ERASMUS MUNDUS FLOOD RISK MANAGEMENT MASTER PROGRAMME SYLLABUS

UNESCO-IHE Institue for Water Education

Erasmus Mundus Flood Risk Management Master Programme Syllabus

INTRODUCTION

Integrated flood risk management aims to reduce the human and socio-economic losses caused by flooding while at the same time taking into account social, economic, and ecological benefits from floods and the use of flood plains or coastal zones. The need for the adaption of a holistic integrated approach to managing flood risk has been reflected in Flood Directive of the European Parlament.
The Erasmus Mundus Master Programme in Flood Risk Management: Global Change, Hydroinformatics and Planning (FLOODRisk Master) follows the holistic approach and is explicitly designed to cover wide range of topics – from drivers and natural processes to models, decisions and socio-economic consequences and institutional environment, and is therefore an important advance in water education for Europe.

This course is designed for young graduates in civil/environmental engineering or a related discipline, and water professional (engineers and scientists), decision-makers and others involved in flood modelling and flood risk management, particularly those who would like to learn the latest tools and techniques in flood risk management.

The Erasmus Mundus Master Programme in Flood Risk Management is offered by consortium consisting of:

- UNESCO-IHE Institute for Water Education (Netherlands),
- Technical University of Dresden (Germany)
- Polytechnical University of Catalonia, Barcelona Tech (Spain)
- University of Ljubljana (Slovenia)

The mobility scheme is given in the following figure.

<table>
<tr><td colspan="12">Year 1</td><td colspan="11">Year 2</td></tr>
<tr><td colspan="6">Semester 1</td><td colspan="5">Semester 2</td><td></td><td colspan="5">Semester 3</td><td colspan="6">Semester 4</td></tr>
<tr><td colspan="6">30 ECTS</td><td colspan="5">30 ECTS</td><td></td><td colspan="3">20 ECTS</td><td colspan="2">10 ECTS</td><td colspan="6">30 ECTS</td></tr>
<tr><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td></tr>
<tr><td colspan="6">TU, Dresden</td><td colspan="5">UNESCO-IHE</td><td>Vacation</td><td colspan="3">UPC, Barcelona</td><td colspan="2">Lubljana</td><td colspan="6">MSc thesis with anyone of the four or an industrial partners</td></tr>
</table>

The associated members – industrial partners include European hydraulic laboratories, namely DHI (Denmark), Deltares (Netherlands) and HR Wallingford (UK) and key organizations responsible for flood management , including Rijkswaterstaat (Netherlands), ICHARM (Japan) and three organizations from Bangaldesh. These partners bring their specific complementary expertise in flood risk management.
Moreover, a number of elective subjects are provided in each semester. International fieldtrips are organized and during 2-year programme students accumulate 120 ECTS credits.

TECHNISCHE UNIVERSITÄT DRESDEN

I Semester at TU Dresden

Module number	Module name	Professor in charge
MHSE07	**Ecology**	**Prof. Dudel**
Contents and qualification aims	Know how to define and to get knowledge in ecology as a pure and applied science; hierarchy of living systems and the ecosystem concept; physical and chemical determinants of biosphere and of here parts; evolution and coevolution of living beings and entire biosphere; Effect of environmental conditions on individuals, populations and communities and contrast between conditions and resources (availability, acquisition and trade-offs); demographic processes (growth, birth, death, migration, life cycles), intra- und interspecific competition, coexistence and mutualism (e.g. symbiosis) as well as interaction and regulation in food webs; flux of energy-, matter - and information between organisms and through ecosystems; biodiversity in different spatial and temporal scales; global change and sustainability (ecological dimension); To get understanding and knowledge on causes and effects of fast change of dynamic steady states in species populations, communities and of entire biosphere as well as to understand our capacities and limitations for control, utilization, rehabilitation and conservation of species populations and ecosystems.	
Module character	2 hours a week, lectures, 1 hour a week, tutorial, 1 hour a week, practical training for the study work	
Pre-requisite of attendance	Basic knowledge in physics, chemistry and biology Literature: **Townsend C.R., Begon, M., Harper, J.L.** (2005), Essentials in Ecology Blackwell Scientific	
Applicability	The module is compulsory for students wit engineering background (students with a degree in engineering like water management, civil engineering, waste management, landscaping, forestry, agricultural engineering, or environmental engineering).	
Pre-requisite to achieve credit points	Having passed the module exam. The module exam consists of a presentation and either a written examination (90 minutes).	
Credit points and marks	The module earns 5 ECTS. The total mark is formed by 25% from rating of the oral presentation in the seminar and by 75% from the rating of the written exam **or** the study work.	
Frequency of the module	The module is offered each winter semester.	
Work load	The student’s work load is 150 hours.	
Duration of the module	The module is finished in one semester.	

Module number	**Module name**	**Professor in charge**
MHSE02	**Climatology and Hydrology**	**Prof. Bernhofer,** **Dr. Lennartz**
Contents and qualification aims	The module transports fundamentals on the basic processes in the atmosphere and hydrosphere. Energy budget and water budget are presented physically: radiation, precipitation, evapotranspiration and above and below ground runoff, as well as relevant storages are treated. Also climate and climatic variability are captured. Students learn to deal critically with meteorological and hydrological information (data, forecasts and consulting) and with its application for water management (planning, designing, and management of water plants). The student achieves knowledge on the relevant processes in atmosphere and hydrosphere, as well as on methods of observation and modelling. This implies basic principles, and includes estimation technologies for all components of the water cycle. The module is the basis for all water quantity related modules of the master course.	
Module character	2 hours a week, lectures, Bernhofer 2 hours a week, lectures, Lennartz	
Pre-requisite of attendance	Pre-requisite of attendance: basic knowledge in physics and mathematics Literature: **Oke, T.R.**, 1987: Boundary Layer Climates. **Dingman, W.L.**, 1994: Physical Hydrology.	
Applicability	The module is a mandatory module.	
Pre-requisite to achieve credit points	The successful students have to pass two module exams. It consists of a written exam (90 minutes). It is a mandatory pre-requisite for the written exam to take part in a one day excursion.	
Credit points and marks	The module earns 5 ECTS. The mark is identical to the weighted mean of the written exams.	
Frequency of the module	The module is offered each winter semester.	
Work load	The student’s work load is 150 hours.	
Duration of the module	The module is finished in one semester.	

