to adapt. Climate change mitigation and smart adaptation serve not only to protect ecosystems. In the best case, they also provide definite social advantages, as they anticipate potential social effects and seek to minimize risks to democracy, health, safety, and social justice, drawing upon social integration and cohesion, respecting fundamental rights and cultural diversity, guaranteeing the equality of men and women, and fighting against discrimination of any kind.

The treatment of the environment and the related risk perception is influenced by individual factors as well as by the social environment. How people confront climate change and whether and in what way they are capable of implementing appropriate strategies or dedicating available resources to adaptation depend largely on the specific social conditions of those affected, from individual prerequisites and the social-cultural environment.

At the global level, but also within Austrian society, there are inequalities in terms of lifestyles, income levels, and resource consumption. There are those who consume more resources but nevertheless are less affected by adverse environmental impacts (such as the negative consequences of climate change), and there are others, generally the socially disadvantaged, who suffer both socially and as a result of increased environmental burden.

In addition to a social discourse of how we deal with the environment and how much risk of climate change we are willing to take, the social aspects of climate change and adaptation to climate change act further include value systems that delve deep into the ideological and ethical thinking of all affected. This entails issues such as social and ecological justice among the living as well as for future generations.

Currently, no detailed scientific assessments of the social consequences of climate change or the social effects of adaptation measures are available. However, the following questions should be considered:

- How are people in Austria affected by climate change and potential adaptation measures on the basis of their location and socio-economic situation?
- How will everyday life, especially working conditions and lifestyles, be altered through climate change?
- How are national aspects of adaptation to climate change connected to European and global aspects?
- What measures are required in order to minimize or prevent the vulnerability of social systems and the adverse effects of climate change?

More research is needed in particular on how the effects of climate change can or will affect communities (social justice, integration, cohesion, stability, character, security), political participation (democracy, opportunities for participation), everyday life (employment, lifestyles, and interactions), culture (cultural diversity, values, beliefs, education, cultural change), health and welfare (of a physical, mental, and social nature; safety), and individual rights (fundamental rights, economic concerns of individuals, gender equality, discrimination).

In addition, research should examine which sectors and regions in Austria are particularly affected by the social consequences of climate change, which population groups (the elderly, the disabled, low-income households) are more likely to feel the effects of climate change, which measures (under regimes of both climate change mitigation and adaptation) entail social and economic benefits, how the resilience of health and social policies can be improved, and how adaptation measures in all policy areas can be sensitized to the social dimension (see also EC 2009a).

In Austria, the politically approved common social objectives can be found in the National Strategy for Sustainable Development (NSTRAT, BMLFUW 2002) and in the Austrian Strategy for Sustainable Development – Scope of action for the Federal Government and the States, adopted in July 2010 (ÖSTRAT, BMLFUW 2010b), as well as in the ÖSTRAT Work Programme 2011ff adopted in August 2011.

Taking into account European and international developments in the sustainability discourse, the federal government within its area of competence has complemented the thematic orientation included in the ÖSTRAT resolution of the regional governors, adopted on 5 May 2009, with social, economic, and socio-political concerns. These are presented in the ÖSTRAT Work Programme 2011 under the new priority areas “Public Health, Prevention, and Aging” and “Fair Working Conditions for All”, and will be implemented through specific initiatives and measures at the federal level.

Enacted by the Council of Ministers, the elaboration of a new national sustainability strategy (NSTRATneu) of the federal government has started in October 2011. On the basis of NSTRAT 2002, ten cross-sectoral areas for action were defined:

1. Sustainable Thinking and Action
2. Stability, Crisis Resilience, and Capacity for Innovation
3. Quality of Life, Qualitative Growth, and Resource Conservation
4. Secured Livelihoods and Social Cohesion
5. Equal Live Chances
6. Natural Environment Functions and Ecosystem Services
7. Sustainable Energy Systems
8. Sustainable Mobility
9. Perspectives on Local and Regional Development
10. Global Responsibility

The potential impact of climate change and first general considerations of potential action will be investigated in accordance with the central guiding principles of NSTRAT. Once the amended NSTRAT and most recent research results are available, it will be necessary to revise the information in this chapter.

**Quality of Life in Austria – A Sustainable Lifestyle**

The goal of a sustainable future lifestyle is influenced by the defining principles of “sustainable development”: local identity, longevity, diversity, naturalness, partnership, quality before quantity, and proximity. The so-called “Western lifestyle” is only possible through the above-average (on the global scale) consumption of energy and resources. The concept developed in the 1990s of an ecological footprint, graphically representing the consequences of the Western lifestyle, demonstrates that three planets would be needed if all 7 billion people on Earth were to lead such a lifestyle.

Due to the increasing worldwide demand on resources (above all, energy and food), prices are beginning to rise. Particular importance is attached to the fact that food prices in 2011 in comparison to 2008 reached a new international record high. Price increases due to, inter alia, higher energy costs, the increasing scarcity of resources, and also the effects of climate change (such as flooding, aridity, drought and the resultant crop failures, etc.) will – without compensatory measures – lead to a deterioration in living conditions, especially for low-income and poverty groups. In contrast, because of their relatively lower spending on basic needs as a percentage of income, high earners will be less affected by higher prices. It is to be expected that price increases accelerated by climate change will exacerbate the already existing social disparities between the rich and the poor. Primarily for financial reasons, low-income groups have fewer opportunities to prevent or avoid undesirable developments. The number and distribution of low-income people and the individual concern with regard to climate change vary regionally. Furthermore, an increase in inequality and issues of distributive injustice can lead to conflicts.

Graphic illustrations of the consequences of a resource-intensive lifestyle (such as those provided by the ecological footprint) must therefore also take into account the fact that a reduction in resource consumption without appropriate accompanying measures can have negative social effects.

**Recommendations**

- Measures for adaptation to climate change in all areas for action should be oriented on the principles of sustainable development in order to consider and balance social, economic, and ethical aspects.
- Adaptive capacity and personal responsibility in the field should be reinforced and fostered through supporting programmes and initiatives at the federal and state levels. As needed, these programmes can vary from region to region and/or be socially differentiated.
- The social aspects and consequences of climate change and adaptation measures should be integrated into the implementation of existing programmes and initiatives, such as the ÖSTRAT Work Programme 2011ff, the Austrian Climate Initiative “Klima:aktiv”[12], and the Climate Alliance (Klimabündnis)[13].
- Research on the social consequences of climate change and adaptation measures should be generally promoted. These should include topics such as “Lifestyle and social environments in connection with risk perception”, “Risk communication and adaptation to climate change”, “Ethical aspects of adaptation to climate change” (distributive justice), “Social cohesion and democratic development”, “Technological change and climate change adaptation”, “Scenario development with impact orientation on various groups”, etc.

**Quality of Life in Austria –**
**Development Opportunities for all Generations and Living with Dignity**

In addition to climate change, broad demographic changes in Austrian society are to be expected. Changes in population size, age distribution, number of single-person households, or other demographic characteristics have implications on the handling of the environment, but also on specific needs (e.g., heat sensitivity increases with age). Demographic changes thus also imply consequences for the planning and implementation of climate change adaptation measures.

[12] *http://www.klimaaktiv.at/english.html*

[13] *http://doku.cac.at/englishversionueberuns.pdf*

It can be assumed that the following Austrian population groups will be particularly affected by climate change and by potential adaptation measures due to their location and/or socio-economic situation:

- the poor and those at risk of poverty;
- chronically ill people, people in poor health condition (especially during heat waves or outbreaks of vector-borne diseases);
- children;
- the elderly;
- people living in areas at risk of natural hazards;
- people living in areas increasingly subject to heat waves;
- people who are occupationally exposed to extreme weather conditions;
- people whose income may be at least temporarily threatened by the effects of climate change.

According to the results of current analyses, the population of Austria will continue to grow in the future, reaching approximately 9.5 million in the year 2050. As the population grows, there will be a parallel shift in the age distribution, with the percentage of Austrians over 60 years old growing in both numbers and proportional representation.

One measure for the material standard of living is the equivalised household income. Should this fall below a certain threshold, those living in the household in question are regarded as being at risk of poverty. According to an analysis from 2010, for a single-person household the threshold for being at risk of poverty is approximately € 12,400 per year (BMASK 2011). Around one in eight Austrians is regarded as poor or at risk of poverty. Already at present, population groups with low levels of education and income are often additionally affected by environmental stresses. In cities, poor people and those at risk of poverty often live in areas exposed to heavy traffic noise and high levels of particulate pollution, and generally have little access to green spaces or recreation areas. The effects of climate change (such as heat waves, drought, and heavy rainfall) will represent an additional burden and could affect the health of the population. Presumably most affected will be those with neither the knowledge nor the financial resources for precaution.

Densely populated residential areas will be especially impacted by increased heat load in summer, leading to more unfavourable indoor and living environments and thereby to negative consequences for health. This problem will be exacerbated by the lack of night-time cooling. Low-income individuals often live in rental properties and have neither the financial means nor the legal resources to persuade the property owners to install climate change adaptation measures such as insulation or shades. In addition, lower-income households spend proportionately more of their income on energy than better-off households.

In the future, there will be high demand on public finances due to demographic shifts and the associated consequences for the health care, welfare, and pension systems. Yet, it is unclear whether climate change will simultaneously create significant additional burdens on public finances, creating a double threat.

**Recommendations**

- In the planning and implementation of adaptation options – especially in the areas for action of health, construction and housing, energy, spatial planning, transportation infrastructure, and urban green and open spaces – the varying needs of different generations and particularly demographic shifts should be taken into consideration.
- Health status also influences how well people can cope with changes in the climate and how well they can adapt. These differences should be taken into account in climate change adaptation measures.
- In the selection and design of adaptation measures, special attention should be devoted to the perspective of distributive justice and the effects on those living in poverty or at risk of poverty.
- Measures focused on adaptation to climate change should be linked to existing social objectives, opportunities for social participation, or health-related objectives (such as the reduction of noise or particulate pollution).
- Appropriate intervention measures should be investigated and implemented. Attention should be paid that such measures do not represent any additional burden on labour.
- The costs and benefits of climate change adaptation should be represented as stratified by various population levels with due regard to gender aspects. Here, social advantages and disadvantages as well as conflicts of interest should be considered (Adaptation measures can also entail an increase in the ecological footprint – e.g., air conditioning, technological protection measures, etc.).
- The social dimension of climate change adaptation, including social and price-related effects on various population groups, should be integrated into existing programmes: for example, by their consideration in future revisions of NREAP (National Action Plan 2010 for Renewable Energy in Austria, BMWFJ 2010) and the Energy Efficiency Action Plan (BMWFJ 2007).
- A national action plan against energy poverty should be developed, taking the following aspects (among others) into account:
  - Information and advice for private households (free on-site energy consultation); studies on performing target group specific consultation are already available or in progress (e.g., from Caritas);
  - Promotion of research on issues of “energy poverty” and the social aspects of climate change (varying degrees of individuals affected, changes in energy consumption behaviours);
  - Implementation of educational measures;
  - Identification of aspects that increase energy consumption, especially in poorer households, as a result of climate change (price trends, consumption trends), and the development of counterstrategies;
  - Creation of an energy efficiency fund for the exchange of inefficient household appliances and heating systems. This entails enormous potential savings over the long term and will additionally contribute to emission reduction;
  - Increased federal/state cooperation for subsidies;
  - Encouragement of the use of alternative energy sources.
- Research on employment effects in connection with climate change adaptation.
- Vulnerability assessment (qualitative and quantitative) of the employment situation; analysis to determine what effects can be linked to climate change; estimation of how technological changes will negatively or positively influence the situation (including the consequences of technology).

**Quality of Life in Austria – Equality for Women and Men**

Men and women have different needs and attitudes towards risks such as climate change and towards adaptation. In the areas of climate change adaptation and mitigation, women are generally more willing to make lifestyle changes, while men often rather rely on technological solutions.

In terms of perception and behaviour, it makes a difference where one lives, the extent of one's knowledge of the risks related with climate change, and whether nature is perceived as unpredictable or fragile. Individual characteristics such as anxiety or disability can also contribute to behavioural patterns.

Income is an additional factor that determines whether an individual is even in the position to implement measures for climate change adaptation. Income differences between men and women still exist; single older women and single mothers in particular are over-represented in the population group at risk of poverty.

It is important that any measures for adaptation to climate change provide women and men equal opportunities for participation, design, and decision-making in social processes.

Research has been conducted on the subject of gender and climate change, but primarily in development-policy contexts in which the different roles of men and women are addressed. In many areas, women assume an important role as "agents of change" for both climate change mitigation and adaptation.

**Recommendations**

- Gender-specific analyses on the subject of climate change in Austria and adaptation to climate change should be encouraged for being able to consider the different needs and concerns of women and men and align programmes and strategies accordingly.
- In the planning, development, and implementation of all climate-relevant strategies and measures, women and gender experts should be involved.
- The participation of women in dialogues concerning climate change adaptation should be promoted.

**Quality of Life in Austria – Education and Research Create Solutions**

Climate change and the energy crisis are already perceived as a threat by the population. However, these problems are not directly associated with personal lifestyles, and there is a lack of knowledge regarding appropriate possibilities for action. Even when information is on hand, knowledge alone is often insufficient to initiate necessary changes in behaviour. Motivation and the creation of incentives and appropriate social frame conditions are considered crucial elements in increasing the capacity to act of each and every individual member of society.

Knowledge on the subject of climate change adaptation is limited by the perception of risk. Various perceptions and attitudes affect the decision of how and if one adapts to climate change, as adaptation measures are influenced by deep-rooted (but not unchangeable) cultural and social norms and values, as well as by individual perceptions.

Consideration of the cultural and social environments (also at the individual level) that influence the perception of risk and the ability and knowledge to adapt should always be included in communication on the subject of climate change adaptation. This can make the transfer of information in various social environments a challenging task.

In all of the areas for action addressed, there are topic-specific recommendations on measures for communication and education. Communication and educational efforts should pertain to all age groups, all social environments, and all levels of administration, and need to be prepared target group specific. The objective is to provide every individual with sufficient knowledge to be able to act self-dependent within an appropriate framework.

**Recommendations**

- Advice on climate change adaptation should be target group-oriented and gender-specific; it should also be accessible to the educationally disadvantaged.
- Adaptation to climate change and the resulting necessary lifestyle changes should be addressed in dialogue with those affected when possible. Ethical issues should also be discussed.
- The responsibility of each and every individual with regard to climate change should be made clear; in this way, willingness to perceive individual opportunities for adaptation to climate change can be increased.
- Relatively little information is publicly available on the subject of risk communication and climate change adaptation and social environments. Research that addresses these issues should be encouraged.
- In communication, information on the potential opportunities offered by climate change should also be compiled and effectively disseminated.

# Guiding Principles for Adaptation

# 8 Guiding Principles for Adaptation

Adaptation to climate change is an ongoing process that will extend over a long time horizon and must be administrated by many actors. In support of adaptation planning, generic guiding principles have been devised that can be independently applied by the participating sectors, levels, and stakeholders. Ten guiding principles (Prutsch et al. 2010) summarize the key factors for successful adaptation. This offers an orienting framework for adaptation, while still leaving sufficient room for situation-specific decisions.

**The guiding principles for adaptation can be summarized as follows:**

- **Assume responsibility:** The clear commitment of decision-makers to adaptation and their willingness to accept management tasks in an organization or group of people must be present from the outset. In the long term, sufficient personnel and financial resources for adaptation must be available.
- **Share information:** Learning from other actors, the continuous enhancement of knowledge, and the communication of information are all essential for adaptation processes. Scientific information must be presented in a way that meets the requirements of the specific target audience. At the same time, all parties concerned must share a common understanding of concepts and terminology in order to facilitate communication and cooperation.
- **Foster cooperation:** Working in partnership with the relevant and affected parties throughout the entire adaptation process is an important prerequisite for successful adaptation. The following guidelines may be helpful for identifying relevant actors:
  - Who is affected by the consequences of climate change or by potential adaptation decisions?
  - Who is responsible for the implementation of potential adaptation measures?
  - Who can facilitate the success of adaptation measures?
  - From the outset, the objectives of cooperative efforts and the areas of influence of the participants must be clearly determined and communicated.
- **Work with uncertainties:** Uncertainties are an inherent part of all projections of climate change and its impacts. In accordance with the precautionary principle, adaptation measures must nevertheless be introduced. Adaptive management is characterized by a stepwise and iterative approach to the planning, implementation, and improvement of adaptation measures. For sectors with long-term planning horizons, it is crucial to maintain or enhance the resilience of natural and human systems.
- **Prioritize climate change impacts:** For the prioritization of climate change impacts at the regional level, both past weather events and scenarios of possible future climatic and socio-economic changes should be analysed. In order to minimize the uncertainty in climate scenarios, several scenarios should always be drawn upon for the estimation of climate trends.
- **Employ a wide range of adaptation options:** In planning, the entire potential portfolio of technological, behavioural, informative, organizational, ecosystem-based, and socio-economic adaptation measures, both sector-specific and cross-cutting, should be considered. The available options should be described in the greatest detail possible – for example, in terms of their objectives, direct, indirect, temporal, and spatial effects, as well as the actors and those affected.

- **Prioritize adaptation measures:** To prioritize the implementation of the identified adaptation measures, a set of selection criteria can be applied, such as efficiency, effectiveness, urgency, flexibility, side effects, etc. Priority should be assigned to any measure that generates benefits independent of climate change ("win-win") or that entails no disadvantages in case the actual climate change does not correspond to projections ("no regret").
- **Integrate into existing instruments and structures:** Existing instruments and decision-making processes, both in the public administration and in the private sector, should be reviewed with regard to their suitability to address climate change and modified as needed. Where necessary and appropriate, new instruments must be considered.
- **Avoid conflicts of objectives and interests:** In the planning of adaptation measures, anticipatory balancing of short- and (especially) long-term effects – also on other areas – is critical for the success of their implementation. Above all, it must be ensured that adaptation measures do not contradict the objectives of climate change mitigation and sustainability.
- **Establish a system for monitoring and evaluation:** Adaptation is a continuous process that requires regular review of the prioritized climate change impacts and the effectiveness of the selected adaptation measures. Monitoring should accompany the ongoing learning process of adaptation, while the evaluation system focuses on the assessment of results. Monitoring and evaluation in adaptation efforts should be considered in parallel with the design of the measures. The use of indicators can facilitate the monitoring and evaluation of adaptation measures.

# Criteria for Prioritizing the Recommendations for Action

# 9 Criteria for Prioritizing the Recommendations for Action

The Action Plan for the Austrian adaptation strategy includes a number of recommendations in the various areas for action for both public and private actors.

Certain sectors of society and regions are affected by climate change in different ways and to varying degrees. The extent to which the people, the environment, and the economy of a region will be influenced by the consequences of climate change depends on both the natural vulnerability of the region and on its existing adaptive capacity to cope with climate change and extreme weather. This results in differing requirements for action.

In order to determine which recommendations should be assigned priority in a certain area for action or a certain region, a list of criteria is introduced. This list serves to support the actors concerned for setting their priorities in the adaptation process.

In general, however, it must be noted that any measure should be prioritized if it provides benefits independent of climate change ("win-win") or entails no disadvantages in case the actual climate trends do not correspond to projections ("no regret"). Due to the inherent uncertainty in the effects of future climate warming, it is necessary to select and implement flexible measures that can be easily adjusted to changing conditions.

As a basis for prioritization, comprehensive descriptions of the recommendations for action are required. Detailed information concerning the objective of each recommendation, the planning horizon, the actors and stakeholders concerned, the resources needed, possible conflicts with other environmental objectives, etc., can facilitate the selection. The recommendations in the Action Plan of the Austrian adaptation strategy offer this type of detailed description.

