StartClim2005

Climate Change and Health

Final Report

Project Leader

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

Contracting Parties

Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management
Austrian Federal Ministry for Health and Women
Austrian Ministry for Economics and Labour
Austrian Federal Ministry for Education, Science and Culture
Österreichische Nationalbank
Austrian Hail Insurance
Federal Environment Agency
Verbund AHP

Administrative Coordination
Federal Environment Agency

Vienna, November 2006

StartClim2005
„Climate Change and Health"

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

Editors

Helga Kromp-Kolb and Ingeborg Schwarzl,
Institute of Meteorology
Department of Water-Atmosphere-Environment
BOKU - University of Natural Resources and Applied Life Sciences

Vienna, November 2006

Contributions to StartClim2005

StartClim2005.A1a: Impacts of temperature on mortality and morbidity in Vienna
Medical University of Vienna, Centre for Public Health, Institute of Environmantal Hygiene
Hanns Moshammer, Hans-Peter Hutter
Institute of Meteorology, BOKU
Andreas Frank, Thomas Gerersdorfer
Austrian Federal Intitute 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 Environmantal 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 climatic 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

Scientific Board

Dr. Gerhard Berz, ehem. Münchener Rückversicherung

Dr. Jill Jäger, Sustainable Europe Research Institute (SERI)

Dr. Bettina Menne, Global Change and Health, WHO Regional Officer for Europe

Coordinating Group

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

Elfriede Fuhrmann, Helmut Hojesky, Birgit Kaiserreiner, Barbara Kronberger-Kießwetter, Heinz Stiefelmeyer, Stefan Vetter, Werner Glantschnig

Austrian Federal Ministry for Health and Women

Ulrich Herzog, Christoph Hörhan, Fritz Wagner, Robert Schlögel

Austrian Federal Ministry for Education, Science and Culture

Martin Smejkal, Christian Smoliner

Austrian Ministry for Economics and Labour

Eva Dolak, Herwig Dürr, Elisabeth Kasal, Monika Wallergraber

Austrian Hail Insurance

Stefan Oitzl, Kurt Weinberger, Josef Stroblmaier

Österreichische Nationalbank

Johann Jachs, Martin Much

Federal Environment Agency

Karl Kienzl, Sepp Hackl, Ursula Bodisch

Verbund AHP

Otto Pirker, Herbert Schröfelbauer

Administrative Project Coordination

Federal Environment Agency
Ursula Bodisch, Karl Kienzl, Sepp Hackl

Acknowledgement

Major contributions to the realisation of StartClim2005 and the Final Report were made by:

- Ingeborg Schwarzl, assistant in co-ordinating and editing
- Andrea Stocker, administrator of the homepage
- Ursula Bodisch, administrative project coordinator and
- Susanne Ostertag as secretary

Our thanks to all of them.

Table of Contents

Abstract

The hot summer in 2003 brought a considerably increased mortality in many parts of Western and Southern Europe: Europe-wide at least 25,000 cases of death were caused by the extreme heat. The **impact of this extreme weather event on the population in Austria** has not been sufficiently studied so far. In the light of the expectation that such events will be much more prevalent in the near future such an analysis seems important.

In StartClim2005 daily mortality due to temperature-effects in the past were analysed for Vienna. In time-series analyses the impact of relevant meteorological parameters from various Viennese monitoring sites on daily mortality in the years 1990-2004 was calculated, based on the definition of heat waves by Kysely: essentially three or more consecutive days with maximum temperatures above 30°C.

In the analysed period an increase in daily mortality on “Kysely days” of approximately 10% (7.8 % – 15.8 % depending on the model used) resulted. This is comparable to the mortality increase during epidemic influenza days. Possible confounders (especially ozone levels for hot days) do not influence the estimates for “Kysely-days”.

Synoptic downscaling (as developed in the project StartClim 2004.B) was applied to estimate local maximum temperatures from the global climate model scenarios for the future. Based on the projections of three scenarios the annual number of hot days and of days during Kysely episodes was estimated for three different future periods. While currently approximately 12 hot days per year are observed, this number will increase to approximately 18 by the years 2011-2040. Until the end of this century, depending on the scenario, 26 to 38 hot days are to be expected at Hohe Warte while in the Inner City of Vienna the figures will be even higher.

All scenarios show an increase in the number of heat caused deaths. By the end of this century 0.5 to 1.6% of all deaths in Vienna will be caused by heat. Per year this translates into 50 to 200 additional deaths compared to current figures. These estimates are in accordance with the observations from the 2003 heat wave, when approximately 5 more deaths per day occurred than in the previous year

During the hot days in 2003 ambulance calls were also more frequently than on normal days. However no increase was seen for hospital admissions during extreme temperatures. This should give cause to check whether the health care system is sufficiently reactive to and prepared for stressful events like heat waves.

Heat episodes following the Kysely-definition are only one way to show the influence of temperature. **Nocturnal cooling** in hot regions or during periods with high temperatures greatly affects peoples´ physiological well-being. Reduced nocturnal cooling is one reason for the higher physiological stress in cities. As known from climate data analysis, minimum temperatures have increased more strongly than maximum temperatures (IPCC 2001). Therefore the effects of nocturnal cooling should be investigated in addition to the above analysis of the correlation between mortality and “Kysely-days”.

In the center of the City of Vienna (Wien – Innere Stadt) there are 30 more days per year that show a minimum temperature of 15 °C or above (85.8 days per year) than at a station at the outskirts of the city (Wien Hohe Warte, 55.5 days per year). In Innsbruck, a city in an Alpine valley, the difference between urban and suburban areas is only 10 days (31.0 vs. 20.4 days per year). High nocturnal temperatures do not occur as frequently in valleys and basins as in the eastern plains of Austria due to the nocturnal formation of atmospheric inversions by cold drainage flows.

Comparing the climatic norm period 1961-1990 with the period 1985-2005 almost all analysed stations show at least a doubling in the number of warm nights per year (Tmin > 18 °C). At some stations (e.g. Bad Gleichenberg) minimum temperatures were observed recently that were higher than any that occurred during the climatic norm period.

The nocturnal temperature minimum has a clear impact on the increase of mortality, even stronger than the daily maximum. One single event of nighttime minimum temperatures exceeding 20 °C (which is no rare event, particularly in cities) has the same effects as a heat spell of three days duration. Warm nights between hot days have an even more significant effect on mortality rates.

Climate scenarios for the next 20 or 50 years assume an increase in the frequency of high nocturnal temperatures in summer and therefore increasing physiological stress. For the station “Graz-Universität” scenarios indicate an increase in days with minimum temperatures of 18 °C or more compared to the period 1961-1990 of 4.5 and 15.1 days/year for 1989-2018 and 2019-2048, respectively. For “Wien-Hohe Warte” 2019-2048 scenarios suggest similar conditions as presently found at City Centre of Vienna (Wien-Innere Stadt).

These analyses show that the assessment of heat related deaths might profit from integrating nocturnal cooling into the definition of heat spells.

Drinking water supply in Austria is sensitive to extreme events related to climate change in terms of quality and quantity. The hot summer 2003 showed this clearly. But drinking water supply is not only jeopardised by lack of precipitation. In recent years meteorological extreme events – especially floods and droughts - have caused emergency and disaster situations for drinking water supply in Austria. The type of damage occurring during precipitation events depends strongly on the intensity of rainfall (heavy precipitation events tend to cause destruction of infrastructure, while continuous steady rain tends to flood the intake area). An example for the destruction of infrastructure during heavy rainfalls were the floods in Tyrol and Vorarlberg in 2005. Typical for the damage due to steady rainfalls were the second floods in August of the year 2002 in Upper- and Lower Austria. Droughts mainly affect the intake areas, especially those intake areas with a low soil coverage over the ground water body.

By analysing past damages measures can be derived to reduce the probability of disruption of the drinking water supply. With astonishing little effort in planning or operational management drinking water supply can sometimes be assured during extreme events. These arrangements involve: disaster preparedness (organisational and technical arrangements), provisions when an extreme event is imminent, and a crises- and catastrophe management in case of emergency (drinking water emergency supply, information policy and cooperation with the media, collaboration with crises- and catastrophe management group).

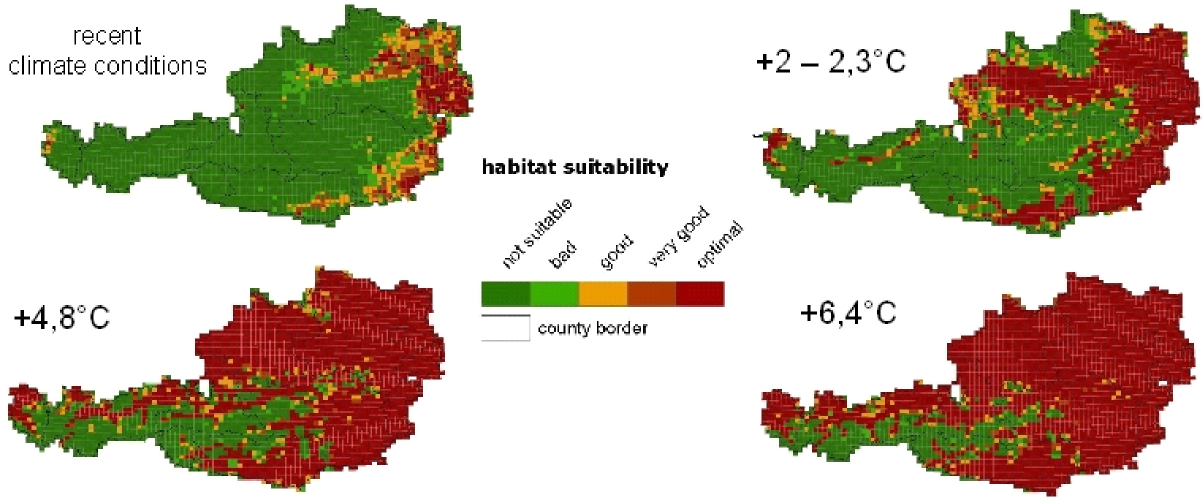
The comparison of different national and regional concepts has shown that safety in drinking water supply depends strongly on stimulations offered to water suppliers by the federal states (e.g. financial stimulations). Styria, for example, is sponsoring arrangements that go towards assuring the supply during extreme events. Therefore the impacts of the drought 2003 were not as serious in Styria as in other Austrian provinces.

Climate change scenarios show an increase of the frequency of extreme events. To make sure that water suppliers are well prepared for this development, integral planning procedures (e.g. the Water Safety Plan (WSP) of the WHO) must be taken into account. Furthermore water suppliers should focus on a greater diversity in the water supply sector in order to reduce their vulnerability in case of extreme events.

Predicted climate warming will likely change the **potential range of different plants and animals** within Austria. Highly mobile species will be among the first to follow shifting climatic range margins. Special interest is naturally paid to species man considers to be either harmful or beneficial. Species that affect human health or reduce quality or quantity of agricultural production are considered to be harmful.

Common ragweed, *Ambrosia artemisiifolia*, an annual herb native to North-America is one of the harmful species affecting human health. It has demonstrated considerable mobility during its recent invasion into large parts of Eastern- and Central Europe. Unfortunately, *Ambrosia* is a highly problematic alien species with respect to human health due to ample production of allergenic pollen.

Within Austria, its main distribution is limited to the warm, eastern parts of the country as yet. However, climate change may trigger a rapid new wave of invasion into currently unoccupied regions. Consequently, allergic reactions are likely to increase among Austrians.



Graphic: Distribution of Ambrosia's potential habitats under various climate change scenarios (numbers indicate increase of July mean temperature)

The potential extent of such a range expansion of common ragweed in Austria under various climate change scenarios was assessed by means of simulation models. Models are based on analysing the bioclimatic envelope of the current *Ambrosia* range using information from Austrian distribution data together with climatic and environmental maps. Results were then used for predictive simulation of range shifts driven by potential climate change, based on three different scenarios. These simulations suggest a six-fold increase of the area suitable to *Ambrosia* even under a comparably moderate warming scenario (+ 2°C mean July temperature) until 2050. More severe temperature rises (4.8°C and 6.4°C, respectively) will make 67% or 80% of Austria potentially suitable for common ragweed. Protecting new regions from ragweed turns out to be a very complex problem due to various anthropogenous dispersal pathways (e.g. deployment of contaminated birdseed, seeds sticking to car wheels etc.). Thus, effort has to be put into developing a co-ordinated European-wide initiative against ragweed.

Organic production of crops is particularly affected by invasive plants and animals because there are fewer possibilities to combat them. Therefore it is important to investigate if and how far the recent changes in composition and abundance of **pests and beneficials in organic crop production** of Eastern Austria can be attributed to climate change.

The available literature on the influence of climate on biology and on the occurrence of conspicuous pests mainly dates from before the 1960´s. For recent, climate related changes in pest status, published data are lacking in Austria as well as in the neighbouring Eastern Middle European countries. Therefore, remarkable recent pest outbreaks were documented from existing data and evaluated for their climatological background on the one hand, whereas changes in the status of domestic as well as immigrant pests and their possible causes were documented by interviewing plant protection experts on the other hand.

In recent years an increasing pest pressure was found for a number of species of cereals, root crops, oil-, protein- and fodder crops, caused rather by changes in cultivation systems (e.g. crop rotation, reduced soil cultivation) than climate change. Several other pests, mainly for cereals (including maize) showed outbreaks from 2000 onwards, with a maximum in the extremly warm and dry year 2003. In case studies for two selected pests (wheat bug, sugar beet weevil) and one beneficial species (dock leaf beetle) the weather and climate-related background of their distribution and abundance was investigated. In comparing the "wheat bug years" 1953 and 2003 similarities in weather-trends were detected, which might have caused the bug outbreaks in the respective years. The extreme year 2003 enabled a mass-reproduction of the warm-preferring sugar beet weevil followed by maximum damages in the following year 2004. Distribution and abundance data of the dock-leaf beetle are correlated with differences in regional climate and climate-anomalies.

From these results, the demand for long-term monitoring of climate related fauna changes in agrarian production was derived, aiming at risk-prevention of climate-caused pest calamities. A methodological approach towards a suitable long-term monitoring system was worked out.

Human activities influence the range of expansion of pests, for example by using glass-houses. Some pests and beneficials adapted to certain temperatures could only exist in glasshouses so far and may now survive outside in warm winters and then extend their range of expansion. One such pest is **Western Flower Thrips (WFT)**.

Published data of laboratory experiments claim that adults of Western Flower Thrips (WFT) - a key glasshouse pest - can survive at a temperature of +5°C for only 26 days. This would nearly exclude survival in outdoor conditions even in Southern Europe, where the pest is known to occur outdoors. It is therefore assumed that overwintering is successful if continuous development of WFT at least at a low level is possible during the winter months. Numerous publications about damage on typical outdoor cultures such as wine or nectarines by WFT show that the most northerly outdoor occurrence presently is situated in the Italian province of Emilia Romagna. There the mean daily maximum temperatures during winter range between 7° and 8°C, and temperatures higher than 15°C occur in intervals of less than 3 weeks. These winter conditions are thought to be similar to the temperature threshold that allows overwintering of WFT. According to scenarios predicted for alpine regions, winter conditions that presently occur in the Emilia Romagna could prevail in the warmest regions of Austria towards the middle of this century. Accordingly, it is considered to be very likely that WFT escaped from greenhouses could overwinter outdoors in Austria from then on. In that case fruitcrops and grapes could be damaged by this new key pest.

Tularaemia is an infectious bacterial disease that can be transmitted to humans. Looking at the area of incidences of tularaemia leads to the assumption, that there is a connection to climate change. A total of 271 cases of tularaemia in hares was recorded and georeferenced in the area under investigation (Lower Austria, Burgenland, Styria) in the period from 1994 to 2005. Temperature and precipitation data for the selected region provided the basis for calculating an altitude dependent temperature distribution for suitable monthly means and period sums. The special distribution of precipitation was calculated using the geostatistical universal kriging method without taking the influence of altitude into account. An astoundingly good correlation was established between the two climate parameters and local disease incidence using a linear regression model.

Of special note is the highly significant ($p< 0.05$) influence of the parameters selected (number of hares affected; average of monthly mean temperatures for December, January and February; monthly mean temperature for May; precipitation sum for June and July) on the incidence rate of the disease and the coefficient of determination obtained ($R^2 = 74.6$ %).

These findings provided the basis for specifying empirical limits for the parameters defined in the formula, which best correspond to the actual spatial distribution obtained by geographical analysis. Hence, the probability of tularaemia occurrence is high for a total annual precipitation below 720 mm, a summer precipitation rate around 180 mm, a winter temperature above 0.5° Celsius and a May temperature below 14° Celsius.

A temperature increase of 2 to 4°C was assumed for estimating the distribution area of the disease by 2035. Under these conditions, tularaemia might slowly spread from the eastern lowlands via the Danube valley to the west and via southern Styria further to the south. Additional incidents of the disease could also occur in inner Alpine areas providing favourable climatic conditions. This means that a huge extension of the potential tularaemia distribution area from currently 13% to 46.5% of the Austrian territory might be expected. It therefore appears advisable to provide potential risk groups (hunters, foresters, farmers, laboratory staff, taxidermists, housewives etc.) with targeted information on the risk and recommendations for behaviour in endangered areas.

Modification of vegetation may necessitate more adaptations in fauna than adaptations due to changing climate conditions themselves. In higher regions within the Alps such adaptations often are not possible. **Wild animal species such as the black grouse, snow grouse, chamois and ibex** have for example adapted to life in an Alpine environment **above the tree line** in the course of their evolution and thus form part of this very sensitive ecosystem. The habitat of these wild animal species might be substantially reduced by a potential upward movement of the tree line as a result of climate change. An attempt was made to quantify these changes with the aid of models and a geographical information system (GIS). The calculations were based on the temperature development of the past 50 years and an estimate of future warming. The exemplary scenario derived from a climate model predicts a warming of approx. 2.2°C for the area under investigation (Niedere Tauern) over the next 50 years.

The natural elevation of the tree line strongly depends on temperature. A high correlation was found between the growth limit of trees and the 10°C July isotherm. The climate model used for this analysis shows that the relevant isotherms will rise by approx. 450 m over the next 50 years. The temperature changes, however, strongly depend on the climate model and the scenario that is selected. No statement can be made on how fast the tree line advances towards the temperature related growth limit without additional research work. Human management practices also have a substantial influence on tree line position so that changes in the future tree line cannot be derived from climatic data alone.

The current habitats of the animal species investigated were determined and mapped using a knowledge based habitat model and a GIS. The present suitable habitats for snow grouse, e.g., are shown in the figure below. Assuming that the future tree line will adjust to the changed calculated temperature of the decade 2040 - 2050, this shift will lead to a dramatic loss in suitable habitats, which may range from 78% to 98% depending on the season and animal species. The habitat loss to be expected for snow grouse is also illustrated in the figure.

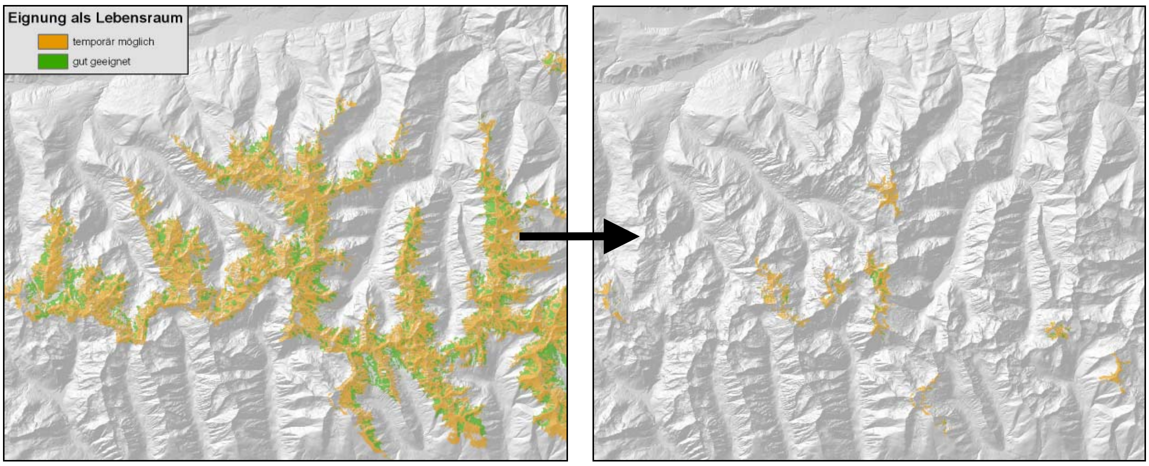


Figure: Current and predicted habitat suitability for snow grouse assuming a temperature increase of 2.2.°C and derived shift in the tree line

Development of the meteorological extreme event database MEDEA (Meteorological Extreme event Data Information System for the Eastern Alpine Region) was begun at the time of the first StartClim-projects. Since then MEDEA has been continuously extended and improved. It is designed to provide a long term archive for data relevant to extreme weather events in Austria for scientists working in climatology as well as those working on the consequences of climate change with features to allow integrated analyses of diverse data related to extreme weather events.

A comprehensive view of extreme weather events including besides meteorological, climatological and geomorphological data also data such as damages, health impacts etc., is an extreme complex task. The possibility to map those heterogeneous data and to allow an integrated analysis requires extensive preparatory work. The very complex database MEDEA is therefore still in the development phase. Data integrated in MEDEA till now have only exemplary character. Within StartClim2005 the data set was extendend and a web access for data base queries was programmed and implemented.

1 The research programme StartClim

The climate research programme StartClim was implemented 2002 following extensive floods in Austria based on an initiative of the Austrian Federal Minister of Environment. StartClim developed into a research programme for new topics concerning climate and climate change, analysed from different points of view and by different scientific disciplines. Results achieved so far demonstrate that substantial research work on climate, climate change and its impacts in Austria is essential. The increasing number of Austrian scientists participating in StartClim shows, that the required know-how is available in Austria and growing.

StartClim is financed by an investors consortium presently consisting of eight institutions. In the coordinating group the investors develop the topics of research together with the scientific project leader. An international advisory board reviews project applications and final reports. The administrative tasks are assumed by the Austrian Federal Environment Agency. The scientific responsibility lies with the Institute of Meteorology, Department of Water-Atmosphere-Environment, BOKU - University of Natural Resources and Applied Life Sciences Vienna.

New topics picked up in StartClim cannot be studied in depth within StartClim due to limited funding. StartClim research projects are therefore intended to subsequently be carried farther in the framework of normal research funding or as studies commissioned by interested stakeholders.

Working on new topics gives young researchers the opportunity to start their research work within the frame of StartClim.

Finally, StartClim offers added value to the investors financing the programme jointly. Each investor profits from the joint administration and quality control. Furthermore synergies between projects and institutions have proven very usefull.

1.1 StartClim2005

The StartClim2005 topic “Climate Change and Health” affords an opportunity for first analyses of relations between health and climate change in Austria, a question which received some public attention in the very hot summer of 2003. Besides questions dealing with the effect of extreme temperatures on mortality including future projections for Austria the problem of how drinking water supply can be guarantied during extreme events or the dispersion of invasive plant species causing allergic reactions are treated. Changes in habitats of certain animals may spread diseases, as in the case of rodents seized with tularaemia that will primarily affect certain risk groups (f. e. hunters).

Dispersion of agricultural pests not known in Austria to date may lead to losses of quality and quantity in food production. Some pests disperse naturally due to climate change, others that could so far only survive in glasshouses may be able to survive outside the glasshouses in the near future when winter temperatures are sufficiently high. Both could trigger increased use of pesticides and new regulations may be necessary to protect human health. In many cases analyses of new pests and beneficials within organic crop production may provide better and earlier indicators for occurring changes, as no chemicals are applied to combat pests.

The meteorological extreme event database MEDEA was extended and improved in StartClim2005.

1.2 Structure of this report

The StartClim2005 report consists of an overview of the results in both German and English along with a (separately bound) documentation in which the individual projects are described in detail by the respective project teams. All reports will be published as a CD as well.

A complete list of former StartClim projects, the institutions and researchers involved can be found in the annex.

1.3 How StartClim2005 worked

The organisational structure of StartClim2005 was similar to that of former StartClim phases. StartClim2005 consists of eight subprojects that encompass 28 persons from 14 different institutions, representing far more than the 60 months of scientific work calculated in the project proposals. The breakdown of participating scientists reveals six female contributors and nine contributors under 35 years of age.

In order to promote scientific exchange between the individual subprojects, two workshops were held with members of the scientific board participating. All scientists were invited to present the results of their ongoing work and to discuss linkages between the subprojects.

The Information and data exchange within the StartClim community was again supported by the FTP server and the StartClim webpage (http://www.austroclim.at/startclim/) at the Institute for Meteorology of the BOKU University of Natural Resources and Applied Life Sciences, Vienna.