Module number	Module name	Professor in charge
MHSE03	**Geodesy**	**Prof. Wanninger**
Contents and qualification aims	The module provides an introduction to the various aspects of geodetic techniques including sensor technology and collection, administration, and visualization of spatial information in hydro science. At the end of the module the students know the most important geodetic techniques of data acquisition and data processing. They will be able to select appropriate geodetic techniques for various applications.	
Module character	2 hours a week lectures, 1 hour a week, tutorial	
Pre-requisite of attendance	Basic knowledge of mathematics, statistics, and physics. Literature: **Wolf, P.R., Ghilani, C.D.** (2005): Elementary Surveying. 11th edition, Pearson Prentice Hall, Upper Saddle River, NJ, USA. **Kavanagh, B.F.** (2003): Geomatics. Prentice Hall, Upper Saddle River, NJ, USA.	
Applicability	The module is a mandatory module.	
Pre-requisite to achieve credit points	Credit points are achieved by passing the written exam of 90 minutes. Pre-requisite for the participation in the exam is the successful participation in at least 70% of the offered practical which include assignments.	
Credit points and marks	The module earns 5 ECTS. The mark is based on the result of the written exam.	
Frequency of the module	The module is offered once a year in the winter semester.	
Work load	The work load is 150 hours.	
Duration of the module	The module is finished in one semester.	

Module number	Module name	Professor in charge
MHSE08	**Hydrochemistry**	**Prof. Worch**
Contents and qualification aims	Characteristics of water and aqueous solutions, absorption and desorption, acid-alkali-reactions, chemical precipitation, redox reactions, chelate formation, and coupled equilibrations The students have profound knowledge about the main hydrochemical processes within natural and technical cycles. They are able to apply physiochemical laws for basic hydrochemical computations.	
Module character	2 hours of lectures per week 1 hour of practical training per week	
Pre-requisite of attendance	Basic knowledge in chemistry	
Applicability	The module is compulsory for students wit engineering background (students with a degree in engineering like water management, civil engineering, waste management, landscaping, forestry, agricultural engineering, or environmental engineering).	
Pre-requisite to achieve credit points	Having passed the module exam. The module exam is a written examination (90 minutes). Preparatory requirement to the exam is the protocol of the practical training.	
Credit points and marks	The module earns 5 ECTS. The grade for the examination equals the module grade.	
Frequency of the module	The module is offered once a year in the winter semester.	
Work load	The work load is 150 hours.	
Duration of the module	The module is finished in one semester.	

Module number	**Module name**	**Professor in charge**
MHSE05	**Hydromechanics**	**Prof. Pohl**
Contents and qualification aims	The physical characteristics of water will be discussed, starting with the hydrostatics and the mainly steady hydrodynamics with emphasis on the principles of conservation of energy, mass and momentum, pipe hydraulics, open channel hydraulics. The students are able to answer hydromechanical questions in engineering: - identification of hydromechanical problems in engineering - quantitative solution of hydromechanical problems - knowledge application for dimensioning and design of hydraulic structures and devices and to scientific problems	
Module character	2 hours of lectures per week 1 hour of tutorial per week	
Pre-requisite of attendance	Knowledge in physics, higher mathematics	
Applicability	The module is compulsory for the students with non-engineering background (students with a degree in natural sciences as hydrology, meteorology, geography, geology, chemistry, biology, and physics)	
Pre-requisite to achieve credit points	Having passed the module exam. The module exam is a written examination (90 minutes).	
Credit points and marks	The module earns 5 ECTS. The grade for the examination equals the module grade.	
Frequency of the module	The module is offered once a year in the winter semester.	
Work load	The work load is 150 hours.	
Duration of the module	The module is finished in one semester.	

Module number	Module name	Professor in charge
MHSE06	**Hydraulic Engineering**	**Prof. Stamm**
Contents and qualification aims	On the basis of knowledge about natural watercourses hydraulic structures for flood protection (levees, water retention reservoirs) and for use of water (weirs, dams, water power stations) are discussed with respect to water management, ecological and economic aspects. Environmentally friendly structures, sustainability and renewable energies are dealt with emphasis. In addition navigation engineering systems are introduced. The students have knowledge about the design, operation and calculation of hydraulic structures.	
Module character	2 hours of lectures per week 1 hour of tutorial per week 1 hour of practical training per week	
Pre-requisite of attendance	Knowledge in physics and higher mathematics	
Applicability	The module is compulsory for the sutents with non-engineering background (students with a degree in natural sciences as hydrology, meteorology, geography, geology, chemistry, biology, and physics)	
Pre-requisite to achieve credit points	Having passed the module exam. The module exam is a written examination (90 minutes). A positively evaluated term paper (30 hours) has to be handed-in.	
Credit points and marks	The module earns 5 ECTS. The grade for the written examination equals the module grade.	
Frequency of the module	The module is offered once a year in the winter semester.	
Work load	The work load is 150 hours.	
Duration of the module	The module is finished in one semester.	

Module number	Module name	Professor in charge
MHSE23	**Flood Risk Management II**	Prof. Schanze
Contents and qualification aims	To develop and interpret management strategies for flood risk reduction demands an extensive risk management and complex transdisciplinary solutions. The whole of physical processes of flood events as well as the societal governance have to be considered. The integrated flood risk management consists of 3 major parts: risk analysis (material to describe the flood risk system), risk evaluation (including risk perception) and risk mitigation (with risk prevention and communication, crisis management and maintenance). The students are able to understand all relevant components of flood risk management with respect to vulnerability. They can determine a tolerable level of risk, they are able to develop and interpret management strategies and different options for flood risk reduction. Case studies of river floods and coastal floods are discussed in two flood type oriented workshops.	
Module character	2 hours of lectures per week 6 hours of tutorial per week (3 workshops with 2 hours per week each)	
Pre-requisite of attendance	N.A.	
Applicability	The module is a mandatory module.	
Pre-requisite to achieve credit points	Having passed the module exam. The module exam consists of a written examination (90 minutes) and 2 out of 3 seminar papers (10 hours each).	
Credit points and marks	The module earns 10 ECTS. The module grade is generated from the written examination with 50%, and two out of three seminar papers with 25% each.	
Frequency of the module	The module is offered once a year in the winter semester.	
Work load	The work load is 300 hours.	
Duration of the module	The module is finished in one semester.	

