



ISSUE 05 JUNE 2011

Integrated model-based assessment of groundwater protection for the Egebjerg area - Pilot Area F, Denmark

by Hans Jørgen Henriksen, Lars Trolborg & Torben O. Sonnenborg

Drinking water supplies in Denmark are drawn exclusively from groundwater sources. The decrease in the quality of shallow groundwater in recent decades has increased the interest in exploiting deep aquifers for safe drinking water supply. As part of this, accurate delineation of areas with potential contamination risks, including groundwater recharge and capture zones to well fields, is needed.

For the Egebjerg area a numerical groundwater and surface water model has been constructed based on a detailed lithological model with 84 lithological units. The MIKE SHE / MIKE 11 numerical flow and particle transport model has been constructed with a vertical discretisation of 30 calculation layers and a uniform horizontal discretization of 100 x 100 m grid cells. The model area is shown in Figure 1. (cont'd./... p.2)

Editorial

Dear Reader,

The main theme of this fifth newsletter is *Coupled groundwater and surface water models for evaluation of climate change impacts on water quantity and quality in coastal regions*. Coastal catchments, aquifers and ecosystems are currently under pressure globally from a wide range of forces including flooding, droughts, over-exploitation, saltwater intrusion and nutrient pollution. Population growth, climate change and sea level rise will increase these pressures and the corresponding need for protection and sustainable management of water resources and ecosystems for coastal communities. New and improved tools are therefore needed for evaluation of the current status and projection of future changes in groundwater and surface water quantity and quality in a changing climate as well as for providing the necessary knowledge base for efficient and adaptive water management. The CLIWAT project develops and applies new innovative tools for mapping the current physical and chemical characteristics of the subsurface, and for assessing climate change impacts on quantity and quality of water bodies and ecosystems in coastal areas. In previous CLIWAT newsletters we have focused on tools for geological, geophysical and geochemical mapping and characterisation of the subsurface including the distribution of freshwater and saltwater.

In this issue, we focus on assessing climate change impact on water resources quantity and quality, primarily with the use of integrated hydrological models. The

methods for assessing future changes to water resources quantity and quality include

1. groundwater models which are able to simulate density-dependent groundwater flow (described in Newsletter no. 3)
2. integrated hydrological models.

The latter allow for an integrated evaluation of changes in groundwater and surface water quantity and quality (e.g. water tables, runoff and flooding risks in a variety of climate scenarios and for different irrigation scenarios). In this newsletter, we describe five examples from the CLIWAT project and related projects where coupled groundwater and surface water models (integrated hydrological models) are or have been used to project the climate change impacts on water quantity and quality in selected study areas. The applications in these case studies include an assessment of issues related to changes in water tables and flow systems, climate proofing of technical infrastructure such as roads and railroads, effects of changing irrigation needs, changes in runoff, coastal and hinterland flooding risks, increasing water and contaminant discharge to sewers and ecosystems, and increasing pressures on the quantitative and chemical status of groundwater bodies, and hence the ecological status of dependent terrestrial and aquatic ecosystems.

For more information about the project, please visit our website: www.cliwat.eu

We hope you enjoy reading this issue.

Klaus Hinsby
GEUS
khi@geus.dk

Table of Contents

Articles

Assessment of groundwater protection	p. 1
Irrigation demands and low flow in streams	p. 3
Integrated assessment of flooding risks	p. 4
Mapping the Eskelund landfill	p. 5
Highway climate proofing	p. 6
BaltCICA	p. 7
HYACINTS	p. 7

Meetings

CLIWAT Partner Meeting in Ghent	p. 8
CLIWAT Transnational Board Meeting in Ghent	p. 8
CLIWAT workshop in Hannover	p. 9
WaterCAP	p. 10
International BaltCICA conference	p. 10
HydroEco conference in Vienna	p. 11
Workshop on groundwater and climate change	p. 11



About CLIWAT: Adaptive and sustainable water management and protection of society and nature in an extreme climate

The CLIWAT project focuses on the effects of climate change on groundwater systems. CLIWAT is identifying the challenges caused by higher water levels, and developing climate scenarios focusing on surface water and water supply as well as the impacts on the built environment. The changes to groundwater quality caused by salinisation, outwash from point sources and new demands for irrigation are some of the issues that are being in-

vestigated. This applied research will enable the North Sea Region to respond more efficiently to the consequences of climate change. The project is building on and improving existing geophysical and geochemical methods; these are being tested in the partner regions in order to develop groundwater models and recommendations for the North Sea Region on how to address the consequences of rising groundwater levels.

(Continued from p.1)

Evaluation of wellhead protection zones/capture zones in a future climate scenario

The simulation of particle tracking enables an evaluation of areas with major groundwater recharge to the well fields in the area.

Preliminary results of capture zones and travel times associated with a future climate scenario (A2, 2071-2100) are shown in Figure 2 for the eight well fields that are included in the analysis as part of CLIWAT.

Capture zones: The results show that groundwater capture zones in the area are highly complex and capture zones are mutually interdependent due to the intense abstraction from the “dominating” Højballegaard well field (shown in green colors). Gedved (blue), Hovedgaard (light blue) and Tebstrup (brown) well field capture zones are semi-dependent on abstraction from Højballegaard well field.

Recharge areas: It is important to protect the most vulnerable recharge areas. Many areas have travel times from infiltration in groundwater to arrival at wells below 40 years.

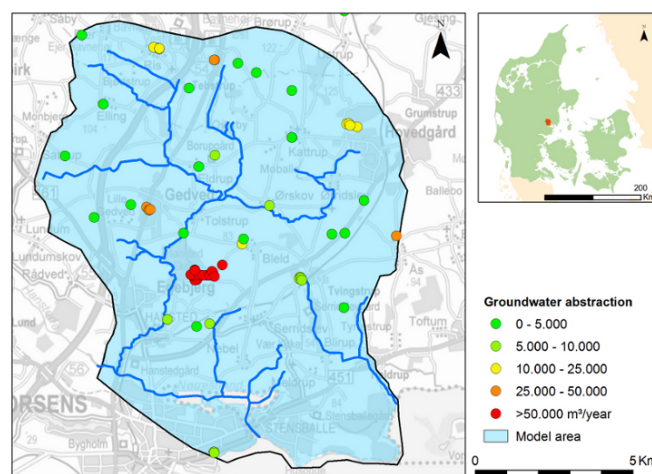


Figure 1: Model area for the Egebjerg model with the abstraction wells. Eight waterworks are included in the analysis with a total abstraction of 3.5 mil. m³/year, of which the Højballegaard waterworks (red dots) dominates with its 3.0 mil. m³/year.