Scientific literature pertaining to the 2005 projects will be added to the literature data base that was set up during StartClim2003 and is available from the StartClim home page, as are all the project reports.

1.4 MEDEA - Meteorological Extreme event Data information system for the Eastern Alpine region

The meteorological extreme event database MEDEA was extended and improved in StartClim2005. MEDEA is designed to provide a long term archive for data relevant to extreme weather events in Austria for scientists working in climatology as well as those working on the consequences of climate change, with features to allow integrated analyses of diverse data related to extreme weather events in Austria.

A comprehensive view of extreme weather events including besides meteorological, climatological and geomorphological data also data such as damages, health impacts etc., is an extreme complex task. The database called MORIS developed by the Umweltbundesamt can deal with this complexity. The MORIS PowerBuilder Client facilitates the handling and storing of data in an ORACLE database as well as the data selection.

MORIS was already tested successfully in 2003 regarding the requirements of the meteorological extreme event database MEDEA. A proposal how to structure the data in MEDEA was elaborated and implemented. The fact that the data comes from diverse sources and thus not all data is of the same quality, accuracy and dependability is an important factor. This should be visible in the database. In this respect the „Uncertainty Concept“ by Moss and Schneider was implemented. After that test data were imported in MEDEA.

To facilitate the external access to the MEDEA data a JAVA Web application was programmed. A registered group of users can define their queries in a password protected web portal. Users can design and store their queries for further use reasonable grouped in a hierarchical tree structure. No SQL knowledge is needed for appliers.

In addition, a search function was implemented to allow the easy retrieval of stored queries. Registered users are able to search for predefined queries and display them in a list or a tree view. By clicking one of the listed queries the results are shown directly. This option increases the useability of the web client.

Data sets can be reduced in size or time by using the function “time period” or pivot. By using the filter function data sets can be further narrowed. The web portal offers the opportunity of showing data sets as a graph or a list. The time period the user is interested in can be defined for each query.

For the web portal four different user roles were defined. Depending on this, users are allowed to develop new queries or only view predefined queries with no right of changing them. Furthermore the user role defines if datasets can be downloaded or not. The format for the download is Excel or SPSS.

The further technical development of the web client is addressed. With the planned functionalities users will be able to handle the data more easily. Due to a cartographic application the data sets will be visible in maps too.

Beside the technical the organisational and scientific part of the database is essential. MEDEA tries to put together data from different data sources. But an integrated analysis will only be able with data compatble with each other and available for all sectors. These data are stored by different organisations using methods of data gathering which are not homogenous a priori. Data cover different time periods. Different terms and definitions are used that make integrated analyses difficult. Furthermore due to the legal restrictions not all of the data can be provided for MEDEA easily.

For the further development of the database a common ontology is important. An ontology is a formal defined system of concepts and relation to structure existing information and to combine.

Furthermore, it will be a central requirement to facilitate the interlinkage of different data sources with network technologies and to merge data sets virtually.

The aim of allowing integrated analyses of diverse data related to extreme weather events can only be reached by a stepwise extension regarding the techniques and the content of the database which has to be continued in the next years.

2 Direct Impact of Climate Change on Human Health

2.1 StartClim2005.A1a: Impacts of Temperature on Mortality and Morbidity in Vienna

Rationale

In the summer of 2003 in France alone approximately 15,000 persons died due to the extreme heat; for the whole of Europe estimates range between 25,000 and 60,000 deaths. Hot temperatures affect human health through various mechanisms: Loss of salts and dehydration can directly disturb the regulatory capacities of the body. Persons with pre-existing disorders of the cardiovascular or endocrine system are endangered even by relatively moderate increases in temperature. While short episodes of hot temperature are well tolerated by most persons a prolonged episode especially with lack of cooling during the night increases the risk.

It is expected that in the course of the global climate change the number of hot days will increase and this will have a direct impact on human health.

In the framework of StartClim2005 the impact of hot days on mortality and morbidity as well as the future prospects were investigated for the first time for Austria. Because shifts in “moderate” (normal) temperatures and in exceptionally hot days call for different preventive strategies both were analysed separately in this study.

It is well known that temperature has a non-linear influence on daily mortality with the lowest mortality counts on days with moderate temperatures. For Vienna this optimum lies at a daily maximum temperature of 20°C. This optimum differs between regions, indicating a capability for long-term adaptation to local climate. This adaptation is not so much based on physiological processes but on socio-cultural measures such as techniques in building construction and maintenance. Therefore climate change, as it affects average temperatures, also the calls for long-term measures.

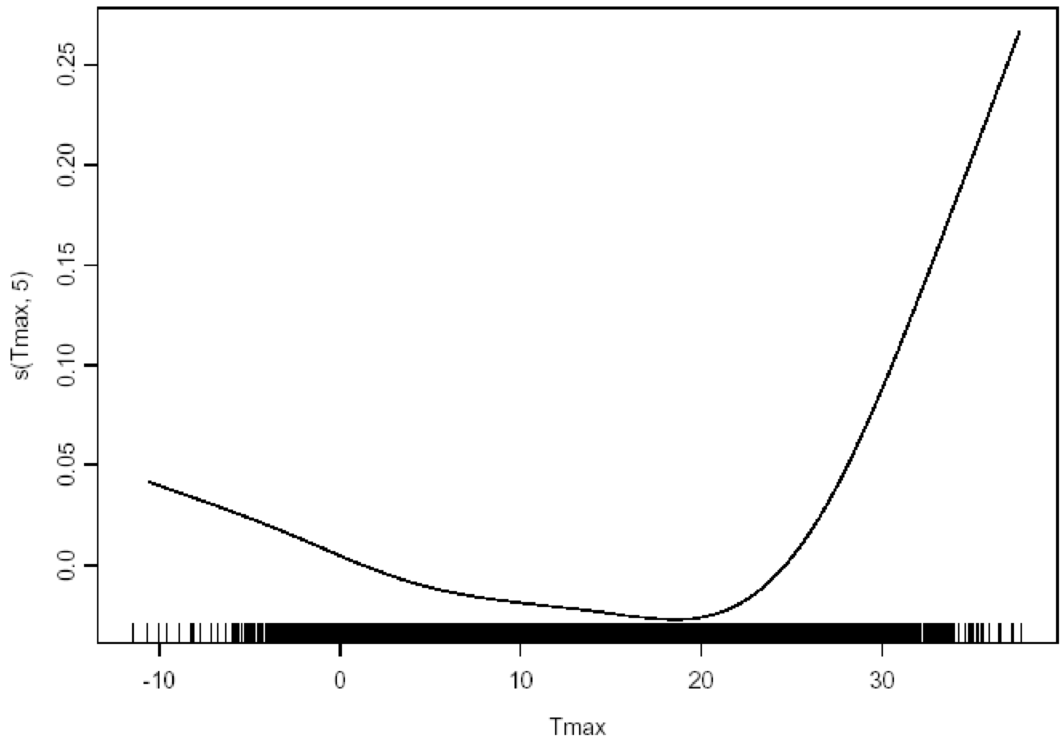


Fig. 1: Number of daily deaths in relation to the daily maximum temperatures

The situation is quite different with exceptional heat episodes that are so rare that preventive measures are rather needed in terms of organised activities of the healthcare system and the public health institutions.

Scientific literature describes different definitions of heat waves. Within this context the definition by Kysely, which was developed for Central Europe, is used: Kysely periods are periods of at least three consecutive days with daily maximum temperatures of at least 30°C that continue as long as maximum temperature does not drop below 25°C and the average daily maximum temperature remains at 30°C or above. Days of such periods are called "Kysely-days" below.

In the statistical model the influence of the "moderate" temperature was entered as a polynomial spline while Kysely-Days were entered as binary variables.

Mortality in figures

In the years 1990 – 2004 in total 206 Kysely-Days were observed in Vienna. On these days on average 53.91 persons died, while during the other summer days (June – August) only 46.58 persons died. This equals an increase of 15.75%. When the more complex statistical model was applied the increase in daily mortality on Kysely-Days was only 7.8%, while the remaining increase in mortality was attributed to the continuous change of the temperature (above the optimal 20°C).

To better grasp the impact of hot days these effects are compared to the impact of influenza epidemics in Vienna in winter. In the same period 713 influenza-days were observed. Compared to the other winter days (December – February) on the influenza-days 6.73% more people died (on average 59.69 instead of 55.93). So the relative increase in daily mortality on hot days is comparable to the effect of an influenza epidemic. But of course in the observed period (1990-2004) there were more days with influenza than hot days. So overall the impact of influenza was greater.

Tab. 1: Calculated and the counted numbers of deaths on Kysely-Days and in the summer (June - August). The increase in daily deaths during influenza epidemics is shown in comparison.

	summer (June-August)		number of days		winter (Dec-Feb)	Whole year
number of deaths	counted	calculated			counted	counted
all days	47,67		1380	All days	57,43	51,18
no Kysely-day	46,58	46,58	1174	No influenza	55,93	50,01
Kysely-day	53,91		206	influenza	59,69	59,01
increase	7,33	3,63			3,76	9,00
increase %	**15,75**	**7,80**			**6,73**	**17,99**

Increase of daily mortality due to climate change

The future number of Kysely-Days was calculated based on two distinct scenarios (A1B and B1) proposed by the IPPC. The first is based on the continuation of high CO_2 emissions and thus a rather strong increase in temperature, while the latter is very optimistic regarding future emissions and thus forecasts only moderate increases in temperature. Calculations were performed for the meteorological station "Hohe Warte". The number of Kysely-Days would even have been higher if the calculations were based on the inner city temperatures.

While from 1990 till 2004 on average 13.7 Kysely-Days were observed per year (and already in this period an increasing trend was observed), according to the "warmer" scenario A1B this figure will increase to 14.6 (2010 to 2039), 24.3 (2036 to 2065), and 39.4 (2061 to 2090).

These figures multiplied by the calculated (3.63) and counted (7.33) figures of additional daily deaths on Kysely-Days give estimates for future death tolls of heat waves.

Tab. 2: Annual deaths due to climate change assuming scenario A1B or B1 for overall increases (counted raw data) and increases statistically attributed to heat waves (calvulated numbers).

	additional deaths per year		additional deaths per year	
	counted raw data	calculated numbers	counted raw data	calculated numbers
currently (1990-2004)	100,67	49,85	-	
time frame	Szenario A1B		Szenario B1	
2010-2039	107,02	53,00	80,63	39,93
2036-2065	178,12	88,21	117,28	58,08
2061-2090	288,07	142,66	168,59	83,49

In the years 2010 to 2039 there is no significant increase in the health impact compared to the recent past (where the extremely hot summer of 2003 already caused a high toll). But until the end of this century the increase in the number of deaths attributable to heat-waves is impressive. According to the extreme scenario 1.6% of all deaths will be caused by heat-waves, according to the moderate scenario 0.5%. This would mean that per year approximately 100 to 300 persons will die because of heat-waves in Vienna. Compared to current findings this means about 50 to 200 additional deaths.

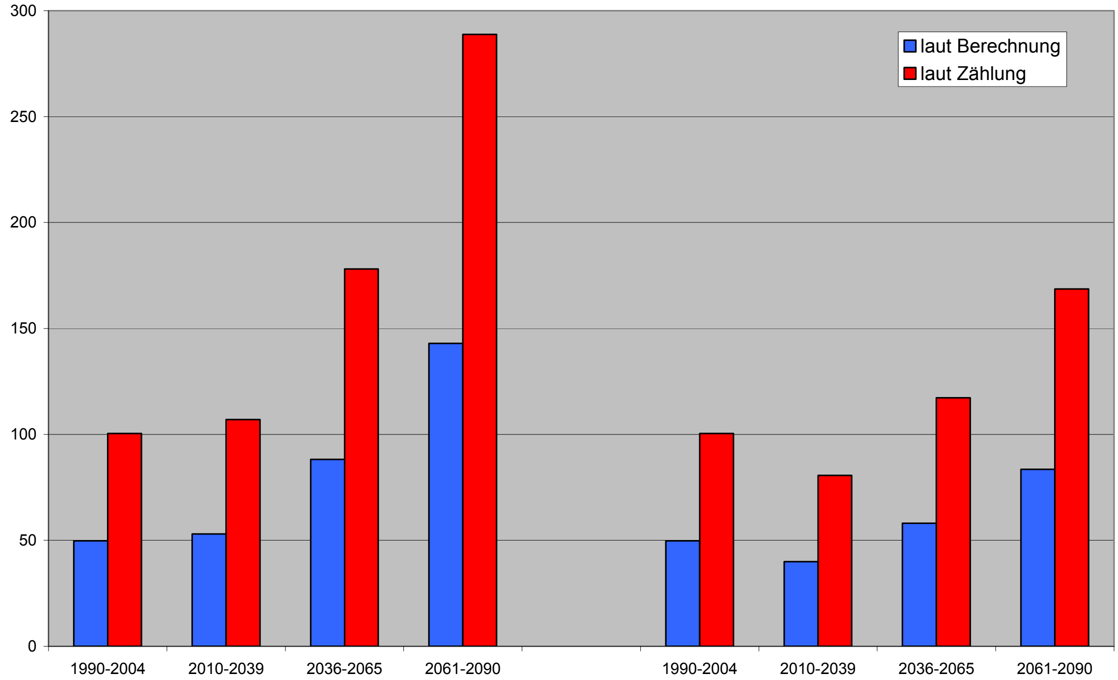


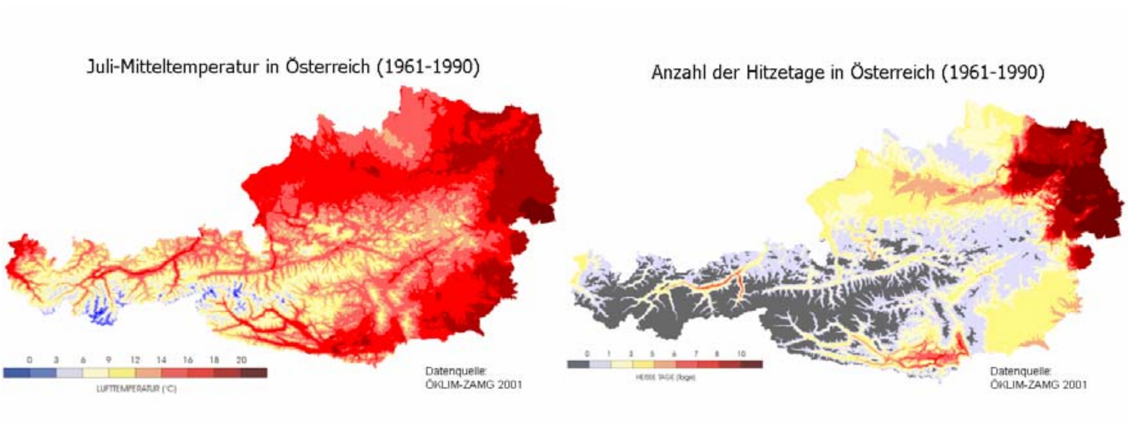
Fig. 2: Number of annual deaths due to heat. Two scenarios (A1B and B1) and results from two statistical models based on the years 1990 - 2004 are compared

On the whole most of the deaths are seen in elderly people. Therefore the effect of heat-waves is more easily demonstrated statistically in this age-group. Women (above 65 years) experience a higher increase in mortality on hot days, while for the whole range of age groups no significant difference was observed between males and females. Practically all causes of death increase on hot days. The increase was exceptionally strong for respiratory diseases.

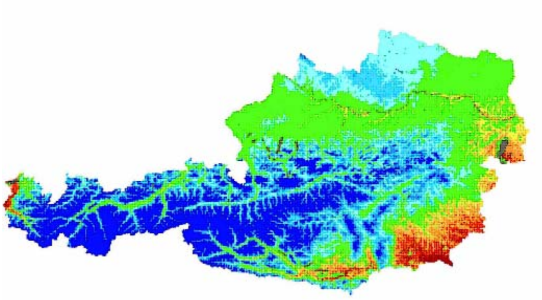
During hot days also ambulance calls are more frequent. However, no increase in hospital admissions was seen with extreme temperatures. This should give cause to check whether the health care system is sufficiently reactive to and prepared for stressful events like heat waves.

2.2 StartClim2005.A1b: Nocturnal cooling under a changing climate

The distribution of monthly mean temperatures in Austria is mainly influenced by altitude. Fig. 1a shows the pattern for July. The lowest temperatures are to be found across the Alpine ridge and the highest temperatures in the eastern lowlands that are more continentally influenced. The distribution of heat-days - days with a maximum temperature of 30 °C or more - shares many features with the mean temperature in July (Fig. 3b). The north-eastern part of Austria shows highest frequencies but high values can be reached in the southern basins and in the inneralpine Inntal as well. Thermal exposure, which depends on temperature, wind speed and humidity, is still another parameter that is commonly used to characterize thermal properties of regions. Areas of high thermal stress (Fig. 3c) are within the south-eastern part of Austria (Styria) and to a somewhat lesser extent in the east (around Neusiedlersee), in southern basins (Klagenfurter Becken) and in the valleys of the rivers Rhein and Inn.



(a) (b)



(c)

Fig. 3: Thermal conditions in Austria, characterized by different aspects: (a) monthly means, (b) heat-days and und (c) thermal exposure (bio-climate).

The high temperatures displayed in the North and the North-east (see Fig. 3a,b) are perceived as „cooler“ due to prevailing stronger winds in this part of Austria whereas in the Southeast and South lower wind speeds and higher humidity cause higher thermal and physiological stress. Physiological well-being is influenced by nocturnal cooling as well. However, this quantity cannot be easily read from figure 3. It is known that reduced nocturnal cooling, especially in big cities, is adverse to human well-being. Dependent on the particular region the increase of minimum-temperature (achieved during night-time) can be stronger than the increase of (day-time) maximum temperatures (IPCC 2001). Hence, nocturnal cooling and its temporal development is essential for the assessment of thermal stress. In the following the nocturnal minimum temperature will be taken as a substitute for nocturnal cooling. The frequency distribution of minimum temperatures is investigated for a historical period (1961-2005) and, based on climate change scenarios, for a future period up to 2050.

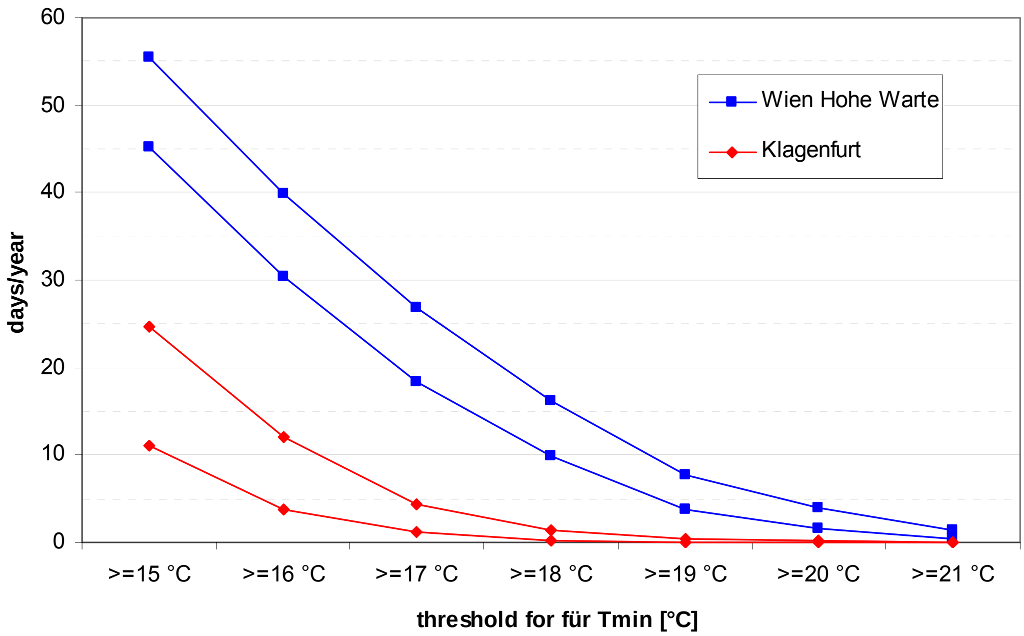


Fig. 4: Changes in the frequency (days/year)of nocturnal minimum temperatures equal or above different thresholds for “Wien Hohe Warte” and “Klagenfurt” during the period 1961-1990 (lower line) and during the period 1985-2005 (upper line).

Tab. 3: Frequencies (days/year) of nocturnal minimum temperatures equal or above different thresholds for the analyzed stations in Austria during the period 1961-1990 (climatic normal period) and the period 1985-2005.

Station	Climatic Normal Period 1961-1990							Period 1985-2005						
	>=15 °C	>=16 °C	>=17 °C	>=18 °C	>=19 °C	>=20 °C	>=21 °C	>=15 °C	>=16 °C	>=17 °C	>=18 °C	>=19 °C	>=20 °C	>=21 °C
Wien Innere Stadt								85,8	67,9	51,8	37,5	24,6	14,8	7,9
Wien Hohe Warte	45,2	30,4	18,4	9,9	3,8	1,6	0,5	55,5	39,9	26,8	16,3	7,7	4,0	1,4
Mariabrunn	17,8	10,4	5,3	2,6	1,1	0,4	0,1	30,9	19,3	11,1	5,4	2,4	1,2	0,2
Großenzersdorf	30,8	17,5	9,5	4,7	1,9	0,6	0,2	45,7	30,5	18,8	10,6	5,3	2,3	0,9
Eisenstadt	45,1	31,2	19,6	10,9	5,4	2,2	0,6	51,6	38,3	23,5	13,1	6,4	3,2	1,0
Bregenz	33,3	20,5	10,3	4,7	1,8	0,5	0,2	45,0	31,1	19,3	10,2	4,4	1,7	0,5
Klagenfurt	11,0	3,8	1,1	0,1	0,0	0,0	0,0	24,7	12,0	4,4	1,3	0,3	0,2	0,0
Graz Uni	33,6	19,6	9,6	3,6	1,0	0,3	0,1	44,8	29,5	16,8	7,8	3,1	1,0	0,2
Graz Flugplatz	16,5	7,3	2,5	0,7	0,2	0,0	0,0	39,2	24,4	13,4	5,8	2,4	0,8	0,3
Bad Gleichenberg	23,1	12,4	4,5	1,4	0,5	0,0	0,0	35,4	21,5	10,1	3,7	1,2	0,3	0,1
Innsbruck Uni	16,9	7,3	2,6	0,6	0,2	0,0	0,0	31,0	17,2	7,4	2,3	0,7	0,3	0,0
Innsbruck Flugplatz	11,2	4,4	1,3	0,3	0,1	0,0	0,0	20,4	9,3	3,0	0,9	0,3	0,1	0,0
Bad Radkersburg								42,3	27,4	14,6	6,0	2,0	0,6	0,1

Investigation of the historical dataset (1961-2005)

The comparison of the ‘climatic normal period’ (CLINO=1961-1990) to 1985-2005 shows at all analysed stations a pronounced shift in the frequency distributions for thresholds of minimum temperatures (Tmin) towards higher values (Fig. 4). The quantity of days per year exceeding 18° (Tmin >= 18 °C) has at least doubled with the exception of the stations “Wien Hohe Warte“ and “Eisenstadt“. Other threshold values for Tmin show a comparable increase (see Tab. 3). Furthermore, at some stations 1985-2005 comprises minimum temperatures of more than 21 °C that did not occur in CLINO (e.g. Bad Gleichenberg).

Urban Heat Island

The comparison of stations within cities to suburban or rural stations generally shows a noticeable higher number of days exceeding any threshold-level of minimum temperatures. This reflects the urban area with dense buildings, sealing of most surfaces and sparse vegetation. The urban surfaces are heated during the day and the release of energy during the night causes reduced nocturnal cooling. This heat island effect is evident for Vienna and Innsbruck. The (CLINO-based) average of days with Tmin >= 15 °C in the suburbs is 55.5 days/year for "Wien Hohe Warte" and 85.8 days/year the inner city of Vienna (Wien Innere Stadt), a difference of 30.3 days/year. The difference (between "Wien Innere Stadt" and "Wien Hohe Warte") decreases with increasing levels of Tmin, due to the decreasing frequency of Tmin exceeding higher threshold values. The ratio of corresponding frequencies, however, increases. Hence, the frequency of Tmin >= 19 °C, for instance, is 3 times larger at "Wien Innere Stadt" than at "Wien Hohe Warte" (24.6 times to 7.7 times per year). This results in a difference of 16.9 days per year. At the station "Innsbruck-Universität" the urban heat island effect causes an excess of more than 50% of days/year for several threshold levels (e.g. for 1985-2001, Tmin >= 15 °C occurs on average 20.4 days at "Innsbruck Flugplatz" and 31.0 days at "Innsbruck Universität").

