StartClim2014

Contributions to the Implementation of the Austrian Adaptation Strategy

Final Report

October 2015

MINISTERIUM
FÜR EIN
LEBENSWERTES
ÖSTERREICH

bmwfw
Bundesministerium für
Wissenschaft, Forschung und Wirtschaft

ÖSTERREICHISCHE
BUNDESFORSTE

LAND
OBERÖSTERREICH

umweltbundesamt
PERSPEKTIVEN FÜR UMWELT & GESELLSCHAFT

StartClim2014

Contributions to the Implementation of the Austrian Adaptation Strategy

Final Report

Project Leader

Institute of Meteorology
Department of Water - Atmosphere - Environment
BOKU - University of Natural Resources and Life Sciences, Vienna
Univ.-Prof. Dr. Helga Kromp-Kolb

Contracting Parties

Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management
Austrian Federal Ministry of Science, Research and Economy
Federal State of Upper Austria
Austrian Federal Forests
Federal Environment Agency

Administrative Coordination

Federal Environment Agency

Vienna, October 2015

StartClim2014
„Contributions to the Implementation of the Austrian Adaptation Strategy“

Project Leader

Institute of Meteorology
Department of Water - Atmosphere - Environment
BOKU - University of Natural Resources and Life Sciences, Vienna
Peter Jordan Straße 82, 1190 Vienna
URL: http://www.startclim.at/
http://www.wau.boku.ac.at/met.html

Editors

Helga Kromp-Kolb and Benedikt Becsi
Institute of Meteorology
Department of Water - Atmosphere - Environment
BOKU - University of Natural Resources and Life Sciences, Vienna

Vienna, October 2015

Contributions to StartClim2014

StartClim2014.A: SNORRE - Screening of remarkable weather
Zentralanstalt für Meteorologie und Geodynamik (ZAMG): Christoph Matulla, Brigitta Hollosi
Federal Environment Agency: Maria Balas

StartClim2014.B: Developing a method for assessing climate change effects on productivity and animal welfare as well as adaptation potential of livestock husbandry
Institute of Livestock Sciences, BOKU: Stefan Hörtenhuber, Werner Zollitsch

StartClim2014.C: Effects of ambient temperature on performance and health traits in dairy cattle when considering husbandry factors
Institute of Livestock Sciences, BOKU: Birgit Fürst-Waltl, Verena Auer
ZuchtData EDV-Dienstleistungen GmbH: Christa Egger-Danner, Franz Steininger
Institute of Meteorology, BOKU: Herbert Formayer, David Leidinger
Höhere Bundeslehr- und Forschungsanstalt für Landwirtschaft Raumberg-Gumpenstein: Elfriede Ofner-Schröck, Eduard Zentner
LKV Austria: Karl Zottl

StartClim2014.D: On the importance of climate change for nutrition and diseases of alpine game
Gesellschaft für Wildtier und Lebensraum (GWL): Armin Deutz, Gunther Greßmann
Höhere Bundeslehr- und Forschungsanstalt für Landwirtschaft Raumberg-Gumpenstein: Thomas Guggenberger, Albin Blaschka

StartClim2014.E: Weather-independent tourism offers based on Nature experience offers - relevance and innovative development options
Institute of Landscape Development, Recreation and Conservation Planning, BOKU: Ulrike Pröbstl-Haider, Verena Melzer

StartClim2014.F: permAT – Long-term monitoring of permafrost and periglacial processes and its role for natural hazard prevention: Possible strategies for Austria
Department of Geography and Regional Science, University of Graz: Andreas Kellerer-Pirklbauer, Christoph Gitschthaler, Michael Avian
Zentralanstalt für Meteorologie und Geodynamik (ZAMG): Annett Bartsch, Stefan Reisenhofer, Gernot Weyss, Claudia Riedl

Scientific Lead and Coordination

Institute of Meteorology
Department of Water - Atmosphere - Environment
BOKU - University of Natural Resources and Life Sciences, Vienna
Univ. Prof. Dr. Helga Kromp-Kolb, Dipl.-Ing. Benedikt Becsi

Scientific Board

Dr. Jill Jäger, Independent Scholar and Guest Professor at BOKU

Prof. Dr. Hartmut Graßl, Max Planck Institute for Meteorology, University of Hamburg

Dr. Roland Hohmann, Federal Office for the Environment FOEN, Switzerland

Coordinating Group

Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management

Elfriede Fuhrmann, Helmut Hojesky, Birgit Kaiserreiner, Michael Keller, Barbara Kronberger-Kießwetter, Andreas Pichler, Drago Pleschko, Florian Rudolf-Miklau, Heinz Stiefelmeyer, Ruth-Maria Wallner

Austrian Federal Ministry of Science, Research and Economy

Ingrid Elue, Gudrun Henn, David Rezac-Kowald, Christian Smoliner, Monika Wallergraber

Austrian Federal Forests

Monika Kanzian, Norbert Putzgruber

Federal State of Upper Austria

Andreas Drack

Federal Environment Agency

Maria Balas, Karl Kienzl, Sabine McCallum

Administrative Project Coordination

Umweltbundesamt
Maria Balas, Lukas Strahlhofer

Table of Contents

Abstract

StartClim has been studying the topic of adaptation to climate change since 2008. The projects in StartClim2014 addressed various research questions and provided scientific support for implementation of the Austrian Adaptation Strategy. Two projects developed concepts for systematic acquisition of data that is either not available at all or not in an appropriately accessible form but would be crucial for the implementation of climate change adaptation measures. One project examined weather-independent tourism, and three investigated animal health and climate change adaptation in the context of livestock husbandry and Alpine game.

Extreme events like heavy precipitation, hail, storms or black ice with the potential to cause disasters occur every year. Large-scale catastrophes naturally attract much more attention than small-scale ones. The actors in the rescue chain, however, document all operations at the same high level, regardless of the scale of the natural disaster. Some organisations also make their documentation available on the Internet. Resource scheduling and awareness-raising depend directly on the quality of this documentation, which also helps in the identification of optimisation potential.

Together with Austrian organisations responsible for public protection, one StartClim2014 project devised a concept for improving the documentation, analysis and evaluation of the rescue chain in response to small-scale extreme weather events and the collation of the data on the events and the damage caused by them obtained by the individual rescue, aid and research organisations (RAR platform). The synergies and added value introduced by this project is perhaps best seen from a bird's-eye perspective in the form of a chain, in which each link represents a single stakeholder. At the moment each link acts independently, collecting data, gaining expertise and working hard to improve its performance. The concept presented joins these links and permits analysis along the entire chain. Connections are established, information flows back and forth, up and down between organisations. The concept facilitates the exchange of experiences, ideas are easily shared, and improvements can be made by comparing related processes along the chain. Problems can be viewed from many perspectives and solutions identified jointly. The willingness of the stakeholders and decision makers to put the concept into practice and the commitment of the involved organisations are encouraging.

Around 2.5 per cent of Austria consists of permanently frozen ground overlain by a seasonally unfrozen layer (i.e. active layer). These regions are called permafrost areas. A further 1.5 per cent of Austria is affected by deep seasonal frost, which has a similar impact on weathering processes.

Permafrost and associated processes directly or indirectly concern twenty-three ski resorts, thirty-one reservoirs and forty-two mountain huts. Ground stability and thus infrastructure (dams, supports, buildings) can be affected by temperature increase due to climate change. There are also substantial impacts on hydrology. The modification of permafrost-affected regions is therefore of economic and ecological importance. A range of institutions, including several Austrian universities, national and regional geological surveys, the Austrian torrent and avalanche control agency, and various Alpine clubs, are interested in systematic permafrost monitoring. To date, no coordinated monitoring network has been established at the national level, and there is no strategy for long-term observation. This impedes the evaluation of the existing sparsely distributed measurements and the development of an understanding of underlying processes.

An analysis of the current situation and discussion with stakeholders indicate that the number of monitoring sites should be increased. Temperature measurements in deep boreholes and shallow ones close to the surface, geophysical surveys and ground movement measurements (rock glaciers, instable rock faces) are required, along with spatially continuous observation of surface movements by remote sensing. Demand is highest in Tyrol as a whole, the district of Zell am See and southeastern Vorarlberg. A minimum investment of 1.5 million euros is required to achieve a similar representativity as in Switzerland, taking synergies with ZAMG and HZB stations, Alpine huts and the skiing infrastructure into account. As in Switzerland, financial support could come from a combination of industrial and public-sector research partners.

The diverse natural and cultural landscapes in Austria offer great potential for a wide range of nature-based and nature-experience-based touristic offers. Current research results confirm that there is considerable interest by tourists in nature experience offers. Adaptation strategies need to be considered to reduce dependence on specific weather conditions as a result of climate change.

A project within StartClim2014 has examined the current situation regarding weather-independent nature experience offers in Austria. First, the term 'weather-independent nature experience offers' was defined. The inclusion criteria were availability to visitors for at least eight months a year (including those available for less time but extendible to eight months) as well as a local landscape reference, and appeal to a broad target audience. A total of 236 offers by 118 different providers were surveyed. The most offers were found in Styria, followed by Lower Austria and Burgenland.

Discussion of offers and their relevance for touristic development with representatives of the Österreichische Hoteliervereinigung (Austrian Hotel Association) revealed that their adaptation for all-year tourism can be successful only if criteria such as authenticity, the 'staging' of the touristic experience, professionalism and cooperation are met. In other words, offers must have an authentic and well-thought-out setting in order to be well received. A professional service is necessary to guarantee the quality of the offers to allow them to be appropriately promoted. Furthermore, cooperation with regional partners is essential so as to embed the offers within the region, and also to allow the design of individual packages combining e.g. a hike with a tasting and overnight stay.

Agricultural animal husbandry, including feed production, is directly affected by climate change. So far, considerations on the adaptation of livestock production systems (PS) to climate change impacts (CCI) have mostly focussed on policy advice or have been reduced to the technical adjustment of housing systems. There are still no useful concepts for assessing individual farms in terms of their sensitivity to CCI that take into account the multiple relationships between the various PS elements.

The aim of one StartClim2014 project was to provide a method for assessing the susceptibility and the resistance of livestock farms to CCI that addressed the overall PS complexity. Based on a system analysis and on literature it was shown that the influence of CCI on productivity, animal welfare and animal health depends on a number of factors, which can be used to adjust the PS (e.g. genetic potential of fodder plants and animals, securing access to land for fodder production and to the supply infrastructure with key factors such as water or energy). The method for evaluating sensitivity to CCI is based on ten criteria with a total of sixty-three indicators. Two model farms and four active dairy and pig farms were evaluated.

In all farms, the yield stability of fodder plants and soil protection were the most vulnerable to CCI. The other critical aspects varied depending on the farm. A comparison of these results

with climate data for future scenarios underlines the need for long-term adjustment of livestock farms that have not yet taken action in this respect.

Prolonged periods of high ambient temperatures, particularly in connection with high humidity, not only affect the farms' production resources but may also have a direct impact on dairy cows. Rising ambient temperatures result in problems with regard to the regulation of the internal body temperature, as the cows' ability to dissipate body heat is reduced. This may even be the case at temperatures just above 20 °C. In high-yielding cows this effect is additionally enhanced owing to higher metabolic activity.

Building and husbandry measures in dairy farms may alleviate the negative effect of high ambient temperature and humidity. Based on a questionnaire, data on specific building and husbandry aspects were collected in 150 Austrian dairy farms. The data were merged with performance data from the central cattle database and meteorological data. The effect of high ambient temperature on dairy performance and udder health was analysed with account taken of different husbandry factors. Additionally, indoor and outdoor temperature and humidity were measured in selected farms.

Results revealed deteriorating effects of high ambient temperatures on dairy performance, while udder health was only negatively affected in certain husbandry systems. Generally, the effect of ambient temperature depends on the husbandry system. In view of the anticipated increase in days with high ambient temperature, the results illustrate the need to reduce heat stress in dairy cows in some husbandry systems.

During the last decades, wild game in the Alpine region has been confronted by changing site conditions and pathogenic organisms. A StartClim2014 project studied the impact of climate change on disease and parasitosis in Alpine wild game, and on fodder and pasture quality, plant phenology and ibex horn growth.

The first part of the project established the current disease situation in wild game in the Austrian Alpine region as a baseline value for the estimation of future developments. Recent project results have already revealed a clear increase in parasitic diseases at altitudes above 2,500 m.

The second part of the project showed that the vegetation period in inner Alpine valleys starts three to four days earlier per decade. This results in nutritional and physiological problems for young animals, as they are not able to digest plants with higher raw fibre content as efficiently as adults are. Consequently, physical development is handicapped and the young animals are prone to disease. Additionally, the composition of plant communities is changing in the different altitudinal belts.

In the third part, the influence of climatic changes on the growth of ibex horns was studied. As the start of horn growth is coupled with the start of the vegetation period and most of the yearly increase occurs between May and June, development is stimulated by humid, mild conditions in spring and hindered by an early hot summer. Each horn growth segment thus mirrors the weather conditions. Long-term horn measurements could function as a bio-indicator for changes in climatic conditions in mountainous areas.

An interdisciplinary workshop discussed the many possibilities for adaptation. The main issues from an agricultural point of view are the date of turning out and returning to/from the Alpine pastures, worming of livestock, fertiliser management and subsidies. Forestry issues include clearing of shrubs and bushes, protection against damage by forest chamois and the general susceptibility of forest to damage. Members of the hunting community mentioned the sustainable management of hunting/shooting permits for chamois and ibex, early achievement of the hunting quota and regulation of red deer as the main concerns. It is evident that climate change is already having a marked influence on wild game, which will increase and involve even more severe changes.

1 The StartClim research programme

The StartClim climate research programme is a flexible instrument. Because of the short project duration and annual allocation of project topics, it can react quickly to topical aspects of climate and climate change. It is financed by a donor consortium currently consisting of nine institutions:

- Federal Ministry of Agriculture, Forestry, Environment and Water Management (since 2003)
- Federal Ministry of Health (2005, 2006, 2007)
- Federal Ministry of Science, Research and Economy (since 2003)
- Federal State of Upper Austria (since 2012)
- Austrian Federal Forests (since 2008)
- Oesterreichische Nationalbank (2003, 2004)
- Austrian Hail Insurance (2003, 2004, 2006, 2007, 2008)
- Federal Environment Agency (2003)
- Verbund AG (2004, 2007)

StartClim has been studying adaptation to climate change since 2008. Since StartClim2012, the programme's objective was to deliver valuable scientific contributions to the implementation of the Austrian National Adaptation Strategy.

The six StartClim2014 – projects examined different aspects that are relevant to climate change adaptation in Austria. The topics explored were

- screening of remarkable weather
- developing a method for assessing climate change effects on productivity and animal welfare as well as adaptation potential of livestock husbandry
- effects of ambient temperature on performance and health traits in dairy cattle under consideration of husbandry factors
- the importance of climate change for nutrition and diseases of alpine game
- relevance and innovative development options of weather-independent tourism offers based on nature experience offers
- long-term monitoring of permafrost and periglacial processes and its role for natural hazard prevention.

The StartClim2014 report consists of an overview of the results in German and English along with a separate documentation that contains detailed descriptions of the individual projects by the respective project teams. All StartClim2014 reports and documents will be available for download on the StartClim website (www.startclim.at). Furthermore, a limited number of CDs containing all StartClim reports and a folder with a short summary of the results will also be made available.

2 StartClim2014.A: SNORRE - Screening of remarkable weather

Extreme events like heavy precipitation, hail, storms and black ice occur every year and have the potential to cause disasters. Large-scale catastrophes naturally attract much more attention than small-scale ones. The actors in the rescue chain, however, document all operations at the same high level, regardless of the scale of the natural disaster. The deployment documentation and post-disaster management information are often available on the Internet. Resource scheduling and awareness-raising depend directly on the quality of this documentation, which helps in the identification of the potential for optimising equipment and personnel to permit flexible reactions to alerts and in operation.

The aim of the StartClim 2014 project was to collect information and expertise from the organisations along the rescue chain, from the weather alert to clean-up efforts, on a communication, information and data (CID) platform. As it turned out, StartClim addressed an urgent need, as the stakeholders were interested in streamlining the process chain to eliminate redundancies, avoid unnecessary reporting circuits or other duplications in individual stages and identify understaffing at critical sections.

To achieve these objectives, SNORRE carried out the following steps: (i) a thorough literature and Internet review to identify similar or related investigations both within and outside Austria and the concepts used by stakeholders and associations at the various organisational or political stages. This process resulted in an object-oriented database with attributes and more than 500 individual names from sixty-one organisations; (ii) a survey among the relevant authorities jointly developed with sociologists addressing: (a) the perception of climate change in their work; (b) their expectations regarding the collation of data from different sources, and (c) the subjective demand for a platform consolidating communication, data and information. The survey had a response rate of 65 per cent, and the outcome may therefore be considered representative. Of those polled, 75 per cent are already experiencing the effects of climate change in their regular work; 86 per cent expect a significant additional benefit for their own organisation from data originating from different sources, and 82 per cent would like to see the establishment of a CID platform, which they believe would help in the identification of optimisation potential and the exploitation of synergies. They are also willing contributing data themselves.

This commitment was also seen in the telephone interviews. The stakeholders themselves were interested in elaborating the concept, defining the functions of the analysis and visualisation tools and shaping the interface to the public. The agenda for the workshop at the ZAMG in April 2015 was established on the basis of the survey, telephone interviews and meetings. The main items discussed there were: (i) what information is most important; (ii) where such a collection of different data from various organisations in their various formats should be located; and who can provide the required technical infrastructure and supervision funds. It was decided to ask the CCCA Data Centre if it could host the database; (iii) the necessity for defining a special format for storing the data; (iv) control and organisation of access authorisation; (v) the best solution for analysing and visualising the data.

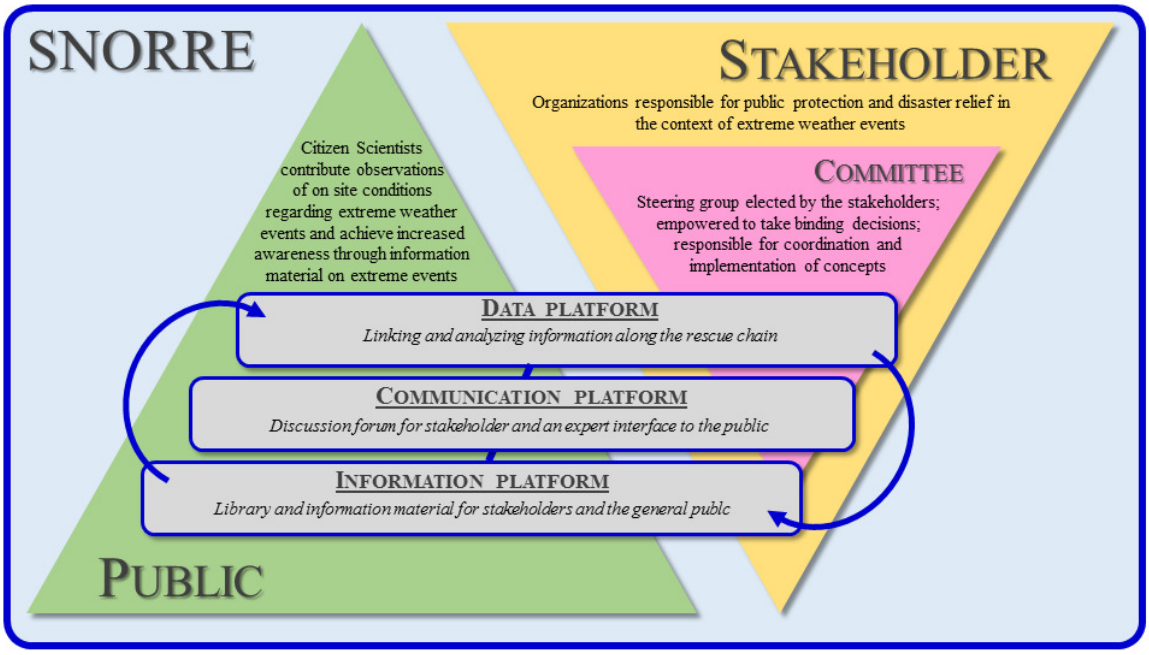

Fig. 1: The SNORRE concept generated jointly with the stakeholders

For brevity, only a few of the points raised in the discussions can be listed here. More of these topics, however, may be found in the long version of the final report. Fig. 1 sketches the main result of SNORRE, the CID platform supporting the stakeholders in overcoming disasters and protecting society, summarising the survey, discussion processes (via telephone, personal encounters, workshop) and expert advice. The platform consists of the stakeholder consortium and residents and combines them in three columns: the database platform linking and analysing information, the information platform with information for stakeholders and the general public, and the communication platform for increasing practical implementation. The stakeholders repeatedly underlined the importance of communicating information to the general public through, for example, educational campaigns in schools and universities. For many obvious reasons, students are the best target group. Heavy storm warnings using the Beaufort scale do not mean much to the general public unless they realise, for example, that garden furniture may be thrown through windows and that barbecue cutlery may turn into dangerous projectiles. Once a proper understanding has been obtained, ac-cidents and serious injuries can be avoided, which would be a significant step forward. In addition, as citizen scientists the public could contribute very important information to the stakeholders through photographs or eyewitness accounts, which would improve knowledge at the beginning of the whole rescue chain. This point is crucial, as the decisions taken at the very beginning are decisive for the success of the entire programme – solid information on the spatio-temporal conditions on site helps to gain time and improve coordination in emergencies. As such, a robust cooperative model involving the consortium and the public is of utmost importance for at least these two central reasons. This is in line with major undertakings at the European level aimed at improving rescue measures and involving the public to improve warning and response systems. In the SNORRE workshop it was suggested that these aspects be addressed through an online forum. There are several online structures of this type in other countries. The general pattern is always the same: residents submit their observations under appropriate headings, in this way providing information, for example, on the formation of local thunderstorms. With this information, decision makers can increase the effectiveness of their intervention measures. The pink triangle in Fig. 1 indicates a small group of people called the Committee representing the entire consortium and provided with necessary power to take binding decisions with account taken of the following modules: (i) communication (combining all functions needed for internal communication and issuance of warnings), (ii) information (managing reports, technical and scientific literature necessary for optimisation and information material for the public, citizen scientists), (iii) tools required for

the data analysis and visualisation of results (e.g. comparisons of present developments with long-term trends). The Committee's aim is to define the objectives for sustainable development in general and to make decisions on reconstruction or implementation of optimisation potential, procurement planning, etc.

