PhD scholarships in Hydrology

Villum Kann Rasmussen's Foundation has recently provided funding for a Research Center of Excellence in Catchment Hydrology – HOBE (Hydrological Observatory and Exploratorium). The main objectives of the center are:

1. To establish a Danish hydrological observatory and exploratorium within the Skjern river catchment and carry out integrated and interdisciplinary measurements and experiments at multiple spatial and temporal scales
2. To create a high density multi-scale data set that can provide a platform for long-term innovative interdisciplinary hydrological research at the highest international level particularly with respect to development of improved process understandings, scaling theories and integrated hydrological models
3. To improve the scientific basis for better water resources management decisions and for reducing the uncertainty in water balance closure at catchment scale
4. To further strengthen the graduate education and training program within hydrology by facilitating PhD scholarships, by providing instrumented field sites for experimentation, and by providing a high quality data base for theoretical and modeling analyses

The center currently has three openings for PhD scholarships within the following subject areas:
****

1. Estimation of precipitation

Accurate measurement of precipitation in the form of rain or snow is of obvious importance for the simulation of the catchment behavior and for the water balance. Data from rain gauges are commonly used in hydrological applications, but the regionalization is complicated by the often short correlation distance of point measurements. Advantages in precision and temporal and spatial resolution can be obtained by application of radar data. Several studies have documented the potential of radar data in improving the estimation of precipitation. Radar data are contaminated by several sources of error and thus need to be corrected by comparing to rain gauge observations which also need to be corrected for systematic gauge errors due to wind effects.

A dense network of rain gauges equipped with various weather sensors will be established in a sub-catchment to provide support for converting radar data into precipitation estimates. Particular attention will be paid to the effects of vertical variations of the reflectivity profile, reflectivity enhancement due to melting of hydrometeors, clutter and anomalous propagation of the radar beam. The Skjern river catchment region is ideally situated from two radars at Rømø and Sindal (about 100 km and 150 km distances, respectively). Furthermore, the Danish Meteorological Institute will install a new radar just east of the Skjern River catchment in 2008 that will be even closer to the study area.

The impact of new precipitation schemes on the hydrological response will be analyzed using an integrated and distributed hydrological model for the catchment.

The successful candidate will be employed at the Danish Meteorological Institute and enrolled as a PhD student at the University of Copenhagen.

Further information on the scientific content of the study can be obtained from: Senior Researcher Flemming Vejen, Danish Meteorological Institute, phone +45 3915 7500, email fv@dmi.dk.

2. Estimation of evapotranspiration

Evapotranspiration is a key component of the hydrological cycle but its estimation is still subject to large uncertainties. Evapotranspiration rates vary with surface roughness and vegetation type. For estimation of catchment scale evapotranspiration it is therefore important to assess the contribution from the main surface types in the catchment. The eddy correlation technique will be applied for measuring vapor flux to the atmosphere. For this purpose three micrometeorological eddy correlation stations will be established to obtain the most accurate measure of evapotranspiration and energy balance for three sites representing the main land-use types in the catchment: agricultural field, forest, and meadow. The instrumentation will be mounted within the surface boundary layer 2 – 15 meters above the vegetation. The instrumentation at each site consists of a sonic anemometer and an open-path infrared gas sensor for fast frequency measurements of H_2O and CO_2 and based on these measurements heat and water vapor fluxes can be calculated. The eddy correlation measurements will be compared with other estimates of evapotranspiration based among other on remote sensing data. The study will also contribute to developing and testing techniques for estimating the regional evapotranspiration of the catchment using a distributed hydrological model.

The successful candidate will be employed and enrolled as a PhD student at the University of Copenhagen.

Further information on the scientific content of the study can be obtained from: Associate professor Thomas Friborg, Department of Geography and Geology, University of Copenhagen, phone: +45 3532 2574, email: tfj@geogr.ku.dk.

3. Soil moisture and groundwater recharge

Soil moisture is a key variable for the exchange of water and energy between the atmosphere and the subsurface and for groundwater recharge. The flux of water leaving the root zone can only be estimated indirectly using, among others, information on changes in moisture content. Additional information on recharge can be obtained from tracer experiments as the vertical migration of a solute front is driven by the recharge. When chloride or bromide is used as the tracer, the migration can be monitored using suction cells, soil coring, TDR probes and other dielectric techniques or geophysical methods, representing measurement scales in increasing order. The soil moisture investigations will take place at three sites representing the main land-use types in the catchment: agricultural field, forest, and meadow. While tracer techniques represent a valuable tool at many types of sites, tracer experiments may be particularly required for exploring water flows at the riparian wetland/meadow site. In riparian wetlands complex interactions between groundwater, surface water and climatic conditions exist. Recordings of water table rises are indirect measures of groundwater recharge and recent research has also documented the potential of using temperature profiles as a means for estimation of recharge.

A several meter (~7 m) deep concrete lined instrument well will be established at the agricultural site. The well will be instrumented for automatic measurements of water content (TDR probes) and temperature in the surrounding soil with a 1 m depth resolution. The instrument well will provide detailed and unique information on the percolation of water through the upper part of the unsaturated zone. At the two remaining sites (forest and wetland) equivalent TDR and temperature sensors will be installed near the surface. At these sites the maximum installation depth will be limited to app. 2 m.