The difference between urban areas and rural areas at present is in many cases larger than the shift due to climate change.

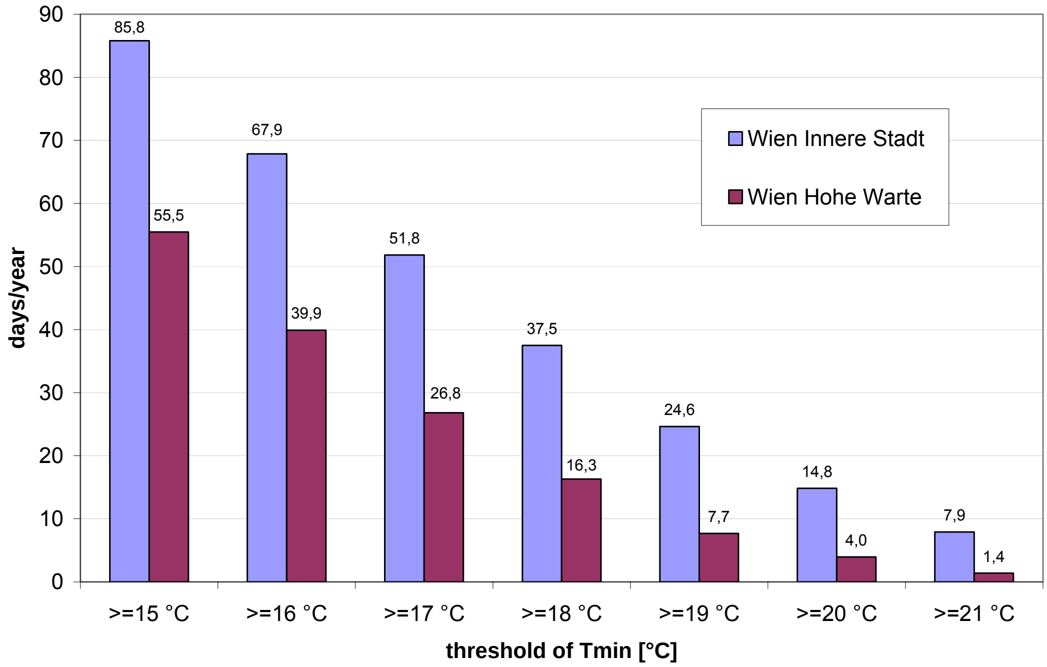


Fig. 5: Urban heat island: Comparison of the frequency (days/year) of nocturnal minimum temperatures equal or above different thresholds for "Wien Hohe Warte" and "Wien Innere Stadt" during the period 1985-2005.

Relation between minimum temperature and mortality

Daily mortality rates in Vienna are linked to several indicators of heat (Fig. 6) with a varying strength of the correlation. The exceedance of Tmax >= 30 °C, for instance only predicts a small additional mortality risk. The mortality rate also increases with increasing nocturnal minimum temperature. During heat spells (as defined by Kysely 2004) the increase in risk is higher compared to single hot days. This risk is still higher when high minimum temperatures are considered as well. This is shown in the example of "warm nights" (in Fig. 4). The term "warm night" refers to a sequence of a hot day (Tmax >= 30°) preceding and following a night with lack of cooling (Tmin >= 18 °C). An increase in mortality rate of almost 12% in Vienna (with approximately 45 daily deaths in summer) results in an excess mortality of about 5 additional deaths per day. These calculations were made without the statistical approach to separate the influence of temperature shifts from heat episodes (see StartClim2005.A1a). Nevertheless, they indicate that including nocturnal cooling in the definition of a heat episode would improve the fit of the statistical models and therefore could give a better estimation of additional heat related deaths.

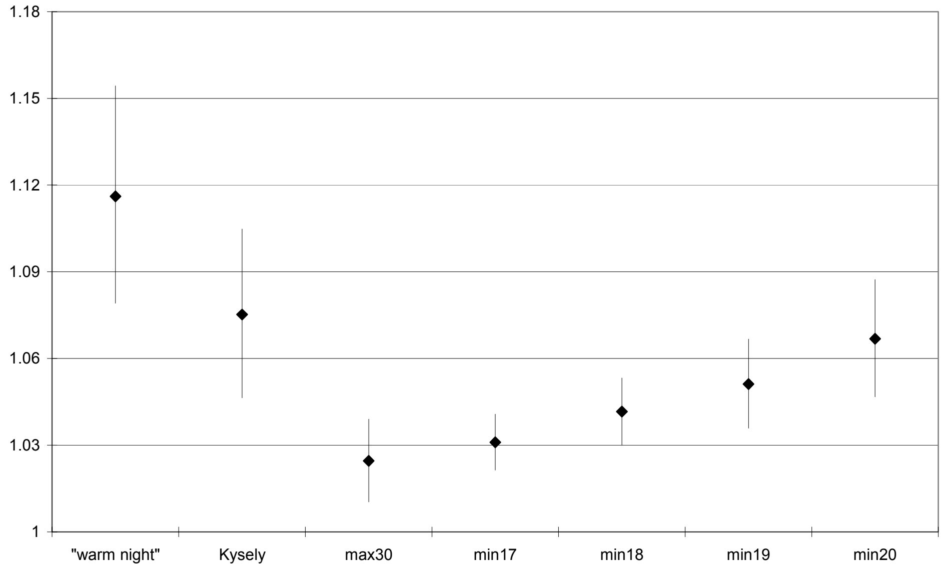


Fig. 6: Increase of mortality rate (relative risk) depending on different parameters and defined periods, respectively, based on the period 1990-2004 in Vienna (total mortality). The term "warm night" refers to a sequence of a hot day (Tmax >= 30°) preceding and following a night with lack of cooling (Tmin >= 18 °C).

Scenarios

The decrease of nocturnal cooling, as found in the observations further continues in the scenarios: this means a continued increase in the number of days/year with moderate to high levels of Tmin (Fig. 7). Nights with high minimum temperatures are simulated to become noticeably more frequent. Results suggest that this increase is stronger towards the upper range of Tmin than at its lower tail. Assuming a minimum temperature of 18 °C or more at station „Graz-Universität", for example, scenarios indicate a frequency of 12.3 days/year for 1989-2018 and of 22.9 days/year in the period 2019-2048, respectively. This corresponds to an increase of 4.5 and 15.1 days/year. Thus the increase of the „warm nights" (as defined before) is likely to translate into a progression of deaths due to higher frequencies of nights at higher levels of Tmin (Tab. 4).

To sum up, increasing frequencies of nocturnal minimum temperatures above certain threshold levels are to be observed throughout the last decades. Regionalized climate scenarios suggest a further progression in the amount of warm nights for the future. This will very likely affect the physical well being in general and in particular the degree of regeneration during sleep.

The levels of minimum temperatures that were not observed in 1961-1990 and the projected future increase in occurrence of very high nocturnal temperatures can be considered to result in a growth and intensification of the present regions of high thermal exposure.

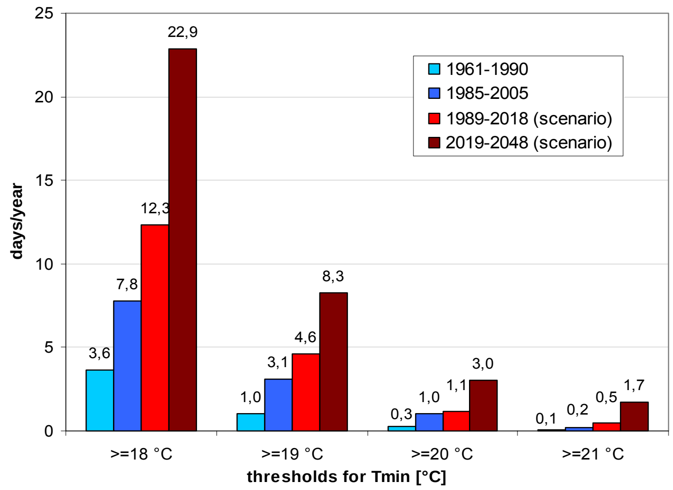


Fig. 7: Historical evolution of the frequency (days/year) of nocturnal minimum temperatures equal or above different thresholds at station "Wien Hohe Warte" for the periods 1961-1990 and 1985-2005 as well as the expected evolution based on scenarios for the periods 1989-2018 and 2019-2048.

Tab. 4: Historical evolution of the frequency (days/year) of nocturnal minimum temperatures. Comparison of the historic dataset of the stations "Graz-Universität" and "Wien Hohe Warte" for the periods 1961-1990 and 1985-2005 as well as the expected evolution based on scenarios for the periods 1989-2018 and 2019-2048.

Graz Universität	>=18	>=19	>=20	>=21	"warm night""
1961-1990	3,6	1,0	0,3	0,1	0,4
1985-2005	7,8	3,1	1,0	0,2	3,3
1989-2018 (scenario)	12,3	4,6	1,1	0,5	4,0
2019-2048 (scenario)	22,9	8,3	3,0	1,7	7,3

Wien Hohe Warte	>=18	>=19	>=20	>=21	"warm night""
1961-1990	9,9	3,8	1,6	0,5	2,7
1985-2005	16,3	7,7	4,0	1,4	6,4
1989-2018 (scenario)	23,5	13,6	6,9	3,4	8,3
2019-2048 (scenario)	33,6	20,9	10,8	7,3	13,2

3 Direct Impact of Climate Change on Human Health

3.1 StartClim2005.A4: Impacts of meteorological extreme events on safety of drinking water supply in Austria

During the last years, several extreme meteorological events led to an increasing number of episodes with problems in water supply (flood 2005 Tyrol, Vorarlberg, drought 2003 e.g. southern Styria). Depending on the type of extreme events, different damages can result for the water providing companies. Heavy precipitation events mainly affect infrastructure (washing out of pipelines, breaking of pipelines due to landslides, destruction of pipes mounted on bridges, etc.) due to the kinetic energy of the running water. For continuous precipitation events the damage stems mainly from the flooding of intake area.

Fig. 8: left: Damage on the pipeline route at the Samina (Hans Amman,2005);
right: Groundwater field Frastanzer Ried during the flood 2005 (Hans Amman, 2005)

Dry conditions do not affect the technical equipment, but the intake area itself. Groundwater bodies lying near the surface are much more affected from droughts than deeper lying ones. This can be explained by the better isolation of the deeper lying water (e.g. less water extraction by evapotranspiration).

Based on damage analyses measures to protect against supply interruption can be derived. These measures can be structured into three phases:
- accident precaution (organizational and technical measures),
- precautionary measures at threat,
- disaster management (alternative drinking water supply, information and media campaign, cooperation with the regional disaster management)

Table 5 lists possible damage due to flooding and classifies precautionary protective measures according to the best method and time of avoidance, i.e. in the planning process or in the operational management. The table also suggests priorities on what to do first – issues with high risk priority numbers – and what could be done later due to lower priority.

A prerequisite to react appropriately to extreme events is accident precaution. With relatively little efforts in planning or organizational measures supply interruptions can be prevented. To be able to set the appropriate actions in case of emergency (e.g. filling of the reservoir, information of the customers, etc.) the water supplier has to be in contact with the regional disaster management. The customers have to be informed, also regarding the fact that normal operating is not possible in all cases. The customers have to be aware that they also have personal responsibility (e.g. keeping emergency stocks of water). The guiding principles for information flows (in all directions) has to be to get “ the right information to the right place at the right time”.

A comparison of national and international concepts of measures to minimize water supply interruption showed, that Austrian water supplying companies are highly influenced by the incentives offered by the particular federal states. Styria prepared a water supply plan in the 1990s that has partly been implemented. This plan includes incentives to stimulate water supply companies to invest in network improvements and in redundant sources. This in one of the reasons why the drought in 2003 did not have as serious consequences as in other Austrian states. Vorarlberg and Carinthia are just preparing, respectively implementing their water supply plans, including also measures against flooding. But in Austria neither the federal government nor all the states have clear concepts or regulations on the obligation of water suppliers to prepare for emergency situations.

Tab. 5: Classification of damage

Number	**Technical Equipment including intake area** Description of damage	classification of damage [1 - 3]	prevention through planning arrangements [1- 3]	prevention through operational arrangements [1- 3]	damage effects on customer [1- 10]	risk priority number [1- 30]
1	**intake area**					
1.1	flooding of the intake area	2	1	3	6	12
1.2	increase of river bank infiltration	2	2	3	4	8
1.3	leaky house wells	2	2	3	6	12
2	**well**					
2.1	mud accumulation in the well	3	1	3	7	21
2.2	microbiological contamination	3	1	3	8	24
2.3	oil contamination	3	1	3	9	27
3.	**source**					
3.1	turbidity	2	3	1	3	6
3.2	penetration of contaminated water	2	3	1	5	10
4	**distribution network**					
4.1	underwashing of distribution pipes	1-2	3	3	6	12
4.2	underwashing of culverts	1-2	3	3	6	12
4.3	break of pipe bridges	2	1	3	6	12
4.4	slide-valves in flooded areas	2	2	2	4	8
4.5	destruction of valves (water hammer)	2	3	1	7	14
4.6	water infiltration in distribution and transport pipes	3	3	3	7	21
4.7	street and bank destruction	3	2	3	6	18
5	**water treatment**					
5.1	failure of UV equipment	3	2	2	9	27
5.2	floating of treatment equipment (tanks)	3	1	2	6	18
6.	**storage tank**					
6.1	contaminated water inflow because of permeable sections	2	1	3	4	8
6.2	contaminated water from wells and sources	2	3	2	5	10
7.	**measurement instrumentation and control**					
7.1	flooding of instrumentation and control	3	2	2	6	18
7.2	failure of electric controlled fittings and devices	3	2	2-3	5	15
7.3	failure of well	2	2	2-3	5	10
7.4	shut down of energy supply	3	2	3	6	18

According to the Swiss legal framework all water suppliers are obliged to ensure the water supply for the public also under defined model disasters. Therefore every water supplier has to develop and implement a concept on how the drinking water supply is ensured in the case of emergency (demand analyses, possibly develop new resources, etc.). In Germany the water supplying companies (WVU) are also obliged by law to deliver an agreed amount of water to the customer under all circumstances. Every interruption has to be repaired immediately by the WVU.

The Water Safety Plan (WSP) is a new, integral concept of the WHO to ensure water quality that has been implemented in some waterworks already (e.g. in Tulln). During the implementation of the WSP an accident precaution respectively a disaster management plan with the necessary measures can be included. It is intended to include the WSP in the EU-drinking water regulation that is to be issued by 2008. It will be mandatory to implement this regulation in the national laws and hence will also be binding for the Austrian water suppliers.

When planning future supply infrastructure the effect of present and future climate change has to be considered. In water demand analysis the growing rates of the water demand are included as a matter of course, but the question whether the natural water supply in the future climate will be sufficient is mostly not investigated so far. Yet, according to state of the art regional climate change scenarios, the frequency of extreme events affecting the water supply will increase. To be prepared and to lower the vulnerability for extreme events the water suppliers have to use integral planning principles and invest in higher diversity of the water resources. Just as monocultures are more vulnerable against disturbances than cultures with higher diversity, water supplier with a higher diversity in their area (e.g. redundant sources, networks, etc.) are less vulnerable to extreme events.

3.2 StartClim2005.C5: An allergenic neophyte and its potential spread in Austria – range dynamics of common ragweed (*Ambrosia artemisiifolia L.*) under the influence of climate change

Predicted climate warming will likely allow thermophile plants to expand their ranges within Austria. Highly mobile species will be among the first to follow shifting climatic range margins. Non-indigenous common ragweed, *Ambrosia artemisiifolia*, an annual herb native to North-America, has demonstrated considerable mobility during its invasion into vast parts of Eastern and Central Europe, and has reached Austria by the end of the 19th century. Preferred habitats for colonisation are locations significantly altered by human activities, like gravel deposits, embankments of railways and highways and abandoned farmland as well as agricultural land, gardens and grassland. As an agricultural weed the species is known to decrease crop yields.

Unfortunately, *Ambrosia* is a highly problematic neophyte (introduced species) with respect to human health as well, due to ample production of allergenic pollen, which can cause hay fever and even allergenic asthma.

Analyses showed that its main distribution is limited to the warm, eastern parts of the country as yet. However, climate change may trigger a rapid new wave of invasion into currently unoccupied regions. Consequently, allergic reactions are likely to increase among Austrians.

Compilation of distribution data from various sources (i.e.: the project “Mapping the Flora of Austria”, Dept. of Biogeography, University of Vienna), evaluation of herbarium data and literature surveys as well as data from the project “Mapping the embankments of main streets in Lower Austria”) allowed to reconstruct the spatial-temporal process of the spread of *Ambrosia artemisiifolia* in Austria (see graph). Four periods can be distinguished:

1. period of rare and impermanent occurrence (1883 – c.a. 1950): small populations of Ambrosia can be detected, but rarely; introduction is due to separate introductions from far distances.

2. period of incipient spread (c.a. 1950 – c.a. 1980): increasing occurrences, but Ambrosia is still rare, best suitable habitats locally show significant increase of durable populations.

3. period of increasing spread and naturalisation (c.a. 1980 – 1995): spread speeds up, large naturalised occurrences are found.

4. period of rapid spread (from c.a. 1995): common ragweed is naturalised in lower and warm parts of Austria, occurrences increase especially in the Northern Alpine foreland, the Pannonic region (Seewinkel, Weinviertel), for the first time many populations extend area-wide.

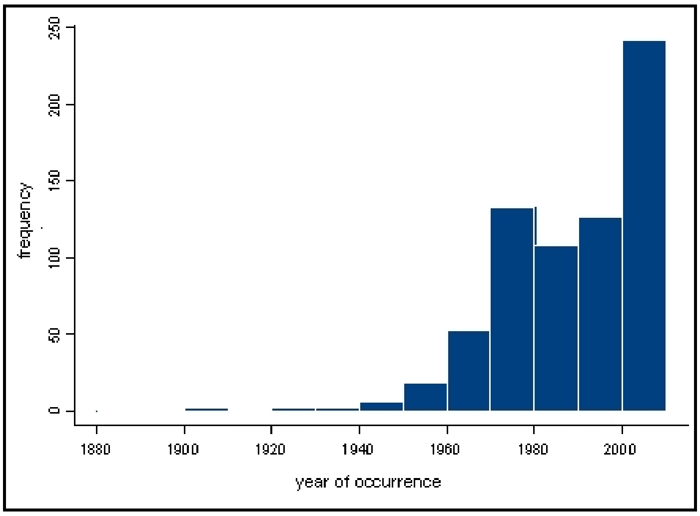


Fig. 9: Occurrences of Ambrosia in Austria, summarised by decades

Furthermore, the distribution of Ambrosia related to different landuse types was assessed. Frequent occurrences at waste sites and birdseed sites allow for conclusions on one of the most important pathways: contaminated birdseeds.

The potential extent of range expansion of common ragweed in Austria under various climate change scenarios has been assessed by means of simulation models. Models are be based on analysing the bioclimatic envelop of *Ambrosia*. This statistical approach relates probabilities of occurrences at a given location to climate and environmental conditions at this site. The grid of “Mapping the Flora of Austria” is used as a common spatial reference system. Austria is covered by 2612 grid cells (or quadrants, size approximately 6x5.5 km). All in all, 691 findings of Ambrosia-occurrences from 1883 to 2005 are distributed over 366 quadrants. In order to describe habitat conditions data on climate (annual and monthly mean temperatures, precipitation sums, number of frost days, etc.), terrain structure (elevation, roughness, etc.) and landcover/landuse (settlements, streets, agricultural land, etc.) were prepared for each quadrant.

The model shows significant correlations between occurrence probabilities and a) mean July temperature, b) landuse-index, c) curvature and d) length sum of main streets. Among these, temperature has the most important influence. Results indicate that more then ¾ of the quadrants are not suitable for colonisation under current climate conditions. Just under 11% are good or optimal habitats for *Ambrosia*. However, the picture changes rapidly if range shifts driven by potential climate change are simulated, based on three different scenarios. These simulations suggest a six-fold increase of quadrants suitable to *Ambrosia* even under a comparably moderate warming scenario (+ 2°C mean July T until 2050). A higher temperature rise (4.8°C and 6.4°C, respectively) would make 67% or 80% of Austria potentially suitable to common ragweed by the end of the century. Only 14% of the quadrants remain unsuitable for *Ambrosia*; mostly regions in the High Alps. Thus, in highly populated areas increased risk of getting in touch with allergenic pollen must be expected.

How fast the process of spread finally takes place depends on speed of climate change as well as speed of seed-dispersal. These questions cannot be answered with a static model. Currently specialised dynamic simulations (i.e. diffusion models) are being prepared to assess these processes.

Preventing the invasion of ragweed to new regions proves to be a very complex problem due to the various anthropogenous dispersal pathways (e.g. deployment of contaminated birdseed, seed sticking to cars wheels, excavation material etc.) Thus, effort has to be put into developing a co-ordinated European wide initiative against ragweed.

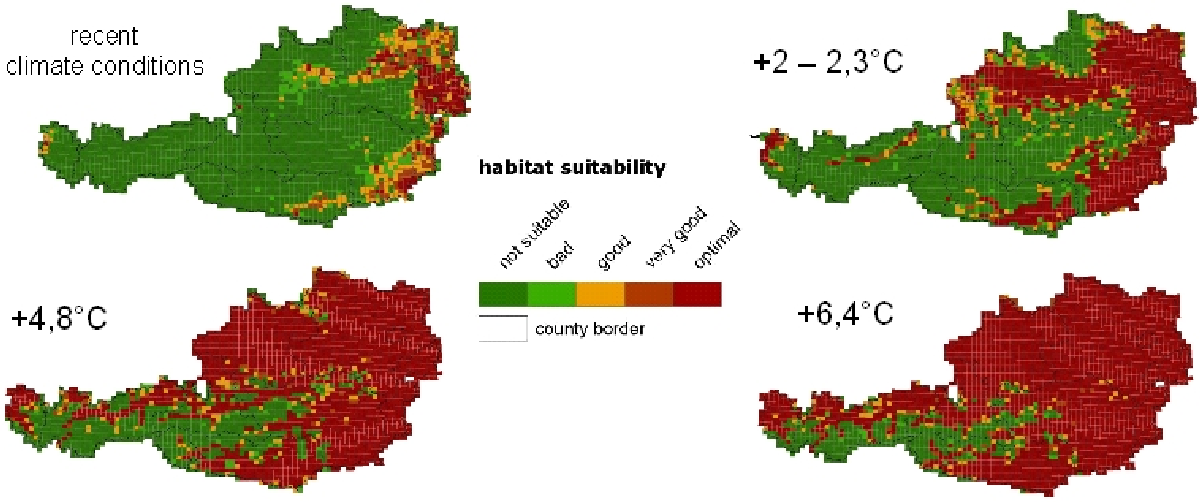


Fig. 10: Distribution of Ambrosia's potential habitats under various climate change scenarios (numbers indicate an increase of July mean temperature)

4 Climate change and agricultural pests an beneficials

Dispersion of agricultural pests not known in Austria to date may lead to losses of quality and quantity in food production. Some pests disperse naturally due to climate change, others that could so far only survive in glasshouses may be able to survive outside the glasshouses in the near future when winter temperatures are sufficiently high, Both types could trigger increased use of pesticides and new regulations may be necessary to protect human health. In many cases, analyses of new pests and beneficials within organic crop production can provide better and earlier indicators for occurring changes, as no chemicals are applied to combat pests.

4.1 StartClim2005.C3a: Impacts of climate change on agricultural pests and antagonists in organic farming in Eastern Austria

During the last years, the pest spectrum of Austrian organic crop production changed noticeably: well-known, regularly occurring pests (e.g. pea leaf weevil, wireworms) increased in abundance and damage pressure rose but during the last decades so far inconspicuous pests suddenly caused heavy damage locally or regionally (e.g. wheat bugs, cereal aphids as vectors of yellow barley dwarf virus YBDV, sugar beet weevil), and recently invaded insect species (e.g. cotton bollworm) were recorded the first time as pests in organic farming in Austria. So far no information is available about comparable, possible changes in the development of beneficial insects.

The question investigated here is whether and how far the changes in composition and abundance of pests and beneficials in arable crop production of Eastern Austria can be attributed to climate change.

A literature survey for known correlations between climatic factors and biology as well as occurrence of pest insects focussing on Austria and Eastern Middle Europe showed that relevant information was available only in the older literature before the 1960s. For recent, climate-related changes in pest status only little published literature was found in Austria as well as in the neighbouring countries of Eastern Europe.