Climate change impacts on groundwater level

In Figure 3, results of the change in mean groundwater level in an A2 climate scenario are shown. In large parts of the area the groundwater level is expected to increase due to the increase in precipitation.

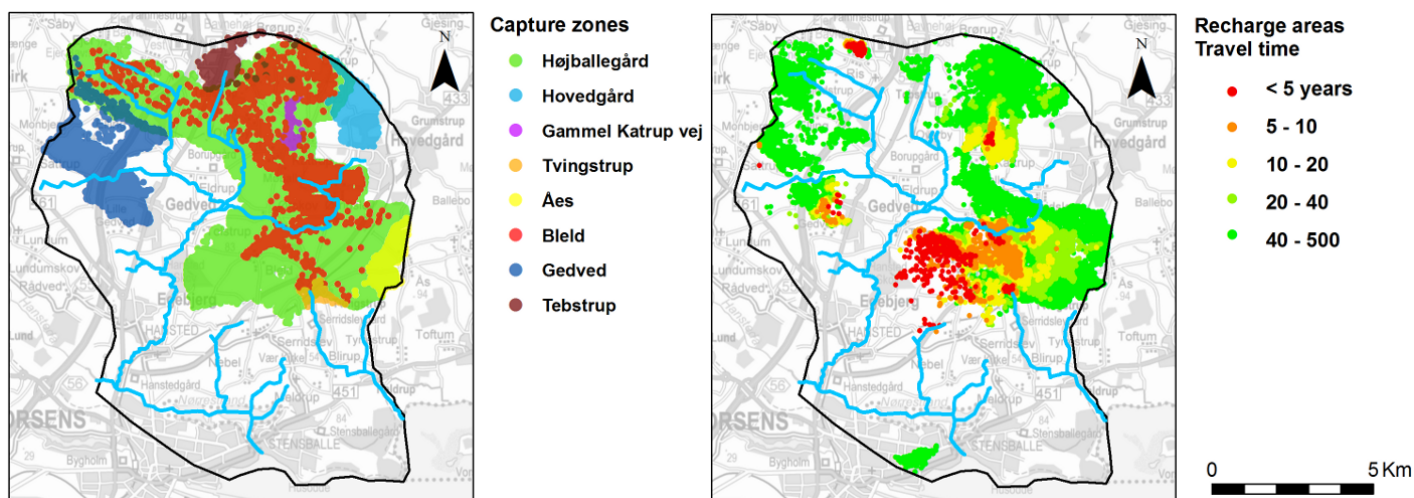


Figure 2: Top: Capture zones for eight well fields for future climate scenario (A2). Bottom: Travel times in years from recharge to arrival in wells.

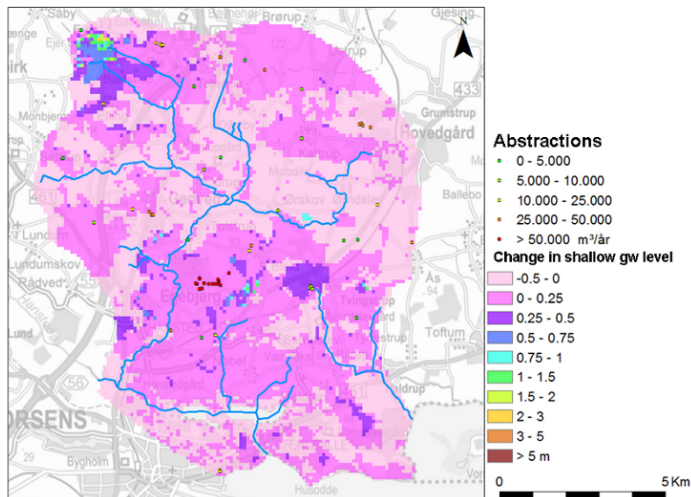


Figure 3: Change in groundwater level for a future climate scenario in meters (preliminary results)

Hans Jørgen Henriksen
GEUS
hjh@geus.dk

Lars Trolborg
GEUS
ltr@geus.dk

Torben O. Sonnenborg
GEUS
tso@geus.dk

Impact of climate change on irrigation demands and low flow in streams – the Vidaa catchment, Pilot Area E by Britt S.B. Christensen & Torben O. Sonnenborg

In the summer period precipitation is projected to decrease and temperatures to increase. This is expected to result in increasing demands for irrigation in the future. Other factors might also affect irrigation demand. The growing season may be longer and land use may change (e.g. changes in crop choice). Additionally, increasing atmospheric CO₂-concentrations may result in decreasing transpiration resulting in lower irrigation demands. The study in the Vidaa catchment in Denmark is quantifying the impact of climate change on the future demand for irrigation and the resulting effects on low flow in streams.

Hydrological model setup

Using an integrated and distributed hydrological model that describes the entire land phase of the hydrological system including the root zone, the saturated zone and the river system, the effects of changes in climatic variables such as precipitation, temperature and potential evapotranspiration are investigated. The study is carried out in the Danish part of the Vidaa catchment in Southern Jutland, Denmark. The area is characterized by sandy soils and dependence on groundwater for irrigation is presently very intensive (see Figure 1) which affects the minimum discharge in the streams. Low flow levels are expected to be sensitive to future climate changes in part due to decreasing summer precipitation, and in part because of increasing groundwater abstraction for irrigation resulting in decreasing base flow into streams. A distributed description of present land use is included in the model and the irrigation demand is described as a function of the water content in the root zone. Data that has been downscaled from a regional climate model are used for simulation of future conditions. The effect of using alternative land use scenarios,

for example changes in crop type and thereby growing season, as well as the effect of changes in CO₂-concentration on transpiration is being investigated. The effects on irrigation demands and impact on low flow in streams for the different scenarios will be generated. Finally, the potential for maintaining current agricultural management practice in the future will be assessed.

