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INTERESTING SCIENTIFIC PROJECTS • NEW CHALLENGES

Climate change: Impacts, costs and adaptation in the Baltic Sea region (the BaltCICA project)

In the first decade of the 21st century, climate change and its potential impacts on human society have developed from a scientific discussion towards a nearly omnipresent issue in sciences, daily media, and political agendas. It is not questionable that the Earth's climate has been warming over the last 100 years and resulted in a measurable shift in the climate zones of Europe. A very important discussion is the potential impact of climate change on the frequency and magnitude of natural hazards. There are observations of an increase in the magnitude of tropical storms in some regions. An increase in their frequency is not traceable; in fact, there might be a decrease in storm frequency. Nevertheless, hydro-meteorological hazards will remain a highly potential source of adverse impacts on human settlements, especially as they also trigger important hazards such as storm surges and floods. Human vulnerability to extreme events has been rising, even despite climate change impacts. While there has been a strong increase in damages and costs, especially over the last 30 years, a normalization of the costs shows no trends of a rise in either frequency or magnitude. With the continually expanding population and a strong trend to settle in coastal and flood-prone areas, one question will certainly remain of high importance: how can land-use planning properly respond to the potential impacts of natural hazards and the potential impact of climate change on those? In other words, how can spatial planning respond to extreme events, and what kind of knowledge is required to support decision-makers?

The project "Climate Change: Impacts, Costs and Adaptation in the Baltic Sea Region" (BaltCICA) is aimed to develop approaches by a cooperation of several scientific disciplines, including geosciences, to support planners and decision-makers in finding appropriate, and cost-beneficial, ways to adapt to current extreme events, taking into account their potential future changes.

The project is part-financed by the European Union Baltic Sea Region Programme 2007–2013 and comprises 24 partners including municipalities, regional authorities and research institutes (Figure). The project duration is from February 2009 to January 2012. The BaltCICA project builds on the experiences gained from the INTERREG IIIB projects "Sea Level Change Affecting the Spatial Development in the Baltic Sea Region" (SEAREG) and "Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region" (ASTRA), of which the GTK was also the lead partner. All three projects follow a logical chain of development. While SEAREG laid the basis of rising the awareness of potential climate change impacts on regional development, ASTRA went a step further and assessed its potential impacts. The BaltCICA project supports local and regional decision-makers in evaluating and implementing adaptation measures.

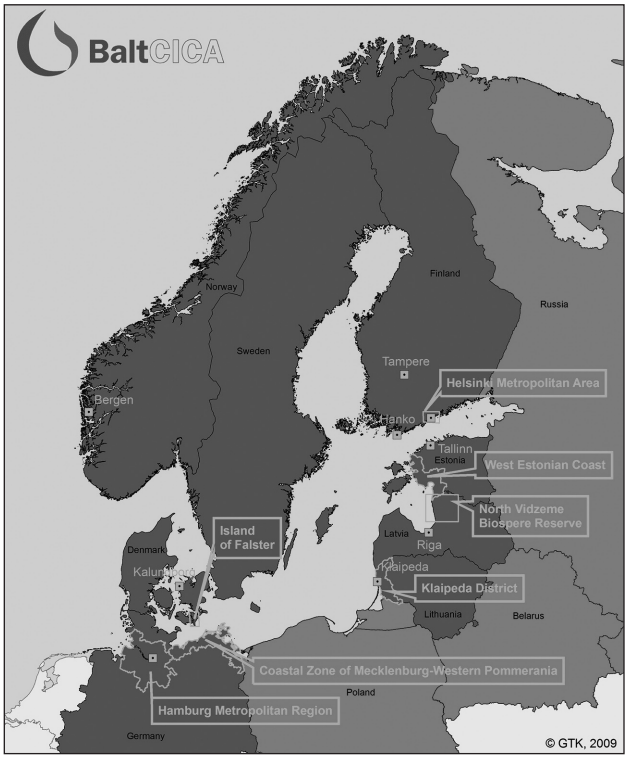

Figure. Case study areas of the BaltCICA project (www.baltCICA.org)

WHY IT IS IMPORTANT THAT GEOLOGY PARTICIPATES IN CLIMATE CHANGE IMPACT RESEARCH

Climate change belongs to one of the most recent scientific endeavors of which society demands reliable scientific answers. Geoscientists have been researching the causes and extents of climatic changes in Earth's history for a long time. Most of the current climate change research is based on numerical modeling and focuses on future developments and impacts, and on how climate change could be mitigated. An equally important research field of adapting to climate changes is now evolving strongly, especially in political contexts. Because of its deep understanding of climate changes in Earth's history, geology can make important contributions to solving the issues arising around the capacities and necessities of our society to adapt to both the current and the potential climates. Often, past climate

changes, which can be deduced from geological records, may help in understanding the rate of potential climate change effects, i. e. how quickly have sea levels changed, how drastically has nature reacted to the ups and downs of the temperature, etc. These analyses of past events help in giving outlooks on potential changes in our living environment. They are also helpful in understanding the magnitude and potential effects of extreme events, such as droughts and floods.

