lbres2102

2024

Engineering of the water and the pollutants in grounds and groundwaters

4.00 credits	22.5 h + 22.5 h	Q2

Teacher(s)	Vanclooster Marnik ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	- Transport phenomena - Soil sciences - General hydrology - Soil physics
Main themes	The course aims to introduce students into the modeling of transport phenomena (transport of water, solute transport, heat transfer) in variably-saturated soil and in groundwater aquifers. The following topics are covered: - Theoretical concepts governing the transfer of water, solutes and other pollutants and heat in partially saturated soils and aquifers; - Approaches for modeling transport processes in soil and aquifers (analytical approaches, numerical approaches, transfer function); - Methods for the assessment of hydrodynamic properties of soils and aquifers; - Integration of hydrodynamic aspects in soil and water engineering and management.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 a. Contribution to Learning Outcomes program M1.1 , M1.2 , M1.3 , M2.1 , M2.2 , M2.3 , M5.1 , M5.6 , M5.8 , M6.1 , M6.2 , M6.4 , M6 . 9 , M7.1 , M7.2 , M8.1 , M8.2 , M8.3 , M8.4 ; b . Specific formulation for this activity LO program (maximum 10) At the end of the course (2 ECTS) and pratical work (2 ECTS) , students will be able: - To explain the principles of flow of water and solutes (including pollutants) in soils and aquifers; - To develop and implement the transport equations for modelling flow in unsaturated (soil) and saturated (aquifer) natural porous media in steady state and transient conditions; - To discuss and understand hydrodynamic assessment techniques for soils and groundwater aquifers, especially using hydrogeophysical techniques; - To estimate, using traditional methods and advanced methods (inverse modeling , data assimilation) the hydrodynamic properties of soils and aquifers; - To apply hydrodynamic modeling to solve complex engineering problems of water and soil.
Evaluation methods	The exam consists of 3 parts: • Written multiple-choice. Specific theoretical questions in multiple-choice format. 20 multiple-choice questions for 40 minutes. This part counts for 30% of the final score • Case study exam. Oral exam with written preparation. The student analyses a complex case study in order to evaluate his ability to integrate the different elements of the subject in order to solve a complex problem of soil hydrodynamics. Written preparation 1h40, oral defence 20 minutes. This part counts for 30% of the final grade • Examination exercise: Solving a concrete problem in a computer room with specific software (Hydrus and/or Modflow). Preparation 50 minutes, oral defense 10 minutes. This part counts for 40% of the final score. The evaluation is based on the coherence of the answers, the accuracy of the answers, the quality of the preparation document, and the quality of the oral defense. The exam can be made in English or French

Teaching methods	**Lectures**: Reverse class. Through the course website (Moodle), the student has access to a syllabus, video clips that explain the theoretical foundations of the course and Python notebooks to illustrate certain aspects. Classes in the classroom allow students to answer questions and deepen their knowledge of the subject. Due to lecture room capacity limitations related to the COVID crisis, some part of the course can be organised at distance. **Practical work:** Exercises in computer rooms.
Content	Sustainable soil and groundwater management requires approaches to quantify water and solute fluxes (nutrients, pollutants) in subsurface environments. In this course, we establish the basis for modeling water and solute flows (nutrients, pollutants...) in soils and aquifers. **Lectures:** Methodological approaches for quantitative modeling, applied to water and solute (nutrients, pollutants) transport into soil and groundwater systems. • Equations for water transport in soil (Richards equation, Fokker-Planck equation), solute transport in soil (convection-dispersion equation, with degradation, adsorption, mobile-immobile water), water diffusion in groundwater. • Solutions: analytical solutions (Laplace and Boltzman transformation); numerical solutions (finite differences, finite elements); integrated solutions (transfer function). • Methods for characterizing hydrodynamic parameters. Laboratory methods, in situ methods. Inverse modeling. • Applications: water infiltration in the soil, pollutant transport in the soil, pumping tests in a groundwater system. **Practical work:** The main concepts presented during the courses will be illustrated by exercises in the computer room using Python notebooks and open source software . • Estimation of hydrodynamic parameters from laboratory observations. • Analytical solutions for water transport and solutes. • Numerical modelling in water-unsaturated soils using HYDRUS 1-D. • Modelling of groundwater diffusion using MODFLOW
Inline resources	Moodle site of the course • Organization of the course • Course syllabus • Video clips • Python notebooks • Tutorial & assignments
Bibliography	M. Vanclooster, 2019. Modelling soil and subsoil hydrodynamic processes. Syllabus AGRO-UCLouvain. 120 pp.
Other infos	This course is given in English, combined with a french friendly format.
Faculty or entity in charge	AGRO

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Civil Engineering	GCE2M	4		🔍
Master [120] in Environmental Bioengineering	BIRE2M	4		🔍
Master [120] in Chemistry and Bioindustries	BIRC2M	4		🔍
Master [120] in Agriculture and Bio-industries	SAIV2M	4		🔍