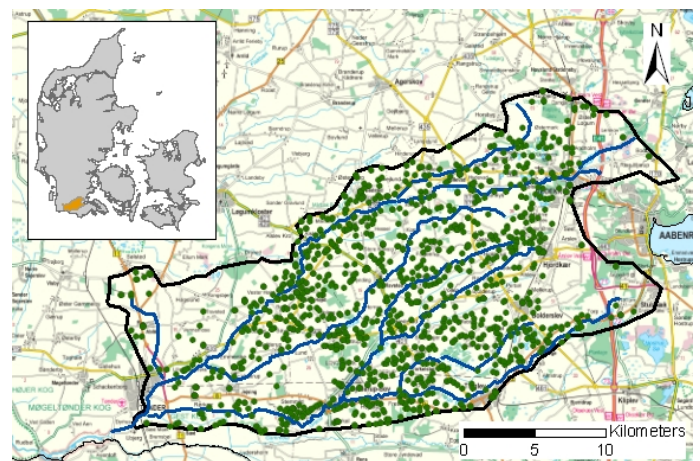


Figure 1: Location of model domain (upper left) and distribution of streams and irrigation wells within the catchment

Britt S.B. Christensen
GEUS
bc@geus.dk

Torben O. Sonnenborg
GEUS
tso@geus.dk

Integrated assessment of flooding and inundation risks in coastal areas

by Torben O. Sonnenborg & Hans Jørgen Henriksen

In Scandinavia, future climate changes are expected to result in increasing precipitation and sea level. This may result in increased groundwater levels that can cause inundation problems and flooding from rivers. In addition, coastal areas are threatened by flooding from the sea. The focus of the Horsens project is on the interaction between the sea, groundwater and rivers for the Horsens Fjord catchment in Denmark.

Evaluation of climate change impacts at different scales

The city of Horsens is located at the upstream end of a fjord on the east coast of Jutland, Denmark (see Figure 2). The surface elevation of large parts of the city is below 2.5 m above the present sea level and the groundwater is at a shallow depth. A relatively large stream, Bygholm stream, discharges through the centre of the city. Hence, the city is expected to be highly vulnerable to the effects of increasing precipitation and rising sea level.



Figure 1: Houses threatened by flooding near Horsens
(©Torben O. Sonnenborg)

To examine the risk of inundation and/or flooding of the city, a modelling approach comprising a large scale hydrological model covering the entire catchment of Horsens Fjord together with a small scale hydrological model encompassing only the area near the city have been developed.

The large scale model provides the boundary conditions for the small scale model. The small scale model has been designed to obtain a better resolution of the city for a more precise determination of water levels and flooding risk. Both models are constructed using the MIKE SHE modelling system which includes the unsaturated zone, groundwater, and surface waters.

The large scale model has been calibrated and used to evaluate the impacts of climate change. In Figure 3, the expected increase in groundwater level is illustrated for an A2 climate scenario representing the period 2071-2100. Sea level changes are not included in the simulation. Both increasing and decreasing groundwater levels are found as a result of

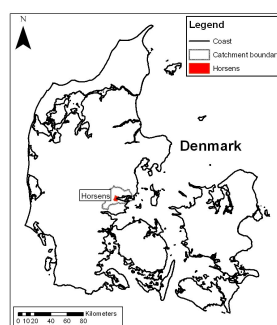


Figure 2: Location of the city of Horsens at the east coast of Jutland

the scenario. However, increasing groundwater levels of up to 1.5 m are found especially in the northern part of the model area. This indicates that changes in climate (precipitation, temperature and evapotranspiration) alone have a significant impact on the groundwater in the area.

The next step in the modelling process is to complete the local scale model and to link it to the large scale model. The local scale model includes a more precise description of the streams

and the structures in the streams (including sluices), a new geological model of the urban area in which anthropogenic structures are represented, and sea level rise.

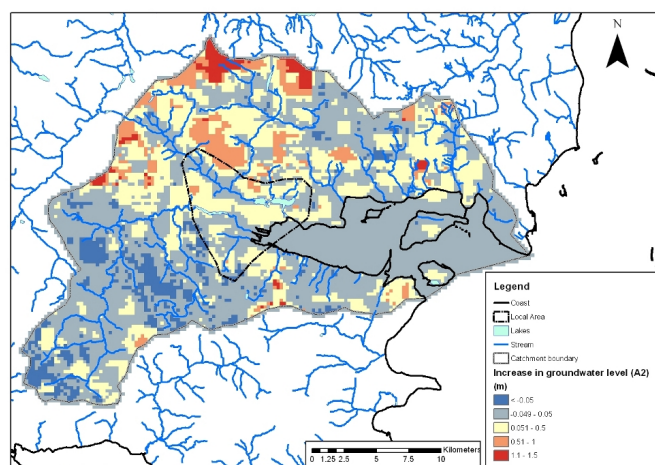


Figure 3: Impact of climate change on groundwater levels in the catchment of Horsens Fjord. The A2 scenario representing 2071-2100 is used.

It is expected that the results of this model will give a realistic representation of the risk of flooding in the city and the associated risks of pollutant leaching from deposits in the urban area. Results from the climate scenario simulations in the regional scale model will also be used for assessment of future groundwater threshold values, as well as the chemical composition and quantitative data concerning groundwater quality and quantity in a changing climate in the CLIWAT project.

Torben O. Sonnenborg
GEUS
tso@geus.dk

Hans Jørgen Henriksen
GEUS
hjh@geus.dk

Mapping the Eskelund landfill using time-domain spectral induced polarization data

by Aurélie Gazoty, Gianluca Fiandaca, Jesper Pedersen, Esben Auken & Anders Vest Christiansen

Between November 2009 and July 2010, researchers from the HydroGeophysics Group, Aarhus University, carried out a survey in the former municipal landfill, Eskelund (Denmark). Induced polarization measurements (IP) and electrical resistivity tomography (ERT) were used to define the spatial boundaries of the dump site. The joint application of these two methods may allow the discrimination between materials displaying an identical signature in resistivity (e.g., brine and clay).

