

WATER QUALITY MONITORING ASSESSMENT & MANAGEMENT



GEMS/WATER

*A Guide to the Modular
GEMS/WATER Training Programme*

WATER QUALITY MONITORING,

ASSESSMENT AND

MANAGEMENT

**A GUIDE TO THE MODULAR
GEMS/WATER TRAINING PROGRAMME**

Edited by
Robens Institute
University of Surrey

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PREFACE

The establishment, sustainable development and operation of national or regional networks for the monitoring of water quality requires not only considerable investments into laboratory installations, sampling equipment, etc., but also technicians, chemists, data experts and other supporting professionals at different levels. This crucial role of capacity building was already recognised at the outset of the GEMS/WATER programme as expressed in one of its three long-term objectives:

"To strengthen national water quality monitoring networks in developing countries, including the improvement of analytical capabilities and data quality assurance."

As the major capacity building activity in support of water quality monitoring, GEMS/WATER has been providing a large number of training courses, workshops and seminars on a variety of subjects. These were delivered through the collaborating centres in their respective areas of expertise.

Due to the success of this programme and the high demands expressed by network participants, it was agreed by the GEMS/WATER Steering Committee to develop a comprehensive guide which compiles all training course opportunities currently available from collaborating centres in the global network. The aim of this guide is to provide water resources management authorities, water surveillance agencies, regulatory bodies and external support agencies with detailed information about readily available training courses. Course descriptions cover aims, target audiences, course contents and the more practical organizational details. The guide also provides examples on how a series of courses can be packaged into a modular training programme for a specific target group of trainees.

The guide should thus not only assist countries in formulating and presenting their training needs but also stimulate the organization of training opportunities by bilateral and multinational support agencies. One particular avenue of training promotion is the Framework Agreement for Cooperation in Capacity Building between UNEP and UNDP, signed on 28 November 1995, which should facilitate the awareness of developing countries about the training opportunities available in the area of water quality monitoring, assessment and management.

The UN organizations cosponsoring the GEMS/WATER programme are grateful to the Robens Institute, University of Surrey, for collecting and presenting the information from the other collaborating centres in this Guide. In particular, Jennie Lynch and Guy Howard have dedicated considerable time, energy and persistence to compile in this Guide a truly comprehensive package of training courses, novel and unique in the area of water quality.

Walter Rast
UNEP

Richard Helmer
WHO

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PART I

INTRODUCTION

INTRODUCTION

Background

Water quality, resource management and their impacts on human health are amongst the most important global issues. With finite freshwater resources and increasing demand, both in terms of quantity and variety of uses, the need for water resource protection and management has never been greater. Consequently, policy makers, engineers and scientists in both the public and private sectors are facing increasing pressures to improve environmental performance and reduce the risks to human health.

In order to adequately manage water resources, protect them from pollution and maintain a suitable quality of water, it is essential to possess information about both the naturally occurring and anthropogenically induced changes in water quality. This requires the establishment of sustainable programmes of water quality monitoring and assessment which are designed to meet management needs and facilitate decision making. Thus, more than ever, there is a need for flexible high-quality training in all areas of water quality monitoring, assessment and management.

As part of the UNEP/WHO/UNESCO/WMO global freshwater monitoring programme known as GEMS/WATER, a number of capacity building initiatives have been developed for the freshwater sector over the last 10 years. These integrated training activities have now been brought together in a modular training programme on water quality monitoring, assessment and management.

Characteristics of the Modular Programme

The modular programme is based on a linked series of short courses. Each of the courses (or modules) described in this guide are of one or two weeks duration and between them cover all aspects of freshwater quality monitoring and assessment; a synopsis is presented overleaf. Each module may either be delivered as an individual short course to meet a specific training need, or alternatively as part of a structured training programme covering several aspects of water quality monitoring, management and assessment. Whilst some suggested module combinations are included in Part 3 of this guide, it should be emphasised that these are not the only possible combinations and individual programmes can be designed to meet specific needs.

Each module is designed to provide participants with a thorough understanding of the key concepts and their practical application. In recognition of the varied

MODULAR TRAINING PROGRAMME

Introductory Modules:

- *Introduction to Monitoring and Assessment, Module 1, p5*
- *Advanced Monitoring: Network Evaluation/Optimization and Modernization of Programmes, Module 2, p11*

Analytical Control and Laboratory Operations Modules

- *Laboratory Establishment and Operations, Module 11, p49*
- *Advanced Laboratory Management, Module 12, p53*
- *Quality Assurance in Laboratory Management, Module 13, p57*
- *Advanced Quality Assurance and Inter-Laboratory Comparison, Module 14, p61*

Water Body Specific Modules

- *River Water Quality Monitoring Data Assessment, Module 3, p15*
- *Lakes and Reservoir Water Quality Management, Module 4, p21*
- *Groundwater Pollution Risk Assessment and Protection, Module 5, p25*
- *Groundwater Quality Assessment, Module 6, p29*

Information Management

- *Water Quality Data Management Software (RAISON/GEMS), Module 15, p65*
- *Advanced Environmental Information Management, Module 16, p69*

Water Media Specific Modules

- *Hydrological Monitoring for Water Quality Assessments, Module 7, p33*
- *Sediment Quality: Monitoring and Assessment, Module 8, p37*
- *Field Biomonitoring, Module 8, p41*
- *Bioassay Laboratory Methods, Module 10, p45*

Pollution Control and Water Quality Management Modules

- *Drinking Water Supply Surveillance and Control, Module 17, p73*
- *Water Pollution Control: Regulatory and Technical Approaches, Module 18, p79*
- *Rapid Inventory Techniques and Assessment of Water Pollution Sources, Module 19, p83*
- *Wastewater Use in Agriculture and Aquaculture, Module 20, p87*

MODULES AVAILABLE IN FRESHWATER QUALITY MONITORING ASSESSMENT AND MANAGEMENT

needs in water quality monitoring, assessment and management worldwide, both foundation and advanced levels of training are available for many of the topic areas. This not only allows selection of courses to match participant requirements, but also facilitates the progressive upgrading of knowledge and skills.

