Stochastic Hydrology

(GEO4-4420)

Course guide

2014

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Course Guide Stochastic Hydrology (2014)

General course information

- Name: Stochastic Hydrology
- Code: GEO4-4420
- Credits: 7.5 ECTS
- Level: M
- Timing: period 3, Feb 10th 2014 till Apr 14th 2014
- Hours per week: 4-8 hours / week, timeslot C: Monday afternoon (13.15-17:00), and Thursday morning 9:30/10.00-12.45).
- Language: English
- Blackboard: www.uu.nl/blackboard
- Course website: http://www.earthsurfacehydrology.nl/education/stochastic-hydrology/
- Course coordinator / lecturer: M.F.P Bierkens.(m.f.p.bierkens@uu.nl, Zonneveldvleugel, room 128)

This course guide

This course guide provides general information on the MSc course Stochastic Hydrology, which is delivered in period 3 of the academic year 2013-2014. Classes and practical work are scheduled in timeslot C: Monday afternoon (13.15-17.00), and Thursday morning 9:30/10.00-12.45).

Introducing stochastic hydrology

Hydrological systems are both complex and extremely heterogeneous in time and space. As hydrological models are simplified versions of reality, they produce predictions of hydrological variables (e.g. runoff, hydraulic head, concentration) that by definition are in error. Errors in hydrological model prediction can occur because the model concept is wrong or may be due to errors in parameters, boundary and initial conditions. We may choose to ignore these errors and accept our model predictions at face value. However, in operational hydrology, when actual decisions have to be made based on hydrological model predictions (sometimes involving human life such as in flood control), it is imperative that uncertainty is taken into account. Also, it has been shown in numerous instances that predictions that take account of uncertainty in an explicit manner may even improve model predictability. Stochastic hydrology is mainly concerned with the assessment of uncertainty in model predictions. In stochastic hydrology, the assessment of uncertainty is an integral part of hydrological analysis and modelling, being as important as the predictions themselves. This is achieved by using “stochastic models”, which are models that are partly driven by some random process. The random process expresses the part of reality that is not covered by our model, i.e. the part about which we are uncertain.

Goals

This course aims at exposing the student to basic concepts and issues that are essential to stochastic modelling of hydrological processes. After completing this course students

1) possess a good overview of stochastic hydrology;
2) possess a good basis for reading and understanding literature on stochastic hydrology and stochastic modelling in the earth sciences;
3) are able to apply basic methods of mathematical statistics, probability theory and random function theory;
4) are able to incorporate stochastic methods and principles in hydrological analysis and model building;

5) will appreciate the added value of the stochastic approach, i.e. “it pays to be certain about uncertainty”.

Although this course treats stochastic approaches in the context of hydrological modelling, the methods presented are applicable to modelling in the earth and environmental sciences in general.

Contents

After an introduction on the added value of the stochastic approach to hydrology, we start with the basics: descriptive statistics followed by lectures on probability, random variables and random processes (random functions). A well-known application of the use of probability and random variables is treated, i.e. calculating return periods of extreme hydrological events. After the basic concepts of the random processes, the lectures will deal with the following topics: time-series analysis, geostatistics, forward stochastic modeling, optimal state prediction and data-assimilation. Furthermore, students are required to select a special topic for further study from the following list: sampling and monitoring; inverse estimation; ordinary stochastic differential equations; point processes; upscaling and downscaling methods; uncertainty and decision making. Special topics will be studied by reading a brief introduction (lecture notes) and two articles for each topic. Students are required to write and present a research proposal on the subject. A detailed description of the program (provisional) is given at the end of this document.

Prerequisites

Essential: BSc. or equivalent degree in Earth Sciences or related field; having followed *Principles of Groundwater Flow* or *Land Surface Hydrology* or equivalent Master’s level courses in earth system or environmental modelling. *Useful background*: general knowledge or hydrology and statistics.

Modes of instruction

40 hours of lectures, 8 hours of exercise sessions, 9 hours of computer practicals
literature study, writing a research proposal, presentations

Subject matter tested at exam

- Content of the syllabus
- Content of course handouts
- Subject matter treated at the lectures and computer practicals

Exam and grading

- The written research proposal and its presentation account for 30% of the grade, the reports of the computer practicals for 10%, and the exam for 60% of the grade.
- The grades of the computer practicals, the research proposal and its presentation are given in half points, i.e. 6.5, 7, 7.5, 8, 8.5, etc.
- The grade of the exam is given in tenths of a point, varying between 0.0 and 10.0.
- The total grade is obtained by weighted averaging of the three parts and rounding off to two decimals, using the normal rules of rounding off. A total grade of 5.49 means failing the course (final grade 5) and 5.50 means passing the course (final grade 6).

- Only the final grade is communicated to the "studiepunt" Geosciences. Final grades of 6 and lower are communicated as whole grades, e.g. 4, 5, 6. Grades higher than 6 are communicated in decimals, e.g. 6.3, 7.1, 7.5, 8.0 etc.
- A resit (second chance exam) is possible for students with final grades of 5.00 or higher. The date of the resit is set in block 4 in consultation with the students involved. The grade after a resit is 6 (pass) or fail only and is only based on the resit itself. Instead of a resit, the course coordinator may also decide to issue a reparation assignment.
- Students should be able to provide valid proof of their identity at the exam. For the exam, a pocket calculator is required. No books are allowed during the exam but a summary sheet of equations will be provided.