As already mentioned with the guiding principles of adaptation, a series of criteria for prioritizing adaptation measures is available. As these criteria can have different meanings depending on the objective and the context, weighting of the criteria is suggested. The selection of the prioritization criteria and their weighting should be undertaken with affected actors.

With a view to a comprehensive macroeconomic analysis, it is generally suggested that the prioritization of recommended actions take into account the "Europe 2020 – A strategy for intelligent, sustainable, and inclusive growth" (EC 2010).

- **Significance/Relevance:** The recommended actions have a large potential to reduce the risk of negative consequences of climate change, to improve the resilience of the sector/system, and to take advantage of the positive effects of climate change. Aspects to be addressed: How significant is the measure in absolute terms? Is only a relatively small portion of the population and society affected, or a very large part? If this measure were not implemented, would the damage to society as a whole be large or rather small?
- **Urgency:** The recommendation requires rapid implementation because the effects are already being felt, long-term planning processes are necessary, or the recommended action only becomes effective with a lag of time (e.g., forestry, technical infrastructure).

- **Robustness:** Recommendations will be given priority that unfold an advantage independent of climate change ("win-win") or entail no disadvantage in case actual climate change does not correspond to projections ("no regret"). Under this criterion, those measures will be highly rated that create an environmental, economic, or other benefit for society independent of the extent of climate change.
- **Flexibility and Reversibility:** The recommendations take due account of uncertainties regarding future global warming. They are therefore designed to be flexible, so that they can be easily adjusted or reversed based on changing conditions.
- **Cost/Benefit Ratio:** This option represents a good cost-benefit-ratio. However, it should be noted that it is not foreseen in the framework of this national adaptation strategy to quantify the costs and benefits of adaptation measures. Therefore it will only be possible to take into account qualitative estimates and values from the literature as available. The issue of potential loss in competitiveness in an international comparison is also to be considered in this context.
- **Positive Side Effects:** The recommended actions have a positive effect on the environment (ecosystems, biodiversity, water resources, soil) and on socio-economic aspects. The measures should also be consistent with the objectives of other environmental policy processes, such as sustainability.
- **Simultaneous Mitigation Effects:** Specifically, recommendations for adaptation action support the objectives of climate change mitigation and, in the best case, contribute to reductions in greenhouse gas emissions.
- **Interactions with Other Recommended Actions:** Climate change as a cross-cutting issue affects different levels and sectors and will present major challenges in the coming years and decades requiring substantial changes and investments. The question is to what extent proposed adaptation measures in one sector affect and influence measures from other sectors. In addition, there are also other developments, trends, and measures to consider. Priority should be assigned to recommended actions that feature synergies with other measures and developments.
- **Political Feasibility:** The prioritization should also take into account an estimation of the political feasibility. Will consensus be achievable and can the implementation probability be rated as high, or will the measure be difficult to realize?

In the prioritization of recommended action, it is also suggested to differentiate assumptions on climate change and its effects on the basis of their evidence (e.g., in a classification of hard/medium/soft assumptions).

# The Status Quo of Adaptation in Austria – Federal State Initiatives

# 10 The Status Quo of Adaptation in Austria – Federal State Initiatives

Austria has already been dealing with the issue of adaptation to climate change for a number of years.

At the level of the **federal states ("Bundesländer")**, a variety of initiatives have already been enacted, ranging from research projects to concrete measures in individual sectors. All nine federal states appreciate climate change adaptation as a part of an integrated climate mitigation policy. In some federal states, state-specific strategies for adaptation are in preparation. The following section presents an overview of the adaptation activities of the Austrian federal states.

In 2006, **Burgenland** commissioned ARC Seibersdorf Research GmbH to conduct a study on "Lake Neusiedl – Tourism with a Future", in order to scientifically analyse the effects of the water level in Lake Neusiedl on the surrounding region. On the basis of a description and analysis of the current state of the lake, the aim of this study was to develop a realistic scenario and to investigate and evaluate the effects of various water levels (reduction or drying out) on the economy and tourism in the UNESCO World Heritage Lake Neusiedl region under the specification of various time horizons.

In order to counter negative economic prognoses, a number of touristic and water-management measures have been proposed, some of which are already accounted for in Burgenland's tourism concept and are currently being implemented.

In addition to measures in the field of tourism, water management measures such as the artificial extension of lake water balance, irrigation management, the introduction of drought-resistant crops for use in agriculture, and a cross-border water management and tourism concept for the Lake Neusiedl region (e.g., Interreg initiative) will also be necessary.

In a World Heritage management plan in accordance with the guidelines of UNESCO, national and local administrations in Austria and Hungary defined natural and cultural values, the future outlook and strategies for the region, and short-, medium-, and long-term objectives and initiatives. The management plan serves merely as a set of recommendations. It plays a strategically guiding and influential role, but its recommendations are not generally obligatory. The management plan includes strategies for tourism policy development in the Lake Neusiedl region, defining the objectives and measures for sustainable touristic superstructures and infrastructure which are for marketing and touristic organizations based on the awareness of the region's World Heritage status.

Burgenland has enacted a series of measures in the field of renewable energy sources; these are considered essential for climate change mitigation, but also represent an important contribution in terms of adaptation. With its wind turbines and the Güssing biomass cluster, Burgenland seeks to become autonomous in its electricity supply in the medium to long term. On certain days, the current power generation from renewable sources equals the total energy consumption of the federal state. In addition to managing demonstration installations, the European Centre for Renewable Energy (EEE) in Güssing is engaged in research and development, training and education, and eco-energy tourism.

With regard to the area for action agriculture, certain adaptation measures should be noted exemplarily: irrigation management in the district of Neusiedl includes already balancing groundwater supply and irrigation needs. In practice, a shift in cultivation habits is taking place – for example, the increased installation of green cover for humus formation and protection from erosion, an increase in biological farming and viniculture, and the use of heat- and drought-resistant seed varieties. In the construction of livestock stables, Burgenland agriculture increasingly focuses on the use of open stables with improved ventilation. The lower construction cost of this design represents a positive side effect. Since a number of years, the Burgenland chamber of agriculture has built up an extensive network of climate stations and an early warning service, primarily for plant protection measures.

In **Carinthia**, to improve the implementation of climate change mitigation objectives and the development of adaptation strategies, the Carinthian Institute for Climate Protection (KIKS) was established as a non-profit association and is sited in the Competence Centre Environment, Water and Nature Protection of the Provincial Government of Carinthia. For the sustainable implementation of regional measures in connection with global warming, it was necessary to set up a separate administrative body in Carinthia, as the extensive cross-cutting issues of climate change mitigation and adaptation reach far beyond the responsibilities of individual state departments.

With a first coordinating meeting on 14 January 2009, the federal state of Carinthia launched a working group on adaptation to climate change. This group covers the sectors of water management, agriculture, forestry, spatial planning, housing construction, health care, transport, municipalities, the energy industry, and atmospheric chemistry, and shall be further extended in the future to include additional areas (chambers of commerce and agriculture, energy supply enterprises such as KELAG and Verbund, geology, the tourism industry, natural scientific associations). The task of this group is to develop and realize strategies for adaptation to climate change customized for Carinthia, as well as to identify sectors in Carinthia that specifically require initiatives, thereby also participating in Austria's national adaptation strategy. The steps leading to the development of the national adaptation strategy have been actively supported; Carinthian experts were sent to take part in the accompanying participatory process.

In the area of research, the Interreg project AdaptAlp (Adaptation to Climate Change in the Alpine Space)[14] extended knowledge on the impact of climate change on the regional scale, and adaptation measures have been specifically developed for the Alpine region. In addition, Carinthia played a leading role in the project ClimChAlp (the predecessor to AdaptAlp). The project Alp-Water-Scarce (Water Management Strategies against Water Scarcity in the Alps)[15] specifically examined the effects of climate change on water availability in the Alps, developing early-warning systems for water scarcity in the region. The project SILMAS (Sustainable Instruments for Lakes Managements in the Alpine Space)[16] seeks to adapt the management of Alpine lakes to the new requirements arising from climate change. The project MANFRED (Management Strategies to Adapt Alpine Space

[14] Link: *http://www.adaptalp.org/*

[15] Link: *http://www.alpwaterscarce.eu/*

[16] Link: *http://www.silmas.eu*

Forests to Climate Change Risks)[17] attempts to bridge the gap between research and applied forest management, with a focus on the effects of climate change and growth, natural hazards and stressors as well as measures to adapt to changing environmental conditions. Carinthia is actively engaged in these projects and also participates in the project FAMOUS (Factory for Adaptation Measures Operated by Users at Different Scales).

In collaboration with the Central Institute for Meteorology and Geodynamics (ZAMG), a current climatography of Carinthia is under development since January 2009 which examines the consequences of climate change for Carinthia, describing them by means of comparison with long-term averages. Based on this information, adaptation measures customized to the regional scale shall be developed and implemented. This climatography will not be static; rather, it will act as a dynamic Internet platform, updated on a monthly and annual basis. In preparation for Carinthia´s climatography, the ZAMG study "Long-term climate Carinthia – Long-term time series and future scenarios for the federal state of Carinthia" was completed at the end of 2010 (Auer et al. 2010), which should assist with the estimation of the specific effects of climate change in Carinthia and the development of appropriate adaptation measures. The study is freely available on the Internet at *www.kiks.ktn.gv.at*; the first interim results for the climatography of Carinthia will also be published online.

In **Lower Austria**, the research project "Impacts of Climate Change in Lower Austria – Lower Austria climate study 2007"[18] was commissioned to present the effects of climate change in the region. In the study, the latest climate scenarios were regionalized for Lower Austria and examined using five application-oriented issues related to climate change. The sub-studies were:

- **Forestry:** "Lower Austria's forests in climate change: Climate impact study for the region Waldviertel"
- **Agriculture:** "Potential effects and adaptation measures to climate change in agriculture in north-east Austria"
- **Energy demand:** "Effects of climate change on heating and cooling energy demand in Lower Austria"
- Potential developments in the **discharge patterns** of rivers: "Climate impacts on the formation of runoff using the example of the Lainsitz River"
- **Winter tourism:** "Vulnerability of winter tourism in Lower Austria: Overview of the climate change-induced regional economic vulnerability of tourism with a case study for a winter sport area".

**Forestry**

Lower Austria took part in the Interreg III-B Alpine Space project "ClimChAlp" (Climate, Change, Impact, and Adaptation Strategies in the Alpine Space) 2006–2008. Based on a model region, adaptation strategies in forestry were modelled, and a computer-aided advisory instrument for practical application was developed. This should provide early information for economic policy decisions regarding the climate-sensitive biomass production area "Forest" which is quite cumbersome to adaptation.

[17] Link: *http://www.manfredproject.eu/*

[18] Link: *http://www.noe.gv.at/Umwelt/Klima/Klimawandel-Klimaschutz/klimawandelklimaschutzuebersicht.html*

**Agriculture**
Lower Austria's Landscape Fund (LAFO) considers the issue of climate change in planning and cultivation. Measures such as minimum tillage, mulching and direct sowing, soil cultivation, and erosion protection are strongly promoted by the state government. As part of the "Land-Impulse" (an educational and service institute of agricultural technical and vocational schools), awareness-raising and sensitization projects are carried out. Through the state's participation in the research project WEINKLIM 2011–2013[19] (using the model region of Traisental as an example), the adaptation possibilities for viniculture in the context of climate change could be investigated and according recommendations for action were developed.

**Spatial Planning**
Lower Austria's Spatial Planning Law has been amended in response to the recent flooding events and is in this respect strictly worded since 1999. Rezoning for construction is not permitted in flood plains of a 100-year flood, likewise not in the red or yellow zones of Torrent and Avalanche Control hazard maps. When construction areas become endangered by natural hazards, rezoning is obligatory (after a formal investigation procedure).

**Water Management**
In the research projects FloodRisk I and FloodRisk II, there were several sub-projects that focused on regions in Lower Austria. In FloodRisk II, Lower Austria was especially involved in the work package "Law", with the objective of presenting findings from the 2002 flood, describing potential courses of action, and developing strategies for implementation.

In Lower Austria, the structure of the water supply to all municipalities was surveyed to provide the basis for increasing the security of supplies together with the municipalities through the expansion of public networks, increased networking of existing facilities, and the development of additional water dispensers. Building on a study commissioned by the federal government and the states ("Adaptation strategies to climate change for Austria's water management"), concepts are now being developed for regions with projected future reduction in groundwater recharge that cannot be compensated by the existing supra-regional supply structure.

Lower Austria is currently the lead partner in the EU-funded project CEframe, which seeks to develop a comprehensive, cross-border harmonization of flood management with partners from the Czech Republic, Slovakia, and Hungary in the common river basins to adapt to climate-induced changes.

**Nature Conservation**
In connection with nature conservation measures, which also make a significant contribution to climate change adaptation, several projects have been initiated and implemented (e.g., the restoration of near-natural ecosystems, inter alia, as carbon sinks and retention areas; the networking of existing protected zones/natural habitats in order to permit necessary migration or exchange of (partial) populations).

[19] Link: *http://seri.at/de/projects/completed-projects/weinklim-viniculture-and-climate-change/*

In addition, a project is currently being implemented that aims to elaborate the value of natural ecosystems ("ecosystem services", also in the context of adaptation to climate change) and communicate this to interested parties and the public.[20]

Notable examples include the project AKK (Alpine-Carpathian Corridor 2009–2012) and RAMSAR-SKAT 2010–2012.

**Cross-sectoral Projects**

In the framework of the research project FAMOUS (Factory for Adaptation Measures Operated by Users at Different Scales, 2011–2013), methods and tools for adaptation to climate change are conceptualized, tested, and evaluated with the participation of future users. The Waldviertel region is one of the study regions.

The Mostviertel is the test region for RIVAS (Regional (Participatory) Integrated Vulnerability Assessment for Austria), a project that seeks to develop the concept, process design, indicators, and assessment methods for regional vulnerability assessments in Austria. For the practical application, special attention is devoted to the necessary interactions between research and regional stakeholders.

As part of the interdisciplinary collaborative project KLIMZUG-Nordhessen, structures, products, and services related to climate change adaptation are developed and implemented. This project features close cooperation between partners from science, business, politics, and social groups. The adaptation measures from the model region of Nordhessen will be exchanged and transferred to the Waldviertel region.

Lower Austria also participates in C3-Alps (Capitalizing Climate Change Knowledge for Adaptation in the Alpine Space). The objective of this project is to synthesize the results of previous and ongoing Alpine space projects on the topics of climate change mitigation and adaptation, to transfer these results into policy making, and implement in practice.

In **Upper Austria**, following the flooding event of August 2002, six working groups developed proposals for improved flood protection, divided into short-term and long-term measures (e.g., improvements to the Civil Protection Act, new information systems, a flood protection programme). Currently, in the framework of pilot projects conducted together with the Austrian Ministry for Transport, Innovation and Technology (BMVIT) and the Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW), various projects focusing on the management of flood risks in the context of the implementation of the EU Floods Directive are under development.

In addition, in 2009, a study on water management development in flood plains was initiated in cooperation with the University of Natural Resources and Life Sciences. The overall aim is to develop methods for risk assessment, gain information regarding retention area losses and damage potentials, and elaborate concepts for compensatory measures.

[20] Link: *http://www.vielfalt-2010-plus.at/*

Between July 2005 and December 2007, Upper Austria participated in the Interreg Programme AMICA[21] (Adaptation and Mitigation – An Integrated Climate Policy Approach). In this project, short descriptions of potential adaptation measures and good practice examples were developed and published. The sectors of energy, construction, and urban and spatial planning were identified as crucial sectors with significant areas of overlap between adaptation and mitigation and addressed in detail.

Furthermore, in 2008, the Interreg project CLISP[22] (Climate Change Adaptation by Spatial Planning) began, in which Upper Austria served as a model region. A comprehensive climate research project with the University of Natural Resources and Life Sciences provided additional information: "Temperature increase in Upper Austria", "Impact of climate change on flood events in Upper Austria", and "Heat and Mortality" have thus far been presented.[23] Further state cooperation in research studies is ongoing with the Johannes Keppler University (macroeconomic effects of climate change), the Environment Agency Austria (nature, peatlands, floods and climate change), and the University of Natural Resources and Life Sciences (agriculture, tourism).

In collaboration with the University of Natural Resources and Life Sciences, a heat load plan for the Traun-Ager system was developed. In this and a further study in cooperation with the Institute for Water Ecology, Fishery Biology, and Limnology in Scharfling, the effects of changes in water temperature on fish fauna were observed. A study conducted by the Environment Agency Austria provides recent results on changes in discharge regime types in Upper Austria's running waters due to climate change.

To investigate the influence of climate change on groundwater resources and establish adaptation strategies to mitigate land use conflicts between agriculture and public water supply, a study has been awarded to the Austrian Institute of Technology Seibersdorf.

Based on the study "Adaptation strategies to climate change for Austria's water management" (ZAMG & Vienna University of Technology (TU Vienna) 2010) it is foreseen to divide Upper Austria into various regions and formulate principles for strategic planning for climate change adaptation in the area of water management.

In a study entitled "Climate change and tourism in Upper Austria" (Formayer & Kromp-Kolb 2009), the effects of climate change on specific items from the "Guide to the Tourism and Leisure Industries 2003–2010" were investigated in selected tourist regions of Upper Austria.

In the state government administration, a network of experts in the field of climate change adaptation was set up; this network has provided valuable assistance in the steps leading up to the development of the national adaptation strategy. The development of an Upper Austrian adaptation strategy was anchored in the government programme ÖVP-Green 2009–2015. In the context of the FAMOUS project and in collaboration with the Environment Agency Austria, tools and guidance for the elaboration of an adaptation strategy are developed and tested in Upper Austria. The FAMOUS handbook will subsequently become available to other federal states and cities.

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[21] Link: *www.amica-climate.net*

[22] Link: *http://www.clisp.eu*

[23] Link: *http://www.anschober.at/service/materialien*

**Salzburg** has been responding to the challenges of climate change, both directly and indirectly, for some time – for example, by enacting measures for flood protection and adaptation in forests.

For years, under the auspices of the Department of Environmental Protection, all relevant services have been participating in the "Working Group on Climate Protection". This working group is also dealing with all issues related to adaptation and activities towards developing a regional adaptation strategy which is linked to the federal one. Currently, the issue of vulnerability in various sectors of the federal state´s regions is being examined.

In terms of research, numerous studies have already been conducted, such as the report "Climate change and potential effects on winter tourism in Salzburg" (Kromp-Kolb & Formayer 2001)[24] and a study on the climate sensitivity of districts in Salzburg (Breiling et al. 2008).

In addition, regionalized climate scenarios were created by the Wegener Center for Climate and Global Change as a basis for further planning in the field of adaptation.

In 2008, a study in the area of spatial planning and climate change mitigation ("Development of transport and emission balance in economical site development – A case study of Salzburg's central region") was conducted by the Wegener Center for Climate and Global Change and office Trafico which serves as the basis for the consideration of climate change mitigation concerns in spatial planning.

Salzburg took part in the Interreg IVB Project CLISP (Climatic Change Adaptation by Spatial Planning in the Alpine Space)[25]; in which also one of the regions in Salzburg was examined as a model region.