By adopting the modular approach to larger capacity building programmes, training events can be interspersed with application in the work environment, thus allowing the integration of theory with practice and the consolidation of learning. Furthermore, the multiple contact with trainers and colleagues allows participants to feedback, discuss and review their experiences, thus resulting in more sustainable improvements in water quality monitoring, assessment and management.



Advantages of the Modular Approach

The success of the GEMS/WATER capacity building programme and other programmes adopted by the collaborating institutions has shown the validity of the modular approach. Advantages of this approach are:

- Wide range of modules available covering quality and quantity aspects
- Flexible format suitable for those in employment
- Increases availability of training to staff at all levels, particularly those at more senior levels who have limited time for study
- Enables expertise in water quality monitoring, assessment and management to be built up as needed
- Can be linked to practical application
- May be deployed 'in-country' at local institutions or regional centres
- Many modules may be given at national, regional level or river basin level
- A cost-effective approach

MODULAR TRAINING PROGRAMME

Guide Organization

The remainder of this guide is divided into 3 parts:

Part 2: Course Descriptions

Contains detailed descriptions for each of the 20 modules including: scope and purpose of the course; course design and programme; course organization.

Part 3: Modular Packages

Outlines suggested module combinations showing how individual programmes may be designed to meet specific needs.

Part 4: GEMS/WATER Training Institutions

Institute profiles of the GEMS/WATER sponsoring agencies and collaborating institutions.

PART II
COURSE DETAILS

COURSE 1
INTRODUCTION TO MONITORING AND ASSESSMENT

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To provide the conceptual and practical framework within which freshwater quality monitoring programmes can be planned and executed; and to introduce the GEMS/WATER programme.

1.2 Objectives

At the conclusion of the workshop, participants should:

- Be aware of the available freshwater quality monitoring techniques, including both laboratory and field based analytical methods.
- Be able to select techniques to be employed for water quality analysis and understand the appropriate use of simple field based techniques.
- Understand the procedure for planning of national and regional monitoring programmes and their refinement.
- Be aware of the need for monitoring of water quality as part of water resource management; and understand how monitoring data should be used to improve management of water resources.
- Be familiar with the basic aims, objectives and methodology for conducting quality assessments for all water bodies.
- Be able to design appropriate monitoring networks, select variables and interpret data to ensure valid water quality assessment.
- To familiarize participants with the GEMS/WATER programme and methods of participating.

1.3 Target audience

Professionals from the water, health or environment sectors. Ideally there will be a mixture of participants from all three sectors as this allows a greater degree of discussion.

2. COURSE PROGRAMME AND DESIGN

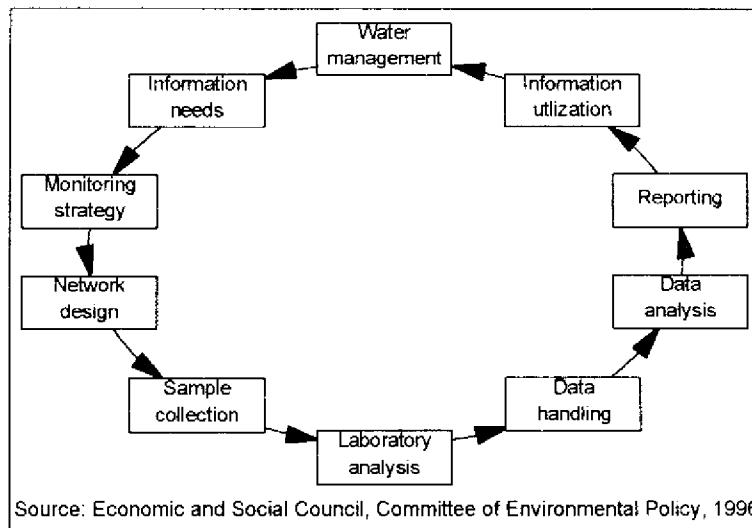
2.1 Course content

Introduction to water quality and defining water quality with respect to biological, chemical and physical parameters; water quality variation in all water bodies.

Strategies and planning of water quality assessments; establishing the aim of assessment, specific objectives and methodology; planning implementation of assessments - staffing, finance and analytical considerations.

Planning and strategies for freshwater quality monitoring programmes; designing monitoring programmes and sampling networks for short, medium and long-term monitoring of water quality; frequency of sampling, and; location of sample sites for surface and groundwaters.

Selection of water quality variables for monitoring programmes and water quality assessments; use of restricted parameters for monitoring programmes; use of expanded range of parameters; selecting appropriate ranges for different types of monitoring.



The use of particulate material in water quality monitoring and water quality assessments; methods for analyzing particulate matter; routine monitoring of particulate material.

