Project No. 037005

CECILIA

Central and Eastern Europe Climate Change Impact and Vulnerability Assessment

Specific targeted research project

1.1.6.3.I.3.2: Climate change impacts in central-eastern Europe

D8.2: Project presentation

Due date of deliverable: 1st October 2006
Actual submission date: 20th October 2006

Start date of project: 1st June 2006 Duration: 36 months

Lead contractor for this deliverable: Charles University (CUNI)

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

SIXTH FRAMEWORK PROGRAMME

SUB-PRIORITY 1.1.6.3

Global Change and Ecosystems

SPECIFIC TARGETED RESEARCH PROJECT

Project Presentation

Contract no.: **037005**
Project acronym: **CECILIA**
Project full title: **Central and Eastern Europe Climate Change Impact and VulnerabiLIty Assessment**
Priority thematic areas: 1.1.6.3.I.3.2 - Climate change impacts in central-eastern Europe
Duration of the project: **1 June 2006 – 31 May 2009**

List of Participants

Participant No.	Participant name	Participant short name	Country
1	Charles University, Prague	CUNI	Czech Republic
2	The Abdus Salam ICTP, Trieste	ICTP	Italy
3	Météo-France, Toulouse	CNRM	France
4	Danish Meteorological Institute, Copenhagen	DMI	Denmark
5	Aristotle University of Thessaloniki	AUTH	Greece
6	Czech Hydrometeorological Institute, Prague	CHMI	Czech Republic
7	Institute of Atmospheric Physics, Prague	IAP	Czech Republic
8	Swiss Federal Institute of Technology Zurich	ETH	Switzerland
9	University of Natural Resources and Applied Life Sciences, Vienna	BOKU	Austria
10	National Meteorological Administration, Bucharest	NMA	Romania
11	National Institute of Meteorology and Hydrology, Sofia	NIMH	Bulgaria
12	National Institute of Hydrology and Water Management, Bucharest	NIHWM	Romania
13	Hungarian Meteorological Service, Budapest	OMSZ	Hungary
14	Forest Research Institute, Zvolen	FRI	Slovakia
15	Warsaw University of Technology, Warsaw	WUT	Poland
17	Eötvös Loránd University, Budapest	ELU	Hungary

Total cost: **4,424,572 € (incl. estimated own resources of AC partners)**
Commission funding: **2,749,891 €**

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Project main goal

The main goal of CECILIA is to provide climate change impacts and vulnerability assessment in targeted areas of Central and Eastern Europe (CEE). This addresses directly the topic I.3.2 "Climate changes in central-eastern Europe" under research area 3.1.3 "Prediction of climatic change and its impacts" in part 3.1 concerning the "Impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks" within FP6 Sub-Priority Area "1.1.6.3 Global Change and Ecosystems". Our objectives and work plan contribute to the scientific, technical and social and policy objectives of this topic area. We target our analysis on selected key areas of specific interest to the region. The floods and droughts which occurred in recent summers in the region highlight the importance of the hydrologic cycle and water management in Elbe and Danube river catchments in response to the occurrence of precipitation extremes. Impacts on agriculture and forestry affecting the economy of countries in the region will be studied as well. The 2003 heat wave demonstrated the importance of the health impacts of extreme conditions that could also lead to considerable changes in air quality, both regionally and in major urban centres.

The aim of the project is to assess the impact of climate change at the regional to local scale for CEE using very high resolution in order to capture the effects of the complex terrain of the region. This goal will be achieved mainly using very high resolution RCMs run locally for targeted areas. From the viewpoint of climate change scenario production two time slices are planned, for 2020-2050 and 2070-2100. Changes in weather patterns and extreme events are addressed within the project as they affect the important sectors for the economies and welfare of individual countries in the region. Uncertainties will be evaluated by comparing results with those from previous projects (PRUDENCE, ENSEMBLES). The selected applications of the CECILIA outputs are supposed toward water resources and management, agriculture, forestry, air quality and health. In addition, CECILIA will improve the access of CEE researchers to information and facilities for climate change research by providing an efficient use and access to the results of previous and ongoing EC projects which the proposed research will benefit greatly from, e.g.:

- "Modelling the Impact of Climate Extremes (MICE)"
- "Statistical and regional dynamical downscaling of extremes for European regions (STARDEX)".
- "Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects" (PRUDENCE)
- "ENSEMBLE-based Predictions of Climate Changes and their Impacts" (ENSEMBLES)
- "Quantifying the Climate Impact of Global and European Transport Systems" (QUANTIFY)

Thus, CECILIA will integrate world leading European expertise in regional climate modelling with high resolution impact studies to provide new policy relevant information on climate change and its interactions with society at the regional scale. It will also feed into adaptation and mitigation strategies in targeted areas.