Introduction

Landfills represent the primary choice for municipal solid waste disposal in many parts of the world, as landfilling is seen as an easy and low-cost waste management option. Even though waste management policies have considerably evolved in the last decades the reliance on landfills and the type of waste buried still vary from one country to another. Many landfills operational between 1950 and 1980 were designed without any kind of underlying capture system, leading to percolation of pollutants through the waste and into the underlying geological layers and aquifer systems. For large areas, it is very expensive to obtain information on the landfill delineation using only drillings. Thus, the introduction of a fast, cheap and non-destructive mapping technique allowing coverage of the entire area of interest would be a significant benefit. Although the mapping of the waste body is a target itself (for instance for the recognition and delineation of buried and forgotten landfills), it is also highly useful to assess the cover layer and the layers below the waste in order to assess and identify potential pollution threats.

The area of interest

The area of interest is a former landfill active from 1950 to 1980. It is located in the vicinity of Aarhus, Denmark, and belongs to a complex of four landfills, covering an area of approximately 150000 m². The site was established in the meadows adjacent to Aarhus River and was moved several times to the north allowing more space for the waste deposits. The landfill has been uncontrolled, and was established without any kind of membranes, leachate capture or isolation systems. The waste mainly consists of domestic waste, but also industrial waste including oils and chemical waste. The nature of the waste can be significantly different from one location to another within the landfill, as deposits were first stored according to their content, and incinerated afterwards in some places. Because of the excessive volume of waste, the landfill partially collapsed, causing a flat area. Numerous geochemical surveys and underground water samples reveal contamination resulting from water seepage through the landfill. The contamination levels vary according to the location, probably because of differences in the waste content.

Use of the landfill mapping in the CLIWAT project

As a result of predicted climate changes it is believed that the groundwater fluctuations will become more extreme in the years to come, resulting in increased risks of leaching due to the physical and chemical environments. In winter there will likely be increased precipitation and therefore increased risk of leaching of contaminants, which will increase the risk of outwash of chemical compounds from the landfill to the groundwater and the nearby Aarhus River.

How the Eskelund area will be affected by changes in climate is still poorly understood, and a mapping of the landfill and surroundings will thus help to understand the possible risk to ground and surface water associated with climate change.

Using dense coverage of TDIP sections over the area, this study will delineate the waste body, providing evidence, for the very first time, of the 3-D volume of the in-fill materials, and knowledge concerning the overall geological setting. By correlating ground-based measurements and in-situ IP/DC measurements from an el-log, the researchers intend to improve the spatial characterisation of the waste body by producing 3-D chargeability maps and comparing the results with a large number of existing drillings.

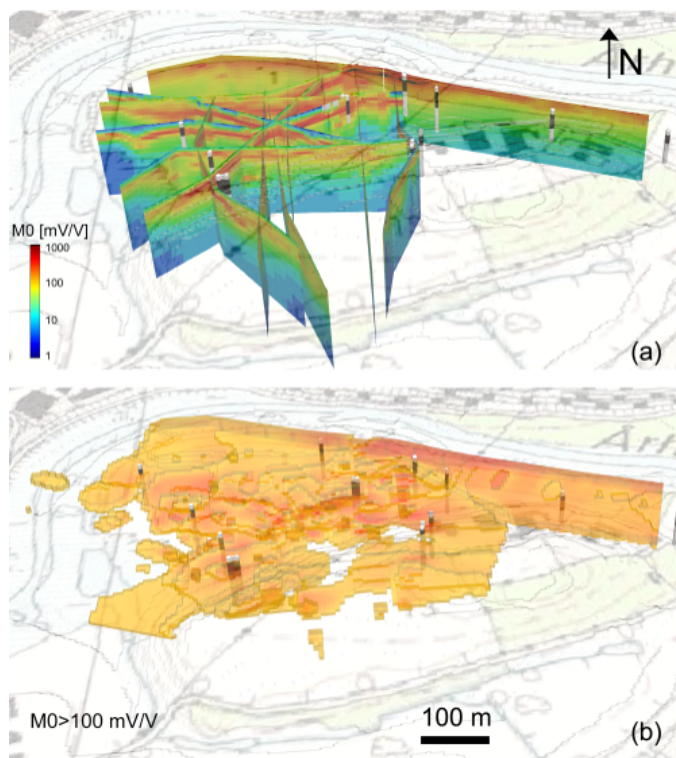


Figure 1: 3-D characterisation of the landfill area. a) Gathered 2-D sections with boreholes. The black layer in the boreholes represents the waste location. b) Isosurface in chargeability displaying the 3-D waste body.

Results

Within the landfill, the sections clearly show a chargeable unit of several hundred milli-volts per volt (mV/V), which is consistent with the waste layer identified in the boreholes, matching both the thickness and the depth. The waste layer is characterised by a high-chargeability signal in the range of 200 mV/V, depending on the location in the sections. The presence of the waste and its thickness is identified by all induced polarization sections and matches the borehole information almost exactly wherever present.

The delineation of the landfill was successfully achieved and based on these results, it is now possible to give an estimate of the waste volume and provide reliable information as input for hydrogeological models.

Aur lie Gazoty

Aarhus University, HydroGeophysics Group
aurelie.legaz@geo.au.dk

Gianluca Fiandaca

Aarhus University, HydroGeophysics Group; University of Palermo
gianluca.fiandaca@geo.au.dk

Jesper Pedersen

Aarhus University, HydroGeophysics Group
jesper.bjergsted@geo.au.dk

Esben Auken

Aarhus University, HydroGeophysics Group
esben.auken@geo.au.dk

Anders Vest Christiansen

Aarhus University, HydroGeophysics Group; GEUS
anders.vest@geo.au.dk

Climate proofing of new highway constructions by Lars Trolborg

The Danish Road Directorate (DRD) is currently planning a new highway across central Jutland. GEUS is conducting a study assisting the DRD to ensure climate-proof highway installations.

