Seminar on Climate Change Impacts on Water Resources

23.09.2008, Geocenter Copenhagen

Abstracts

Climate models: From projections to predictions of climate change

Jens H. Christensen, Danish Climate Centre, Danish Meteorological Institute

Projections of climate change based on climate model simulations have existed for more than 20 years. By combining information from many models at a large scale, model agreements and disagreements can be interpreted in a probabilistic manner. This opens up the door for a different understanding of climate change information based on large ensembles of model simulations. The question is whether we can combine this knowledge into a comprehensive methodology that enables the definition of a quantified likelihood of change, which in fact will become a prediction and not simply a projection?

Linking climate change modelling to impacts studies: recent advances in downscaling techniques for hydrological modelling

Hayley Fowler, Reader in Climate Change Impacts, School of Civil Engineering and Geosciences, Newcastle University, UK

Although a large published literature exists on the strengths and weaknesses of downscaling methods for different climatic variables, in different regions and seasons, little attention is given to the choice of downscaling method when examining the impacts of climate change on hydrological systems. There is a need to move away from comparison studies into the provision of decision-making tools for planning and management that are robust to future uncertainties; with examination and understanding of uncertainties within the modelling system. This seminar will introduce the downscaling concept, the results from comparative studies, new downscaling methods

and how developments in climate scenario construction may offer the potential for advancement within the 'downscaling for hydrological impacts' community. In particular, the use of multi-model ensembles in a probabilistic framework will be demonstrated.

Coping with climate model biases in assessing climate change impacts to hydrology

Phil Graham, Swedish Meteorological and Hydrological Institute

- even as improvements in climate models occur, biases will remain
- impacts modellers must understand and deal with this
- current methods at SMHI have evolved into a "scaling" approach to correct for biases
- this can improve the information that we use from climate models
- some examples will be given, including the use of ensembles simulations

Refinement of dynamically downscaled climate scenarios and hydrological modelling

Stein Beldring, Norwegian Water Resources and Energy Directorate
Torill Engen-Skaugen, Norwegian Meteorological Institute

Two methods for transferring temperature and precipitation simulations from regional climate models to meteorological stations sites are compared; the delta change or perturbation method and an empirical adjustment procedure that reproduces observed monthly means and standard deviations based on daily observations from the regional climate model. The trend obtained in the regional climate model both for temperature and precipitation is maintained with the empirical adjustment procedure, and the frequencies of modelled and observed rainy days show good agreement. Thus, this method is appropriate for tailoring dynamically downscaled temperature and precipitation values for climate change impact studies. A comparison between the two methods is provided by comparing hydrological model results for several catchments.

Climate change effects on groundwater and streams in Denmark

Lieke van Roosmalen, Dept. of Geography and Geology, University of Copenhagen

A study on the effects of climate change for two geologically and climatologically different catchments in Denmark is presented. Results for the change in groundwater recharge and discharge to streams are shown, but the main focus is on the uncertainties related to these results. Quantifying the effects of climate change on hydrological systems results in a cascade of uncertainties related to for example the choice of GCM and emissions scenario, the choice of RCM and output variables, the downscaling and bias correction method applied, and the model structure and parameterization of the

hydrological model. This study does not include all these uncertainties, but sheds some light on the effect of the chosen emissions scenario on the hydrological results by comparing two scenarios. Furthermore the choice of RCM and the horizontal resolution of the RCM are examined and the application of the delta change method in different study areas is compared. This study shows the added value of studying different climate scenarios and hydrological systems, but a more extensive study is needed if all aspects of uncertainty are to be quantified.

Uncertainty on climate change effects prediction

Jørgen E. Olesen, Dept. of Agroecology and Environment, Aarhus University

The uncertainties and sources of variation in projected impacts of climate change on agriculture and terrestrial ecosystems depend not only on the emission scenarios and climate models used for projecting future climates, but also on the impact models used, and the local soil and climatic conditions of the managed or unmanaged ecosystems under study. A study under the PRUDENCE project gave the following conclusions on uncertainties in projections of climate change effects until 2100:

- For ecosystem effects the inclusion of direct CO_2 effects on plant performance makes a large difference (also for water use)
- The variation in simulated results attributed to differences in differences between climate models were in all cases smaller than the variation attributed to either emission scenarios or local conditions
- The methods used for applying the climate model outputs (downscaling) played a larger role than the choice of the GCM or RCM.
- The variation in simulated impacts was smaller between scenarios based on RCMs nested within the same GCM than between scenarios based on different GCMs or between emission scenarios.
- The thermal suitability for grain maize cultivation in Europe was estimated to expand by 30 to 50% across all SRES emissions scenarios, i.e. high certainty.
- Changing water balance dominated the projected responses of southern European ecosystems, with NPP declining or increasing only slightly relative to present-day conditions.
- Site-based, regional and continental scale models showed large spatial variations in the response of nitrate leaching from winter wheat cultivation to projected climate change due to strong interactions with soils and climate.
- The ranking of uncertainties is likely to be different for other projection timeframes (e.g. 2050)

HYACINTS – a new research project

Jens Christian Refsgaard, Geological Survey of Denmark and Greenland (GEUS)

HYdrological Modelling for **A**ssessing **C**limate Change **I**mpacts at differe**NT S**cales (**HYACINTS**) is a new research project supported by the Danish Strategic Research

Council during the period 2008-2012. It will develop new methodologies and tools to enable easier and more accurate use of regional scale climate and hydrological models to address local scale water resources problems.

A new fully dynamic coupling exploiting OpenMI technology will be established between the climate model code HIRHAM and the distributed physically based hydrological model code MIKE SHE. Based on the coupled model system, an integrated climate-hydrological model for the entire Denmark will be established by combining the regional climate model HIRHAM and the national hydrological model (DK model). As part of the coupling a statistical downscaling and bias-correction method will be developed for conversion of data from large (25 km) climate grids to small (e.g. 1 km) hydrological grids. Remote sensing data and techniques will be utilised and further developed with respect to assessing and downscaling of global precipitation datasets in mountainous areas where precipitation is controlled by orographic effects. In order to facilitate downscaling of hydrological models from regional models (e.g. the existing DK model) to local scale models with more detailed geological and topographical resolution, improved grid refinement methods based on the local model builder concept will be developed. Furthermore, improved methods will be developed for handling complex geological environments when changing model scale. The total uncertainty in hydrological change predictions taking all sources of uncertainty into account will be assessed and an improved methodology for assessing the effects of geological uncertainty will be developed.

HYACINTS has 12 partners: two universities, two research institutes, one GTS institute, one SME research and consulting company, one large consulting company, three water companies from the largest cities in Denmark and two Environment Centres.