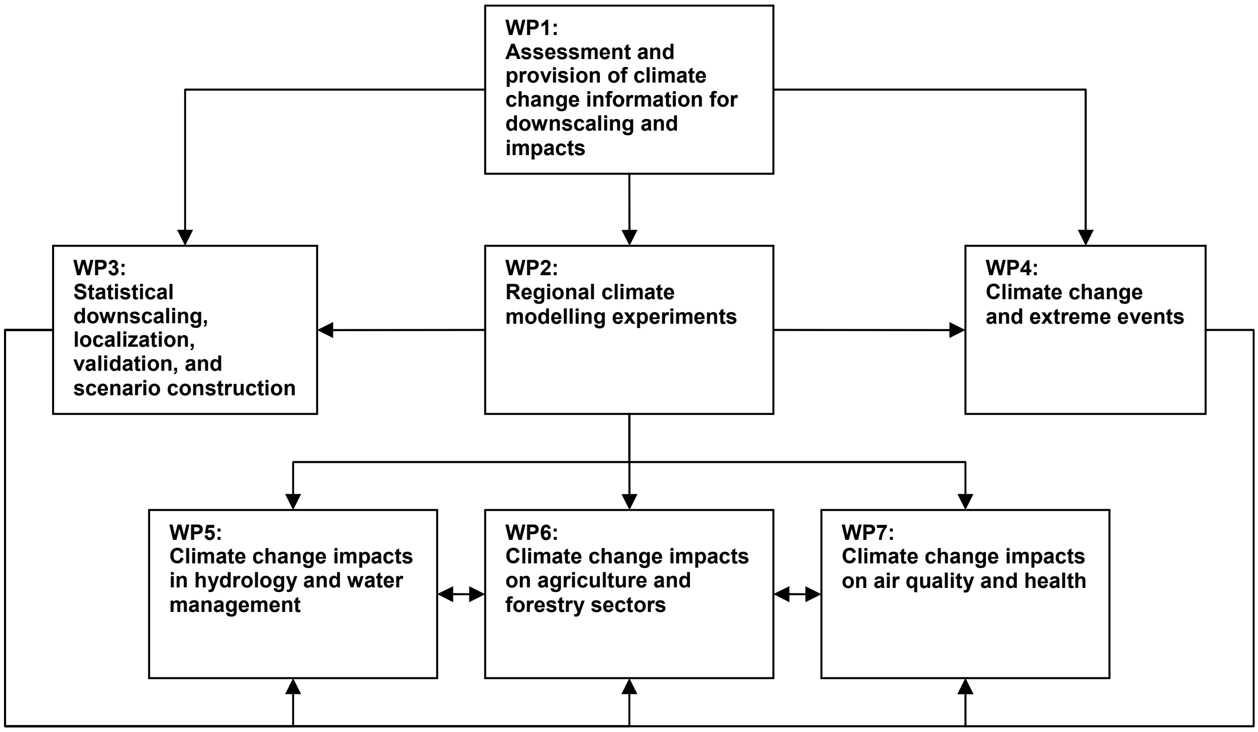


Figure 1. *Interactions between the workpackages*

Key issues

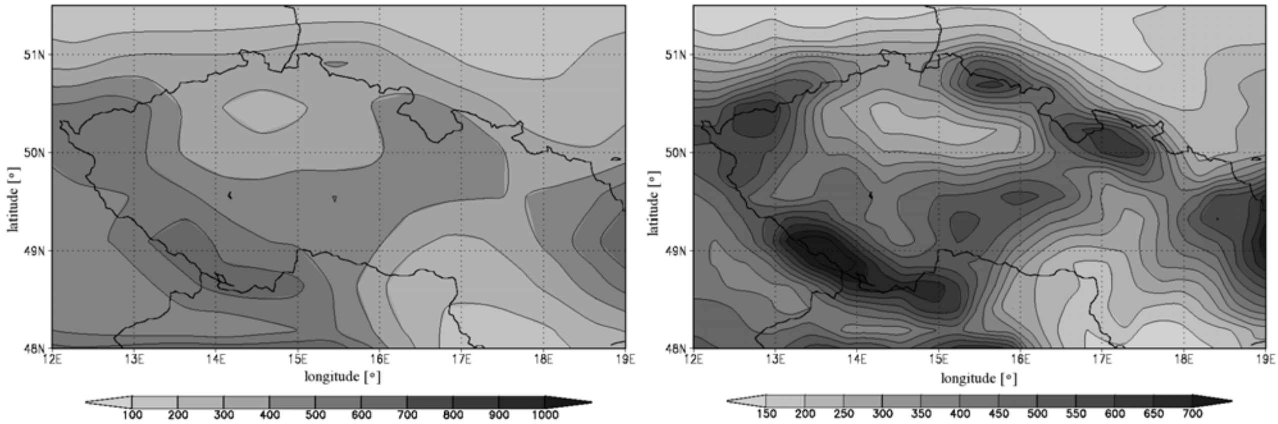
Emphasis is given to application of regional climate modelling studies at a resolution of 10 km for local impact studies in key sectors of the region. Very high resolution simulations over this region are necessary due to the presence of complex topography and land use features. Impacts on large urban and industrial areas modulated by topographical and land-use effects resolved at the 10 km are investigated. The high spatial and temporal resolution of national observational networks and of regional model experiments will feed into investigations of consequences for weather extremes in the region. Comparison with the results based on statistical downscaling will also be provided. Statistical downscaling methods for verification of the regional model results will be developed and applied, and assessments of their use in localization of model output for impact studies will be performed. The objectives will be achieved through the following tasks:

- To collect, assess and make available for first local impact studies the scenarios and climate simulations produced in previous relevant projects where available. (WP1)
- To adapt and develop very high resolution RCMs for the region (10 km grid spacing) and perform regional time-slice nested runs driven by ERA40 data and by GCMs for selected GHG change scenarios. (WP2)
- To verify the model results, compare RCM and statistical downscaling results, analyze and develop the methods for verification, particularly at local scales, to provide the scenarios. (WP3)
- To estimate the effect of global climate change on extreme events in the region, including the assessment of the added value of high-resolution for the simulation of the relevant processes and feedbacks. To evaluate uncertainties in regional projections by comparing results from previous projects (WP4)
- To assess (using high resolution downscaling results) the impacts of climate change on the hydrological cycle and water resources over selected catchments; the effects of climate change on the Black Sea (WP5)