The study evaluates how climate change affects water table conditions during the coming 100 years using research based on integrated hydrological modelling.

The climate change effects on the average depth to water tables, as well as location, duration and frequency of water table extremes are of great importance for the technical installations and planning of the highway transect. A nested modelling approach captures and transfers catchment scale water balance changes to a fine grid model of critical highway sections. Simulated changes in groundwater level have great temporal and spatial variations from centimeters to almost one meter for the only 2 km long critical highway section. Construction of the highway starts in 2013 and it will be open for traffic in 2016.

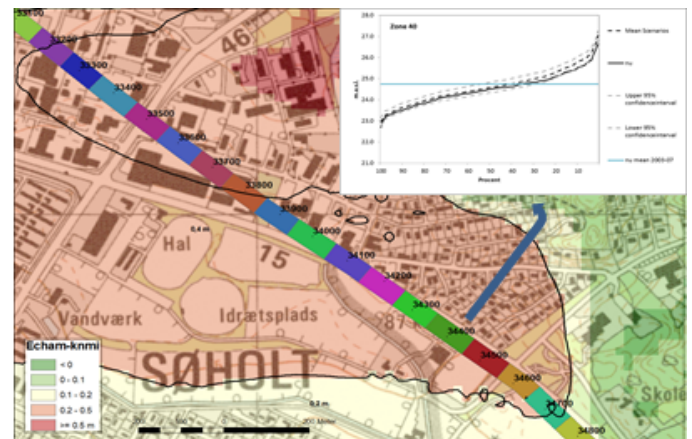


Figure 2: Water table changes for a planned highway transect through Silkeborg town

Lars Trolborg

GEUS
ltr@geus.dk

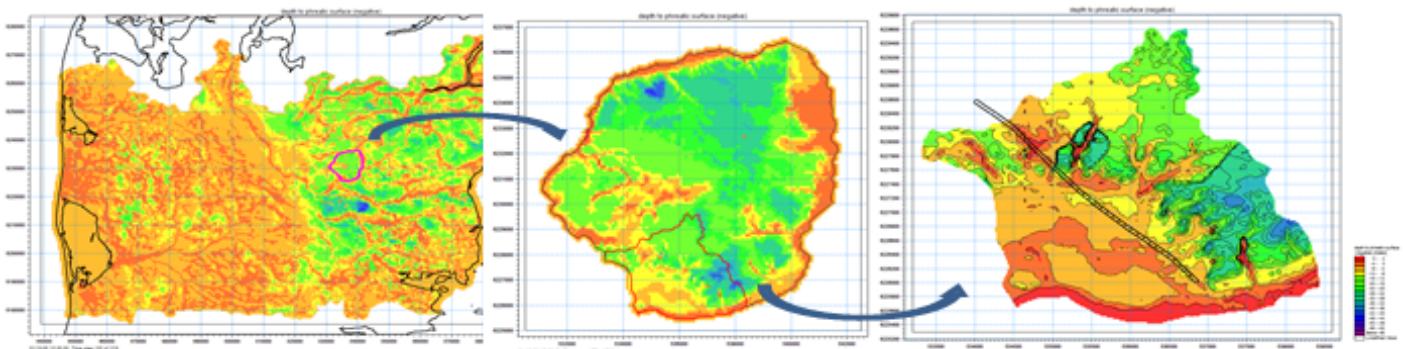


Figure 1: Nested modelling approach of water fluxes and water tables

Simulating climate change impacts on water quantity and quality in the Kalundborg Area

by Klaus Hinsby & Torben O. Sonnenborg

Project: BaltCICA (Climate Change: Impacts, costs and adaptation in the Baltic Sea Region) www.baltcica.org

Funding: The Baltic Sea Region programme 2007-2013 and GEUS



Figure 1: Logo of the BaltCICA project

The BaltCICA project examines the impacts and costs associated with climate change on ground and surface water in the Baltic Sea region, and proposes measures for adaptation to these changes. The specific objective of this study was to quantify how projected climate change and water abstraction from groundwater and surface water affect the hydrological cycle and water balance of a coastal catchment. Furthermore, the project evaluates how climate change may affect the quantitative, chemical and ecological status of groundwater and surface water with respect to EU legislation and directives. The model that was developed for this was driven by dynamically downscaled GCM results for a future climate scenario. The study demonstrates that such an approach is important for the assessment of climate change impacts on water quantity and quality and dependent ecosystems. Furthermore, the results of the study have identified, for example:

1. the location of areas with increased flooding risks
2. that a lake in the catchment (Lake Tissø) serves as a reservoir for increased winter precipitation indicating that water abstraction can continue from the lake also during dry summers

3. that there is a risk of salt water intrusion via streams into the lake with increasing sea levels

4. that nutrient loadings to water in the catchment will probably increase and hence that groundwater threshold values for nitrogen, which have to be established to protect aquatic ecosystems according to EU directives, will have to be lowered in the future due to increasing temperatures and runoff.

The study is described in a scientific article submitted to the international journal, "Climatic Change" (Sonnenborg et al., 2011), which after minor revisions was recently "resubmitted" to the journal.

References

Sonnenborg, T.O., Hinsby, K., van Roosmalen, L. and Stisen, S. 2011. Assessment of climate change impacts on the quantity and quality of a coastal catchment using a coupled groundwater-surface water model. Climatic Change. Revision submitted.

Klaus Hinsby
GEUS
khi@geus.dk

Torben O. Sonnenborg
GEUS
tso@geus.dk

Hydrological modelling for assessing climate change impacts at different scales

by Jens Christian Refsgaard

Project: HYACINTS www.hyacints.dk

Funding: The Danish Strategic Research Council

The HYACINTS project uses hydrological modelling for the assessment of climate change impacts on water resources at various scales in Denmark.

The main objectives are:

- To make a full dynamic coupling of a climate model code (HIRHAM) and a distributed physically-based hydrological model code (MIKE SHE).