At the agricultural site a large-scale lysimeter will also be established. The lysimeter will be filled with the local soil, and the vegetative cover of the tank and the immediate surroundings will be a mix of grasses cut at regular intervals to maintain green dense vegetation. The lysimeter will be equipped with a multiplexed TDR system for monitoring of the water content in the tank with high time resolution. Outflow from the lysimeter will be measured using two independent methods.

The collected data will be analyzed using numerical modeling and compared to other data on soil moisture collected by other partners in the HOBE research center. Regionalization of soil moisture to catchment scale will also be carried out using the distributed hydrological model developed for the catchment.

The successful candidate will be employed and enrolled as a PhD student at the University of Aarhus.

Further information on the scientific content of the study can be obtained from: Senior Researcher Kirsten Schelde, Department of Agroecology and Environment, University of Aarhus, phone: +45 8999 1816, email: Kirsten.Schelde@agrsci.dk.

****

Applicants are requested to submit an application that includes (1) a short description of their qualifications; (2) a curriculum vita that provides relevant academic, employment and personal details; (3) authorized transcripts of coursework and authorized copies of diplomas of university degrees all translated into English; (4) a list of reference persons; and (5) authorized evidence of English language competence.

Please note that filling of an application form is not requested.

Applicants should hold a MA degree of relevance for the research project either in science (meteorology, geography, physics, hydrology or biology), agronomy or civil/agricultural engineering. Under certain circumstances candidates may also be considered if they have completed four full years of university study.

The scholarships are open to both Danish and international applicants.

A committee will evaluate the applications and selected applicants will be invited for interviews. The final selection of the successful candidates will be made by the committee. The successful candidates are requested to apply for enrolment as a PhD student at the relevant universities.

The PhD studies are expected to start in autumn 2007.

Further information can be obtained from the contact persons of the individual projects or from the Head of the Research Center, Professor Karsten Høgh Jensen, Tel. +45 3532 2484, Fax +45 3314 8322, email khj@geol.ku.dk.

Applications in English are to be sent to Professor Karsten Høgh Jensen, Geological Institute, University of Copenhagen, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark.

Only applications in hard copy will be accepted. The original and three copies must be forwarded. Applications with insufficient documentation or applications that do not comply with the above requirements will not be considered.

The deadline for receipt of applications is September 10, 2007 at noon.

****

Research Center of Excellence in Catchment Hydrology – HOBE

There is a growing need to obtain a better scientific understanding of the hydrological processes at catchment scale in order to assess the impact of climate change and land use. Additionally, water resources management as prescribed by e.g. EU's Water Framework Directive requires that water resources management strategies must be developed at catchment scale - the natural geographical and hydrological unit - instead of according to administrative or political bounds. Several investigations have documented that our knowledge of the in- and outgoing water fluxes and the exchange of water between the different hydrological compartments at catchment scale is insufficient. Even for the two most basic hydrological fluxes, precipitation and evapotranspiration, significant uncertainties are related to their estimation at larger scale. These uncertainties have among others been reflected in problems with closure of the water balance at catchment scale. To remedy these problems various empirical correction factors have been applied to the various fluxes in order close the water budget. As a result current assessments of the available groundwater resources for water supply in Denmark are inherently uncertain because of the uncertainty in the estimates of basic hydrological variables and processes.

The proposed research center HOBE is a Danish research initiative bringing together 7 multidisciplinary research groups in order to enhance the scientific understanding of large-scale hydrological processes. We will establish a hydrological observatory and exploratorium (HOBE) in the Skjern river catchment in the western part of Denmark and bring into play integrated state-of-the-art monitoring, time-lapse measurements, experiments and modeling at a hierarchy of nested temporal and spatial scales within the 1500 km^2 catchment region. Reliable field measurements of hydrological fluxes, state variables and parameters at various spatio-temporal scales is an absolute requisite for advancing science. Integrated and spatially distributed hydrological models will be applied for a coherent analysis and interpretation of the data. Hydrological observatories have been established or are underway in other countries. To cope with the increasing pressure on the water resources in many parts of the world and to address the hydrological consequences of external stresses it is very important that such observatories are established in different hydrological regimes for long-term measurements of basic state variables and fluxes. Denmark has a unique hydrological characteristic by being all surrounded by sea, and therefore seepage of groundwater to the sea is an important element in the water balance. Furthermore, Denmark has a unique international position with respect to groundwater based water supply. Thus in addition to investigating the land surface – atmosphere exchange processes we will pay particular attention to expanding the knowledge of recharge and groundwater dynamics and how groundwater interact with surface water and sea water. We will exchange information and collaborate with similar initiatives in USA and within the EU.

The HOBE center emphasizes the educational element by educating 7 PhD students and 6 Postdocs, and we also expect that a number of MSc thesis projects can be connected to the center. Moreover, as a unique field site with an associated comprehensive data base will be established we anticipate that the center will be able to attract funding from other sources for additional PhD projects. In this regard the International Research School of Water Resources (FIVA) will play an important role.

****