- To study (based on the high resolution downscaling results) the impacts of climate change on agriculture and forestry, carbon cycle and selected species (WP6)
- To study (based on the high resolution downscaling results) the impacts of climate change on health and air quality (photochemistry of air pollution, aerosols) (WP7)

Technical approach

The project CECILIA brings for the first time very high resolution localization of climate change scenarios into the targeted areas of CEE. Improving upon the project ENSEMBLES where Europe-wide scale is adopted at high resolution, here we address even higher resolutions on a significantly smaller domain. This higher resolution enables not only more detailed description of the topography and land use, but it allows to introduce new processes, as interactive interaction of climate change and air quality, subgrid effects etc. However, it requires the adaptation of parameterizations available at coarser resolution. One of the main objectives of this proposal is to adapt a few of the models used for ENSEMBLES (ALADIN-Climate and RegCM) for very high resolution (grid spacing of 10 km) simulations over selected sub-domains. The assessment of the role of significant but previously not resolved topographical features and land-use patterns will be provided in these experiments as well as the evaluation of the sensitivity of the simulations to the choice of the model domain. Development of new features in the parameterization of high resolution physics in the models is expected (e.g. cloud microphysics, chemistry of urban areas etc.). This provides a connection with the EC FP6 Project QUANTIFY, which aims at quantifying the impact of transportation on climate change. In the region of CEE the need for high resolution studies is particularly important due to the appearance of complex topography features as Alps, Carpathians basin and smaller mountain chains and highlands in most of the countries that significantly affect the local climate conditions. A resolution sufficient to capture the effects of these topographical and associated land-use features is necessary as illustrated in Fig. 2, where comparison of topography representation in different resolutions is presented in the detailed view on the Czech Republic.