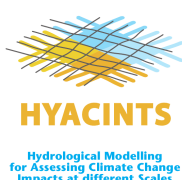


Figure 1: Logo of the HYACINTS project

➤ To establish a coupled climate-hydrological model for the entire country of Denmark based on the regional climate model, HIRHAM and the MIKE SHE-based national hydrological model (DK-model), and to assess hydrological change at the local scale for selected cases.

➤ To assess the uncertainties related to prediction of climate change effects on water resources at the local scale, including all sources of uncertainty (i.e., climate scenarios, model structure, geological interpretations, model parameters and adaptation strategies).

The Danish hydrological regime is groundwater dominated. Traditional regional climate models do not include groundwater descriptions and cannot handle lateral subsurface flows that will affect the water availability for evapotranspiration and

hence the water and energy feedback from the land surface to the atmosphere. The results from the coupled climate-hydrological model will be compared to a traditional regional climate model to assess the importance of including an improved feedback from the land surface to the atmosphere in a groundwater dominated hydrological regime as the Danish.

Furthermore HYACINTS will evaluate the relative importance of the various sources of uncertainty for climate change impact assessments on groundwater.

Jens Christian Refsgaard
GEUS
jcr@geus.dk

Fifth CLIWAT partner meeting in Ghent, December 1st and 2nd, 2010 by Rolf Johnsen

The CLIWAT group gathered in Ghent to discuss the output of the project to date. The partner meeting was hosted by Ghent University in the historical building "Het Pand", a former monastery and hospital.

The presentations from the seven pilot areas showed interesting results, for example, from the groundwater models. At the meeting, the partners agreed to develop a scientific journal special issue on the CLIWAT results. This will broaden the audience and give added value from the project. The content of the handbook on Climate and Water was also discussed. The target group of the handbook includes technical decision makers, planners, engineers, policy makers, authorities and employees in the water sector.

The slide presentations and the minutes can be downloaded from the CLIWAT website: www.cliwat.eu



Figure 1: Partners at "Het Pand"

Rolf Johnsen
Region Midtjylland
rolf.johnsen@ru.rm.dk

Second transnational board meeting in Ghent, December 3rd, 2010 by Caroline van Bers

The second transnational board (TNB) meeting involving representatives of all national boards was held in December 2010 in Ghent just after the fifth partner meeting.

The national board representatives that comprise the TNB were presented with the initial CLIWAT project results from the pilot areas. As a follow up to this, the board members identified ways in which integration is taking place in these case study areas and the project as a whole. They pointed to the integration of ground and surface water management, which it is hoped will help protect against sea level rise and provide storage for freshwater through deep drainage. Members also identified the integrated planning of irrigation and groundwater protection. The group then considered barriers to integrated thinking, and pointed to a lack of exchange of ideas across national and regional boundaries, economic competition between farmers in the various countries, and the conflict between farming and environmental management of aquifers. Uncertainty is certainly a barrier to action for all four CLIWAT countries involved, and keeps us from moving beyond an assessment of impacts.

Finally, the board discussed the transferability of approaches and results from the CLIWAT project. Research on salin-

isation in coastal low-lying areas could also be transferred from the North Sea region to the Baltic Sea region. Furthermore, there is much potential for the transfer of modelling approaches across boundaries, and for carrying out transboundary modelling. Emphasis was placed on the value of an ecosystem, rather than a jurisdictional focus for water resources research and management. The Geographical Inter-calibration Groups were identified as an important means for facilitating comparable ecological regions (in groundwater).

Generally, the board members stressed a need to strengthen the research and management link between salt and groundwater, and for better recognition of the influence of groundwater on habitat protection. Furthermore, land use needs to be incorporated in hydrological modelling, where this is not already happening.

Finally, the TNB recommended that project's results be communicated with transparency to three major sectors: nature protection, agriculture and urban planning.

Caroline van Bers
seeconsult GmbH
cvanbers@seeconsult.org

CLIWAT workshop in Hannover, June 22nd and 23rd, 2011

by Helga Wiederhold & Bernhard Siemon

During the first days of summer, the CLIWAT partners met for a workshop with 37 participants at GEOZENTRUM in Hannover.

This second CLIWAT workshop was possible as a result of a project timeline extension of six months that has been formally confirmed by the North Sea Region Programme Secretariat. Another positive message from the Secretariat has been the approval of the cluster project, WaterCAP, that brings together five Interreg projects and 14 partners to raise awareness of the wealth of knowledge these single projects are generating about climate change impact on the hydrological cycle, and to better communicate the results at the policy level.

The discussion of the results of the seven CLIWAT pilot areas focused on the handbook on adaptation that will be a central output of the CLIWAT project. Furthermore, the group examined how management of water resources in polder areas and on islands, promising new research methods for climate-related water issues, and stakeholder involvement could be illustrated in the handbook.

As scientific output of the project, more than 20 manuscripts have been announced for a special issue of Hydrology and Earth System Sciences (HESS), an interactive open access journal of the European Geosciences Union. The content and

interpretation of scientific findings were discussed intensively in small transnational working groups. The final results of the project will be presented at the final CLIWAT conference that takes place in January 2012 in Aarhus, Denmark.



Figure 1: Participants of the second CLIWAT workshop at GEOZENTRUM Hannover (@Helga Wiederhold)

Helga Wiederhold

Leibniz-Institut für Angewandte Geophysik (LIAG)
Helga.wiederhold@liag-hannover.de

Bernhard Siemon

Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)
Bernhard.siemon@bgr.de

CLIWAT news

Final CLIWAT Conference - January 2012

In January 2012, CLIWAT will hold its final conference in Aarhus, Denmark. This two-day event will present the final results of the project and examine future challenges for assessing and managing the impacts of climate change on water resources in coastal regions. For practitioners, there will be special sessions focusing on management issues including groundwater modelling as a management tool and involving stakeholders in groundwater research and management. For the scientific community, a special session on technical studies will focus on issues of saltwater intrusion, groundwater quantity and quality, and groundwater modelling techniques. There will also be a session on what has been learned in the project and how this can be communicated for awareness-raising and influencing policy. Poster sessions will be present the results of the project as well as from related initiatives. Specific dates will be announced in this summer. For more information, contact **Rolf Johnsen**, Rolf.Johnsen@ru.rm.dk.