COURSE 1: INTRODUCTION TO MONITORING AND ASSESSMENT

Principal analytical techniques for water quality analysis; standard methods for analysis of key parameters; the use of laboratory and field based analysis; selecting appropriate techniques; the need for analytical quality assurance and control.

Key surface water and groundwater quality issues and their sampling requirements; principal pollutants and their sources; prevention of contamination; source and resource protection and management; remediation of contaminated water.

Management of water resources and the need for water quality monitoring for effective decision making; using monitoring data to improve management of water resources; designing management orientated monitoring programmes.

Fresh water quality and human health; key impacts of freshwater on health resulting from contact and ingestion of freshwater; water related diseases and their impact on morbidity and mortality; preventing disease transmission.

Environmental freshwater quality requirements; environmental impact of freshwater contamination; establishment of environmental standards; pollution control programmes and prevention of pollution.

Information management in freshwater quality monitoring and assessment; storage and treatment of data; the use of computerised data management systems; and decision making and prioritisation of action.

Institutional arrangements and legal frameworks for freshwater management in the environment sector; defining responsibilities and remit of agencies; interaction between the monitoring agency and water users; defining monitoring and management policies.

2.2 Supporting material

Bartram, J. & Ballance, R. (eds) (1996) *Water Quality Monitoring*. Chapman and Hall. Available in English, French & Spanish.

Chapman, D. (ed) (1996) *Water Quality Assessments*. 2nd Ed. Chapman and Hall. Available in English.

Allard, M. (ed) (1992) *GEMS/WATER Operational Guide*. 3rd Ed. UNEP, WHO, UNESCO & WMO. Available in English, French, Spanish, Russian and Chinese.

MODULAR TRAINING PROGRAMME

2.3 Teaching methods

The emphasis of this course is to balance practical training with analysis and discussion of the issues related to surveillance. Thus a mixture of presentations, group discussions and practical work (including fieldwork) is undertaken. Group work will also be undertaken to allow participants to develop their understanding of freshwater quality monitoring and improve their decision making skills.

2.4 Language capacity

This course is available in English, Spanish, French and Russian.

3. COURSE ORGANIZATION

3.1 Course duration

The course is a two week event including field visits. A shorter one week event which covers some aspects included in this course is also available.

3.2 Participant numbers

The optimum number of participants for this course is 15, although numbers of up to 24 can be accommodated.

3.3 Participant requirements

Participants should be either technical or managerial staff and be reasonably senior within their organization, with considerable experience.

3.4 Course Venue

The course requires a lecture room equipped with OHP; transport facilities for the field visit and laboratory space for the practical exercises.

3.5 Suggested course combinations

Courses: Any

3.6 Institutions offering this course:

Robens Institute
University of Surrey
Guildford
Surrey GU2 5XH
United Kingdom

Contact: Jennie Lynch
Tel:+44 1483 259209
Fax:+44 1483 503517
E-mail: rbs1jl@surrey.ac.uk

NWRI
P O Box 5050
Burlington
Ontario L7R 4A6
Canada

Contact: GEMS/Water Programme Office
Tel:+1 905 336 6440
Fax:+1 905 336 4582
Email: gems@cciw.ca

MARC
The Old Coach House
Campden Hill
London W8 7AD
United Kingdom

Contact: Peter Williams
Tel:+ 44 171 376 1577
Fax: +44 171 937 5396
E-Mail: udba124@kcl.ac.uk

CEHA
P O Box 926 967
Amman 11110
Jordan

Contact: M.Z. Ali-Khan
Tel: + 962 6 684 655/657
Fax: + 962 6 686 591
Email: CEHA@nets.com.jo

COURSE 2
ADVANCED MONITORING:
NETWORK EVALUATION/OPTIMIZATION
AND PROGRAMME MODERNIZATION

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

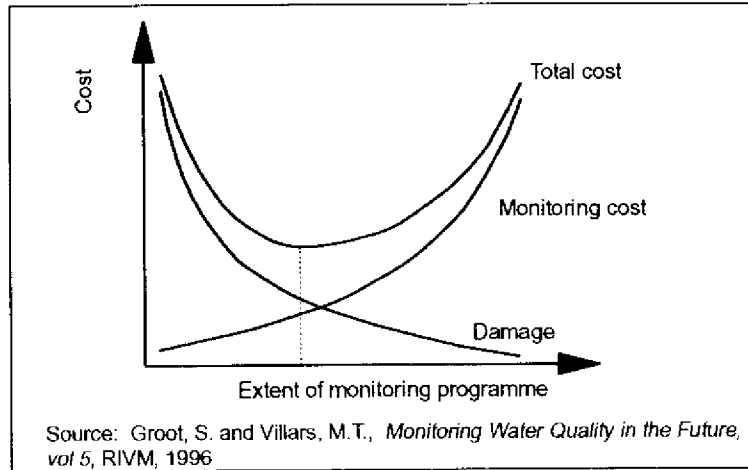
To assist water agencies to become more cost-effective and more responsive to management needs for data that address current pollution management concerns and that provide the basis for decisions on programme and infrastructure investment. This is achieved by demonstrating how modernization and simplification through the use of inexpensive modern diagnostic, screening and assessment/optimization procedures, lead to more useful data at reduced cost.