Some recent notable, weather-caused pest outbreaks and their climatological background were documented. In spring 2002, the mass reproduction of cereal aphids caused an epidemic of YBDV never before observed. Winter barley fields in Eastern Austria as far as Upper Austria were damaged so heavily that over 20,000 hectares had to be turned over. The aphid mass reproduction was enabled by the extreme warm October of 2001. In 2002 and 2003, pea aphids caused heavy harvest losses in organically cultivated fodder peas in Burgenland and Lower Austria. For the first time since 1953 and 1954, a pest outbreak of wheat bugs occurred in 2003 in Burgenland destroying the baking quality of wheat by bug saliva enzymes.

Due to the lack of published data, recent changes in the status of domestic and invaded pests as well as their possible causes were assessed by interrogating plant protection experts. For a number of pests from cereals (e.g. cereal leaf beetle, wireworms, European corn borer, maize rootworm), root crops (e.g. potato aphids, wireworms, sugar beet weevil, locally: alfalfa snout beetle), leguminous (pea leaf weevil, locally: clover seed weevil, alfalfa weevil) and oil seed crops (cabbage flee beetle, cabbage root fly, cabbage seed weevil, brassica pod midge, rape pollen beetle) an increasing pest pressure was noted during the last years, which, however, cannot be related clearly to the warming climate but might also be caused by changes in cultivation measures (e.g. reduced soil tillage, ban of insecticides, pesticide resistance) as well as land use patterns (crop rotation, set-asides). Other pests, mainly from cereals and maize (e.g. wheat bugs, wheat stem sawfly, cereal aphids, wheat grain beetle, picknick beetle) showed pest outbreaks in single years since 2000, with a climax in the extreme warm and dry year 2003. For the first time in Austria the cotton bollworm, flying in from

Southern Hungary, caused damages in maize and vegetables (bell pepper, tomatoes, green beans) under open-field as well as greenhouse cultivation.

Case studies for two pest species (wheat bugs, sugar beet weevil) and one beneficial species (dock leaf beetle), selected because their increased occurrence is suspected to be climate related, showed some correlation between weather and climate conditions and insect abundance and distribution.

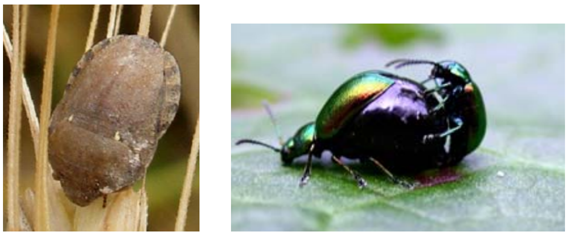


Fig. 11: : wheat bugs (left side) und leaf beetle (right side)

Case study wheat bugs: a distributional map showed the focus of damages in Eastern Austria influenced by pannonic climate. The mass development of wheat bugs in the “bug” years 1953 and 2003 might have been caused by the extreme warm and dry weather in these years. The years before might have enhanced the successive build-up of populations, because they showed higher summer temperatures compared to the 30-years average (Fig. 12). In the years since 2003 the wheat bugs remained inconspicuous, possibly due to the rather average weather conditions with cool and humid spring and summer periods.

Case study sugar beet weevil: the extreme weather conditions of 2003 very likely enabled the mass-reproduction of the warm-preferring sugar beet weevil, which by concurring unfavourable growth conditions for sugarbeet seedlings in spring 2004 led to a maximum extension of damaged acreage in Lower Austria and Burgenland, that decreased again in the following years 2005 and 2006.

Case study dock leaf beetle: interrogation and farm-visit data in Lower Austria on distribution and abundance of the dock leaf beetle, considered beneficial for biological control of broad-leaved docks, were evaluated for their correlations with regional climate differences and anomalies. The results showed that the beetle occurs during the summer months only in regions with at least 400 mm yearly precipitation (Fig. 13) and that in years and regions with precipitation deficits like in 2003 the beetles withdraw into micro-climatically favoured, cool and shadowy landscape spots. These results are important for the application of dock leaf beetle enhancement for biological dock control.

From these results, a need for long-term monitoring of climate-caused faunal changes in agriculture is derived aiming at risk prevention of climate-caused pest calamities. The monitoring systems presently run in Austria in behalf of the Agency of Food Safety and the Agricultural Chambers of the Federal States mainly link current weather data with phenological data of certain pests and plant diseases to provide decision support for scheduling pesticide applications. With exception of the pheromone trapping survey of the western corn root worm, having shown up in Austria for the first time in 2002, no countrywide long term monitoring systems for arable pests are run in Austria at present. Therefore, a methodological approach for such a long term surveillance system of pest status in the most important arable crops is suggested, aiming at recognizing climate-caused changes in time and inducing preventive measures for avoidance of pest calamities in Austrian crop and field vegetable production.

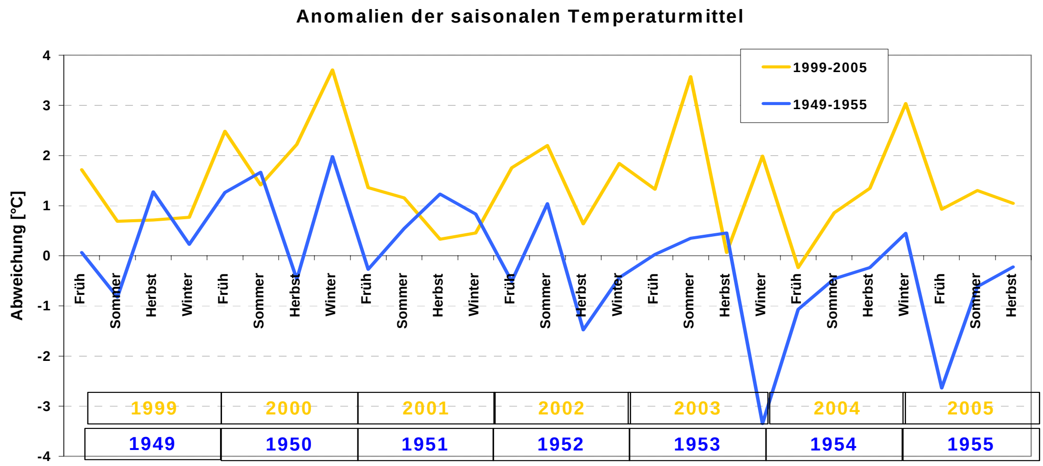


Fig. 12: Deviation from the 30-year average temperature (0-line) in the years before and after the years 1953 and accordingly 2003 with pest outbreaks of wheat bugs in Austria; Neusiedl/See, ZAMG.

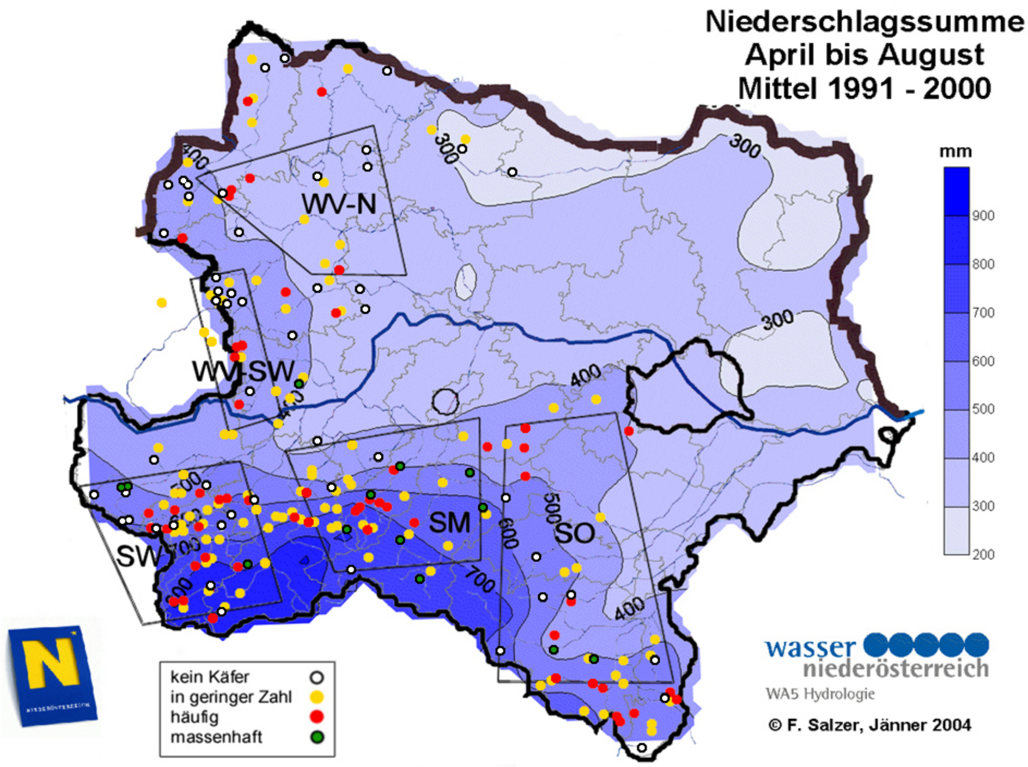


Fig. 13: Mean precipitation sums 1991-2000 (provided by F. Salzer, Abt. Hydrologie der NÖ Landes-regierung) and intensity of appearence of leef beetles in Lower Austria (NÖ) estimated by farmers.

4.2 StartClim2005.C3b: Risk analysis of the establishment of the Western Flower Thrips (*Frankliniella occidentalis*) under outdoor conditions in Austria as a result of climatic change

The Western Flower Thrips (=WFT, *Frankliniella occidentalis*) that originates from the south-west of North America has spread worldwide in greenhouses in the last 30 years. It lives on ornamentals and vegetable plants and is considered as key pest for these.

Published data of laboratory experiments at low constant temperatures show that its adults can survive at a temperature of +5°C or less for only 26 days. This would nearly exclude survival in outdoor conditions even in Southern Europe, where its survival is documented. It is therefore assumed that overwintering is successful if WFT is still in the development stage and slow, but continuous development is possible during the winter months. Such development could take place at a low level at temperatures of 15°C or somewhat lower: at this temperature which lies above the threshold of development, oviposition was observed. Numerous publications about damage on typical outdoor cultures such as wine or nectarines by WFT show that the most northerly outdoor occurrence is situated in the Italian province of Emilia Romagna. There the mean daily maximum temperatures during winter range between 7° and 8°C, and temperatures higher than 15°C occur in intervals of less than 3 weeks. These winter conditions are thought to be similar to the temperature conditions that allow overwintering of WFT. According to scenarios for the alpine regions, winter conditions that presently occur in the Emilia Romagna could prevail in the warmest regions of Austria towards the middle of this century. Accordingly, it is considered to be very likely that WFT having escaped from greenhouses could overwinter outdoors in Austria from then on. In that case fruitcrops and grapes could be damaged by this new key pest.

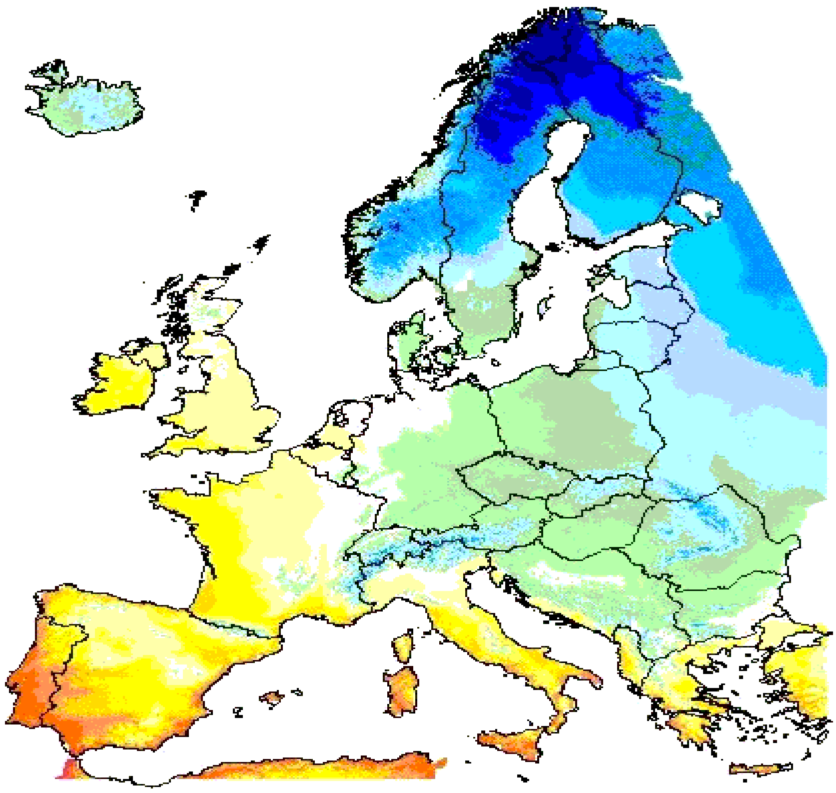


Fig. 14: Documented damage induced by Frankliniella occidentalis on different typical outdoor cultures (purple stars) of nectarines and wine. It can be anticipated, that Frankliniella occidentalis hibernates in this regions. Background map is the average January temperature in Europe (IIASA 2006))

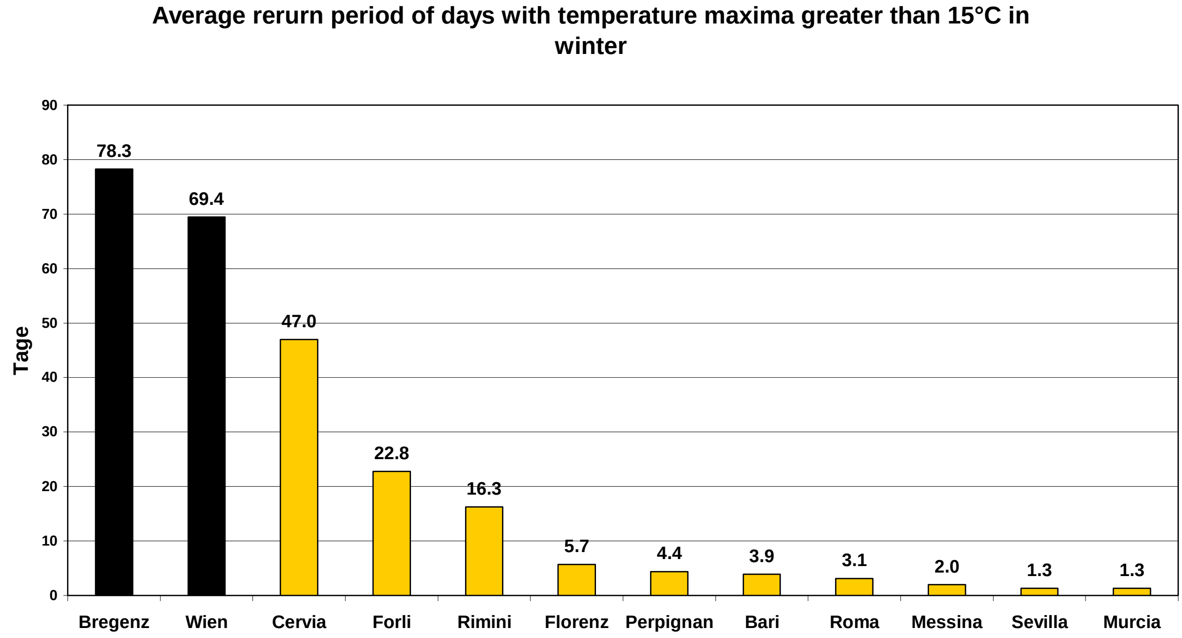


Fig. 15: Average return period of days with temperature maxima greater than 15°C in winter. Yellow are meteorological station in regions with Frankliniella occidentalis and as reference the two black Austrian stations (Vienna and Bregenz). The stations Cervia, Forli and Rimini are neighbouring to the most northern documented outdoor occurrence at Brisighella.

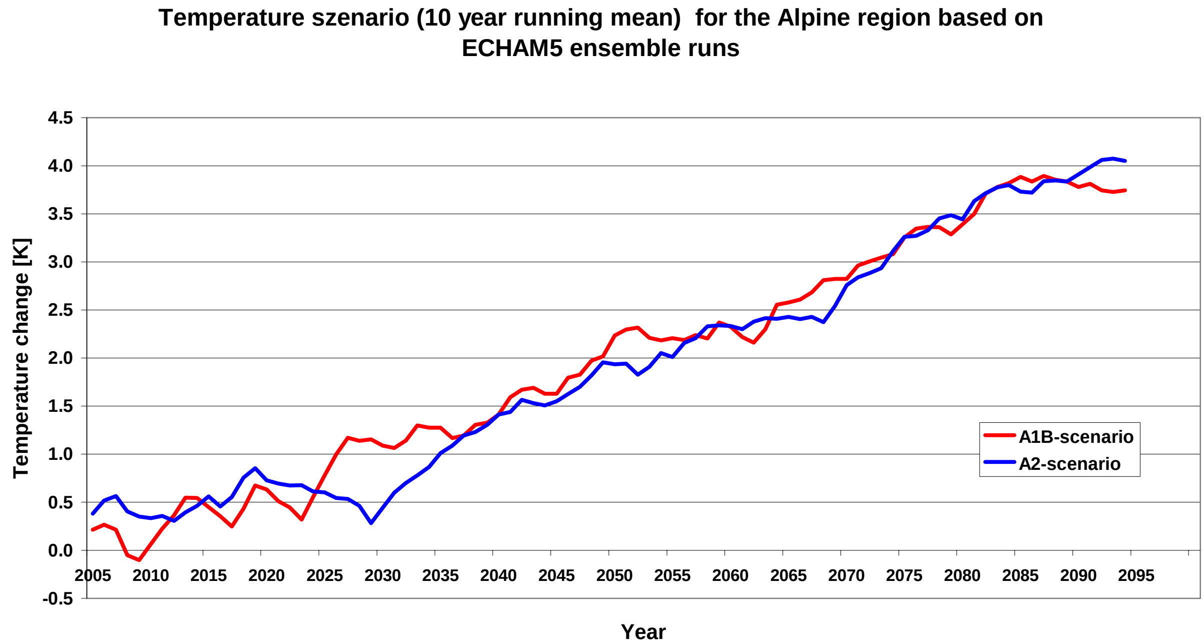


Fig. 16: Average change in winter temperature in the Alpine region. The scenarios are based on three realisations with the GCM ECHAM5, forced with the emission scenarios A1B and A2. 10 year running mean on the average of the three runs.

5 Impacts of Climate Change on Health of Animals

Changes in habitats of certain animals caused by climate change may spread epizootics. Tularaemia which seizes rodents is an example for this. Tularemia is also relevant for certain human risk groups, e.g. hunters. Shortage of wildlife habitat and therefore more compact colonisation may lead to higher liability to diseases in the population of animals. Climate change in Alpine regions can possibly menace the habitat of black grouse, snow grouse, chamois and ibex and so also the health of those populations.

5.1 StartClim2005.C2: Investigation of the prevalence of tularaemia under the aspect of climate change

Wild animal habitats are greatly influenced by geographical location, structure, climate, fauna and flora and may extend deep into human settlement areas, depending on animal species. This also poses the danger of animal-human disease transmission. This research project aims at investigating the impact of climate and weather on the prevalence of tularaemia (pathogen: *Francisella tularensis*) in hare populations in the lowlands of eastern Austria.

The fundamental relationship between bacterial infectious diseases, such as tularaemia, and climate parameters can be identified by the ambient conditions required by the pathogen. Bacteria reproduce at moderate, rising temperatures, are destroyed at elevated temperatures and are resistant to cold. In addition, the population density of host animals and the abundance of potential disease vectors (ticks, gnats) also play a decisive role. The infection is transmitted to animals and humans by direct contact with infected animals and vectors, by inhalation of pathogens or the consumption of insufficiently cooked infected hare meat. An average of 10 to 20 human cases are recorded in Austria each year, but the number of unreported cases is likely to be far higher. The causative agent of tularaemia is also considered as a potential biological weapon due to its low infection dose and the occurrence of multiresistant strains.

A total of 271 cases of tularaemia in hares was recorded in the area under investigation (Lower Austria, Burgenland, Styria) in the period from 1994 to 2005 and georeferenced according to sender postcode. Temperature and precipitation data for the selected region were available from 30 weather stations of the Central Institute of Meteorology and Geodynamics. These data provided the basis for calculating an altitude dependent temperature distribution for suitable monthly means and period sums. The spacial distribution of precipitation was calculated using the geostatistical universal kriging method without taking the influence of altitude into account. A clear correlation was established between the two climate parameters and local disease incidence, which can be represented by the following linear regression model.

*Number of diseased hares per year = 52.12 + 4.08 * (average of monthly mean temperature for December, January and February) – 3.46 *(monthly mean temperature for May) + 0.26 * (precipitation sum for June and July)*

This formula does not allow absolute prevalence in nature to be calculated, since it is based on sample data of one specific region. Of special note, however, is the highly significant ($p < 0.05$) influence of the parameters selected on the incidence rate of the disease and the coefficient of determination obtained (R^2 = 74.6 %). It becomes clear that about ¾ of inter-year differences can be explained by temperature and precipitation conditions: warm winter temperatures result in an increase in incidence, while warm May temperatures lead to a decrease; high precipitation in summer again has an enhancing effect. The ideal conditions for the spread of the disease are thus warm winters combined with cool May temperatures and precipitation in summer.

This correlation was derived from observations and of course does not apply to arbitrary temperature and precipitation values. It was therefore attempted to find empirical limits for the parameters contained in the formula on the basis of actual prevalence. A high incidence probability was obtained for annual precipitation totals below 720 mm, summer precipitation around 180 mm, winter temperatures above 0.5°C and May temperatures below 14°C. These limit values allow the spatial distribution of the disease to be calculated for current and future conditions.

A climate change induced warming of 2 to 4°C was assumed for predicting the special distribution of the disease by 2035, with warming expected to be more pronounced at higher altitudes than in the lowlands. Figure 17 shows the possible spatial distribution of tularaemia in 2035 following a rise in mean annual temperatures. Changes in precipitation were not taken into account due to the lack of a suitable scenario. Under these conditions, tularaemia will slowly spread from the eastern lowlands via the Danube valley to the west and via southern Styria further to the south. Additional incidents of the disease could also occur in those inner Alpine areas providing favourable climatic conditions.

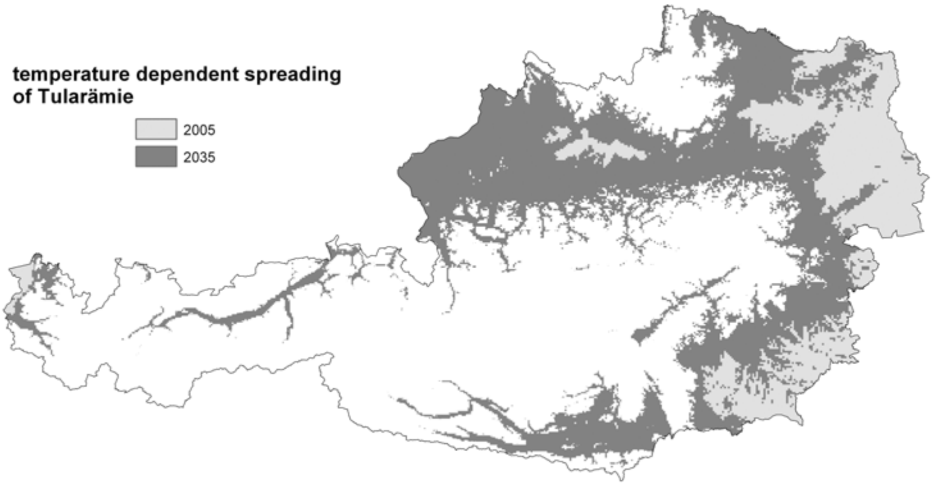


Fig. 17: Prevalence of tularaemia in the years 2005 and 2035

In summary it can be stated that climate is the key parameter for explaining the distribution of tularaemia in the past and that limit values for individual climate parameters can be identified. The expected warming could result in a massive expansion of the potential tularaemia distribution area. It would therefore be important to inform risk groups (hunters, foresters, farmers, laboratory staff, taxidermists, housewives etc.) beyond current prevalence regions and recommend their taking preventative measures of work hygiene (protective gloves, moistening the fur when skinning hares, insect protection, face masks in the lab) when handling hares and rodents and their following good kitchen hygiene practices when preparing and cooking hares.

5.2 StartClim2005.F: GIS-based analysis of changes in the habitats of alpine wild animal species (black grouse, snow grouse, chamois, ibex) due to shifts in the tree line as a result of climate change

Wild animal species such as the black grouse, snow grouse, chamois and ibex have adapted to life in an Alpine environment above the tree line in the course of their evolution and thus form part of this very sensitive ecosystem. The habitat of these wild animal species might be substantially reduced by a potential upward movement of the tree line as a result of global warming.