UNESCO-IHE
Institute for Water Education

II Semester at UNESCO-IHE

<table>
<tr><td colspan="2">Computational Intelligence and Operational Water Management</td><td colspan="6">WSE/HI06
FRM</td></tr>
<tr><td colspan="2">The module is compulsory</td><td colspan="6">5 ETCS Credit Points</td></tr>
<tr><td>Mentor:</td><td colspan="7">Prof. dr. Dimitri P. Solomatine</td></tr>
<tr><td rowspan="3">Tuition form and study load</td><td rowspan="2">Topic</td><td colspan="3">Contact hours</td><td rowspan="2">Study load [hrs]</td><td rowspan="2" colspan="2">Examination/weigh</td></tr>
<tr><td>Lecture</td><td>Exercise</td><td>Workshop</td></tr>
<tr><td>Introduction to optimisation

Real time control of water systems

Data driven modelling and computational intelligence

(total contact hours 70)</td><td>4

16

14</td><td>2</td><td>4

12

18</td><td>20

60

60

Total 140</td><td colspan="2">Exercise report (10%)
Written exam & exercises (45%)
Written exam (25%)
Exercise report (20%)</td></tr>
<tr><td>Prerequisites:</td><td colspan="7">N.A.</td></tr>
<tr><td>Learning objectives:</td><td colspan="7">After completing the module participants should be able to:
1. Understand the main optimization techniques
2. Understand and explain how real-time control systems work
3. Identify the potential of control to solve hydrological problems
4. Sketch a general plan for a regional real-time control system
5. Know the main techniques of data-driven modelling from machine learning (neural networks, model trees, fuzzy systems, etc.)
6. Correctly classify a modelling problem as a physically-based, data-driven, or hybrid
7. Select proper methods and tools for building data-driven models</td></tr>
<tr><td rowspan="3">Content:</td><td colspan="7">Introduction to optimisation, D. P. Solomatine (IHE)
Classical optimisation. Linear and non-linear optimisation. Derivative-based and direct methods. Dynamic programming. Global (multi-extremum) optimisation. Genetic and evolutionary approaches. Multi-objective optimization. Applications in water sector. Exercises and workshops: optimal water allocation; automatic model calibration</td></tr>
<tr><td colspan="7">Real time control of water systems, A. Lobbrecht (IHE), S.J. van Andel (IHE), L. Alfonso (IHE)
Introduction to Real-Time Control; Modelling hydrological systems and optimal control problems with AQUARIUS; Control-systems functions and techniques; Hardware and software components; Control systems in industry; Identifying control system components; One day field trip to North-West Netherlands.</td></tr>
<tr><td colspan="7">Data driven modelling and computational intelligence, D. P. Solomatine (IHE) and B. Bhattacharya (IHE)
Modelling in the framework of Hydroinformatics. Data-driven and physically based models. Overview of machine learning and computational intelligence. Main types of machine learning: classification, association, clustering, numeric prediction. Decision, regression and model trees. Artificial neural networks. MLP and RBF networks. Instance-based learning. Fuzzy logic and fuzzy rule-based systems. Exercises and workshops: using data driven methods in hydrological forecasting.</td></tr>
<tr><td>Course materials:</td><td colspan="7">Solomatine. Lecture notes on Data-driven modelling.
Solomatine. Reader on optimization.
Mitchell. Machine learning. McGraw-Hill, 1997.
Witten and Frank. Data mining. Morgan-Kaufman, 2000.</td></tr>
</table>

	Lobbrecht: *Lecture notes on Real time control of water systems* Modelling software: AQUARIUS; Exercises Modelling software: WEKA; GLOBE; Exercises Optimization software: LINGO; Exercises
Didactics	Formal lectures; classroom exercises; home assignments; exercises and workshops in computer lab; classroom workshops on case study analysis
Additional reading:	Proceedings of the Hydroinformatics Conferences. Selected papers. Practical Hydroinformatics (Abrahart, See, Solomatine, eds.). Springer, 2008. Artificial neural networks in hydrology, Govindaraju, Rao (eds). Kluwer, 2000.

<table>
<tr><td colspan="6">River Basin Modelling</td><td colspan="2">WSE/HI07
FRM</td></tr>
<tr><td colspan="6">The model is compulsory</td><td colspan="2">5 ETCS Credit Points</td></tr>
<tr><td>Mentor:</td><td colspan="7">Prof. dr. Andreja Jonoski</td></tr>
<tr><td rowspan="3">Tuition form and study load</td><td rowspan="2">Topic</td><td colspan="3">Contact hours</td><td rowspan="2">Study load [hrs]</td><td colspan="2" rowspan="2">Examination/weigh</td></tr>
<tr><td>Lect ure</td><td>Exer cise</td><td>Work shop</td></tr>
<tr><td>River basin management
Groundwater modelling
Catchment modelling

(total contact hours 68)</td><td>4
8
12</td><td>4
4
16</td><td>8
8
4</td><td>28
40
72

Total 140</td><td colspan="2">Exercises reports on three topics
(10%)
(20%)
(30%)
participation
& oral exam (40%)</td></tr>
<tr><td>Prerequisites:</td><td colspan="7">Hydrology and Hydraulics; Fluid dynamics, Information technology and computer science; Information management and numerical methods</td></tr>
<tr><td>Learning objectives:</td><td colspan="7">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</td></tr>
<tr><td rowspan="3">Content:</td><td colspan="7">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.</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td colspan="7">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 MIKESHE 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.</td></tr>
<tr><td>Course materials:</td><td colspan="7">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</td></tr>
</table>

	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

Modules **8a** and **8b** are elective modules. The participants choose one of the two modules. In addition, modules offered by other specializations of MSc programme Water Science and Engineering (WSE) are also available.

Introduction to River Flood Modelling Option: River Flood Modelling & Risk Management (RFM)						**WSE/HI08a** **FRM**
The module is elective.						**5 ETCS Credit Points**
Mentor:	Prof. dr. Ioana Popescu					
Tuition form and study load	*Topic*	*Contact hours* *Lect ure*	*Exer cise*	*Work shop*	*Study load [hrs]*	*Examination/weigh*
	Hydroinformatics: floods, urban systems and environment	4		2	14	Written exam 10% Exercise report (50%) Oral exam (40%)
	Climate change and its impact on hydrology	4		2	14	
	Environmental processes and water quality	4	2	4	20	
	Introduction to uncertainty analysis	4		2	14	
	Introduction to 1D2D, 2D modelling	2		2	8	
	Flood analysis, river flood modelling and 1D flood routing	8	22	2	70	
	(total contact hours 64)				Total 140	
Prerequisi tes:	Basic knowledge of hydraulics and hydrology					
Learning objecti	On completion of this module the participants are able to: 1. Understand and explain the main flood management problems; 2. Understand and explain the governing processes of flood generation and propagation 3. Identify the proper modelling methodology for a given problem 4. Utilise their hands-on experience in the step-by-step modelling procedure (geometry, bathymetry, boundary conditions, forcing) needed to carry out a practical study with MIKE11, SOBEK 1D or HEC-RAS package; 5. Know how the river flood model may be used for structural and non-structural measures for flood mitigation					
Content:	***Application domains of Hydroinformatics: floods, urban systems and environment, R. K. Price (IHE), Z. Vojinovic (IHE) and A. Mynett IHE)*** Introduction to floods and flooding. Introduction to urban floods and urban water systems. Introduction to environmental systems.					
	Climate change and its impact on hydrology, S. Uhlenbrook (IHE) Climate change problematique. Global, regional and local climate models, development of climate change scenarios. Effects of climate variability on the hydrology that affects rainfall-runoff processes in river-basin					
	Environmental processes and water quality, H. J. Lubberding (IHE) Environmental processes. Water quality problems from a modelling point of view: outfalls, BODDO, eutrophication, toxic substances, best technical means approach, water quality objectives approach; Properties of the natural system from a modelling point of view, residence times, time scales of transport processes compared with those					