The most reliable source of information on the evolution of the atmospheric environment in the next decades comes from RCMs. It was demonstrated in PRUDENCE that the major source of uncertainty for RCM was the driving GCM. It is thus essential to use at least two GCMs (ARPEGE and ECHAM5). Since ARPEGE and ALADIN have been written and developed to work with each other and RegCM has been used already with ECHAM5 as well, it is natural to use these two pairs. As the forcing GCMs introduce their own systematic errors in the regional climate, a first step consists of forcing the high resolution RCM with data as close as possible to observation. The ERA40 dataset provides a good forcing at 150 km resolution, the other 3 RCM simulations are snapshots driven by GCM conditions: 1961-1990, 2021-2050, and 2071-2100.



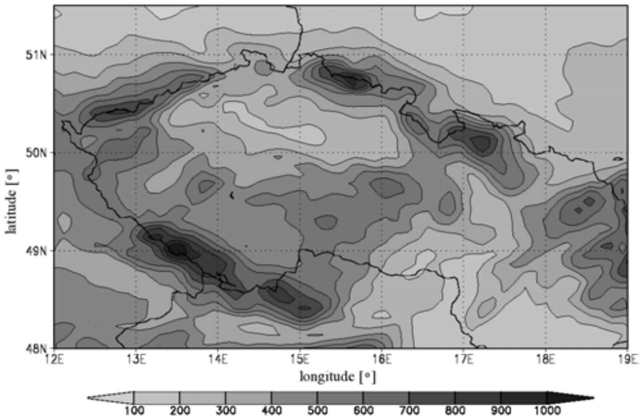


Figure 2. *Detail of topographical features seen in ENSEMBLES' 50 km resolution (upper left) and 25 km (upper right) and 10 km for CECILIA proposal (bottom panel).*

Statistical downscaling (SDS) is an alternative approach to get high resolution insight to climate change issue. SDS consists of seeking statistical relationships between the variables simulated well by GCMs and the surface climate variables of interest. These relationships are usually trained on observed data and then applied to the control and perturbed GCM outputs, the former serving for verification and the latter for climate change scenario construction. As for the methods, the majority of SDS studies employ linear methods, most notably multiple linear regression and canonical correlation analysis. Nonlinear methods have recently begun to emerge as well. The added value in the project consists mainly in a complex intercomparison of performance between the dynamical and statistical models. The ability to simulate extreme values is also of great importance. RCMs even at high resolutions of less than 20 km do not provide site-specific information required in many impact models, which becomes relevant especially in regions with complex topographical features as typical in focal areas of the project. Methods for localization of model outputs have recently been proposed based on regression against geographical variables, with the residuals being interpolated using geostatistical methods. An alternative procedure is a MOS-like approach using model variables as predictors.

Previous results show the possibility of the changes of statistical distribution of climate parameters in our targeted domains. Despite the relative agreement of climate-change scenarios concerning the changes in extremes over this region, a significant uncertainty remains with regard to their exact magnitude and the attribution of the causes for these changes. Some studies have highlighted the role of large-scale circulation changes, but land-atmosphere interactions are clearly of key relevance as well. Moreover, certain aspects central to this issue are often not well represented in GCMs (land surface heterogeneity, complex topography, convection), or even in RCMs. Very high-resolution simulations could help investigating some of these open questions and yield more accurate estimates of future changes in extreme weather events over the targeted regions. Other issues that need investigation are the effects of domain size on the simulated processes, choice of parameterizations and boundary conditions.