Fig. 2: Possible design of the visualisation of extreme events investigated in SNORRE

Together with Austrian organisations responsible for public protection, SNORRE established the above concept to provide the highest possible protection against future disasters triggered by extreme weather events. It integrates the stakeholders acting along the rescue chain. The benefit introduced by SNORRE is perhaps most obviously seen from a bird's-eye perspective. Each link in the chain may be regarded as the contribution made by a single stakeholder. These links provide an effective way for organisations to collect data and acquire expertise. SNORRE joins these links and allows analysis across the chains. Connections are established, information flows back and forth, up and down between organisations; The SNORRE concept facilitates the exchange of experience regarding technical instruments, heavy devices, team performance and purchasing strategies; ideas are easily shared, and improvements can be made by comparing related processes along such rescue chains. Problems can be viewed from many perspectives and solutions jointly detected. SNORRE showed that 75 per cent of the organisations responsible for public protection have already experienced the impact of climate change on their work. Moreover, the great willingness of stakeholders and decision makers to work closely together as shown in SNORRE and the commitment of the organisations to their mission and their readiness to put the developed concept into practice are highly encouraging.

3 StartClim2014.B: Developing a method for assessing climate change effects on productivity and animal welfare as well as adaptation potential of livestock husbandry

Agriculture is one of the sectors most directly affected by climate change. The aim of this project was to develop a method taking into account both the feed supply chain and the livestock for assessing the degree of susceptibility or resistance of livestock farms to climate change impacts (CCI). This is important because climate models predict that the number of hot days will double or even triple by 2050, with another doubling by 2100 (see BOKU-Met 2015). An even clearer indication of the development of CCI is the increase in the number of days with the THI (temperature humidity index) exceeding acceptable values. The forecasted precipitation and water balances indicate a drop in rainfall and an increase in drought from 2050 to 2100, especially for arid regions (BOKU-Met 2015). This development underlines the need for adaptation of livestock production systems (PS) and thus the importance of an instrument that can be used by farmers to assess the resilience of their farms to challenges related to climate change.

A broad system analysis estimated CCI's effects on the PS productivity and animal health and welfare and analysed interactions between PS elements. Based on information from system analysis and supplemented by literature (e.g. Choptiany et al. 2014, FAO 2013, International Institute for Sustainable Development 2012, Eitzinger et al. 2009), a checklist of indicators was developed for use in identifying PS resilience to CCI. The main system elements and their relationship to the resilience to CCI of typical Austrian dairy and pig farms are shown in Fig. 3.

With regard to on-farm feed production, a number of system elements were found to be particularly important for maintaining yields in the face of adverse abiotic and biotic consequences of climate change. The use of plants with an appropriate genetic potential was found to be highly relevant. Furthermore, in the light of increasing competition, especially from construction and agro-energy businesses, securing access to land for fodder production at reasonable cost is of particular relevance.

Other important elements are an intensity of land utilisation adapted to local conditions and measures contributing to specific ecological and socio-economic resilience to CCI (see Cabell and Oelofse 2012). Examples include measures to protect biodiversity or soil and diversification of products and income sources, the use of insurance options or investments in CCI-relevant farm infrastructure. To a lesser extent, options such as the installation of water-saving irrigation systems as a buffer in dry years may be relevant for adapting to CCI. For individual farms particularly affected by CCI, customised measures could be highly relevant despite their low overall importance.

Regarding livestock, the following factors were identified as particularly important for achieving optimal productivity, high animal welfare status and favourable economic performance: safeguarding a quantitatively and qualitatively sufficient water supply and the use of (technical) measures to combat the effects of high temperatures, direct solar radiation and other environmental factors in housing systems (see Brade 2013). Management measures such as the use of health plans and prevention of CCI-related diseases have potentially high impact. Other possible options are long-term safeguarding of food supply and the genetic potential of the animals (see Hoffmann 2010). Technical options to maintain (electrical) energy supply, i.e. emergency power generators, are necessary, particularly for pigs.

Based on the scientific literature, experts' knowledge (derived from a comprehensive workshop and additional interviews with selected experts) and the above-mentioned system analysis, a checklist was developed with sixty-three indicators. These were integrated into a methodological framework which, using ten criteria, estimated the degree of resistance or susceptibility to CCI for individual farms with dairy cows or fattening pigs. Additionally, this method analysed strengths and weaknesses for the farms. Feed production indicators in-

cluded maintenance of yields, locally adapted nutrient management, irrigation or structures for greater biodiversity and more favourable evaporation conditions evaporation (hedges, etc.). Other indicators addressed tillage and erosion, the general farmland condition, home-grown feed use and storage capacities, farms' water supplies, the potential impact on the water supply of neighbouring farms and energy requirements. Apart from indicators describ-ing economic resilience, cooperation and social networking, the indicators considered were specifically related to livestock and CCI.

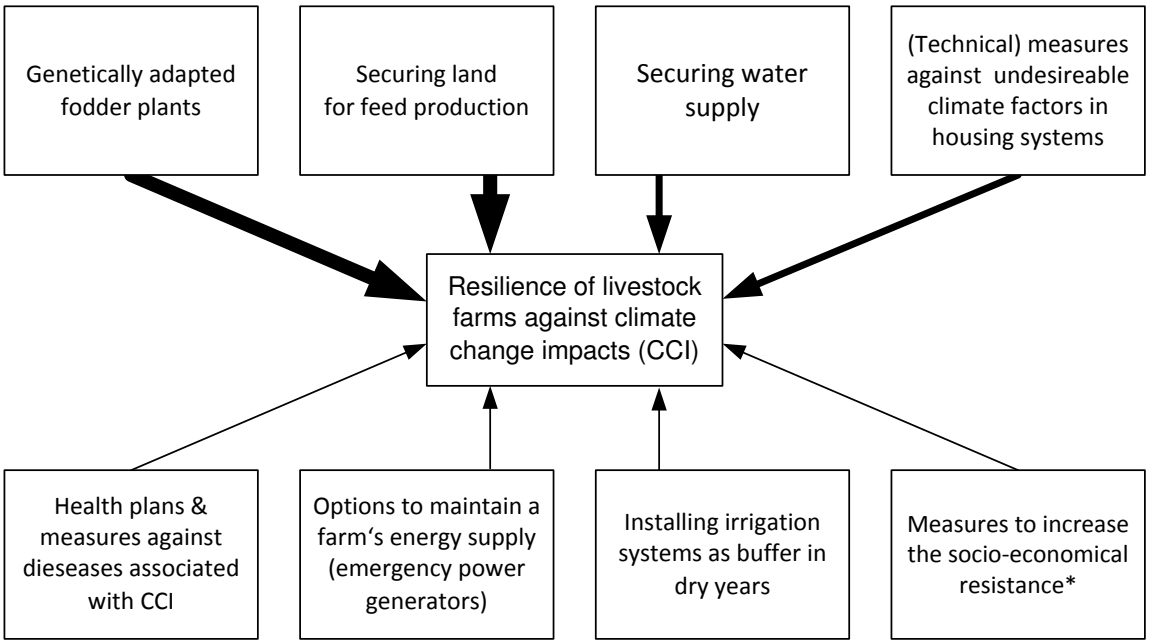

Fig. 3: The main system elements and their relationships to the resilience of typical Austrian live-stock farms (for dairy cows and fattening pigs) to CCI

Fig. 4 presents the degree of achievement of the ten project criteria by two commercial dairy farms in Austria, based on the sixty-three indicators. Criteria directly related to PS productivi-ty include stability of feed and livestock production yields and the stability of the whole farm. Another criterion describes the achievement of animal health and welfare objec-tives. Further criteria refer to resilience to CCI-related stressors, such as the protection of water resources and soils, biodiversity protection, protection and efficient use of external in-puts, profitability and liquidity, and social security.

Two model dairy farms and each two operating farms with dairy cows and fattening pigs were analysed using the this evaluation method. This allowed consideration of the subjective assessment of strengths and weaknesses by farm manager interviews.

Yield stability in feed production showed the lowest degree of achievement for all farms. For the other criteria, farms reached acceptable individual target degrees of achievement, in most cases between 60 and 80 per cent.

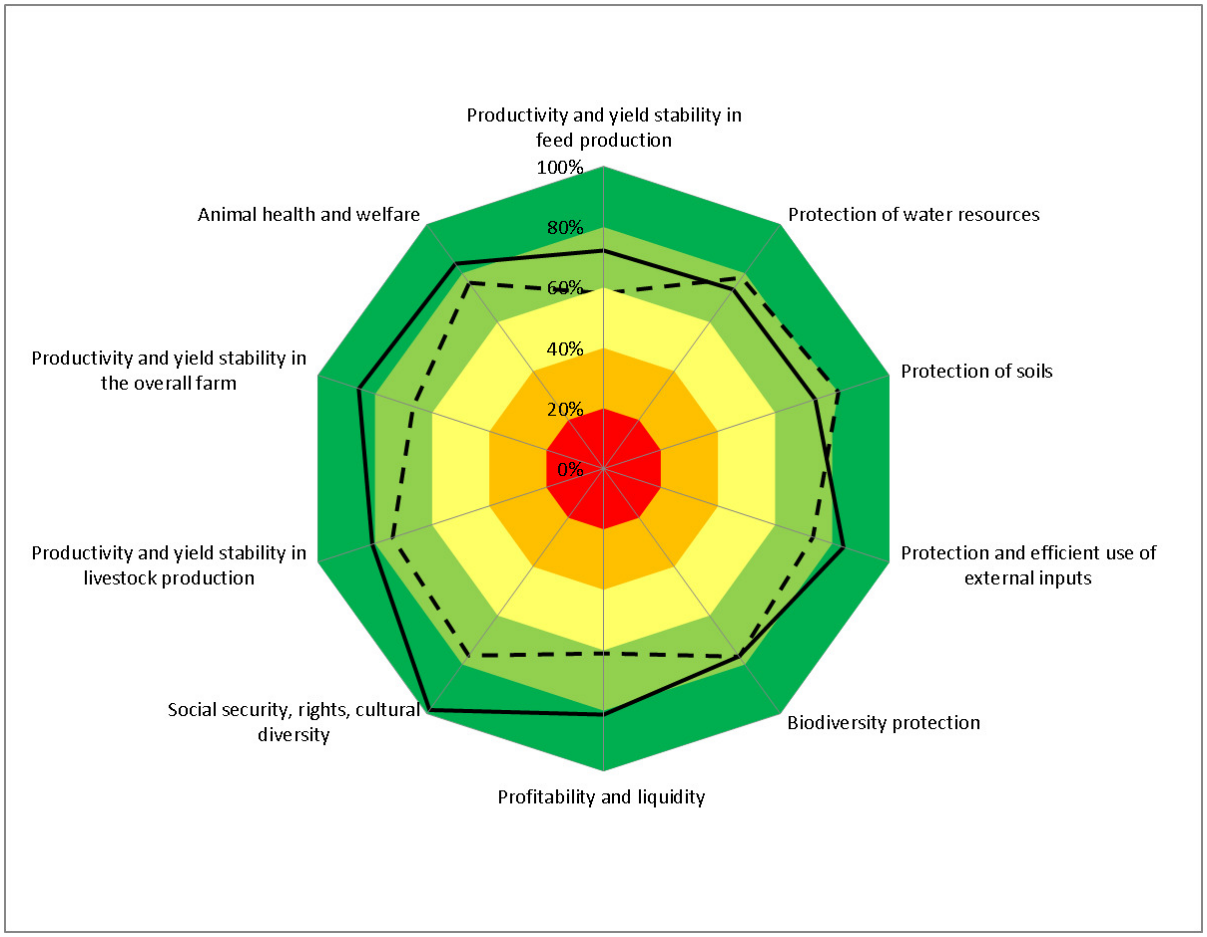

Fig. 4: Target degrees of achievement for criteria of resilience to CCI for two operating dairy farms

From this study, it can be concluded that the proposed evaluation method permits a broad assessment of climate resilience as intended by the FAO (Choptiany et al. 2014). The interest by the managers of the analysed practical farms highlights the importance of a follow-up project to further develop the method into a self-evaluation tool. The project results can be used to determine objectives and options for methodological adaptation in further investigations. In the present study, an additional analysis of climate data confirmed the results from the farm evaluation; objective climate data are therefore an important component for assessing the resilience and the need for adaptation to CCI.

4 StartClim2014.C: Effects of ambient temperature on performance and health traits in dairy cattle when considering husbandry factors

Climatic changes are expected to result in long-term changes in weather conditions in Austria and neighbouring countries. These changes are likely to include not only higher summer temperatures but also alterations in frequency and intensity of precipitation and changes in humidity, which could all affect livestock farms in Austria. Prolonged periods of high ambient temperatures, particularly in connection with high humidity, not only affect the farms' production resources but may also have a direct impact on dairy cows. Rising ambient temperatures result in problems in regulating internal body temperature as the ability to dissipate body heat is reduced. In high-yield cows this effect is enhanced owing to higher metabolic activity. These problems may already arise at temperatures from 20 °C upwards. Heat stress may not only result in decreased animal welfare but also in a reduction in milk production traits and reduced udder health. In hot regions, these relationships have already been confirmed. However, only a few studies have dealt with the effects of high temperature and humidity in temperate zones. Building and husbandry measures in dairy farms could alleviate the negative effect of high ambient temperature and humidity.

Based on 172 farms for which detailed housing information was already available from another project (Efficient Cow, Project No. 100861, www.dafne.at), data from official performance testing were selected from the Austrian central cattle database for the years 2010–2014. Further housing information was provided. Performance and housing information were merged with data from an additional questionnaire dealing with specific ventilation aspects in 150 farms and with meteorological data (INCA data set) from the Central Institute for Meteorology and Geodynamics (ZAMG).

The effect on different traits of higher temperatures (maximum temperatures and temperature-humidity index (THI) as an average of the test day and the three preceding days (TMax3 and THI3)) was analysed with and without taking account of the husbandry systems. Traits analysed were test-day milk yield, fat and protein content and somatic cell count representing udder health. Performance tests are usually performed between eight and eleven times per farm and year, resulting in a reasonably large data set of approximately 87,000 relevant test-day records. Detailed measurements were taken in eight selected farms to compare temperature and humidity inside and outside the stalls so as to show the relationship between outside and inside temperatures in the different housing systems.

A mixed model was applied for the separate analysis of the Fleckvieh (dual-purpose Simmental), Brown Swiss and Holstein breeds. Effects accounted for were farm, calving year, calving season, lactation number-age by calving classes (fixed effects), days in milk (covariate) and cow as repeated factor (random). Additionally, TMax3 or THI3 were alternatively fitted as covariates. In order to consider husbandry systems, a combined effect of housing (warm loose housing, cold loose housing, tie-stall), access to pasture (yes/no), and ventilation (free, mechanical) was defined as fixed effect. Additionally, THI3 and TMax3 were fitted as covariates within the respective husbandry systems.

Results indicated negative effects of heat stress on milk performance under temperate Austrian conditions. Regardless of the husbandry system, THI3 and TMax3 significantly affected the milk yield, fat and protein content in all three breeds. At higher THI3 and TMax3 values, milk yield decreased significantly. However, the observed decline varied between breeds. The same was observed for fat and protein content. Decreases were already observed at TMax3 of around 20 °C, with stronger declines from 26 to 28 °C and upwards. The critical THI3 values were between 55 to 75 THI points. The assumption that udder health, represented by cell count of the milk, is also affected by heat stress could not generally be confirmed. In none of the breeds did temperature or THI significantly affect cell count.

For both production and udder health trait complexes, however, the husbandry system affected THI and maximum temperature, depending on housing, grazing and ventilation system.

In indoor systems (without access to pasture) or in systems with access to pasture but mechanical ventilation, milk yield could be more or less kept at the same level or even increased in some cases with rising temperatures or THI3. Declines in milk yield were observed, however, in systems with access to pasture but free ventilation. Only small differences between husbandry systems were observed with regard to THI3 and Tmax3 and milk content traits. However, the declining effect of higher temperatures found without allowance for the husbandry system was confirmed. THI3 and TMax3 within husbandry systems were only found to have a significant effect on somatic cell count in Fleckvieh. Indoor systems seemed to be better at alleviating the negative effect of high ambient temperature and humidity.

Differences between pasture-based and indoor systems may also reflect different feed resources. Further, it should be noted that only general information on pasture (yes/no) was available, without specific data on when cows were grazed. Information on the quality of outdoor shelter was also unknown. The results nevertheless indicate that during phases of high ambient temperature cows should be put out to pasture early in the morning or towards evening.

Although the ambient temperature and THI were found to have a significant effect on performance traits in the different husbandry systems, no system could be explicitly identified as best or worst. With respect to milk yield, mechanical ventilation seemed to be beneficial.

The comparison of inside and outside temperature further revealed differences within the same husbandry systems. In general, air mass exchange with ambient air was very good in the four farms analysed in detail. In two of the barns the dew-point temperature was markedly higher than outside, while in the other two farms the difference between inside and outside water vapour was noticeably lower. Straw bedding, potentially absorbing water vapour, could be an explanation for this difference. However, neither floor conditions nor bedding were considered in the models applied. In further studies, these effects should also be analysed.

In principle, it can be assumed that the temperature and humidity data provided by ZAMG, are well-suited for this kind of analysis. A direct comparison between the INCA data set for the farms and the measures on-farm was not possible because of time constraints. For those farms, where inside and outside temperature was measured on-farm, further analysis of recent performance and possibly fitness data are suggested. Thanks to the extremely warm weather conditions during early summer 2015, excellent data are available for heat stress analysis.

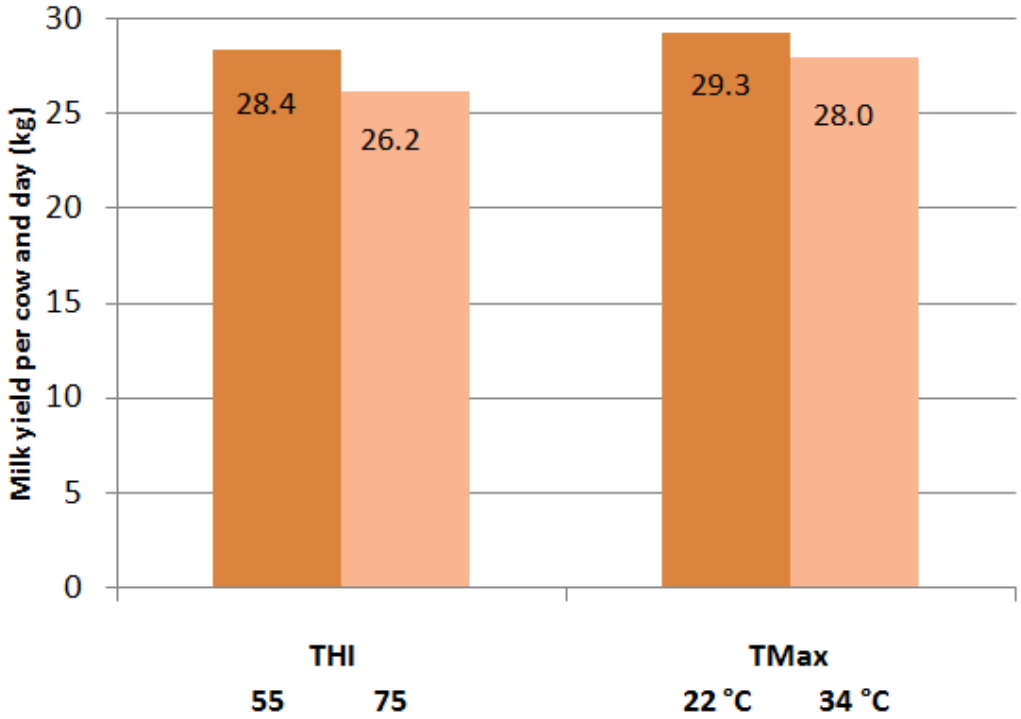

Fig. 5: Effect of THI (temperature-humidity index) and maximum temperature (averages of up to three days before performance testing) on milk yield per cow and day in Fleckvieh cows (N = 2,980 and 50,295 test-day records) without allowance for the housing system

5 StartClim2014.D: On the importance of climate change for nutrition and diseases of alpine game

Wild game like chamois or ibex, but also black game or snow grouse, in the Alpine region have been confronted by changing environmental conditions (Schaumberger et al., 2006) and pathogenic organisms (Boch u. Schneidawind, 1988, Deutz, 2014). Climatic changes can influence pathogens directly, for example through parasites laying more eggs and larvae, and indirectly with vector-borne diseases (ticks, mosquitoes) whose distribution is dependent on climatic conditions. Eggs and larvae of parasites are found increasingly at higher altitudes and have a shorter development cycle as yearly average temperature rises (Prosl, 2008).

Climate change also influences the dynamics of plant growth (Gruber et al., 1998; Schaumberger, 2011, Theurillat u. Guisan, 2001), which can positively affect the yield development of pasture areas but have a negative impact on the distribution of biomass increase during the year and digestibility. The rise in spring temperatures causes earlier onset of the vegetation period in inner-Alpine valleys by three to four days per decade. Consequently, the main pas-turing time for young animals happens at a time with old, overgrown plants, which are 10 per cent less digestible than young, fresh growth. This leads to a worse condition in autumn, especially in young animals, higher susceptibility to diseases and therefore higher losses during (late) winter.

Ibex horn growth depends on living conditions (Büntgen et al., 2013; Fandos, 1995; Giacometti et al., 2002). Measurements of ibex horns can provide information about those conditions and thus indirectly about climatic change. In other words, horns represent an archive of climate. This project is the first attempt to use it in Austria.

Influence of climate change on illnesses and parasitic diseases in Alpine wild game

As there has been no overview of (infectious) diseases of wild game in the Austrian Alpine region to date, an overview based on a literature review and own research (including five first descriptions with chamois and dermatophilosis, intra-uterine infection of para-tuberculosis, babesiosis, para-blackleg, Schmallenberg virus infection) for current populations was compiled in order to estimate recent and future developments. From our own material, over 400 sections, 870 para-tuberculosis samples, 111 organ samples and 80 parasitological examinations were included. As part of the project, another eighty-eight chamois faecal samples and, for comparison, seven sheep samples were examined in 2014/15, along with the histological examination of twenty-four chamois lung samples. The samples came from Styria, Carinthia and Upper Austria. Most important was categorising the parasitological data by elevation to determine an increase in the altitude of the Alpine risk area. During the project, forty-four wild game sections were performed and twenty-eight para-tuberculosis (lymph node) samples were analysed.