Special issue for the Hydrology and Earth System Sciences journal

The scientific journal "Hydrology and Earth Systems Sciences" (HESS) has enthusiastically approved publication of a special issue, "Assessing the impact of climate change for adaptive water management in coastal regions". Focussing on the main research findings of the CLIWAT project, this issue will describe development and application of innovative new tools for mapping the subsurface and simulation of future changes to coastal hydrological systems based on various climate scenarios and models. The papers included in the special issue will describe and demonstrate the methods applied and indicate where improvement and innovative solutions are required. The final goal is to develop a toolbox that is effective for assessing current and future groundwater status and climate change impacts on water resources quantity and quality in coastal regions. The toolbox will include 1) tools for geological, geophysical and geochemical mapping and characterisation of the subsurface including the distribution of freshwater and saltwater and 2) modelling tools for assessing climate change impact on groundwater and surface water chemical and quantitative status. For more information, contact **Klaus Hinsby**, khi@geus.dk.

WaterCAP - a cluster project on Water Management in a Changing Climate

by Antonia Ortmann

Together with other five Interreg IV B funded projects, the results of the CLIWAT project will be clustered in the new Interreg IV B funded project "WaterCAP".

All six projects - CPA, DiPol, Aquarius, SAWA, C2C-islands and CLIWAT - focus on climate change-affected water resources. The increase in temperatures and precipitation predicted by climate change models for Northern Europe will lead to a spatial and temporal change in water quality, and an increased frequency of drought and flood events. Furthermore, sea level rise increases the risk of coastal flooding. Therefore, an adaptation strategy that breaks through institutional and regulatory barriers is needed.

The aim of the cluster project is to add value to the existing projects through sharing and communicating knowledge on adaptation to the effects of climate change on the hydrological cycle in the North Sea Region, using findings, tools and recommendations of the various projects. By matching the project findings to EU, national and regional policies, specific feedback can be provided to the EU policy level in order to "climate proof" future and present initiatives, such as the Water Framework Directive.

Antonia Ortmann

seeconsult GmbH

aortmann@seeconsult.org

Second international BaltCICA conference "Coping with Climate Change" in Bergen, May 11th to 12th, 2011

by Klaus Hinsby

The second international BaltCICA conference "Coping with Climate Change" was held in co-operation between the Baltic Sea Region Project "BaltCICA" (www.baltcica.org) and the North Sea Region Project "MARE" (www.mare-project.eu) in Bergen.

The conference focused on three particular challenges:

- Tools and methods for designing and implementing climate change adaptation measures,
- Strategies for participation and stakeholder involvement in climate change adaptation processes and
- Coordination of adaptive action in metropolitan areas and city regions.

Examples of the coordination of adaptive action in metropolitan areas and city regions were presented for the host city Bergen (Norway), Helsinki (Finland), Rotterdam and Dordrecht (Netherlands), Hamburg and Hannover (Germany), Kalundborg (Denmark) and Klaipeda (Lithuania).

The conference programme and selected presentations can be found at: www.baltcica.org/meetings/conference11.html.

"Politicians and practitioners presented inspiring examples of strategic approaches to climate change adaptation and implementation processes for adaptation measures. A number of questions were raised in presentations on governance (who, what and how), which stressed adaptation as a challenge calling for multilevel approaches and mixed instruments (regulatory and

formal). It was emphasized that imbedded in strategies and policy documents, adaptation to climate change need to be taken into account in all sectors, at all levels.

The responsibility of developed countries was stressed in helping other countries that are exposed to impacts of climate change already today or in the near future. Being able to tackle the risk associated with climate change was presented as a challenge for insurance companies and calls for adjustments not only in society but also in the insurance system."

(www.baltcica.org/meetings/conference11.html)

The CLIWAT partner, GEUS, is involved in the BaltCICA project with two cases studies: the Kalundborg Municipality area and the island Falster. In the Kalundborg case study GEUS applied a coupled groundwater-surface water model to assess climate change impacts on water quantity and quality in a coastal catchment. A short description of the work conducted by GEUS in this case study is provided on page 7. The second case study is conducted in the southern part of the Island of Falster where salt water intrusion is currently threatening water supply from a coastal aquifer around the summer vacation area of Marielyst. In this case study GEUS evaluates the possibility of continued water abstraction from the aquifer based on simulations of the impacts of projected climate change to the groundwater quantity and quality.

Klaus Hinsby

GEUS

khi@geus.dk

CLIWAT case study results presented and commended at the HydroEco conference in Vienna, May 2nd to 5th, 2011 by Klaus Hinsby

A presentation of a CLIWAT case study “Derivation of groundwater and stream threshold values for nitrogen and phosphorus to ensure good ecological status of the Horsens Estuary, Denmark” was commended at the HydroEco conference in Vienna in May 2011.

The presentation was given in a session on the implementation of the Water Framework Directive and was recognised as an excellent and useful contribution to the implementation of the Water Framework Directive. The Water Framework and Groundwater directives stipulate that all EU member states have to establish groundwater threshold values to ensure good ecological status of dependent terrestrial and associated aquatic ecosystems. However, most member states have just reported drinking water standards for the various relevant parameters as they felt data and knowledge generally were too scarce to derive groundwater threshold values for specific ecosystems. Drinking water standards are often far too high for the protection of ecosystems (e.g. in the case of nitrate), and therefore groundwater threshold values derived for protection of specific ecosystems are urgently needed.

The CLIWAT case study from Horsens was presented by Klaus Hinsby of GEUS, and prepared in collaboration with marine and freshwater ecologists from the Danish National Environmental Research Institute, University of Aarhus, based on work described in a recently submitted article to the Water Resources Research journal (Hinsby et al., Water Resources Research, submitted). The work conducted demon-

strates that groundwater threshold values considerably below those of drinking water standards (e.g., for nitrate) have to be used in order to ensure a good ecological status of the Horsens Estuary.