The impacts of climate change on hydrology will be estimated using scenarios for changes of climatic inputs to a hydrological model. Improved models have been developed to simulate water quantity and quality involving representation of the physical processes. The climate change has potential effects on the components of the water balance (precipitation, evaporation, soil moisture, groundwater recharge and river flows) and their variability over time. In a river basin the hydrological variability over time is influenced by variations in precipitation over all the time scales. Flood frequency will be studied in high resolution scenarios of climate change which bring more precise information based on better definition of the catchments. The frequency of low flows is affected primarily by changes in the seasonal distribution of precipitation, year-to-year variability, and the occurrence of prolonged droughts. Climate change has the potential to affect all of these factors in a combined way that is not yet clearly understood. The local effects of climate change on soil moisture will vary not only with the degree of climate change but also with soil characteristics where high resolution of the simulations might be of the great importance. Groundwater is the major source of water, particularly in rural areas in arid and semi-arid regions, but there has been very little research on the potential effects of climate change. The great number of hydrological studies has concentrated on potential changes on streamflow. To estimate the impact of climate change on the hydrological resources, mathematical rainfall-runoff models are used for the reference basins. These basins are selected based on the assessment of the vulnerability of water resources and corresponding adaptation measures. Models can be applied both in the case of present regime and regimes of climate change scenarios taken from downscaled results. When taking the results of statistical downscaling the use of weather generators is required to obtain inputs for most hydrological models, in the case of very high resolution RCMs both spatial and time resolution could be satisfactory for direct input to the basin models. The assessment of water quality changes and impacts on availability and management of surface water resources are important as well. This implies the analysis of hydrological balance changes, nutrient (N, P) concentrations and eutrophication in a river network with reservoirs used for drinking water supply and recreation.

The increased content of CO2 in the air stimulates photosynthesis. At the same time, higher ambient CO2 allows to reduce the transpiration intensity through decreased stomatal conductance, especially under higher temperatures. This should lead to improved water use efficiency by plants and thereby to a lower probability of water stress occurrence. The impact of the changed weather regime brought about by the CO2 increase is referred to as “indirect effect” or “weather effect”. The most important weather variables that directly determine the crop yield are solar radiation, precipitation and temperature. If no management response (e.g., other cultivars, change in the planting date or soil water conserving practices) is applied, cereals in general yields typically decrease with increasing temperature due to a shortening of phenological phases. On the other hand, the crop response to high temperatures clearly depends on the character of the temperature increase as well as the developmental stage of the crop. There are major gaps between the actual and attainable yields of crops, attributable largely to pests, diseases and weeds. Therefore predicting the potential distribution of all pests, both indigenous and introduced, plays a key role in determining the effects of global change effects on agricultural, horticultural and forest ecosystems. The distribution and intensity of current key pests and diseases may be affected, leading to changed effects on yield and on control measures such as pesticides and integrated pest management. However, as it was stated in the IPCC (2001) only modest progress has been made in understanding pests response to climate change since the last comprehensive overview.

Climate change and other pressures will alter future carbon (biomass) storage in forests, but the regional extent and direction of change is still unknown. Research reported since the early nineties confirms the view that the largest and earliest impacts induced by climate change are likely to occur in mountainous and boreal forests, where changes in weather-related disturbance regimes and nutrient cycling are primary controls on productivity. Forest growth has increased during the past several decades in European forests; climate warming, increasing CO2, increased nitrogen deposition, and changes in management practices are factors that are assumed to be behind the increase. The impacts of temperature and CO2 have been shown in experiments and are extrapolated by model calculations.

The concentration of air pollutants depends on both anthropogenic and climate factors. A main issue is the quantity of emissions of primary pollutants as well as of precursors of secondary pollutants. Long range transport to the target regions will be taken into account by simulation for the whole Europe, driven by RCM with a grid resolution of 50x50 km. These simulations will be used to constrain nested higher resolution runs (10x10 km) for a smaller domain focusing in CEE both for present and future climate. The key species will be ozone, sulphur and nitrogen as well as PM, which have a central role in tropospheric chemistry as well as the strong health impacts. Emphasis will be given to future key species exceedances of the EU limits for the protection of human health, vegetation and ecosystems as well as WHO guidelines. Another risk factor for the human health, which finally goes hand in hand with the issue of air quality through the chemistry of pollutants, are heat waves, and in certain extent even cold waves. The summer of 2003 encompassed one of the most severe heat waves on record in central and western Europe causing both human losses and damage to natural ecosystems. First guess of possible impacts of climate change on mortality and attempt to split the direct effect of heat and cold waves from the effects of air quality will be given on the basis of this study. Climate change may affect exposures to air pollutants by a) affecting weather and thereby local and regional pollution concentrations; b) affecting anthropogenic emissions including adaptive response of increased fuel combustion for fossil fuel-fired power generation; c) affecting natural sources of air pollutant emissions; and