Haemonchus contortus was unexpectedly detected at altitudes above 2500 m. This blood-sucking parasite in the abomasum is thermophilic and therefore of no relevance to chamois in the past. It is now causing high losses, possibly due to the short period of co-evolution of host and parasite, resulting in a low immune defence. An increase in the incidence of ulcerous pneumonia can be found in chamois because of an infestation with small lung worms resulting in a secondary bacterial pneumonia. Out of twenty-four chamois lungs examined during the project, originating from Upper Styria, twenty-two were infested with lung worms. It was notable that clinical parasitosis was already found in March and April.

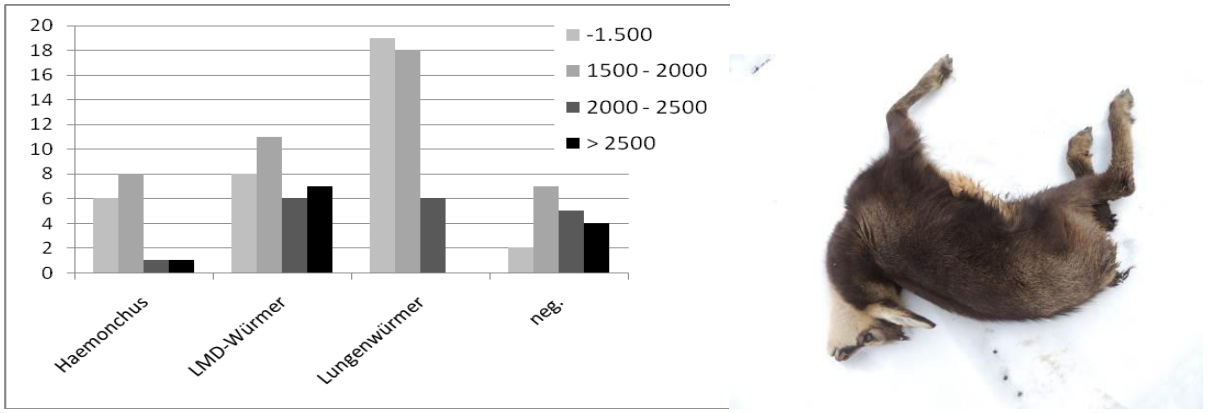

Fig. 6: Evidence of chamois parasites as a function of altitude of location/site of shooting (left); chamois fawn with severe parasitosis (right)

Blindness of chamois (infectious keratoconjunctivitis) also has the potential for spreading as a result of climate change, not least because in warmer winter seasons flies (vectors for the disease) survive longer and at higher altitudes. During an observation campaign in 2006, flies were observed at an altitude of 2000 m at the end of November in the Niedere Tauern moun-tain range. In the last few years, more cases of cerebral setariosis (Setaria cervi – brain thread worm) have been found in red deer, and increasing incidence of sheep liver fluke (Fasciola hepatica) has been found in chamois. Cases of squamous cell carcinoma and sun-burn (!) in chamois have occurred only in the last few years, most probably in connection with higher UV radiation during hot summer periods.

Influence of climate change on fodder and pasture quality and phenology

The Johnsbach Altitudinal Transect provided a network of reference sites/plots for studying changing vegetation dynamics in the project. Biomass yield and fodder quality were studied between 1993 and 1997 in sixteen high Alpine pastures between the towns of Wald am Schoberpass and Hieflau (Upper Styria). Additional research has already revealed the influence of vegetation dynamics on fodder quality. The sixteen sites were distributed equally on the basis of altitude, orientation and base rock. The plots are located at 1100, 1300, 1500 and 1700 m.

The original plots were reduced in size in 2015 by agreement with the respective landowners and again sampled for analysis of fodder quality (raw fibre content) and botanical composition. A statistical analysis of data from 1993 to1996 gave an average of 249 g raw fibre/kg dry matter for the early sample. This value increased within a month to 281 g (end of flowering)

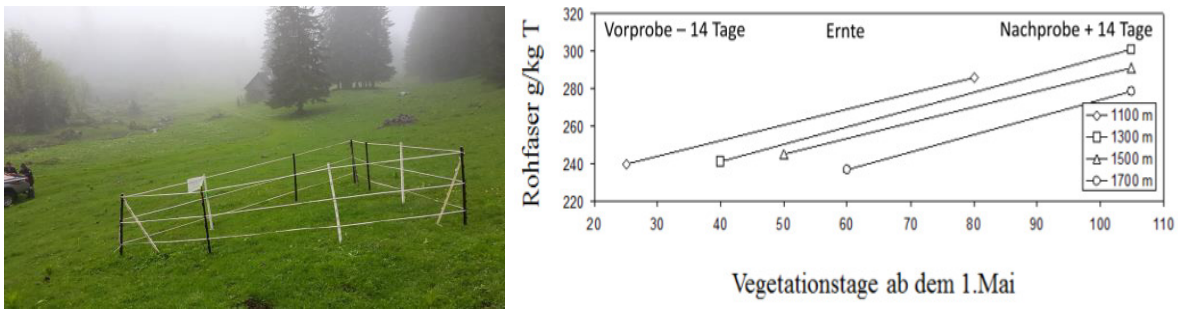

Fig. 7: Fenced sampling site (left) and development of raw fibre content in relation to altitude (right)

There is a close correlation between time of harvest, phenologic ripeness and raw fibre content. The phenologic development of plant stands is 17 m altitude per day (= 5.9d/100m) and the raw fibre gain is 1 g per day. From temperature measurements taken between 1993 and

1996, a mean gradient of 0.54 °C per 100 m altitude could be calculated. With the assumption of an increase in temperature of 1.7 °C and linearity of observed correlations, the season in the study area would start approximately three weeks earlier. This would mean an increase in raw fibre of 22g/kg dry matter, resulting in a lower digestibility, mainly for young animals, hindering the further development and increasing susceptibility to diseases. In the recent releveés from 2015, a change in species composition could not (yet) be found, despite results from the literature (Gottfried et al. 2011). In our case, the influence of land use is most probably stronger, as also shown in the study by Walther (2010). The plots in the altitudinal transect are exclusively Alpine pastures, and changes in species composition are mostly shown at the highest altitudes (sub-Alpine – Alpine – sub-nival).

Changes in vegetation in combination with higher temperatures lead to new situations in both intra- and interspecific competition (red deer – chamois; ibex – goats with kids).

Influence of climate change on ibex horn growth

The horns of male ibex (Capra ibex ibex) are secondary sex characteristics and show periodic growth. The start of growth is coupled with the start of the plant-growing season. Most of the yearly gain occurs in the high zones during May, June and July; afterwards it decreases steadily until it stops completely during winter. This is mainly influenced by the changing quality and yield of available fodder and by hormones. With this periodic cycle, both external influences like weather conditions and individual factors like diseases and wounds can be recognised. Horn growth is stimulated by humid and mild conditions during spring, as those conditions cause an early snowmelt and rapid vegetation growth. Different spring and summer conditions are mirrored in horn growth of males. Climatic developments or good pasture conditions can be inferred from long-term horn measurements.

Fig. 8: Horns are optical signs for the hierarchy among males (left). The length of single growth sections (arrows) is significantly influenced by environmental conditions (right)

Since 1961, single growth sections from 332 horns from the Hohe Tauern National Park have been measured. Differences in the sections are due for the most part to changes in weather/site conditions. Based on these results and population data it has been shown that horn growth increases strongly in the second year. The pattern of horn growth changes as a function of population dynamics. More mass is produced relatively during the first years, and the length decreases with increasing animal density in this period. Conversely, in years with a lower population density, the annual increase is somewhat greater as the individuals grow older. In older studies, this was also confirmed for the growth in the second year , where the males are normally not yet sexually mature and hormones can therefore be excluded as a cause. In the Hohe Tauern the horn growth changed in the 1990s owing to higher population densities. If the measurement data for these two periods are analysed separately, it becomes evident that the growth pattern for two-year-olds does not confirm the above-mentioned cycle. During the second period, there is almost no decrease in growth. This could be an indication of warming, since with an earlier onset of vegetational growth, young males were able

to compensate for the slower growth because of the population density found during the earlier period.

Possible strategies

An interdisciplinary workshop on 27 May 2015 at the Raumberg-Gumpenstein Agricultural Research and Education Centre revealed that there are many possibilities for adaptation. The main issues from an agricultural point of view are the date of turning out and returning to/from the Alpine pastures, worming of livestock, fertiliser management and subsidies. Forestry issues include clearing of shrubs and bushes, protection against damage by forest chamois and the general susceptibility of forest to damage. Members of the hunting community mentioned the sustainable management of hunting/shooting permits for chamois and ibex, early achievement of the hunting quota and regulation of red deer as the main concerns. It is evident that climate change is already having a marked influence on wild game, which will increase and involve even more severe changes.

6 StartClim2014.E: Weather-independent tourism offers based on Nature experience offers - relevance and innovative development options

The diverse natural and cultural landscapes in Austria offer great potential for a number of nature-based and nature experience-based tourism offers. Current research results (Siegrist et al. 2015, Pröbstl-Haider et al. 2014b, Wirth 2010) confirm that there is considerable interest in such offers among tourists. Adaptation strategies are need so that this potential can be made use of regardless of weather conditions, now and particularly in the light of future climate change. One such strategy mentioned by a number of authors (Moen & Fredman 2007, Bürki et al. 2003, Mooshammer et al. 2014) is a development towards all-year tourism.

Critics might ask why a region that generates enough turnover in the winter season should invest in the development of all-year tourism. Current scenarios indicate that climate change will have a generally perceptible, negative impact on winter seasons as of 2035, and foresightful planning is necessary in this case so as to have alternative offers already established by then for guests and for the municipalities affected.

To clarify the current situation in Austria in this regard, this study performed a survey of weather-independent nature experience offers. First, the term 'weather-independent nature experience offers' was defined (see Fig. 9). The inclusion criteria were availability for at least eight months a year, a local landscape reference and appeal to a broad target audience. The study also presented good practice examples and determined success factors for the establishment of such offers.

The survey therefore comprised offers available for more than eight months a year, and also those available for five to eight months and capable of extension to eight months. In researching the existing offers, it was noted that a number of providers (e.g. national parks) offer their extensive range of nature-experience products at set dates only. In view of the study definition, these could not be included.

Fig. 9: Criteria for the definition of weather-independent nature experience offers

A total of 236 offers by 118 different providers were surveyed. The most offers were found in Styria (30.5%; n=72), followed by Lower Austria (25.8%; n=61) and Burgenland (17.8%; n=42). Fig. 10 shows their geographical distribution. The main themes were nature (landscape, animals and plants) in 39% of cases, followed by geology (16%), mysticism and culture (13%) and cuisine (11%). Some 56 per cent of offers were linked to a protected area such as a national park, nature park or biosphere park. About half of the offers (50.4%; n=119) could be accessed only as part of a guided tour, almost 40 per cent (n=93) could be experienced independently, and in around 10 per cent of cases (n=24) both were possible. Regarding cost, 60 per cent (n=141) of offers charged a fee, while all other offers (n=93) were free. Two offers provided no information regarding cost. Clearly, the majority of existing offers already contribute to the regional value added.

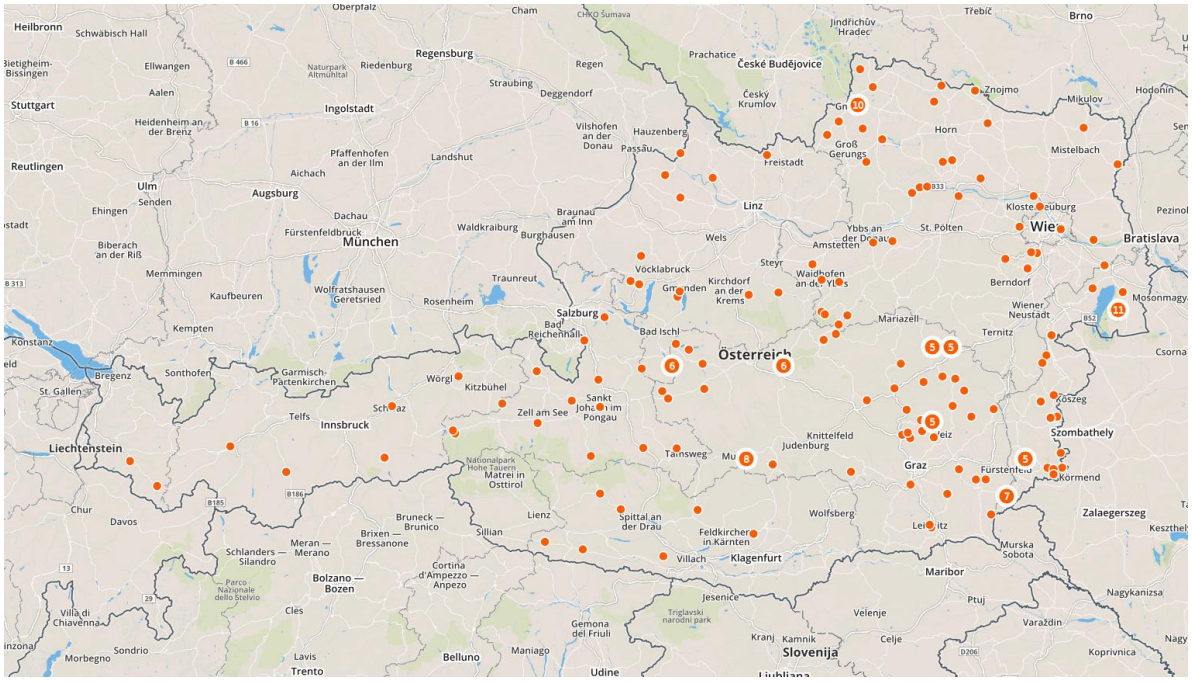

Fig. 10: Distribution of surveyed nature experience offers in Austria (Map tiles by © CartoDB. MapData © OpenStreetMap contributors. Licensed under the Open Data Commons Open Database License. Design © Mapbox. Licensed according to the Mapbox Terms of Services)

During a workshop with representatives of the Österreichische Hoteliervereinigung (ÖHV) Touristik Service GmbH (Austrian Hotel Association Tourism Service), the surveyed nature experience offers were evaluated in terms of their relevance for touristic development and their significance in the light of climate change. A number of criteria need to be met for the successful design and development of offers towards all-year tourism. These include aspects such as authenticity, the 'staging' of the touristic experience, professionalism and cooperation. In other words, offers must have an authentic and well-thought-out setting in order to be well received. A professional service is necessary to guarantee the quality of the offers and to enable them to be appropriately promoted. Furthermore, cooperation with regional partners is essential so as to embed the offers within the region, and also to design individual packages combining e.g. a hike with a tasting and an overnight stay.

An international good practice example is the offer of a hotel on the beach of Tofino, Canada. This hotel offers 'storm watching' in winter as a special nature experience, packaged with fine cuisine and relaxation in a luxurious hotel room. The St. Martins Spa & Lodge in Burgenland is one of the pioneers in this regard in Austria, combining wellness and nature experience with a relatively high contribution to the regional value added. A further example of the successful combination of a number of experiences is Donau Niederösterreich Tourismus GmbH (Danube Lower Austria Tourism), which combines cuisine with sightseeing and hiking.

This evaluation of offers could also form a basis for the development of further innovative products in this segment. The workshop with the ÖHV revealed that physical activity, relaxation and well-being could all have significant potential as themes in the future. There is a trend towards the pursuit of outdoor activities even in bad weather, which allows for a certain degree of weather-independence. Sport activities could thus boost the shoulder seasons in spring and autumn. Regarding relaxation and wellbeing, the trend was thought to be moving towards retreat and conscious relaxation outside of everyday life. The positive health effects of offers also play a role in this case.

7 permAT – Long-term monitoring of permafrost and periglacial pro-cesses and its role for natural hazard prevention: Possible strategies for Austria

Permafrost, perennially frozen ground overlain by a seasonally unfrozen layer, is common in high mountain ranges (e.g. Cremonese et al. 2012). The permAT project examined options for an efficient and spatially representative long-term monitoring network for observing permafrost and mass movements in Austria. Such a network is relevant from a geoscientific and economic point of view: for the prevention of natural disasters as well as adaptation to climate change. A key goal of permAT was also to initiate an exchange platform for scientists and representatives of public institutions, organisations and associations.

An extensive literature review and data search and a two-day workshop at the national level were conducted. The latter allowed the involvement of national and international colleagues in the concept development.

Contrary to the monitoring of glaciers, the extent of permafrost can be determined only by numerical modelling or indirectly from terrain indicators. According to the latest available modelling study for entire Austria (Fig. 11; Boeckli et al. 2012), 1600–2000 km² of Austria are characterised by permafrost. An additional 1.5 per cent of the nations' territory is affected by deep seasonal frost that has a similar impact on weathering processes. At present, there is no coordinated, national monitoring network despite the increasing danger of natural disasters due to climate change (Kellerer-Pirklbauer 2014). A network at this level was initiated in Switzerland fifteen years ago (PERMOS). PERMOS receives €180,000 per year from several sources: the Federal Office for the Environment (FOEN), the Federal Office of Mete-orology and Climatology (MeteoSwiss), and the Swiss Academy of Sciences (scnat). It com-prises a steering committee, scientific committee, the PERMOS office, PERMOS technician, and PERMOS partners (Hoelzle 2015). Methods used by PERMOS include temperature monitoring in boreholes and near the surface, geoelectric measurements and kinematic surveys of especially rock glaciers (downslope moving ice filled debris). Several countries have started similar initiatives, e.g. France (PERMAFRANCE) and Norway (NORPERM).

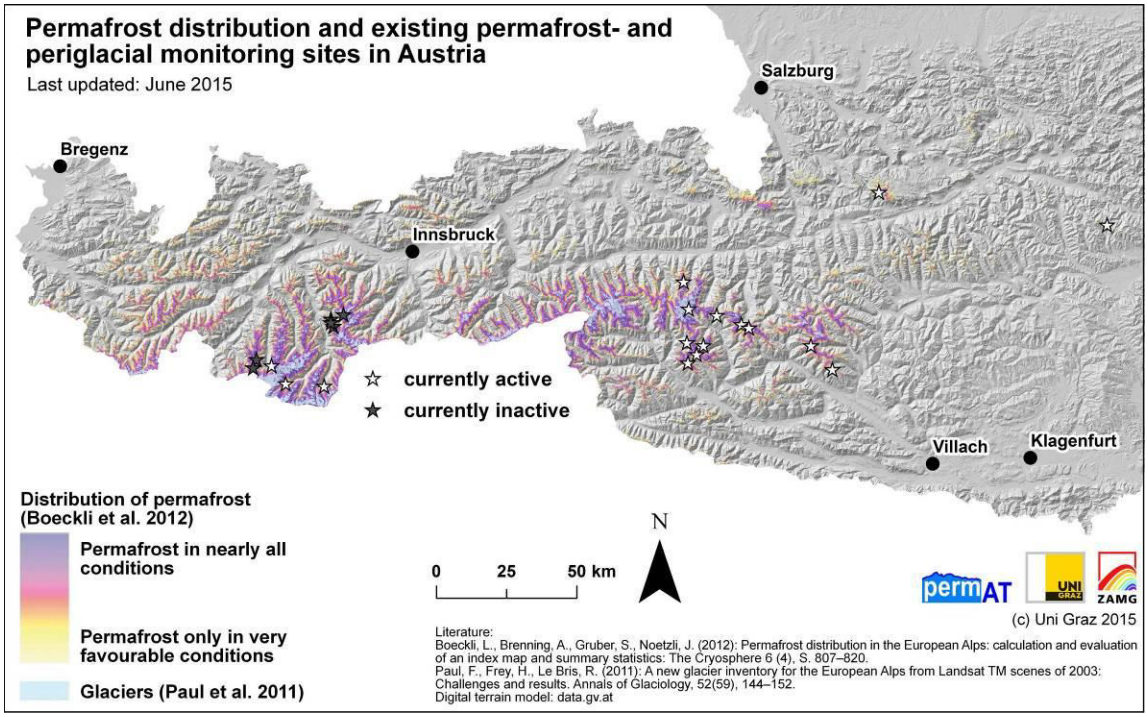

Fig. 11: Distribution of permafrost in Austria, (Boeckli et al. 2012) and location of existing permafrost and periglacial monitoring sites in Austria (n=22). Active – current monitoring; inactive – monitoring has been recently undertaken

PermAT demonstrated that there is extensive interest in a national network for permafrost and associated periglacial processes. The International Permafrost Association (IPA) and Global Terrestrial Network – Permafrost (GTN-P) are the relevant bodies at the international level. GTN-P is the most important programme for permafrost monitoring and is supported by the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS). Permafrost is one of the Essential Climate Variables listed by GCOS. This includes two parameters, namely temperature and the thickness of the active layer (seasonally unfrozen part). Both measures can only be determined by boreholes in Alpine terrain. Currently, there are five boreholes at Kitzsteinhorn, three at Hoher Sonnblick (other sites are located in the Hohe Tauern range) and one in the Dachstein Massif (Northern Calcareous Alps). Related permafrost/periglacial monitoring with other methods has been conducted at another nineteen sites in Austria (Fig. 11). The majority of the permafrost areas in Austria are not monitored, however. Documentation of the state of permafrost serving the needs of stakeholders is not available at present.

More than forty mountain huts are affected directly by permafrost or indirectly by rockfalls from nearby permafrost-affected rock walls. More than half of these huts are owned by the German Alpine Club and are located in Tyrol. The highest mountain hut in Austria (Erzherzog-Johann-Hütte in the Glockner mountain range at 3454 m) has been recently impacted by permafrost changes. Of economic importance is the overlap with twenty-three ski resorts and thirty-one reservoirs. Apart from water availability in permafrost basins (including wells from rock glaciers), destabilisation of slopes and infrastructure need to be considered. Permafrost and its changes are therefore relevant for geological and hydrological services at the regional level, and watercourse and avalanche management and the geological survey at the national level.