	of water quality processes, spatial scales of phenomena, link between transport of substances and water quality processes.
	Introduction to uncertainty analysis, D.P. Solomatine (IHE) Sources of uncertainty; representations of uncertainty. Methods of analysing model uncertainty: analytical, approximation-, model error-based, Bayesian, Monte-Carlo and optimal design. Parallel and cloud computing in the analysis of computationally-intensive models.
	Introduction to 1D2D, 2D modelling, I. Popescu (IHE) Introduction to the basic principles of 1D2D and 2D modelling.
	Flood analysis, river flood modelling and 1D flood routing, R.K. Price (IHE), I. Popescu (IHE), ***B. Bhattacharya (IHE)*** Nature and characteristics of floods: flood analysis – e.g. flood probability - probability and return period analysis of hydrological events and design floods - and estimation of peak flows (using Flood Estimation Handbook (FEH and ReFH) methods, catchment characteristics method, storm hydrographs and unit hydrograph methods River Flooding Modelling: -The significance of overbank flow, floodplain behaviour and stage discharge prediction (using the Ackers Method and Conveyance Estimate System) -Modelling flood propagation - flood routing -hydrological methods – Muskingum, reservoir routing, HEC-HMS -1D hydraulic flood routing/modelling in rivers -The Conveyance Estimate System; modelling resistance for discharge estimation. -Introduction to 'HEC-RAS' software; -Discussion of sustainable flood alleviation methods
Course materials:	*Lecture notes on River flood management and flood routing* Presentation slides; D.P. Solomatine and D.L. Shrestha. *Lecture Notes: Introduction to uncertainty analysis* Modelling packages with user manuals;
Didactics	Formal lectures; classroom exercises; home assignments; exercises & workshops in computer lab.
Additional reading:	Papers and other material provided by the course lectures.

Modules **8a** and **8b** are elective modules. The participants choose one of the two modules. In addition, modules offered by other specializations of MSc programme Water Science and Engineering (WSE) are also available.

Urban Flood Management and Disaster Risk Reduction Mitigation	**WSE/HI08b FRM**
The module is elective	**5 ETCS Credit Points**
Mentor:	Prof. dr. Zoran Vojinović

Tuition form and study load	*Topic*	*Contact hours*			*Study load [hrs]*	*Examination/weigh*
		Lecture	*Exercise*	*Workshop*		
	Application domains of Hydroinformatics: floods, urban systems and environment	4		2	20	Written exam 40% Exercise report (60%)
	Climate change and its impact on hydrology	4		2	14	
	Introduction to uncertainty analysis	4		2	14	
	Ethics of risk	4	2	4	12	
	Mathematical foundation of 2D urban flood modelling	4		2	20	
	Urban flood modelling and evaluation of flood risks	6	6	6	36	
	Structural and non-structural measures	2	2	2	12	
	Managing urban flood disasters	2	2	2	12	
	(total contact hours 64)				Total 140	

Pre-requisites:	Basic knowledge of hydrology and hydraulics
Learning objectives:	From this module the participants will be able to: 1. Develop enhanced understanding of the effects of climate variability on the hydrology that affects urban areas; 2. Understand the structure, service provided and failures of the service for urban stormwater/drainage networks; Urban Drainage Asset Management and Optimisation; 3. Learn how to model these systems and how to apply a typical modelling product (MOUSE, MIKE11, MIKE21 and SWMM); 4. Develop understanding of how to use the models to assess the performance of existing systems and how to design the new ones within the context of different flood risks (pluvial, fluvial, coastal and flash floods); 5. Learn how to build safe and reliable urban drainage models and how to evaluate a system's performance against different standards (engineering, environmental, public health, etc.). 6. Develop understanding of novel techniques for modelling the complex geometry and interaction between surface water (including floodplains), sub-surface flows and urban drainage infrastructure (1D and coupled 1D/2D); 7. Learn how to produce different flood risk maps in a GIS environment and how to calculate different types of flood damages; 8. Develop understanding of structural and non-structural flood resilience measures such as, conventional and innovative structures, early warning systems, etc. 9. Understand how to develop effective flood disaster management plans;

Content:	***Application domains of Hydroinformatics: floods, urban systems and environment, R. K. Price (IHE), Z. Vojinovic (IHE) and A. Mynett (IHE)*** Introduction to floods and flooding. Introduction to urban floods and urban water systems. Introduction to environmental systems.
	Climate change and its impact on hydrology, S. Uhlenbrook (IHE) Introduction to the effects of climate variability on the hydrology that affects urban areas, urban hydrology as a very fast rainfall-runoff process, selection of appropriate time steps in urban runoff modelling, global, regional and local climate models, development of climate change scenarios.
	Introduction to uncertainty analysis, D.P. Solomatine (IHE) Sources of uncertainty; representations of uncertainty. Methods of analysing model uncertainty: analytical, approximation-, model error-based, Bayesian, Monte-Carlo and optimal design. Parallel and cloud computing in the analysis of computationally-intensive models.
	Ethics of risk, N. Doorn Introduction to the basic theory of ethics and its application to the flood risk management.
	Mathematical foundation of 2D urban flood modelling, I. Popescu (IHE), S. Djordjevic (UoE) Introduction to the basic principles of 2D modelling, solutions of the 2D shallow-water equations, schemes for dealing with high velocity flows at shallow depths, numerical issues concerning interaction between 1D and 2D flow domains, below ground and above ground flows, subcritical and supercritical flows over urban floodplains, treatment of buildings in 2D models, etc.
	Urban Flood Modelling and Evaluation of Flood Risks, Z. Vojinovic (IHE), O. Mark (DHI), S. Djordjevic (UoE) Stormwater collection systems; services provided, beneficiaries, structure and concepts of draiange networks, rainfall input, rainfall-runoff modelling, free-surface and pressurised pipe flows, LIDAR filtering of urban features, rainfall and flow measurements, instrumentation, SCADA, telemetry, weather radar, numerical weather forecasts, build-up, wash-off, surface runoff water quality modeling in pipe networks, familiarisation with MOUSE, MIKE11, MIKE21 and SWMM software, setting up 1D and 1D-2D models, calibrating and verifying models using flow survey data, calculation of flood damages (tangible, intangible, direct, indirect damages), production of flood hazard maps, sensitivity-based flood risk attribution.
	Structural and Non-structural Urban Flood Management Measures, Z. Vojinovic (IHE), O. Mark (DHI), B. Gersonius (IHE) Sustainable structural and nonstructural urban flood management measures such as: amplification of pipe networks, open channels, detention/retention basins, on-site-detention, on-site-infiltration, on-site-retention, SUDS, stormwater sensitive urban design, asset management and multi-objective optimization of rehabilitation measures (use of computational intelligence), design and employment of early warning systems.
	Managing Urban Flood Disasters, Z. Vojinovic (IHE), D. Sakulski (UNU) Framework for urban flood disaster management (pre-disaster, during disaster, post disaster phase), disaster morphology, evaluation of disaster scenarios, development and testing of plans, emergency preparedness and response activities, use of GIS and communication and information systems.
Course materials:	Vojinovic, Z. and M.B. Abbott, 2011, Flood Risk and Social Justice: From Quantitative to Qualitative Flood Risk Assessment and Mitigation,2011, IWA Publishing Price: *Lecture notes on Introduction to urban water systems* Price, Vojinovic: *Lecture notes on Urban drainage modelling* D.P. Solomatine and D.L. Shrestha. *Lecture Notes: Introduction to uncertainty analysis.*

