Title of the course: **Water Resources Systems**
Course Instructor: Dr. Saroj Chapagain, Dr. Geetha Mohan and Dr. Giulia Roder

Course description:
Rapid population growth, changes in lifestyle, climate, landuse etc. have made sustainable management of water resources a very complex task. This course aims to provide a broad understanding of the hydrological processes, global environment changes and how they are related to sustainability of water resources systems. This course will introduce the characteristics of major components of water cycle; rainfall, groundwater flow, water sanitation, and the role of remote sensing, GIS, risk analysis, role of water resource planning, climate projections, development impacts and economic analysis in understanding and managing water resources systems. The course will also examine various issues related to water resources and sustainability through case studies and field visit.

Learning Outcome:
The students will gain a comprehensive overview of water and its relation to human and environmental well-being. The students will be able to understand water related issues and tools to manage water-related problems.

Topics covered

Day 1: Introduction of water resources systems
Water terminology, hydrological cycle, water budget, water availability/consumption
Day 2: Challenges for sustainable water resource management
Sustainability concept, water challenges for sustainable development, water resource management policies and tools
Day 3: Development impacts of improved water resources management
Socio-economic and environmental impacts (case studies)
Day 4: Climate change and water resources
Concept, climate projections, climate change impact studies
Day 5: Water resources and extremes
Floods and drought risk
Day 6-7: Groundwater hydrology
Aquifer properties (confined/unconfined) its relationship in context of GW recharge; groundwater movement; basic Darcy's law; well hydraulics
Groundwater contamination and its issue
Groundwater quality, point source, non-point source contamination, highlight with example contaminant model and its importance, integrated watershed management
Day 8: Human health: water sanitation and pollution
Basic environmental sanitation and impact on water resources
Day 9: Water for well-being
Water conflicts and migration. Women and water
Day 10: Economic analyses for water resources
Cost-benefit analysis
Day 11 & 12: Remote Sensing and GIS applications
Sensors; image processing; online data sources; watershed delineation; use of ArcGIS software (Theoretical and practical lesson)
Day 13: Field visit
Day 14: Report/Presentation by students
Day 15: Written examination

Assessment Criteria:
Assessment will be based on class attendance, presentation and discussion, a short final test and extended essay with the following allocations;

- Active attendance: 20 % of total marks (80 % attendance is required)
- Assignment: 30% of total marks (Critical review on topics chosen by the students based on the above lectures)
- Presentation: 20% of total marks (15 minutes presentation on water resource systems including question and answers, maximum number of slides not more than 10)
- Written examination: 30%

Reading materials:

- Water Resources Engineering by Larry W. Mays, John Wiley & Sons, 2nd Edition, 2010.
- Applied Hydrology by Ven Te Chow, David R. Maidment, Larry W. Mays, McGraw-Hill Publishing Company; International edition (1988/09).
- IPCC AR5 WG 2 Summary report for policy makers, 2014.
- World Water Assessment Programme (2009): The United Nations World Water Development Report 3. Water in a Changing World, UNESCO, Part 1 (Ch. 1, 3, 5), Part 2(Ch. 7, 8), Part 3(Ch. 10,11)
- Water Evaluation and Planning System (2012): A collection of stand-alone modules to aid in learning the WEAP software (http://www.weap21.org/index.asp?action=213)
- Remote sensing and GIS for Water Resources Management, Version 2, IIT, Kharagpur (http://nptel.ac.in/courses/105105110/pdf/m6l03.pdf)
- Example of the use of CropWat 8.0
- (http://www.fao.org/nr/water/docs/CROPWAT8.0Example.pdf)
- FAO Irrigation and Drainage Paper No. 56, 1998. Crop Evapotranspiration – guidelines for computing crop water requirements
- Daene C. McKineey (2013): Chapter 2. Economic Analysis of Water Resources, http://www.caee.utexas.edu/prof/mckinney/ce385d/Papers/EconNotes.pdf