Possible changes were determined on the basis of the temperature development of the past 50 years and an estimate of future warming derived from a regional climate model. A potential shift of the tree line and thus also of the habitats of wild animal species was investigated for an area in the Niedere Tauern range. The selected exemplary scenario derived from the climate model predicts a warming of approx. 2.2°C for the area under investigation over the next 50 years.

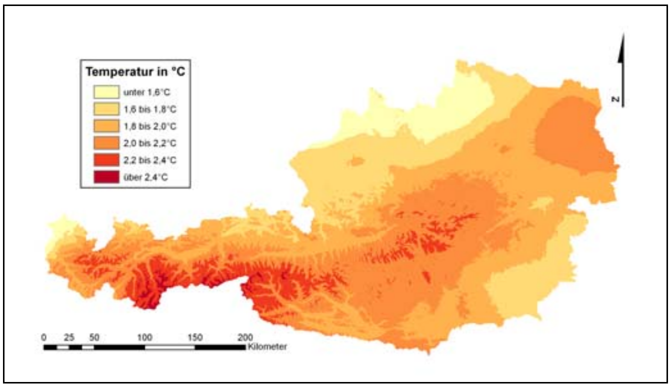


Fig. 18: Temperature change from decade 1990-2000 to decade 2040-2050 (MM5 climate model)

The elevation of the tree line strongly depends on temperature, with literature data suggesting that the growth limit of trees is highly correlated with the 10°C July isotherm. Temperature averages for the entire growth period, however, produce better results than monthly means. A preliminary analysis showed that the 6.9°C isotherm of the growth period is in good agreement with the 10°C July isotherm. The deviations between these isotherms are small and the growth period temperature was thus used for the subsequent investigations.

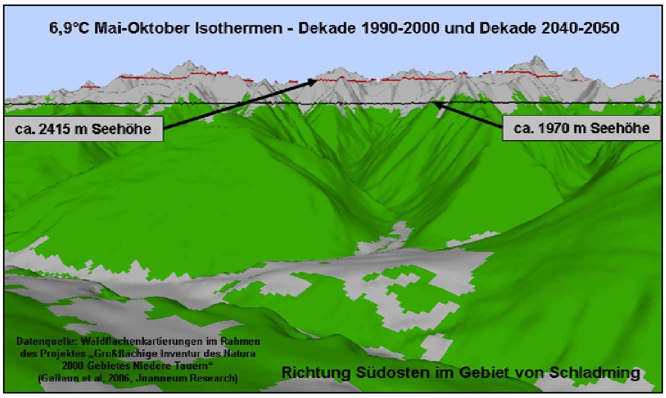


Fig. 19: Isotherms at the temperature related growth limit for trees

Precipitation is considered to be of lower significance in the Niedere Tauern range, since it does not constitute a limiting factor here.

The climate model shows that the relevant isotherms in the Niedere Tauern area will rise by approx. 450 m over the next 50 years, as can be seen in Figure 19. This value is only valid for the specific global climate scenario selected. Values for the potential level of the tree line are very dependant on the selected climate scenario, as the temperature rise for Austria e.g. fluctuates within the range of 1°C for the period of the next 50 years for different scenarios. As the selected scenario is not an extreme one, it can be assumed that the rise of the 6.9°C isotherme could be even more than 450 m.

No statement can be made on how fast the tree line will advance towards the temperature related growth limit without additional research. Human management practices also have a substantial influence on tree line position so that future changes in the tree line cannot be exactly foreseen.

Assuming, however, that the shift of the isotherm will also result sooner or later in a shift of the tree line, the question arises as to what this will mean for the habitats of alpine wild animal species. To answer this question, the relevant parameters for determining the present habitats and land cover were derived from a digital height model and assessed using a GIS and a knowledge based habitat model.

The GIS based simulation of the upward movement of the tree line allows the calculated changes/habitat losses to be mapped and quantified. The use of a geographical information system proved extremely convenient for this project, because it allowed information from different disciplines to be combined in a common spatial framework for subsequent comprehensive analysis. In this way, a direct correlation was established between temperature changes and the tree line and their effects on the habitats investigated.

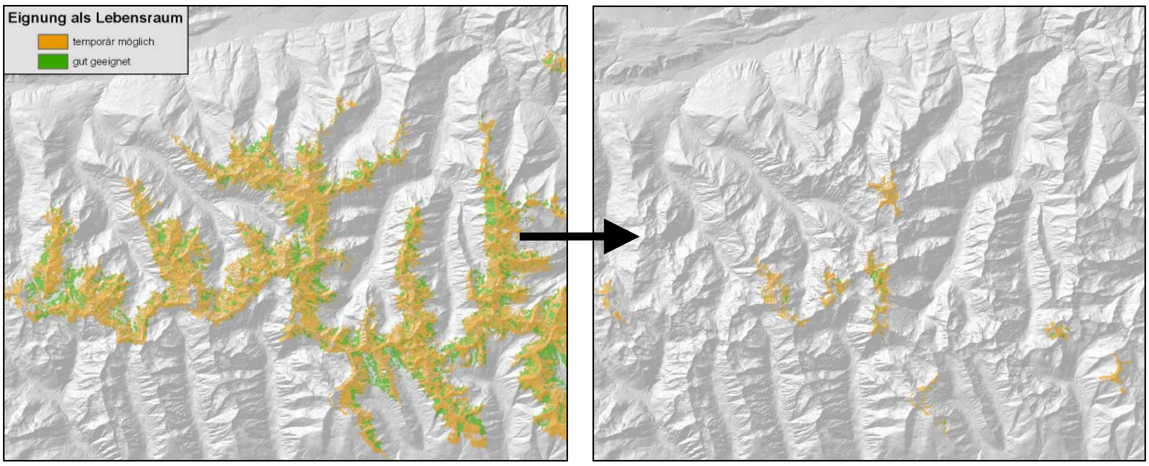


Fig. 20: Present and future habitat suitability for snow grouse, assuming a temperature increase of approximately 2.2°C and derived shift of the tree line.

Tree ring analyses have shown that the tree line has shifted repeatedly in the past 8000 years as a result of temperature changes. In the postglacial period, for example, the Alpine tree line was located at an elevation which it could well approach again in the future.

Assuming that the tree line will reach the isotherm calculated for the decade 2040-2050 in the future, this shift will result in a dramatic habitat loss (Tab.6).

The habitats of all four wild animal species investigated will substantially decrease under the above assumptions and model results. The snow grouse in particular will lose its habitat almost completely. This can be seen even more clearly in the map of Figure 20. The expected results include dissolution of present subpopulations, increased susceptibility to disease in suboptimal habitats as well as increased susceptibility to predators as a result of reduced visibility caused by the increase in vegetation. The four wild animal species investigated can be considered as very sensitive indicators for the negative habitat changes resulting from shifts of the tree line due to climate change. A number of other animal and plant species of alpine habitats, however, will also be affected to a similar extent.

Tab. 6: Change of suitable habitat areas compared to present habitat area assuming a warming of approximately 2.2°C and a future shift of the tree line.

	Change in habitat area [%]		
Assessment	**well suitable**	**moderately suitable**	**temporarily suitable**
Black grouse	-97.95	0	-99.65
Snow grouse	-98.02	0	-93.85
Chamois summer	-79.76	-89.86	103.72
Chamois winter	-80.00	-82.05	29.00
Ibex summer	-93.35	-62.34	-75.65
Ibex winter	-77.52	-79.43	-71.63

References

StartClim2005.A1a

Akaike, H. 1973. Information theory as an extension of the maximum likelihood principle. Pp. 267-281 In: Petrov BN, Csaksi F (Hrsg.): 2nd International Symposium on Information Theory. Akademiai Kiado, Budapest, Hungary.

Bachinger E., Frank E., Fülöp G., Hlava A., Ritter H., Urbas E., Werba A., Winkler T. (2003): Lebenserwartung und Mortalität in Wien. Magistrat der Stadt Wien.

Basu R., Samet JM (2002): Relation between elevated ambient temperature and mortality: a review of the epidemiologic evidence. Epidemiologic Reviews 24: 190-201.

Basu R. (2001): Characterizing the relationship between temperature and cardio-respiratory mortality among the elderly U.S. population. (PhD dissertation). Baltimore, MD: Bloomberg School of Public Health, John Hopkins University, 2001.

Díaz J., Jordán A., García R., López C., Arberdi J., Hernández E., Otero A. (2002): Heat waves in Madrid 1986-1997: effects on the health of the elderly. Int. Arch. of Occupational and Environmental Health. Vol. 75, Number 3, March 2002. Springer Berlin/Heidelberg.

Dominici F., McDermott A., Zeger SL Samet JM et al. (2002) On the Use of Generalized Additive Models in Time-Series Studies of Air Pollution and Health. Am J Epidemiol 156:193-203.

Formayer H., Haas P., Matulla C., Frank A., Seibert P. (2005): Untersuchungen regionaler Klimaänderungsszenarien hinsichtlich Hitze- und Trockenperioden in Österreich. Endbericht von StartClim2004.B; in StartClim2004: Analysen von Hitze und Trockenheit und deren Auswirkungen in Österreich. Endbericht, Auftraggeber: BMLFUW, BMBWK, BMWA, Österreichische Hagelversicherung, Österreichische Nationalbank, Umweltbundesamt, Verbund AHP.

Garssen J., Harmsen C., de Beer J. (2005): The effect of the 2003 heat wave on mortality in the Netherlands. Eurosurveillance 10(7-9): 165-167.

Grize L., Huss A., Thommen O., Schindler C., Braun-Fahrländer C. (2005): Heat wave and mortality in Switzerland. Swiss Med. Wkly 2005;135:200-205

Hajat S., Kovats RS, Atkinson RW Haines A. (2002): Impact of hot temperatures on death in London: A time series approach. Journal of Epidemiology and Community Health 56: 367-372.

Houghton JT, Ding Y., Griggs DJ, Noguer M., van der Linden PJ, Xiaosu D. (2001): Climate Change 2001. The scientific basis. Cambridge University Press. Cambridge.

Hutter H.-P., Moshammer H., Wallner P., Leitner B., Kundi M. (2006): Heatwaves in Vienna: Effects on mortality. Eingereicht bei Wiener Klinische Wochenschrift.

IPCC (2001): Climate Change 2001. Synthesis Report. Summary for Policymakers. http://www.IPCC.ch

Johnson H., Kovats RS, Mc Gregor G., Stedman J., Gibbs M., Walton H., (2005): The impact of the heat wave on daily mortality in England and Wales and the use of rapid weekly mortality estimates. Eurosurveillance, Vol. 10, Issues 7-9 Jul-Sep 2005.

Katsouyanni K., Touloumi G., Spix C., Schwartz J., Balducci F., Medina S., Ross G., Wojtyniak B., Sunyer J., Bacharova L., Schouten JP, Ponka A., Anderson HR (1997): Short term effects of ambient sulphur dioxide and particulate matter on mortality in 12 European cities: results from time series data from the APHEA project. BMJ 314(7095): 1658 - 1658.

Katsouyanni K., Zmirou D., Spix C., Sunyer J., Schouten JP, Ponka A., Anderson HR, Le Moullec Y., Wojtyniak B., Vigotti MA, et al. (1995): Short-term effects of air pollution on health: a European approach using epidemiological time-series data. The APHEA project: background, objectives, design. Eur Respir J 8: 1030-1038.

Kovats RS, Jendritzky G. (2006): Heat-waves and human helath. In: Menne B, Ebi KL (Hrsg.): Climate Change and adaptation strategies for human health. Steinkopff, 63-97.

Kovats RS, Wolf T., Menne B. (2004): Heatwave of August 2003 in Europe: provisional estimates of the impact on mortality. Eurosurveillance Weekly 2004; 8(11)

Kysely J. (2004): Mortality and displaced mortality during heat waves in the Czech Republic. Int J Biometeorol 49: 91–97

Larsen J. (2006): Setting the Record Straight: More than 52,000 Europeans Died from Heat in Summer 2003. http://www.earth-policy.org/Updates/2006/Update56.htm. (besucht am 1.1.2006) Earth Policy Institute.

Le Tertre A., Lefranc A., Eilstein D., Declercq C., Medina S., Blanchard M. et al. (2006): Impact of the 2003 heatwave on all-cause mortality in 9 French cities. Epidemiology 17: 75-79.

Nogueira P. (2005): Modelling heat related excess mortality: New insights given by 2003's Heat wave. Vortrag bei: International Conference Climate Change: Impacts and Responses in CEE Countries. 5.-8.11.2005, Pecs, Ungarn.

Paldy A., Bobvos J., Vamos A., Kovats RS, Hajat S. (2005): The effect of temperature and heat-waves on daily mortality in Budapest, Hungary 1970-200. In: Kirch W, Menne B, Bertollini R (Hrsg.): Extreme weather events and public health responses. Springer, 99-108.

Poumadere M., Mays C., Le Mer S., Blong R. (2005): The 2003 Heat Wave in France: Dangerous Climate Change Here and Now. Risk Analysis 25: 1483-1494)

Robert-Koch-Institut (2004): Hitzewellen und extreme Klimaereignisse – Herausforderungen für das Gesundheitswesen. Epidemiologisches Bulletin 25: 200-201.

Simón F., Lopez-Abente G., Balester E., Martínez F., (2005): Mortality in spain during the heat waves of summer 2003. Eurosurveillance, Vol. 10, Issues 7-9 Jul-Sep 2005.

Statistik Austria (2005): Jahrbuch der Gesundheitsstatistik 2004. Wien

Thommen Dombois O., Braun-Fahrländer C. (2004): Gesundheitliche Auswirkungen der Klimaänderung mit Relevanz für die Schweiz. Literaturstudie im Auftrag der Bundesämter für Umwelt, Wald und Landschaft (BUWAL) und für Gesundheit (BAG). Institut für Sozial- und Präventivmedizin der Universität Basel.

Vandentorren S., Suzan F., Medina S., Pascal M., Maulpoix A., Cohen J-C, Ledrans M. (2004): Mortality in 13 French Cities During the August 2003 Heat Wave. Am J Public Health 94: 1518-1520

WHO (2004): Extreme weather and climate events and public health responses. Report on a WHO meeting Bratislava, Slovakia 09–10 February 2004. WHO, Rom.

StartClim2005.A1b

ACTIVE (2004). ACTIVE -Austrian Climate and Health Tourism Initiative. H. Nefzger, E. Rudel, S. Schunder-Tatzberet al, Universität für Bodenkultur Wien, Institut für Meteorologie, in Zusammenarbeit mit: ZAMG Wien, Abteilung Klimatologie; Universität Freiburg, Meteorologisches institut; Universität Wien, Institut für Physiologie. Im Auftrag des Bundeministeriums für Wirtschaft und Arbeit.

Chmielewski, F.-M., P. Hupfer, et al. (2005). Witterung und Klima, B.G. Teubner Stuttgart Leipzig Wiesbaden.

Easterling, D. R., B. Horton, et al. (1997). "Maximum and minimum temperature trends for the globe." Science 277(5324): 364.

Fezer, F. (1995). Das Klima der Städte, Justus Perthes Verlag Gotha.

Formayer, H., P. Haas, et al. (2005). Untersuchungen regionaler Klimaänderungsszenarien hinsichtlich Hitze- und Trockenperioden in Österreich. Auftraggeber: BMLFUW, BMBWK, BMWA, Österreichische Hagelversicherung, Österreichische Nationalbank, Umweltbundesamt, Verbund AHP. In: StartClim2004.B: Analysen von Hitze und Trockenheit und deren Auswirkungen in Österreich.

Helbig, A., J. Baumüller, et al. (1999). Stadtklima und Luftreinhaltung, Springer.

Houghton, J. T., Y. Ding, et al. (2001). "Climate Change 2001. The scientific basis. Cambridge University Press. Cambridge."

Hulme, M., G. J. Jenkins, et al. (2002). "Climate change scenarios for the United Kingdom: the UKCIP02 scientific report."

Hupfer, P. and W. Kuttler (2005). Witterung und Klima. Eine Einführung in die Meteorologie und Klimatologie., Teubner, Stuttgart, Leipzig.

Hutter, H.-P., H. Moshammer, et al. (2006). "Heatwaves in Vienna: Effects on mortality." Eingereicht bei Wiener Klinische Wochenschrift.

IPCC (2001). Climate Change 2001. Synthesis Report. Summary for Policymakers., IPCC.

IPCC (2001). "Climate Change 2001: The Scientific Basis." Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J. T., Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K. Maskell and C. A. Jonson (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA: 881.

Kirch, W., B. Menne, et al. (2005). Extreme Weather Events and Public Health Responses, Springer, Berlin.

Klein Tank, A. M. G., J. B. Wijngaard, et al. (2002). "Daily dataset of 20th-century surface air temperature and precipitation series for the European Climate Assessment." International Journal of Climatology 22(12): 1441.

Koppe, C., S. Kovats, et al. (2004). Heat-waves: risks and responses. Health and Global Environmental Change. WHO.

Kovats, R. S. and G. Jendritzky (2006). "Heat-waves and human health. In: Menne B, Ebi KL (Hrsg.): Climate Change and adaptation strategies for human health." Steinkopff: 63-97.

Kysely, J. (2004). "Mortality and displaced mortality during heat waves in the Czech Republic." Int J Biometeorol (49): 91-97.

Matulla, C., P. Haas, et al. (2004). Anwendung der Analog-Methode in komplexem Terrain: Klimaänderungsszenarien auf Tagesbasis für Österreich. GKSS Report. GKSS. Hamburg, GKSS. 2004/11: 70.

Roeckner, E., J. Oberhuber, et al. (1996). "ENSO variability and atmospheric response in a global coupled atmosphere-ocean GCM." Climate Dyn. 12: 737-745.

Schöner, W., I. Auer, et al. (2004). Qualitätskontrolle und statistische Eigenschaften ausgewählter Klimaparameter auf Tageswertbasis im Hinblick auf Extremwertanalysen. StartClim 2003. Wien.

Statistik Austria (2005). Jahrbuch der Gesundheitsstatistik 2004. S. Austria. Wien.

WHO (2004). Extreme weather and climate events and public health responses. WHO meeting. R. WHO. Bratislava, Slovakia.

WHO (2005). Extreme Weather Events and Public Health Responses, Springer.

ZAMG (2001). "ÖKLIM- Digitaler Klimaatlas Österreichs."

StartClim2005.A4

Auer, I., E. Korus, R. Böhm, and W. Schöner, 2005, Analyse von Hitze und Dürreperioden in Österreich; Ausweitung des täglichen StartClim Datensatzes um das Element Dampfdruck, Analysen von Hitze und Trockenheit und deren Auswirkungen in Österreich

Start Clim 2004, Wien, Zentralanstalt für Meteorologie und Geodynamik.

Blöchliger, D. H., and F. Neidhöfer, 1998, Auswirkungen von extremen Niederschlagsereignissen, Bern, OcCC ProClim.

Eybl, J., R. Godina, P. Lalk, P. Lorenz, G. Müller, and V. Weilguni, 2004, Trockenheit in Österreich im Jahr 2003, Ein hydrologischer Situationsbericht, Wien.

F.Nobilis, and R. Godina, 2006, Extreme Trockenheit in Österreich: Österreichische Wasser- und Abfallwirtschaft, v. Heft 3-4, p. S. 51.

Formayer, H., S. Eitzinger, H. Nefzger, S. Simic, and H. Kromp-Kolb, 2001, Auswirkungen einer Klimaveränderung in Österreich: Was aus bisherigen Untersuchungen ableitbar ist, Wien, Institut für Meteorologie und Physik, Universität für Bodenkultur.

Godina, R., P. Lalk, P. Lorenz, G. Müller, and V. Weilguni, 2004, Die Hochwasserereignisse im Jahr 2002 in Österreich, Wien, Bundesministerium für Land und Forstwirtschaft,

Godina, R., P. Lalk, P. Lorenz, G. Müller, and V. Weilguni, 2005, Das Hochwasser in Österreich vom 21. bis 25. August 2005, Beschreibung der hydrologischen Situation, Wien, Abteilung VII/3 – Wasserhaushalt (HZB).

Houghton, J. T., Y. Ding, D. J. Griggs, M. Noguer, P. J. v. d. Linden, X. Dai, K. Maskell, and C. A. Johnson, 2001, Climate Change 2001: The Scientific Basis, Cambridge, THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE.

(ISDR), I. S. f. D. R., 2004, Terminology of disaster risk reduction, UN/ISDR.

Kozel, R., and M. Schürch, 2005, Grundwasser auf dem Prüfstand: Forum zum Hitzesommer 2003.

Kromp-Kolb, U.-P. D. H., 2005, Analysen von Hitze und Trockenheit und deren Auswirkungen in Österreich. Endbericht, Wien, Institut für Meteorologie, Department für Wasser-Atmosphäre-Umwelt, Universität für Bodenkultur.

Kunz, M., Das Pfingsthochwasser aus der Sicht eines Meteorologen, Institut für Meteorologie und Klimaforschung Karlsruhe (IMK).

Landesregierung, A. d. V., 2005, Das Starkregen- und Hochwasserereignis des August 2005 in Vorarlberg, Feldkirch, Amt der Voralrberger Landesregierung.

Neu, U., and E. Thalmann, 2005, Hitzesommer 2003 Synthesebericht, Bern, ProClim-Forum for Climate and Global Change. Platform of the Swiss Academy of Science.

OcCC, 2003, Extremereignisse und Klimaänderung: Bern, OcCC, Organe consultatif sur les changements climatiques, Beratendes Organ für Fragen der Klimaänderung.

Reichel, G., 2002, Erfahrungsberichte aus Oberösterreich, Hochwasserkatastrophe-Gefahr für Trinkwasser!?, Linz, ÖVGW, p. S.27.

Schorer, D. M., 2000, Trockenheit in der Schweiz, Klimaänderung Schweiz. Workshopbericht, Bern, Organe consultatif sur les changements climatiques, Beratendes Organ für Fragen der Klimaänderung.

Sigl, G., 2004, Auswirkungen eines Rekordsommers auf die Mikrobiologie des Wassers: Symposium Wasserversorgung, p. S.22.

Wachter, K., 2002, Gefahren für Wasserversorgungen bie Hochwasser, Erfahrungen aus der Sicht eines Krisenstabes, Hochwasserkatastrophe- Gefahr für Trinkwasser!?, Linz, ÖVGW, p. S.32.

Wimmer, H., 2006, Katastrophenmanagement: 11. Österreichische Umweltrechtstage. Naturkatastrophen und Störfälle, 2004, SONDERBEOBACHTUNGSDURCHGANG: HOCHWASSER 2002 – AUSWIRKUNGEN AUF DAS GRUNDWASSER IN SALZBURG, Erhebung der Wassergüte in Österreich – Jahresbericht 2004: Wien.

StartClim2005.C2

Auer, I. et al., (2005): A new instrumental precipitation dataset for the greater alpine region for the Periode 1800 – 2002. International journal of climatology **25**, 139 – 166, Royal meterological society.

Auer, I., Böhm, R., Mohnl, H., Potzmann, R., Schöner, W., Skomarowski, P. (2001): ÖKLIM, Digitaler Klimaatlas Österreichs, Zentralanstalt für Meterologie und Geodynamik Wien, Österreich.

Auer, I. et al., (2006): Histalp – Historical instrumental climatological surface time series of the greater alpine region, http://www.zamg.ac.at/ALP-IMP/

Auer, I., Böhm, R., Maugeri, M. (2001a): A New long-term gridded precipitation data set for the Alps and its Application for MAP and ALPCLIM. Journal for Physics and Chemistry of the Earth, Part B, Vol 26/5-6, 421-424.

Auer, I., Böhm, R., Schöner, W. (2001b): Austrian Long-term Climate 1767-2000, Instrumental Climate Time Series from Central Europe. Österr. Beitr. zu Meteorologie und Geophysik, H.25, 146 pages plus Data und Metadata CD.

Auer, I., Böhm, R., Schöner, W., Hagen, M. (1998): 20th century increase of boundary layer turbidity derived from alpine sunshine and cloudiness series. Preprints of the 8th Conference on Mountain Meteorology, Aug.98 in Flagstaff, Arizona. AMS, Boston, pp.77-80.

Bell, J. F. (1981): Francisella. In: Blobel, H. und Schliesser, T. (Hrsg.): Handbuch der bakteriellen Infektionen bei Tieren. Bd. III., Fischer, Stuttgart, S. 172-256.

Bisping, W., Amtsberg, G. (1988): Farbatlas zur Diagnose bakterieller Infektionserreger der Tiere. Parey, Berlin, S. 212-213.

Böhm, R., Auer, I., Schöner, W. and Hagen, M. (1998): Long alpine barometric time series in different altitudes as a measure for 19th/20th century warming. Preprints of the 8th Conference on Mountain Meteorology, in Flagstaff, Arizona. AMS, Boston, pp.72-76.

Boch, J., Schneidawind, H. (1988): Krankheiten des jagdbaren Wildes. Parey, Hamburg und Berlin.