	Modelling software MOUSE, MIKE11, MIKE21, SWMM, APOSS, Exercise in Excel.
Didactics	Formal lectures; home assignments; exercises and workshops in computer lab;
Additional reading:	Papers and other material provided by the course lectures.

Fieldtrip				**WSE/HI09 FRM**
Fieldtrip is mandatory				**5 ETCS Credit Points**
Mentor:	Prof dr Biswa Battacharya			
Tuition form and study load	*Topic*	*Contact hours*	*Study load [hrs]*	*Examination/weigh*
	Study tour in Europe countries or Bangladesh	80	112	Fieldtrip report
Prerequisites:	N.A.			
Learning objectives	On completion of this module the students are able to: Have an overview of flood-related problems and projects.			
Content:	This is an exposure tour with 'on site' explanation of flood projects and flooding issues.			

<table>
<tr><td colspan="5">Flood Risk Management</td><td colspan="3" align="right">WSE/HI10
FRM</td></tr>
<tr><td colspan="5">The module is compulsory</td><td colspan="3" align="right">5 ETCS Credit Points</td></tr>
<tr><td>Mentor:</td><td colspan="7">Prof. dr. Biswa Bhattacharya</td></tr>
<tr><td rowspan="3">Tuition form and study load</td><td rowspan="2">Topic</td><td colspan="3">Contact hours</td><td colspan="2" rowspan="2">Study load [hrs]</td><td rowspan="2">Examination/weigh</td></tr>
<tr><td>Lect ure</td><td>Exer cise</td><td>Work shop</td></tr>
<tr><td>Flood risk management
Flood modelling: methods and
techniques (advanced features)

(total contact hours 64)</td><td>20</td><td>8
28</td><td>6
2</td><td colspan="2">82
58

Total 140</td><td>Exercise reports (40%)
Written exam on all subjects (60%)</td></tr>
<tr><td>Pre-requisites:</td><td colspan="7">Hydraulics, hydrology, river basin and flood modelling, statistics</td></tr>
<tr><td>Learning objectives:</td><td colspan="7">On completion of this module the participants are able to:
1. Understand and explain the main principles of flood risk management;
2. Understand the Hydroinformatics tools available for flood risk management;
3. Conceptualise the main principles of EU flood directive and have knowledge about European experience in flood risk management;
4. Understand and explain the main principles of flood forecasting and warning and uncertainty issues associated with flood forecasts;
5. Familiarise with the different flood forecasting models;
6. Utilise their hands-on experience in the step-by-step modelling procedure to build flood inundation models.</td></tr>
<tr><td rowspan="2">Content:</td><td colspan="7">Flood risk management, B. Bhattacharya (IHE), P. Samuels (HR Wallingford), F. Klijn (Deltares), M. Werner (IHE)
Introduction to flood risk management. Quantifying flood risk – probabilistic and statistical approaches. Risk-based decision making. Case studies. Introduction to risk analysis of flood defence structures. Case studies. Flood vulnerability and resilience. European experience in managing floods. EU framework directive on floods. Other national (eg UK) flood directives. Flood disaster management (Pre-, post- and during flood). Flood emergency response and flood preparedness. Flood fighting, recovery and insurance. Evacuation management. Flood forecasting and warning. Objectives. Lead time considerations. Data requirements. Flood forecasting models. Issuance of flood warning and response. Uncertainty issues in flood forecasting. Modelling uncertainty and its benefits. Social issues.
Where possible lectures and exercises will be given in conjunction with other Module 10 of the Hydraulic Engineering and River Basin Development Specialization.</td></tr>
<tr><td colspan="7">Advanced river flood modelling, I. Popescu (IHE), B. Bhattacharya (IHE), G. Di Baldassarre (IHE) and S. J. van Andel (IHE)
2D, 1D2D river flood modelling. Dam break modelling. Flood modelling, in 2D, in support of flood mitigation strategies (including flood risk maps. Structural and non-structural approaches in flood mitigation. Engineering solutions - flood routing and flood alleviation: channel & reservoir routing, flood banks, channel improvements, diversion schemes, flood storage on-stream and off-stream ; and non-structural issues - approaches to the reduction of flood impacts, flood risk maps.</td></tr>
<tr><td>Course materials:</td><td colspan="7">Lecture notes on Hydroinformatics for flood management, EU framework directive, flood risk management, Lecture notes on Flood modelling, Presentation slides; Modelling packages with user manuals;</td></tr>
<tr><td>Didactics</td><td colspan="7">Formal lectures; classroom exercises; home assignments; exercises and workshops in computer lab;</td></tr>
</table>