Nine political districts in Austria are underlain by more than 100 km² of permafrost. Most are located in Tyrol (Imst, Lienz, Landeck, Innsbruck-Land, Schwaz and Reutte), with one each in Salzburg (Zell am See), Carinthia (Spittal an der Drau) and Vorarlberg (Bludenz). St. Johann im Pongau has just under 100 km² of potential permafrost. This geographical distribution is not reflected by the current monitoring network. Ongoing research can be documented for only sixteen out of twenty-two sites (Fig. 12). The longest continuous record of ground

temperature in Austria is available from the eastern Alps (Hochreichartgebiet, Niedere Tauern). It shows a clear warming trend of the ground since 2004, which also gives indication of the permafrost beneath (Kellerer-Pirklbauer 2014). Most of the sixteen active sites are located in the Hohe Tauern range. Large permafrost regions between the Glockner mountain range and the Ötztaler Alps, and between Tyrol und Vorarlberg, the Northern Calcareous Alps and the eastern part of the Niedere Tauern Range are not represented.

Existing monitoring sites should be evaluated to establish a spatially representative network. Synergies with other networks need to be exploited in the choice of new sites (existing networks of ZAMG/meteorological office, HZB/hydrological office, LWD/avalanche control, mountain huts, reservoirs and ski resorts, as well as programmes such as GLORIA and LTER/LTSER). As in PERMOS, different types of sites need to be distinguished. There are classical temperature monitoring sites (supplemented by geophysical and hydrological monitoring) as well as kinematics sites with active rock glaciers and unstable rock walls. The number of boreholes needs to be increased, especially in Tyrol. All datasets and derived products need to be distributed to potential stakeholders, for preference in digital format via an online portal.

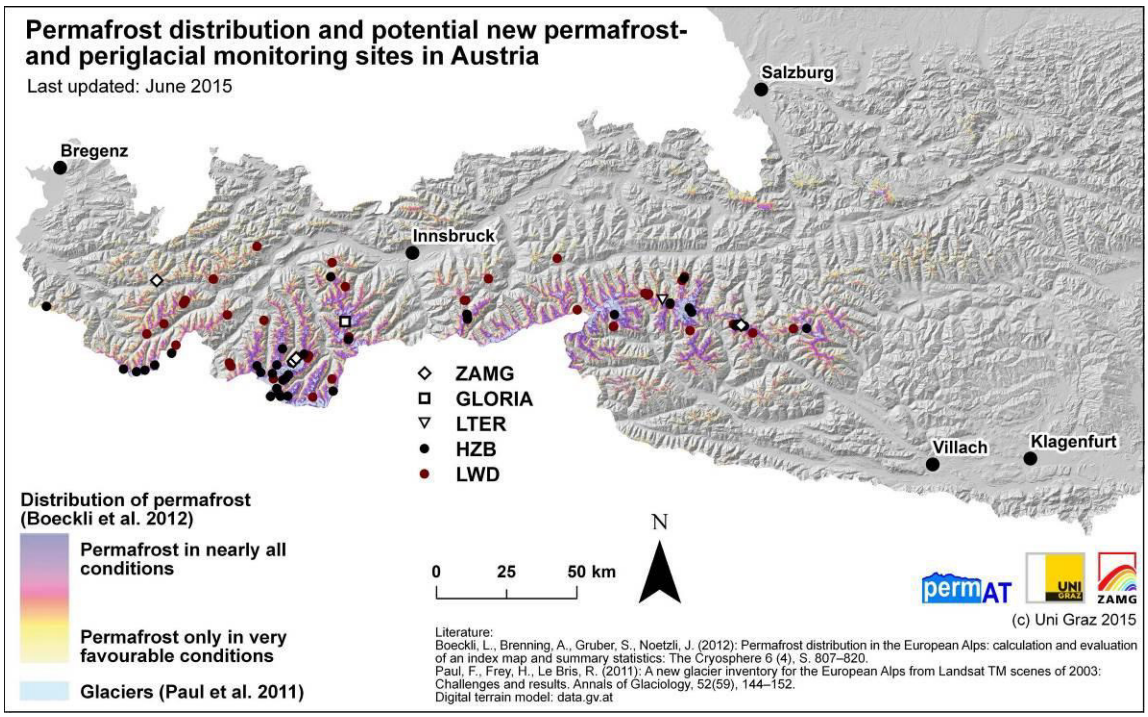

Fig. 12: Potential future monitoring sites using existing infrastructure from the different national agencies (ZAMG, HZB, LWD) and international programmes (GLORIA, LTER). For the sake of clarity, ski resorts, Alpine reservoirs and mountains huts (which are directly or indirectly influenced by permafrost) are not indicated in the map

The required financial support varies depending on the responsibilities of existing networks. The most important networks are maintained by universities (project-based, or HRSM by BMWFW), ZAMG (BMWFW and projects), the avalanche warning service, hydrological survey (BMLFUW), geological survey (project-based), BEV (regional level Landes-GIS-Stellen (production of digital elevation models). Potential sources of project funding are the Austrian Academy of Sciences (BMWFW), FWF (BMWFW), FFG (BMLFUW and BMVIT) and directly the BMLFUW (e.g. eHYD) and BMVIT (KIRAS programme). Locally, provincial gov-ernments and national park authorities could initiate studies. Potential financing for a national network needs to come from a combination of these institutions in addition to stakeholders from industry. A minimum investment of €1.5 million is required in order to achieve a similar representativity as in Switzerland, taking synergies with e.g. ZAMG and HZB stations, Alpine huts and skiing infrastructure into account. Annual costs for further maintenance are in the order of € 200,000.

8 References

StartClim2014.A

Buck, W., & Merkel, U. (1999). Auswertung der HOWAS Schadendatenbank. Institut für Wasserwirtschaft und Kulturtechnik der Universität, Karlsruhe, HY98/15.

Dotzek, N., Groenemeijer, P., Feuerstein, B., Holzer, A. M. (2009). Overview of ESSL's severe convective storms research using the European Severe Weather Database ESWD. Atmospheric Research, 93, 575-586.

Groenemeijer, P., Dotzek, N., Stel, F., Brooks, H., Doswell, C., Elsom, D., Giaiotti, D., Gilbert, A., Holzer, A. M., Meaden, T., Salek, M., Teittinen, J., Behrendt, J. (2004). ESWD - A standardized, flexible data format for severe weather reports. 3rd European Conference on Severe Storms, León, 9-12. November 2004, 2 pp.

Guzzetti, F., & Tonelli, G. (2004). Information system on hydrological and geomorphological catastrophes in Italy (SICI): a tool for managing landslide and flood hazards. Nat-ural Hazards and Earth System Sciences, 4, 213–232.

Hilker, N., Aller, D., Hegg, C. (2007). Ereignisanalyse Hochwasser 2005, Teil 1 - Prozesse, Schaden und erste Einordnung. Bundesamt für Umwelt, Forschungsanstalt WSL, Umwelt-Wissen, 0707, 127–148.

Hübl, J., Kienholz, H., Loipersberger, A. (2002). DOMODIS – Documentation of Mountain Disasters (State of Discussion in the European Mountain Areas). Internationale Forschungsgesellschaft INTERPRAEVENT, 1,1, Klagenfurt, 36 pp.

Kienholz, H., Krummenacher, B., Kipfer, A., Perret, S. (2004). Aspects of Integral Risk Management in Practise-Considerations with Respect to Mountain Hazards in Swit-zerland. Österreichische Wasser- und Abfallwirtschaft, 56, 3-4, Springer, Wien, 43-50.

Kociu, A., Kautz, H., Tilch, N., Grösel, K., Heger, H., Reischer, J. (2007). Massenbewegungen in Österreich. Jahrbuch der Geologischen Bundesanstalt, 147, 215-220.

Komac, M., Fajfar, D., Ravnik, D., Ribieié, M. (2007). Slovenian National Landslide DataBase – A promising approach to slope mass movement prevention plan. Geologija, 50(2), 393–402.

Luzian, R. (2002). Die österreichische Schadens¬lawinen–Datenbank. Forschungsanliegen – Aufbau – erste Ergebnisse (mit Kartenbeilage "gemeindeweise Lawinendichte"). Mit¬teilungen der Forstlichen Bundes¬ver¬suchsanstalt Wien (FBVA), Nr. 175/2002, 51pp.

PLANAT (2004). Strategie Naturgefahren Schweiz. Synthesebericht in Erfüllung des Auftrages des Bundesrates vom 20. August 2003, Biel, 34 pp.

Reisenhofer, S. (2015): Der Weg zum digitalen intelligenten Unwetterarchiv. ZAMG Newsletter 01/2015. 7. https://www.zamg.ac.at/cms/de/dokumente/topmenu/Newsletter

_2015_01.pdf

Steyrer, G., Krenmayer, W., Schaffer, H. (2010). Dokumentation der Waldschädigungsfaktoren (DWF) 2009. Forstschutz Aktuell, Wien, 49, 22-89.

Tschoegl, L., Below, R., Guha-Sapir, D. (2006). An Analytical Review of Selected Data Sets on Natural Disasters and Impacts. Paper prepared for the UNDP/CRED Work-shop on improving Compilation of Reliable Data on Disaster Occurrence and Im-pact, UNDP/CRED, Bangkok, 21 pp.

StartClim2014.B

Albuquerque, L.G., Mercadante, M.E.Z., Eler, J.P. (2006): Recent Studies on the Genetic Basis for Selection of Bos Indicus for Beef Production. 8th World Congress on Genetics Applied to Live-stock Production, August 13–18, 2006, Belo Horizonte, Brazil.

Allen, R.G., Pereira, L.S., Raes, D., Smith, M. (1998): Crop evapotranspiration: guidelines for compu-ting crop water requirements Food and Agriculture Organization of the United Nations, Rome.

Amon, B. , Fröhlich, M. , Weißensteiner, R. , Zablatnik, B. , Amon, T. (2007): Tierhaltung und Wirtschaftsdüngermanagement in Österreich Endbericht Projekt Nr. 1441 Auftraggeber: Bundesmi-nisterium für Land und Forstwirtschaft, Umwelt- und Wasserwirtschaft. 114 pp.

Amon, B., Hörtenhuber, S. (2008): Revision of Austria's Informative Inventory Report (IIR; OLI) for NH3, NMVOC und NOX in Agriculture (sector 4). Internal report on behalf of the Environment Agency Austria (Umweltbundesamt GmbH), 62 pp.

Anderl, M., Haider, S., Lampert. C., Moosmann, L., Pazdernik, K., Pinterits, M., Poupa, S., Purzner, M., Schmidt, G., Schodl, B., Stranner, G., Wieser, M., Zechmeister, A. (2015): Austria's Annual Greenhouse Gas Inventory 1990-2013. Data Status: February 24th 2015. Wien, 2015. REP-0536 Reports, Band 0536. ISBN: 978-3-99004-347-9. 31 pp.

Black, J.L., Mullan, B.P., Lorschy, M.L Giles, L.R. (1993): Lactation in the sow during heat stress. Livestock Production Science 35(1-2):153-170.

Bloemhof, S., van der Waaij, E.H., Merks, J.W.M. Knol, E.F. (2008): Sow line differences in heat stress tolerance expressed in reproductive performance traits. Journal of Animal Science 86(12), 3330-3337.

BOKU-Met (2015): Klimadaten für 4 Standorte. Institut für Meteorologie, Universität für Bodenkultur Wien (Imran Nadeem, MSc, und Dr. Herbert Formayer).

Brade, W. (2013): Milcherzeugung unter den Bedingungen des Klimawandels – Möglichkeiten zur Vermeidung oder Minderung des Hitzestresses. Berichte über Landwirtschaft 91 (3). http://buel.bmel.de/index.php/buel/article/view/34/Brade-91_3.html (zuletzt abgerufen am 6.7.2015)

Brown-Brandl, T. M., Nienaber, J. A., Eigenberg, R. A., Mader, T. L., Morrow, J. L., Dailey, J. W. (2006): Comparison of heat tolerance of feedlot heifers of different breeds. Livestock Science 105, 19-26.

Burns, B.M., Reid, D.J., Taylor, J.F. (1997): An evaluation of growth and adaptive traits of different cattle genotypes in a subtropical environment. Australian Journal of Experimental Agriculture 37, 399-405.

Cabell, J. F., Oelofse, M. (2012): An indicator framework for assessing agroecosystem resilience. Ecology and Society 17(1). http://dx.doi.org/10.5751/ES-04666-170118 (zuletzt abgerufen am 6.7.2015)

Chase, L.E. (s.a.): Climate Change Impacts on Dairy Cattle. Fact Sheet. http://dbccc.onep.go.th/Climate/attachments/article/105/Climate%20Change%20Impacts%20on%20Dairy%20Cattle.pdf (zuletzt abgerufen am 6.7.2015)

Choptiany, J., Graub, B., Phillips, S., Dixon, J. (2014): SHARP - Self-evaluation and Holistic Assess-ment of climate Resilience of farmers and pastoralists (FAO; version 3). Interim project report. 154 pp.

Dikmen, S., Hansen, P.J. (2009): Is the temperature-humidity index the best indicator of heat stress in lactating dairy cows in a subtropical environment? Journal of Dairy Science 92, 109-116.

Drastig, K., Prochnow, A., Brunsch, R. (2010): Wassermanagement in der Landwirtschaft. Diskussi-onspapier 3. Berlin-Brandenburgische Akademie der Wissenschaften, Interdisziplinäre Arbeits-gruppe Globaler Wandel – Regionale Entwicklung. 43 pp.

Dumont, B., Andueza, D., Niderkorn, V., Lüscher, A., Porqueddu, C., Picon-Cochard, C. (2015): A meta-analysis of climate change effects on forage quality in grasslands: specificities of moun-tain and Mediterranean areas. Grass and Forage Science 70, Issue 2, 239-254.

EEA (European Environment Agency, Europäische Umweltagentur; 2009): Annual average river nitrate concentration averaged by National River Basin Districts (mg N/l), EU-27 and EFTA. In: Eurostat (2012): Agri-environmental indicator - nitrate pollution of water. http://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_nitrate_pollution_of_water (zuletzt abgerufen am 8.7.2015)

Eitzinger, J., Kersebaum, K.C., Formayer, H. (2009): Landwirtschaft im Klimawandel. 376 S. Agrime-dia/Erling Verlag, Clenze, Deutschland.

Eitzinger, J., Kubu, G., Thaler, S. (2010): Konsequenzen des Klimawandels für das Ertragspotenzial und den Wasserhaushalt landwirtschaftlicher Pflanzenproduktion. In: ÖWAV (2010): Auswir-kungen des Klimawandels auf Hydrologie und Wasserwirtschaft in Österreich, 11-24.

Eurostat (2009): Organic farming statistics. http://ec.europa.eu/eurostat/statistics-explained/index.php/Organic_farming_statistics (zuletzt abgerufen am 8.7.2015)

FAO (2007): In: The State of the World's Animal Genetic Resources for Food and Agriculture (Ed. by B. Rischkowsky & D. Pilling). FAO, Rom, 511 S. http://www.fao.org/docrep/010/a1250e/a1250e00.htm (zuletzt abgerufen am 5.7.2015)

FAO (2013): SAFA Sustainability Assessment of Food and Agriculture systems indicators. Food and Agriculture Organization of the United Nations (FAO), Rome, 271 S.

Gasteiner, J. (2014): Hitzestress bei Milchkühen. In: LFZ Raumberg-Gumpenstein (2014): Nutztier-schutztagung. Raumberg-Gumpenstein 2014. 15. Mai 2014. 25-28.

Gobiet, A. (2010): Klimamodelle und Klimaszenarien für Österreich. In ÖWAV (2010): Auswirkungen des Klimawandels auf Hydrologie und Wasserwirtschaft in Österreich, 181-190.

Heidenreich, T. (2014): Hitzestress bei Schweinen - Baulich technische Lösungsmöglichkeiten. In: LFZ Raumberg-Gumpenstein (2014): Nutztierschutztagung. Raumberg-Gumpenstein 2014. 15. Mai 2014. 37-40.

Herndl, M., Baumgartner, D., Gaillard, G., Guggenberger, T., Steinwidder, A. (2012): Konzept und Methodik zur einzelbetrieblichen Ökobilanzierung landwirtschaftlicher Betriebe in Österreich. In: ALVA (Arbeitsgemeinschaft für Lebensmittel- Veterinär- und Agrarwesen; 2012): Ernährung si-chern – trotz begrenzter Ressourcen. ALVA-Tagungsbericht 2012. 4. - 5. Juni 2012, Wien. 152-154.

Hoekstra, A.Y., Chapagain, A.K. (2006): Water footprints of nations: Water use by people as a func-tion of their consumption pattern. Water Resources Management 21 (1), 35-48. DOI: 10.1007/s11269-006-9039-x

Hoffmann, I. (2010): Climate change and the characterization, breeding and conservation of animal genetic resources. Animal Genetics 41, 32-46.

Holzheu, M. (2014): Hitzestress bei Schweinen - tiergesundheitliche Aspekte. In: LFZ Raumberg-Gumpenstein (2014): Nutztierschutztagung. Raumberg-Gumpenstein 2014. 15. Mai 2014. 35-36.

Hörtenhuber, S., Weisshaidinger, R., Lindenthal, T., Zollitsch, W. (2014): Water-use and impact-weighted water footprints – methodological approach and case study for two Austrian milk pro-duction systems. In: Schenck, R., Huizenga, D. (Eds.), Proceedings of

9th International Confer-ence LCA of Food. 9th International Conference LCA of Food, San Francisco, OCT 8-10, 2014. 10 pp. http://www.lcafood2014.org/papers/129.pdf (zuletzt abgerufen am 8.7.2015)

Hörtenhuber, S., Kirner, L., Neumayr, C., Quendler, E., Strauss, A., Drapela, T., Zollitsch, W. (2013): Integrative Bewertung von Merkmalen der ökologischen, ökonomischen und sozial-ethischen Nachhaltigkeit landwirtschaftlicher Produktionssysteme am Beispiel von Milchproduktionssys-temen ("Nachhaltige Milch"). Endbericht zum Forschungsprojekt Nr. 100783, Wien. https://www.dafne.at/prod/dafne_plus_common/attachment_download/9f5ee5cf5d893825e3cb16421abffb38/Endbericht_Nachhaltige_Milch_final.pdf (zuletzt abgerufen am 8.7.2015)

Howden, S. M., Soussana, J.-F., Tubiello, F. N., Chhetri, N., Dunlop, M., Meinke, H. (2007): Adapting agriculture to climate change. PNAS 104 (50), 19691-19696.

IPCC (International Panel on Climate Change; 2006): Guidelines for National Greenhouse Gas Inven-tories. Prepared by the National Greenhouse Gas Inventories Programme, ed. by Eggleston, H.S., Buendia, L., Miwa, K., Ngara, T., Tanabe, K. Institute for Global Environmental Strategies (IGES), Kanagawa, Japan.

IPCC (2013): Climate Change 2013: The Physical Science Basis. http://www.ipcc.ch/report/ar5/wg1/ (zuletzt abgerufen am 10.7.2015)

Knap, P.W. (2005): Breeding robust pigs. Animal Production Science 45(8), 763-773.

Koerber, von K., Kretschmer, J. (2007): Klimafreundlich essen: weniger Fleisch, bio, regional & frisch. Ökologie & Landbau, 143 (3), 20-22.

Koller, A., Schmied, R. Zentner, E., Grabner, R. Illmayer, S. (2012): Hitzetage für Tiere erträglicher machen. https://sbg.lko.at/?id=2500,1726276 (zuletzt abgerufen am 6.7.2015)

Leip A., Weiss, F., Wassenaar, T., Perez, I., Fellmann, T., Loudjani, P., Tubiello, F., Grandgirard, D., Monni, S., Biala, K. (2010): Evaluation of the livestock sector's contribution to the EU green-house gas emissions (GGELS) – final report. European Commission, Joint Research Centre. http://ec.europa.eu/agriculture/analysis/external/livestockgas/full_text_en.pdf (zuletzt abgerufen am 5.7.2015)

Mader, T., Davis, S., Gaughan, J., Brown-Brandl, T. (2004): Wind speed and solar radiation adjust-ments for the temperature-humidity index. Proceedings of the 16th Conference on Biometeorol-ogy and Aerobiology; Vancouver, BC; 23 August 2004 – 26 August 2004, 57-62.

Miller, A. M. (2004): Warme Silagen? Warum - weshalb - was tun? Informationsplattform Proteinmarkt – Verband der ölsaatenverarbeitenden Industrie [Deutschland]. 7 pp. http://www.proteinmarkt.de/uploads/media/Warme_Silagen__Warum__-_weshalb_-_was_tun_.pdf (zuletzt abgerufen am 6.7.2015)

Nelson, G. C., Rosegrant, M. W., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Magalhaes, M., Valmonte-Santos, R., Ewing, M., Lee, D. (2009): Cli-mate change: Impact on agriculture and costs of adaptation. Vol. 21, Intl Food Policy Res Inst. 19 pp.

NOAA (National Oceanic and Atmospheric Administration; 1976): Livestock hot weather stress. Oper-ations Manual Letter C-31-76. NOAA, Kansas City, Missouri, USA.

NRC (National Research Council, 1981): Effect of Environment on Nutrient Requirements of Domestic Animals. Subcommittee on Environmental Stress. National Academy Press, Washington, DC, USA.

ÖWAV (Österreichischer Wasser- und Abfallwirtschaftsverband; 2010): Auswirkungen des Klimawan-dels auf Hydrologie und Wasserwirtschaft in Österreich. 202 pp. http://www.oewav.at/Kontext/WebService/SecureFileAccess.aspx?fileguid={ca55095e-3fad-43d9-9f91-69a3834e9491} (zuletzt abgerufen am 6.7.2015)

Pötsch, E. M., Asel, A., Schaumberger, A., Resch, R. (2014): Impact of climate change on grassland productivity and forage quality in Austria. Grassland Science in Europe 19, 139-141.