1.2 Objectives

- To learn from past experience about the serious limitations of conventional data programmes, including the many types of uncertainty that are inherent in conventional monitoring.
- To explain and promote alternative and more modern approaches to monitoring, including diagnostic, screening and survey techniques, which are more cost effective and more informative, and which are more directly linked to the decision process for water management.
- To demonstrate techniques which link data programmes to "client" needs for data, including pollution control and pollution infrastructure investment decisions.
- To promote optimization, simplification, and rationalization of monitoring programmes in order to reduce costs and increase useful information.
- To understand the types of changes required in pollution control legislation to more cost-effectively manage water quality and to save money both for government and industry.
- To examine alternative models for government and the private sector in water quality programmes from the perspective reducing government costs of such programmes.

1.3 Target audience

Senior professionals, including laboratory and programme managers of established water quality programmes.



2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Water quality monitoring as a "service" function: establishing Data Quality Objectives; programme priorities, and "fitness for purpose" concept.

Monitoring for decision making: matching contemporary water quality issues such as point and non-point source control, basin assessment, and toxics control, to relevant water quality parameters and methods, including multi-media sampling.

Types of uncertainty that are inherent in field and laboratory programmes and methods for handling uncertainty.

New, cost-effective monitoring technologies, including diagnostic and screening techniques, and environmental effects monitoring, as alternatives to chemical analysis, and their use in decision-making.

Network optimization and rationalization; efficiency in programme operation.

Roles of government and the private sector in water quality programmes, and cost-reduction for government.

Implications of different types of regulatory requirements on cost of data programmes.

Examples of optimization and modernization from several countries.

2.2 Supporting material

Chapman, D. (ed) (1996) *Water Quality Assessments*. 2nd Ed. Chapman & Hall.

Ongley, E D. *Agriculture and Water Quality*. Food & Agriculture Organization.

2.3 Teaching methods

This is a lecture/seminar course. Interaction with and between participants is expected. There is no laboratory or field work.

2.4 Language capacity

This course is available in English only.

3. COURSE ORGANIZATION

3.1 Course duration

Primary material is covered in one week, but can be augmented with specific technical training in some of the techniques according to client needs.

3.2 Participant numbers

The optimum number of participants is 20-30.

3.3 Participant requirements

Senior laboratory and programme managers having responsibilities for implementing technical aspects of monitoring, or having responsibility for programme recommendations at the national, state or municipal level. Some technical background is assumed.

MODULAR TRAINING PROGRAMME

3.4 Course Venue

The course requires a lecture room, large enough to seat all participants. It should be equipped with an overhead projector and slide projector.

3.5 Suggested course combinations

Courses: 10, 12, 14, 16

3.6 Institutions offering this course

NWRI	<i>Contact:</i> GEMS/Water Programme Office
P O Box 5050	Tel:+1 905 336 6440
Burlington	Fax:+1 905 336 4582
Ontario L7R 4A6	Email: gems@cciw.ca
Canada	

COURSE 3
RIVER WATER QUALITY
MONITORING DATA ASSESSMENT

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To bridge the gap between river water quality monitoring and management through the development of water quality assessment capabilities and to be able to assess and predict the impact of the principal point and non-point sources of pollution on river water quality.

1.2 Objectives

At the conclusion of the course the participants should:

- Be familiar with the most commonly used tools for data treatment for chemical water quality monitoring programmes for rivers;
- Have acquired river-specific data interpretation skills, including basic statistics, flux computations, concentration-runoff relationships and optimization of sampling regimes;
- Developed the ability to estimate the potential impact of a variety of pollution scenarios on river water quality;
- Be aware of the role of water quality assessments and monitoring in river management.

1.3 Target audience

Technical and scientific staff of water resource management authorities at regional or national level such as water resources scientists, water pollution control staff, sanitary engineers. Water resources managers will also gain benefit from attending this course.

2. COURSE PROGRAMME AND DESIGN

This course is based upon the use of the STYX river data set, a synthetic river which can be regarded as an 'average' river in terms of climatology, hydrology and hydrochemistry. The headwaters of this river rise in a pristine mountain environment with a lower basin that flows through an agricultural plain containing a major city located just upstream of the water quality station.

2.1 Course content

Introduction to the common features of river hydrology and natural water quality variations, spatial and temporal, atmospheric inputs and chemical.

Review of anthropogenic water quality sources, impacts and quantification including: domestic sewage; industrial effluents containing both inorganic and organic pollutants; agricultural pollution from point and non-point sources (including agroindustry, drainage return waters and surface runoff).

Review of key river water quality problems, including: oxygen depletion; eutrophication; acidification; toxic effects on biota; and nitrate levels.

Data treatment tools, including: RAISON/GEMS software and its models; recapitulation of basic statistical data treatment methods (eg quartiles); and graphical presentation options for statistically treated data.

Use of the STYX data base, including: introduction to the synthetic river data base concept and its elements; chemical data sets in STYX (including TSS, electrical conductivity, major ions, nutrients, organic carbon and nitrogen, chlorophyll, dissolved and particulate cadmium, PCBs and atrazine).

Basic data exercises including: checking reported monitoring data; ionic balance checking; ionic ratios and graphic representations of ionic analyses; expression of results in appropriate units ($\mu\text{eq/l}$, $\mu\text{mole/l}$, kg/s , t/day , L.s^{-1} , km^{-2} , $\text{g.m}^{-2}.\text{y}^{-1}$, $\text{t.km}^{-2}.\text{yr}^{-1}$).