Hydroinformatics for Decision Support							WSE/HI11 FRM
The module is elective.							**5 ETCS Credit Points**
Mentor:	Prof. dr Andreja Jonoski						
Tuition form and study load	*Topic*	*Contact hours*			*Study load [hrs]*	*Examination/weigh*	
		Lecture	*Exercise*	*Workshop*			
	System analysis in water resources	8	6	6	42	Assignments (35%)	
	Decision support systems	6	4	4	30	Assignments (30%)	
	Software technologies for integration	4	8	8	36	Assignments (20%)	
	Integration of weather prediction and water models	8	2	4	32	Assignments (15%)	
	(total contact hours 68)				Total 140		
Pre-requisites:	Hydrological and hydraulic modelling concepts, basic programming skills						
Learning objectives:	On completion of this module the participants are able to: 1. Understand the role of system analysis in water resources planning and management 2. Formulate and solve water resources problems as optimisation problems 3. Distinguish and properly use different types of decision support methods for water problems 4. Build simple software applications that integrate data and models, both as stand-alone and Internet-based 5. Understand the potential of newly available data sources (e.g. remote sensing, web resources, data generated from climate and meteorological models) in advanced integrated modelling and decision support						
Content:	***Systems analysis in water resources, D.P. Loucks (Cornell University)*** Definition and role of systems analysis in engineering planning; Basic concepts; Multi-objective models and the concept of trade-offs between conflicting objectives; Development and use of static and dynamic stochastic simulation models of river systems.; Introduction to decision support systems and geographic information systems and their use; Exercises in multipurpose integrated river basin (or regional) water resources management modelling						
	Decision support systems, A. Jonoski (IHE) and I. Popescu (IHE) Introduction to decision making process; objectives and alternatives. Optimisation in decision support (single and multi-objective0. Multi-attribute decision methods and tools: formulation of decision matrix, generating and using weights, compensatory and non-compensatory decision methods. Introduction to mDSS4 decision support software; exercises and assignments with case studies implemented in mDSS4						
	Software technologies for integration, A. Jonoski (IHE) Introduction to methods and tools for software integration of models and data: file conversions						

	exercises. Object-oriented integration approaches. Software integration across networks: Client-server programming, Web protocols, Technologies for integrating distributed resources: web-interfaces technologies; creating web-based applications with assignment exercise
	Integration of weather prediction and water models, Y. Xuan (IHE) Approaches and methods for integration of weather models with hydrologic and hydraulic models. Integration of remote sensing data. Downscaling and upscaling issues.
Course materials:	D.P. Loucks: *Lecture Notes on Water Resource Systems Modelling: Its Role in Planning and* *Management* (chapters 2, 3, 4, 10 and 11) A. Jonoski: *Introduction to Decision Making and Decision Support Systems* (PowerPoint Slides) A. Jonoski: *Software Technologies for Integration* (PowerPoint Slides)
Didactics	Formal lectures; classroom exercises; home assignments; exercises & workshops
Additional reading	Van Beek, Loucks (2006).

III Semester

1st part at UPC Barcelona
2nd part at University of Ljubljana

UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

III Semester
1st part at UPC Barcelona

Fluvial Morphodynamics						
The module is compulsory						**5 ECTS Credit Points**
Mentor:	Prof. dr. Allen Bateman					
Tuition form & study load:	*Topic*	*Contact hours*			*Study load [hrs]*	*Examination/weight*
		Lect -ure	*Exer cise*	*Work shop*		
	River hydraulic concepts	5	5	7	17	Exercises and reports on five topics
	GIS water and QGIS for river applications	5	5	7	17	
	Sediment Transport, dynamic stability.	3	3	6	7	2 x (15%) 2 x (10%)
	Scour & Sedimentation process in river & structures	3	3	6	7	1x (5%)
	Field Trip to a case study	2	2		10	Participation (5%) Exam (40%)
	(total contact hours 62)				Total 58	
Pre-requisites:	Hydrology and Hydraulics; Fluid dynamics, information technology and computer science; Information management and numerical methods					
Learning objectives	The principal objective of the present course is to introduce the student to new phenomena as river dynamics. The students learn how to evaluate the principal sediment transport characteristics models. The students learn and apply concepts threshold of motion, dynamic stability, and flow regimen, local and general scour.					
Content:	The river, Sediment characteristics, Grain size distribution , Characteristics of a river, The energy equation, Flow resistance equations, Manning, law profile Karman hypothesis, Keulegan equation, Mannig striclker, Momentum equation, the bed stress. The hydraulic jump, Back water curves. The step method for back water curves, excel application. How to use Hec Ras, modelling a river. Shields diagram. Bed and bank stability. QGIS and GisWater for Hec Ras. Advanced flow resistance Bed form flow resistance. Vegetation flow resistance. Type of sediment transport. Dynamic equilibrium. Sediment transport formulations. Sediment transport examples with excel. Erosion, sedimentation process and 1D Morphodynamics. The exner equation. Examples. Local scour at bridge piers and abutments, local scour at contractions. Other structures. Spur dikes, Sills, Odgaard vanes, Scour control systems. Diversion and union of Rivers. The patia River, The Dique channel – Case Study. Bank erosion and bend scour.					
Course structure:	1. Conventional class activities 2. Optional seminars 3. Personal course work 4. Round table will be planned to discuss the results of the home work.					
Didactics	Formal lectures; classroom exercises; home assignments; exercises & workshops in computer lab					

Implication of Global warming on Floods and Droughts						
The module is compulsory						**3 ECTS Credit Points**
Mentor:	Prof. dr. Allen Bateman					
Tuition form & study load:	*Topic*	*Contact hours*			*Study load [hrs]*	*Examination/weight*
		Lect-ure	*Exer cise*	*Work shop*		
	Climate change effects on Hydrological cycles. Drought management. Water resources management on climate change scene. (total contact hours 42)	2 5 3	2 5 3	4 10 8	10 20 15 Total 45	Exercises reports on three topics (10%) (30%) (20%) & oral exam (40%)
Pre-requisites:	Hydrology and Hydraulics; Fluid dynamics, information technology and computer science; Flash Flood, Drought and Climate change; Information management and numerical methods					
Learning objectives	Description of global warming and the hydrological consequences into a river basin is presented to the student; river flows and water resources. Assess the effect of climate change due to green effect mechanism. Change in water resources and river flows over time and finally changes in water quality. A short introduction of drought assessment and management affected by the global warming effect is studied. Hydrological and meteorological droughts assess. Study of climate generators its utilities and difficulties.					
Content:	Global warming and the impact on river flows and water resources. What is Climate Change? The greenhouse effect, climate change and the hydrological processes in Flood, FF and DF forecasting. Changes in water resources, Changes in Flow regimes, implications of water management. Global Warming and Hydrological Uncertainty, River flood management, Evaluation of Meteorological Drought, Evaluation of hydrologic drought, Drought in water management, Parametric and no parametric climate generators					
Course structure:	1. Conventional class activities 2. Optional seminars 3. Personal course work 4. Round table will be planned to discuss the results of the home work.					
Didactics	Formal lectures; classroom exercises; home assignments; exercises & workshops in computer lab					

