UCL Université catholique de Louvain

LBRES2102

2013-2014

Soil hydrodynamics : modelling

5.0 credits	30.0 h + 22.5 h	2q

Teacher(s) :	Lambot Sébastien ; Vanclooster Marnik (coordinator) ;
Language :	Français
Place of the course	Louvain-la-Neuve
Inline resources:	iCampus
Prerequisites :	-Transport phenomena - Soil sciences - General hydrology - Soil physics
Main themes :	The course aims tointroduce 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, including hydrogeophysical techniques; - Integration of hydrodynamic aspects in soil and water engineering and management.
Aims :	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 (2.5 ECTS) and pratical work (2.5 ECTS) , students will be able: - To explain the principles of flow of water and solutes (including pollutants) , and heat transport 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 ; - To synthesize and present a scientific paper dealing with hydrodynamic issues of soil. *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled “Programmes/courses offering this Teaching Unit”.*
Evaluation methods :	Oral examination with written preparation. The evaluation encompasses two parts: i) discussion of a complex case study allowing to evaluate the ability o f the student to integrate the different elements of the course to solve a complex soil or groundwater hydrodynamic problem; ii) specific theoretical questions. The evaluation focuses on the consistency of the response (part i) the accuracy of the answers (part i and ii), the quality of the document that has been prepared for the evaluation, the quality of the oral defense. Report of the practical work. The evaluation focuses on the accuracy of responses and the quality of the document. Evaluation of the seminar on a scienctific paper in the field of soil hydrodynamics. The evaluation focuses on the quality and rigor of the presentation, the quality of responses and arguments in the debate, the formal quality of the presentation (transparencies, modulation of voice, clarity, ...)
Content :	Lectures : - General concepts: Water transport in soil, solute transport in soil (nutrients, pollutants , ...), water transport in the aquifer, heat transport in soil and groundwater, propagation of electromagnetic waves in the soil . - Transport equations for water transport in the soil (Richards equation, Fokker-Planck equation), solute transport in soil (convection-dispersion equation, with degradation, adsorption, multiple region), water diffusion in groundwater, heat transport, propagation of electromagnetic waves (Maxwell's equations) . - Integration of transport equations : Analytical solutions (Laplace transform and Boltzman), numerical solutions (finite differences, finite elements), integrated approaches (linear transfer function theory) . - Methods for assesing hydrodynamic variables: traditional methods hydrogeophysical methods (TDR , GPR and SAR , electromagnetic induction , ERT ...) - Methods for assessing hydrodynamic parameters. Laboratory methods , in-situ methods. Inverse modeling. - Applications: water infiltration into the soil, distribution of pollutants in soil , pumping tests of an aquifer, propagation of electromagnetic waves in the ground. Practical work:

	The main concepts presented in the course will be illustrated by exercises in the computer room : Estimation of hydrodynamic parameters from laboratory observations. Analysis of the tension infiltrometer . Numerical modeling using HYDRUS 1-D. Diffusion modeling in groundwater by means of MODFLOW. Seminars : Students analyze, synthesize and present a scientific paper related to the theoretical topics covered in this course.
Bibliography :	- Course syllabus - Copy of the slides - Support video explaining dynamic phenomena (eg infiltration in the soil) - MATLAB Tutorial - Lab manual, manuals, software (including HYDRUS 1-D and MODFLOW ...) - Didacticiel en MatlabTM - Manuel des travaux pratiques, manuels des logiciels (notamment HYDRUS 1-D et MODFLOW, ')
Cycle and year of study :	> Master [120] in Environmental Bioengineering > Master [120] in Agricultural Bioengineering > Master [120] in Chemistry and Bio-industries
Faculty or entity in charge:	AGRO