In **Styria**, the Department of Climate Protection Coordination was established in the Styrian regional administration in May 2009, providing for a contact point for central agendas of climate change mitigation and also issues of adaptation. In the development of its climate protection plan, Styria launched an internal project entitled "klimark", not only to accompany the Styrian climate protection plan, but also to address the field of climate change adaptation. During workshops in 2010 and 2011 the basic points of a potential climate change adaptation strategy were set out in consultation with external scientific advisors. Since 2011, preparations for a state's internal process for adaptation to climate change (due to begin in 2012) have been underway.

During the course of these preparations, the Wegener Center for Climate and Global Change was commissioned to develop the study "KlimaWandelFolgen – Climate scenarios and climate change impacts in Styria through 2050". This study developed climatological foundations that provide an optimal basis for further investigations of the impacts of climate change and adaptation. The results of the study will be published online in 2012.

[24] Link: *http://www.salzburg.gv.at/pdf-kyoto-bericht-tourismus.pdf*

[25] Link: *www.clisp.eu*

Styria was a partner in the Interreg IVB project CLISP (Climatic Change Adaptation by Spatial Planning in the Alpine Space), with the Enns Valley region being particularly involved. During the course of the project, selected spatial planning instruments were analysed with regard to their strengths/weaknesses towards the challenges of climate change ("climate change fitness test"); based on this analysis, suggestions for improvements were developed. For the region Liezen, researchers analysed how climate change would come into effect, identifying especially sensitive areas. Based on an analysis of existing measures, proposals were developed and discussed with regional actors to make the region more "climate fit".

As a partner in the EU project GraBS[26] (Green and Blue Space Adaptation for Urban Areas and Eco Towns), Styria had the opportunity to benefit from international expertise, above all in urban areas. GRaBS identifies options to adapt "green and blue infrastructure" in urban areas and eco-cities. Green infrastructure (gardens, parks, productive agricultural land, green corridors, and green-roofs and walls) and blue infrastructure (water, rivers, streams, flood plains, and sustainable drainage systems) play an important role in facilitating resilient climatic development – a role that is presently not sufficiently recognized or utilized. The main objective is to improve regional decision-making and political processes.

In 2010, the "Styrian Climate Atlas"[27] was newly revised by LUIS (the state environmental information system) and Joanneum Research and is available online.

On the part of the state public health authority, the Styrian Heat Protection Plan was developed and published in April 2011, providing an information basis for public health services.

The close cooperation between the federal state of Styria and Styrian research institutions (such as the Wegener Center for Climate and Global Change, the University of Graz, and Joanneum Research) allows the risks of climate change for Styria to continue to be scientifically addressed on the basis of up-to-date studies and expertise. For example, in the spring of 2011, the study "Climate risk in Styria – First steps towards an adaptation strategy"[28] (Prettenthaler et al. 2011) was published.

In **Tyrol**, not least due to the catastrophic flooding events of recent years, initiatives have been intensified aimed at flood prevention and the revitalization of rivers. Special focus is dedicated to Tyrol's largest river, the Inn. In a collaborative effort – the cooperative project "der.inn – Together and safe" – the *Lebensministerium*, the federal state of Tyrol, and WWF will seek to widen the Inn at several points, in order to better protect residential areas during floods and simultaneously to raise the ecological value of the Inn's habitat for flora and fauna.[29]

Of particular significance in Tyrol is the issue of global warming in connection to the thawing of permafrost in Alpine areas. This subject is also addressed in events and research.

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[26] Link: *http://www.grabs-eu.org/*

[27] Link: *http://www.umwelt.steiermark.at/cms/ziel/16178332/DE/*

[28] Link: *http://hw.oeaw.ac.at/7108-9*

[29] For details, see: *http://www.der-inn.at/*

In Tyrol, forests (and especially the intact protected forest) play an important role in the protection of living spaces. Consequently, the federal state government has already at an early stage decided to lay the groundwork for increased preventative protection forest management. The Interreg IIB project "NAB – Natural potentials of Alpine mountain regions" (2003–2007) has developed integrated systems to establish optimally effective protection forests and already put them into practice. The Interreg project "WINALP" (with Bavaria and Salzburg) currently develops two-dimensional maps of forest types in order to examine the ecological potential of various forest communities in different climate scenarios in a practice oriented way. Hence using this tool, optimally adapted combinations of tree species can be quickly and safely transplanted to meet the diverse demands of the forest.

In cooperation with the Forest Technical Service for Torrent and Avalanche Control, the Interreg IVA Project "IREK" focuses on the development of new and innovative protective concepts for the protection of habitats.

In the joint project "Torrent Management", the Torrent and Avalanche Control, the municipalities, and the federal state of Tyrol seek to define the roles of various departments in the elimination of outflow-hindering elements in streams, as well as all the process steps, on the basis of a database. The main routes are categorized and cartographically documented, and since 2008 they have been systematically surveyed. In the meantime, more than 2000 outflow obstructions and damages to protective structures have been documented by foresters; for the most part, the blockages have been eliminated by the municipalities with help from Torrent Control services, and the repairs of the protective structures are underway.

The main purpose and objective of the research network "alp-S – Centre for Climate Change Adaptation Technologies" (founded in 2010) is to address climate change and develop strategies and solutions for adaptation. In the coming years, "alp-S" should internationally play a leading role in the field of natural hazards. Individual and social security in Alpine living spaces should increase in the future, as practical research and development will allow damages resulting from natural hazards to be limited to an acceptable minimum.[30]

In **Vorarlberg**, there has been a particular focus on the implementation of hydraulic measures for disaster and property protection.

The rated values of all relevant surface waters in Vorarlberg have been updated. These values are the basis for projects in the context of a flood protection action programme planned through 2016. This involves the cooperation of the agriculture and forestry sectors, above all in terms of the associated spatial requirements (keyword: retention areas).

One focus is on the development of hazard zone maps, including the calculation and presentation of overloads (HQ300). In collaboration with the spatial planning authority, relevant restrictions and legal amendments to spatial planning and building laws are discussed.

[30] For more information on current projects, see: www.alp-s.at

Among other issues, a flood forecasting model of the Ill will be developed, based on ongoing modelling efforts concerning flood forecasting for the Dornbirn Ach.

With respect to disaster protection, model projects are currently being developed by the municipalities with financial support from the federal state. Private property protection is supported by a broad public relation work, in connection with concrete proposals for initiatives. The issue of "risk culture" will be strongly promoted by publicity efforts.

In the tourism sector, the consequences of climate change are extensively discussed with a focus on the encouragement of year-round tourism and the development of new offers for summer tourism. There is also a trend to invest in winter sport areas at higher elevations.

For years, **Vienna** has engaged in a number of activities related to adaptation to climate change, including research endeavours as well as concrete measures in various sectors – for example, in the areas of flood protection (flood protection along the Danube, natural hazard zone planning for the Wienerwald streams), energy supply (most recently, preparatory activities for developing a supply security plan), drinking-water supply (karst water research programme), and in the building sector (safeguards against summertime overheating, district cooling). In December 2009, the Vienna city council adopted an update to the Vienna Climate Protection Programme (KLiP II) with a time horizon of 2020; this update includes the mandate to determine at an expert level the extent to which Vienna would require additional adaptation measures and to offer concrete suggestions to the political decision-makers.[31] A related brainstorming took place in 2007 in a workshop with experts from the city of Vienna as well as renowned scientists. Here, future areas for action related to climate change adaptation (for example, health, energy and water supply, urban planning, construction, transportation, urban vegetation, agriculture, and forestry) were identified and discussed.

During the development of KLiP II, the city of Vienna commissioned a study from the University of Natural Resources and Life Sciences to summarize the current state of knowledge based on previously developed climate scenarios for the Vienna area (Kromp-Kolb et al. 2007). However, it is important to note that the underlying regional climate models and scenarios were not yet very mature and therefore the derived statements still include a large degree of uncertainty. Projections regarding temperature trends are more certain than those concerning trends in precipitation (see Chapter 5: Climate Change in Austria). In addition, the influences of the building structure leading to the formation of urban heat islands are not yet integrated in current climate models.

As climate change adaptation – like also climate change mitigation – represents a cross-cutting issue, aspects of climate change adaptation and mitigation have always been considered closely interconnected. In addition, climate change adaptation measures have been implemented as an integral part of existing plans (e.g., urban development plan, transportation master plan) and projects (e.g., destination area management).

[31] For details, see: *http://www.wien.gv.at/english/environment/klip/*

As part of the implementation of KLiP II, a set of measures for adaptation to expected climatic changes in Vienna will be developed over the coming years in designated working groups. For this purpose, a further workshop with senior management of the city of Vienna administration was held on 18 October 2011. Further work will be carried out on the basis of the results of this workshop. The areas of public relations and awareness-raising in particular will play important roles. Furthermore, additional in-depth research will be required.

Finally, experts from the city of Vienna are collaborating in various working groups at both national and EU levels on the issue of adaptation to climate change.

# Research Environment and Research Needs

# 11 Research Environment and Research Needs

Science and research in both climate change adaptation and mitigation must be assigned an important structural task. Meaningful political, economic, ecological, and social solutions can only be designed and implemented when the causes of climate change and the consequences for people's lives can be estimated in a substantiated and integrative manner.

Climate research in Austria in recent years has rapidly evolved, but this development could be negatively affected by financial restrictions. On the national level, for the research focus "Climate Change and Adaptation", the national climate research programme StartClim[32] and the Climate and Energy Fund[33] (especially its research programme ACRP) provide important and forward-looking results. In addition, significant insight has been obtained through the research programme proVISION[34] of the Federal Ministry of Science and Research and the Global Change Programme of the Austrian Academy of Sciences.[35]

The **climate research programme StartClim** was founded in 2002 as an initiative of the Ministry of Agriculture, Forestry, Environment, and Water Management (*Lebensministerium*) and transferred to the climate research community AustroClim. In the context of the 70 StartClim projects to date, an extensive knowledge base has been created, also identifying the urgent need for further research in various topics. StartClim has also been able to involve disciplines that at first glance would not seem directly connected to the impacts of climate change, but that provide important contributions in answering socially relevant questions related to climate change.

The research programme StartClim is designed as a flexible instrument that can rapidly pick up current topics in the area of climate change through short-term project durations and the annual awarding of project contracts. To date, more than 100 Austrian researchers from almost 50 institutions have conducted first studies on climate change and its effects. The programme has not only produced interesting results but also significantly contributed to the development of necessary know-how in Austrian climate research arena. StartClim is funded by an open donor consortium (2010: Ministry of Agriculture, Forestry, Environment, and Water Management; Ministry of the Economy, Family, and Youth; Ministry of Science and Research, and the Austrian Federal Forests) and is supported by an international scientific advisory board.

With the launch of the **Austrian Climate Research Programme** (ACRP) within the Climate and Energy Fund, an important conceptual and institutional framework for supporting research questions on issues of climate change and adaptation was established in Austria. Over the past four years, this programme has sought to explore the effects generated by climate change and to create a scientific basis for future-oriented decisions in politics, business, and society.

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[32] Link: *http://www.austroclim.at/index.php?id=45*

[33] Link: *http://www.klimafonds.gv.at/*

[34] Link: *http://www.provision-research.at/*

[35] Link: *http://www.oeaw.ac.at/deutsch/forschung/programme/change.html*

The thematic focus of the ACRP ranges from research on the regional and local effects of climate change and the resulting adaptation requirements to inter- and transdisciplinary vulnerability studies and risk management approaches. The programme seeks to strengthen Austrian´s research competence in this area and enhance its visibility in international research. In a first call for climate impact research in October 2007 and three further ACRP calls between 2008 and 2010, in total 74 projects were commissioned, with a budget of over € 12 million. The fourth call ran from May to September 2011. In 2012, additional calls for tenders are planned.

Important contributions are also made by the BMWF research programme **proVISION**. This programme investigates the effects of climate change on ecosystems, spatial development, and quality of life. proVISION provides information with which the pressing issues of precaution for nature and society (in the sense of sustainability) can be addressed: adaptation to climate change and its consequences, adequate models of life and the economy, the sustainable use of natural and economic resources, and the development and protection of the environment and living spaces. Transdisciplinarity is the guiding principle of research in proVISION; this stands for scientific work in which non-academic partners are involved in the generation of knowledge, introducing their perspective on problems, their expertise, and their experience into the research and thereby enhancing the effectiveness of the science. Among the long list of financed activities are studies on climate change issues from the doctoral programme “Sustainable Development” and the projects “A Tale of Two Valleys”, “STRATEGE”, FutureScapes, LTSER Eisenwurzen, biofuels, tools for models of sustainable land use, healthy diets, and sustainability, and CIRCLE Mountain.

The **Global Change Programme** of the Austrian Academy of Sciences, founded in 1990, consists of three international research networks (the International Geosphere-Biosphere Programme, the World Climate Research Programme, and the International Human Dimension Programme). As part of the programme, projects investigating changes in the global environment (e.g., climate, biodiversity) are fostered. The research programme is financed by the Ministry of Science and Research and is administered by a national committee of the Austrian Academy of Sciences.

Furthermore, research contracted by the *Lebensministerium* (Programme for Research and Development in the *Lebensministerium* – PFEIL 15) has initiated important projects on the topic of climate impacts and adaptation.

It is important to note that the Central Institute for Meteorology and Geodynamics (ZAMG) significantly contributes to laying the groundwork for **climate monitoring**. The extraction of data from the network of automated weather stations (TAWES) and from ZAMG’s phenological observation network allows a description of the state of the atmosphere and the effects on the biosphere. Additionally, ZAMG is involved in ongoing projects in glaciology. Regular measurements of the glacier mass balance, glacial runoff, snow chemistry, and permafrost are necessary to create the basis for glaciological-climatological model studies.[36]

In addition to climate research in Austria, research activities in the **European and international context** dealing with the issues of adaptation to climate change are to be noted. Austrian researchers are participating in numerous international projects devoted to critical issues of climate change

[36] See also: *www.zamg.ac.at/forschung/klimatologie*

and adaptation that also have great relevance to Austria. In this way, essential project results can be derived from the Interreg IIIB research programmes in 2000–2006 (Alpine Space, [37] CADSES[38]), the Interreg IVB research programmes (Alpine Space,[39] Central Europe,[40] South East Europe[41]), and projects from the European Framework Programme (FP5,[42] FP6,[43] FP7[44]). A summary of all the FP-funded projects with a focus on climate change can be found at: *http://ec.europa.eu/research/environment/index_en.cfm?pg=climate*.

An outstanding example of the networking between Austrian and European climate research is **ERA-Net CIRCLE**, coordinated by Austria, and its sequel project **CIRCLE2**.[45] It should also be noted that Austria plays a leading role in the **Joint Programming Initiative** (JPI) "Connecting Climate Knowledge for Europe". Launched by the Ministry of Science and Research, 12 countries (including Austria) have agreed on a shared vision for transnational programme development and a common strategic research agenda on climate research. Through interconnected research priorities, this agenda pursues the objective to enhance the standing of natural and social-scientific climate research in social planning conditions and decision-making processes. In addition, Austria is represented in the JPI-FACCE "Joint Programming Initiative – Agriculture, Food Security and Climate Change" directly and indirectly, through ERANETs such as EUPHRESCO.

Given the dimensions of climate change, institutionalized cooperation in climate and climate impact research in Austria is urgently needed. In 2010, upon the initiative of five Austrian universities (University of Natural Resources and Life Sciences, Graz University of Technology, Vienna University of Technology, University of Graz, and University of Innsbruck), the first steps were taken towards the establishment of a climate change centre for Austria. The objective of the **Climate Change Centre Austria** is to improve the quality and efficiency of Austrian climate research through networking and the promotion of cooperation, but also to enhance its international visibility. As a focal point for research, policy, media, and the public, and for all questions of climate research in Austria, it serves to foster a sustainable climate dialogue in the country.

In June 2011, the Climate Change Centre Austria, which is organized in the form of an association, was formally established. Numerous universities and non-academic research institutions have already confirmed their participation.

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[37] Link: *http://www.alpine-space.org/projects.html*

[38] Link: *http://www.oerok.gv.at/fileadmin/Bilder/4.Reiter-Contact_Point/IIIB/cadses/cadses_results/938_cadses_results_broschuere_issue_1.pdf*

[39] Link: *http://www.alpine-space.eu/*

[40] Link: *http://www.central2013.eu/*

[41] Link: *http://www.southeast-europe.net/hu/*

[42] Link: *http://cordis.europa.eu/fp5/*

[43] Link: *http://ec.europa.eu/research/fp6/index_en.cfm*

[44] Link: *http://cordis.europa.eu/fp7/projects_en.html*

[45] Link: *http://www.circle-era.eu/*

The study commissioned by the *Lebensministerium* in 2008, "Current state of adaptation to climate change in Austria" (Gingrich et al. 2008), provided a first overview of research projects with a focus on climate change adaptation. The results of this study have been included into a database, available at: *www.klimawandelanpassung.at/datenbank/*. This database is continuously updated and offers a good overview of the focus of individual research projects in which Austrian researchers are involved.

Many of the scientific results of the numerous research projects also provide an important basis for the political decision-making process. Thus, the present Austrian adaptation strategy is built on a series of scientific findings. However, "climate change and adaptation" is still a rather young research area where still many unanswered questions in certain areas remain. In order to determine the research needs specifically for the implementation of measures in the national adaptation strategy, a workshop with scientists was conducted within the framework of the participatory process accompanying the development of the strategy.[46] The aim was to facilitate a dialogue between science/research and politicians and other decision-makers. The research needs identified are already being addressed in research programmes such as the Austrian Climate Research Program (ACRP) of the Climate and Energy Fund and the national climate research programme StartClim.

The research needs for the areas for action are presented in the second part of the strategy – the Action Plan; either as separate recommendation for action or within the recommendations.

Further fundamental research requirements relate to the social effects of climate change and adaptation measures (see Chapter 7: Social Aspects of Climate Change).

[46] Link: *www.klimawandelanpassung.at*

**Infobox:**

StartClim
*http://www.austroclim.at/index.php?id=45*

Climate and Energy Fund (ACRP)
*http://www.klimafonds.gv.at*

proVISION (BMWF)
*http://www.provision-research.at/*

Global Change Programm (ÖAW)
*http://www.oeaw.ac.at/deutsch/forschung/programme/change.html*

Pfeil 10 (BMLFUW)
*http://www.dafne.at/dafne_plus_homepage/sections/dafneplus/PFEIL10.pdf*

Central Institute for Meteorology and Geodynamics
*http://www.zamg.ac.at/cms/de/klima/informationsportal-klimawandel*

Alpine Space 2000-2006
*http://www.alpine-space.org/projects.html*

CADSES 2000–2006
*http://www.oerok.gv.at/fileadmin/Bilder/4.Reiter-Contact_Point/IIIB/cadses/cadses_results/938_cadses_results_broschuere_issue_1.pdf*

Alpine Space
*http://www.alpine-space.eu/*

Central Europe
*http://www.central2013.eu/*

South East Europe
*http://www.southeast-europe.net/hu/*

FP5
*http://cordis.europa.eu/fp5/*

FP6
*http://ec.europa.eu/research/fp6/index_en.cfm*

FP7
*http://cordis.europa.eu/fp7/projects_en.html*

Compilation of FP- PJ projects with a focus on climate change
*http://ec.europa.eu/research/environment/index_en.cfm?pg=projects&area=climate*

JPI – FACCE
*http://www.faccejpi.com/*

# Good Practice

# 12 Good Practice

Examples of good practice serve an important function: They indicate the different ways in which systems and areas can successfully respond to a changing climate. Such examples illustrate the range of possible response options and the numerous approaches to cope with various challenges. The analysis and communication of success factors and also potential barriers to adaptation can support other regions and actors in the implementation of their planned activities. The presentation of such good practice examples fosters a new culture of dialogue for the exchange of experiences and information. This enables actors to learn from each other and, to some extent, mutually address the challenges of adaptation.