Regression analysis, calculated inter-elemental; relationships, conductivity-ion relationships (Ca, NA, K etc); ion-ion relationships (Na, Cl, PO_4^{-3} , NO_3^{-3} etc).

Flux computation methods including: total suspended solids loads; transport of various ions; longitudinal and lateral changes in pollutant fluxes; pollutant mass balances; and flux duration.

Water quality variations with river discharge: TSS and discharge relationships; ion concentration-discharge relationships; conductivity-discharge relationship; and nutrient-discharge relationships.

Temporal variation in water quality on a weekly and seasonal basis.

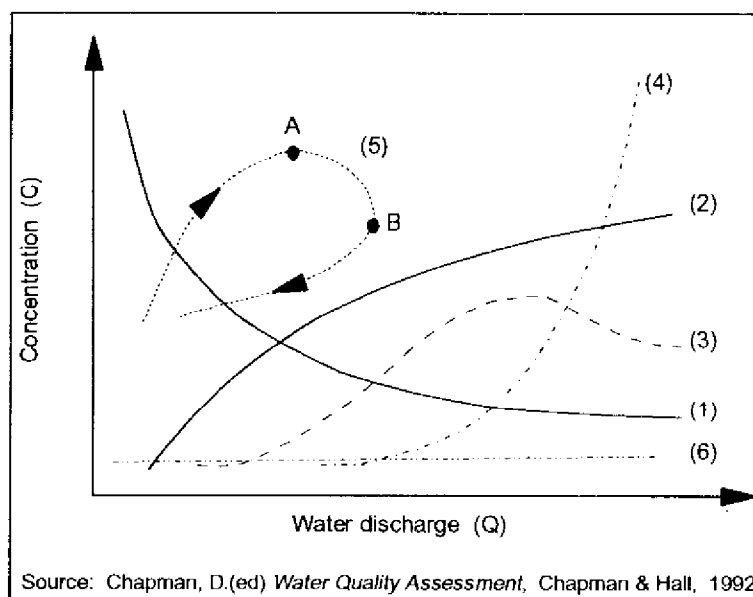
Variations in water quality with total suspended solids, with particular reference total organic carbon, total nitrogen and potassium, total cadmium and total phosphorous.

2.1 Course content (continued)

Influence of natural events on water quality; quality changes during and after flood events (eg monsoon simulation); and impacts of summer peaks in plankton populations.

Impacts of pollution: point sources (municipal sewage discharges and mining effluent); and non-point sources (runoff from agricultural land, surface runoff in mining areas and deicing salts).

Optimization of sampling programmes for river water quality monitoring and assessment: auto regression of concentrations and fluxes; redesign of sampling programmes with reduced/expanded frequencies; and optimization of monitoring networks and programmes.



2.2 Supporting material

The STYX River synthetic data set, RAISON/GEMS software and the RAISON/GEMS users manual.

Chapman, D. (ed) (1996). *Water Quality Assessments, 2nd edition*, Chapman and Hall.

MODULAR TRAINING PROGRAMME

2.3 Teaching methods

The course is based on interactive exercises between participants and resource persons, with introductory lectures and demonstrations. The majority of the course is based on the use of the STYX software, with participants running exercises on computers and there will be a number of group discussions and preparation of written assessment reports.

2.4 Language capacity

This course will become available in English, French and Spanish.

3. COURSE ORGANIZATION

3.1 Course duration

The full course is a one week event and would usually be held immediately following a one week training course in RAISON/GEMS. However, a compressed training course covering both RAISON/GEMS and the use of the STYX programme lasting one week will also become available, although this will only cover selected data manipulations and specific assessment problems.

3.2 Participant numbers

The limit of participants that can be included on this course is ten.

3.3 Participant requirements

Participants should have an academic qualification in an appropriate field such as environmental sciences (chemistry, microbiology, hydrogeology etc), engineering (sanitary engineering, hydrology, water resources engineering) or environmental management.

3.4 Course venue

The venue must be equipped with a minimum of one computer per two students and preferably with one computer per student. A computer coupled with projection facilities such as a liquid-crystal overhead projector is required for the resource persons to demonstrate software applications.

COURSE 3: RIVER WATER QUALITY MONITORING DATA ASSESSMENT

3.5 Suggested course combinations

Courses: 1,7,8,15,18.

3.6 Institutions offering this course:

WHO	Contact: Richard Helmer
CH-1211 Geneva 27	Tel: + 41 22 791 3761
Switzerland	Fax: + 41 22 791 4127
	Email: helmerr@who.ch

Note: This course will become available in 1997 at which time the institutions offering this course will be determined. In the interim all enquiries should be addressed to WHO.

COURSE 4
LAKE AND RESERVOIR
WATER QUALITY MANAGEMENT

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To introduce participants to lake and reservoir management and to promote the environmentally sound management of lakes and reservoirs.

1.2 Objectives

By the end of the course participants will:

- Understand the basic principles for the sustainable development of lakes and water resources at a basin-level.
- Understand the public health issues related to lake and reservoir management.
- Understand the effective utilization of lakes and reservoirs as a freshwater source for drinking water, irrigation, aquaculture, industry, power generation, transport and recreation and their basic management.
- Be aware of the global distribution of lakes and limnological types and the present status of the world's lakes.
- Understand the basic principles of pollution control and lake and reservoir management, to be aware of the principal analytical techniques used to monitor lake and reservoir water quality and to understand the influence of acid snow on lake and reservoir water quality.
- Be aware of the hydrological cycle and understand the interaction between the hydrological cycle and water resource and lake management.
- Understand the different run-off characteristics of different types of catchment area and understand the influence these have on lake and reservoir management.