On-going work is currently evaluating the effects of climate change on groundwater threshold values. Although many uncertainties exist in the evolution of climate and land use in the future, data indicate that groundwater threshold values for nitrate have to be reduced even further compared to present day values due to a projected increase in runoff and nitrogen loads in Denmark and an increased sensitivity to nutrients of aquatic ecosystems at higher temperatures. The use of coupled groundwater and surface water models are essential in the assessment of climate change impact on future groundwater tables, runoff and (for example) nutrient loadings to aquatic ecosystems.

References

Hinsby, K., Markager, S., Kronvang, B., Windolf, J. and L. Thorling (2011), Groundwater and stream threshold values and management options for nitrogen and phosphorus to ensure good ecological status of Horsens Estuary, Denmark. Water Resources Research, submitted.

Klaus Hinsby
GEUS
khi@geus.dk

Workshop on groundwater and climate change at the 21st EU Working Group C Groundwater Plenary Meeting, October 12th, 2011 by Klaus Hinsby

The European Commission White Paper (2009) “Adapting to climate change: towards a European framework for action” calls for promotion of strategies which increase the resilience to climate change, and points to a need for guidance to ensure “climate proofing” of River Basin Management Plans by 2015.

In order to facilitate the process and ensure progress the Water Resources Expert Group (WREG) of the Eurogeosurveys (www.eurogeosurveys.org), which is chaired by Hans Peter Broers (TNO/Deltares), has taken the initiative to establish an ad-hoc activity in the Working Group C Groundwater in the EU common implementation strategy for the Water Framework Directive, and to identify knowledge gaps and future research needs necessary for the development of climate proof river basin management plans. In order to bridge Climate Change science and policy a small working group (Hans Peter Broers (WREG, TNO, Netherlands), Balazs Horvath (European Commission, DG Environment, Bel-

gium), Klaus Hinsby (WREG, GEUS, IAHS/IAHS, Denmark), Elisabetta Preziosi (IRSA, Italy) and Ronald Kozel (BAFU, Switzerland)) are organising the one-day workshop so that policy issues and needs of EU member states are presented and discussed during the morning session, while research progress and needs as well as on-going case studies are presented and discussed during the afternoon session. The case studies will seek to demonstrate the various challenges in the different parts of Europe such as the Mediterranean area, central Europe, and the North and Baltic Sea regions. The afternoon session will be a good opportunity to present the objectives and results of the CLIWAT project for policy makers and researches across Europe, and such a presentation is currently planned in the tentative workshop programme.

Klaus Hinsby
GEUS
khi@geus.dk

Schedule of events

Events				
Date	Event	Content	Location	Link
January 2012	CLIWAT	Final conference of the project	Århus University, Denmark	www.cliwat.eu
October 2011	WaterCAP	Kick-off Meeting	to be announced	
25 – 26/10/2011	Kliwas-Statuskonferenz	Auswirkungen des Klimawandels auf Wasserstraßen und Schifffahrt in Deutschland	Berlin, Germany	www.kliwas.de
12 – 13/10/2011	IWRM	Management of Water in a Changing World: Innovations and Integration of Science and Technology	Dresden, Germany	http://www.bmbf.iwrm2011.de/index.php
12/10/2011	EU Working Group C Groundwater Plenary Meeting	Workshop on groundwater and climate change organised by the Water Resources Expert Group of the Eurogeosurveys	Warsaw, Poland	
29 – 30/09/2011	2 nd “Water Science meets Policy” event	Ecosystem Services	Brussels, Belgium	http://www.onema.fr/IMG/EV/cat1a-14.html
25 – 29/09/2011	14 th World Water Congress	Adaptive Water Management: Looking to the Future	Recife, Brasil	www.worldwatercongress.com
21 – 23/09/2011	UFRIM International Symposium	Urban Flood Risk Management	Graz, Austria	http://www.sufri.tugraz.at/en/ufrim-home.html
15 – 16/09/2011	ETC Joint Conference	The Benefits of Transnational Cooperation	Katowice, Poland	http://www.northsearegion.eu/ivb/events/show/&tid=66
08 – 09/09/2011	International Workshop	Governance of climate-related risks in Europe: the need for policy oriented research	Brussels, Belgium	
21 – 27/08/2011	World Water Week	Responding to Global Changes - Water in an Urbanising World	Stockholm, Sweden	www.worldwaterweek.org
20 – 22/07/2011	Summer School	Adaptation to Climate Change: An essential part of the Climate Change Policy	San Sebastian, Spain	http://www.bc3research.org/summerschool2011/

The above dates and locations may change. The editors are neither responsible nor liable for any inconvenience resulting from such changes.

Imprint

CLIWATInterRegNewsletter is published on a semestral base in PDF format.

Press date for the June issue: 29st of June 2011

Publisher: **seeconsult** GmbH

Contact: info@seeconsult.org

Editors: Caroline van Bers, Antonia Ortmann and Jörg Krywkow, **seeconsult**

This newsletter is an output of the EU InterReg project CLIWAT, (Interreg IVB journal no.: 35-2-1-08). The project is partly financed by the European Regional Development Fund under the European Union.

The views expressed herein are the authors' own and do not necessarily reflect those of the either the editorial team nor of the European Commission. Neither are the editorial team and the European Commission responsible for any data and information appearing herein or any loss, damage or injury to persons or property resulting from any use of information contained in this newsletter.

Contributions: Please, contact info@seeconsult.org. The editorial team retain the right to shorten or grammatically modify authors' articles for editorial purposes. Whilst the editorial team will make all effort to reproduce the contribution faithfully, it accepts no responsibility for mistakes in the finally published text. Any corrections notices relating to the published articles can be requested by their authors and sent in writing to the contact address. The legally responsible editor is: Rolf Johnsen (Region Midtjylland).

The source code (L^AT_EX format) of this newsletter was originally developed and published by **Freies Magazin**, is modified and published under the GNU licence for open documentation (FDL), <http://www.gnu.org/copyleft/fdl.html>. For the source code, please, refer to info@seeconsult.org

If you want to print out **CLIWAT**InterRegNewsletter, please reconsider whether or not you really need a hard copy of this issue.