Bsteh, O. (1937): Fälle von Tularämie. Wien. Klin. Wschr. 50, 108.

Chiari, H. (1937): Über Tularämie. Wien. Med. Wschr. 40, 1015-1019.

Damoser, J., Hofer, E. (1995): Brucella suis Biovar 2-Infektionen beim Feldhasen. Z. Jagdwiss. 41, 137-141.

David, H. (1937a): Über den Verlauf der Tularämie in Österreich. Dtsch. tierärzt. Wschr. 45, 477-481.

David, H. (1937b): Zur Diagnose der Tularämie des Menschen und der Tiere. 17. Tagung der Deutschen Vereinigung für Mikrobiologie, Berlin.

David, H. (1947): Untersuchungen über die Tularämie in Österreich (1935-1945). Wien. Tierärztl. Mschr. 10, 523-544.

Dedie, K., Bockemühl, J., Kühn, H., Volkmer, K. J., Weinke, T. (1993): Bakterielle Zoonosen bei Tier und Mensch. Enke, Stuttgart.

Deutz, A., Hinterdorfer, F. Aste, C. (1997): Woran erkrankt der Hase? Feldhasenuntersuchung in der Steiermark. Der Anblick Heft 6, S. 12-15.

Deutz, A., Fuchs, K., Nowotny, N., Auer, H., Schuller, W., Stünzner, D., Aspöck, H., Kerbl, U., Köfer, J. (2003a): Seroepidemiologische Untersuchung von Jägern auf Zoonosen – Vergleich mit Untersuchungen bei Tierärzten, Landwirten und Schlachthofarbeitern. Wien. Klin. Wschr., Supplement 3-2003, Beilage zu Band 115, Suppl 3, 61-67.

Deutz, A., Fuchs, K., Schuller, W., Nowotny, N., Auer, H., Aspöck, H., Stünzner, D., Kerbl, U., Klement, Ch., Köfer, J. (2003b): Seroepidemiologische Untersuchung von Jägern auf Zoonosen in Südostösterreich – Prävalenzen, Risikopotentiale und Vorbeugemaßnahmen. Berl. Münch. Tierärztl. Wschr. 116, 306-311.

Deutz, A., Sixl, W., Köfer, J., Stünzner, D. (2001): Seroepidemiological Survey of the Prevalence of Borreliosis and Ehrlichiosis in Hunters in South-Eastern Austria. Proc. Symposium on Tick-Transmitted Diseases, 13 to 15 September, Ljubljana, p. 55.

Deutz, A. (2000): Veterinärmedizinischer Beitrag zur Zoonosenforschung. Habilitationsschrift, Vet. Med. Univ., Wien.

Deutz., A., Hinterdorfer, F. (2000): Krankheiten des Feldhasen (Lepus europaeus Pallas) - Sektionsbefunde, Erregerspektrum und zoonotische Aspekte. Tierärztl. Umschau 55, 628-635.

Deutz, A., Köfer, J. (2000): Niederwild (Fuchs, Feldhase, Fasan, Enten) als Träger von Zoonosen. Berl. Münch. Tierärztl. Wschr. 113, 401-406.

Deutz, A., Fuchs, B., Steineck, T., Köfer, J. (2000): Zoonosen bei heimischen Wildtieren – Wissensstand, Forschungsbedarf und Vorbeugemaßnahmen. DVG-Tagung der Fachgruppe „Epidemiologie und Dokumentation“, 6. – 8. September, Wien, S. 14-20.

Ellis, J., Oyston, P.C.F., Green, M., Titball, R.W. (2002): Tularemia. Clin. Microbiol. Rev. 15, 631-646.

Elsässer, J. und Hirsch, F. (1998): Tularämie. Epidemiol. Bull. Heft 44, 312.

Efthymiadis D., Jones P., Briffa K. Auer I., Böhm R., Schöner W., Frei C., und Schmidli J. , (2006): Construction of a 10-min-gridded precipitation data set for the Greater Alpine Region for 1800–2003 In: Journal of Geophysical Research, Vol, 111.

Essl, A. (1987): Statistische Methoden in der Tierproduktion. Verlagsunion Agrar, Frankfurt.

Gerlach, F. (1946): Latent bleibende experimentelle Infektionen mit Tularämie. Ein epidemiologisch wichtiger Befund. Wien. Klin. Wschr. 58, 757-758.

Gratzl, E. (1960): Spontane Tularämie bei Hunden. Wien. Tierärztl. Mschr. 47, 489-499.

Gsell, O. (1968): Tularämie in der Schweiz. Schweizerische Med. Wschr. 98, 380-383.

Guggenberger, T., Bartelme N., (2005): GIS gestützte Modellierung der Nährstoffbilanzen österreichischer Grünlandflächen. Heft 43, Höhere Bundeslehr- und Forschungsanstalt Raumberg – Gumpenstein.

Gurycova, D., Vyrostekova, V.: (1998): Epidemiology and clinical characteristics of tularemia. Antibiotica Monitor, tom. XIV, 3/4.

Gurycova, D. (1998): First isolation of Francisella tularensis subsp. Tularensis in Europe. Europ. J. Epidem. 14, 797-802.

Hayek, H., Flamm, H. (1967): Zum Problem der Reservoirtiere der Tularämieerreger im Marchfeld. Wien. Med. Wschr. 32-34, 765-767.

Hofer, E. (2002): Epidemiologie, Klinik und mikrobiologische Diagnostik der Tularämie. Antibiotika Monitor Heft 1/2, 1-9.

Hofer, E. (1998): Tularämie in Österreich. Weidwerk, Heft 7, 11-13.

Hofer, E., Schildorfer, H., Flatscher, J., Müller, M. (1997): Zum Nachweis der Tularämie bei Feldhasen (Lepus europaeus) in Österreich. Wien. Tierärztl. Mschr. 84, 301-306.

Höflechner-Pöltl, A. (1999): Epidemiologische Untersuchungen zur Tularämie und Brucellose bei Füchsen (Vulpes vulpes) und Feldhasen (Lepus europaeus) in Österreich. Diss., Vet. Univ. Wien.

Höflechner-Pöltl, A., Hofer, E., Awad-Masalmeh, M., Müller, M., Steineck, Th. (2000): Tularämie und Brucellose bei Feldhasen und Füchsen in Österreich. Tierärztl. Umschau 55, 264-268.

Hofstetter, I., Eckert, J., Hauri, A. (2005): Tularämie: Ausbruch unter Teilnehmern einer Hasen-Treibjagd im Landkreis Darmstadt-Dieburg. Epidemiol. Bull. Heft 50, 465-466.

Horne, H. (1912): Eine Lemmingpest und eine Meerschweinchenepizootie. Centralbl. f. Bakt. etc. I. Abt. Originale. Bd. 66, Heft 2/4.

Jellison, W. L., Epler, E., Kuhns, E., Kohls, G.M. (1950): Tularemia in man from a domestic rural water supply. Pub. Health Rept. 65, 1219-1226.

Jusatz, H. J. (1961): Dritter Bericht über das Vordringen der Tularämie nach Mittel- und Westeuropa über den Zeitraum von 1950 bis 1960. Zeitschrift f. Hygiene 148, 69-93.

Karlson, K. A., Dahlstrand, S., Hanko, E., Söderlind, O. (1970): Demonstration of Francisella tularensis in sylvan animals with the aid of fluorescent antibodies. Acta Path. Microbiol. Scand. (B) 78, 647-651.

Karpoff, S. P., Antonoff, N. I. (1936): The spread of tularemia through water, as a new factor in ist epidemiology. J. Bacteriol. 32, 234-258.

Kmety, E., Gurycova, D., Jarekova J., Rehacek, J. (1987): Versuch der Tilgung eines Naturherdes der Tularämie und der Leptospirose. Zbl. Bakt. Hyg. A 266, 249-254.

Kromb-Kolb, H., Formayer, H., (2005): Schwarzbuch Klimawandel, Ecowin Verlag, Salzburg.

Michalka, J. (1960): Die Tularämie in Österreich. Wien. Tierärztl. Mschr. 47, 341-348.

Petersen, J.M., Schriefer, M.E. (2005): Tularemia: emergence/re-emergence. Vet. Res. 36, 455-467.

Pfahler-Jung, K. (1989): Die globale Verbreitung der Tularämie. Diss., Fachber. Vet. Med., Univ. Gießen.

Pikula, J., Beklova, M., Holesovska, Z., Treml, F. (2004): Ecology of European Brown Hare and Distribution of Natural Foci of Tularaemia in the Czech Republic. Acta vet. Brno 73, 267-273.

Pikula, J., Treml, F., Beklova, M., Holesovska, Z., Pikulova, J. (2002): Geographic Information Systems in Epidemiology – Ecology of Common Vole and Distribution of Natural Foci of Tularaemia. Acta vet. Brno 71, 379-387.

Puntigam, F. (1947): Zur Epidemiologie der Tularämie nach Beobachtungen in Niederösterreich. Wiener Klin. Wschr. 59, 103-106, 116-120.

Puntigam, F. (1960): Erkrankungen an thorakalen Formen der Tularämie bei Arbeitnehmern in Zuckerfabriken. Zeitschrift f. Hygiene 147, 162-168.

Reintjes, R., Dedushaj, I., Gjini, A., Jorgensen, T.R., Cotter, B., Lieftuch, A., D'Àncona, F., Dennis, D.T., Kosoy, M.A., Mulligi-Osmani, G., Grunow, R., Kalaveshii, A., Gashi, L., Humolli, I. (2002): Tularemia outbreak investigation in Kosovo: case control and environmental studies. Emerg. Inf. Dis. 8, 69-74.

Rohrbach, B. W. (1988): Tularemia. J. Am. Vet. Med. Assoc. 193, 428-432.

Schacher, E., Wagner, U., Wolf, Th., Grunow, R. (2002): Tularämie – zwei Erkrankungen nach Verarbeiten und Verzehr eines Wildhasen. Epidemiol. Bull. 9, 71-72.

Schaumberger, A. (2006): Ertragsanalyse im österreichischen Grünland mittels GIS unter besonderer Berücksichtigung klimatischer Veränderungen, Heft 42, Höhere Bundeslehr- und Forschungsanstalt Raumberg – Gumpenstein.

Selbitz, H.-J. (1988): Die Tularämie – eine Zoonose mit Naturherdcharakter. Mh. Vet.-Med. 43, 239-241.

Sixl, W., Docekal, J., Mikulaskova, M., Mikulasek, S. (1994): Zur Frage des Auftretens der Tularämie in Endemiegebieten. Geogr. Med. 10, 231-238.

Steineck, T., Onderscheka, K. (1991): Wildkrankheiten sicher erkennen. Tularämie (Nagerpest, Hasenpest). Österreichs Weidwerk Heft 11, 301-306.

Steineck, T., Hofer, E. (1999): Zum Vorkommen der Tularämie in Österreich. Verh.Ber. Erkrg. Zootiere 39., 263-269

Wagner, A. (1948): Über sporadische Tularämiefälle in Wien. Wien. Med. Wschr. 31/32, 341-342.

Weber, A. (2003): Francisella tularensis, in Darai, G., Handermann, M., Hinz, E., Sonntag, H.-G. (Hrsg.): Lexikon der Infektionskrankheiten des Menschen, S. 256-259. Springer Verlag Berlin, Heidelberg.

Weber, A. (2006): Die Tularämie – eine selten diagnostizierte Zoonose? Amtstierärztl. Dienst u. Lebensmittelkontrolle 13, 30-34.

Winkelmayer, R., Vodnansky, M., Paulsen, P., Gansterer, A., Treml, F. (2005): Explorative study on the seroprevalence of Brucella-, Francisella-, and Leptospira antibodies in the European hare (Lepus europaeus Pallas) of Austrian - Czech border region. Vet. Med. Austria 92, 131 – 135.

World Health Organisation (2004): Informal discussion on Guidance on tularaemia. Report of a WHO meeting, 1-2 june, Umea, Sweden.

World Health Organisation (2003): Improving public health preparedness for and response to the threat of epidemics: tularaemia network. Report of a WHO meeting, 14-15 september, Bath, Uni

StartClim2005.C3a

ADAMS, J. B., 1962: Aphid survival at low temperatures. – Can. J. Zool. 40: 951-956.

ANDERSEN, K. T., 1933: Analyse des Schadens und Massenwechsels des linierten Blattrandkäfers (*Sitona lineata* L.). Seine Bekämpfung und Abwehr. – Landw. Jahrb. 78: 55-79.

ANDERSEN, K. T., 1934a: Der Einfluss der Umweltbedingungen, Temperatur und Ernährung auf die Eiererzeugung und Lebensdauer eines Insektes (*Sitona lineata* L.) mit postmetaboler Eientwicklung und langer Legezeit. – Zeitschrift für angewandte Entomologie 20: 86-116.

ANDERSEN, K. T., 1934b: Experimentelle Untersuchungen über den Einfluß der Temperatur auf die Eierzeugung von Insekten. I. Einfluß konstanter Temperaturen auf die Eierzeugung von *Sitona lineata* L. - Biologisches Zentralblatt 54: 478-486.

ANDERSEN, K.T., 1930: Der Einfluß der Temperatur und Luftfeuchtigkeit auf die Dauer der Eizeit. I. Beitrag zu einer exakten Biologie des linierten Graurüßlers (*Sitona lineata* L.). Zeitschrift für Morphologie und Ökologie der Tiere 17: 649-676.

ANDERSEN, K.T., 1931: Der linierte Graurüßler oder Blattrandkäfer *Sitona lineata* L. – Monographien zum Pflanzenschutz 6. Springer, Berlin.

AUFHAMMER, G. & HOFMANN, C., 1936: Wanzenschäden an Getreide. – Praktische Blätter für Pflanzenbau und Pflanzenschutz 9: 253-265.

AUFHAMMER, G., 1937: Wanzenschädigungen am Getreide. – Deutsche Landwirtschaftliche Presse 64.

AWADALLA, S. S. I., 1988: Untersuchungen über Biologie und Ökologie des Blattrandkäfers, Sitona lineatus (L.) (Coleoptera: Curculionidae). – Dissertation zur Erlangung des Doktorgrades an der Universität für Bodenkultur.

BBA, 2006: EU-Maßnahmen gegen den Diabrotica. – Der Pflanzenarzt 9-10: 13.

BENZ, W. 1982. Beobachtungen zum Auftreten und zur Populationsdynamik des Ampferblattkäfers an verschiedenen Standorten in Baden-Würtemberg; Diplomarbeit an der Universität Hohenheim.

BESENHOFER, G., 2003: Pflanzenkrankheiten – ein zunehmendes Problem. – Ökosoziales Forum Österreich. Wintertagung 2003: 81-86.

BILEWICZ-PAWINSKA, T., 1995: Occurence and parasitism of cereal bug species (*Heteroptera*) in different crop systems. – Polish ecological studies 21(3): 349-372.

BOHNER, A. 2001. Physiologie und futterbaulicher Wert des Ampfers; BAL Gumpenstein Bericht, 7. Alpenländisches Expertenforum, S 39 - 44.

BROADBENT, L., 1953: Aphids and potato virus diseases. – Biol. Rev. 28: 350-380.

BUCK 1981. Persönliche Mitteilung. Landesanstalt f. Umweltschutz, Stuttgart.

BULLMAN, O. & FABER, W., 1958: Studien zum Getreidewanzenproblem. – Pflanzenschutzberichte 20: 33-159.

CAMPBELL, R. E., 1937: Temperature and moisture preferences of wireworms. – Ecology 18: 479-489.

CATE, P., 2002: Der Maiswurzelbohrer *Diabrotica virgifera virgifera* (LeConte). – Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft.

CATE, P., 2006: Maiswurzelbohrer: Rasche Ausbreitung in der Steiermark. – Der Pflanzenarzt 9-10: 13.

CATE, P., KLAPAL, H. & SUPPANTSCHITSCH, W., 2002: Versuche zur Bekämpfung des Kleespitzmäuschens (Protapion trifolii) im Rotkleeanbau mit biologischen Präparaten. – Arbeitsgemeinschaft landwirtschaftlicher Versuchsanstalten Jahrestagung 2002 in Klosterneuburg. - http://www.alva.at/alva2002/tagung/cate.pdf.

CHEVIN, H. 1968. Influence de la plante-hôte sur le cycle évolutif de deux éspèces de Gastrophysa; Bull. Soc. Entom. France, 73, S 128 – 140.

CHOUGOUROU, D. C., 1997: Untersuchungen über die Wirkung insektizider Naturstoffe auf ausgewählte Baumwollschädlinge (*Aphis gossypii* Glov., *Bemisia tabaci* Gen., *Spodoptera frugiperda* J. E. Smith, *Helicoverpa armigera* Hbn.) unter Labor- und Gewächshausbedingungen. – 1. Aufl. – Verl. Köster. Berlin.

CRITCHLEY, B. R., 1998: Literature review of sunn pest *Eurygaster integriceps* Put. (Hemiptera, Scutelleridae). – Crop Protection 17(4): 271-287.

CRÜGER, G., 1991: Pflanzenschutz im Gemüsebau. – 3. Aufl. – Verl. Eugen Ulmer GmbH & Co. Stuttgart.

DEFAGO, G., 1937: Observations sur les punaises des céréales en Suisse. Extrait du « Bull. Murithienne », Soc. valais. sci. natur. 54: 94-136.

DICKSON, R. C., LAIRD, E. F. Jr., 1967 : Fall dispersal of green peach aphids to desert valleys. – Ann. Entomol. Soc. Am. 60: 1088-1091.

DOBROVOLSKY, B. V., 1970: Biological grounds for plant protection against wireworms in the USSR. – Pedobiologia 10: 26-44.

DONCASTER, J. P. & GREGORY, P. H., 1948: The Spread of Virus Diseases in the Potato Crop. - His Majesty`s Stationery Office, London, 189 pp.

DOSSE, G., 1954: *Curculionidae*, Rüsselkäfer. – In: BLUNCK, H. (Hrsg.), 1954: Handbuch der Pflanzenkrankheiten 5. – Verl. Paul Parey, Berlin, Hamburg.

DUBNIK, H., 1991: Blattläuse. Artenbestimmung – Biologie - Bekämpfung. – Verl. Th. Mann. Gelsenkirchen-Buer.

EICHLER, W. & SCHRÖDTER, H., 1951: Witterungsfaktoren als Urheber der Massenvermehrung des Rübenderbrüßlers (*Bothynoderes punctiventris*) 1947-49 in Mitteldeutschland. – Zeitschrift für angewandte Entomologie 32: 567-575.

EICHLER, W., 1951a: Rübenfeind Derbrüssler. Ein Buch vom Leben und Treiben des *Bothynoderes punctiventris*. – Verl. A. Ziemsen. Wittenberg, Lutherstadt. 31p.

EICHLER, W., 1951b: Freilandmittelprüfungen beim Rübenderbrüßler. – Anzeiger für Schädlingskunde 24: 39-40.

EL-DESSOUKI, S. A., 1971 : Der Einfluß von Larven der Gattung Sitona (Col., Curculionidae) auf einige Leguminosen. – Z. angew. Entomol. 67: 411-431.

ELLIOTT, W. M. & KEMP, W. G., 1979 : Flight activity of the green peach aphid (Homoptera, Aphididae) during the vegetable growing season at Harrow and Jordan. - Ontario. Proceedings of the Entomological Society of Ontario 110: 19-28.

ENGEL, H. 1956. Beiträge zur Lebensweise des Ampferblattkäfers (Gastrophysa viridula Deg.); Zeitschr. f. Angew. Ent., 18, S 322-354.

FABER, W. & ZWATZ, B., 1978: Wichtige Krankheiten und Schädlinge im Getreide- und Maisbau. – 3. Aufl. – Bundesanstalt für Pflanzenschutz. Wien.

FÖßLEITNER, F. 1999. Situation und Lösungsansätze der herbologischen Probleme durch Ampfer (Rumex obtusifolius L.) im biologisch bewirtschafteten Grünland am Beispiel der Gemeinde Weyer-Land und Gaflenz (Bezirk Steyer-Land/O.Ö.); Diplomarbeit am Institut für ökologischen Landbau der Universität für Bodenkultur, Wien.

Franck, P. 1935. Zur Verbreitung der Gastroidea viridula Deg. in Deutschland in älterer und neuerer Zeit; Ent. Blätt., XXXI, S 51-55.

FRÖHLICH, G., 1974: Pflanzenschutz in den Tropen. - Edition Leipzig.

FURLAN, L., 2004: The biology of Agriotes sordidus Illiger (Col., Elateridae). – Verl. Blackwell, Berlin, Jena 128(9/10): 696-706.

GEORGE, K. S., 1962: Root nodule damage by larvae of *Sitona lineatus* and its effect on yield of green peas. - Plant Path. 11: 172-176.

GLAUNINGER, J. & SCHMIEDL, J., 1995: Was tun gegen den Gestreiften Blattrandkäfer? Auftreten, Schadwirkung und Bekämpfung in Körnererbse. – Der Pflanzenarzt 4: 29-31.

GREEN24, 2004: Mit Schlupfwespen gegen Schädlinge. - http://green-24.de/cgi-bin/mx_cm_archiv.pl?1099481455 (16.10.2006).

GRÜNBACHER, E. M., 2005: Untersuchungen zum Auftreten der Getreidewanzen im biologischen Landbau Ostösterreichs. – Diplomarbeit an der Universität Wien.

HALUSCHAN, M. & BINDREITER, B., 2005: Zuckerrüben auch 2005 von Rüsselkäfern stark bedroht. http://www.agrana.at/at/de/Ruesselkaefer05.pdf

HÄNI, F. (Hrsg.), POPOW, G., REINHARD, H., SCHWARZ, A., TANNER, K. & VORLET; M., 1988: Pflanzenschutz im Integrierten Ackerbau. – 2. Aufl. – Landwirtschaftliche Lehrmittelzentrale. Zollikofen.

HANN P. & KROMP B. 2003A: Der Ampferblattkäfer (*Gastrophysa viridula*) als Möglichkeit zur biologischen Regulierung des Stumpfblättrigen Wiesenampfers (*Rumex obtusifolius*); 7.

Wissenschaftstagung zum Ökologischen Landbau, 24. – 26. Febr. 2003, Wien, Tagungsband, S 605 – 606.

HANN P. & KROMP B. 2003b. Der Ampferblattkäfer (*Gastrophysa viridula* Deg.) – Ein Pflanzenfresser als Nützling in der biologischen Grünlandwirtschaft; Entomologica Austriaca, 8, S 10 – 13.

HANN P. & KROMP B. 2003c. Der Ampferblattkäfer (*Gastrophysa viridula* Deg.) – ein natürlicher Gegenspieler des Stumpfblättrigen Wiesenampfers (*Rumex obtusifolius*); Landbauforschung Völkenrode, Sonderheft 255, Strategien zur Regulierung von Wurzelunkräutern im ökologischen Landbau, Böhm H. et al. Hrsg., Tagungsband zu dem Expertenkolloquium am 18. und 19. Februar 2003 im Forum der FAL, Braunschweig, S 73 – 78.

HANN P. & KROMP 2004. Biologische Bekämpfung des Stumpfblättrigen Wiesenampfers (*Rumex obtusifolius* L.) durch Förderung des Ampferblattkäfers (*Gastrophysa viridula* DEG.) im niederösterreichischen Alpenvorland, Mitt. Dtsch. Ges. Allg. Angew. Ent., 14 (1 – 6), p. 365 – 368.

HANN, P. 2001. Regulierung des Stumpfblättrigen Wiesenampfers (Rumex obtusifolius, Polygonaceae) im Biologischen Landbau mit besonderer Berücksichtigung des Ampferblattkäfers (Gastrophysa viridula, Chrysomelidae), Diplomarbeit an der Naturwissenschaftlichen Fakultät der Universität Wien.

HANS, H., 1959: Beiträge zur Biologie von *Sitona lineatus* L. – Zeitschrift für angewandte Entomologie 44: 343-386.

HANSEN, W., 1986: Die Populationsdynamik von Blattläusen an Weizen in Abhängigkeit von der Qualität des Phloemsaftes bei unterschiedlicher N-Düngung. – Dissertation zur Erlangung des Doktorgrades der Georg-August-Universität Göttingen Fachbereich Agrarwissenschaften.

HEATHCOTE, G. D. & COCKBAIN, A. J., 1966: Aphids from mangold clumps and their importance as vectors of beet viruses. - Annals of applied biology 57: 321-336.

HEIE, O. & PETERSEN, B., 1961: Investigations on *Myzus persicae* Sulz., *Aphis fabae* Scop., and virus yellows of beet (*Beta virus* 4) in Denmark. Condensed reports from the virus-committee. – Danish Acad. Tech. Sci., Copenhagen, 52 pp.