1.3 Target audience

The course is intended for technical administrators and researchers engaged in the decision and policy making process of lake water quality management in developing countries and countries with economies in transition.

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Problems and issues of lake and reservoir water management: features of lakes and reservoirs and geographical factors; environmental factors regarding lakes and reservoirs; multi-purpose use of lakes and reservoirs as fresh water sources, and; basic knowledge of lakes of reservoirs.

Acid precipitation: impacts of acid precipitation of all types on lake catchments and water quality using the example of Lake Biwa, Japan.

Public health aspects: water related disease; public health impacts of water quality; vectors of water-related diseases; parasitic disease associated with poor water quality; public health issues in lake and reservoir management.

Pollution control: history of pollution control law; principles of pollution control policy; setting standards for water quality in lakes and reservoirs; pollution control ordinances; eutrophication ordinances; waste disposal control;

Water resource management: hydrological cycle and the value of artificial lakes; rates of resource movement in the hydrological cycle; current global water resources; run-off characteristics in different catchment types, and; monitoring indices.

Socio-economic aspects: lake management from the perspective of local residents and interest groups; social and environmental problems of lake and water resource management; analytical framework for water resources management, and; the importance of citizen participation in environmental conservation and management.

Status of the world's lakes: global distribution of natural lakes; basic limnological types; present aspects and environmental problems in large reservoirs, and; global comparative analysis of case studies.

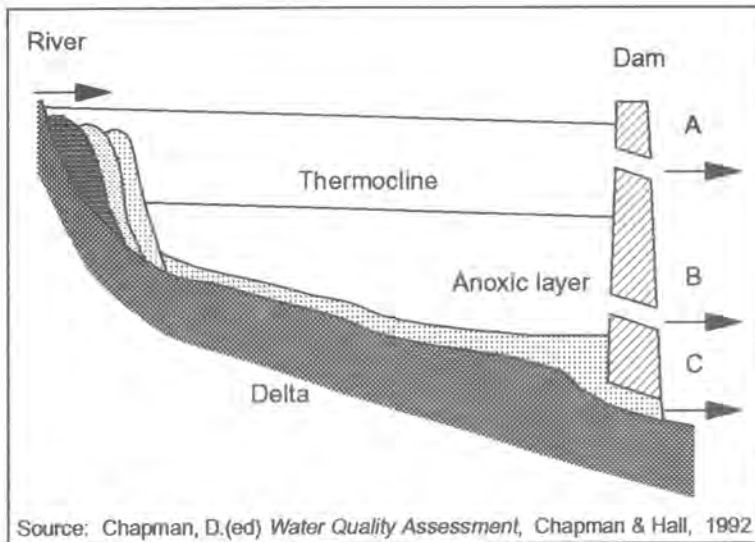
Basic water quality analysis: sampling of water and sample preservation; analytical techniques for water quality analysis; use of sediment analysis; use of biological monitoring; interpretation and use of data, and; planning of monitoring programmes.

2.2 Supporting material

Custom written course handbooks
Software: *Lake Model* for IBM PC

2.3 Teaching methods

Lectures supported by field study, observation and experiment.



2.4 Language capacity

This course is available in English only.

3. COURSE ORGANIZATION

3.1 Course duration

The standard course is of 10 weeks duration. Shorter (2 week) courses which cover some aspects of the topic may also be arranged.

3.2 Participant numbers

The optimum number is 12 participants.

3.3 Participant requirements

Participants should have an academic background in an appropriate field such as environmental science (limnology, biology, chemistry etc), engineering (hydrology, water resources engineering, sanitary engineering etc) or environmental/water resources management.

MODULAR TRAINING PROGRAMME

3.4 Course Venue

The full 10 week version of this course is held at ILEC in Japan. Courses of shorter duration may be held elsewhere.

3.5 Suggested course combinations

Courses: 1, 3, 7, 8, 9, 15, 18

3.6 Institutions offering this course

ILEC
1091 Oroshimo-cho
Kusatsu Shiga 525
Japan

Contact: Kiyoshi Imai
Tel: + 81 775 68 4567
Fax: + 81 775 68 4568
E-Mail: ilec:pop.biwako.or.jp

COURSE 5
GROUNDWATER POLLUTION
RISK ASSESSMENT AND PROTECTION

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To highlight the practical aspects of groundwater pollution risk assessment for a range of aquifer types and sources of pollution, and to describe strategies which can be adopted for protecting groundwater quality.

1.2 Objectives

- To disseminate appropriate methodologies for the assessment of the risk of groundwater quality deterioration by man-made contaminant loads and inadequate aquifer management.
- To interchange and evaluate national experiences related to groundwater quality management and protection.
- To increase the awareness and collaboration of professionals from the disciplines involved in groundwater quality protection.
- To initiate the development of, or strengthen existing national action plans for groundwater pollution risk assessment and groundwater protection.

1.3 Target audience

The course is intended for practising water resource & supply engineers, water quality managers and scientists, public health officers and land-use planners and agricultural advisers. The course is intended to be offered at national level, or at most to a small number of neighbouring countries.