In Austria, only a few practical adaptation measures are implemented to date; therefore, the identification of good practice examples serves difficult. In the following section, examples are presented that offer relevant insights into a well-established adaptation process.

***Agriculture***

## Practice-Oriented Tool for Humus Balancing

The humus content of the soil plays a fundamental role in the context of climate change: Soil with high humus content can store more water and therefore better support crops under dry conditions, but it also has enhanced abilities to absorb heavy rainfall, reduce erosion, and store nutrients. On the basis of humus balancing, the effects of crop rotation and cultivation on the humus content of farmland can be demonstrated. However, the currently employed calculation method does not sufficiently take into account regional crop rotation, yield ratios, or certain management factors (e.g., greening).

In the framework of StartClim, the objective of the project conducted by Bio Forschung Austria (BFA), "*Humus balancing as a practice-oriented tool for farmers supporting $CO_2$-storing agriculture*", was to develop a humus-balancing method that would be easy to use and that would accurately reflect humus development in agricultural areas of the Weinviertel region. This would provide farmers with a tool to facilitate the planning and implementation of $CO_2$-storing agricultural management practices.

After comparing various humus balancing methods and taking into account the existing data and the time and financial expenditure, the Kolbe method was chosen. The selected humus-balancing method was tested and evaluated in a workshop with Weinviertel farmers on the basis of data from practice. This method will further be used in Bio Forschung Austria's regularly scheduled workshops with farmers also from other regions.

Further information:
*http://www.austroclim.at/fileadmin/user_upload/StartClim2009_reports/StCl09D.pdf*

***Agriculture***

## Viniculture in a Changing Climate: The Model Region Traisental

Wine is influenced by its location, region, and the climatic conditions. This close interdependency is demonstrated by the variable qualities of wine from year to year. Climatic changes such as higher temperatures, changes in the water supply, and also new diseases and pests represent new challenges to viniculture. Higher temperatures can lead to earlier harvest dates, changing the quality and the taste of the wine.

The project WeinKlim focused on the Krems-Traisental region, posing the question of how viniculture can best adapt to future conditions and simultaneously reduce greenhouse gas (GHG) emissions. The study region of Traisental seeks to make the sustainability of its wine-production a hallmark of the local wine region and become a model for other wine regions.

Based on data from nine companies for the years 2007–2009, the influence of climate change on the winegrowing and the greenhouse gas emissions resulting from viniculture and the production and distribution of wine was investigated.

The involvement of vintners and other local stakeholders was a central focus of the project. This ensured that the recommendations for climate change adaptation measures and measures for the reduction of greenhouse gas emissions would be scientifically sound as well as practice-oriented and region-specific in design.

With regard to adaptation to climate change, the following proposed measures were developed:

- Cultivation of specialized varieties,
- Expansion of cultivated areas,
- Optimization of certain operations,
- Establishment of a warning service for diseases to facilitate the use of plant protection products “on demand”
- Monitoring of new diseases and pests and identification of tolerance levels,
- Combination of protection against hail, sun, and birds through the use of nets,
- Optimization of green-cover management.

In addition, proposals seeking to reduce GHG emissions (e.g., by means of soil preparation, fertilization, and crop management) have been developed.

Further information:
*http://seri.at/de/projects/completed-projects/weinklim-viniculture-and-climate-change/*

***Forestry***

## Adaptive Management Strategies for the Austrian Federal Forests

Scarcely any other industry depends as heavily on the climate as forestry does. The Austrian Federal Forests (ÖBf AG) has long recognized the significance of this issue and has sought to meet the challenges of climate change. To this end, the ADAPT project was launched and implemented by experts from the Institute for Silviculture at the University of Natural Resources and Life Sciences. The direct involvement of forest planners and the relevant ÖBf employees ensured the high practical relevance of the project's results.

The results show that the vulnerability of the ÖBf's forests to the consequences of climate change will drastically increase, especially in the second half of the twenty-first century. While the proportion of highly vulnerable forest stock in the period 2001–2020 is only 5.9% of the total, 39.6% of forests were classified as highly vulnerable in the second half of the twenty-first century. In particular, locations with lower water supplies in calcareous sub-soil will be negatively affected. However, sites at higher elevations could benefit from the effects of climate change.

The results of ADAPT serve as a practical, realizable decision aid for assessing how forests will develop in certain regions under changing climatic conditions, and determining which management strategies (e.g., adaptation in the selection of tree species, regeneration methods) can counter negative trends. Thereby it will be possible to integrate future challenges resulting from climate change into the ÖBf's forest planning practices. Especially at the strategic level, the project results contribute to an estimation of the extent and the urgency of the necessary adaptation measures. Based on the results of ADAPT, ÖBf's internal silviculture guidelines were revised. Since the completion of the project, ÖBf-internal training and workshops have ensured that its findings are further communicated.

Further information:
*https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&menue_id_in=300&id_in=6167*
*http://www.dafne.at/*

***Water Supply and Water Management***

## Regional Network in the Lavanttal Region

In the Alpine region, the effects of climate change are more noticeable than in almost any other region in Europe. One consequence is that in the hot, low-precipitation summer months, shortages in the water supply can increasingly occur. This equally affects private households, tourism, and agriculture. Over the last century the average annual precipitation has decreased by up to 25% in the Lavanttal, while the temperature has risen 1.2°C over the last 50 years. The responsible authorities in the region have already reacted to this development, initiating timely measures.

Since 1994, the Lavanttal Water Board (*Wasserverband Verbundschiene Lavanttal*) has connected the water supply networks of the municipalities of Wolfsberg, St. Andrä, St. Paul, and St. Georgen. Through the joint operation the water supply can be balanced between the communities in times of intermittent regional shortages. The implementation of this idea was achieved due to the initiative of one individual who recognized the potential of inter-municipal cooperation. To date, the network consists of a conveying system with a through flow volume of 260.000 m³ and supplies 42.000 consumers. The water originates from springs belonging to twelve private owners who have signed long-term use agreements with the Water Board.

In parallel with this measure, the municipalities motivate their citizens with well-prepared information and data as well as concrete tips on how to conserve water. This continuing information stream and the long-term education and sensitization of the population have significantly contributed to the project's success.

Further information:
*www.wasserwerk.at/home/wasserwerke/lavanttal*

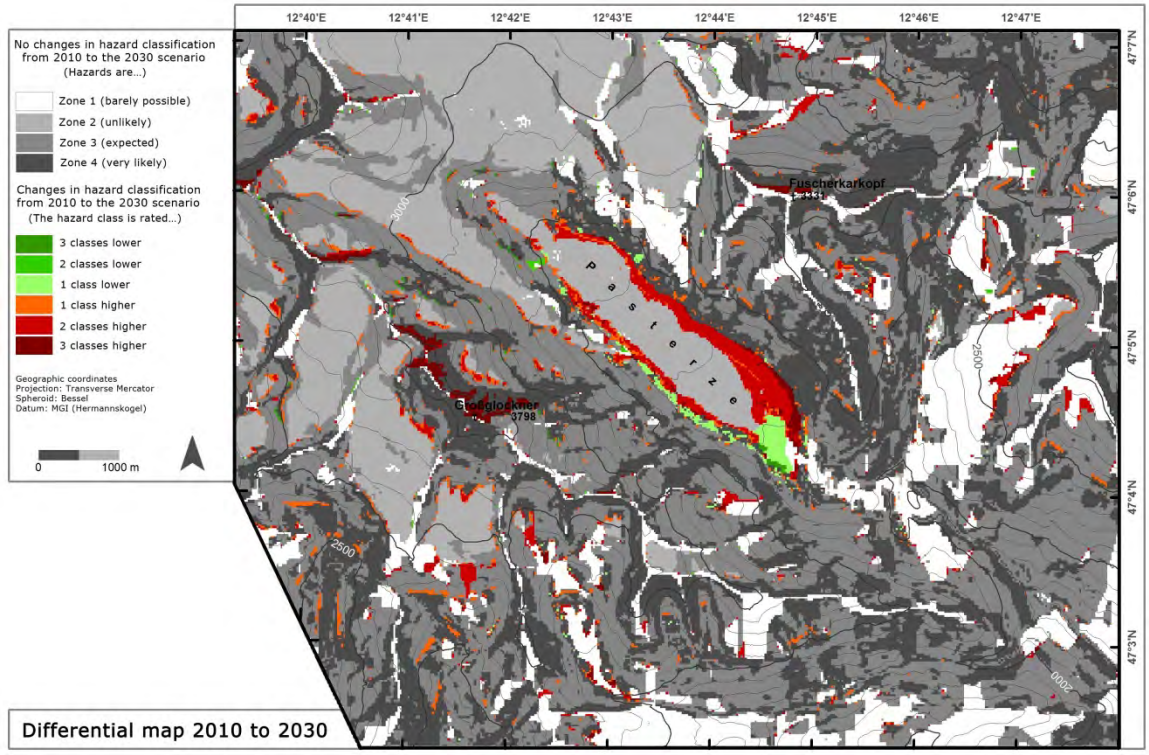
***Tourism***

## Natural Hazard Maps for High-Alpine Hiking Trails

Should natural processes (e.g., landslides) at high elevations accelerate as a consequence of climate change, they could pose a danger for people and for infrastructure. While protective measures for residential areas, transportation routes, and areas heavily used for touristic purposes already exist, is the safety of people outside protected areas on hiking trails not guaranteed.

For this reason, the StartClim project AlpinRiskGP examined one of the most frequently visited mountain landscapes in Austria – the Großglockner-Pasterze region – in terms of the risk of rockfalls, mudslides, avalanches, and similar processes of erosion. The primary causes of these processes are glacial retreat and the thawing of the permafrost.

A hazard map was created which divides the area under investigation into four hazard classes. In addition, with data from climate models, the conditions for a scenario in 2030 were estimated. By superimposing the network of trails and paths, maps of the vulnerability of individual path segments were created; these were reviewed by experts from the region and evaluated in terms of potential measures. The proposed measures range from concrete local efforts to improve trail safety (e.g., by closing trails or creating new paths) to new forms of organization (e.g., the establishment of a trail information system) to expanding the knowledge of those who spend their free time in high mountains.




The differential map of hazard classes 2010-2030 indicates a general increase in risk (orange to dark red), while the reduction of risk potential will only occur at discrete spots (green).

Further information:
*http://www.austroclim.at/index.php?id=startclim2009*

***Tourism, Health***

## Vienna is Different – Even in Terms of Drinking-Water Supply

With rising temperatures, offices, apartments, and shops heat up significantly in the summer. Consequently, the demand for air-conditioned workplaces and business premises has significantly increased in recent years. Compressor-based coolers are efficient at cooling but consume electricity and cause climate-relevant emissions.

District cooling represents an environmentally friendly, electricity- and $CO_2$-saving alternative. District cooling is a sensible cooling choice primarily for consumers in urban areas with high energy demand, such as hospitals, hotels, event venues, and office buildings. Generation of district cooling takes place largely in absorption cooling machines, whereby waste heat rather than electricity produces the refrigeration. The origin of the heat is critical in determining the environmental friendliness; in Vienna, the heat comes from combined heat and power plants and from the thermal treatment of waste. The district cooling centre in Spittelau claims a savings of 62% of primary energy and 70% of greenhouse gas emissions in comparison to conventional cooling centres. In 2010, the Austrian consumption of district cooling grew from 25 to 60 gigawatt-hours. This corresponds to a 140% increase within a twelve-month period.

Buildings can be supplied by a cooling centre over the district cooling grid or remotely. With decentralized generation of district cooling, a cooling centre is installed in the customer's building and is supplied with input energy over the district heating grid. This option is expedient when no district cooling grid is available. In Vienna, among others, the General Hospital, the office complex Town Town, the University of Natural Resources and Life Sciences, and the Skyline office building, are cooled with district cooling. In Linz, the Brucknerhaus and the Elisabethinen Hospital are district cooling customers. A significant expansion of the offer is planned.

Further information:
*http://www.wienenergie.at/we/ep/programView.do/channelId/-22449/programId/12413/pageTypeId/11893*
*http://www.gaswaerme.at/bfk/themen/index_html?uid=2742*

***Energy, Construction & Housing***

## District Cooling: An Energy-Efficient Cooling Alternative

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*http://www.wienenergie.at/we/ep/programView.do/channelId/-22449/programId/12413/pageTypeId/11893*
*http://www.gaswaerme.at/bfk/themen/index_html?uid=2742*

***Construction & Housing, Energy***

## Awareness-Raising – Summer-Suitable Construction

Due to higher extreme and average temperatures and more frequent and intense heat waves, the issue of building cooling and summer suitability will become increasingly important in the future. Cooling demand will be especially rise in urban areas. An immediate reaction can already be observed in the growing use of air conditioning running counter to climate change mitigation efforts, as it causes a significant increase in energy consumption. Building design must therefore not only meet the requirements for optimized thermal insulation, but also take into account summer cooling needs.

Through awareness-raising and informational materials, planners, architects, property developers, builders, and property managers receive assistance that presents the various options for designing summer-suitable, energy- and user-optimized buildings. Brochures and guides indicate climate-friendly measures and strategies for achieving comfortable internal temperatures in the summer months.

Comprehensive information is provided in the brochure “Summer-Suitable Construction: How Your House Can Stay Cool in Summer” and the handbook “Summer-Suitable Design and Construction: Guidelines for Efficient Construction” from the Upper Austrian Energy Saving Association. The handbook covers in detail issues of “reduction of heat entry”, “heating/cooling storage” “optimization of the use of daylight”, “technical building systems”, and “the use of plants”.

Another source of information is the brochure “Summer Suitability in Existing Buildings”, published by the Working Group on Resource-Oriented Construction at the University of Natural Resources and Life Sciences Vienna. In addition to basic strategies on the topics of building shells, thermal mass, and shading options, cooling strategies and concepts for the thermal renovation of casement windows from currently ongoing projects are described.

Further information:
Upper Austrian Energy Saving Association:
Handbook: *http://www.esv.or.at/info-service/publikationen/sommertauglich/*
Brochure: *http://www.esv.or.at/fileadmin/redakteure/ESV/Info_und_Service/Publikationen/Sommertauglich_Bauen_2013.pdf*
University of Natural Resources and Life Sciences: *http://www.baunat.boku.ac.at/18827.html?&L=*

***Construction & Housing, Urban Green and Open Spaces, Spatial Planning, Health***

## Green Roofs

The benefits of green roofs and roof gardens are numerous: They provide new habitats for animals and plants, improve the microclimate, and produce a cooling effect in summer due to increased evaporation. They absorb up to 90% of precipitation (retention effect), remove dust and air pollutants (due to the higher humidity), and serve heat- and sound-insulating functions.

**City of Vienna Pilot Project "Green Roof"**

In this pilot project, an existing gravel roof was converted into a green roof. The long-term goal is to "green" all the flat roofs in Vienna. This is more climate- and environmentally-friendly, prolongs the lifespan, and is (for extensive greening) also more cost-effective. The know-how for the implementation of green roofs is largely provided by the environmental protection department of the city of Vienna (MA 22). In addition to the dissemination of information to interested parties (e.g., architects and building designers), this department also carries out initiatives for green-roof projects. Furthermore, the city of Vienna financially supports the greening of roofs under certain conditions, up to a maximum of € 2.200.

Further information:
*http://www.tinavienna.at/Dachbegruenung/*
*http://images.umweltberatung.at/htm/dachbegruenung-infobl-garten.pdf*

**First Austrian Green Roof City Competition**

The aim of this competition was to increase the awareness of green roofs, display different variants, and create an incentive for additional greening projects. To this end, the best projects were featured. Not only regional capital cities but also medium-sized and small towns participated in the competition. The key criterion was that the entry represented an outstanding and remarkable green roof within the town or city.

A prime example of a successful green roof is the Landscape Park Bindermichl-Spallerhof, which bridges the Mühlkreis highway and connects the city districts of Bindermichl and Spallerhof and moved traffic underground. The resulting 8.3 hectare park represents currently the largest green roof in Linz and substantially increases the quality of life for residents and visitors.

Private residential projects and green roofs installed by various companies have also been realized in Linz.

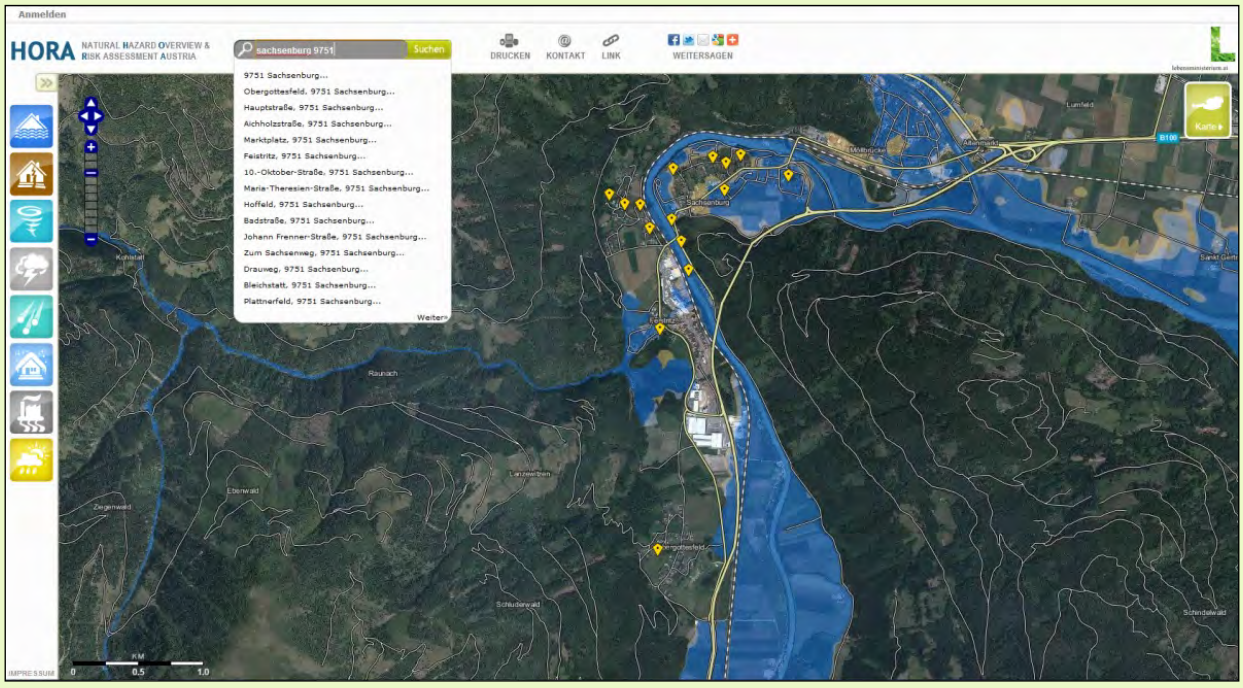
Further information:
*http://www.bauinfo24.at/news/personalien/1329-preisverleihung-gruendachwettbewerb/index.html*

***Protection from Natural Hazards***

# HORA 2.0 – Online Platform for Natural Hazard Detection

Following the severe flood events of recent years, in 2002 the *Lebensministerium* and the Insurance Association (VVO) jointly initiated the project “Flood risk zoning in Austria – HORA”, a nationwide risk zoning system for natural hazards with a special focus on floods. The objective of the project was to document the risk of natural disasters (especially floods) for all of Austria in order to be able to better assess damage potential. To this end, data on the high water levels of 25,000 kilometres of river in Austria were gathered.