d) changing the distribution and types of airborne allergens. In addition, the chemical composition of the atmosphere may in turn have a feedback effect on the local climate. Weather is also associated with energy demands (e.g., for space heating and cooling) that could alter patterns of fossil fuel combustion. In particular, individual responses to extremely hot weather can result in large increases in air conditioner use. In addition, high temperatures cause increased VOC evaporative emissions when people run motor vehicles. The health effects of air pollution are broad and diverse, including dramatic episodes of increased mortality at high concentrations. In humans, the pulmonary deposition and absorption of inhaled chemicals can have direct consequences for health. Nevertheless, public health can also be indirectly affected by deposition of air pollutants in environmental media and uptake by plants and animals, resulting in chemicals entering the food chain or being present in drinking-water and thereby constituting additional sources of human exposure. Furthermore, the direct effects of air pollutants on plants, animals and soil can influence the structure and function of ecosystems, including their self-regulation ability, thereby affecting the quality of life. The most sensitive groups include children, older adults and persons with chronic heart or lung disease.

Expected achievements/impact

Although the broad response of global climate to increased greenhouse gas concentrations is well established, many unknowns remain in the regional details of projections of future climate change. Thus, the central internal objectives of CECILIA are to improve regional climate scenarios and their localization for climate impacts models, and comparing these results against the results of previous and ongoing projects to assess the added value of dynamical downscaling at very fine scales. The general aim of CECILIA is to improve Europe's ability to assess the consequences of global climate change at the local scale, and on this basis to assist to formulate more precise response strategies and more scientifically based negotiating positions. Such an effort will assist in the successful implementation of the FCCC (Framework Convention on Climate Change) and the Kyoto Protocol, for the negotiations in the post Kyoto process and in regulations to mitigate the possible consequences of climate change as concluded by IPCC. Very high resolution and better regional predictions are required to guide long term planning in sectors such as agriculture and energy.

Several key issues connected with climate change have become of interest in recent years, such as the occurrence of extremes or effects on air quality, with potentially severe impacts on the quality of life, health and safety. The occurrence of these extreme events, in some cases causing loss of human life and extensive damages or costs, is affected by the relation between extremes and climate change which can be better explored using high resolution climate modelling. Results will allow us to evaluate the vulnerability of different sectors in the regions. CECILIA will provide high resolution tools to help anticipate and ameliorate the adverse impacts of climate change on humans both at the individual and at the societal level. It will help to identify and exploit positive impacts. It will provide demonstrations of the use of these tools in important economic, environmental or social sectors where the impacts of climate change are likely to be felt. Results of simulations generated within the project are expected to be available for other interested institutes in Europe, with the possibility of use in national projects on climate change impacts over the targeted area.

Climate change represents a major factor affecting the global and European environments. Natural ecosystems will become stressed if climatic zones shift at a faster rate than the ecosystems can migrate. Changing availability of natural resources such as water supply may adversely affect the sustainability of European activities. A more stressed environment will be even more vulnerable to natural hazards. CECILIA with high resolution climate simulation can help anticipate and ameliorate the adverse impacts on the local environment and natural resources of the targeted regions. It can also provide mitigation information to reduce the hazards concerning these important factors. Concerning the environment, CECILIA, similarly as the EC project QUANTIFY, will provide a platform for reducing the gap between climate change and air quality sciences, putting together traditional aspects of climate change impacts and impacts on air quality.

This project brings very high resolution localization of climate change scenarios into the targeted areas of CEE, with the added value of climate scenarios produced locally. This will provide necessary policy relevant information concerning the local adaptation and/or mitigation measures. Moreover, it will provide know-how and tools which can be further used for the analysis of the climate change development and climate change impacts on different sectors of the society in the target region. With the emphasis on former Eastern Block countries the CECILIA project will provide new access and contacts for researchers from this area to the European research activities and thus help to bridge existing gaps. An important point of innovation consists in the fact that very high resolution climate information will allow application in integrated climate change impact studies, which will in turn provide for the first time necessary policy relevant information for decision makers and local authorities in the region.