FACULTY
OF SCIENCE

Date
12 September 2022

Reg. no
U2022/401

NGE006F, Hydrogeological Conceptual Models for Groundwater Use and Protection. Characterisation methods and scaling considerations, 4.5 credits

Konceptuella hydrogeologiska modeller för tillämpningar inom och skydd av grundvatten. Karakteriseringsmetoder med hänsyn till olika skalor, 4,5 högskolepoäng

Third Cycle/Forskarnivå

Confirmation

This course syllabus was confirmed by The Research Programmes Board at the Faculty of Science 12 September 2022. The course is in the third cycle and amounts to 4.5 credits.
The course syllabus is formally approved in Swedish. This is a translation.

Learning outcomes

Proper investigations and characterization of the underground soil and rock properties and their spatial distribution related to water occurrence and movement is vital to understanding ecosystem and geosystem services. The course aim is to show how our understanding of groundwater systems depends on the vertical and horizontal characterization using multiple lines of evidence (data types) and scales of measurement to inform hydrogeologic conditions.

On completion of the course, participants shall be able to:

Knowledge and understanding

- Exemplify the need for groundwater system understanding and consequences when it is lacking.
- Develop an understanding of a hydrogeological system (building conceptual site models (CSM)) with scientifically sound data at appropriate scales.

- Discuss and compare conventional and novel methods for characterization and monitoring in distinct hydrogeologic conditions.
- Exemplify method selection and scales of measurement to address bias and uncertainty in a cost-efficient manner.
- Define how characterization is distinct from monitoring designs.

Competence and skills

- Identify, apply and evaluate relevant methods to inform physical, biological and chemical processes appropriate for characterization of different groundwater flow conditions and transport processes.
- Integrate site characterisation results into a coherent CSM.
- Identify what methods are most useful to improve the conceptual model to the degree needed for a certain hydrogeological analyses/question.
- Explain groundwater flow system characteristics within different geologic frameworks that inform internal flow system variability, hydrogeologic unit delineation and properties and links to boundaries.

Judgement and approach

- Distinguish and compare different hydrogeologically sound methods of both invasive and non-invasive techniques possible for varying surface and subsurface conditions at various scales.
- Compare methods for spatial hydrogeologic characterization to design monitoring systems and inform hydrogeologic system behaviour.
- Reflect on and improve site conceptual models from multiple data types to assess measurement bias, precision, accuracy; and data analysis methods to inform processes, parameters and variability at different scales.
- Critically analyse data gaps when practicing development of a site conceptual model.

Course content

The presentation and analysis of measurements and synthesis is relevant to designing robust 3D monitoring networks for evaluation of risks, and performance assessments for remediation and resource protection. Hydrogeological conceptual models are essential for forecasting sustainable groundwater use and protection outcomes, and the course will focus on characterisation methods and scaling considerations and includes the following:

- Introduction of groundwater as a key component of the hydrologic cycle, its role in critical ecosystem and geosystem services, and current societal challenges.
- Gravitational flow system behaviour, estimating recharge and discharge, and their spatio-temporal variability at multiple scales.
- Fluid potential concepts and measurement methods.
- Introduction to high-resolution borehole methods including sensors for monitoring with hands-on experience at nearby research site(s).

- Introduction to surface and airborne geophysical methods.
- Role of aquitards and methods for delineation and characterization.
- Hydraulic response data analysis methods; ambient and forced-gradient testing and analysis for parameters estimation.
- Influence of subsurface variability in distinct (hydro)geologic environments affecting flow system characteristics and methods for characterization and monitoring.
- Introduction and application of tracer methods in hydrogeology: atmospheric derived tracers ($^{3}H/^{3}He$, CFCs), geogenic tracers (4He, U, Th, Sr isotopes) and point and non-point source contaminants.
- The role of flow system understanding for predicting transport and fate of contaminants to assess risks and remediation needs for water resource protection.

Forms of instructions

Teaching consists of lectures, field exercises and desktop (data analysis) exercises, as well as seminars, discussions, and project work. It is compulsory to participate in exercises and field exercises as well as seminars, discussions, project work and associated elements.

Forms of examination

The assessment is based on a written project report and oral seminars and through participation in compulsory components.

Grades

Possible grades are Pass and Fail. For a grade of Pass, the student must have:

- participated in all compulsory components and
- passed the written project report as well as the oral seminars.

Language of instruction

The course is given in English.

Necessary prior knowledge

Basic hydrogeology education at the master's level corresponding to 15-30 credits or corresponding knowledge from working experiences.

Additional information

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