In the summer of 2011, the HORA platform was updated and expanded. Since then, a new version of the digital application has been available at: *http://hora.gv.at*. The Internet platform offers all citizens the possibility to obtain a first risk assessment for various natural hazards and weather events (such as flooding, earthquakes, storms, hail, lightning, and snow load) simply by entering an address. In addition, current weather warnings for floods, hail and heavy rainfall, earthquakes, etc., are available. Since August, a HORA-APP has been available for all widely-used smart phones, making an estimation of risk potential even easier.




HORA’s primary objective is to raise risk awareness among the population so that precautions can be taken in a timely fashion. Its visualization of hazardous areas should serve as an important basis for the optimization and prioritization efforts of municipalities, states, and the federal government in flood protection and spatial planning.

Further information:
*http://www.hora.gv.at/*

***Protection from Natural Hazards***

## Severe Weather Warnings by Text Message/E-Mail

For several years already, locally (by post code) and temporally precise forecasts and information about the nature and intensity of an approaching severe weather event (storm, heavy rain or snow, ice, hail, thunderstorms) can be electronically distributed. Warnings are sent by text message and/or e-mail. This permits early *safety precautions* to be enacted, saving lives and preventing or reducing damage. In co-operation with the Central Institute for Meteorology and Geodynamics (ZAMG), several institutions (including insurance companies and the radio station Ö3) provide this (usually fee-based) service.

The weather alerts are determined by the Central Institute for Meteorology and Geodynamics through INCA, a computer programme that was specifically developed for regional weather forecasting in Austria. Weather data from more than 140 weather stations are analysed. When the severe weather criteria for a certain target area are met, a weather warning is immediately issued – up to two hours before the onset of the event.

Further information:
*http://warnungen.zamg.at/html/de/heute/alle/at/*
*http://www.versichern24.at/unwetterwarnung-sms-f%C3%BCr-ganz-%C3%B6sterreich*
*http://www.uniqa.at/uniqa_at/cms/service/unwetterwarnung/index.jsp*
*http://www.wetter.at/wetter/oesterreich/uw-sms*

***Disaster Management***

## Team Austria: Rapid, Non-Bureaucratic Disaster Relief

With the increase in extreme weather events, there is also an increased need for helpers in the management of natural disasters. Consequently, in 2007 a new concept of citizen participation was implemented in Austria. Team Austria is an initiative of the radio station Hitradio Ö3 and the Red Cross, with the objective of rapidly and non-bureaucratically supporting disaster relief efforts with on-site professional assistance.

The strength of Team Austria stems from the abundance of different skills offered by its helpers; precise selection of these skills, identified at the helper's registration, facilitates targeted application. Necessary tasks in disaster events range from simple auxiliary work (e.g., filling sandbags) to jobs that require specialized expertise (e.g., care of disaster victims, assistance in construction).

Assistance is voluntary: Whoever has time and wants to help can participate. Anyone over the age of 18 can take part. All helpers are registered in a database and can be quickly notified; currently (as of August 2011) over 29,000 members have enrolled. Every team member on duty is insured and receives a basic training course in disaster relief from the Red Cross in preparation for their active participation. The operation is organized by the Red Cross.

In 2008, the initiative received the silver medal in the category of Social Affairs from the International Advertising Association. The idea and the concept of Team Austria have since been copied by other European countries.

Further information:
*http://apps.teamoesterreich.at/*
*http://oe3.orf.at/teamoesterreich*

***Health***

## Ozone Warnings on Smart Phone

Due to the warming associated with climate change and increased solar radiation, the danger of increased ground-level ozone concentration has risen. High levels of ozone levels primarily affect children with hypersensitive bronchi, people with severe respiratory or cardiac illnesses, and asthmatics. Short-term elevations in ozone levels can cause headaches, burning eyes, respiratory symptoms, and asthma attacks and limit physical performance. When ozone levels are high, only the consequences can be minimized – for example, by avoiding strenuous activity or reducing time spent outside. Timely warnings when safe ozone limits are exceeded are therefore of enormous importance to public health.

To protect the public, informational and warning limits have been set. The information threshold is reached when a one-hour exposure to ozone levels exceeds 180 µg/m³; the alarm threshold is set at an ozone concentration of more than 240 µg/m³.

Owners of smart phones can check the precise current ozone levels in their area and be alerted when threshold levels are exceeded. The Open Data application is available free of charge and can be installed in smart phones from all manufacturers. The application works in modern browsers and smart phones and can be accessed at: *www.ozon-info.at*.

Further information:
*http://www.umweltbundesamt.at/aktuell/presse/lastnews/newsarchiv_2008/news080729/*
*http://www.open3.at/projekte/ozon-info-at-ozon-warnung-am-smartphone*

***Health***

## Heat Protection Plan in Styria

Heat waves occur in regular intervals, even at our latitudes. Due to climate change, more prolonged and more frequent heat waves are to be expected. Heat waves are defined by persistent daytime and nighttime temperatures that exceed certain limits, negatively affecting the health of individuals and at-risk groups.

The action plan of the federal state of Styria primarily serves to increase awareness of the health-related problems caused by prolonged heat waves. Practical tips and a guide for authorities and institutions should help to prevent heat-induced illnesses and fatal casualties.
The heat protection plan is divided into two main stages:

- **Early warning stage:** For times outside the observation period of May through September and periods in which the temperature limits have not been exceeded.
- **Warning stage:** For periods in which the limits are expected to be exceeded for at least three days. When the warning stage is announced, the population should be informed of general safety directives. In addition to the media preparation, an online service is available on the website of the state public health authority. The activation of the early warning signifies that the affected institutions will receive an e-mail alert with regional forecasts one day before the onset of a hot period expected to result in significant heat stress. These institutions can then apply the necessary emergency measures (e.g., coordination of schedules, organization of additional personnel, telephone checks on at-risk individuals, etc.) in a timely fashion.

The threshold values for the early-warning system have been established in cooperation with experts from the Central Institute for Meteorology and Geodynamics (ZAMG) on the basis of scientific data, namely the results of a bioclimatic study of Styria including both temperature values and humidity-related effects.

The cornerstones of the heat protection plan include:

- The identification of at-risk groups and individuals,
- Ensuring care and support by relatives or volunteers,
- Providing timely information to important institutions
  (nursing homes, hospitals, schools and kindergartens, mobile services, emergency services, etc.),
- The development of fact sheets for specific target groups and at-risk groups, and their online publication,
- Providing detailed information on general safety precautions and preventative health measures,
- Raising awareness, specialized expertise, and knowledge of concerned parties with regard to heat-related problems and illnesses,
- The preparation of informational material for the mass media.

Further information:
*http://www.verwaltung.steiermark.at/cms/beitrag/11685019/74836857/*

***Ecosystem/Biodiversity***

## Invasive Species Project – Johnsbach

Higher temperatures due to climate change often favour invasive alien species. The term “alien species” encompasses plant and animal species from other continents which have been introduced by human activities into Austria after the year 1492 and in parts massively spread.

The Austrian National Forests (ÖBf AG) have initiated a three-year pilot project in four federal states on habitat management aiming at the long-term control of certain invasive plants and their eradication. The project will be conducted in selected areas of Lower and Upper Austria, Vienna, and Styria and will be funded in each federal state through the “Programme for Rural Development”. This project is facilitated by the active participation of the population.

One of the affected communities is Johnsbach in Gesäuse (Styria). In recent years, three plant species have explosively spread in this region: Himalayan balsam, Canadian goldenrod, and Japanese knotweed. These plants have reached low-lying meadows up to an elevation of 1600 metres.
Johnsbach is located in a valley surrounded on all sides by mountains; the only entry for invasive plants is by means of the *Zwischenmäuerstrecke* of the Johnsbach stream, which will therefore need to be kept free of invasive species. The ÖBf’s project team will handle the project’s operations and organization, as well as the coordination of activities, training, and monitoring of success.

Further information:
*http://www.nationalpark.co.at/de/das-besucherlenkungskonzept/neuankommlinge-und-der-umgang-mit-fremden-arten.html*

***Transportation Infrastructure***

## Pilot Project Green Tracks– Ecological Principles and Evaluation Methods for Tramway Superstructures (GrüGl)

“Greened” rail tracks contribute to the rehabilitation of public space as well as the retention of rainwater and improvements in the microclimate. Green tracks are thus often claimed for new tramway constructions as a sustainability measure. Because of the general lack of basic rules establishing environmental criteria for railway infrastructure projects, construction tenders often turn out to be quite difficult. In the project GrüGl, indicators to evaluate environmental effects will be developed; these indicators will be tested in practice with the implementation of a new type of green track on a new section of tram line 26 in Vienna. This should allow public transport network operators in the future to determine and ensure that construction tenders meet the requirements of environmental protection, guaranteeing that the infrastructure will be built as environmentally friendly as possible.

Another goal of the project is to develop an alternative to the so-called “grass track” aiming to improve, the microclimate, increase water retention, enhance sound insulation, and meet aesthetic criteria. A mixture of native salt- and drought-resistant wild plant species shall be used that are optimally adapted to the prevailing environmental conditions, easy to care for, and self-sustaining (no reseeding required). The final results of the pilot project will be available in June 2012.

Further information:
*http://www2.ffg.at/verkehr/projekte.php?id=709&lang=de&browse=programm*
*https://forschung.boku.ac.at/fis/suchen.projekt_uebersicht?sprache_in=de&menue_id_in=300&id_in=8248*
*http://publik.tuwien.ac.at/files/PubDat_199677.pdf*

***Spatial Planning***

## CLISP – Climate Change Adaptation by Spatial Planning in the Alpine Space (Implementation in Model Regions)

The effects of climate change (such as increasing water scarcity, heat waves, and especially the increasing risk of natural hazards) substantially influence spatial planning, land use, and life-sustaining ecosystem services. Questions such as “What role can spatial planning play in adaptation to climate change?” and “How “climate-change fit” are our spatial planning systems and processes?” were the focus of a project funded by the Alpine Space Programme (ETZ 2007–2013), CLISP (Climate Change Adaptation by Spatial Planning in the Alpine Space).

In the course of this project, detailed investigations were carried out in a total of ten model regions in the Alpine space. In Austria, this included the federal state of Upper Austria as well as the NUTS-3 regions of Liezen (Styria) and Pinzgau-Pongau (Salzburg). For each model region, a first step analysed the vulnerabilities of selected sectors (the focus in Pinzgau-Pongau and Liezen was primarily on tourism and residential development; in Upper Austria, on tourism, agriculture, forestry, water management, and energy, among others). In a second step, selected spatial planning instruments were evaluated, identifying their strengths and weaknesses and developing concrete recommendations. Another work package in the model regions involved the initiation of a stakeholder process on the issues of risk management and risk control in the region, including the organisation of several workshops and interviews.

Through the work in the model regions over the course of CLISP’s project term, awareness could be raised about the role of spatial planning in adaptation to climate change with politicians and decision-makers, planning authorities, stakeholders, and the public. In several model regions, activities and processes for the future orientation of spatial development in the region were initiated outside the framework of the project. For example, in Upper Austria, an inter-sectoral working group under the direction of the spatial planning department was established that – based on the results of CLISP – continues to address the issue of climate change adaptation and spatial planning by developing recommendations for future strategies. In the model region of Liezen, the results of CLISP have also been incorporated into processes at the federal state level (e.g., the Styrian Climate Change Mitigation Plan).

Further information:
*http://www.clisp.eu/*

***Raumordnung, Schutz vor Naturgefahren***

## Programme for Flood-Safe Development of Residential Areas in Styria

Enacted in 2005, the Styrian regional planning programme for the flood-safe development of residential areas includes mandatory regulations with clearly defined legal consequences for zoning and construction in flood plains and hazardous areas. Flood discharge zones (HQ100), red hazard zones, and blue reserved areas (e.g., areas particularly suited for flood protection measures) according to the risk zone maps laid out in forestry regulations, as well as a strip of shoreline along naturally flowing waters of at least 10 metres in width, are to be kept free from building activities and should not be rezoned to allow construction. Exceptions to the zoning and construction ban within the HQ100 area are clearly defined. In areas of potential hazard where neither the HQ100 boundaries nor the hazard zones apply, either empirical high-water inundation lines from the past should be used for zoning decisions, or the opinions of the Torrent and Avalanche Control authorities should be sought.

Further information:
*http://www.raumplanung.steiermark.at*

***Spatial Planning, Protection from Natural Hazards***

## Salzburg's Flood Protection Act of 2004

The Flood Protection Act of 2004 requires that in addition to the safeguarding of HQ30 areas and red hazard zones, important flood drainage and retention areas should not be zoned for construction activities. In planning practice, the classification of the affected areas is carried out using the HQ100 inundation boundaries (yellow-red hazard zones, according to the BWV's hazard zone map). Flood plains and hazard zones were established in Salzburg's spatial planning law in 2009, which sets out a construction zoning ban for areas critical for flood drainage and retention. Salzburg's construction code provides that within the HQ100 area, building permission will not be granted when the risk of drainage impairment cannot be corrected with economically justifiable measures. Moreover, in building law, the retroactive stipulation of object-related freezing measures for existing buildings in hazard zones was made possible.

Further information:
*http://www.salzburg.gv.at/raumplanung*
*http://www.salzburg.gv.at/themen/nuw/wasser/hochwasser_hauptseite.htm*

***Urban Green and Open Spaces, Spatial Planning, Ecosystems/Biodiversity***

## Climate Regulation in Cities: "Green Network Graz" & "Revitalize Graz's Courtyards"

Building density, soil sealing, and the emission of air pollutants and waste heat can lead to higher average temperatures and pollution levels, lower wind speeds, and reduced humidity in cities. This effect, referred to as the urban climate effect, will be further reinforced by climate change. Green and open spaces serve an important function in climate regulation and can counteract the temperature rise in cities. Therefore, two projects have been implemented by the city of Graz in an effort to improve the urban climate and the quality of life of the city's residents.

**"Green Network Graz"**

The aim of this project is to link existing green and open spaces by means of connecting paths and green elements. In addition to the ecological and urban climate impacts, a recreational function is also a focus of the project. Attractive footpaths and bicycle paths will offer alternative transportation opportunities. Recreational areas will practically begin at residents' front doors or will be easy to access by means of "green paths".

The Green Network is not only a strategy paper on urban development; it also clearly defines certain needs for action in urban development. It serves as the basis for urban planning, zoning, and for opinions on building applications.

Further information:
*http://www.stadtland.at/htm/projekte/grNetzGraz.htm*
*http://www.geoportal.graz.at/cms/beitrag/10189880/4530149*

**"Revitalizing Graz's Courtyards"**

In addition to parks and urban forests, cities also feature courtyards that can be used as living and experience space. As semi-public and private open spaces, they can contribute significantly to the quality of life in densely built neighbourhoods. With appropriate planting, they improve the microclimate and thereby raise the quality of life in adjacent buildings. Especially in areas with high population density and few parks open to the public, courtyards are of particular importance. In the framework of a project funded by the European Union, the sociological, planning, and legal aspects of the conservation and revitalization of Graz's courtyards were investigated and implemented in pilot projects. The brochure "Urban Oases" presents possibilities for the renovation of courtyards for all interested parties, as well as information on existing incentives.

Further information:
*http://www.graz.at/cms/beitrag/10066544/1248185*
*http://www.graz.at/cms/beitrag/10066553/1248267*
*http://www.verantwortung-zeigen.at/index.php?id=1117*


# Communication and Education

# 13 Communication and Education

Especially when it comes to issues that affect society as a whole (such as adaptation to climate change) and that are characterized by uncertainty and a high degree of risk, intensive social dialogue is needed. This is more of central importance as measures necessary for adaptation relate to various decision-making levels and will impair the immediate areas of everyday life of many people. The need for adaptation equally applies to the general public as well as to entrepreneurs, interest groups, and government administrators (local to federal). In order to support those affected in the adaptation process, enable robust solutions for the future and enhance successful implementation of the present climate change adaptation strategy, communication and education will play a crucial role.

For adaptation strategies and measures to be successfully implemented, they must be **borne by the entire society** to the greatest extent possible. The provision and dissemination of target group-oriented and practice-relevant information on the consequences of climate change and possible adaptation measures are key steps in motivating people to take preventative actions. This will allow the "best" knowledge available to be incorporated into the decision-making process.

In recent years, several Austrian web-platforms have been launched with the intent to transfer information from politics and research to the general public. Worth mentioning is the website of the *Lebensministerium* (*klimaanpassung.lebensministerium.at*), which reports on the ongoing political process on adaptation to climate change at the national level. As part of the participatory process accompanying the development of the Austrian adaptation strategy, a homepage was set up to present Austria-specific information on climate change and adaptation (*www.klimawandelanpassung.at*; conceptualized and implemented by the Environment Agency Austria with financing from the Climate and Energy Fund). Further noted should be the information platform developed under the project "Triple-C", financed by the Climate and Energy Fund (*http://www.modul.ac.at/departments/new-media-technology/projects/triple-c/*). In November 2010, the climate research department of the Central Institute for Meteorology and Geodynamics (ZAMG) opened an information portal on the subject of climate change (*http://www.zamg.ac.at/cms/de/klima/informationsportal-klimawandel*). This platform seeks to present sound scientific information on climate change in an understandable form.

In addition to the information available on the Internet, since January 2011 a newsletter on climate change adaptation has been prepared and made available (*http://www.klimawandelanpassung.at/ms/klimawandelanpassung/de/newsletterregistrierung/kwa_archiv/*), providing practical information for governmental decision-makers, interest groups, etc. (designed and implemented by the Environment Agency Austria with financing from the Climate and Energy Fund).

Access to sound and targeted information over the Internet significantly contributes to awareness-raising. However, appropriate information on climate change and adaptation should also be integrated into school curricula. The elaboration of appropriate teaching materials is therefore an additional essential element.

However, scientific studies (IPCC 2007, Grothmann et al. 2009) have demonstrated that the provision of information does not necessarily lead to action. In other words, **knowledge** is not always sufficient to motivate people to **act**. Consequently, in addition to the procurement of information, a further phase in which methods and approaches are developed to increase Austrians' motivation and ability to take action will be required. Possible options in this regard include advertising campaigns, personal interviews, and articles in professional journals. Although examples and experience in this field are still scarce in Europe (e.g., dialogue events on the Germany's Adaptation Strategy[47] and the educational programme of UKCIP[48]), communication and education are regarded as essential elements of successful adaptation in all current adaptation strategies in European countries (Swart et al. 2009).

The importance of communication and education for raising awareness and competence to act with all parties concerned is also recognized in Austria. In the further development of the current strategy for adaptation to climate change, special attention will be devoted to this topic.

[47] Link: *http://www.anpassung.net/cln_319/nn_1467980/DE/Anpassungsstrategie/AnpStrategie__deutsch/Veranstaltungen/veranstaltungen__node.html?__nnn=true*

[48] Link: *http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=205&Itemid=320*

# Global Context

# 14 Global Context

Consequences of climate change will even more severely affect people, the environment, and economic and social development in other regions of the world than in Austria and Europe.

These adverse effects will primarily strike developing countries, which often have unstable and threatened natural habitats and are mainly dependent on natural resources and the associated economic sectors (such as agriculture, forestry, and fishing). Due to an insufficient social and economic development, these countries have only limited ability to adapt to climate change.

Global climate change increases the risk that global poverty and social conflict will intensify. Counteracting the negative consequences of climate change represents an important common goal of both industrialized and developing countries.

Art. 4 (1) of the United Nations Framework Convention on Climate Change states that all Parties, taking into account their common but differentiated responsibilities shall formulate and implement national and regional programmes containing measures to mitigate climate change and measures to facilitate adequate adaptation to climate change. Art. 4 (4) stipulates that the industrialized countries shall support developing countries in bearing the costs incurred by adaptation.