Poiger, T., Buser, H.R., Müller, M.D. (Agroscope FAW Wädenswil, Eidg. Forschungsanstalt für Obst, Wein- und Gartenbau; 2005): Evaluation der Ökomassnahmen und Tierhaltungsprogramme, Synthesebericht Bereich Pflanzenschutzmittel. http://www.blw.admin.ch/dokumentation/00018/00112/00503/index.html?download=NHzLpZig7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCDeIR7fmym162dpYbUzd,Gpd6emK2Oz9aGodetmqaN19XI2IdvoaCUZ,s-&lang=de (zuletzt abgerufen am 10.7.2015)

Rosenzweig, C., Elliott, J. Deryng, D., Ruane, A.C., Müller, C., Arneth, A., Boote, K. J., Folberth, C., Glotter, M., Khabarov, N., Neumann, K., Piontek, F., Pugh, T. A. M., Schmid, E., Stehfest, E., Yang, H., Jones, J.W. (2014): Assessing agricultural risks of climate change in the 21st century in a global gridded crop model intercomparison. PNAS 111 (9), 3268-3273. doi:10.1073/pnas.1222463110

Rowlinson, P. (2008): Adapting livestock production systems to climate change – temperate zones. In: Rowlinson, P., Steele, M., Nefzaoui, A. (2008): Livestock and Global Climate Change 2008. 61-63.

Schmitz, C., Schütte, G., Kullmann, S., Kuschel S. (PAN Deutschland, Pestizid Aktions-Netzwerk Deutschland; 2010): Auswirkungen chemisch-synthetischer Pestizide auf die biologische Viel-falt. 23 pp. Hamburg. http://www.pan-germany.org/download/biodiversitaet/Auswirkungen_chemisch-synthetischer_Pestizide.pdf (zu-letzt abgerufen am 5.7.2015)

Schoenherr, W.D., Stahly, T.S., Cromwell, G.L. (1989): The Effects of Dietary Fat or Fiber Addition on Yield and Composition of Milk from Sows Housed in a Warm or Hot Environment. Journal of Animal Science 67(2), 482-495.

Schönthaler, K., von Andrian-Werburg, S., Wulfert, K., Luthardt, V., Kreinsen, B., Schultz-Sternberg, R., Hommel, R. (2010): Establishment of an Indicator Concept for the German Strategy on Ad-aptation to Climate Change. Umweltbundesamt Deutschland. 164 pp.

Scholz, R.W., Tietje, O. (2002): Embedded case study methods. Integrating quantitative and qualita-tive knowledge. Sage Publications, Thousand Oaks, California, USA.

Spencer, J.D., Gaines, A.M., Berg, E.P. Allee, G.L. (2005): Diet modifications to improve finishing pig growth performance and pork quality attributes during periods of heat stress. Jounral of Animal Science 83(1), 243-254.

Starz, W. (2010): Düngerverständnis und Düngerkonzept in der Biologischen Landwirtschaft. In: Ta-gungsband zu 2. Umweltökologisches Symposium 2010, LFZ Raumberg-Gumpenstein, 2./3. März 2010. ISBN: 978-3-902559-41-8. S. 51-56.

Starz, W., Steinwidder, A. (2007): Weidehaltung – mehr als ein Low-Input Produktionssystem. In: (Hö-here Bundeslehr- und Forschungsanstalt für Landwirtschaft Raumberg-Gumpenstein, Hrgb.; 2007). Tagungsband – Österreichische Fachtagung für biologische Landwirtschaft. Irdning, 14. März 2007. 1-5.

Thaler, S., Eitzinger, J., Trnka, M., Dubrovsky, M. (2012): Impacts of climate change and alternative adaptation options on winter wheat yield and water productivity in a dry climate in Central Eu-rope. Journal of Agricultural Science 150, 537-555. doi:10.1017/S0021859612000093

Thornton, P.K., van de Steeg, J., Notenbaert, A., Herrero, M. (2009): The impacts of climate change on livestock and livestock systems in developing countries: A review of what we know and what we need to know. Agricultural Systems 101, 113-127.

Tietje, Olaf (2013): Systemanalyse. Qualitative Modellierung des Dynamik eines komplexen Systems. Zürich.

Trnka, M., Bartošová, L., Schaumberger, A., Ruget, F., Eitzinger, J., Formayer, H., Seguin, B., Olesen, J.E. (2011): Climate change and impact on European grasslands. Grassland Science in Europe 16, 39-51.

Tubiello, F N., Soussana, J.-F., Howden, M. S. (2007): Crop and pasture response to climate change. PNAS 104, 19686-19690. doi: 10.1073/pnas.0701728104

Walker, B.H., Anderies, J.M., Kinzig, A.P., Ryan, P. (Hrgb; 2006): Exploring resilience in social-ecological systems: comparative studies and theory development. Special feature of Ecology and Society. 11(1), 12 - 21.

Willerstorfer, T. (2013): Der Fleischverbrauch in Österreich von 1950-2010. Trends und Drivers als Zusammenspiel von Angebot und Nachfrage. Social Ecology Working Paper 139. Institute of Social Ecology, IFF - Faculty for Interdisciplinary Studies (Klagenfurt, Graz, Vienna), Alpen-Adria Universität. https://www.uni-klu.ac.at/socec/eng/downloads/WP139_webversion.pdf (zu-letzt abgerufen am 8.7.2015)

Zentner, E. (2014): Hitzestress bei Rindern - Baulich-technische Lösungsmöglichkeiten. In: LFZ Raumberg-Gumpenstein (2014): Nutztierschutztagung. Raumberg-Gumpenstein 2014. 15. Mai 2014. 29-34.

Zentner, E., Mösenbacher, I. (2012). Möglichkeiten zur Stallkühlung im Schweinestall. Blick ins Land 8/2012, 16-18.

Zumbach, B., Misztal, I., Tsuruta, S., Sanchez, J.P., Azain, M., Herring, W., Holl J., Long T., Cul-bertson, M. (2008): Genetic components of heat stress in finishing pigs: development of a heat load function. Journal of Animal Science 86, 2082-20

StartClim2014.C

Batz, F.J. (1990). Grundvoraussetzungen für eine tiergerechte Milchviehhaltung. Birkhäuser Verlag, Berlin, Tierhaltung Band 21, 10-22

Bianca, W. (1962). Relative importance of dry- and wet-bulb temperatures and humidity in causing heat stress in cattle. Nature Publishing Group, Nature, 195, 251 - 252

Bockisch, F. (1991). Quantifizierung von Interaktionen zwischen Milchkühen und deren Haltungsumwelt als Grundlage zur Verbesserung von Stallsystemen und ihrer ökonomischen Bewertung. Verlag der Ferber'schen Universitätsbuchhandlung, Deutschland, 46-52, 76-79, 202-203

Bogner, H. und Suess, M. (1981). Einige Anmerkungen zur Gestaltung der technischen Umwelt fuer Rinder und Schweine. Züchtungskunde, 52, 352-358

Brade, W. (2013). Milcherzeugung unter den Bedingungen des Klimawandels – Möglichkeiten zur Vermeidung oder Minderung des Hitzestresses. Bundesministerium für Ernährung und Landwirtschaft, Hannover, Zeitschrift für Agrarpolitik und Landwirtschaft, 1-20

Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (2014). Grüner Bericht 2014. http://www.agraroekonomik.at/index.php?id=gruenerbericht2014&no_cache=1 besucht am 2014-11-15

Egger-Danner, C., Fürst-Waltl, B., Ledinek, M., Zollitsch, W., Fürst, C., Steininger, F., Gruber, L., Zottl, K., Weißensteiner, R. (2015). Analyse und Optimierung der Produktionseffizienz und der Umweltwirkung in der österreichischen Rinderwirtschaft. https://www.dafne.at/prod/dafne_plus_common/attachment_download/75215d89f8c87f0eb59a23547cca2b02/Efficient_cow_2_Zwischenbericht_FINAL.pdf besucht am 2015-07-19

Eitzinger, J. (2007). Einfluss des Klimawandels auf die Produktionsrisiken in der österreichischen Landwirtschaft und mögliche Anpassungsstrategien. Ländlicher Raum (on-line), 1-8

Findlay, J. D. (1950). The effects of temperature, humidity, air-movement and solar radiation on the behaviour and physiology of cattle and other farm animals : a review of extisting knowledge. Hannah Dairy Research Institut, Kirkhill, 9, 4-22

Haiden, T., A. Kann, G. Pistotnik, K. Stadlbacher, Wittmann, C. (2009). Integrated Nowcasting through Comprehensive Analysis (INCA) - System description. ZAMG report, 60p.http://www.zamg.ac.at/fix/INCA_system.pdf
http://www.zamg.ac.at/fix/INCA_system.pdf

Hammami, H., Bormann, J., M'hamdi, N., Montaldo, H. H., Gengler, N. (2013). Evaluation of heat stress effects on production traits and somatic cell score of Holsteins in a temperate environment. American Dairy Science Association, Mexico, Journal Dairy Science, Volume 96/3, 1844-1855

Hill, D.L. und Wall, E. (2014). Dairy cattle in a temperate climate: the effect of weather on milk yield and composition depend on management. The Animal Consortium, Animal, 9, 1, 138-149

Hvidstein, H. (2009). Die Haltung von Milchkühen im Offenstall im Vergleich zum Massiv-Anbindestall. Blackwell Verlag GmbH, Zeitschrift für Tierphysiologie Tierernährung und Fut-termittelkunde, Auflage 17, 223–235

Jentsch, W., Derno, M., Weiher, O. (2001). Wärmeabgabe der Milchkühe in Abhängigkeitvon der Leistung – eine Studie. FBN, Dummersdorf, Arch. Tierzucht, 44, 599-610

Joksimovic-Todorovic M., Davidovic, V., Hristov, S., Stankovic, B. (2011). Effect of heat stress on milk production in dairy cows. Institute for Animal Husbandry, Belgrade-Zemun, Biotechnology in Animal Husbandry 27, 3, 1017-1023

Kadzere, C.T., Murphy, M.R., Silanikove, N., Maltz, E. (2002). Heat stress in lactating dairy cows: a review. Elservier Science B.V., Urbana (USA), Livestock Production Science, Vol-ume 77, 59-91

Koppe, C., Jendritzky, G., Pfaff, G. (2003). Die Auswirkungen der Hitzewelle 2003 auf die Gesundheit. DWD, Klimastatusbericht 2003, 152-161

Lambertz, C., Sanker, C., Gauly, M. (2014). Climatic effects on milk production traits and somatic cell score in lactating Holstein-Friesian cows in different housing systems. J. Dairy Sci., 97, 319–329

Liebe, A. (1996). Zusammenhänge zwischen Zellzahl und Wachstumsfaktorengehalt der Milch sowie Mastitis beim Rind unter besonderer Berücksichtigung von Haltungseinflüssen. Dissertation Veterinärmedizinische Universität München, Herbert Utz Verlag, München, 7-11

Loebsin, C., Fiedler, M., Tober, O., Hoffmann, G., Hempel, S., Amon, T. (2012). Minderungsmöglichkeiten von Hitzestress am Beispiel von Zusatzlüftung. In: Beiträge zum Thema Stallklima in der Tierhaltung, Dummersdorf, 31-41

Sambraus, H. H. (1978). Nutztierethologie, 1. Auflage, Verlag Paul Parey, s.p.

Schormüller, J. (1974). Lehrbuch der Lebensmittelchemie. Springer-Verlag Berlin Heidelberg, Berlin, 220-239

Schüller, L.K., Burfeind, O., Heuwieser, W. (2013). Short communication: Comparison of ambient temperature, relative humidity, and temperature-humidity index between on-farm measurements and official meterological data. American Dairy Science Association, Berlin, Journal of Dairy Science, 96, 7731-7738

Shathele, M.S. (2009). Weather effect on bacterial mastitis in dairy cows. International Journal of Dairy Science, 4, 57-66

Smith, D.L., Smith, T., Rude, B.J. Ward, S.H. (2013). Comparison of the effects of heat stress on milk and component yields and somatic cell score in Holstein and Jersey cows. J. Dairy Sci., 96, 3028-3033

Steininger, F. (2015). Projektvorstellung „Efficient Cow". Der effizienten Kuh auf der Spur. https://www.dafne.at/prod/dafne_plus_common/attachment_download/84af3092c20b3a3179d2c07e51d4257c/Efficient_Cow_2._Zwischenbericht___Anlagen.pdf besucht am 2015-07-19

Strauss, F., Formayer, H., Schmid, E. (2013). High resolution climate data for Austria in the period 2008–2040 from a statistical climate change model. Int. J. Climatol. 33: 430–443

Tietze, M., Gruszecki, O., Lipecka, C., Szymanowska, A., Markiewicz, J., Bryl, M. (2001). Level of selected biochemical indices in blood serum and health state of mammary glands in sheep under different environment systems. Dummerstorf, Arch. Tierz., Special Issue, 219-223

Tucker, C. und Schütz, K. (2009). Behavioral Responses to Heat Stress: Dairy Cows Tell the Story. Animal Science Department, Hamilton New Zealand, 13-21

Werner, P.C.; Gerstengarbe, F.-W. (2007). Welche Klimaänderungen sind in Deutschland zu erwarten? In: Endlicher, W.; Gerstengarbe, F.-W. (Hrsg.): Der Klimawandel – Einblicke, Rückblicke und Ausblicke. Potsdam, 56-59

West, J. W. (2003). Effects of heat-stress on production in dairy cattle. J. Dairy Sci., 86, 2131–2144

Wyss, U., Mauer, J., Frey, H., Reinhard, T., Bernet, A., Hofstetter, P. (2001). Aspekte zur Milchqualität und Saisonalität der Milchlieferungen. Agrarforschung Schweiz 2, 9, 412-417

StartClim2014.D

Literatur Krankheiten

BEIGLBÖCK, C., KÜBBER-HEISS, A., WALZER, C. (2013): Bericht „Ökopathologische Untersuchun-gen im Nationalpark Hohe Tauern – Zeitraum 2009, 2011, 2012. Forschungsinstitut für Wildtierkunde und Ökologie, Department für Integrative Biologie und Evolution, Veterinärmedizinische Universität Wien.

BOCH, J., SCHNEIDAWIND, H. (1988): Krankheiten des jagdbaren Wildes. Verlag Paul Parey, Ham-burg und Berlin.

BOCH, J.; NERL, W., 1960: Gamsräude. München-Solln, Verlag F.C. Mayer.

BURGSTALLER, J., DEUTZ, A., MANSFELD, M.D. (2014): Fallbericht: Erstbeschreibung einer Infek-tion mit Clostridium septicum bei einer Gämse (Rupicapra rupicapra). Wien. Tierärztl. Mschr. 101, 98-102.

CORLATTI, L., BÉTHAZ, S., von HARDENBERG, A., BASSANO, B., PALME, R., LOVARI, S. (2012): Hormones, parasites and male mating tactics in Alpine chamois: Identifying the mechanisms of life history trade-offs. Animal Behaviour, 84 (4), pp. 1061-1070.

DEGIORGIS, M.-P., OBRECHT, E., RYSER, A., GIACOMETTI, M. (1999): The possible role of eye-frequenting flies in the transmission of Mycoplasma conjunctivae. Mitt. Schweiz. Entomol. Ges. 72, 189 – 194.

DEUTZ, A., SCHLAGER, S., GUSTERER, E., PLESS, P. (2014): Untersuchungen zum Vorkommen von VTEC/EHEC/EPEC auf Schlachtkörpern von Gämsen im Bereich der Wildzerlegung in der Stei-ermark. 55. Arbeitstagung des Arbeitsgebietes Lebensmittelhygiene der DVG, 23.-26. September, Garmisch-Partenkirchen, S. 146.

DEUTZ, A. (2014): Krankheiten des Gamswildes – Entwicklungen und Lösungen. Ber. 20. Österr. Jägertagung, 13.-14. Februar, Aigen i.E., S. 65-72.

DEUTZ, A., GRESSMANN, G. (2014): Gülle auf Almflächen – Auswirkungen auf Wildtiere? Jagd in Tirol 06/14, 4-7.

DEUTZ, A.; GASTEINER, J. (2013): Wechselweise Krankheitsübertragung zwischen Haus- und Wild-tieren. Schafe & Ziegen aktuell – Fachzeitschrift für Schaf- und Ziegenbauern Heft 2, 7-8.

DEUTZ, A. (2012): Wildbrethygiene heute. BLV Buchverlag München, 159 Seiten.

DEUTZ, A., DEUTZ, U. (2011): Wildkrankheiten, Hundekrankheiten, Zoonosen: Erkennen – Vermeiden – (Be)Handeln. Leopold Stocker Verlag, Graz-Stuttgart, 264 Seiten.

DEUTZ, A., GUGGENBERGER, T., GASTEINER, J. (2011): Influence of climate change on diseases of wild animals. In: Game meat hygiene in focus, Wageningen Academic Publishers, p. 157-172.

DEUTZ, A., SPERGSER, J. (2009): Paratuberkulose bei Wildtieren – Verbreitung, klinische und post-mortale Befunde. RFL - Rundschau für Fleischhygiene und Lebensmittelüberwachung 61, 12-15.

DEUTZ, A. (2008): Lebensräume und Krankheiten des Gamswildes unter dem Aspekt des Klimawan-dels. Ber. Tagung „Das Gamswild in Bedrängnis? – Ökologie - Störfaktoren – Jagd – Management“, Nationalpark Hohe Tauern, 9.-10. 10., St. Jakob i. Defreggental, S. 58-62.

DEUTZ, A. (2008): Klimaveränderung und deren zu erwartende Auswirkung auf Wildtierkrankheiten. Ber. Fachtagung „Wildtiergesundheit, Wildtierkrankheiten, deren Bedeutung und Vermeidung“, 13.11., Veterinärmedizinische Universität Wien, S. 7-14.

DEUTZ, A., SPERGSER, J., WAGNER, P., ROSENGARTEN, R., KÖFER, J. (2005): Nachweise von Mycobacterium avium subsp. paratuberculosis bei Wildtieren und Rindern in der Steiermark/Österreich. Berl. Münch. Tierärztl. Wschr. 118, 314-320.

DEUTZ, A., WAGNER, P. (2004): Untersuchungen zum Vorkommen von Antibiotikaresistenten Bak-terien bei Wildtieren. 20. Umweltschutzbericht 2004 des Landes Steiermark. S. 176-181.

DEUTZ, A., SPERGSER, J. (2004): Erhebungen zum Auftreten von Paratuberkulose bei heimischen Wildtieren unter Erfassung epidemiologischer Zusammenhänge der Übertragbarkeit zwischen Wild- und Haustieren. Forschungsbericht, Bundesministerium für Gesundheit und Frauen, 31 Seiten.

DEUTZ, A., SPERGSER, J., FREI, J., ROSENGARTEN, R., KÖFER, J. (2004): Nachweis von Myco-plasma conjunctivae in zwei Schafbetrieben – Klinik, Diagnostik und Ausbruchsepidemiologie. Vet. Med. Austria/Wien. Tierärztl. Mschr. 91, 152-157.

DEUTZ, A., FUCHS, K., SCHULLER, W., NOWOTNY, N., AUER, H., ASPÖCK, H., STÜNZNER, D., KERBL, U., KLEMENT, CH., KÖFER, J. (2003): Seroepidemiologische Untersuchung von Jägern auf Zoonosen in Südostösterreich – Prävalenzen, Risikopotentiale und Vorbeugemaßnahmen. Berl. Münch. Tierärztl. Wschr. 116, 306-311.

DEUTZ, A., SPERGSER, J., ROSENGARTEN, R., KÖFER, J., (2003): Erstnachweis der intrauterinen Übertragung von Paratuberkulose bei Rot- und Gamswild. Europ. J. Wildlife Res. 49, 314-319.

DEUTZ, A. (2002): Gamswildkrankheiten unter besonderer Berücksichtigung der Räude und der Gamsblindheit. Schriftenreihe des Landesjagdverbandes Bayern, Band 9, „Gamswild in den Alpen, S. 81-94.

DEUTZ, A., GRESSMANN, G. (2001): „Gams- und Steinwild - Biologie, Krankheiten und Jagdpraxis“. Stocker-Verlag, Graz-Stuttgart.

DEUTZ, A., FUCHS, K., GRESSMANN, G. (1999): Beitrag zur Epidemiologie von Räude und Gams-blindheit bei Gams- und Steinwild in der Steiermark. Ber. der DVG-Tagung „Modellierung in der Epi-demiologie und ihre Anwendbarkeit“, 1. bis 3. September, Tänikon, 127-135.

DEUTZ, A., FUCHS, K., GRESSMANN, G. (1999): Nutzung geographischer Informationssysteme zur Erfassung der Epidemiologie der Gamsräude. Ber. DVG-Tagung „Neuere Methoden und Ergebnisse zur Epidemiologie von Parasitosen“, 10. bis 12. März, Tierärztliche Hochschule Hannover, S. 211-220.

DEUTZ, A., HINTERDORFER, F. (1997): Dermatophilose bei Rind, Pferd und Gemse - Epidemiolo-gie, Diagnostik, Therapie und zoonotische Aspekte. Wien. Tierärztl. Mschr. 84, 97-101.

DUFOUR, B., MOUTOU, F., HATTENBERGER, A.M., RODHAIN, F. (2008): Global change: impact, management, risk approach and health measures – the case of Europe. In: Climate change: impact on the epidemiology and control of animal diseases. Rev. sci. tech. Off. Int. Epiz. 27 (2), p. 529-541.

FUCHS, K., DEUTZ, A., GRESSMANN, G. (2000): Detection of space-time clusters and epidemiologi-cal examinations of scabies in chamois. Vet. Parasitol. 92, 63-73.

FUCHS, K., DEUTZ, A. (1999): Methodische Aspekte zur Aufbereitung und Präsentation raum-zeitbezogener Daten am Beispiel der Gamsräude. Ber. DVG-Tagung „Neuere Methoden und Ergeb-nisse zur Epidemiologie von Parasitosen“, 10. bis 12. März, Tierärztliche Hochschule Hannover, S. 146-155.

GEISEL, O. (1995): Wildkrankheiten erkennen und beurteilen. BLV, München.

FERNANDEZ-MORAN, J.; GOMEZ, S.; BALLESTEROS, F.; QUIROS, P.; BENITO, J. L.; FELIU, C.; NIETO, J. M. (1997): Epizootiology of sarcoptic mange in a population of cantabrian chamois (Rupi-capra pyrenaica parva) in Northwestern Spain. Vet. Parasitol. 73, 163-171.

Forschungsprojekt Gamsblindheit (1998): Erloschene Lichter. Hofmann, H. (Hrsg.), Casanova Verlag, Chur.

GIACOMETTI, M., WILLING, R., DEFILA, C. (2002): Ambient temperature in spring influences horn growth in male alpine ibex. J. Mammal, 83, 245-251.

GIACOMETTI, M., FREY, J., ABDO, EL-M., JANOVSKY, M., KRAWINKLER, M., SCHLATTER, Y., BELLOY, L., FATZER, R., NICOLET, J. (2000): Gemsblindheit. Schweiz. Arch. Tierheilk. 142, 235-240.

