International Research School of Water Resources

International PhD Course in

Assessment and Propagation of Uncertainty in Spatially Distributed Environmental Modelling.

September 8 - 11, 2009
Geocenter Copenhagen
Østervoldgade 10, DK-1350 Copenhagen K, Denmark

Lecturers
Dr. Gerard BM Heuvelink, Land Dynamics Group, Wageningen University, Netherlands
Dr. James D Brown, Hydrologic Ensemble Prediction Group, Office of Hydrologic Development, National Weather Service, NOAA, Maryland, USA
Professor Jens Christian Refsgaard, Geological Survey of Denmark and Greenland
Dr. Anker Lajer Højberg, Geological Survey of Denmark and Greenland

Background and objective

Both scientists and practitioners are continuously confronted with uncertainty as well as associated concepts such as error, risk and ignorance. Uncertainty occurs at all levels of the water management process right from uncertainty on basic data, to uncertainty on our understanding of physical and environmental processes as represented in mathematical models and to uncertainty on framing of the water management problems to be dealt with.

When spatial information is used in environmental modelling or for decision making, then the uncertainties contained in the data that are stored in the spatial information system will propagate through the models and affect decisions. It is important that users of spatial information are able to determine whether the accuracy of the information used is sufficient for the intended use. If it is not, then this may result in inaccurate model results and poor decisions. This PhD course presents theory and practice of spatial uncertainty propagation analysis, by presenting and discussing various uncertainty propagation techniques. The emphasis is on Monte Carlo simulation methods. Workshop participants will receive a copy of and learn to use the Data Uncertainty Engine software tool, which is specifically designed to help users define, assess, store and simulate uncertain spatio-temporal environmental variables. Attention is given to the effect of cross- and spatio-temporal correlations on the results of an uncertainty analysis and on methods to determine the relative

contribution of individual uncertain inputs to the accuracy of the final result. The techniques are illustrated with examples on environmental contamination and digital terrain analysis. Many of the examples will be carried out by the course participants themselves. After completing this course, participants will have a clear understanding of how uncertainties in spatial information can be represented statistically using probability distributions, how uncertainties propagate through spatial analyses, and how to apply uncertainty propagation techniques in their own work.

The target group for the course is PhD students with an interest in uncertainty assessment of environmental data and models at different spatial and temporal scales. In addition, young researchers and professionals with the same interests may also benefit from following the course.

Form and Content
The course will have a duration of four days. Three of the days will be a class room course with up to 20 course participants. The fourth day the participants will attend a seminar on 'Uncertainties in Climate Change Impacts on Water Resources'. The participants will be introduced to the following tools:

- The Data Uncertainty Engine (DUE) software tool.
- The statistical software package R.

Both of which are freely available in the public domain.

Course Programme

DAY 1, Tuesday 8 September

9.00	–9.15	Welcome, introduction
9.15	–10.45	Lecture 1, *Heuvelink,* including exercise 1 (problem definition, what is uncertainty, definition of uncertainty model (pdf), identification of uncertainty model)
10.45	–11.15	Coffee/tea break
11.15	–12.45	First halve of the course participants present their research (questions) in max 5 slides
12.45	–13.45	Lunch
13.45	–15.15	Lecture 2, *Heuvelink,* including exercises 2 and 3 (Taylor series method)
15.15	–16.00	Computer practical 1 (Kriging with R, Taylor method with R, using the Geul data)
16.00	–16.30	Coffee/tea break
16.30	–17.30	Computer practical 1 continued

18.30		Social dinner hosted by FIVA. Venue: Most likely Restaurant Royal Garden, Dronningens Tværgade 30. www.royalgarden.dk

DAY 2, Wednesday 9 September

9.00	–9.45	Lecture 3, *Brown*, (introduction DUE software)
9.45	–10.45	Computer practical 2 (build probability model using DUE for Geul case: both for lead concentration and soil consumption)
10.45	–11.15	Coffee/tea break
11.15	–12.45	Second halve of the course participants present their research (questions) in max 5 slides
12.45	–13.45	Lunch
13.45	–15.15	Lecture 4, *Heuvelink*, including exercise 4 (Monte Carlo method, including spatial sequential simulation)
15.15	–16.00	Computer practical 3 (Monte Carlo method for Geul using DUE to generate realisations and using R to run the model and display and analyse results)
16.00	–16.30	Coffee/tea break
16.30	–17.30	Computer practical 3 continued

DAY 3, Thursday 10 September

8.45	–16.00	Seminar 'Uncertainty in Climate Change Impacts on Water Resources'. See programme on http://www.hyacints.dk

DAY 4, Friday 11 September

9.00	–10.45	Lecture 5, *Refsgaard*, (Uncertainties in hydrological modeling, framework and methodologies, model structure uncertainty)
10.45	–11.15	Coffee/tea break
11.15	–12.45	Lecture 6, *Højberg*, (The importance of geological uncertainty on groundwater modeling – a case study)
12.45	–13.45	Lunch
13.45	–14.30	Lecture 7, *Heuvelink*, (remaining issues, wrap up)
14.30	–16.00	Computer practical 4 (Baranja Hill or try your own data)
16.00	–16.30	Evaluation
16.30	–17.30	Uncertainty game, with drinks and snacks

Organizer

Jens Christian Refsgaard, Geological Survey of Denmark and Greenland (jcr@geus.dk).

Background of participants

Participants are expected to have a basic understanding of statistics and hydrology.

Course material

- DUE software and manual
- Course exersices and computer practical
- Journal papers

Work load and credit points

Approximately 100 hours in total including lectures and exercises during the course and preparatory reading before and during the course.

The work load corresponds to 4 ECTS.

A course diploma will be issued upon satisfactory completion of the course.

Registration and admission

Registration on FIVA's website: www.fiva.dk.

Deadline: July 15, 2009. Information on admission to the course will be forwarded shortly after.

The total number of participants is limited to 20. PhD students are given first priority but depending on the number of registrants we also welcome post-graduate participants.

International students are requested to provide a very short description of their research interests and background when they register. Additionally, a letter of recommendation needs to be forwarded from the research advisor.

Fee

The course is free for PhD students enrolled at universities. Post-graduate participants will be charged a course fee of DKK 5.000 (€ 675).

Accommodation and travel

FIVA will provide accommodation for PhD students near the university free of charge. Participants are requested to cover travel expenses and per diem from their own funding.

Other participants are requested to make their own arrangements. Hotel suggestions:

1. CAB INN Scandinavia (cheap)
http://www.cabinn.com/english/kbh/scandinavia/sca.html
Transport via metro from the airport to "Forum metro station"

2. Comfort Hotel Østerport (a little more expensive)
http://www.choice.no/html/da247048.jsp
Transport via regional train from the airport to Østerport station. Book a superior room if you are sensitive to the sounds of the railway tracks. Hotel Østerport is within walking distance of the Geocenter.

Further information
Please contact course organizer or Frederik Uldall (email: fu@geo.ku.dk, phone: +45 3532 2414**)**.