This support for developing countries in adaptation to climate change is a central component of the negotiations for an international climate regime, and also an integral part of a variety of measures in multilateral and bilateral development cooperation.

The global aspects of climate change adaptation are intensively discussed, especially in the field of development cooperation, and have already found their way into the related national (e.g., the strategic guidelines on “Environment and Development”, BMeiA & *Lebensministerium* 2009) and international (OECD 2009) policy documents.

This issue of adaptation plays an increasing role in development, security and environmental cooperation as well as for migration policy. For this reason, the Austrian adaptation strategy also addresses the international aspects of climate change.

## Securing Living Conditions

In many regions of the world, climate change will significantly affect living conditions, leading to, e.g., a severe threat to the food supply due to water shortages. Other effects of climate change will include heat-related deaths, the spread of vector-borne diseases such as malaria, and changes in access to natural resources. The achievement of the Millennium Goals and the associated national goals to eradicate poverty and promote sustainable development also appears to be threatened by the effects of climate change (OECD 2009). This is expected to result in an increase in environmental refugees.

The number of environmental refugees estimated at 25 million for the year 1999 will rise to 150–200 million by 2050. Sea level rise alone is expected to cause ten million additional environmental refugees over the next ten years (EC 2007c). Yet, climate change is not the only factor contributing to migration; the trigger is often an already existing problematic situation (political, economic, religious, etc.). Such triggers can include inadequate infrastructure, general water shortage, poor medical care, etc.

## Globally Sustainable Economy

Both industrialized and developing countries face the challenge of developing social and ecologically sustainable economies (BMLFUW 2002). In addition, measures addressing adaptation to climate change must be implemented. For developing countries, these two tasks are aggravated due to the lack of financial resources and the appropriate know-how.

In addition, unsustainable production and consumption patterns in industrialized countries have negative consequences on developing countries and lead to increased pressure on natural resources. All countries thus bear responsibility for the sustainable development of our planet (BMeiA 2009). Of particular importance are the unintended indirect effects of climate change mitigation or adaptation measures in wealthier countries due to market forces: land grabs, animal feed imports, and demand for biofuels all entail additional conflict potential (Breitwieser 2011).

## Conserving and Protecting the Environment

On a global scale, the state of the environment and natural resources has steadily deteriorated over recent decades in many regions; climate change exacerbates this situation. The integration of environmental protection measures and the conservation of natural resources thus number among the most important tasks of development cooperation, as is evident in Austrian legislation.

The consequences of climate change and the need for adaptation especially intensify the problems of poor populations in rural areas and coastal communities already exposed to difficult agro-ecological conditions, environmental risks, and greater climate variability. Insecure land rights, lack of access to environmental information, and the impact of natural disasters threaten their existence to a large extent. Legislation in such regions are often poorly implemented, and the capacities of ministries, regions, municipalities, and institutions are weak (BMeiA 2009).

## Recommendations

- Taking into account all climate factors (climate change mitigation and adaptation), third countries and regions should be directly supported in measures for sustainable development.
- Development cooperation should be strengthened by the objective to improve environmental and living conditions, health, nutrition, etc., on site.
- Participatory initiatives that help local societies to improve their resilience to climatic risks should be fostered.
- Studies on the contextual origins of migration to Austria and Europe should be initiated, so that migration flows can be reduced or controlled.
- In the Austrian climate change adaptation policy, external consequences must be taken into account in order to prevent the outsourcing of negative or counterproductive effects.
- Sectoral know-how transfer should flow in both directions: mutual learning.
- For activities with an international dimension (e.g., the import of products), aspects of climate change adaptation must be increasingly considered.

# Recommendations for Action

# 15 Recommendations for Action

## 15.1 Overall Principles

To support the planning and implementation of adaptation measures, the following steps are generally recommended:

**Legal Aspects**

- Complement and extension of the existing administrative framework conditions (regulations, funding guidelines, etc.) with aspects relevant to adaptation to climate change.

**Social Aspects of Climate Change**

- Balanced consideration of the consequences of climate change on both the ecosystem and socio-economic systems in adaptation measures and minimization of the risks to democracy, health, security, and social justice in society. Social integration and cohesion must be supported, fundamental rights and cultural diversity respected, equality of men and women guaranteed, and discrimination of any sort prohibited.

**Information and Education**

- Promotion of the exchange of knowledge and experiences between politics, administrations, science, and the concerned actors.
- Increase in the exchange of knowledge and experiences with regard to modern, climate change-resistant systems and practices through consulting, training, and information. The access to information for concerned parties should thus be facilitated and the effective dissemination and use of knowledge ensured. Corresponding adjustments in research, consulting, and educational facilities are to be envisaged.
- Encouragement of the use, networking, and extension of existing instruments and platforms to gain a common understanding of the relevant climatic changes. Such dialogue fora can contribute to better coordination between the actors concerned, interest groups, administrations, and science, as well as to a more efficient and rapid implementation of adaptation measures.
- Improvement of data bases (knowledge of the system and effects of climate change) and the provision and expansion of information towards a climate information system for actors and decision-makers as a basis for decisions.
- Continued inclusion and improvement of adequate topics as educational priorities in all school types and levels of education, development of appropriate teaching materials, and training and further education of multipliers in schools and other educational institutions.

**Individual Responsibility**

- Reinforcement of individual responsibility in the population through awareness-raising and information, in order to promote responsible behaviour in relation to the consequences of climate change.

**External Conditions**

- Consideration of variable global conditions such as long-term rising prices for energy, resources, etc. and demographic trends.

**Overall View**

- Minimization of use conflicts through a holistic approach: A forward-looking balancing in the planning of measures in terms of their implications for nature conservation, climate change mitigation, and for other areas for action is desirable (e.g., river basin management). Thereby, complex interactions are to be described and those measures should be favoured that are expected to produce synergy effects.
- Development of a customized risk-management system in order to improve the identification, prevention, and mitigation of risks as well as the management of incurred damages. Within the framework of an iterative risk-management process that involves both adaptation and emission reduction, the damages arising from climate change, positive side effects, sustainability, equity, and attitudes toward risks should all be taken into account (IPCC 2008).

Due to partially long lead times for the measures to become effective, the consideration of different time scales for adaptation measures is necessary.

## 15.2 Tabular Compilation of Recommendations for Action

In order to support a coordinated and harmonized approach at the national level, the Austrian adaptation strategy provides recommendations in 14 areas for action (see the following tabular summary). The Action Plan describes the recommendations in detail.

## Agriculture

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.1.4.1 | Sustainable soil composition and protection of soil fertility, structure, and stability | Protection of natural soil functions;<br>Construction 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;<br>Prevention of damage (especially soil compaction and erosion) and conservation of soil productivity through sustainable and site-adapted land use and a conservation tillage method. | Federal and state governments, interest groups (advice, information), academic and non-academic research institutions, farmers, Bio-Austria, b4 Corporate Soil Competence (AGES, BFW, Environment Agency Austria, BAW), agricultural schools, rural training institutes, apprenticeship and specialized training units |
| 3.1.4.2 | Enhanced establishment and promotion of water-saving irrigation systems and improvements in irrigation planning | 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. | Federal and state governments, municipalities, interest groups, academic and non-academic research institutions, farmers, industry |
| 3.1.4.3 | Breeding and targeted use of water-saving, heat-tolerant plants (species/ varieties) within the meaning of a regionally adapted management | Use of species and new varieties of plants that can tolerate changing climatic conditions. Especially heat-tolerant and water-saving crops and grasses and species with low susceptibility to pests shall be favoured. | 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) |
| 3.1.4.4 | Adjustment of fertilizer management to seasonal weather patterns | Need-based and site-specific plant nutrition as a contribution to plant quality, plant health, and yield security. | Federal government, academic and non-academic research institutions, interest groups, AGES, LFZ Raumberg-Gumpenstein, Committee for Soil Fertility and Soil Conservation, farmers |
| 3.1.4.5 | Provision of scientific advice on potential new agricultural diseases and pests | Improvement in the state of knowledge regarding emerging diseases and pests, in order to enable a quick and efficient response in case of need and optimization of plant protection measures. | Federal and state governments, interest groups, AGES, academic and non-academic research institutions, farmers, industry (producers) |
| 3.1.4.6 | Environmentally sound and sustainable use of plant protection products (pesticides) | Optimization of plant protection measures through changes in the timing and method of application and/or spectrum of pesticides and establishment of a systematic monitoring, with the goal of fostering environmentally friendly and sustainable agricultural practices. | Federal and state governments, interest groups, AGES, academic and non-academic research institutions, Committee for Soil Fertility and Soil Conservation, agricultural trade, farmers, industry |
| 3.1.4.7 | Review of site suitability based on changing climatic conditions and development of recommendations for the selection of a site-adapted crop | Selection of suitable crops for the respective site conditions. | Federal and state governments, water management authorities, AGES, LFZ Raumberg-Gumpenstein, interest groups, natural hazard insurance companies, academic and non-academic research institutions |
| 3.1.4.8 | Risk minimization and the development and extension of risk sharing instruments | Reduction of weather-related production risks and the development and extension of additional insurance models. | Federal and state governments, water management authorities, AGES, LFZ Raumberg-Gumpenstein, interest groups, natural hazard insurance companies, academic and non-academic research institutions |

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.1.4.9 | Integrated landscaping for soil protection and the improvement of agricultural ecology, including the conservation and management of landscape features | 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. | Federal and state governments, interest groups (advice, information), farmers, nature conservation associations, tourism associations |
| 3.1.4.10 | Preservation of existing pastures and revitalization of abandoned pastures | Maintenance of the protective and recovery function, of feed production and the targeted revitalization and rehabilitation of abandoned pastures under consideration of nature conservation aspects. | Federal and state governments (funding of pasture management), interest groups, Almwirtschaft Österreich (Austrian Pasture Management), potentially tourism associations, farmers |
| 3.1.4.11 | Optimization of greenhouse cultivation in terms of energy, water, and cooling supply strategies | Efficiency improvements in energy and water consumption in greenhouse and plastic-sheet cultivation, in particular with regard to increasing heat stress in summer and potentially more frequent natural disasters. | Federal and state governments, academic and non-academic research institutions, interest groups, Bundesgemüsebauverband Österreichs (Austrian Vegetable Growers Association), municipalities, producer associations, industry, farm managers |
| 3.1.4.12 | Promotion of animal welfare and animal health under changing climatic conditions | 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. | Federal and state governments, research, veterinary authorities, AGES, interest groups, LFZ Raumberg-Gumpenstein, farmers, Austrian Animal Health Service (TGD) and animal health services of the federal states |
| 3.1.4.13 | Consideration of future requirements for the cooling of stables due to increasing thermal stress | Reduction of thermal stress on farm animals, appropriate and stress-free livestock rearing, and reduction of harmful pollutants in stables. | Federal and state governments, interest groups, (funding for stable adjustments), farmers, academic and non-academic research institutions (in particular, LFZ Raumberg-Gumpenstein, BOKU, VMU), municipalities |
| 3.1.4.14 | Optimization of adaptation and combat strategies for new diseases and pests | Further optimization and, if needed, extension of existing warning systems, improvement of information and data transfer (e.g., between meteorological units, science, and farmers), and the nationwide monitoring of potentially harmful organisms;<br>Designation of particularly endangered areas and the development and adjustment of decision-making aids for measures. | Federal and state governments, academic and non-academic research institutions, interest groups, AGES, LFZ Raumberg-Gumpenstein, insurance companies, farmers |

## Forestry

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.2.4.1 | Modification in the selection of tree species and provenance, including targeted promotion of diversity through appropriate silvicultural management and rejuvenation of over aged stock | Increase of stability and reduction of vulnerability of forest ecosystems to pests and diseases;<br>Increase in diversity at all levels (genetic, species-specific, structural, diversity of habitat, etc.) adapted to the respective site-specific conditions;<br>Increase of stability and reduction of susceptibility to disturbances, e.g., through the timely introduction of rejuvenation measures. | Forest owners, interest groups, academic and non-academic research institutions, federal and state governments, EU (responsibility lies with all listed) |
| 3.2.4.2 | Soil-protective cultivation | Preservation of the physical functions of the soil, in particular in terms of water retention and nutrient supply. | Forest owners, felling companies, authorities, interest groups, research institutions, federal and state governments, EU, water management, foresters, municipalities, forest leaseholders |
| 3.2.4.3 | Reduction of damage caused by game animals | Reduced damages caused by game animals for safeguarding rejuvenation and stock stability. | Hunters, forest owners, state governments (hunting legislation), federal government, interest groups |
| 3.2.4.4 | Development of an advisory concept for foresters with regard to adaptation of forests to climate change | Improvements in consulting, training, and further education of forest owners taking into account latest research results. | Federal government, forest authorities, Chamber of Agriculture and other advisory institutions, academic and non-academic research institutions |
| 3.2.4.5 | Adjustment and improvement of crisis and calamity management | Mitigation of damage from harmful events such as windfalls or bark beetle calamities. | Federal and state governments, forest authorities, further authorities (e.g., water authorities), interest groups, forest owners, forestry unions (forest management collaborations (WWGs), forest associations), transport industry, wood and paper industries, EU |
| 3.2.4.6 | Establishment of preventative measures with regard to the potential increase in forest fires | Development of preventative measures and systems for forest-fire monitoring and early-warning in order to minimize the risk of forest fires;<br>Elaboration or revision of emergency plans to combat forest fires. | Federal and state governments, municipalities, interest groups, forest owners, forest management collaborations (WWGs), forest associations, academic and non-academic research institutions, EU |
| 3.2.4.7 | Forest pollution control - Integrated forest inventory and pollutant monitoring | Nationwide inventory of Austrian forests through improving the forest inventory with remote sensing methods (laser scanning, multi-spectral satellite imagery) for enhanced system knowledge, and the establishment of a pollution monitoring system. | EU, federal and state governments, Federal Research and Training Centre for Forests, Natural Hazards, and Landscape (BFW), Environment Agency Austria |
| 3.2.4.8 | Development of modified and innovative techniques for wood processing taking into account potential changes in wood quality and tree species | Development of efficient, innovative techniques for wood processing in order to increase the value added in the wood use chain. | Researchers, wood-working and -processing industry, interest groups, Cooperation Platform Forestry-Wood-Paper (FHP), federal government,<br>EU (Forest Technology Platform) |

## Water Resources and Water Management

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.3.4.1 | Analysis of existing data and promotion of further data collection on water resources | Reduction of knowledge deficits regarding the effects of climate change on water resources and their use. | Federal and state governments, districts, municipalities, academic and non-academic research institutions, water suppliers (water consumption/use and demand) |
| 3.3.4.2 | Improving coordination/information concerning water consumption and water demand | Data collection to the greatest possible extent on actual water consumption by various users as a basis for the management of water supply and its safeguarding. | Federal and state governments, interest groups, regions, municipalities |
| 3.3.4.3 | Securing future water supply | Increasing qualitative and quantitative security of the water supply in areas threatened by water scarcity by means of planning and technological measures. | EU, state governments, municipalities, water utility companies |
| 3.3.4.4 | Mindful use of water resources | Protection of water resources in areas threatened by water shortages by means of the encouraged use of efficient water-saving technologies and through targeted awareness-raising. | State governments, municipalities, water utility companies, water users, academic and non-academic research institutions |
| 3.3.4.5 | Promotion of management of water resources when water supplies are low | Ensuring the achievement of water management objectives in periods of low water. | Federal and state governments, municipalities, academic and non-academic research institutions |
| 3.3.4.6 | Achieving and ensuring the good ecological and chemical status of water bodies (including groundwater) | Achieving and ensuring the good ecological and chemical status of water bodies (including groundwater) or the good ecological potential. | Federal and state governments, municipalities, EU, and other actors such as power suppliers, water suppliers, industry, flood associations, AGES, etc. |
| 3.3.4.7 | Intensification of water management planning for groundwater resources | 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. | Federal and state governments, municipalities, EU, nature conservation organizations |
| 3.3.4.8 | Adaptive flood management with robust measures | Prevention of an increase in peak runoffs and damages. | EU, federal and state governments, municipalities, academic and non-academic research institutions |
| 3.3.4.9 | Greater emphasis on water temperatures in water management measures | Reduction of the influence of higher water temperatures on the use and protection of water bodies. | Municipalities, federal and state governments, EU, and other actors such as energy suppliers, water companies, fisheries, industry |
| 3.3.4.10 | Installation of industrial water management instruments | Ensuring industrial water supply for various areas for 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. | EU, federal and state governments, factory operators |

## Tourism

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.4.4.1 | Consideration of climate change in tourism strategies | Intensification of strategic considerations on issues of climate change and tourism as frame conditions for the implementation of adaptation measures. | State governments, federal government, actors such as mobility providers, international actors, etc.<br>Furthermore, extensive networking between the various administrative levels (vertical) and between the areas for action (horizontal) is desirable. |
| 3.4.4.2 | Development of climate-friendly adaptation measures based on tourism strategies | Increased consideration of adaptation measures that best contribute to the reduction of greenhouse gas emissions and provide added value for businesses. | 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 Planungsverband (planning association, Tirol) |
| 3.4.4.3 | Development, provision, and improvement of regional data as the basis for decision-making for adaptation measures | Minimization of existing uncertainties and the elaboration of a robust decision-making basis by using regional data bases, particularly through the integration of regional climate scenarios. | Alpine clubs, destinations<br>With regard to the creation of new data bases (e.g., regional climate scenarios, information on new offers) the input of both the federal government and the states is required. |

# Energy – Focus on the Electrical Industry

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.5.4.1 | Optimization of network infrastructure | Avoidance of foreseeable energy shortages and overcapacity. | Federal and state governments, electricity industry, e-control, network operators, EU, academic and non-academic research institutions , |
| 3.5.4.2 | Promotion of decentralized energy generation and grid feed-in | Use of regional renewable resources to increase the security of supply (even in a crisis situation) and public awareness-raising with regard to energy issues. | Federal government (BMWFJ, BMLFUW, BMVIT, BMF), state governments, electricity industry, e-control, network operators, EU |
| 3.5.4.3 | Increased research on potential methods of energy storage | Relief of the balancing function of the networks for differences between generation and consumption. | Academic and non-academic research institutions (research funds, universities, research institutions such as Industries of Technologies ATI), energy industry |
| 3.5.4.4 | Stabilization of the transport and distribution network through appropriate climate-adapted system planning | Reduction of the susceptibility of transportation networks to interference and the prevention of overload or supply shortages arising from the expected climatic changes. | Federal and state governments, energy industry, local residents |
| 3.5.4.5 | Optimization of the interaction between generation (from various sources) and consumption in the power supply system under varying supply and demand | Avoiding critical peak loads in the case of shortages; relieving the transport network during peak loads; optimization of the decentralized network feed-in. | Network operators, EU, federal and state governments, municipalities, energy industry, e-control, industry (producers/generators of devices), customers |
| 3.5.4.6 | Consideration of the effects of climate change in energy sector decision-making and research activities, e.g., in view of a further diversification of the energy supply | Increasing security of supply through more diversified energy sources structures and far-reaching avoidance of negative consequences for other areas and their adaptive capacity. | Energy suppliers, federal government (BMWFJ, BMVIT, BMLFUW, BMF), state governments, municipalities, energy service providers, interest groups, NGOs (e.g., Biomasseverband, Photovoltaik) |
| 3.5.4.7 | Reduction of demand by means of increasing end energy efficiency and reducing internal loads | Reduction of energy consumption through increases in efficiency and the improvement of thermal comfort by reducing internal loads. | Federal and state governments, EU, building occupants, real estate developers, building services planners, IT planners, device developers, academic and non-academic research institutions |
| 3.5.4.8 | Development of an energy supply strategy on the basis of a comprehensive forecast of power and heating demand that takes “adaptation scenarios” into account | Creation of a long-term strategy 2030–2050 as a planning instrument, taking into account potential future developments, and the elaboration of appropriate adaptation-relevant measures. | Federal and state governments, energy suppliers, network operators |