GIACOMETTI, M. (1999): Die infektiöse Keratokonjunktivitis. Z. Jagdwiss. 45, 151.

GLAWISCHNIG, W., KHASCHABI, D., SCHÖPF, K., SCHÖNBAUER, M. (2000): Ein seuchenhafter Ausbruch von Salmonella enterica Serovar Dublin bei Gemsen (Rupicapra rupicapra). Wien. Tierärztl. Mschr. 87, 21-25.

GRAUER, A., KÖNIG, A. (2009): Management of chamois in Bavaria (Germany): The importance of game activities in scabies control. Wildlife Biology in Practice, 5 (2), pp. 115-127.

GRESSMANN, G., DEUTZ, A. (2001): Überlegungen zur Eindämmung der Räudegefahr beim Gams-wild durch gezielte Bejagung der einzelnen Altersklassen. Z. Jagdwiss. 47, 34-42.

GRESSMANN, G. (2001): Gamsräude und Gamsblindheit: Auftreten in der Steiermark zwischen 1952 und 1999 sowie Schlussfolgerungen für Präventionsmaßnahmen im Rahmen der Jagd. Diss. Karl-Franzens Universität, Graz.

HOBY, S., WALZER, C., SLOTTA-BACHMAYR, L., SEGNER, H., ROBERT, N. (2006): Untersuchungen zur Pathologie von Wildungulaten im Nationalpark Hohe Tauern, Österreich. Wien. Tierärztl. Mschr. 93, 104-112.

IPPEN, R., NICKEL, S., SCHRÖDER, H.-D. (1995): Krankheiten des jagdbaren Wildes. DLV Deutscher Landwirtschaftsverlag Berlin, 3. Aufl.

JELOCNIK, M., SELF, R., TIMMS, P., BOREL, N., POLKINGHORNE, A. (2015): Novel sequence types of Chlamydia pecorum infect free-ranging Alpine ibex (Capra ibex) and red deer (Cervus elaphus) in Switzerland. Journal of Wildlife Diseases, 51 (2), pp. 479-483.

JOACHIM, A., PROSL, H. (2004): Magen-Darm-Würmer bei Schaf und Ziege. Klauentierpraxis 12, 95-100.

KERSCHAGL, W. (1965): Wildkrankheiten. Österreichischer Jagd- und Fischerei-Verlag, Wien. S. 91 - 101.

KNAUS, W., SCHRÖDER, W. (1975): Das Gamswild. 2. Aufl., Verlag Paul Parey, Hamburg und Berlin.

KROMP-KOLB, H., H. FORMAYER (2005): Schwarzbuch Klimawandel. Wie viel Zeit bleibt uns noch? ecowin Verlag der Top Akademie GmbH, Salzburg.

LOVEJOY, T. (2008): Climate change and biodiversity. In: Climate change: impact on the epidemiolo-gy and control of animal diseases. Rev. sci. tech. Off. Int. Epiz. 27 (2), p. 331-338.

MARCO, I. , CABEZÓN, O., VELARDE, R., FERNÁNDEZ-SIRERA, L., COLOM-CADENA, A., SER-RANO, E., ROSELL, R., CASAS-DÍAZ, E., LAVÍN, S. (2015): The two sides of border disease in Pyre-nean chamois (Rupicapra pyrenaica): Silent persistence and population collapse. Animal Health Re-search Reviews, 16 (1), pp. 70-77.

MARTÍNEZ-GUIJOSA, J., MARTÍNEZ-CARRASCO, C., LÓPEZ-OLVERA, J.R., FERNÁNDEZ-AGUILAR, X., COLOM-CADENA, A., CABEZÓN, O., MENTABERRE, G., FERRER, D., VELARDE, R., GASSÓ, D., GAREL, M., ROSSI, L., LAVÍN, S., SERRANO, E. (2015): Male-biased gastrointestinal parasitism in a nearly monomorphic mountain ungulate. Parasites and Vectors, 8 (1), art. no. 165.

MAVROT, F. ZIMMERMANN, F. VILEI, E. M. RYSER-DEGIORGIS, M. P. (2012): Is the development of infectious keratoconjunctivitis in Alpine ibex and Alpine chamois influenced by topographic fea-tures? Europ. J. Wildlife Res. 58(5), 869-874.

MAYER, D., NICOLET, J., GIACOMETTI, M., SCHMITT, M., WAHLI, T. MEIER, W. (1996): Isolation of Mycoplasma conjunctivae from conjunctival swabs of Alpine ibex (Capra ibex ibex) affected with keratoconjunctivitis. J. Vet. Med B 43, 155-161.

MICHEL, A.O., MATHIS, A., RYSER-DEGIORGIS, M.-P. (2014): Babesia spp. in European wild rumi-nant species: Parasite diversity and risk factors for infection. Veterinary Research, 45 (1), art. no. 65.

MICK, V., CARROU, G.L., CORDE, Y., GAME, Y., JAY, M., GARIN-BASTUJI, B. (2014): Brucella melitensis in France: Persistence in wildlife and probalble spillover from alpine ibex to domestic ani-mals. PLoS ONE, 9 (4), art. no. A1446.

MILLER, C., 1986: Die Gamsräude in den Alpen. Z. Jagdwiss. 32, 42-46.

MILLER, C. (1983): Verbreitung der Gamsräude und Dynamik der befallenen Bestände. Diplomarbeit, Universität München.

NICOLUSSI, K., G. PATZELT (2006): Klimawandel und Veränderungen an der alpinen Waldgrenze - aktuelle Entwicklungen im Vergleich zur Nacheiszeit. BFW-Praxisinformation 10, April 2006, Wien, S. 3-5.

PROSL, H. (2008): Parasiten und Klimawandel. Ber. Parasitologische Fachgespräche, 30. Mai, Inns-bruck, S. 3-4.

PROSL, H., KUTZER, E. (2006): Bedeutende Parasitosen beim Schalenwild und deren jagdwirtschaft-liche Bedeutung. Ber. Fachtagung, 10. November, Veterinärmedizinische Universität Wien, S. 6-20.

PROSL, H., REITER, I. (1984): Vergleichende Untersuchung zur Gastrointestinal-Nematodenfauna von Gemse (Rupicaprarupicapra) und Steinbock (Capra ibex). Z. Jagdwiss. 30, 89-100.

REHBEIN, S., VISSER, M., MESSNER, WOHLTMANN, A. (2011): Massiver Befall mit Larven von Kepkatrombicula desaleri (Acari: Trombiculidae) bei einem Gamskitz aus Tirol. Wien. Tierarztl. Mschr. 98, 255-260.

ROMMEL, M., ECKERT, J., KUTZER, E., KÖRTING, W., SCHNIEDER, T. (2000): Veterinärmedizini-sche Patasitologie, 5. Aufl., Parey Buchverlag, Berlin.

ROSSI, L. (1999): Untersuchungen zur Räude-Epidemie in der Provinz „Alto Bellunese“ (Italien). Gamswild-Tagung in Auronzo di Cadore: Ökologie, Krankheiten und Management. Zeitschr. Jagdwiss. 45, 148-149.

RYSER-DEGIORGIS, M.-P. (2013): Output of surveillance and research activities carried out at the FIWild – an overview. In: Wildlife population health in Switzerland: Novel approaches and applications, Habilitation thesis, University of Bern, Switzerland, p. 103–111.

SARNO, E., KELLER, S., WITTENBRINK, M.M., STEPHAN, R. (2013): Occurrence of Mycobacterium avium subsp. paratuberculosis in fecal samples of hunted deer, chamois and ibex in Switzerland. Schweiz. Arch. Tierheilk. 155, 523-525.

SCHAUMBERGER, J., SCHARDT, M., GUGGENBERGER, T., GALLAUN, H., SCHAUMBERGER, A., DEUTZ, A., GRESSMANN, G., GASTEINER, J. (2006): GIS-gestützte Ermittlung der Veränderung des Lebensraumes alpiner Wildtierarten bei Anstieg der Waldgrenze aufgrund Klimaveränderung. Endbericht StartClim 2005, Universität für Bodenkultur, Wien, 42 Seiten.

SCHEBECK, M., DEUTZ, A., GUGGENBERGER, T. (2014): Zur Zeckenfauna von Wildtieren in Ost-österreich (Ixodida, Ixodidae). Entomologica Austriaca 21, 209-222.

SCHIEFER, P., STEINRIGL, A., WODAK, E., DEUTZ, A, SCHMOLL, F. (2013): Detection of SBV antibodies in wild ruminants in Austria, 2012. Internat. Meeting on Emerging Diseases and Surveil-lance, February 15-18, Vienna.

SILAGHI, C., HAMEL, D., PFISTER, K., REHBEIN, S. (2011): Babesia species and co-infection with Anaplasma phagocytophilum in free-ranging ungulates from Tyrol (Austria). Wien. Tierarztl. Mschr. 98, 268-274.

TURCHETTO, S., OBBER, F., PERMUNIAN, R., VENDRAMI, S., LORENZETTO, M., FERRÉ, N., STANCAMPIANO, L., ROSSI, L., CITTERIO, C.V. (2014): Spatial and temporal explorative analysis of sarcoptic mange in Alpine chamois (Rupicapra r. rupicapra). Hystrix, 25 (1).

WAGNER, P., DEUTZ, A., FUCHS, K., MÜLLER, M., SCHULLER, W., KÖFER, J. (2005): Seroepide-miologische Untersuchungen zur Verbreitung von Chlamydia psittaci und Coxiella burnetii bei Schafen und Ziegen in der Steiermark. Vet. Med. Austria/Wien. Tierärztl. Mschr. 91, 114-118.

Literatur Vegetation

ABDELGAWAD, H., PESHEV, D., ZINTA, G.. VAN DEN ENDE, W., JANSSENS, I., ASARD, H. (2014): Climate Extreme Effects on the Chemical Composition of Temperate Grassland Species Un-der Ambient and Elevated CO2: A Comparison of Fructan and Non-Fructan Accumulators. PLoS ONE 9 (3), 1–13. doi:10.1371/journal.pone.0092044.

BLOOR, J.MG, PICHON, P., FALCIMAGNE, R., LEADLEY, P., SOUSSANA, J.F. (2010): Effects of Warming, Summer Drought, and CO2 Enrichment on Aboveground Biomass Production, Flowering Phenology, and Community Structure in an Upland Grassland Ecosystem. Ecosystems 13 (6), 888–900. doi:10.1007/s10021-010-9363-0. http:/www.springerlink.com/index/10.1007/s10021-010-9363-0.

BROOKSHIRE, E N J, WEAVER, T. (2015): Long-Term Decline in Grassland Productivity Driven by Increasing Dryness." Nature Communications 6 (January), 7148. doi:10.1038/ncomms8148. http://www.nature.com/ncomms/2015/150514/ncomms8148/full/ncomms8148.html

BÜTOF, A., VON RIEDMATTEN, L.R., DORMANN, C.F., SCHERER-LORENZEN, M., WELK, E., BRUELHEIDE, H. (2012): The Responses of Grassland Plants to Experimentally Simulated Climate Change Depend on Land Use and Region." Global Change Biology 18 (1) (January), 127–137. doi:10.1111/j.1365-2486.2011.02539.x. http:/doi.wiley.com/.

ELSEN, P.R., TINGLEY, M.W. (2015): Global Mountain Topography and the Fate of Montane Species Under Climate Change. Nature Climate Change Early view (May): 1–6.doi:10.1038/nclimate2656. http://www.nature.com/doifinder/10.1038/nclimate2656.

ERHARDT, A., RUSTERHOLZ, H.-P. (1997): Effects of Elevated CO2 on Flowering Phenology and Nectar Production. Acta Oecologica 18 (3) (January), 249–253. doi:10.1016/S1146-609X(97)80011-2. http://www.sciencedirect.com/science/article/pii/S1146609X97800112.

FUHRER, J., SMITH, P., GOBIET, A. (2014): Implications of Climate Change Scenarios for Agriculture in Alpine Regions - A Case Study in the Swiss Rhone Catchment. Science of the Total Environment 493 (September): 1232–1241. doi:10.1016/j.scitotenv.2013.06.038. http:/dx.doi.org/10.1016/j.scitotenv.2013.06.038, http:/www.sciencedirect.com/science/article/pii/ S0048969713006906.

GOBIET, A., KOTLARSKI, S., BENISTON, M., HEINRICH, G., RAJCZAK, J., STOFFEL, M. (2014): 21st Century Climate Change in the European Alps - a Review. The Science of the Total Environment 493 (September): 1138–51. doi:10.1016/j.scitotenv.2013.07.050. .http://www.sciencedirect.com/science/article/pii/ S0048969713008188.

GOTTFRIED, M., PAULI, H., FUTSCHIK, A., AKHALKATSI, M., BARANČOK, P., ALONSO, J.L.B., COLDEA, G. (2012): Continent-Wide Response of Mountain Vegetation to Climate Change. Nature Climate Change 2 (2) (January): 111–115. doi:10.1038/nclimate1329. http:/dx.doi.org/10.1038/nclimate1329.

GRABHERR, G., GOTTFRIED, M., AND PAULI, H. (1994): Climate Effects on Mountain Plants. Nature 369 (6480) (June): 448–448. doi:10.1038/369448a0. http://dx.doi.org/10.1038/369448a0.

GRUBER, L., GUGGENBERGER, T., STEINWIDDER, A., SCHAUER, A., HÄUSLER, J., STEIN-WENDER, R., SOBOTIK, M. (1998): Ertrag und Futterqualität von Almfutter des Höhenprofils Johns-bach in Abhängigkeit der Standortfaktoren. 4. Alpenländisches Expertenforum zum Thema „Zeitge-mäße Almbewirtschaftung sowie Bewertung von Almflächen und Waldweiden, 24. – 25. März, BAL Gumpenstein.

KÖRNER, C., DIEMER, M., SCHÄPPI, B, NIKLAUS, P., ARNONE, J. (1997): The Responses of Alpine Grassland to Four Seasons of CO2 Enrichment: a Synthesis. Acta Oeco-

logica 18 (3) (January): 165–175. doi:10.1016/S1146-609X(97)80002-1. http://www.sciencedirect.com/science/article/pii/ S1146609X97800021.

LENOIR, J., SVENNING, J.C. (2014): Climate-Related Range Shifts - a Global Multidimensional Syn-thesis and New Research Directions. Ecography 38 (1): 15–28. doi:10.1111/ecog.00967.

PAULI, H., GOTTFRIED, M., REITER, K., KLETTNER, C., GRABHERR, G. (2007): Signals of Range Expansions and Contractions of Vascular Plants in the High Alps: Observations (1994-2004) at the GLORIA Master Site Schrankogel, Tyrol, Austria. Global Change Biology 13 (1) (January): 147–156. doi:10.1111/j.1365-2486.2006.01282.x. http:/doi.wiley.com/10.1111/j.1365-2486.2006.01282.x.

RESCH, R., GUGGENBERGER, T.; WIEDNER, G., KASAL, A., WURM, K., GRUBER, L., RINGDOR-FER, F., Buchgraber, K. (2006): Futterwerttabellen für das Grundfutter im Alpenraum. Gemeinschaft-lich herausgegeben von: HBLFA Raumberg-Gumpenstein, Futtermittellabor Rosenau, LK Niederöster-reich, LK Steiermark, Land- und Forstwirtschaftliches Versuchszentrum Laimburg (Südtirol) und der ÖAG.

SCHAUMBERGER, A. (2011): Räumliche Modelle zur Vegetations- und Ertragsdynamik im Wirt-schaftsgrünland, Dissertation, TU-GRAZ.

THEURILLAT, J.P., FELBER, F., GEISSLER, P., GOBAT, J.M., FIERZ, M., FISCHLIN, A., KÜPFER, P., SCHLÜSSEL, A., VELUTTI, C., ZHAO, G.F. (1998): Sensitivity of Plant and Soil Ecosystems of the Alps to Climate Change. In Views from the Alps: Regional Perspectives on Climate Change, 225–308. Views from the Alps: Regional Perspectives on Climate Change. Boston: MIT Press.

THEURILLAT, J.P., GUISAN, A. (2001): Potential Impact of Climate Change on Vegetation in the Eu-ropean Alps: A Review. Climatic Change 50 (1-2): 77–109. doi:10.1023/A:1010632015572.
http://link.springer.com/article/10.1023/A\%3A1010632015572.

WALTHER, G.-R. (2010): Community and Ecosystem Responses to Recent Climate Change. Philo-sophical Transactions of the Royal Society of London. Series B, Biological Sciences 365 (1549): 2019–2024. doi:10.1098/rstb.2010.0021.

ZAMG (2014): Wetterrückblick für 2014. https://www.zamg.ac.at/cms/de/klima/klima-aktuell/jahresrueckblick, letzter Besuch: 13. August 2015

Literatur Steinbockhorn

BARBOSA, I.C.R., KLEY, M., SCHÄUFELE, R., AUERWALD, K., SCHRÖDER, W., FILLI, F., HERTWIG, S., SCHNYDER, H. (2010): Analysing the isotopic life history of the alpine ungulates Capra ibex and Rupicapra rupicapra rupicapra through their horns. Rapid Comunn. Mass. Spectrom., 2009, 23, 2347-2356.

BARBOSA, I.C.R., KÖHLER, I. H., AUERWALD, K., LÜPS, P., SCHNYDER, H. (2010): Last-century changes of alpine grass-land water-use efficienca: a reconstruction through carbon isotope analysis of a time-series of Capra ibex horns. Glob. Change. Biol., 16, 1171-1180.

BERGERON, P., FESTA-BIANCHET, M., VON HARDENBERG, A., BASSANO, B. (2008): Heteroge-neity in male horn growth and longevity in a highly sexually dimorphic ungulate. OIKOS, 117, 77-82.

BUCHLI (1998): Untersuchungen zur Konstitution von Steinböcken anhand von Hornmaßen. Z. Jagdwiss., 44, 244-250.

BUNNELL, F. L. (1978): Horn growth and population quality in Dall sheep. J. Wildlife Management, 42, 764-775.

BÜNTGEN, U., LIEBHOLD, A., JENNY, H., MYSTERUD, A., EGLI, S., NIEVERGELT, D., STENSETH, N. C., BOLLMAN, K. (2013): European springtime temperature synchronises ibex horn growth across the eastern Swiss Alps. Ecology Letters 2013.

COUTURIER, M.A.J., 1961: Determination de l'age du bouquetin des Alpes (Capra aeggrus ibex ibex) à l'aide des dens et des cornes. Mammalia, 25, 453-461.

EEA (Europ. Environment. Agency) (2009): Regional climate change and adaptations. EEA Report 8.

FANDOS, P. (1995): Factors affecting horn growth in male Spanish ibex (Capra pyrenaica). Mammalia, t. 59, 2, 229-235.

FANDOS, P. and VIGAL, C.R. VIGAL, 1988: Body weight and horn length in relation to age of Spanish wild goat. Acta Theriologica, 33, 339-344.

FANDOS, P., 1991: La cabra montés (Capra pyrenaica) en el Parque Natural de las Sierras de Cazor-la, Segura y las Villas. Instituto para la Conservación de la Naturaleza (ICONA), Madrid.

FESTA-BIANCHET, M., COLTMAN, D.W., TURELLI, L., JORGENSON, J.T. (2004): Relative allocation to horn and body growth in Bighorn rams varies with resource availability. Behav. Ecol., 15, 305-312.

FILLI, F. (2001): Die Wiederansiedlung des Steinbocks im Spiegel von Theorie und Management. Diss. TU München, Dep. F. Ökosystem- und Landschaftsmanagement.

GIACOMETTI, M., WILLING, R., DEFILA, C. (2002): Ambient temperature in spring influences horn growth in male alpine ibex. J. Mammal, 83, 245-251.

HEIMER, W.E., SMITH, A.C. (1975): Ram horn growth and population quality. Their significance to Dall sheep management in Alaska. Alaska Departm. of Fish and Game, Wildlife Technical Beulletin, 5, 1-41.

HEMMING, J.E. (1969): Cemntal deposition, tooth succession, and horn development as criteria of age in Dall sheep. J. of Wildlife Management, 33, 552-558.

HERFINDAL, I. (2013): Populationsdynamik. In: Der Alpensteinbock – Forschungsgeschichte und neue Erkenntnisse. Cratschla, Editiun speziala, 24-25.

HOEFS, M. (1974): Food selection in Dall sheep (Ovis dalli dalli, Nelson). In: The behavior of ungu-lates and its relation to management. Eds. V. Geist and F. Walther. IUCN. Publ. New Series 24, 759-786. Morges. Switzerland.

MEILE, P., GIACOMETTI, M., RATTI, P. (2003): Der Steinbock. Bern, Salm.

NIEVERGELT, B. (1966): Der Alpensteinbock (Capra ibex L.) in seinem Lebensraum. Hamburg, Paul Parey.

TAMME, O. (2012): Klimawandel im österreichischen Berggebiet. Forschungsbericht 65. Hrsgb.: Bun-desanstalt für Bergbauernfragen.

TOIGO, C., GAILLARD, J.-M., FESTA-BIANCHET, M., LARGO, E., MICHALLET, J., MAILLARD, D. (2007): Sex- and age-specific survival of the highly dimorphic Alpine ibex: evidence for a con-servative live history tactic. J. Animal Ecol., 76, 679-686.

VON HARDENBERG, A., BASSANO, B., FESTA-BIANCHET, M., LUIKART, G., LANFRANCHI, P., COLTMAN, D. (2007): Age-dependent genetic effects on a secondary sexual trait in male Alpine ibex, Capra ibex. Mol. Ecol., 16: 1969-1980

VON HARDENBERG, A., CAMPELL ANDRI, S. (2013): Populationsdynamik. In: Der Alpensteinbock – Forschungsgeschichte und neue Erkenntnisse. Cratschla, Editiun speziala, 14-15.

ZAMG (2015): http://www.zamg.ac.at/cms/de/klima/informationsportal-klimawandel/ klimazukunft/alpenraum

StartClim2014.E

Abegg, B. (1996). Klimaänderung und Tourismus. Klimafolgenforschung am Beispiel des Wintertourismus in den Schweizer Alpen. vdf Hochschulverlag an der ETH Zürich, Zürich.

Ansoff, I. (1957): Strategies for Diversification. Harvard Business Review 35, 113-124.