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Introduction to groundwater occurrence and movement, and the fundamentals of contaminant transport in aquifers

Groundwater quality issues related to unsustainable, heavy groundwater usage:-
saline intrusion, pollution incidents

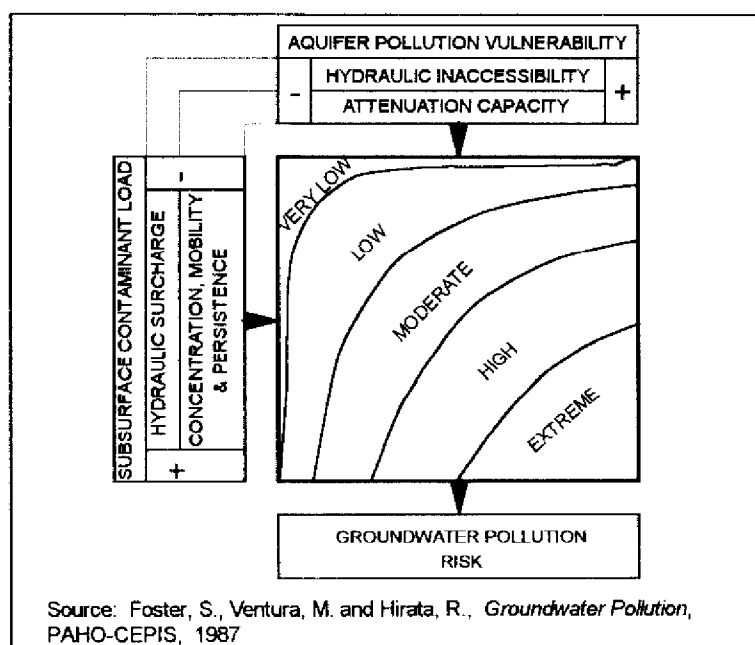
2.1 Course content (continued)

The conceptual basis for groundwater pollution risk assessment

Aquifer vulnerability - concepts and practice

Types of groundwater pollution, assessment of contaminant load from urban and industrial sources, solid waste disposal and agricultural land-use. The potential for GIS in data analysis for pollution risk assessment

Groundwater protection strategies, control of groundwater abstraction, land surface zoning for resource and source protection, control of pollution sources



2.2 Supporting material

The course uses as documentation the manuals of groundwater pollution risk assessment and groundwater protection developed by the PAHO-CEPIS/ODA-BGS groundwater programme for Latin America and the Caribbean.

2.3 Teaching methods

The course uses a combination of lectures, presentation and discussion of case studies given by the participants, and group exercises.

COURSE 5: GROUNDWATER POLLUTION RISK ASSESSMENT/PROTECTION

2.4 Language capacity

This course is available in English and Spanish.

3. COURSE ORGANIZATION

3.1 Course duration

One week (5 days) including a field visit.

3.2 Participant numbers

The optimum number of participants is 25-30.

3.3 Participant requirements

Participants would be expected to have a scientific or engineering background, and a professional interest in groundwater protection. No prior qualifications in or knowledge of hydrogeology are required.

3.4 Course Venue

The course requires a lecture room, large enough to seat all participants. It should be equipped with an overhead projector and slide projector.

3.5 Suggested course combinations

It is strongly recommended that this course be run in conjunction with the associated course: "Groundwater quality assessment" and should precede that course.

Other courses: 17, 18, 19, 20

3.6 Institutions offering this course

British Geological Survey	<i>Contact:</i> Stephen Foster
Keyworth	Tel:+44 1159 363296
Nottingham NG12 5GG	Fax:+44 1159 363296
United Kingdom	

COURSE 6
GROUNDWATER QUALITY ASSESSMENT

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To describe the basic requirements for the planning and implementation of a groundwater quality monitoring programme, and highlight the practical aspects of developing strategies for the assessment and monitoring of groundwater quality to detect groundwater pollution.

1.2 Objectives

- To discuss the requirements for groundwater quality monitoring and describe the main factors affecting monitoring network design.
- To discuss and evaluate national experiences in groundwater quality monitoring.
- To increase the awareness of professionals from relevant disciplines of the needs for and benefits of groundwater quality monitoring.
- To initiate or strengthen the development of national strategies for groundwater quality monitoring.

1.3 Target audience

The course is intended for practising water resource & supply engineers, public health officers and water quality scientists. The course is intended to be offered at national level, or at most to a small number of neighbouring countries.

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Introduce and discuss the scope, objectives and types of groundwater quality monitoring

Describe the main factors affecting the design of groundwater monitoring networks

Review groundwater sampling techniques, including advantages, disadvantages and costs of the different techniques, and provide guidance in selection