## Construction and Housing

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.6.4.1 | Implementation of structural measures (in new buildings and in renovations) to ensure thermal comfort | Ensuring thermal comfort indoors through structural measures, especially with regard to the increased incidence of hot days. | Federal and state governments, architects, planners, building owners, real estate developers, academic and non-academic research institutions |
| 3.6.4.2 | Encouraged use of passive and active cooling with alternative, energy-efficient, and resource-saving technologies | Ensuring thermal comfort inside new buildings, in renovations, and in existing buildings by means of passive and alternative ("active") cooling strategies. | Federal and state governments, (energy consultancy), environmental consultancy, architects, planners, building owners, real estate developers, research, technology providers |
| 3.6.4.3 | Climatological improvement of urban spaces, with particular emphasis on micro- and mesoclimatic conditions in urban and open space planning | Optimization of living conditions, conditions of human and wind comfort, as well as reduction in the heat-island effect through urban and open space planning. | State governments, municipalities, real estate developers, planners, microclimate experts, academic and non-academic research institutions, builders |
| 3.6.4.4 | Implementation of structural measures in buildings as protection from extreme weather events | Structural adaptation of buildings (new and existing buildings) for protection from extreme weather events. | Federal and state governments, architects, planners, building owners, real estate developers, technology providers, research institutions, microclimate experts |
| 3.6.4.5 | Increase of water retention | Prevention of local flooding through structural measures around buildings. | Federal and state governments, municipalities, planners |
| 3.6.4.6 | Revision of building standards and norms considering climate change | Consideration and integration of adaptation requirements in construction standards and norms. | Federal and state governments, Austrian Institute of Construction Engineering (OIB), Standards Institute |
| 3.6.4.7 | Evaluation and further development of funding instruments for the consideration of climate change aspects in new constructions and renovations | Increased emphasis on adaptation needs in the funding of new construction and the renovation of residential and non-residential buildings. | Federal and state governments, in part interest groups, municipalities, public-private partnerships, BMJ, BMWFJ |
| 3.6.4.8 | Research on adaptation to the consequences of climate change in the area of construction and housing | Improvement of the knowledge base with the goal of optimized adaptation to the effects of climate change and improvement of data bases. | EU, federal government, research funding bodies (Climate and Energy Fund, FWF, FFG), academic and non-academic research institutions |
| 3.6.4.9 | Pilot projects on "climate change-adapted architecture" | Demonstration of the feasibility and advantages of "climate change-adapted architecture". | 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, logisticians |
| 3.6.4.10 | Publicity and awareness raising on the subject of adaptation to the consequences of climate change in the area of construction and housing | Awareness raising and dissemination of knowledge on the subject of adaptation to the effects of climate change and the necessary adaptation measures. | Federal and state governments, municipalities, NGOs, interest groups |
| 3.6.4.11 | Training and further education on issues of adaptation to the consequences of climate change in the area of construction and housing | Creation of a sound knowledge base for the implementation of measures for adaptation to the consequences of climate change. | Federal government, training and education institutions, interest groups (chambers), academic and non-academic research institutions |

# Protection from Natural Hazards

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.7.3.1 | Promotion of hazard and risk awareness, self-sufficiency of the population, and the development of consulting models | Incorporation and strengthening of responsible behaviour in coping with risks from natural hazards, and the development of a “one-stop shop” for public concerns on the subject of climate change adaptation in the area “Protection from Natural Hazards”. | 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 |
| 3.7.3.2 | Promotion of sustainable spatial development strategies, including increased consideration of hazard zone mapping and risk presentation | Keeping areas potentially affected by natural hazards free from uses for residential, commercial, or infrastructure purposes, or targeted control of such use. | Federal government (hazard zone maps, GZP), state governments, municipalities |
| 3.7.3.3 | Promotion of water retention in the catchment and the reactivation of natural flood plains, particularly as a contribution to precautionary land use | Reduction of peak flows by ensuring water retention in the catchment. | Federal and state governments, municipalities, infrastructure managers, land owners, water boards, ÖROK |
| 3.7.3.4 | Promotion of research on the impact of climate change on extreme events and on changes in the natural environment and human use thereof | Provision of decision-making bases using the state of the art in science and technology. | EU, federal and state governments, research institutions (public/private), cooperation among universities, national research programmes |
| 3.7.3.5 | Promotion of risk management with inclusion of appropriate risk transfer mechanisms (risk partnerships) | Raising awareness of the need for insurance-based personal provision. | Public sector (federal and state governments, municipalities), insurance sector, individuals |
| 3.7.3.6 | Promotion of technological property protection measures (permanent and temporary) as a contributing factor to self-sufficiency | Prevention of damage to buildings and property related to the effects of natural hazards. | Federal and state governments, municipalities, association of insurers, science, developers, individuals, OIB (Austrian Institute of Construction Engineering), certification body |
| 3.7.3.7 | Promotion of forecasting, (early-) warning, and measuring systems | Expansion of the scope of data and information on hazardous natural processes and the resulting possibility of (early-)warning. | Federal government (e.g., BMVIT), Torrent and Avalanche Control, state governments, municipalities, interest groups, scientific institutions, infrastructure managers, ZAMG, Geological Survey of Austria, emergency response organizations |

## Disaster Risk Management

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.8.3.1 | Continuous review, modification, and implementation of the SKKM Strategy 2020 (Strategy for National Crisis and Disaster Protection Management), taking into account the effects of climate change | Timely and forceful implementation of the SKKM Strategy | Federal and state governments, municipalities, science, industry, emergency response organizations |
| 3.8.3.2 | Establishment of a national multi-sectoral communications platform for disaster risk reduction | Improvement of knowledge transfer between the actors in disaster risk management and the promotion of a broad-ranging dialogue. | Authorities at the federal level (BMI, BMLVS, BMVIT, BMLFUW, BMG) and at the state and local levels, emergency response organizations (fire service, Red Cross, etc.), industry (e.g., insurance, operators of critical infrastructure), science, general public |
| 3.8.3.3 | Creation and maintenance of appropriate frame conditions for volunteer engagement in the field of disaster risk management | Creation of appropriate frame conditions for volunteer resources in the field of disaster risk management in order to ensure continued qualified self-sufficiency. | EU, federal and state governments, municipalities, emergency response organizations, humanitarian organizations, volunteers, industry, trade unions |
| 3.8.3.4 | Increasing the flexibility of financing and funding instruments in the field of disaster risk management | Creation of a financing mechanism for short-, medium-, and long-term activities of an integrated disaster risk management on the basis of defined criteria. | Federal and state governments, emergency response organizations, (insurance) industry, science |
| 3.8.3.5 | Improving risk communication in the field of disaster prevention | Exposure to natural disasters is recognised by the general public and adequate precautionary measures are set. | Federal and state governments, municipalities, emergency response organizations, (communications) industry, the media, research, (communications) science |
| 3.8.3.6 | Increase in training offers in the field of disaster risk management | Improvement in training and increasing competencies of the actors in disaster risk management. | Actors in disaster risk management, educational institutions of disaster risk management, tertiary educational institutions |
| 3.8.3.7 | Uniform methodology for performing risk analysis | Development and implementation of a uniform method for assessing disaster risks as the basis for a coordinated, integrated, risk-based, and cost- and benefit-oriented planning of measures in Austria. | Federal and state governments, municipalities, infrastructure managers, research institutions, insurance industry |
| 3.8.3.8 | Development of participatory methods to integrate all actors in the field of disaster risk management | Development and implementation of methods designed to accelerate the involvement of all concerned actors in opinion-forming-, decision-making and implementation processes in terms of an integrated disaster risk management. | EU, federal and state governments, municipalities, industry, science, citizens |
| 3.8.3.9 | Focus on research activities related to disaster risk management | Research activities and the establishment of complementary research programmes whose contents are derived from the SKKM Strategy 2020 or its implementation. | SKKM working groups, federal and state governments, municipalities, industry (particularly operators of critical infrastructure), academic and non-academic research institutions, emergency response organizations |

# Health

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.9.4.1 | General public relations and specific work on preparing for extreme events or outbreaks of infectious diseases | Raising awareness and 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. | 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, BMLFUW, BMUKK, tourism organizations |
| 3.9.4.2 | Dealing with heat and drought | 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). | BMG, BMASK, ÖGD, BMWA, BMUKK, state governments, Gesundheit Österreich GmbH, ÖGB, cities, municipalities, 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 |
| 3.9.4.3 | Dealing with floods, mudslides, landslides, avalanches, and rockfalls | Maintaining supply functions of central services in cases of disaster and preventing fatal casualties for acute, chronic, physical, and mental health effects. | Cooperation between federal and state governments, municipalities, aid organizations, Health Care, Disaster Protection Management, hospital operators, BMI, mental health services, emergency services, the army, ÖÄK, psychotherapy associations, hospitals, insurance companies, water utilities, BMG, ÖGD, BMLFUW, state governments, Gesundheit Österreich GmbH, AGES, ÖWAV, ÖVGW, NGOs, universities |
| 3.9.4.4 | Advancement of knowledge and preparation for handling pathogens/infectious diseases | Improving the knowledge base on climate change-related alterations in the establishment and spread of pathogens and infectious diseases;<br>Suppression of the establishment and spread of pathogens, infectious diseases, and disease carriers (vectors);<br>Improving the early recognition, diagnosis, and therapies for “new and emerging diseases”. | BMG, BMWF, BMLVS, BMFLUW, BMASK, state governments, academic and non-academic research institutions, AGES, Gesundheit Österreich GmbH, ÖÄK, EU (ECDC) |
| 3.9.4.5 | Risk management with regard to the spread of allergenic and toxic species | Prevention/reduction of adverse health effects due to allergenic and toxic plants and animals. | BMG, AGES, BMLFUW, state governments, Chamber of Agriculture, Gesundheit Österreich GmbH, academic and non-academic research institutions, municipalities, gardeners, ÖÄK, the media |
| 3.9.4.6 | Dealing with pollutants and ultraviolet radiation | Prevention/reduction of adverse health effects due to new exposure to pollutants resulting from extreme events and climate change. | BMLFUW, BMG, BMASK, state governments, Chamber of Agriculture, Gesundheit Österreich GmbH, ÖÄK, AGES, ÖGB, Chamber of Labour, municipalities, the media |

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.9.4.7 | Establishment of monitoring and early-warning systems | 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 for the respective risks (e.g., floods, heat, cold, pathogens/infectious diseases). | BMG, BMLVS, BMASK, state governments, universities, Gesundheit Österreich GmbH, ÖÄK (Austrian Medical Chamber), insurance companies, Statistics Austria, ZAMG, cities/municipalities, care services, retirement homes, nursing homes, hospitals, mental health services, Chamber of Labour, Disaster Protection Management, emergency services, civil defence associations, the media |
| 3.9.4.8 | Training and further education of doctors and personnel in medical, therapeutic, and diagnostic health professions (MTDG) in consideration of climate-relevant topics | Increasing the competence of doctors and health care personnel in handling climate-relevant health topics. | BMG, state governments, ÖÄK (Austrian Medical Chamber), training academies, hospital operators, academic and non-academic research institutions, Gesundheit Österreich GmbH, public health services, mental health services, the media |

## Ecosystems and Biodiversity

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.10.4.1 | Improving the knowledge base through research on the effects of climate change on ecosystems/biodiversity | Advancement of knowledge on the effects of climate change on ecosystems and biodiversity as a basis and support for the implementation of potential measures. | Federal government (BMWF, BMLFUW), state governments, academic and non-academic research institutions, ZAMG, Austrian Academy of Sciences, FWF, Climate and Energy Fund (ACRP, Austrian Climate Research Programme) |
| 3.10.4.2 | Increased consideration of climate change in existing monitoring systems and further establishment of monitoring and early-warning systems | 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. | BMWF, BMFLUW, state governments, NGOs, BFW, ÖAW, FWF, universities, Environment Agency Austria, Austrian Climate Research Programme (ACRP), Long Term Ecological Network (LTER), museums (e.g., Zobodat) |
| 3.10.4.3 | Integration of climate change into nature conservation concepts | Consideration of the effects of climate change and representation of potential needs for action in nature conservation concepts. | State governments, BMLFUW |
| 3.10.4.4 | Strengthening of knowledge transfer on the importance of biodiversity and ecosystems for climate change adaptation in training and increased public relations efforts | Increased integration of the importance of biodiversity for adaptation to climate change of society in education and accelerated public relations efforts. | 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 |
| 3.10.4.5 | Perpetuation of extensive land use in mountainous and Alpine elevations and in selected locations | Protection of the traditional cultural landscape as a sanctuary for respective species. | EU, BMLFUW, state governments (nature conservation departments), land users, land owners, NGOs, interest groups, agricultural authorities, municipalities, LFZ Raumberg-Gumpenstein, tourism associations |

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.10.4.6 | Adjustments of offers for leisure and vacation activities | Management and adjustment of leisure activities that threaten biodiversity in favour of sustainable activities. | Associations, businesses, and professionals in the tourist industry, cable-car industry, land owners, protected area administrations, educational institutions, NGOs, interest groups, general public |
| 3.10.4.7 | Adjustment in the design of public and private open spaces in residential areas to objectives of nature conservation and climate change effects | 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). | Building owners, municipalities, architects, garden owners, real estate developers, parks departments, educational institutions, Eco Counselling, "Aktion Natur im Garten", BMG, BMLFUW |
| 3.10.4.8 | Strengthening of threatened populations and species | Reducing the hazardous situation of species threatened by climate change through restocking or ex-situ conservation (including seed and gene banks). | Land users, associations, conservation departments, protected area administrations, universities, botanical gardens, Environment Agency Austria |
| 3.10.4.9 | Maintenance and facilitating the embedding and connectivity of protected areas and habitats | Facilitating the connectivity 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. | BMLFUW, BMWF, 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 |
| 3.10.4.10 | Protection of wetland habitats by ensuring the quality and quantity of groundwater and by raising the water storage and retention capacity of landscapes | Protection of wetland habitats by ensuring adequate groundwater quality and quantity under conditions of climate change, and increasing the water storage and retention capability through runoff-retarding measures. | BMLFUW, state governments, land owners, energy producers, water suppliers, interest groups, agricultural authorities, spatial planning, NGOs, ÖBf, universities |
| 3.10.4.11 | Promotion of restoration of waters, reinforcement of an integrated watershed management , and prevention of substantial warming of water bodies | Combined flood and biodiversity protection through restoration and a comprehensive treatment of water bodies, as well as the prevention of the their substantial warming. | BMLFUW, 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 |
| 3.10.4.12 | Conservation of ecosystem services in sustainable land use and nature conservation | Awareness-raising regarding ecosystem services in all affected areas under the precondition of sustainable land use and in nature conservation (e.g., contribution to water retention, flood protection, biodiversity, drinking-water formation, $CO_2$ binding, etc.) to promote sustainable land use and strengthen nature conservation. | Federal and state governments (nature conservation departments), interest groups/associations, land users, NGOs, agricultural and forestry authorities |
| 3.10.4.13 | Consideration of ecosystems/ biodiversity issues in a global context | Reduction of indirect negative effects on biodiversity worldwide. | Federal and state governments, ADA, municipalities, industry, Global Responsibility – Platform for Development and Humanitarian Aid, ANRICA (Austrian Natural Resources Management and International Cooperation Agency) |

## Transportation Infrastructure

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.11.4.1 | Further expansion of informational and early-warning systems | Implementation of the precautionary principle for transportation infrastructure with regard to extreme weather events. | Federal and state governments, municipalities, operators of transportation infrastructure, universities, FH, meteorological institutions and companies (e.g., ZAMG, AustroControl) |
| 3.11.4.2 | Safeguarding a functional transportation system | Adjustment of the transportation infrastructure to safeguard a functional and climate-friendly transportation system and accommodation of public needs. | Federal and state governments, Federal Transport Agency, municipalities, operators of transportation infrastructure, planners, developers, businesses |
| 3.11.4.3 | Safeguarding thermal comfort through the reduction of thermal loads | Reduction of thermal loads in residential areas, in modes of transport, and in industrial buildings. | Real estate developers, IT planners, device developers, federal and state governments |
| 3.11.4.4 | Reduction of potential heat stress for passengers and personnel in public transportation through appropriate air conditioning | Increase operational safety in terms of heat stress in public transportation (safety of people and equipment). | Federal government, public transport operators, educational institutions, state governments, municipalities, manufacturers of public transport |
| 3.11.4.5 | Review and (if necessary) amendments of legal standards to account for climate change in the construction and operation of transportation infrastructure | Amendments of laws, standards, and guidelines to the effects of climate change. | Federal and state governments, standardization authorities, Austrian Institute of Construction Engineering (OIB), Austrian Association for Research on Road - Rail - Transport (FSV) |
| 3.11.4.6 | Consideration of micro- and mesoclimatic conditions in urban and open space planning | Ensuring thermal comfort through adapted infrastructure planning as part of urban and open space planning. | State governments, municipalities, planners, meteorologists, transport users |
| 3.11.4.7 | Reduction in the increase of permanently sealed surfaces for transportation infrastructure as flood protection | Reduction of excessive sealing areas of transportation infrastructure to reduce/prevent local flooding. | Federal and state governments, municipalities, operators of transportation infrastructure, developers, land owners |
| 3.11.4.8 | Research on adaptation to the consequences of climate change in the area of transportation infrastructure | Improving the knowledge base with the goal of optimized adaptation to the consequences of climate change. | EU, 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 |
| 3.11.4.9 | Pilot projects on climate-change adapted transportation infrastructure | Demonstration of the feasibility of climate-change adapted transportation infrastructure. | 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 |
| 3.11.4.10 | Improved public relations | Manufacturing acceptance of necessary actions and dissemination of knowledge on the subject of adaptation to climate change in the transport sector. | NGOs, NPOs, federal and state governments, municipalities, schools, universities, interest groups, the media, individuals |
| 3.11.4.11 | Training and further education on adaptation to the consequences of climate change in the area of transportation infrastructure | Advancement of knowledge on adaptation to the effects of climate change through the inclusion of relevant information in training and further education. | Federal government, training and further education institutions, interest groups (chambers) |

