School of Civil and Environmental Engineering (SCEE)
National University of Sciences & Technology

Course Title: Climate Change & Hydrologic Cycles

Course Code: CE-834

Course Objectives

- To get familiar with the application domains of hydroinformatics, with focus on the environment.
- Understand and explain the chemical and biological processes affecting water quality in the natural environment.
- Get experience in several modeling paradigms to represent the environmental and ecological processes.

Course Outcome

After the completion of the course, the students will be able to:

- Explain the principles of modeling land use change and climate change, and develop probabilistic risk assessments.
- Have a more ecologically sound approach to river basin management whereby emphasis is placed on allowing the physical processes to drive the ecological healing by natural evolution, rather than an instantaneous engineering fix.

. Course Contents

Application domains of Hydroinformatics: floods, urban systems and environment
Introduction to floods and flooding. Introduction to urban floods and urban water systems. Introduction to environmental systems.

Climate change and its impact on hydrology
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 modeling, global, regional and local climate models, development of climate change scenarios**.**

Environmental processes and water quality
Environmental processes. Water quality problems from a modeling point of view: outfalls, BOD-DO, eutrophication, toxic substances, best technical means approach, water quality objectives approach; Properties of the natural system from a modeling 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.

Spatial Modeling using PCRaster and Land use modeling using CLUE
The PCRaster Environmental Modeling language is a computer language for construction of iterative spatio-temporal environmental models. It runs in the PCRaster interactive raster GIS environment that supports immediate pre- or post-modeling visualisation of spatio-temporal data. Introduction to land use modeling in relation to water modeling and management; Modeling scenarios of land use change and the impacts and feedbacks on the hydrological system; Handson training for the tool CLUE.

Probabilistic assessment of environmental risks

The concepts of environmental vulnerability, hazard, risk. Description of the most common sources of uncertainty and variability in the risk assessment process. Deterministic and probabilistic risk assessment. Example applications of probabilistic approaches for assessing risk.

Downscaling of climate change scenarios

Introduction to the concept of downscaling, general downscaling methods used to fit GCM data into catchment modelling in studying climate change impacts on local scale. Exercise: downscaling for a river basin.

Climate change and uncertainty

Analysis uncertainties related to climate change. Application of Monte-Carlo and other sampling based methods. Bayesian averaging and model ensembles. Exercise: uncertainty analysis of the SWAT model

Recommended / Reference Books:

The readings will be assigned from the text given below. Additional readings will be assigned to supplement the text.

- Marc Bierkens, Han Dolman, Peter Troch, "Climate and the Hydrological Cycle", IAHS Special Publication, 2008.
- Relevant research articles.