HEINZE, K., 1939: Zur Biologie und Systematik der virusübertragenden Blattläuse. – Mitt. Biol. Reichanst. (Berlin) 59: 35-48.

HERNDL-SILMBROD, A. 1989. Untersuchungen über die Auswirkungen von Grünlandbearbeitungsmaßnahmen auf *Gastrophysa viridula*, Degeer (Coleoptera, Chrysomelidae) unter besonderer Berücksichtigung des möglichen Einsatzes zur integrierten Eindämmung von Rumex obtusifolius L. (Polygonaceae); Dissertation an der Formal- und Naturwissenschaftlichen Fakultät der Universität Wien.

HILTERHAUS, V. 1965. Biologisch-ökologische Untersuchungen an Blattkäfern der Gattungen *Lema* und *Gastroidea* (Chrysomelidae, Col.). (Ein Beitrag zur Agrarökologie); Z. Angew. Zoologie, 52, S 257 – 295.

HOCHSTRASSER, M., 2005: Kartoffeln / Soja / Mais. - http://www.strickhof.ch/index.php?id=970 (20.10.2006).

HOFFMANN, G. M. & SCHMUTTERER, H., 1983: Parasitäre Krankheiten und Schädlinge an landwirtschaftlichen Kulturpflanzen. – Verl. Eugen Ulmer GmbH & Co.

HUJBER, A. 1988. Untersuchungen zur Biologie, Verbreitung und zum Wirtpflanzenspektrum von Gastrophysa viridula (Coleoptera, Chrysomelidae) und Apion miniatum (Coleoptera, Curculionidae); Dissertation an der Formal- und Naturwissenschaftlichen Fakultät der Universität Wien.

JOLIVET, 1951. Contribution á l Etude du genre Gastrophysa Chevrolat; Inst. royal. d. Sc. nat. de Belgique, Bruxelles, XXVII, 9, S 1-11, 13, S 1 - 12, 21, S 1 - 47.

KIRNER, L. & SCHNEEBERGER, W. 2000. Österreich: Wie kann der biologische Landbau gesichert und ausgeweitet werden? Ökologie & Landbau, 114, S 30 – 33.

KLEINE, R. 1911. Biologische Betrachtungen an Gastroidea (Gastrophysa) viridula Deg. (Col.); Int. Ent. Z. (Guben), S 63 – 64, S 70 – 72.

KÖHLER, F., 2003: Helicoverpa und die Gentechnik. - http://www.fotocommunity.de/pc/pc/mypics/28067/display/781213 (16.10.2006).

KÖPPL, H., 2003: Neuer Maisschädling in Oberösterreich: Der „Picknick-Käfer“ liebt Mais, Himbeeren u. a. reife Früchte. – Der Pflanzenarzt 56(9-10): 16.

KRANZ, J., SCHMUTTERER, H. & KOCH, W., 1979: Krankheiten, Schädlinge und Unkräuter im tropischen Pflanzenbau. – Paul Parey Verlag, Berlin und Hamburg.

LAFRANCE, J., 1968: The seasonal movements of wireworms (Coleoptera. Elateridae) in relation to soil moisture and temperature in the organic soils of Southwest Quebec. – The Canadian Entomologist 100: 801-807.

LANGENBUCH, R., 1932: Beiträge zur Kenntnis der Biologie von *Agriotes lineatus* L. und *Agriotes obscurus* L. – Zeitschrift für angewandte Entomologie 19: 278-300.

LE ROMANCER, M., C. KERLAN, M. NEDELLEC (1994): Biological characterisation of various geographical isolates of potato virus Y inducing superficial necrosis on potato tubers. Pl. Pathol. 43, 138-144.

LEHMANN, H. & KLINKOWSKI, M., 1942: Zur Pathologie der Luzerne. 1. Die schädlichen Rüsselkäfer (*Curculionidae*). – Entomologische Beihefte aus Berlin-Dahlem 9: 1-78.

LIPP, H. 1937. Beitrag zur Verbreitung von Gastroidea viridula Deg.; Ent. Blätt., XXXIII, 5, S 341-342.

LOTTER, M. 2000. Hinweise zur Ampferbekämpfung bzw. –reduzierung im ökologischen Landbau; Biospezialseminar: Ampfer – ein Problemunkraut? Teil 1, 8. bis 9. Februar 2000 BAL Gumpenstein.

LUTTENBERGER, G., 2003: Dem Maiswurzelbohrer wurde eine eigene Tagung gewidmet: Kleiner Käfer – große Wirkung. – Der Pflanzenarzt 56(11-12): 14.

LUTTENBERGER, G., 2005: Maiswurzelbohrer, Getreidewanzen & Co. im Visier der Pflanzenschützer. – Der Pflanzenarzt 6-7: 15.

MANNINGER, A. G. sen. & MANNINGER, A. G. jun., 1933: A gabonapoloskak elete, kartetele es javaslat az ellenük valo vedekezesre. (Das Leben der Getreidewanze, die von ihr verursachten Schäden und Vorschläge zu ihrer Bekämpfung). – Mezögazd. Kutatasok 6: 1-34.

MATTERN, D. & SCHUBERT, J., 2002: Erste Erkenntnisse zur Blattlausbesiedlung transgener Pflanzen. – Angewandte Wissenschaft 494: 104-112.

MEIXNER, H. & PASCH, C. 1998 – 1999. Ampferregulierung mit Ampferblattkäfern; http://home.t-online.de/home/meixner-edling/ampferre.htm

MEYER, E., 1937: Beobachtungen über „Weizenwanzen“ in der Kölner Bucht. – Zeitschrift für Pflanzenkrankheiten (Pflanzenpathologie) und Pflanzenschutz 47: 321-338.

MEYERS Konversationslexikon: http://susi.e-technik.uni-ulm.de:8080/Meyers2/seite/werk/meyers/band/7/seite/0271/meyers_b7_s0271.html

MILLER, R. H. (Hrsg.) & MORSE J. G. (Hrsg.), 1996: Sunn pests and their control in the Near East. – FAO Plant Production and Protection Paper 138. 165 pp.

NABU, http://www.nabu-schorndorf.de/Distelfalter.htm

OBERFORSTER, M. & KRÜPL, K., 2003: Winterweizen: Erzeugungsstrategien differenzieren! – Der Pflanzenarzt 56: 17-20.

PALM, C., LINCOLN, C. & WYLIE, W., 1938: Ecological and life History Studies on the alfalfa snout beetle. – Cornell University Agric. Exp. Sta. 51 Annual Report: 111-112.

PAUL, V. H., 1992: Krankheiten und Schädlinge des Rapses. – 2. Aufl. – Verl. Th. Mann, Gelsenkirchen-Buer.

PIERINGER, E. & ZWINGEL, W. 2000. Ampfer – ein (zunehmendes?) Problemunkraut im Ackerbau; Naturland Nachrichten, 2000/2, S 6.

PIQUEMAL, J. P. & FOUGEROUX, A., 1980 : Les pucerons vecteurs de la jaunisse de la betterave. Deux anneés d`observations dans le Nord et la Picardie. – Phytoma 321 : 10-11.

PÖTSCH, E. M. 2001. Der Ampfer – das Problemunkraut im Grünland; Wintertagung „EU-Erweiterung: Probleme, Herausforderungen und Chancen“, 15. – 16.2.2001.

REMAUDIERE, G. 1963. Les Gastrophysa; Entomologie appliqué à l’agriculture, I. Coleoptères 2, Traité publié sous la direction de A.S., Balachowsky.

RENNER, K. 1970. Die Zucht von Gastroidea viridula Deg. (Col., Chrysomelidae) auf Blättern und Blattpulversubstraten von Rumex obtusifolius L.; Zeitschrift für angewandte Entomologie, 65/2, S. 131 – 146.

RIECKMANN, W. (2000): Ohne Blattläuse kein Y-Virus. - Kartoffelbau 51 (4), 148-153.

SCHERF, H., 1964: Die Entwicklungsstadien der mitteleuropäischen Curculioniden (Morphologie, Bionomie, Ökologie). – Abh. Senckenb. Naturf. Ges. 506: 1-335.

SCHNELL, W., 1955: Synökologische Untersuchungen über Rüsselkäfer der Leguminosekulturen. – Zeitschrift für angewandte Entomologie 37: 192-238.

SCHÖGGL, G., 2003: Erfahrungen mit Wanzenstichweizen. – Mühle + Mischfutter 140: 438-439.

SCHÖN, W., 2006: Portal für Schmetterlinge/Raupen. - http://www.schmetterling-raupe.de/art/armigera.htm (16.10.2006).

SCHWARZ, A., ETTER, J., KÜNZLER, R., POTTER, C. & RAUCHENSTEIN, H. R., 1990: Pflanzenschutz im Integrierten Gemüsebau. – Verl. Landwirtschaftliche Lehrmittelzentrale, Zollikofen.

SEAL, D. R., CHALFANT, R. B. & HALL, M. R., 1992: Effects of cultural practices on rotational crops on abundance of wireworms (Coleoptera: Elateridae) affecting sweetpotato in Georgia. – Environmental Entomology 21: 969-974.

SHUMBA, O., 1995: Untersuchungen über die Wirkung von Naturstoffen (Niempräparate, Syringaextrakte) auf ausgewählte Baumwollschädlinge in Labor- und Gewächshausversuchen. – Diplomarbeit, Wissenschaftsbereich Tropische Landwirtschaft, Univ. Leipzig, 1995.

STEUDEL, W., & BLAESEN, P., 1958: Bericht über die in den Jahren 1955 und 1956 durchgeführten Gemeinschaftsuntersuchungen zum Auf- bzw. Ausbau eines Blattlauswarndienstes im Rübenbau. – Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft Berlin-Dahlem 92: 1-37.

SYNGENTA Agro GmbH: Schädlinge der wichtigsten Ackerkulturen. Copyright 2002.

SZITH, R., 2003: Mit dem Maiswurzelbohrer leben lernen müssen...!. – Der Pflanzenarzt 56(9-10): 4-6.

TISCHLER, W., 1937: Untersuchungen über Wanzen an Getreide. – Arbeiten über physiologische und angewandte Entomologie aus Berlin-Dahlem 4: 193-231.

TISCHLER, W., 1938: Zur Ökologie der wichtigsten in Deutschland an Getreide schädlichen Pentatomiden I. – Zeitschrift für Morphologie und Ökologie der Tiere 34: 317-366.

TISCHLER, W., 1939a: Zur Ökologie der wichtigsten in Deutschland an Getreide schädlichen Pentatomiden II. – Zeitschrift für Morphologie und Ökologie der Tiere 35: 251-287.

TISCHLER, W., 1951: Die Überwinterungsverhältnisse der landwirtschaftlichen Schädlinge. - Zeitschrift für angewandte Entomologie 32: 184-194.

UNGER, K. & MÜLLER, H. J., 1954: Über die Wirkung geländeklimatisch unterschiedlicher Standorte auf den Blattlausbefallsflug. - Züchter 24: 337-345.

VAN DER PLANK, J. E., 1944: Production of seed potatoes in a hot dry climate. – Nature 153: 589-590.

VAN EMDEN, H. F., HUGHES, R. D., EASTOP, V. F. & WAY, M. J., 1969: The ecology of *Myzus persicae*. – Annual Review of Entomology 14: 197-270.

WEBER, G., 1983: Untersuchungen zur ökologischen Genetik der Grünen Pfirsichblattlaus *Myzus Persicae*. – Dissertation zur Erlangung des Doktorgrades der Georg-August-Universität Göttingen Fachbereich Agrarwissenschaften.

WIKIPEDIA, http://de.wikipedia.org/wiki/Distelfalter

WILKE, S., 1922: Der Rüsselkäfer *Tanymecus palliatus* F., ein neuer Schädiger der Zuckerrübenfelder in Deutschland. – Nachrichtenbl. Dtsch. Pflanzenschutzd. 2: 97-98.

WOHLLAIB, D., 2004: Probleme mit Virosen bei der Pflanzkartoffelvermehrung in Baden-Württemberg unter besonderer Berücksichtigung der Sorte Selma. – Diplomarbeit an der Fachhochschule Nürtingen.

WYNIGER, R., 1962: Pests of crops in warm climates and their control. – CTA, Basel, Switzerland.

ZAMG, www.zamg.ac.at

Warndienste:

AGES Warndienst Pflanzengesundheit:
http://www13.ages.at/servlet/sls/Tornado/web/ages/content/EA69BAC10B41606BC125701A00354CDF

proPlant:
http://www.proplantexpert.com/expert/index.jsp?betr=56

ONLINE-Pflanzenschutzwarndienst für Niederösterreich:
http://www.lbg.at/land-impulse/pflanzen/index.htm

ISIP:
http://www.isip2.de/coremedia/generator/isip/Start.html

Weizen-Expert:
http://services.warndienst.proplant.de/weizenexpert/start.jsp

Rebschutzdienst:
http://www.rebschutzdienst.at/

StartClim2005.C3b

ABBRUZZETTI G., GRANDE C (1999). Prove di lotta al tripide americano Frankliniella occidentalis su uva da tavola con l'impiego di chlorfenapyr. Informatore Fitopatoplogico 49(11), 36-39.

BALE J.S. (1987): Insect Cold Hardiness: Freezing and supercooling - an ecophysiological perspective. J. Insect Physiology 33(12), 899-908.

BALE J.S. (1989): Cold Hardiness and Overwintering of Insects. Agricultural Zoology Reviews 3, 157-192.

BAUST J.G., ROJAS R.R. (1985): Review – Insect cold hardiness: Facts and Fancy. J. Insect Physiology. Vol 31(10), 755-759

CIAMPOLINI M., PERRINI S., TUMINO S. (1990): Forti danni da tripidi ad uva da tavolanei vigneti meridionali. Informatore Agrario 47(7): 127-131

CHRISTENSEN J. H. (2004): Prediction of Regional scenarios and Uncertainties for Defining European Climate change risks and Effects. PRUDENCE EVK2-CT2001-00132 –Final Report. http://prudence.dmi.dk

DANKS H.V. (1978): Modes of seasonal adaptation in the Insects. Canad. Entomologist 110: 1167-1204

DEL BENE G., GARGANI E. (1989): Contributo alla conoscenza di Frankliniella occidentalis (Pergande). Redia 72(2), 403-420.

GAUM W.G., GILIOMEE J.H. und PRINGLE K.L. (1994): Life History and life tables of western flower Thrips Frankliniella occideltalis on english cucumbers. Bull. Ent. Res. 84, 219-224.

GONZALES E., ALVARADO M., BERLANGA E., SERRANO A.,DE LA ROSA A. (1994): Danos producidospor tripsen nectarinasen el Valle del Guadalquivir. Bolletin de Sanidad Vegetal, Plagas 20(1): 229-241.

IIASA (2006): EUROPE - MONTHLY MEAN TEMPERATURE 1 KM HTTP://WWW.IIASA.AC.AT/RESEARCH/LUC/GIS/CLIM_EUR.HTM

KATAYAMA H. (1997): Effect of temperature on development and oviposition of western flower thrips Frankliniella occidentalis (Pergande). Jap. Jour. of Applied Entomology and Zoology 41(4), 225-231.

KROMP-KOLB, H., GERERSDORFER, T., ASPÖCK, H., BAIER, P., SCHOPF, A., GEPP, J., GRAF, W., MOOG, O., KROMP, B., KYEK, M., PINTAR, M., FORMAYER, H., PARZ-GOLLNER, R., RABITSCH, W., SCHEIFINGER, H., SCHMUTZ, S., JUNGWIRTH, M., VOGL, W., WINKLER, H. (2003): Auswirkungen von Klimaänderungen auf die Tierwelt – derzeitiger Wissensstand, fokussiert auf den Alpenraum und Österreich. Endbericht, im Auftrag des BMLFUW; ISBN: 978-3-900962-63-0.

LACASA A., TORRES J., MARTINEZ M.C. (1993): Frankliniella occidentalis en los cultivos de nectarina de Murcia. Evolucion de las poblaciones y comportamiento de variedades. Bolletin de Sanidad Vegetal, Plagas 19(3): 335-344.

LEWIS T. (1997): Thrips as Crop Pests, Wallingford , UK

LOWRY V.K., SMITH J.W., MITCHELL F.L. (1992): Life fertility tables for Frankliniella fusca and Frankliniella occidentalis on Peanut. Ann. of the ent. Soc. Amer. 85(6), 744-754.

MAC DONALD, BALE J.R. WALTERS K.F.A. (1997): Low temperature mortality and overwintering of the western flower thrips Frankliniella occidentalis. Bull. Entom. Res. 87, 497-505.

MAC DONALD, BALE J.R. Walters K.F.A. (1998): Effect of temperature ondevelopment of the western flower thrips , Frankliniella occidentalis. Europ. Journ. Entom. 95(2), 301-306.

MARULLO R. (1991): Frankliniella, biologia, e strategie di difesa. Terra e Vita 15, 72-73.

MARULLO R. (1999): (Impact of an introduced pest thrips on the indigenous natural history and agricultural systems of southern italy. Proceedings of the 7th International symposium on Thysanoptera, 285-288.

NICOLAS J., AUMONT C. (1994): Le thrips californien sur pecher-nectarinier en Roussillon. Synthese de trois annees d'etudes. Phytoma 460, 30-34.

POLLINI A., CERONI M.R.(2004): Le problematique della difesa dai tripidi del pesco. Informatore Agrario 60(12), 85-87.

ROECKNER (2005): IPCC DDC AR4 ECHAM5/MPI-OM. http://cera-www.dkrz.de/

VAN RIJN, P.C.J., MOLLEMA C., STEENHUIS BROERS G.M. (1995): Comparative life history studies of *Frankliniella occidentalis* and *Thrips tabaci* on Cucumber. Bull. Entom. Res. 85(2), 285-297.

ZUR STRASSEN R. (1986): *Frankliniella occidentalis* (Pergande 1895), ein nordamerikanischer Fransenflügler als neuer Bewohner europäischer Glashäuser. Nachrichtenblatt d. Deutschen Pflanzenschutzdienstes 38: 86-88.

StartClim2005.C5

Adolphi K. (1998): Anthropogene lineare Strukturen als Wuchsstätten und Ausbreitungswege von Arten. Braunschweiger Geobot. Arb. 5: 271-274.

Altieri M.A. & Liebman M. (1988): Weed management in agroecosytems: ecological approaches. Weed management in agroecosytems: ecological approaches., viii + 354 pp.

Aubrecht P.(1998): Corine Landcover in Österreich. Vom Sattelitenbild zum digitalen Bodenbedeckungsdatensatz. Umweltbundesamt, Wien.

Balogh L., Dancza I. & Kiraly G. (submitted): Preliminary report on the grid-based mapping of invasive plants in Hungary. Neobiota 7.

Bassett I.J., Crompton C.W. (1975): The biology of Canadian weeds. 11. Ambrosia artemisiifolia L. and A. psilostachya DC. Canadian Journal of Plant Science 55: 463–476.

Bohren C., Mermillod N. & Delabys N. (2006): Common ragweed (Ambrosia artemisiifolia L.) in Switzerland: development of a nationwide concerted action. Journal of Plant Diseases and Protection 113.

Botond, M. & Botta-Dukat, B. (2004): Biologai invaziok magyaroszaragon Özönnövenyek. Alapitavany Kiado, Budapest, 408 pp.

Chauvel, B., Dessaint, F., Cardinal-Legrand, C. & Bretagnolle, F. (2006) The historical spread of Ambrosia artemisiifolia L. in France from herbarium records. Journal of Biogeography, **33**, 665-673.

Currie D.J. (1991): Energy and large-scale patterns of animal- and plant-species richness. American Naturalist, 137, 27-49

Delisle, F.C., Lavoie, M.J. & Lachance, D. (2003): Reconstructing the spread of invasive plants: Taking into account biases associated with herbarium specimens. Journal of Biogeography, **30**, 1033-1042.

Dirnböck T, Dullinger S, Grabherr G. (2003): A regional impact assessment of climate and land use change on alpine vegetation. - Journal of Biogeography 30: 401-418.

Dubayah T. & Rich P.M. (1996): GIS-based solar radiation modeling. – In: Goodchild, M.F., Steyaert, L.T. und Parks, B.O. (Hrsg.) GIS and Environmental Modeling. John Wiley & Sons, New York. S. 129-134

Essl F. (1994): Floristische Beobachtungen aus dem östlichen oberösterreichischen Alpenvorland. Beitr. Naturk. Oberösterreichs **2**: 65-86.

Essl, F. & Rabitsch, W. (2002): Neobiota in Österreich. Umweltbundesamt, Wien, 432 pp.

Essl F. & Rabitsch W. (2005): Österreichischer Aktionsplan zu gebietsfremden Arten (Neobiota). Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, 26 pp.

Essl F. & Walter J. (2005): Ausgewählte neophytische Gefäßpflanzenarten Österreichs. Grüne Reihe des Bundesministeriums für Landwirtschaft und Forstwirtschaft, Umwelt und Wasserwirtschaft, Böhlau Verlag, Wien.

Fink. J., Walder W. & Reyrich W. (1979): Böden und Standortsbeurteilung. – In: Österreichische Akademie der Wissenschaften (Hrsg.) *Atlas der Republik Österreich*. 6. Lieferung. Freytag-Berndt und Ataria, Wien.

Fischer, M.A., Adler, W. & Oswald, K. (2005): Exkursionsflora für Österreich, Liechtenstein und Südtirol. Biologiezentrum Oberösterreich, Linz, 1392 pp.

Forcella F, Wilson RG, Dekker J, Kremer RJ, Cardina J, Anderson RL, Alm D, Renner KA, Harvey RG, Clay S, Buhler DD (1997): Weed seed bank emergence across the Corn Belt. Weed Science, 45(1): 67-76.

Forstner W & Hübl E (1971): Ruderal-, Segetal- und Adventivflora von Wien. Notring Verlag, Wien, 148 pp.

Freundorfer G. (2006): Ambrosia in Österreich und angrenzenden Ländern. Ursprung, Beschreibung, Ausbreitung sowie Möglichkeiten der Bekämpfung des Neophyten Ambrosia artemisiifolia aus der Familie Compositae oder Asteraceae. Abschlussarbeit des Universitätslehrgangs Mediae Naturae, 49 pp.

Gebben, A. I. (1965): The ecology of common ragweed (*Ambrosia artemisiifolia*) in southern Michigan. Univ. Microfilms Inc. Ann Arbor, Michigan, 234 pp.

Genton, B.J., Shykoff, J.A. & Giraud, T. (2005): High genetic diversity in French invasive populations of common ragweed, Ambrosia artemisiifolia, as a result of multiple sources of introduction. Molecular Ecology, **14**, 4275–4285.

Gerstberger, P. (2001): Plantago coronopus subsp. commutatus als Straßenrandhalophyt eingebürgert in Mitteleuropa. Tuexenia 21: 249-256.

Gobiet, A., Beck, A., Truhetz, H., Dorninger, M., Formayer, H., Riegler, A., Haas, P. And Loibl, W. (2006): High resolution Climate Hindcasts and Scenarios for the Alpine Region. Presentation at the European Geosciences Union General Assembly, April 2006, Vienna.

Griese, D. (1998): Die viatische Migration einiger neophytischer Pflanzensippen am Beispiel norddeutscher Autobahnen. Braunschweiger Geobot. Arb. 5: 263-270.

Guisan, A. & Harrell, F.E. (2000): Ordinal response regression models in ecology. Journal of Vegetation Science 11: 617-626.Haberl, H., Aman, C., Bittermann, W., Erb, K.-H., Fischer-Kowalski, M., Geissler, S., Hüttler, W., Krausmann, F., Payer, H., Schandl, H., Schidler, S., Schulz, N., Weisz, H. und Winiwarter, V. (2001a): Die Kolonisierung der Landschaft. Indikatoren für nachhaltige Landnutzung. Schriftenreihe des Forschungsschwerpunktes Kulturlandschaftsforschung, Bd. 8. Bundesministerium für Bildung, Wissenschaft und Kultur, Wien.

Haberl, H., Erb, K.-H., Krausmann, F., Loibl, W., Schulz, N.B. und Weisz, H. (2001b): Changes in Ecosystem Processes Induced by Land Use: Human Appropriation of Net Primary Production and Its Influence on Standing Crop in Austria. Global Biochemical Cycles, 15(4), 929-942

Haberl, H. und Zangerl-Weisz, H. (1997): Kolonisierende Eingriffe: Systematik und Wirkungsweise. – In: Fischer-Kowalski, M. (Hrsg.) Gesellschaftlicher Stoffwechsel und Kolonisierung von Natur. Ein Versuch in Sozialer Ökologie. Gordon & Breach Fakultas, Amsterdam. S. 129-148

Hamburger I (1948): Zur Adventivflora von Graz. Dissertation, Univ. of Graz, 121 pp

Harrell F.E. (2001): Regression modelling strategies. Springer, New York.