APCC (2014): Österreichischer Sachstandsbericht Klimawandel 2014 (AAR14). Austrian Panel on Climate Change (APCC), Verlag der Österreichischen Akademie der Wissenschaften, Wien, Österreich, 1096 S.

Benur, A.M., Bramwell, B. (2015): Tourism product development and product diversification in destinations. Tourism Management 50, 213-224.

Bürki, R., Elsasser, H., Abegg, B. (2003): Climate change –impacts on the tourism industry in mountain areas. 1st International Conference on Climate Change and Tourism, Djerba, Tunisia, 9-11 April. Online: http://breiling.org/snow/djerba.pdf(Zugriff 04.05.2015)

Gössling, S., Scott, D., Hall, M.C., Ceron J-P., Dubois, G. (2012): Consumer behaviour and demand response of tourists to climate change. Annals of Tourism Research 39(1), 36-58.

Holloway, J.C., Robinson, C. (1995): Marketing for tourism. Third edition. London: Longman.

Komppula, R. (2001): New-product development in tourism companies - case studies on nature-based activity operators. 10th Nordic Tourism Research Symposium, October 18-20 2001, Vasa, Finnland.

Lichtenecker, A., Eder, R., Restetzki, G. (2009): Natur, Erlebnis, Region: Ein Leitfaden zur Etablierung von nachhaltigen Naturerlebnisangeboten für Gemeinden und Regionen. Naturfreunde Internationale (Hrsg.), 58 S.

Moen, J., Fredman, P. (2007): Effects of Climate Change on Alpine Skiing in Sweden. Journal of Sustainable Tourism 15(4), 418-437.

Moshammer, H., Prettenthaler, F., Damm, A., Hutter, H.P., Jiricka, A., Köberl, J., Neger, C., Pröbstl-Haider, U., Radlherr, M., Renoldner, K., Steiger, R., Wallner, P., Winkler, C. (2014): Gesundheit und Tourismus. In: Österreichischer Sachstandsbericht Klimawandel 2014 (AAR14). Austrian Panel on Climate Change (APCC), Verlag der Österreichischen Akademie der Wissenschaften, Wien, Österreich, S. 933-978.

Müller, H., Scheurer, R. (2004): Tourismus-Destination als Erlebniswelt. Ein Leitfaden zur Angebots-Inszenierung. FIF Universität Bern, Bern.

Pröbstl, U. (2011): Tourismus, Natur und Klimawandel –Herausforderungen durch den Klimawandel für naturtouristische Angebote. Natur und Landschaft 86(12), 534-538.

Pröbstl, U., Schuster, S. (2011): Naturpark Pöllauer Tal. Eine Bilanz nach 20 Jahren Entwicklung im ländlichen Raum. zoll+ Österreichische Schriftenreihe für Landschaft und Freiraum 18, Wien. 13-17.

Pröbstl, U., Prutsch, A., Dallhammer, E., Formayer, H., Grabler, K., Haas, P., Jesch, M., Krajasits, C., Kulnig, A., Stanzer, G. (2008): Endbericht STRATEGE. Strategien zur nachhaltigen Raumentwicklung von Tourismusregionen unter dem Einfluss der globalen Erwärmung am Beispiel der Wintersportregion um Schladming. 81 S.

Pröbstl-Haider, U. (2015): Energie im Tourismus: Bevorzugt erneuerbar, kostengünstig & unsichtbar. Tourismus Wissen - quarterly 1, 8-13.

Pröbstl-Haider, U. (2013): Regionalwirtschaftliche Effekte von Naturparken. In: Verband der Naturparke Österreichs (VNÖ), Naturparke und nachhaltige Regionalentwicklung, 149 S.

Pröbstl-Haider, U., Melzer, V., Jiricka, A. (2014a): Rural tourism opportunities: Strategies and requirements for destination leadership in peripheral areas. Tourism Review 69(3), 216-228.

Pröbstl-Haider, U., Wirth, V., Haider, W. (2014b): Wie viel "Natur" suchen deutsche Urlauberinnen und Urlauber in den Alpen? Eine Quellgebietsstudie bezogen auf den Sommertour-ismus. Natur und Landschaft 1/2014, 26-32.

Scott, D., Jones, B., Konopek, J. (2007): Implications of climate and environmental change for nature-based tourism in the Canadian Rocky Mountains: A case study of Waterton Lakes National Park. Tourism Management 28, 570-579.

Scott, D., McBoyle, G. (2007): Climate change adaptation in the ski industry. Mitig Adapt Strat Glob Change 12, 1411-1431.

Siegrist, D., Gessner, S., Ketterer Bonnelame, L. (2015): Naturnaher Tourismus. Qualitätsstandards für sanftes Reisen in den Alpen. Zürich, Bristol-Stiftung; Bern, Haupt, 309 S.

UNWTO and UNEP and WMO (2008): Climate Change and Tourism: Responding to Global Challenges, (prepared by Scott, D., Amelung, B., Becken, S., Ceron, JP., Dubois, G., Gössling, S., Peeters, P. and Simpson, M.C.), UNWTO, Madrid, and UNEP, Paris.

Wirth, V. (2010): Entwicklungsperspektiven für den Alpentourismus unter Berücksichtigung von Klimawandel und geschützter Landschaft: Modellierung von Destinationsentscheidungen, Dissertation am Institut für Landschaftsentwicklung, Erholungs-und Naturschutz-planung, Universität für Bodenkultur, Wien, 212 S.

Zeithaml, V.A., Bitner, M.J. (1996): Services Marketing. Integrating customer focus across the firm. 2nd Edition. US: McCraw-Hill Higher Education.

StartClim2014.F

Boeckli L., Brenning A., Gruber S. & Noetzli J. (2012): Permafrost distribution in the European Alps: calculation and evaluation of an index map and summary statistics, The Cryosphere, 6, 807-820.

Brown J.O., Ferrians J.J., Heginbottom J.A. & Melnikov E.S. (1997): Circum- Arctic map of permafrost and ground-ice conditions. Washington, DC: U.S. Geological Survey in Cooperation with the Circum-Paci□c Council for Energy and Mineral Resources. Circum-Pacic Map Series CP-45, scale 1:10,000,000.

Cremonese E., Gruber S., Phillips M., Pogliotti P., Boeckli L., Noetzli J., Suter Ch., Bodin X., Crepaz A., Kellerer-Pirklbauer A., Lang K., Letey S., Mair V., Morra di Cella U., Ravanel L., Scapozza C., Seppi R., & Zischg A. (2011): An inventory of permafrost evidence for the European Alps. The Cry-osphere, 5, 651-657.

Delaloye R., Perruchoud E., Avian M., Kaufmann V., Bodin X., Ikeda A., Hausmann H., Kääb A., Kel-lerer-Pirklbauer A., Krainer K., Lambiel C., Mihajlovic D., Staub B., Roer I. & Thibert E. (2008): Recent Interannual Variations of Rockglaciers Creep in the European Alps. Proceedings of the Ninth Interna-tional Conference on Permafrost (NICOP), University of Alaska, Fairbanks, USA, June – July 2008, 343-348

Ebohon B. & Schrott L. (2008): Modelling Mountain Permafrost Distribution - A New Permafrost Map of Austria. Proceedings of the 9th International Conference on Permafrost (NICOP), University of Alaska, Fairbanks, USA, 397-402.

Fegerl, L. (2015): Bedeutung von Permafrost und Periglazial bedingte Naturgefahren bei geologischen Landesdienststellen: Das Beispiel Salzburg. Vortrag im Rahmen des permAT Workshops in Graz, 26. und 27. Februar 2015.

Gruber S. (2012): Derivation and analysis of a high-resolution estimate of global permafrost zonation. The Cryosphere, 6, 221–233, 2012

Haeberli W& Patzelt G (1982): Map of permafrost distribution in area of Hochebenkar-Blockgletscher, Austria. doi:10.1594/PANGAEA.802398, In Supplement to: Haeberli, Wilfried; Patzelt, Gernot (1982): Permafrostkartierung im Gebiet der Hochebenkar-Blockgletscher, Obergurgl, Ötztaler Alpen. Zeitschrift für Gletscherkunde und Glazialgeologie, 18(2), 127-150, hdl:10013/epic.40222.d001

Hallet B., Walder J. & Stubbs C.W. (1991): Weathering by segregation ice growth in microcracks at sustained sub-zero temperatures: Verification from an experimental study using acoustic emissions. – Permafrost and Periglacial Processes 2: 283-300.

Hasler, A., Gruber, S. & Beutel, J. (2010): Kinematics of steep bedrock permafrost. Journal of Geo-physical Research, 117, F01016.

Hoelzle M. (2015): Das Langzeitpermafrostmonitoring Programm PERMOS in der Schweiz: Past, Pre-sent and Future. Vortrag im Rahmen des permAT Workshops in Graz, 26. und 27. Februar 2015.

Kapelari, P. 2015: Bedeutung von Langzeitmonitoring von Permafrost und Periglazialen Prozessen für die Prävention von Naturgefahren: Die Sicht des Österreichischen Alpenvereins. Vortrag im Rahmen des permAT Workshops in Graz, 26. und 27. Februar 2015.

Kaufmann V. & Kellerer-Pirklbauer A. (2015): Active rock glaciers in a changing environment: Geo-morphometric quantification and cartographic presentation of rock glacier surface change with exam-ples from the Hohe Tauern Range, Austria: Kriz K. (ed.): 16 years of the Commission on Mountain Cartography (CMC) of the International Association of Cartography (ICA) – in Druck

Keller, F., 1994: Interaktionen zwischen Schnee und Permafrost. Eine Grundlagenstudie im Oberen-gadin. Mitteilungen der Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie 127, ETH Zürich.

Kellerer-Pirklbauer A. (2013): Ground surface temperature and permafrost evolution in the Hohe Tauern National Park, Austria, between 2006 and 2012: Signals of a warming climate? 5th Symposium for Research in Protected Areas - Conference Volume, 10 to 12 June 2013, Mittersill, Austria, 363-372.

Kellerer-Pirklbauer A. (2014): Permafrost. In Stowasser R. & Köhler M., Global Climate Observing System – Bericht Österreich, Vienna 2014, 58-59.

Kellerer-Pirklbauer A. & Kaufmann V. (2012): About the relationship between rock glacier velocity and climate parameters in central Austria. Austrian Journal of Earth Sciences, 105/2, 94-112.

Kellerer-Pirklbauer A., Lieb G.K., Avian M. & Carrivick J. (2012a): Climate change and rock fall events in high mountain areas: Numerous and extensive rock falls in 2007 at Mittlerer Burgstall, Central Aus-tria. Geografiska Annaler: Series A, Physical Geography, 94, 59-78.

Kellerer-Pirklbauer A., Lieb G.K. & Kleinferchner H. (2012b): A new rock glacier inventory of the east-ern European Alps. Austrian Journal of Earth Sciences, 105/2, 78-93.

Kern K., Lieb G.K., Seier G. & Kellerer-Pirklbauer A. (2012): Modelling geomorphological hazards to assess the vulnerability of alpine infrastructure: The example of the Großglockner-Pasterze area, Aus-tria. Austrian Journal of Earth Sciences, 105/2, 113-127.

Klene A.E., Nelson F.E. & Shiklomanov N.I. (2001): The n-factor as a tool in geocryological mapping: seasonal thaw in the Kuparuk River Basin, Alaska. Physical Geography 22: 449–466.

Krainer K. & Ribis M. (2012): A rock glacier inventory of the Tyrolean Alps (Austria). Austrian Journal of Earth Sciences, 105/2, 32-47.

Krainer K., Kellerer-Pirklbauer A., Kaufmann V., Lieb G.K., Schrott L. & Hausmann H. (2012a): Perma-frost Research in Austria: History and recent advances. Austrian Journal of Earth Sciences, 105/2, 2-11.

Krainer K., Kellerer-Pirklbauer A., Kaufmann V., Lieb G.K., Schrott L. & Hausmann H. (2012b): Perma-frost in Austria. Austrian Journal of Earth Sciences, 105/2; http://www.univie.ac.at/ajes/

Krainer K., Bressan D., Dietre B., Haas J.N., Hajdas I., Lang K., Mair V., Nickus U., Reidl D., Thies H. & Tonidandel D. (2015): A 10,300-year-old permafrost core from the active rock glacier Lazaun, southern Ötztal Alps (South Tyrol, northern Italy). Quaternary Research, 83, 2, 324–335.

Lambrecht, A. & Kuhn, M. (2007): Glacier changes in the Austrian Alps during the last three decades, derived from the new Austrian glacier inventory. Annals of Glaciology, 46, 177-184.

Lieb, G.K. (1998): High-mountain permafrost in the Austrian Alps (Europe). Proceedings of the 7th International Permafrost Conference, Yellowknife, Canada, 663-668.

Lieb G. K. (2007): Vom Klimawandel beeinflusste Naturprozesse im Hochgebirge als potenzielle Ge-fahren für Freizeitaktivitäten – qualitative Überlegungen mit Beispielen aus den Hohen Tauern. In: Geograph. Jahresbericht aus Österreich LXII/LXIII, 79-94.

Lieb G. K. & Krobath M. (2015): Permafrost – ein sinnvolles Thema im GW-Unterricht? GW-Unterricht 138/2, 44–55.

Lieb, G.K., Kern, K. & Seier, G. (2010): AlpinRiskGP - Abschätzung des derzeitigen und zukünftigen Gefährdungspotentials für Alpintouristen und Infrastruktur bedingt durch Gletscherrückgang und Per-mafrostveränderung im Großglockner-Pasterzengebiet (Hohe Tauern, Österreich). Endbericht von StartClim2009.F in StartClim2009: Anpassung an den Klimawandel: Beiträge zur Erstellung einer An-passungsstrategie für Österreich, Auftraggeber: BMLFUW, BMWF, BMWFJ, ÖBF

Mair, V., Zischg, A., Lang, K., Tonidandel, D., Krainer, K., Kellerer-Pirklbauer, A., Deline, P., Schoen-eich, P., Cremonese, E., Pogliotti, P., Gruber, S., Böckli, L., 2011: PermaNET - Permafrost Long-term Monitoring Network. Synthesis report. INTERPRAEVENT Journal Series 1, Report 3. Klagenfurt. 28 pp

Matsuoka, N. (2008): Frost weathering and rockwall erosion in the southeastern Swiss Alps: Long-term (1994–2006) observations. – Geomorphology 99: 353-368.

Mirtl M., Bahn M., Battin T., Borsdorf A., Dirnböck T., Englisch M., Erschbamer B., Fuchsberger J., Gaube V., Grabherr G., Gratzer G., Haberl H., Klug H., Kreiner D., Mayer R., Peterseil J., Richter A., Schindler S., Stocker-Kiss A., Tappeiner U., Weisse T., Winiwarter V., Wohlfahrt G., Zink R. (2015): Forschung für die Zukunft – LTER-Austria White Paper 2015 zur Lage und Ausrichtung von prozess-orientierter Ökosystemforschung, Biodiversitäts- und Naturschutzforschung sowie sozio-ökologischer Forschung in Österreich. LTER-Austria Schriftenreihe, Vol. 2, 74 S.

Mölk, M. 2015: Bedeutung und Einfluss von Permafrost und periglazialen Prozessen auf den Schutz vor Naturgefahren im Tätigkeitsbereich der Wildbach- und Lawinenverbauung. Vortrag im Rahmen des permAT Workshops in Graz, 26. und 27. Februar 2015.

Naeimi V., Paulik C., Bartsch A., Wagner W., Kidd R., Boike J. & Elger K. (2012): ASCAT Surface State Flag (SSF): Extracting Information on Surface Freeze/Thaw Conditions From Backscatter Data Using an Empirical Threshold-Analysis Algorithm. IEEE Transactions on Geoscience and Remote Sensing. DOI: 10.1109/TGRS.2011.2177667.

Noetzli, J., Gruber, S., and Hoelzle, M. 2004. Permafrost und Felsstürze im Hitzesommer 2003. GEOforum actuel, 20, 11-14

Paul F., Frey H. & Le Bris R. (2011): A new glacier inventory for the European Alps from Landsat TM scenes of 2003: Challenges and results, Ann. Glaciol., 52, 144-152.

Park, S.E., Bartsch, A., D. Sabel, W. Wagner, V. Naeimi, Y., Yamaguchi (2011): Monitoring Freeze/Thaw Cycles using ENVISAT ASAR Global Mode Remote Sensing of Environment 115, 3457-3467.

PERMOS 2013. Permafrost in Switzerland 2008/2009 and 2009/2010. Noetzli, J. (ed.), Glaciological Report (Permafrost) No. 10/11 of the Cryospheric Commission of the Swiss Academy of Sciences, 80 pp.

Pfeiler, S. 2015: Permafrost und Periglazial bedingten Naturgefahren: Bedeutung für die Geologische Bundesanstalt. Vortrag im Rahmen des permAT Workshops in Graz, 26. und 27. Februar 2015.

Pröbstl U, & Damm B. (2009): Wahrnehmung und Bewertung von Naturgefahren als Folge von Glet-scherschwund und Permafrostdegradation in Tourismus-Destinationen am Beispiel des Tuxer Tals (Zillertaler Alpen/Österreich). Endbericht von StartClim2008.F in StartClim2008: Anpassung an den Klimawandel: Beiträge zur Erstellung einer Anpassungsstrategie für Österreich, Auftraggeber: BML-FUW, BMWF, BMWFJ, ÖBF

Schoeneich P., Bodin X., Echelard T., Kaufmann V., Kellerer-Pirklbauer A., Krysiecki J.M. & Lieb G.K. 2014: Velocity changes of rock glaciers and induced hazards. In: G. Lollino et al. (eds.), Engineering Geology for Society and Territory – Volume 1, Springer International Publishing Switzerland, 223-227. DOI:10.1007/978-3-319-09300-0_42

Schöner W. 2015: The Global Cryosphere Watch (GCW) - Surface Observations Programme CryoNet. Vortrag im Rahmen des permAT Workshops in Graz, 26. und 27. Februar 2015.

Stowasser R., 2015: Das Global Climate Observing System (GCOS) und die Rolle von Permafrost darin. Vortrag im Rahmen des permAT Workshops in Graz, 26. und 27. Februar 2015.

Vaughan, D.G., J.C. Comiso, I. Allison, J. Carrasco, G. Kaser, R. Kwok, P. Mote, T. Murray, F. Paul, J. Ren, E. Rignot, O. Solomina, K. Steffen and T. Zhang, 2013: Observations: Cryosphere. In: Climate Change 2013: The Physical Sci¬ence Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge Uni-versity Press, Cambridge, United Kingdom and New York, NY, USA, 317-382.

ZAMG (2013): Permafrost-Monitoring Sonnblickgebiet. Abschlußbericht: SSBO (Strukturprojekt „ Sonnblick Observatorium – Begleitende Maßnahmen zur Umsetzung der ENVISON Ziele), 48 S.

9 List of Figures

Annex

The following projects were part of StartClim2003 to StartClim2013. All reports can be found on the StartClim2014 CD-ROM or downloaded from the StartClim webpage (www.startclim.at).

