Professional Master (PM) and Master of Science (MSc) courses

Water Resources and Environmental Management

September 2004

New generations of satellites and sensors, and developments in geo-information technology and hydrological modelling have had a huge impact on the methods and techniques available for dealing with water resources and environmental management. New developments have made it possible to determine from space spatial rainfall and even actual evapotranspiration and crop yields, as well as to produce accurate land cover maps. Both automated data acquisition systems on the terrain and web-based databases provide a wealth of data for applied research. Those involved in studying and solving problems in water resources - even in data-scarce areas - and developing plans for the sustained use of water should benefit from this improved data supply. The Water Resources and Environmental Management programme exposes participants to the latest developments in assessment and monitoring techniques using geographical information systems (GIS), remote sensing, public domain data and models.

What will be achieved?

Participants will learn how to use GIS, remote sensing and modelling in the field of water resources and environmental management. Applicability and fieldwork play a crucial role, enabling participants to acquire a thorough working knowledge of modern tools and methods. Skills will be developed in using GIS, remote sensing and models for irrigation management, integrated catchment hydrology, and groundwater and/or environmental hydrology.

Through real-life case studies the participants will be exposed to new methods of solving problems related to water resources. Software for GIS, remote sensing and public domain models is provided so that participants will be able to apply their acquired skills back in their own organisations. The research concluding the study can focus on topics related to the participants' own jobs and may even be partly carried out in their own organisations.

Course content and structure

The courses are composed of a series of three-week modules. There are four types of module: core modules, programme modules, specialisation modules and elective modules.

Core modules

The core modules deal with the theory, tools and techniques of GIS and remote sensing. Knowledge of the principal concepts of spatial data acquisition through remote sensing and spatial data handling with GIS is supplemented by developing the practical skills required to apply these tools. A strong component of specialisation exercises and study cases within the core modules provides the opportunity to develop a full understanding of their relevance to water resources and environmental management.

Programme modules

The programme modules introduce participants to the use of computational methods in hydrology. A focal point is the use of GIS and remote sensing for the quantification of components such as precipitation, evapotranspiration, runoff, infiltration and groundwater flow. Water quality indicators also come under scrutiny, as do skills in the use of geostatistical methods.

Specialisation modules

Specialisation modules are offered in two directions. Participants of either specialisation can opt for a course consisting of four modules on the Advanced Use of Remote Sensing in Water Resource Management, Irrigation and Drainage (Satellite Hydrology). This course is also offered as short course.

Groundwater Resources Evaluation and Management

Groundwater is the earth's largest freshwater source; it forms a buffer of good-quality water for drought periods. However, this resource is being increasingly used and is threatened by over-exploitation, contamination and expected climatic changes. This specialisation focuses on the applied knowledge of the processes of the saturated and unsaturated zones and the use of modern techniques for the sustainable management of groundwater.

The specialisation covers:

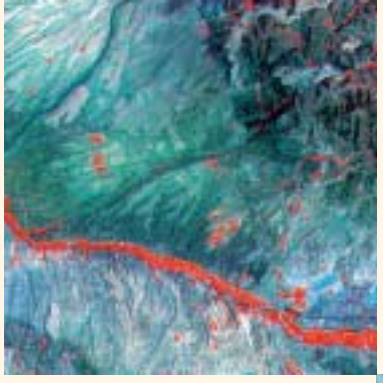
- the use of remote sensing and geophysics to determine groundwater occurrence
- the use of remote sensing and geophysics for exploration purposes
- the use of GIS and remote sensing for monitoring groundwater recharge and evapotranspiration
- environmental monitoring, including automated data acquisition systems and data integration
- modelling for purposes of assessing and managing groundwater, artificial recharge and irrigation
- the use of GIS and remote sensing for mapping aquifer vulnerability and water quality.

Geo-information and Earth Observation for Integrated Catchment and Water Management

There are two streams within this specialisation:

(1) Watershed Management

Watershed Management focuses on water quantity and on hydrological and erosion processes in small- to medium-



scale watersheds. A variety of topics are covered and include:

- surface water resource assessment for water resources development
- rainfall-runoff and erosion modelling
- spatial modelling and satellite image processing
- interpretation related to the physical processes in watersheds
- water harvesting and other soil and water conservation methods.

(2) Environmental Hydrology

Environmental Hydrology deals with the environmental aspects of hydrology and water resources, including water quality management and the environmental impacts of water resource projects. The key elements are:

- spatial analysis and interpretation of hydro-geochemical and water quality data
- environmental monitoring and assessment, where the aim is to strengthen participants' ability to collect, analyse and interpret environmental data, and where exposure is given to field sampling, automated data logging, environmental laboratory practice and reporting
- water quality hydrology and water systems modelling.

In both specialisations a three-week course is given on scenario analysis and multicriteria evaluation, with topics such as decision-making processes, support systems and the selection of interventions.

Optional course

Advanced Use of Remote Sensing in Water Resource Management, Irrigation and Drainage

Irrigation systems have to produce more food from less water resources. Remote sensing techniques can be used extensively as a tool for improving irrigation and water resources management. This course explores the data and physical background needed for implementing these remote sensing techniques. It also addresses the processing to acquire hydrological data from time series of satellite images. The remote sensing methods are also useful in managing rainfed agriculture and protecting ecologically sensitive wetland areas.

The key elements of this course are:

- image acquisition from Internet archives
- preprocessing techniques for geometric and radiometric image correction
- solutions to the energy balance problem, combining ground meteorological data with low- and high-resolution imagery in order to determine actual evapotranspiration and latent heat fluxes
- applications in irrigation management, such as irrigation performance, water productivity, crop classification, yield forecasting, soil salinity and environmental impact assessment.

Inter-specialisation Geo-information Management

Participants may elect to follow the Geo-information Management interdisciplinary specialisation spanning modules 9 to 12.

Participants should have an interest in working with geodata and geo-information technology to improve the quality and performance of organisational processes. These processes can range from data capture, via planning and analysis, to monitoring and decision support information provision. Participants will study:

- the geo-information flow within an organisation,
- implementation of GIS capacity within an organisation (including third party support)
- information system development and appropriate ways of introducing geo-ICT into the organisation (including aspects of technical, financial and human resource development).

Elective modules

All ITC participants may choose from a variety of elective modules offered simultaneously by all ITC's scientific departments. For the PM course, two such electives are scheduled; for the MSc course three. Examples of modules related to water resources include Hydrological and Environmental Monitoring Techniques; Modelling Water Erosion, Sediment and Chemical Transport; Project Planning, Formulation and Funding; Geophysics for Aquifer Modelling; Environmental Impact Assessment.

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