Lecturer / instructor

The course is delivered by prof. dr. M.F.P. Bierkens and prof. dr. F.C van Geer. You may find Prof. Bierkens' room on the second floor of the Jan Zonneveldvleugel, room 118; tel.: 030 253 2777/2749; e-mail: m.f.p.bierkens@uu.nl;
url: http://www.earthsurfacehydrology.nl/people/marc-bierkens
url: http://www.earthsurfacehydrology.nl/people/frans-van-geer/

Course material

Course material consists of a syllabus with lecture notes and handouts of the sheets. The syllabus can be purchased from the "printing on demand service" about which you will be or have been notified. The syllabus and the handouts can also be downloaded from blackboard or from the following website:
http://www.earthsurfacehydrology.nl/education/stochastic-hydrology/

Illness / circumstances outside one's control

A student who falls ill or is faced with other circumstances outside his/her control such that it prevents him/her from following the course should notify the lecturer as soon as possible. If a student cannot take the exam because of illness or other circumstances outside his/her control he/she should notify the lecturer before the exam. As soon as the student is present again, he/she should contact the lecturer directly to discuss in what way – if possible – the course can be completed successfully. In case the lecturer falls ill or cannot be present due to unforeseen circumstances, the lectures are cancelled. The students are then compelled to study the planned subject matter by themselves.

Unforeseen

For all circumstances not accounted for in this course guide the lecturer decides, following the examination regulations of the Master's degree programme.

Table of Contact hours of this course

Contact hours with classroom reservations in Syllabus+	wk 7	wk 8	wk 9	wk 10	wk 11	wk 12	wk 13	wk 14	wk 15	wk 16	wk 17	Total
Lecture	4	4	4	4	4	4	4		4	4		36
Tutorial/(computer) practical/workshop/semin-ar	3	4	3	3	4	3	3	4				27
exam, preliminary examination, computer test										3		3
Other, e.g. presentations									4			4
Programmed contact hours without classroom reservation												
Field work												0
Excursion												0
Atelier												0
Meeting between lecturer and student (real life or digital)												0
Supervision of paper/ assignment (real life or digital)												0
Open office hours lecturer (real life or digital)												0
Peer feedback (real life or digital)												0
Inter-student meetings (real life or digital)												0
Self-tuition hours	14	14	14	14	14	14	14	14	14	14		140
Total	21	22	21	21	22	21	21	18	22	21	0	210

Program 2014 (SUBJECT TO CHANGE)

GEO4-4420: STOCHASTIC HYDROLOGY
Instructors: B = Bierkens, VG = van Geer K = Karssenberg

Day	Date	Start	Finish	Building	Room	Work form	Topics	
week 7								
Mon	2/10/2014	13:15	17.00	MINNAERT	204	Lecture	VG: Introduction	Descriptive statistics
Thu	2/13/2014	10:00	12:45	MINNAERT	202	Lecture	VG: Random variables	
week 8								
Mon	2/17/2014	13:15	17:00	MINNAERT	204	Lecture	B: Hydrological statistics	Exercises
Thu	2/20/2014	9:30	12:45	UNNIK	402	CPR	B: Hydrological statistics	
week 9								
Mon	2/24/2014	13:15	17.00	MINNAERT	204	Lecture	B: Random functions	
Thu	2/27/2014	10:00	12:45	MINNAERT	202	Lecture	B: Random functions	Exercises
week 10								
Mon	3/3/2014	13:15	17.00	MINNAERT	204	Lecture	B: Geostatistics	
Thu	3/6/2014	10:00	12:45	MINNAERT	202	Lecture	B: Geostatistics	Introduction to special topics
week 11								
Mon	3/10/2014	13:15	17.00	MINNAERT	204	Lecture	VG: Time series analysis	
Thu	3/13/2014	9:30	12:45	UNNIK	402	CPR	B: Geostatistics	

week 12									
Mon	3/17/2014	13:15	17:00	MINNAERT	204	Lecture		VG: Time series analysis	
Thu	3/20/2014	10:00	12:45	MINNAERT	202	Lecture		VG: Time series analysis	Explanation home practical TSA
week 13									
Mon	3/24/2014	13:15	17:00	MINNAERT	205	Lecture		B: Forward stochastic modelling	
Thu	3/27/2014	10:00	12:45	MINNAERT	202	Lecture		VG: Kalman filtering	
week 14									
				MINNAERT					
Ma	3/31/2014	13:15	17:00	UNNIK	402	Lecture		VG: Kalman Filtering + Evaluation of TSA practical	Hand in practical TSA
Thu	4/3/2014	9:30	12:45	UNNIK	402	CP		K: Forward stochastic modelling	
week 15									
Mon	4/7/2014	13:15	17:00	MINNAERT	204	Lectures		B: Presentation research proposals	Hand in research proposals
Thu	4/10/2014	10:00	12:45	ZO	027	Exercise		B: Practising an old exam	
Week 16									
Mon	4/14/2014	13:15	17:00	MINNAERT	211	Exam		Exam	