Contributions to StartClim2003

StartClim.1: **Quality control and statistical characteristics of selected climate parameters on the basis of daily values in the face of extreme value analysis**
Central Institute of Meteorology and Geodynamics**:** Wolfgang Schöner, Ingeborg Auer, Reinhard Böhm, Sabina Thaler

StartClim.2: **Analysis of the representativeness of a data collected over a span of fifty years for the description of the variability of climatic extremes**
Central Institute of Meteorology and Geodynamics**:** Ingeborg Auer, Reinhard Böhm, Eva Korus, Wolfgang Schöner

StartClim.3a: **Extreme events: documentation of hazardous events in Austria such as rock avalanches, floods, debris flows, landslides, and avalanches**
Institute of Forest and Mountain-Risk Engineering, BOKU**:** Dieter Rickenmann, Egon Ganahl

StartClim.3b: **Documentation of the impact of extreme weather events on agricultural production**
ARC Seibersdorf research: Gerhard Soja, Anna-Maria Soja

StartClim.3c: **Meteorological extreme event data information system for the eastern Alpine region – MEDEA**
Federal Environment Agency: Martin König, Herbert Schentz, Johann Weigl
IIASA: Mathias Jonas, Tatiana Ermolieva

StartClim.4: **Development of a method to predict the occurrence of extreme events from large-scale meteorological fields**
Institute of Meteorology and Physics, BOKU: Andreas Frank, Petra Seibert

StartClim.5: **Testing statistical downscaling techniques for their applicability to extreme events in Austria**
Institute of Meteorology and Physics, BOKU: Herbert Formayer, Christoph Matulla, Patrick Haas
GKSS Forschungszentrum Geesthacht: Nikolaus Groll

StartClim.6: **Adaptation strategies for economic sectors affected heavily by extreme weather events: economic evaluation and policy options**
Austrian Humans Dimensions Programme (HDP-A)**,** Department of Economics, Karl-Franzens-Universität Graz**:** Karl Steininger, Christian Steinreiber, Constanze Binder, Erik Schaffer**,** Eva Tusini, Evelyne Wiesinger

StartClim.7: **Changes in the social metabolism due to the 2002-flooding in Austria: case study of an affected community**
Institute of Interdisciplinary Studies of Austrian Universities (IFF)**:** Willi Haas, Clemens Grünbühel, Brigitt Bodingbauer

StartClim.8: **Risk-management and public prosperity in the face of extreme weather events: What is the optimal mix of private insurance, public risk pooling and alternative transfer mechanisms?**
Department of Economics, Karl-Franzens-Universität Graz**:** Walter Hyll, Nadja Vetters, Franz Prettenthaler

StartClim.9: **Summer 2002 floods in Austria: damage account data pool**
Centre of Natural Hazards and Risk Management (ZENAR), BOKU - University of Natural Resources and Applied Life Sciences: Helmut Habersack, Helmut Fuchs

StartClim.10: **Economic aspects of the 2002 floodings: data analysis, asset accounts and macroeconomic effects**
Austrian Institute of Economic Research (WIFO)**:** Daniela Kletzan, Angela Köppl, Kurt Kratena

StartClim.11: **Communication at the interface science – education**
Institute of Meteorology and Physics, BOKU - University of Natural Resources and Applied Life Sciences**:** Ingeborg Schwarzl
Institute of Interdisciplinary Studies of Austrian Universities (IFF)**:** Willi Haas

StartClim.12: **Developing an innovative approach for the analysis of the August 2002 flood event in comparison with similar extreme events in recent years**
Department of Meteorology and Geophysics, University of Vienna**:** Simon Tschannett, Barbara Chimani, Reinhold Steinacker

StartClim.13: **High-resolution precipitation analysis**
Department of Meteorology and Geophysics, University of Vienna**:** Stefan Schneider, Bodo Ahrens, Reinhold Steinacker, Alexander Beck

StartClim.14: **Performance of meteorological forecast models during the August 2002 floods**
Central Institute of Meteorology and Geodynamics: Thomas Haiden, Alexander Kann

StartClim.C: **Design of a long term climate/climate-impact research programme for Austria**
Institute of Meteorology and Physics, BOKU: Helga Kromp-Kolb, Andreas Türk

StartClim Reference database: Implementation of a comprehensive literature database on climate and climate impact research as a generally accessible basis for future climate research activities
Institute of Meteorology and Physics, University of Natural Resources and Applied Life Sciences**:** Patrick Haas

Contributions to StartClim2004

StartClim2004.A: **Analysis of heat and drought periods in Austria: extension of the daily StartClim data record by the element vapour pressure**
Central Institute of Meteorology and Geodynamics**:** Ingeborg Auer, Eva Korus, Reinhard Böhm, Wolfgang Schöner

StartClim2004.B: Investigation of regional climate change scenarios with respect to heat waves and dry spells in Austria
Institute of Meteorology, BOKU: Herbert Formayer, Petra Seibert, Andreas Frank, Christoph Matulla, Patrick Haas

StartClim2004.C: Analysis of the impact of the drought in 2003 on agriculture in Austria – comparison of different methods
ARC Seibersdorf research: Gerhard Soja, Anna-Maria Soja
Institute of Meteorology, BOKU: Josef Eitzinger, Grzegorz Gruszczynski, Mirek Trnka, Gerhard Kubu, Herbert Formayer
Institute of Surveying, Remote Sensing and Land Information, BOKU: Werner Schneider, Franz Suppan, Tatjana Koukal

StartClim2004.F: Continuation and further development of the MEDEA event database
Federal Environment Agency: Martin König, Herbert Schentz, Katharina Schleidt
IIASA: Matthias Jonas, Tatiana Ermolieva

StartClim2004.G: "Is there a relation between heat and productivity?" A project at the interface between science and education
Institute of Meteorology, BOKU**:** Ingeborg Schwarzl, Elisabeth Lang, Erich Mursch-Radlgruber

Contributions to StartClim2005

StartClim2005.A1a: Impacts of temperature on mortality and morbidity in Vienna
Medical University of Vienna, Centre for Public Health, Institute of Environmental Hygiene: Hanns Moshammer, Hans-Peter Hutter
Institute of Meteorology, BOKU**:** Andreas Frank, Thomas Gerersdorfer
Austrian Federal Institute of Health Care**:** Anton Hlava, Günter Sprinzl
Statistics Austria: Barbara Leitner

StartClim2005.A1b: Nocturnal cooling under a changing climate
Institute of Meteorology, BOKU**:** Thomas Gerersdorfer, Andreas Frank, Herbert Formayer, Patrick Haas
Medical University of Vienna, Centre for Public Health, Institute of Environmental Hygiene: Hanns Moshammer
Statistics Austria: Barbara Leitner

StartClim2005.A4: Impacts of meteorological extreme events on safety of drinking water supply in Austria
Institute of Sanitary Engineering and Water Pollution Control, BOKU**:** Reinhard Perfler, Mario Unterwainig
Institute of Meteorology, BOKU**:** Herbert Formayer

StartClim2005.C2: Studies on the distribution of tularaemia under the aspect of climate change
Gesellschaft für Wildtier und Lebensraum – Greßmann & Deutz OEG**:** Armin Deutz
HBLFA Raumberg Gumpenstein, Agricultural Research and Education Centre: Thomas Guggenberger

StartClim2005.C3a: Impacts of climate change on agricultural pests and antagonists in organic farming in Eastern Austria
Bio Forschung Austria: Bernhard Kromp, Eva Maria Grünbacher, Patrick Hann
Institute of Meteorology, BOKU: Herbert Formayer

StartClim2005.C3b: Risk analysis of the establishment of the western flower thrips (Frankliniella occidentalis) under outdoor conditions in Austria as a result of the climate change
The Austrian Agency für Health and Food Safety, AGES: Andreas Kahrer
Institute of Meteorology, BOKU: Herbert Formayer

StartClim2005.C5: An allergenic neophyte and its potential spread in Austria – range dynamics of ragweed (Ambrosia artemisiifolia) under influence of climate change
VINCA, Vienna Institute for Nature Conservation & Analysis**:** Ingrid Kleinbauer, Stefan Dullinger
Federal Environment Agency**:** Franz Essl, Johannes Peterseil

StartClim2005.F: GIS-sustained simulation of diminishing habitats of snow grouse, black grouse, chamois and capricorn under conditions of global warming and heightening forest limits
Joanneum Research: Heinz Gallaun, Jakob Schaumberger, Mathias Schardt
HBLFA Raumberg-Gumpenstein: Thomas Guggenberger, Andreas Schaumberger, Johann Gasteiner
Gesellschaft für Wildtier und Lebensraum - Greßmann & Deutz OEG: Armin Deutz, Gunter Greßmann

Contributions to StartClim2006

StartClim2006.A: Particulate matter and climate change – are there connections between them in north-eastern Austria?
Institute of Meteorology, BOKU: Bernd C. Krüger, Irene Schicker, Herbert Formayer
Medical University of Vienna, Centre for Public Health, Institute of Environmental Hygiene: Hanns Moshammer

StartClim2006.B: Risk Profile for the autochthonous occurrence of Leishmania infections in Austria
Medical University of Vienna: Horst Aspöck, Julia Walchnik
Institute of Meteorology, BOKU: Thomas Gerersdorfer, Herbert Formayer

StartClim2006.C: Effects of climate change on the dispersion of white grub damages in the Austrian grassland
Bio Forschung Austria: Eva Maria Grünbacher, Patrick Hann, Claus Trska, Bernhard Kromp
Institute of Meteorology, BOKU: Herbert Formayer

StartClim2006.D1: Sensitivity of Austrian summer tourism to climate change
Institut für touristische Raumplanung: Volker Fleischhacker
Institute of Meteorology, BOKU: Herbert Formayer

StartClim2006.D2: Effects of climate change on the climatic potential of tourism
Institute of Meteorology, University of Freiburg: Andreas Matzarakis, Christina Endler, Robert Neumcke
Central Institute of Meteorology and Geodynamics: Elisabeth Koch, Ernest Rudel

StartClim2006.D3: See-Vision: influence of climate change-induced fluctuation of water level in Lake Neusiedl on the perception and behaviour of visitors and locals
Institute of Landscape Development, Recreation and Conservation Planning, BOKU: Ulrike Pröbstl, Alexandra Jiricka, Thomas Schauppenlehner
Simon Fraser University, Burnaby, Canada: Wolfgang Haider

StartClim2006.F: Climate change impacts on energy use for space heating and cooling in Austria
Institute of Technology and Regional Policy, Joanneum Research (1);
Wegener Center for Climate and Global Change, University of Graz (2);
Institute for Geophysics, Astrophysics and Meteorology, University of Graz (3);
Institute for Meteorology and Geophysics, University of Vienna (4);
Institute of Energy Research, Joanneum Research (5)
Franz Prettenthaler 1,2, Andreas Gobiet 2,3, Clemens Habsburg-Lothringen 1, Reinhold Steinacker 4, Christoph Töglhofer 2, Andreas Türk 2,5

Contributions to StartClim2007

StartClim2007.A: Enlargement and completion of the StartClim dataset for the element daily snow depth. Update of the already existing StartClim datasets (air temperature, precipitation and vapour pressure) until April 2007
Central Institute of Meteorology and Geodynamics: Ingeborg Auer, Anita Jurković, Reinhard Böhm, Wolfgang Schöner, Wolfgang Lipa

StartClim2007.B: Health risks for the Austrian population due to the depletion of stratospheric ozone
Institute of Meteorology, University of Natural Resources and Applied Life Sciences, Vienna: Stana Simic
Institute of Medical Physics and Biostatistics, University of Veterinary Medicine Vienna: Alois W. Schmalwieser
Medical University of Vienna, Centre for Public Health, Institute of Environmental Hygiene: Hanns Moshammer

StartClim2007.C: Adaptations of insect pests to climate change in crop production of eastern Austria: conception of a long-term monitoring system
Bio Forschung Austria: Eva-Maria Grünbacher, Patrick Hann, Bernhard Kromp
Institute of Meteorology, University of Natural Resources and Applied Life Sciences, Vienna: Herbert Formayer

StartClim2007.D: Consequence of the climate-induced upwards shift of the timberline on the release of greenhouse gases - dynamics of soil organic matter
Federal Forest Office: Robert Jandl, Andreas Schindlbacher, Sophie Zechmeister-Boltenstern, Michael Pfeffer
Department of Forest and Soil Sciences, University of Natural Resources and Applied Life Sciences, Vienna: Klaus Katzensteiner
Federal Environment Agency: Sabine Göttlicher
University of Vienna: Hannah Katzensteiner
Tiroler Landesforstdirektion: Dieter Stöhr

StartClim2007.E: Global change and its effect on runoff behaviour of glacierised basins with regard to reservoir power stations
Institute of Meteorology and Geophysics, University Innsbruck: Michael Kuhn, Marc Olefs, Andrea Fischer

StartClim2007.F: ALSO WIKI – Alpine summer tourism in Austria and the potential effects of climate change
Austrian Institute for Regional Studies and Spatial Planning: Cornelia Krajasits, Gregori Stanzer, Adolf Anderl, Wolfgang Neugebauer, Iris Wach
Central Institute of Meteorology and Geodynamics: Christine Kroisleitner, Wolfgang Schöner

StartClim2007.G: Integrated modelling of the economy under climate change in application of the STERN report (STERN.AT)
Wegener Centre for Climate and Global Change, University of Graz: Olivia Koland, Karl Steininger, Andreas Gobiet, Georg Heinrich, Claudia Kettner, Alexandra Pack, Matthias Themeßl, Christoph Töglhofer, Andreas Türk, Thomas Trink
Joanneum Research, Institut für Technologie- und Regionalpolitik: Raimund Kurzmann
University of Natural Resources and Applied Life Sciences, Vienna: Erwin Schmid

Contributions to StartClim2008

StartClim2008.A: Impacts of adaptation measures on the acute mortality risk due to extreme temperature in Vienna
Institute of Environmental Hygiene, Centre for Public Health, MUW: Hanns Moshammer, Hans-Peter Hutter
Institute of Meteorology, BOKU: Thomas Gerersdorfer

StartClim2008.B: Which adaptations of soil erosion protection measures can be recommended for expected climate change impacts?
Institute of Hydraulics and Rural Water Management, BOKU: Andreas Klik
Institute of Meteorology, BOKU: Josef Eitzinger
Institute of Agronomy and Plant Breeding, BOKU: Peter Liebhard

StartClim2008.C: Practical testing of the monitoring concept "Adaptations of insect pests to climate change in crop production of eastern Austria" by investigating the distribution of current cutworm (Agrotis segetum, Schiff.; Fam. Noctuidae) damage as a function of site-related and climatic factors
Bio Forschung Austria: Patrick Hann, Claus Trska, Eva Maria Frauenschuh, Bernhard Kromp

StartClim2008.D: Organic agriculture in the mountains of Tyrol—contributions to mitigating climate change and adaptation strategies
Division of Organic Farming, BOKU: Michael Dorninger, Bernhard Freyer

StartClim2008.E: Development and economic valuation of landscape structures to decrease evapotranspiration on agricultural acres with account taken of climate change and biomass production
Institute of Landscape Development, Recreation and Conservation Planning, BOKU: Christiane Brandenburg, Bernhard Ferner, Sonja Völler, Brigitte Allex
Institute of Meteorology, BOKU: Josef Eitzinger, Thomas Gerersdorfer
Division of Organic Farming, BOKU: Bernhard Freyer, Andreas Surböck, Agnes Schweinzer, Markus Heinzinger
Institute of Agricultural and Forestry Economics, BOKU: Enno Bahrs

StartClim2008.F: Perception and evaluation of natural hazards as a consequence of glacier retreat and permafrost degradation in tourism destinations—a case study in the Tux Valley (Zillertaler Alps, Austria)
Institute of Landscape Development, Recreation and Conservation Planning, BOKU: Ulrike Pröbstl
University of Regensburg, University Eichstätt-Ingolstadt: Bodo Damm

StartClim2008.G: Adaptation of forest soils to a changing climate
Federal Research and Training Centre for Forests, Natural Hazards and Landscape: Barbara Kitzler, Verena Stingl, Sophie Zechmeister-Boltenstern
Institute of Meteorology and Climate-Research – Atmospheric Environmental Research, Garmisch: Arjan De Brujin, Ralf Kiese, Klaus Butterbach-Bahl

Contributions to StartClim2009

StartClim2009.A: Vegetation change according to different climate and management conditions in Austrian mountain grassland – a case study on Styrian mountain grasslands
Institute of Botany, BOKU: Gabriele Bassler, Gerhard Karrer
Institute of Meteorology, BOKU: Herbert Formayer
LFZ-Raumberg-Gumpenstein: Andreas Schaumberger, Andreas Bohner, Walter Starz
Bio Ernte Steiermark: Wolfgang Angeringer

StartClim2009.B: Climate-growth response of Norway spruce provenances in the Alpine region – an opportunity for adaption of the Austrian forestry
Federal Research and Training Centre for Forests, Natural Hazards and Landscape: Silvio Schüler, Stefan Kapeller
Central Institute of Meteorology and Geodynamics: Johann Hiebl

StartClim2009.C: Analysis of vulnerability and adaptation to climate change in the Wienerwald biosphere reserve
Institute of Silviculture, BOKU: Stefan Schörghuber, Werner Rammer, Rupert Seidl, Manfred J. Lexer

StartClim2009.D: Humus assays as a practical tool for farmers to support carbon sequestration in agriculture
Bio Forschung Austria: Wilfried Hartl, Eva Erhart

StartClim2009.E: Adapting office buildings to climate change: optimisation of thermal comfort
Danube University Krems: Tania Berger, Peter Pundy

StartClim2009.F: AlpinRiskGP - estimation of present and future risk potential for Alpine tourists and infrastructure caused by glacier retreat and permafrost changes in the Grossglockner-Pasterze glacier area (Hohe Tauern, Austria)
Geography and Regional Science, Karl-Franzens-University Graz: Gerhard Karl Lieb, Katharina Kern, Gernot Seier, Andreas Kellerer-Pirklbauer-Eulenstein, Ulrich Strasser

Contributions to StartClim2010

StartClim2010.A: Fields of action and responsible actors for climate change adaptation of public parks in cities
Institute of Landscape Development, Recreation and Conservation Planning (ILEN), BOKU: Stephanie Drlik, Andreas Muhar

StartClim2010.B: Recommendations for an adaptation of urban open and green spaces in Austrian cities and city regions
PlanSinn GmbH, Office for Planning and Communication: Erik Meinharter
Federal Environment Agency: Maria Balas

StartClim2010.C: The social costs of adaptation: approaches to an evaluation of adaptation options (SALDO)
Wegener Center for Climate and Global Change, University Graz: Birgit Bednar-Friedl, Olivia Koland, Janine Raab
Federal Environment Agency: Martin König

StartClim2010.D: Integrated precautionary and adaptation measures for the Marchfeld region
Institute for Sustainable Economic Development, BOKU: Christine Heumesser, Mathias Kirchner, Erwin Schmid, Franziska Strauss

StartClim2010.E: Ecological and silvicultural characteristics of European larch (Larix decidua Mill.) – consequences for forest management in Austria in consideration of climate change
Institute of Silviculture, BOKU: Eduard Hochbichler, Gabriele Wolfslehner, Roland Koeck, F. Arbeiter
Federal Research and Training Centre for Forests, Natural Hazards and Landscape: Herfried Steiner, Georg Frank
Institute of Meteorology, BOKU: Herbert Formayer

Startclim2010.F: Hot town, summer in the city – effects of hot days on recreational and leisure behaviour and sightseeing programmes of city tourists as exemplified by the case of Vienna
Institute of Landscape Development, Recreation and Conservation Planning (ILEN), BOKU: Christiane Brandenburg, Brigitte Allex, Ursula Liebl, Christina Czachs
Institute of Meteorology, BOKU: Thomas Gerersdorfer

StartClim2010.G: Knowledge-based platform to optimise operations strategies in handling natural hazards
Austrian Red Cross: Jürgen Högl, Clemens Liehr, Gerry Foitik
Institute of Production and Logistics, BOKU: Manfred Gronalt, Magdalena Schweiger, Patrick Hirsch

Contributions to StartClim2011

StartCim2011.A: Climatic influence on voltinism and spread of the spruce bark beetle, Ips typographus, in alpine areas
Institute of Forest Entomology, Forest Pathology & Forest Protection, BOKU: Axel Schopf, Emma Blackwell, Veronika Wimmer

StartClim2011.B: Analyzing Austria's forest disturbance regime as basis for the development of climate change adaptation strategies
Institute of Silviculture, BOKU: Rupert Seidl, Dominik Thom
Institute of Forest Protection, Federal Research and Training Center for Forests, Natural Hazards, and Landscape (BFW): Hannes Krehan, Gottfried Steyrer

StartClim2011.C: Effects of soil drying on the transpiration of Austrian tree species
University of Innsbruck: Georg Wohlfahrt, Stefan Mayr, Christoph Irschick, Sabrina Obwegeser, Petra Schattanek, Teresa Weber, Dorian Hammerl, Regina Penz

StartClim2011.D: Adapting Austrian forestry to climate change: Assessing the drought tolerance of Austria's autochthonous tree species
Institute of Botany, BOKU: Gerhard Karrer, Gabriele Bassler
Institute of Forest Ecology, BOKU: Helmut Schume, Bradley Matthews
Vienna Institute for Nature Conservation and Analyis, V.I.N.C.A: Wolfgang Willner

Contributions to StartClim2012

StartClim2012.A: Cover crops as a source or sink of soil greenhouse gas emissions?
Division of Agronomy, Department of Crop Sciences, BOKU: Gernot Bodner, Andreas Klik, Sophie Zechmeister-Boltenstern

StartClim2012.B: Effects of climate change on soil functions: metadata analysis
Federal Research and Training Centre for Forests, Natural Hazards, and Landscape (BFW): Michael Englisch, Barbara Kitzler, Kerstin Michel, Michael Tatzber
Federal Agency for Water Management, Institute for Land & Water Management Research (BAW-IKT): Thomas Bauer, Peter Strauss
Austrian Agency for Health and Food Safety (AGES): Andreas Baumgarten, Hans-Peter Haslmayr
Federal Environment Agency: Alexandra Freudenschuß

StartClim2012.C: Disturbance of forest stands and humus loss
Institute of Forest Ecology, BOKU: Douglas Godbold, Mathias Mayer, Boris Rewald

StartClim2012.D: To count with and on wood: adaptations of tools and data (German: Holz BZR)
Kompetenzzentrum Holz GmbH: Tobias Stern, Franziska Hesser, Georg Winner, Sebastian Koch
Institute of Marketing and Innovation, BOKU: Leyla Jazayeri-Thomas, Verena Aspalter, Martin Braun, Wolfgang Huber, Peter Schwarzbauer
Institute of Wood Science and Technology, BOKU: Robert Stingl, Marie Louise Zukal, Alfred Teischinger
Federal Environment Agency: Peter Weiss, Alexandra Freudenschuß

StartClim2012.E: Snow line climatology within the Alpine region, derived from re-analysis data
Institute of Meteorology, BOKU: Herbert Formayer, Imran Nadeem

StartClim2012.F: Values as performance indicators: a path towards a proactive climate protection
Centre for Global Change and Sustainability, BOKU: Maria Miguel Ribeiro, Julia Buchebner

Contributions to StartClim2013

StartClim2013.A: Thermal stress for brown trout in the headwaters of the river Traun during summer
Harald Ficker, M.Sc.

StartClim2013.B: Loss of floodplains and flood risk in the context of climate change
Institute of Water Management, Hydrology and Hydraulic Engineering, BOKU: Helmut Habersack, Bernhard Schober, Daniel Haspel

StartClim2013.C: Runoff scenarios in the Ötztal valley (Tyrol, Austria) considering changes to the cryosphere as a result of climate change
alpS GmbH: Matthias Huttenlau, Katrin Schneider, Kay Helfricht, Klaus Schneeberger
Institute of Meteorology, BOKU: Herbert Formayer

StartClim2013.D: Recommendations for changes to regional development and spatial planning in areas of high flood risk
PlanSinn GmbH - Office for Planning & Communication: Bettina Dreiseitl-Wanschura, Erik Meinharter, Annemarie Sulzberger
Rambøll Group: Herbert Dreiseitl
Federal Environment Agency GmbH: Theresa Stickler, Jochen Bürgel

StartClim2013.E: How and where will Austrian river systems respond to climate change? An interdisciplinary analysis of fish fauna and nutrients
Institute of Hydrobiology and Aquatic Ecosystem Management, BOKU: Thomas Hein, Andreas Melcher, Florian Pletterbauer
Department of Integrative Zoology, University of Vienna: Irene Zweimüller

StartClim2013.F: GIAClim – Gender Impact Assessment in the context of climate change adaptation and natural hazards
Institute of Landscape Planning, BOKU: Doris Damyanovic, Florian Reinwald, Britta Fuchs, Eva Maria Pircher
Institute of Landscape Development, Recreation and Conservation Planning, BOKU: Christiane Brandenburg, Brigitte Allex
Institute of Mountain Risk Engineering, BOKU: Johannes Hübl, Julia Eisl

StartClim2013.G: Validation of the applicability of the SIMAGRIO-W wireworm prognosis model, based on soil temperature and moisture measurements, in Eastern Austrian agriculture
Bio Forschung Austria: Patrick Hann, Katharina Wechselberger, Rudi Schmid, Claus Trska, Birgit Putz, Markus Diethart, Bernhard Kromp

Zentralstelle der Länder für EDV-gestützte Entscheidungshilfen und Programme im Pflanzenschutz (ZEPP): Jeanette Jung
Institute of Meteorology, BOKU: Josef Eitzinger