<table>
<tr><td colspan="5">Coastal flooding: Impacts, Conflicts and Risks</td></tr>
<tr><td colspan="3">The module is compulsory</td><td colspan="2">3 ECTS Credit Points</td></tr>
<tr><td>Mentor:</td><td colspan="4">Prof. dr Agustín Sánchez-Arcilla</td></tr>
<tr><td rowspan="2">Tuition form & study load:</td><td>Topic</td><td>Contact hours</td><td>Study load [hrs]</td><td>Examination/weight</td></tr>
<tr><td>Coastal flooding
Estuarine areas
Impacts, Conflicts, vulnerability and resilience

(total contact hours 42)</td><td>42</td><td>100

Total 100</td><td>Conventional exam and/or a case study (100%)</td></tr>
<tr><td>Pre-requisites:</td><td colspan="4">Hydrology and Hydraulics</td></tr>
<tr><td>Learning objectives</td><td colspan="4">The principal objective of the module is to present the coastal zone as a dynamic zone submitted to an increase in pressures of use and, thus, with a high level of risk for the infrastructures/activities that "rigidize" it. To present the main driving factors for coastal dynamics in terms of the risk that they produce and how risk does develop, how to manage risk and its perception by the “agents” that live at and use the coast.</td></tr>
<tr><td>Content:</td><td colspan="4">Introduction to the subject. Coastal zone. Estuarine areas. Dynamics and risks. Evaluation of environmental impacts in the marine environment. Environmental control at the costal zone. Precipitation, floods and river mouth discharges. Erosion and flooding risks at the coastal fringe. Pollution risks. Sources, dispersion and evolution. Vulnerability, resilience and risk. Operational models and services. Risk management.</td></tr>
<tr><td>Course structure:</td><td colspan="4">1. Conventional class activities
2. Optional seminars
3. Personal course work
4. Round table will be planned to discuss the results of the home work</td></tr>
<tr><td>Didactics</td><td colspan="4">Formal lectures; classroom exercises; home assignments; exercises & workshops in computer lab</td></tr>
</table>

Debris Flow and Flash Flood: Risk, Hazard, Vulnerability and Resilience concepts	
The module is compulsory	**5 ECTS Credit Points**
Mentor:	Prof. dr. Allen Bateman

Tuition form & study load:

Topic	*Contact hours*			*Study load [hrs]*	*Examination/weight*
	Lect-ure	*Exer cise*	*Work shop*		
Debris Flow, concepts and modelling.	7	7	10	25	Exercises reports on five topics 2 x (15%) 2 x (10%) 1 x (5%) participation (5%) Exam (40%)
Flash Floods, concepts and modelling.	7	7	10	25	
Drought concepts and modelling.	4	4	9	10	
Vulnerability and Uncertainty	4	4	9	10	
Experimental works (Fluvial Morphodynamics Laboratory GITS) and field trip to a case study.	2	2		12	
(total contact hours 86)				Total 82	

Pre-requisites:	Hydrology and Hydraulics; Fluid dynamics, information technology and computer science; Information management and numerical methods
Learning objectives	The principal objective of the present course is to introduce the student to new phenomena as the debris flow and flash flood. The students learn how to evaluate the debris flows and flash floods mathematics and how to delimitate flooded areas, and also to calibrate and create new models. The students learn and apply concepts as risk, vulnerability and resilience.
Content:	Description of debris flow phenomenon and basic concepts are presented. Description and definition of flash flood assessment. This course transport to the student to new concepts on flood phenomena produces by debris or water. The student learns mathematical models adapted to both phenomena, learn how to apply different rheologies. Learn to create flood (debris or water) risk maps from simple and complex models. Debris Flow theories, triggering variables, rheology, mathematical modelling. Debris Flow modelling aspects, 0D, 1D and 2D numerical models. Delimitation of occurrence zones and run-off. Shalstab, Triggs, Sinmap, FLATModel (Gits-2d Model), GITS1D. Flash Flood modelling and analysis. Simplified methods.The socio economical aspects at the Maresme Basins, usually basins with high level of risk and FF events. Translation of hydraulic models output variables into hazard. Scouring. Construction of Hazard Maps from DF & FF. Using GIS and different models (Hydraulic and Debris kinds)
Course structure:	1. Conventional class activities 2. Optional seminars 3. Personal course work 4. Round table will be planned to discuss the results of the home work.
Didactics	Formal lectures; classroom exercises; home assignments; exercises & workshops in computer lab

<table>
<tr><td colspan="5">Application of Radar-based Rainfall Observations and Forecasts
In Early Warning Systems and Flood Forecasting</td></tr>
<tr><td colspan="2">The module is compulsory</td><td colspan="3">4 ECTS Credit Points</td></tr>
<tr><td>Mentor:</td><td colspan="4">Prof. dr Daniel Sempere Torres</td></tr>
<tr><td rowspan="2">Tuition form & study load:</td><td>Topic</td><td>Contact hours</td><td>Study load [hrs]</td><td>Examination/weight</td></tr>
<tr><td>Quantitative precipitation estimates (QPE) using the radar data
Hydrological application of radar QPE
Precipitation Forecast (QPF) based on radar rainfields
Application of rainfall forecast in operational early warning systems

(total contact hours 50)</td><td>50</td><td>100</td><td>Conventional exam and/or a case study (100%)</td></tr>
<tr><td>Pre-requisites:</td><td colspan="4">N.A.</td></tr>
<tr><td>Learning objectives</td><td colspan="4">Flood risk management and decision making is highly dependent on rainfall forecast and the use of meteorological radar has become a useful tool in rainfall forecast. The principal objective of this module is to show how research and methodologies regarding the application of radar measurements within hydrologic forecast has been improved in the last decades and how operative early warning systems are taking advantage of high spatial and temporal resolution radar-based rainfields.</td></tr>
<tr><td>Content:</td><td colspan="4">The application of radar-based rainfall observations and forecast in Early Warning Systems and Flood Forecasting.
- Principles of quantitative precipitation estimates (QPE) using radar data. Associated errors and correction methods.
- Hydrological applications of radar QPE. Derived products for water management. Short term Quantitative Precipitation Forecast (QPF) based on radar data. Applications in real time and historical series reanalysis.
- Processes and elements of a hydrological forecasting system based on QPE and QPF.
- Simplified Early warning systems based on radar QPE and QPF. The European Flood Alert System (EFAS): A case study.
- Fieldtrips, visit to Hydrometeorological and Civil Protection agencies (SMC, Consell Comarcal Maresme, ACA, CECAT)</td></tr>
<tr><td>Course structure:</td><td colspan="4">1. Conventional class activities
2. Optional seminars
3. Personal course work
4. Round table will be planned to discuss the results of the home work</td></tr>
<tr><td>Didactics</td><td colspan="4">Formal lectures; classroom exercises; home assignments; exercises in computer lab</td></tr>
</table>