# Spatial Planning

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.12.4.1 | Development and provision of practice-relevant data and information bases, awareness-raising, and improved networking of actors | Generation, deployment, and transfer of improved spatial planning-relevant knowledge on climate impacts that is useful and useable in spatial planning decision-making processes;<br>Increasing the willingness and ability to act among spatial planning actors and affected citizens in coping with climate change. | Federal government, ÖROK, state governments, municipalities, interest groups, research institutions, planners |
| 3.12.4.2 | Establishment and protection of flood retention and drainage zones and clear regulation of zoning prohibitions and restrictions | Protection of residential areas from floods by securing and recovering natural flood plains and water retention areas;<br>Improvement of water retention in the catchment areas of rivers;<br>Protection from flood-related damage by reducing peak flows and slowing flood waves. | ÖROK, state governments, municipalities, planners, water protection management, Torrent and Avalanche Control |
| 3.12.4.3 | Increased legal interconnections between zoning and hazard mapping | Protection of residential areas and infrastructure from natural hazards;<br>Reservation of areas threatened by natural hazards through prohibition of construction and usage involving high damage potential;<br>Ensuring proactive hazard prevention. | ÖROK, state governments, municipalities, planners, water protection management, Torrent and Avalanche Control |
| 3.12.4.4 | Regulations for the management of existing zoning and buildings in hazard zones | Lowering the damage potential of natural hazard events;<br>Ensuring proactive hazard prevention. | State governments, municipalities, Torrent and Avalanche Control (in an expert and advisory role in individual approvals) |
| 3.12.4.5 | Promotion of inter-municipal cooperation | Protection of large-scale “solidarity” areas for flood retention and hazard prevention;<br>Introduction of compensation mechanisms and risk transfer models of between municipalities or bodies under public law according to the Water Rights Act WRG (e.g., water cooperatives/water boards) for the compensation of mutual land use between upstream and downstream communities. | Federal and state governments, municipalities, planners |
| 3.12.4.6 | Protection of fresh/cold air production areas, ventilation paths, and “green” and “blue” infrastructure within residential areas | Improvement in microclimates in densely built areas, prevention of overheating and heat-island effects, and compensation for increased bioclimatic stress on human health;<br>Ensuring fresh/cold air supply in densely built areas;<br>Overarching goal is the prevention of heat-related health risks. | State governments, municipalities, planners, nature conservation (at the state level), research (especially meteorology/microclimatology) |
| 3.12.4.7 | Review and (if necessary) adjustment of bioclimatic measures in development plans | Improvement of microclimates in densely populated areas, prevention of overheating and heat-island effects, and compensation for increased bioclimatic stress on human health;<br>Prevention of heat-related health risks. | Municipalities, planners, urban planning, research (especially meteorology/microclimatology) |

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.12.4.8 | Increased protection of water resources and improved integration of spatial planning, water management planning, and usage with water demand | Protection of groundwater and drinking-water resources and support for groundwater recharge;<br>Guarantee of quantitative and qualitative water supply security. | State governments, municipalities, planners, water management, agriculture, industry, energy industry, tourism |
| 3.12.4.9 | Increased protection of ecologically important open spaces (non-fragmented natural areas, habitat corridors, biotope networks) and minimization of further habitat fragmentation | Maintenance and improvement of a functional (even under changing natural conditions) network of protected areas and habitats for animal and plant species;<br>Establishment and maintenance of non-fragmented areas of retreat for animal and plant species and prevention of further habitat fragmentation. | ÖROK, state governments, municipalities, planners, nature conservation (at the state level), transportation and infrastructure planning |
| 3.12.4.10 | Increased cooperation between spatial planning and tourism to promote a climate change-adapted, sustainable tourist infrastructure | Securing and supporting sustainable and climate change-adapted spatial development in tourism. | ÖROK, state governments, municipalities, planners (tourism planning, regional development: BMWFJ, state governments, tourism associations, regions, municipalities, Torrent and Avalanche Control) |
| 3.12.4.11 | Promotion of energy-efficient spatial structures | Strengthening the spatial dimension of the energy system;<br>Reducing energy consumption and improving energy efficiency;<br>Improved achievement of climate change mitigation objectives through reduction in greenhouse gas emissions;<br>Increasing the contribution of renewable energy sources in the regional fulfilment of energy demand. | Federal government, ÖROK, state governments, municipalities, planners, energy suppliers, energy agencies, energy institutes, regional associations, regional management |
| 3.12.4.12 | “Climate-proofing” of spatial plans and instruments | Ensuring the resilience and adaptive capacity of plans, programmes, and development concepts to the current and future effects of climate change;<br>Systematic consideration of potential consequences of climate change in future spatial development strategies, spatial plans, and planning processes. | BMLFUW, ÖROK, state governments, municipalities, planners |
| 3.12.4.13 | Promotion of quantitative soil protection | Consideration of soil functions in spatial planning procedures to ensure the ecosystem services of the soil. | Federal and state governments, municipalities, ÖROK, b4 Corporate Soil Competence (AGES, Environment Agency Austria, BFW, BAW), academic and non-academic research institutions, spatial planners |

## Business/Industry

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.13.4.1 | Protection of supply, transportation networks, and production through differentiated supply networks, regional clusters, and production close to the market | 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;<br>Reducing the risk of failure and/or fluctuations in price/amount (availability) in the supply chain through the regionalization of sub-supplier relationships;<br>Securing the transportation routes in the supply and distribution networks, reducing the risk of interruptions along the transportation network, ensuring the quality, e.g., of agricultural products or food. | Companies, federal and state governments (food safety authorities), AGES, municipalities |
| 3.13.4.2 | Protection of delivery and production through long-term contracts and expansion of inventory | Maintenance of processes of freight flow along the value chain through long-term contracts and the extension of existing contracts, reducing the risk of losses, e.g., of agricultural delivery products, ensuring the quality of agricultural advance services;<br>Reducing the risk of failure and/or fluctuations in price/amount (availability) in the supply chain by expanding inventory and avoiding supply shortages. | Companies, federal government |
| 3.13.4.3 | Measures to increase the resilience of production, sales, and operational infrastructure | Maintenance of the production process, ensuring adequate conditions of storage, preventing quality deterioration due to impaired storage, functional logistics in 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). | Companies, federal and state governments, municipalities |
| 3.13.4.4 | Increasing the security of energy supply through the promotion of alternative/ energy-efficient technologies | Increasing the security of energy supply through the increased use of renewable energy, diversification of energy sources, further development of heat and power cogeneration, network expansion, operational energy production, and measures to increase efficiency. | Companies, federal and state governments, energy industry |
| 3.13.4.5 | Development of climate-friendly and adaptation-fostering products | Increasing adaptive capacity with the help of innovative products. | Companies (supply- and demand-side), public sector (demand-side) |
| 3.13.4.6 | Adequate future scenario-based risk assessment, cooperation with R&D, monitoring of scientific results | Development of new risk assessment methods for the insurance industry taking climate scenarios into account; improved basis for risk assessment for companies. | Insurance companies, academic and non-academic research institutions |
| 3.13.4.7 | Public awareness-raising to prevent damages and reinforce the individual responsibility of the insured | Awareness-raising regarding potential damages as a contributing factor in their reduction. | Insurance companies, public institutions |
| 3.13.4.8 | Better risk diversification for insurers, thereby increasing the insurability of climate- and weather-induced damages | Introduction of a combined fire and natural hazard insurance for extended risk diversification. | Insurance companies, federal government |
| 3.13.4.9 | Provision of services to clients after damage claims | Assistance in managing and repairing damages as a contributing factor in limiting consequential damages. | Insurance companies, other service providers |

## Cities – Urban Green and Open Spaces

| Nr. | Title | Objective | Key Actors |
|---|---|---|---|
| 3.14.4.1 | Adaptation of the water management strategy for green and open spaces | Ensuring the water supply and retention functions of green and open spaces under changing climatic conditions. | Municipal departments, parks departments, water suppliers |
| 3.14.4.2 | Adaptation of soil management in urban green and open spaces | Maintenance of soil functions, especially their water storage and water filtration functions. | State governments, municipal departments, parks departments, planners, individuals |
| 3.14.4.3 | Conservation and promotion of biodiversity in urban green and open spaces | Maintenance of ecosystem services and species diversity in urban green and open spaces. | BMLFUW, state governments, municipal departments, parks departments, planners, urban planning, spatial planning, garden centres, horticulture |
| 3.14.4.4 | Adaptation of planning strategies for urban green and open spaces | Consideration of climate change in urban planning instruments. | State governments, municipal departments, urban development and planning, parks departments, spatial planning, planners, micrometeorologists |
| 3.14.4.5 | Adaptation of open space planning and maintenance | Consideration of climate change in the design, implementation, and maintenance of urban green and open spaces. | Municipal departments, parks departments, planners, micrometeorologists |
| 3.14.4.6 | Promotion and adaptation of green and open spaces for recreation and leisure uses under changing climatic 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). | Municipal departments, parks departments, planners, micrometeorologists |
| 3.14.4.7 | Awareness-raising, improved networking, and adaptation of the training and further education of actors (public and private) | Advancement of knowledge and improvement of networking among affected actors. | City administrations, Association of Austrian Cities and Towns |
| 3.14.4.8 | Improvement of the knowledge base through inter- and transdisciplinary research on urban green and open spaces | For the purpose of adapting urban green and open spaces to climate change, issues must be explored at various levels and prepared in an interdisciplinary fashion for implementation. | Federal government (research programmes), academic and non-academic research institutions, city administrations, planners, micrometeorologists |

# Resource Requirements in the Course of Adaptation to Climate

# 16 Resource Requirements in the Course of Adaptation to Climate Change

Even though no reliable conclusions can yet be drawn regarding the costs of adaptation, as more specific information is required, it can be assumed that the costs of action for coping with climate change (including climate change mitigation and adaptation measures) will be much lower than the medium- to long-term costs of inaction (EC 2009a).

Currently, national and international studies (especially at the EU level) are working intensively to develop a method for presenting the net adaptation costs. A screening of strategy documents of other European and non-European countries clearly indicates that thus far no reliable information on the resource requirements of adaptation is possible.

Available adaptation strategies of countries such as Belgium, Finland, Germany, and France make only general statements and identify at most the costs for specific programmes whose implementation has already been approved and budgeted.

Economic analysis can contribute substantial arguments to the discussion of priorities within the adaptation process and to the consideration of possible measures. The particular challenge here is that not the absolute figures or costs are directly relevant, but rather calculations that take the following factors (among others) into account:

- Activities that are initiated without a direct reference to climate change adaptation, nevertheless contribute to adaptation;
- Potential damage costs or economically assessable benefits resulting from climate change that would/could take place without timely countermeasures;
- Additional benefits of adaptation measures.

Studies and research projects that address this topic should therefore choose an integrated, cross-sectoral, and holistic approach, by which the environmental costs caused by the deterioration of physical and biological systems are internalized. This is currently being pursued intensively in international research.

A scientific study of the rough first estimate of the costs of inaction for Austria will be commissioned in the next few months. For more details, see Chapter 17: Outlook and Further Steps.

No direct normative measures are connected as yet to the current Austrian adaptation strategy, and therefore the provisions of § 14 BHG regarding the presentation of the financial implications of these measures do not apply. However, the discussion of this topic deserves greater attention and will be addressed in a stepwise approach (see Chapter 17: Outlook and Further Steps).

## Resource Requirements in the Course of Adaptation to Climate Change

In general, the following premises apply for the implementation of the Austrian adaptation strategy:

- **The implementation of the recommendations must be achieved within the existing jurisdictions of all governmental authorities (federal, state, local).**
- **All recommendations listed in the adaptation strategy are to be covered by the resources available in the applicable financial frameworks of the public sector (federal, state, local).**
- **The costs of implementing the recommendations are to be covered by prioritization and shifting within the available budget. In many cases, implementation of the recommendations will require the cooperation of various actors in the public sector (federal, state, local) and the private sector. To ensure fair burden-sharing, cooperation within the public sector and between the public and private sectors is recommendable and meaningful.**

# Outlook and Further Steps

# 17 Outlook and Further Steps

In the coming years and decades, Austria will gradually have to adapt to climate change. The present adaptation strategy provides an appropriate framework for this process. For its successful implementation, the best possible cooperation between all actors concerned will be essential. The development of the national adaptation strategy was therefore designed from the outset as an iterative process in which all interested parties at the national and federal state levels, interest groups, NGOs, and other institutions challenged with the implementation were intensively involved. Information, dialogue, and participation were characteristic of the path to the national adaptation strategy.

Adaptation to climate change is a process that must begin immediately but will extend over long time horizons. Continuous improvement in the state of knowledge and experience with implementation are the basis for constant learning and the prerequisite for a successful further progress.

A particular challenge in the process that seeks to move from strategic considerations to concrete implementation is its high level of complexity, arising from the variety of concerned parties, decision-making levels, cross-cutting interactions, and dependencies, and the multiplicity of key actors.

Unlike the field of climate change mitigation, for which a clear target for reducing the emission of greenhouse gasses serves as the focal point, adaptation to the consequences of climate change sets out to achieve a long-term objective that is more difficult to define and can only be qualitatively described: to reduce the vulnerability of natural, social, and economic systems, to maintain or increase their adaptive capacity, and to make most use of any new opportunities that may arise.

**It proves essential that the potential consequences of climate change are taken into account in all relevant future planning and decision-making processes from the national to the local level, by the competent authorities, in the private sector, and by individuals.**

The White Paper on Adapting to Climate Change (EC 2009a) suggests (among other proposals) for the EU level to incorporate aspects of adaptation to climate change into all relevant policy areas (so-called “mainstreaming”). In the EU Adaptation Strategy currently under development, consideration of climate change adaptation in all relevant EU policies constitutes a major focus.

The “Assessment of the Current State of Adaptation to Climate Change in Austria” (Gingrich et al. 2008) indicates that numerous activities related to adaptation to climate change have already been reactively set. This study also shows that a number of other currently ongoing activities and measures primarily triggered by other motivations are also reasonable and necessary from the perspective of adaptation.

From this perspective, an analysis of existing instruments at the federal level (e.g., laws, regulations, guidelines, strategies, support programmes) is currently underway in order to investigate on how they already contribute in one form or another to climate change adaptation (“**Climate Proofing**”).

By identification of the anchor points for adaptation in the respective regulations, synergies in implementation can be best used and potential conflicts can be defused in advance.

In the 14 areas for action listed in the Action Plan, only a few instruments are currently in place that directly and sufficiently address the effects of climate change.

Nevertheless, several current strategies, regulations, guidelines, support programmes, etc., exhibit goals or sub-goals that can be easily reconciled with those of the Austrian adaptation strategy.

Thus, valuable information and data bases are already provided through the implementation of existing instruments (e.g., forestry law, forest inventories) which serves as an important basis for adaptation to climate change.

In many areas, activities and measures are foreseen that seem suitable to support climate change adaptation, either in their current state or with slight modifications. Incorporating aspects relevant to adaptation in these existing instruments could have a significant impact and reduce the costs of adaptation.

In conclusion, based on the available interim results, it can be stated that many starting points exist upon which efforts can be built in terms of preparing for future climate changes.

In accordance with the precautionary principle, it is generally recommended that all relevant instruments should take aspects of climate change into account. This process will extend over a long time horizon, as it depends on the networking and cooperation of all participating actors.

Detailed estimates about the financial contribution that can be attributed to the issue of climate change adaptation within the frame of existing provisions cannot be made yet. A number of measures that support adaptation independent of their primary objective are currently being implemented in budgets and funding programmes. In the absence of appropriate methods, even in a comprehensive detailed analysis, “filtering out” the proportion of costs attributable to adaptation is currently hardly possible.

However, this issue will continue to be considered of great importance, requiring the development of scientifically sound approaches.

Through the support of research activities, the federal government seeks to strengthen the scientific data bases of its climate change adaptation strategy in order to ensure its successful implementation. Research programmes such as StartClim (*www.austroclim.at/startclim*) and ACRP (Austrian Climate Research Programme) of the Climate and Energy Fund (*http://www.klimafonds.gv.at/foerderungen/aktuelle-foerderungen/2011/austrian-climate-research-program/)* will represent an essential part of this effort. In this regard, ACRP will also play a supporting role in terms of monitoring and implementation research.

It is also envisaged to enhance coordination with the Climate Change Centre Austria (CCCA), founded in June 2011 as a coordinating body for the promotion of climate research in Austria. To this end, by establishing good contact between science and politics, new research results will be made immediately available for concrete environmental policy decisions.

Adaptation to climate change is a long-term effort; however, it requires immediate action. It must also be based on the most up-to-date scientific knowledge. In the overall coordination of the process by the *Lebensministerium*, the following issues will be in the focus for detailed examination:

### 1. Scientific-Economic Evaluation of the Consequences of Climate Change in Austria

Award of a study still in 2012 for a first rough estimate of the "costs of inaction" that can be expected due to climate change in Austria.

To be surveyed/estimated are the potential damage costs and possibly also the economically evaluable benefits due to climate change that will be incurred if no further consistent and active adaptation to climate change is implemented ("business as usual" scenario in climate change adaptation). An important aspect here is that a scientifically sound economic evaluation of the damage scenarios is possible.

The project is to be conducted with the participation of international partners who already have expertise in this topic (e.g., Germany, the Scandinavian countries, United Kingdom). International "good practices" would be the qualitative minimum standard applied (see the first proposals of the "Stern Report").

The tender for the project took place on 3 May 2012 within the 5th call of the ACRP (Austrian Climate Research Programme) of the Climate and Energy Fund.

Main findings of the study should be available by December 2013 at the latest.

### 2. Criteria catalogue

Closely related to the above issue is the development of a criteria catalogue that will allow evaluation and a clear demonstration of the implementation success of the Austrian adaptation strategy. A pragmatic and easy to apply evaluation tool for the estimation/assessment of the status quo in climate change adaptation in the defined areas for action will be designed (on the basis of international experiences). This criteria catalogue will also contribute to further clarify the objectives of each respective recommendation.

Main findings will be available in September 2013.

### 3. Estimation of Adaptation Costs

Award of a study to estimate the resource requirements of each area for action under the Austrian adaptation strategy on the basis of a scientifically sound assessment.

This study shall preferably take into consideration the following aspects:

- Activities that are implemented without direct reference to climate change adaptation, but nevertheless contribute to adaptation; can one directly attribute a part of their effect to climate change?
- Additional benefits of adaptation measures (additional synergistic effects related to objectives other than climate change)
- Temporal dimension of adaptation measures (e.g., costs in relation to the timing of interventions)
- Holistic approach (in many areas, aspects of climate change adaptation can be integrated into existing regulatory and private-law provisions (or those currently under development or in revision) without causing any additional financial demands. Further synergies exist between various measures in one area for action or between measures in different areas for action, such that costs can be kept lower in total.)

Main findings will be available in June 2015.

### 4. Social Aspects of Climate Change

Transdisciplinary research on the social effects of climate change and adaptation measures.

Adaptation is a dynamic process; as such, progress in adaptation should be regularly evaluated. Measuring success is essential in assessing the effectiveness of the strategy. This will be accomplished by regular reporting on ongoing activities in each area for action. The overall process will be managed and coordinated by the *Lebensministerium*.

- A first **Implementation Report** including a clear description of the state of implementation of the Austrian adaptation strategy will be presented and published by the *Lebensministerium* by the end of 2014.
- This report will based on a systematic survey among the ministries concerned, the federal states, and the Association of Towns and Municipalities, using the evaluation tools described under item 2 above. By means of a questionnaire/digital tools, the state of implementation in the various areas for action shall become apparent in concrete terms.

Future reporting is envisaged on a three-year cycle.

The submission of the implementation report at the end of 2014 makes an intentional connection to the Fifth Assessment Report of the IPCC (Intergovernmental Panel on Climate Change). The Synthesis Report of the IPCC will be published in October 2014. The results revealed in this report will also be highly significant for the adaptation strategy in Austria.

In addition, by 2014 at the latest, an “Assessment Report” focused on Austria on the topic of climate change (APCC) will be released by the CCCA (Climate Change Centre Austria), providing concrete contributions for discussion.

The current Austrian adaptation strategy is the **first political milestone in addressing the consequences of climate change**. However, the document must be further developed on a regular basis to reflect the growth in knowledge and factual needs. **In a certain sense, the Austrian adaptation strategy should therefore also be regarded as a “living document”.**

The further evolution of the adaptation strategy will in any case incorporate new scientific/practical insights, such as regards the vulnerability of each area for action.

A first updated version of the Austrian adaptation strategy is envisaged for the end of 2015.

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