GROUNDWATER AS THE KEY GEOENVIRONMENTAL ISSUE IN EUROPE

At present, surface water plays a substantial role in public water supply in European countries, but also an increasing share of groundwater in the public water supply is observed. This is because groundwater has advantages over surface water. Groundwater generally contains micro- and macrocomponents needed for the human body; it does not require expensive treatment and is much better protected from contamination. The EU has a number of directives and regulations aimed to protect water resources. These include the Urban Waste Water, Nitrates, and Drinking Water Directives, and the Directive on Integrated Pollution Prevention and Control which requires licensing of discharges at sustainable levels. A coherent water policy had been developed by 1995, but the measures were focused on preventing emissions leading to more pollution rather than on the improvement of water resources. The EU Water Framework Directive (2000/60/EC) establishing a framework for the Community action in the field of water policy was adopted in 2000. This Directive requires establishing technical specifications to complement the overall water (surface water, groundwater, and coastal beaches) regulatory regime. These specifications cover a number of key elements ranging from the characterization and analysis of pressures and impacts to the monitoring of measures. All of these elements are linked to the development and implementation of river basin management plans aimed at achieving a "good environmental status" by 2015.

Taking into consideration that groundwater is very important (Table) and in some countries is the only source of potable water (in Europe, 65% of potable water is taken from groundwater aquifers), in 2006 the European Commission adopted the new Groundwater Directive (2006/118/EC) aimed at protecting groundwater from pollution. Based on the EU-wide approach, the Directive has introduced the quality objectives which oblige Member States to monitor and assess groundwater quality on the basis of common criteria and to identify and reverse trends in groundwater pollution.

The use of groundwater for public water supply is increasing in Europe, and especially in bigger cities. However, it is estimated that 60% of European cities overexploit their groundwater resources. The European countries that use a high percentage of groundwater for public water supply can be listed in the following order: Lithuania 100%, Denmark 98%, Italy 93%, Hungary 90%, Poland 70%, Estonia 65%, Romania 43%, UK 35%, Scandinavian countries and Ireland 15%. This raises an important question of how climate change can potentially affect the recharge, availability, and quality of groundwater resources. The ASTRA and BaltCICA projects have data of several case studies that address a wide range of potential impacts, some of which are described in more detail below.

EXAMPLES FROM THE BALTIC SEA REGION

The concentration of large parts of its population and many larger cities in the coastal areas make the Baltic Sea Region sensitive to climate changes. Among others, sea level rise and impacts on drinking water availability and quality (both surface and ground water) can be expected to have important socio-economic impacts. Already under present climatic conditions, many coastlines in the Southern Baltic Sea face coastal retreat. The public water supply of many coastal municipalities is currently depending on shallow groundwater aquifers vulnerable and sensitive to changes in precipitation patterns and sea level. The intrusion of brackish water can affect water quality or water supply facilities and requires measures such as well relocation or adjustment of the water pumping rate.

Changes in the hydrological cycle and higher temperatures (of water and air) can lead to shifts in the yearly groundwater cycle and runoff patterns in rivers and catchment areas. Most climate change scenarios expect higher temperatures and higher precipitation in the yearly average, especially in wintertime, which leads to changing snow cover and flood patterns. In the Baltic Sea Region, the higher evapotranspiration and the shift of the runoff peaks to an earlier time in the year (caused by less snow and more rain in winter) can contribute to droughts in summertime.

The aim of applied interdisciplinary climate change impact research is to achieve a better capability to deal with the impacts at those levels where reliable adaptation measures have to be implemented and are visible and tangible for the population. Assessment of climate change impacts on water bodies contributes to the development of methods for safeguarding sustainable water supply as regards both quality and quantity. Special emphasis is placed on the adaptation to sea level rise and changing flood patterns for settlements located on the Baltic coast.

The Klaipėda case study within the BaltiCICA project is compiling hydrodynamic models for the Klaipėda district groundwater resources. The evaluation of the potential climate change impacts is based on different climate change scenarios that shall help defining adaptation measures in both the use and protection of water resources, including the cost–benefit analysis.

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Table. **Water issues in the European Union**

– 20% of surface water within the European Union is seriously threatened by pollution,
– 60% of European cities overexploit their groundwater resources, since 1985, the area of irrigated land has increased by 20% in Southern Europe,
– the number of regions and populations affected by drought has increased by approximately 20% between 1976 and 2006,
– in 2003, one of the longest droughts affected more than 100 million people and one third of the territory of the European Union,
– droughts in the last thirty years have cost a total of 100 billion Euro. (http://europa.eu/scadplus/leg/en/s15005.htm)