Univerza *v Ljubljani*

III Semester
2nd part at University of Ljubljana

Spatial Planning for Flood Protection						
The module is compulsory						**5 ECTS Credit Points**
Mentor:	Prof.dr Andrej Pogačnik, Prof.dr Mitja Brilly					
Tuition form & study load:	*Topic*	*Contact hours*			*Study load [hrs]*	*Examination/weight*
		Lect-ure	*Exer cise*	*Work shop*		
	Introduction and to spatial planning, foundations of sustainable planning and overview of legal foundations of spatial planning	14		6	30	Written exam (20%)
	Planning with respect to flood protection on state, regional and local levels	10		15	55	Written exam & exercises (40%)
	Local and site planning with respect to flood control and protection and flood mitigation by spatial planning	10		15	55	Written exam & exercises (40%)
	(total contact hours 70)				Total 140	
Pre-requisites:	N.A.					
Learning objectives	- Overview of principles of sustainable planning on different scales - Knowledge of the aims, methods and techniques of spatial planning - Understand the problems of water management and flood control in the open channels and within settlements - Ability for team work on regional, urban and local plans with respect to flood Control -Design flood control together with land use planning, planning the infrastructure, nature 2000 other protected areas					
Content:	**Introduction and to spatial planning, foundations of sustainable planning and overview of** **legal foundations of spatial planning A. Pogačnik (UL)** Overview of state of the art in spatial planning in EU countries. International planning. Planning on state level. Regional planning. Urban and landscape planning. Local and detail planning. Flood control on all level of spatial planning. Legal aspects of spatial planning. Comprehensive and sect oral planning. Sustainable planning. Examine of good practice.					
	Planning with respect to flood protection on state, regional and local levels, Local and site planning with respect to flood control and protection and flood mitigation by spatial planning A. Pogačnik (UL) M. Brilly (UL) Methods and techniques. Site analysis. Spatial data collection and procession. Attractiveness, Vulnerability Mapping, Flood impact analysis, environmental impact analysis and spatial planning. Methods and techniques of urban planning with respect to flood control. Project planning and flood protection by structural and non-structural measures. Workshop: Students work out together a plan of a region or town in terms of its development and flood control					

Course material:	Colley B.C. Practical manual of land development, Mc Graw Hill, 2005 De Chiara Time saver standards for regional development Fukuoka S., Floodplain riska management, Balkema AA, 1998
Didactics	Formal lectures; classroom and home workshops; field work on case study analysis
Additional reading:	EU commission: European spatial development and floods directives CESDP, POTSDAM // FLOODS Directive 1999 // Stiftel B.,Watson C., Dialogues in urban and regional planning. Routledge Espon Atlas selection topics, 2005 // Wegener M. Button K., Nijkamp P., Planning history and methodology, EE Pugusnik, UK selected topics, 2007 // The World Bank, Environmental assessment source book, Washington, Chapters 1-3, 1991 // EU flood research reports, AWARE, URBEM

<table>
<tr><td colspan="7">Socio-Economical Assessment of Flood Protection</td></tr>
<tr><td colspan="3">The module is compulsory.</td><td colspan="4">5 ECTS Credit Points</td></tr>
<tr><td>Mentor:</td><td colspan="6">Prof.dr. Brilly M. Prof.dr Kos D., Prof.dr Polič Prof.dr M. Kovač B.</td></tr>
<tr><td rowspan="5">Tuition form & study load:</td><td rowspan="2">Topic</td><td colspan="3">Contact hours</td><td rowspan="2">Study load [hrs]</td><td rowspan="2">Examination/weight</td></tr>
<tr><td>Lect-ure</td><td>Exer cise</td><td>Work shop</td></tr>
<tr><td>Introduction in socioeconomics aspect of water policy and flood protection</td><td>8</td><td></td><td>10</td><td>40</td><td rowspan="3">Exercise report (10%)

Written exam & exercises (45%)

Written exam (25%)

Exercise report (20%)</td></tr>
<tr><td>Involve of stakeholders and public in communication and decision making process</td><td>12</td><td></td><td>14</td><td>50</td></tr>
<tr><td>Economy of flood protection

(total contact hours 70)</td><td>14</td><td>4</td><td>8</td><td>50

Total 140</td></tr>
<tr><td>Pre-requisites:</td><td colspan="6">N.A.</td></tr>
<tr><td>Learning objectives :</td><td colspan="6">After completing the module participants should be able to:
- Understand the importance of socioeconomics questions in flood management
- Understand the role of communication and public participation in decision making process;
- Estimate level of social support of particular solution;
- Have acquired a basic understanding of social processes and estimate social capital;
- Select proper methods and tools for economical analysis of flood protection</td></tr>
<tr><td rowspan="3">Content:</td><td colspan="6">Introduction in socioeconomics aspect of water policy and flood protection, Brilly M. (UL)
Basic principles of water policy. Social and economical aspects of decision making process. Different cultural and political aspect in up-down and down-up decision making process. Historical overview.</td></tr>
<tr><td colspan="6">Understanding o social assessment problems of flood protection, D. Kos (UL), Polič M. (UL)
Communication and public participation in water policy (Aarhus c.). Sociological aspects of flood risk perception. Legitimization and communication of emergency information. Public opinion vs. expert knowledge. Public perception of floods and emergency information vulnerability. Stakeholders competences in communicating flood warnings</td></tr>
<tr><td colspan="6">Economy of flood protection, Kovač B. (UL)
Cost-benefit analyse of flood protection measures and decision making. Economical methods for damage evaluation. Economic incentives for flood prevention and regulative aspects. Risk management.</td></tr>
<tr><td>Course materials:</td><td colspan="6">Becker H., Social Impact assessment, UCL Press, London, 1997.
Harper L.C., Environment and Society – human perspective on environmental issues, Pearson, New Jersey, 2004
Milleti D.S., Disaster by Design, Joseph Henry Press, 1999</td></tr>
<tr><td>Didactics</td><td colspan="6">Formal lectures; home assignments; classroom workshops on case study analysis.</td></tr>
<tr><td>Additional reading:</td><td colspan="6">Public Participation in Making Local Environment Decisions, (2000) The Aarhus Convention // Newcastle Workshop. London: Good Practice Handbook, Department of the Environment //Hart U.R.P., Flood response and Crisis Management in Western Europe, Springer, 1998 //Correira F.N., Institutions for Water Resources management in Europe, AA Balkema, 1998</td></tr>
</table>

IV Semester

Master thesis in one of the partner institutes or with the Associated Partners