CE 408 Water Resources Engineering

Co-ordinator: Dr. A.P. Butler**,** Room 306, a.butler@imperial.ac.uk

Status: Environmental Elective

Lecturers:	Dr. A.P. Butler, (APB) Dr. C.J. Onof, (CJO), Room 410 N. McIntyre, (NM), Room 310A
Structure:	54 hours of lectures, tutorials, computer workshops and associated coursework.
Links:	CE201, CE204, CE302, CE407 & CE411

Introduction

Drinking water is essential for human survival, and provision of a reliable water supply is a pre-requisite for social and economic development, both in the developed and developing world. Water Resources Engineering seeks to achieve this goal in a quantitative and sustainable manner.

Aims

The module is concerned with the identification, design and management of surface water and groundwater resources. It considers the hydrological processes that can be managed to sustain a reliable yield, and develops mathematical modelling methods for the simulation of surface and groundwater systems and places these within a risk management framework. It introduces techniques of reservoir design to account for climatic variability, and methods of systems analysis for optimal resource management. Integrated river basin management is discussed in the context of optimal use of resources, water quality constraints and minimisation of adverse environmental impacts. The development of groundwater as a resource is also considered, along with and the fate and transport of pollutants and the need for groundwater protection in order to ensure a sustainable resource.

SYLLABUS:

1. Introduction to Water Resources: Current issues in water resources engineering; hydrological processes; measuring fluxes; calculating catchment water balances. (6 hours)
2. Water Resources and the Hydrosocial Cycle: aspect of man's use of water and the problems it raises. (1 hour)
3. Water Demand: Introduction to the management and forecasting of water demand. (1 hour)
4. The Economic Nature of Water Resources: An overview of the specific nature of water resources project from an economic point of view - project duration and economy of scale. (1 hour)
5. Reservoir Design: Introduction; critical period design techniques: mass curve methods and methods based upon low flow sequences (6 hours). Probability Matrix methods (4 hours)
6. Reservoir Operation: Methods for decision-making in operational mode (2 hours)
7. Rainfall-runoff modeling: Introduction to rainfall-runoff modelling. The unit hydrograph, linear and non-linear storage models, advanced conceptual

modelling, regression and transfer function models. Includes a case study and a computer workshop (7.5 hours).

8. Surface water quality modelling: Introduction to surface water quality modelling. Plug-flow and fully mixed systems, partially mixed rivers, and non-conservative modelling. Integrated rainfall-runoff and water quality modelling. Includes a case study and a computer workshop (7.5 hours).
9. Groundwater Resources Management - Quantity: Introduction; resource exploration and evaluation; well pumping tests for yield assessment and hydrogeological parameter determination; use of modelling techniques for aquifer management. (6 hours)
10. Groundwater Resources Management - Quality: Groundwater quality and contaminant transport; groundwater vulnerability and source protection through risk assessment and management. (6 hours); computer lab. (3 hours)

Coursework and submission dates

Design of a surface water storage reservoir*:*

Development of a program to calculate net rainfall using supplied climate data, followed by the application of the obtained time series to investigate the design of a water supply reservoir in central England. *Issue dates: Part A 15 November 2004; Part B 13 December 2004. Submission deadline: 13 January 2005.*

Water Quality Modelling

A short (1 week) assessed assignment on the application of water quality modelling techniques will be set during the middle of the spring term.

Assessment

One 3-hour examination during the summer term and 2 pieces of coursework. 40% of the allotted mark for this module will be given for the projects described above (weighted 32% and 8%) and 60% for a 3-hour written examination in April/May, the written examination carries the rubric, “Answer 5 questions, (out of a total of 8 questions)”.

Recommended Textbooks/Reading:

Detailed handouts during lectures.

BEVEN, K. J. (2000) Rainfall-runoff modelling : the primer, Wiley.

DOMENICO, P.A. AND SCHWARTZ, F. (1997) Physical and Chemical Hydrogeology, 2nd Ed, Wiley.

FETTER, C.W. (1994). Applied Hydrogeology, MacMillan.

LINSLEY, R.K., FRANZINI, J.B. AND FREYBERG, D.L. (1992). Water Resources Engineering, 4th Edition, Mcgraw-Hill.

MAYS, L.W. AND TUNG, Y-K. (1992). Hydrosystems Engineering and Management. McGraw-Hill.

PRICE, M. (1985). Introducing Groundwater, George Allen and Unwin.

SHAW, E.M. (1994) Hydrology in Practice, 3rd Edition, Van Nostrand Reinhold.

CHAPRA, S.C. (1997) Surface Water Quality Modelling, McGraw-Hill.

CHAPRA, S.C. AND CANALE, R.P. (1998) Numerical Methods for Engineers, 3rd Edition, McGraw-Hill.

Learning Outcomes

- understand individual hydrological processes and their integrated behaviour in catchments
- understand the processes controlling the fate and transport of contaminants in hydrological systems

- appreciate the use of modelling techniques for water resources management, and an ability to construct and apply a range of models.