River Basin Modelling						**WSE/HI07 HIFRM**
2-20 April 2013						**5 ECTS Credit Points**
Mentor:	A. Jonoski					
Tuition form & study load:	*Topic*	*Contact hours*			*Study load [hrs]*	*Examination/weight*
		Lect -ure	*Exer cise*	*Work shop*		
	River basin management	4	4	8	28	Exercises reports on three topics (10%)
	Groundwater modelling	8	4	8	40	(20%)
	Catchment modelling	12	16	4	72	(30%) participation
	(total contact hours 68)				Total 140	& oral exam (40%)
Pre-requisites:	Hydrology and Hydraulics; Fluid dynamics, information technology and computer science; Information management and numerical methods					
Learning objectives:	On completion of this module the participants are able to 1. Understand and explain the multi-purpose nature of river basins and approaches for their integrated planning and management 2. Know how to model flow processes in porous media 3. Use MODFLOW to simulate groundwater flow in the saturated zone 4. Know how to model hydrological processes in catchment rainfall-runoff 5. Use NAM to simulate rainfall runoff in a natural catchment 6. Know how to use MIKE-SHE to model both surface and groundwater flow in a natural catchment, including the unsaturated zone					
Content:	**River basin management, A. van Griensven (IHE), W. van der Krogt (Deltares)** Introduction to the management of river basins; water resources; catchment yield; land use and agriculture; storage; groundwater; flood mitigation; irrigation; power generation; navigation; demand forecasting; dealing with droughts. Exercises and workshops with SWAT and RIBASIM.					
	Groundwater modelling, A. Jonoski (IHE) The continuum approach; definitions; Darcy's law; groundwater flow in the saturated zone: equations for 1D, 2D and 3D flow; modelling approaches; modelling protocol; contaminant transport through advection and diffusion; exercises and workshops with the MODFLOW software package to solve a water resources analysis problems: problem definition, model building; Exercise report					
	Catchment modelling, M. Butts (DHI), A. Jonoski (IHE) and I. Popescu (IHE) Types of hydrological models: empirical/data-driven/black box; conceptual and physically based models. NAM lumped-conceptual model: model-set-up of a catchment & calibration from rainfall & discharge records. Focus on distributed physically based catchment modelling with MIKE-SHE: 1) introduction to the modelling exercises and workshops; presentation of MIKE-SHE software package and the catchments used for the exercises; 1) Initial model building - saturated zone; 2) Overland and river flow modelling - comparison of models with and without the river network; 3) Unsaturated zone modelling 4) Fully integrated catchment model: river + drainage + saturated + unsaturated zone; Exercise report.					
Course materials:	*Lecture Notes*: Price and van Griensven: *River basin management* Refsgard: *Introduction to hydrological modelling: Modelling of the processes of the land phase of the hydrological cycle* *PowerPoint slides:* Jonoski: *Groundwater modelling* Butts: *Catchment modelling* *Handout*: Jonoski and Popescu: *Catchment modelling with MIKE SHE (handout)* van der Krogt: *RIBASIM user manual* van Griensven: *SWAT* (*handout*) *Modelling software*: RIBASIM, MODFLOW; NAM and MIKE-SHE; MIKE11					
Didactics	Formal lectures; classroom exercises; home assignments; exercises & workshops in computer lab					