Hegi G. (Begr.) (1979): Illustrierte Flora von Mitteleuropa. Bd. VI/3: Compositae. Paul Parey Verlag, Hamburg, 2. Auflage.

Hetzel G. (2006): Die Neophyten Oberfrankens. Floristik, Standortcharakteristik, Vergesellschaftung, Verbreitung, Dynamik. Diss. Univ. Würzburg, 160 pp.

Hohla, M., Kleesadl, G. & Melzer, H. (1998): Floristisches von den Bahnanlagen Oberösterreichs. Beitr. Naturk. Oberösterreichs **6**: 139-301.

Hohla M., Kleesadl G. & H. Melzer (2002): Neues zur Flora der oberösterreichischen Bahnanlagen – mit Einbeziehung einiger grenznaher Bahnhöfe Bayerns – Fortsetzung. Beitr. Naturk. Oberösterreichs **11**: 507-578.

Jacob et al. (2005): unpublished report within the EU-project prudence - Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects.

Jäger, S. (2000): Ragweed sensitisation rates correlate with the amount of inhaled airborne pollen. A 14-year study in Vienna, Austria. Aerobiologia, **16**:149-53.

Jäger S. & Litschauer R. (1998): Ragweed in Austria. In: Spieksma, F. (Ed.): Ragweed in Europe, 6th International Congress on Aerobiology, Satellite Symposium Proceedings, p. 22-26.

Janchen, E. (1956-1960): Catalogus Florae Austriae 1. Springer Verlag (Wien).

Jehlík V. (1995): Occurrence of alien expansive plant species at railway junctions of the Czech Republic. Ochrana Rostlin, 31(2):149-160

Jogan N. (Hrsg.) (2001): Gradivo za Atlas flore Slovenije. Center za Kartografijo Faune in Flore, Miklavz na Dravskem polju, 443 pp.

Jogan N. & Vres B. (1998) Ambrosia artemisiifolia – known distribution half a century after the first record in Slovenia. Hladnikia **10**: 45-47.

Jorgensen PM (2002): Ambrosia, nourishment for gods or dangerous weeds?. Blyttia, 60(3):160-162.

Kowarik I. (2003): Biologische Invasionen: Neophyten und Neozoen in Mitteleuropa. Ulmer, Stuttgart, 380 pp.

Kot, M., Lewis, M.A. & van den Driessche, P. (1996): Dispersal data and the spread of invading organisms. Ecology 77: 2027-2042.

Maurer, W. (1998): Flora der Steiermark, Band 2/1: Verwachsenkronblättrige Blütenpflanzen (Sympetale). IHW Verlag (Eching), 240 pp

McCullagh, P & Nelder, J.A. (1989): Generalized Linear Models. Chapman and Hall, London.

Melzer H. (1971): Neues zur Flora der Steiermark, XIII. Mitt. Nat. Ver. Stmk 100: 240-254.

Melzer, H. (1989): Über *Cyperus esculentus* L., die Erdmandel, und weitere für Kärnten neue Gefäßpflanzen-Sippen und neue Fundorte bemerkenswerter Arten. Verh. Zool.-Bot. Ges. Österreich **126**: 165-178.

Melzer H. & Bregant E. (1993): Bemerkenswerte Funde von Gefäßpflanzen in der Steiermark. Mitt. naturwiss. Ver. Steiermark 123: 183-205.

Moser, D., Dullinger, S., Englisch, T., Niklfeld, H., Plutzar, C., Sauberer, N., Zechmeister, H.G. und Grabherr, G. (2005): Environmental determinants of vascular plant species richness in the Austrian Alps. Journal of Biogeography, 32, 1117-1127

Niklfeld, H. (1998): Mapping the flora of Austria and the eastern Alps. Rev.Valdot.Nat. 51, Suppl.: 53-62.

Oppermann, F. W. (1998): Die Bedeutung von linearen Strukturen und Landschaftskorridoren für Flora und Vegetation der Agrarlandschaft. Dissert. Bot. 298: 214 S.

Peterseil, J., Wrbka, T., Plutzar, C., Schmitzberger, I., Kiss, A., Szerencsits, E., Reiter, K., Schneider, W., Suppan, F. und Beissmann, H. (2004): Evaluating the ecological sustainability of Austrian cultural landscapes – The SINUS approach. *Land Use Policy, 21, 307-320*

Pope, V. D., Gallani M. L., Rowntree P. R. und Stratton R. A. (2000): The impact of new physical parametrizations in the Hadley Centre climate model -- HadAM3. *Climate Dynamics, 16: 123-146*

Preston CD, Pearman DA & Dines TD (2003): New Atlas of the Britsh and Irish Flora. Oxford University Press, Oxford, 910 pp.

Pyšek, P., Sadlo, J. & Mandak, B. (2002) Catalogue of alien plants of the Czech Republic. Preslia, **74**, 97-186.

Pyšek, P. & Hulme, P. (2005): Spatio-temporal dynamics of plant-invasions: Linking pattern to process. Ecoscience, **12/3**, 302-315.

Reinhardt F., Herle M., Bastiansen . & Streit B. (2003): Ökonomische Folgen der Ausbreitung von Neobiota. Umweltbundesamt Texte 79/03, 248 pp.

Savotikov, Yu. F., Smetnik, A. I. (Hrsg.) (1995): [The handbook of pests, diseases and weeds having quarantine importance for the territory of the Russian Federation.] Arnika, Nizhnyj Novgorod (in Russisch).

Sheppard AW., Shaw RH. & Sforza R. (2006) Top 20 environmental weeds for classical control in Europe: a review of opportunities, regulations and other barriers to adoption. Weed Research 46, 93-117.

Shigesada, N. & Kawasaki, K. (2002): Invasion and the range expansion of species: effects of long-distance dispersal. *Dispersal Ecology* (eds. J.M. Bullock, R.E. Kenward & R.S. Hails), pp. 350-373. Oxford, Blackwell.

Taramarcaz, P., Lambelet, C., Clot, B., Keimer, C. & Hauser, C (2005) Ragweed (Ambrosia) progression and its health risks: will Switzerland resist this invasion? Swiss Medical Weekly, **135**, 538-548.

Turc L. (1961): Évaluation des besoins en eau d'irrigation, évapotranspiration potentielle, formoule simplifié et mise à jour. *Annales Agronomiques, 12, 13-49*

USDA Plant Database (2006): Ambrosia artemisiifolia. (http://plants.usda.gov) (Zugriff: 12 September 2006). National Plant Data Center, Baton Rouge, LA 70874-4490 USA

Umweltbundesamt (2005) Naturschutzfachliches Informationssystem Austria (NISA). http://gis.umweltbundesamt.at/austria/natur/nisa/Default.faces (Accessed August 2005).

Vitousek, P.M., Ehrlich, P.R., Ehrlich, A.H. und Matson, P.A. (1986): Human Appropriation of the Products of Photosysthesis. *BioScience, 36(6), 363-373*

Walther, G.R. (2003): Plants in warmer world. Perspectives in Plant Ecology, Evolution and Systematics 6/3: 169-185.

Wayne P., Foster S., Connolly J., Bazzaz F. & Epstein P. (2002): Production of allergenic pollen by ragweed (Ambrosia artemisiifolia L.) is increased in CO_2-enriched atmospheres. Ann. Allergy Asthma Immunol. 88: 279-282.

Weber, L. (1997). Geologische Karte 1:500.000 von Österreich (modifiziert). Geologische Bundesanstalt, Wien

Wright, D. (1990): Human Impacts on the Energy Flow through Natural Ecosystems, and Implications for Species Endangerment. *Ambio, 19(4), 189-194*

Zidorn C. & Dobner M.J. (1999): Beitrag zur Ruderalflora der Bahnhöfe von Nordtirol. Ber nat.-med. Ver. Innsbruck 86: 89-93.

Ziska L.H. & Caulfield F.A. (2000): Rising CO_2 and pollen pollen production of common ragweed (Ambrosia artemisiifolia), a known allergy-inducing species: implications for publiv health. Aust. J. Plant. Physiol. 27: 893-898.

Zwander H. (2000): Neue Daten zum Pollenflug des Traubenkrautes (Ambrosia artemisiifolia) in Klagenfurt (Kärnten). Linzer biol. Beitr. 32/2: 738-739.

StartClim2005.F

ABDERHALDEN, W. (2005): Raumnutzung und sexuelle Segregation beim Alpensteinbock, Capra ibex ibex. Nationalpark-Forschung in der Schweiz. Bd. 92.

BARTELME, N. (2000): Geoinformatik. Modelle, Strukturen, Funktionen. 3. Auflage, Springer Verlag.

BERTERMANN, C., C. WEBER-SPARENBERG, A. PECHURA, A.-I. RENARD, H.-H. BERGMANN (1998): Zur Ernährung von Alpenschneehühnern Lagopus mutus helveticus im Sommer. Egretta 41:15-26.

BLÖSCHL, G. und R. MERZ (2002): Methoden der hydrologischen Regionalisierung im Zusammenhang mit der Niederschlag-Abflussmodellierung. In: Wiener Mitteilungen, Wasser-Abwasser-Gewässer, Band 164, Technische Universität Wien, 149-178.

BÖHM, R., I. AUER, M. BRUNETTI, M. MAUGERI, T. NANNI, W. SCHÖNER (2001): Regional Temperature Variability in European Alps 1760-1998 from homogenised instrumental Timer Series. International Journal of Climatologiy 21/14: 1779-1801.

BRIEDERMANN, L. (1985): Gamswild – Rupicapra r. r. (L). In: Buch der Hege, Band 1, Haarwild; Hrsgb.: Stubbe H., 210-233.

CARMIGNOLA, G. (2000): Das Steinwild in Südtirol. Hrsgb.: Autonom. Prov. Bozen, Amt für Jagd und Fischerei. Bozen: Athesia.

CHILDS, C. (2004): Interpolating Surfaces in ArcGIS Spatial Analyst. ESRI Education Services. ArcUser July-September 2004.

DAUBENMIRE, R. (1954): Alpine timberlines in the Americas and their interpretation. Butler Univ. Bot. Studies, 11. 119-136.

DAVID, A. (1999): Das Steinwild. In: Muffel-, Gams- und Steinwild – Vorkommen, Biologie, Hege, Jagd. Sonderheft Wild und Hund – Exclusiv 82-95. Singhofen: Paul Parey.

DEUTZ, A., C. ASTE (1985): Das Gamswild in der Steiermark. Anblick 11, 8-11.

DEUTZ, A. und G. GRESSMANN (2001): Gams- und Steinwild – Biologie, Krankheiten, Jagdpraxis. Graz: Leopold Stocker.

ELLENBERG, H. (1986): Vegetation Mitteleuropas mit den Alpen. Verlag Eugen Ulmer, Stuttgart; 520 pp.

ELLENBERG, H. (1996): Vegetation Mitteleuropas mit den Alpen. Verlag Eugen Ulmer, Stuttgart.

FLACKE, W. und B. KRAUS (2003): Koordinatensysteme in ArcGIS. Praxis der Transformationen und Projektionen. Points Verlag Norden, Halmstad.

FILLI, F. (2002): Der Steinbock im Spiegel von Theorie und Management. Diss. Techn. Univ. München.

FILLI, F. und S. CAMPELL (2005): Der Sommerlebensraum der Gämse Rupicapra rupicapra in einem inneralpinen Lebensraum am Beispiel der Gebiete Il Fuorn und Val Trupchun im Schweizerischen Nationalpark. Nationalpark-Forschung in der Schweiz, Bd. 95, 149-170.

KLAUS, S., H.-H. BERGMANN, C. MARTI, F. MÜLLER, O.A. VITOVIČ, J. WIESNER (1990): Die Birkhühner. Die Neue Brehm-Bücherei, A. Ziemsen Verlag; 288 pp.

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

GALLAUN, H., P. SACKL, C. PRASCHK, M. SCHARDT, P. TRINKAUS (2006): IPAM-Toolbox. Großflächige Inventur eines Alpinen Natura 2000 Gebietes mittels Fernerkundung in den Niederen Tauern / Steiermark. Im Auftrag der Steiermärkischen Landesregierung, Graz, 167p.

GLUTZ, V. BLOTZHEIM, U. N., P. GÉROUDET, M. SCHWARZ, P. GRÜNIG (1962): „Die Brutvögel der Schweiz“ - Aargauer Tagblatt AG, Aarau; 648 pp.

GLUTZ, V. BLOTZHEIM, U. N., K. BAUER, E. BEZZEL (1973): Handbuch der Vögel Mitteleuropas. Band 5, Akademische Verlagsgesellschaft Wiesbaden; 699 pp.

GOBIET, A., A. BECK, H. TRUHETZ, M. DORNINGER, H. FORMAYER, A. RIEGLER, W. LOIBL (2006): High resolution climate hindcasts and scenarios for the Alpine Region. Geophysical Research Abstracts, Vol. 8, 06788. European Geosciences Union 2006

GOOVAERTS, P. (2000): Geostatistical approaches for incorporating elevation into the spatial interpolation of rainfall. J. Hydrology (228) 1-2. 113-129

GRABHERR, G., M. GOTTFRIED, H. PAULI (2003): Klimawandel und Vegetationsveränderungen im Hochgebirge. Beobachtungen, Messungen, Prozessmodellierungen. In: Colloquium Geographicum, Vol. 26, 104-113.

GRACE, J., F. BERNINGER, L. NAGY (2002): Impacts of Climate Change on the Tree Line. Institute of Ecology & Resource Management, University of Edinburgh, UK and Department of Forest Ecology, University of Helsinki, Finnland.

GRESSMANN, G. (1997): Populationsentwicklung von ausgesetzten Alpensteinböcken (Capra ibex L.) am Ostalpenrand. Dipl.arbeit, Naturwiss. Fak. Univ.Graz.

GRESSMANN, G. (2005): Lebensraumbewertung für das Steinwild im Bundesland Salzburg. Unveröffentl. Endbericht im Auftrag der Salzburger Jägerschaft.

GRESSMANN, G., A. DEUTZ, C. ASTE, W. SCHRÖDER (2000): Die Bedeutung der Topographie für das Populationswachstum von Steinwildkolonien am Ostalpenrand. Z. Jagdwiss. 46, 14-22.

GRIGNOLIO, S., F. PARRINI, B. BASSANO, S. LUCCARINI, M. APOLLINIO (2003): Habitat selection in adult males of Alpine ibex, Capra ibex ibex. Folia Zool. 52(2), 113-120.

HAFNER, F. (1993): Untersuchungen an den Rauhfußhühnern und dem Steinhuhn in den Hohen Tauern. Ökologische Bildungsstätte Oberfranken: 79-84.

HAMR, J. (1984): Home range sizes and determinant factors in habitat use and activity of teh chamois (Rupicapra rupicapra L.) in northern Tyrol, Austria. Diss. Univ. Innsbruck.

HARTL, G. B. (1987): Genetische Gefährdung des Alpensteinbocks? Der Anblick 1, 34–36.

HEIRI, C., H. BUGMANN, W. TINNER, O. HEIRI, H. LISCHKE (2006): A model-based reconstruction of Holocene treeline dynamics in the Central Swiss Alps. Journal of Ecology. British Ecological Society 2006.

HÖHN, O. E. (1969): „Die Schneehühner“ – A. Ziemsen Verlag Wittenberg Lutherstadt; 82 pp.

HOLTMEIER, F.K. (2003): Mountain timberlines. Ecology, patchiness and dynamics. Advances in Global Change Research, Band 14. Kluwer Academic Publisher, Netherlands.

HÖLZINGER, J. (1980): Der Untergang des Birkhuhns Lyrurus tetrix in Baden-Württemberg und dessen Ursachen. Beihefte zu den Veröffentlichungen für Naturschutz und Landschaftspflege in Baden-Württemberg, 16: 123-134.

HUBER, B. und P. INGOLD (1991): Bestand und Verteilung der Territorien des Alpenschneehuhns Lagopus mutus am Augstmatthorn BE. Der Ornithologische Beobachter 88: 1-7.

JOHNSTON, K., J.M. VER HOEF, K. KRIVORUCHKO and N. LUCAS (2001): Using ArcGIS Geostatistical Analyst. ESRI, Redlands, USA.

KLAUS, S., H.-H. BERGMANN, C. MARTI, F. MÜLLER, O.A. VITOVIČ, J. WIESNER (1990): Die Birkhühner. Die Neue Brehm-Bücherei, A. Ziemsen Verlag; 288 pp.

KÖRNER, CH. (1998): A re-assessment of high elevation treeline position and their explanation. Oecologia, 115. 445-459.

KÖRNER, CH. (1999): Alpine plant life. – Functional Plant Ecology of High Mountain Ecosystems. Springer-Verlag Berlin Heidelberg.

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

LINDNER, A. (1977): Die Waldhühner. Hamburg, Berlin: Parey; 148 pp.

LINDSTRÖM, J., P. RINTAMÄKI, I. STORCH (1998): Tetrao tetrix (Black Grouse) In: BWP Update, The Journal of the Birds of the Western Palearctic. Vol. 2 No. 3, Oxford University Press; 173-191.

MAYER, H. (1976): Gebirgswaldbau-Schutzwaldpflege. Gustav Fischer-Verlag, Stuttgart: 436.

MEILE, P. (1980): Zur Platzkonkurrenz von Balzplätzen und Wintersportanlagen. Beihefte zu den Veröffentlichungen für Naturschutz und Landschaftspflege in Baden-Württemberg, 16: 51-58.

MEILE, P., M. GIACOMETTI, P. RATTI (2003): Der Steinbock – Biologie und Jagd. Bern: Salm.

MILLER, C., (1999): Gamswild: Die Felsenziege – ein vitaler Sonderling. In: Muffel-, Gams- und Steinwild – Vorkommen, Biologie, Hege, Jagd. Sonderheft Wild und Hund – Exclusiv, 58-81. Singhofen: Paul Parey.

NERL, W., L. MESSNER, P. SCHWAB (1995): Das große Gamsbuch. Klosterneuburg; Hubertus.

NICOLUSSI, K., M. KAUFMANN, G. PATZELT, J. PFLICHT VAN DER, A. THURNER (2005): Holocene tree-line variability in the Kauner Valley, Central Eastern Alps, indicated by dendrochronological analysis of living trees and subfossil logs. Vegetation History and Archaeobotany 14. Springer-Verlag Berlin Heidelberg.

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

NIEVERGELT, B. (1965): Der Alpensteinbock in seinem Lebensraum. Diss. Univ. Zürich.

OBLED, C. (1990): Hydrological modelling in regions of rugged relief. In: Lang, H. and Musy, A. (Eds.) Hydrology in Mountainous Regions. I-Hydrological Measurements; the Water Cycle (Proc. Lausanne Symp., Aug. 1990). IAHS Publ. 193, 599-613.

ONDERSCHEKA, K., G.B. HARTL (1985): Steinwild. Capra ibex L. In: Buch der Hege, Band 1, Haarwild; Hrsgb.: Stubbe H., 236-247.

OZENDA, P. (1988): Die Vegetation der Alpen im europäischen Gebirgsraum Aus d. franz. Übers. von Hannes Mayer u. Andreas Zirnig. Gustav Fischer Verlag. Stuttgart - New York.

PAULI, H-R. (1980): Nahrungsökologische Untersuchungen am Birkhuhn in den Schweizer Alpen. Beihefte zu den Veröffentlichungen für Naturschutz und Landschaftspflege in Baden-Württemberg, 16: 28-35.

PEZZI, G. und C. FERRARI (2004): Spatial pattern of the upper timberline and heath deficiency of Fagus sylvatica L. in the Northern Apennines. 14th Meeting of the Italian Society of Ecology. 4.-6. Oktober 2004, Siena.

RECLIP:MORE TEAM (2006): Project reclip:more - overview: Objectives, tasks and results 2004-2005. In: Klimaforschungsinitiative AustroClim: 9. Österreichischer Klimatag „Klima, Klimawandel und Auswirkungen“, 16. und 17. März 2006, Wien.

REIMOSER, F. (2001): Problem Waldgams. Weidwerk 3, 10-13.

REIMOSER, F. (2002): Das Waldgamsproblem. Schriftenreihe des LJV Bayern e. V. 9, 15-20. In: Int. Symp. D. LJV Bayern e.V. u. d. Bayr. Ak. F. Tiersch., Umwelt und Jagdwiss..

SACKL, P. und SAMWALD (1997): Atlas der Brutvögel der Steiermark. Austria Medien Service, Graz, 432 pp.

SACKL, P. und L. ZECHNER (1995): „Niedere Tauern“ In : Dvorak, M. & Karner, E. (1995): „Important Bird Areas in Österreich. Umweltbundesamt Monogr. 71, Wien: 367-373.Schaffer, A. (1904): Pfarrer P. Blasius Hanf als Ornitholog. Selbstverlag Benediktiner-Abtei, St. Lambrecht, 384 pp..

SÄGESSER, H. und F. KRAPP (1986): Rupicapra rupicapra (Linnaeus 1758). In: Handb. der Säugetiere Europas. Wiesbaden: Aula.

SCHATZ, H. (1998): Das Gamswild und die Sonne. Anblick 8, 8-11.

SCHARFETTER, R. (1938): Das Pflanzenleben der Ostalpen. Wien: 419 p.

SCHAUMBERGER, A. (2005): Ertragsanalyse im österreichischen Grünland mittels GIS unter besonderer Berücksichtigung klimatischer Veränderungen. Höhere Bundeslehr- und Forschungsanstalt für Landwirtschaft Raumberg- Gumpenstein, Irdning.

SCHERZINGER, W. (1976): Rauhfuß-Hühner. Nationalparkamt Bayerischer Wald, Heft 2; 71 pp.

SCHÖNBECK, H. (1955): Die Verbreitung des Alpenschneehuhnes in der Steiermark. Vogelkundliche Nachrichten aus Österreich Folge 6: 2-5.

SCHNIDRIG-PETRIG, R. und U.P. SALM (1998): Die Gemse. Biologie und d Jagd. Bern: Salm..

SLOTTA-BACHMAYR, L. und N. WINDIG (1994): Verteilung und Siedlungsdichte von Schnee- und Birkhuhn (Lagopus mutus, Tetrao tetrix) im Laufe der Vegetationsperiode im Wald- und Baumgrenzebereich (Hohe Tauern, Österreich). Der Ornithologische Beobachter 91: 195-202.

STARLING-WESTERBERG, A. (2001): The habitat use and diet of Black Grouse (Tetrao tetrix) in the Pennine Hills of Northern England. Bird Study 48: 76-89.

WIERSEMA, G. (1982): Zur Wiedereinbürgerung des Alpensteinbockes. Jahrbuch des Vereins zum Schutz der Bergwelt, 9-15.

WIERSEMA, G. (1984): Seasonal use and quality assesment of ibex habitat. Acta Zool. Fennica. In: Proceedings of the Third International Theriological congress, Helsinki 15.-20. August 1982.

WIERSEMA, G. und W. SCHRÖDER (1983): How to find Suitable Ibex Habitat Using Landsat Imagery. S. Lovari ed.: The Biology and Management of Montain Ungulates. Croom Helm, 226-230.

ZECHNER, L. (1996): Siedlungsdichte und Reproduktion des Steinadlers (Aquila chrysaetos) in den südlichen Niederen Tauern (Steiermark). In: Abhandlungen der zoologisch-botanischen Gesellschaft Österreich; 29: 123-139.

ZEILER, H. (1996): Jagd und Nachhaltigkeit. Monographien Band 73, Umweltbundesamt Wien.

ZEITLER, A. (1999): Rauhfußhühner und Wintersport. Laufener Seminararbeit. 6/99: 47-51.

Figures and Tables

Figures

Tables

Annex

Subprojects of StartClim2003

These reports can be fond on the StartClim2005-CD-ROM as well as in the StartClim-webpage (www.austoclim.at/startclim/)

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 - University of Natural Resources and Applied Life Sciences
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 - University of Natural Resources and Applied Life Sciences
Andreas Frank, Petra Seibert

StartClim.5: Testing statistical downscaling techniques for their applicability to Extreme Events in Austria
Institute of Meteorology and Physics,
BOKU - University of Natural Resources and Applied Life Sciences
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-floodings 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 welfare 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
Center 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 Program for Austria
Institute of Meteorology and Physics,
University of Natural Resources and Applied Life Sciences
Helga Kromp-Kolb, Andreas Türk

StartClim.Reference database:
Implementation of a comprehensive literature data base 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

Subprojects of StartClim2004

These reports can be fond on the StartClim2005-CD-ROM as well as in the StartClim-webpage (www.austoclim.at/startclim/)

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: Contiunation and further development of the MEDEA event data base
Federal Environment Agency
Martin König, Herbert Schentz,
Katharina Schleidt
IIASA
Matthias Jonas, Tatiana Ermolieva

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