MODULAR TRAINING PROGRAMME

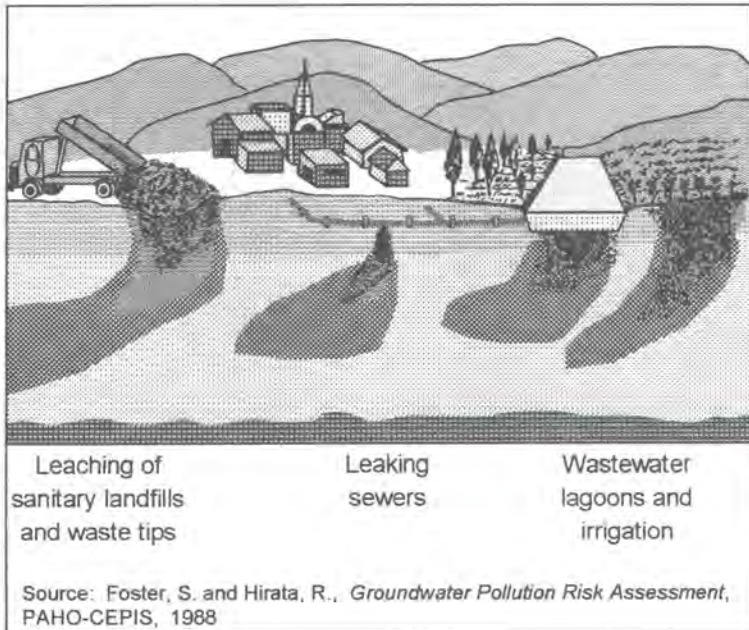
2.1 Course content (continued)

Review the selection of determinants in relation to monitoring objectives and water uses

Discuss data presentation requirements and review approaches to data presentation

2.2 Supporting material

The course uses as documentation the manual on groundwater quality monitoring developed by the PAHO/CEPIS groundwater protection programme for Latin America and the Caribbean and also draws on the handbook of groundwater quality monitoring prepared in the GEMS/WATER programme.



2.3 Teaching methods

The course uses a combination of lectures, presentation and discussion of case studies given by the participants, and group exercises.

2.4 Language capacity

This course is available in English and Spanish.

3. COURSE ORGANIZATION

3.1 Course duration

One week (5 days) including a field visit.

3.2 Participant numbers

The optimum number of participants is 25-30.

3.3 Participant requirements

Participants would be expected to have a scientific or engineering background, and a professional interest in groundwater quality. No prior qualifications in or knowledge of hydrogeology or chemistry are required.

3.4 Course Venue

The course requires a lecture room, large enough to seat all participants. It should be equipped with an overhead projector and slide projector.

3.5 Suggested course combinations

It is strongly recommended that this course be run in conjunction with the associated course:- "Groundwater pollution risk assessment" and for best results should follow that course.

Other courses: 11, 13, 17

3.6 Institutions offering this course

British Geological Survey	<i>Contact:</i> Stephen Foster
Keyworth	Tel:+44 1159 363296
Nottingham NG12 5GG	Fax:+44 1159 363296
United Kingdom	

COURSE 7
HYDROLOGICAL MONITORING
FOR WATER QUALITY ASSESSMENTS

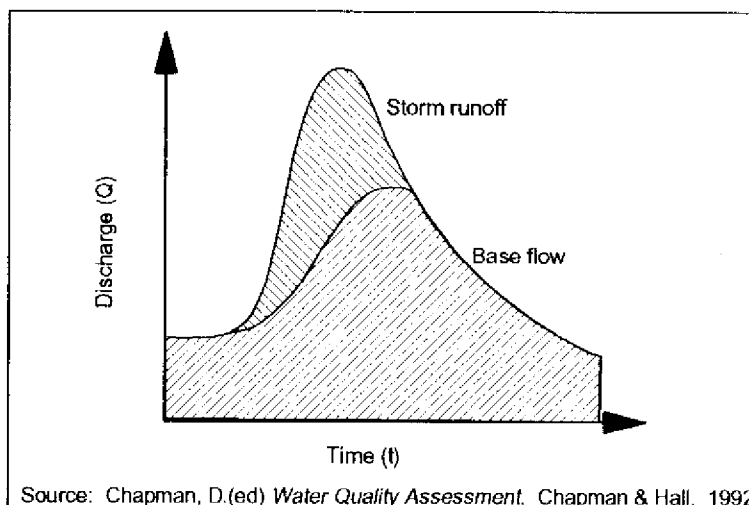
1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To introduce the basic hydrometric techniques necessary for the assessment of water quality monitoring data.

1.2 Objectives

- To discuss the problems of designing, installing, operating and maintaining monitoring systems for hydrological variables.
- To summarise the requirements for the collection, collation, screening and publication of the data provided by hydrological networks, and to review typical examples of computer software available for these purposes.
- To provide an opportunity to use typical instruments in the field and to visit authorities with the responsibility of maintaining large hydrological monitoring systems.



1.3 Target audience

Professionals from the water resources and environmental sectors with responsibilities for the organisation and maintenance of measuring networks for hydrological variables.

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Meteorological observations:

- Meteorological instruments: rain gauges; thermometers; radiation meters; radar radiosonde; principles of observation and recording for attended and unattended sites.

Surface water hydrometry:

- Water levels: site selection; types of gauges and recorders; stilling well design; measurement accuracy
- Bed levels: measurement of cross-section using sounding instruments
- Discharge measurements: velocity-area method instruments; determination of mean velocity and total discharge; construction of rating curves; estimation of measurement errors.
- Sediment transport: methods and instruments to measure bed load, suspended load and wash load; bottom sampling; grain sizes.
- Flow measuring structures: classification of structures; selection of structures and artificial controls; head-discharge relationships; estimation of measurement errors.
- Chemical dilution gauging techniques: ultrasonic and electromagnetic methods; the moving boat technique; floats; the slope-area method.
- Surface water networks: design considerations.

Groundwater monitoring:

- Planning of exploratory programmes: surface geophysical methods - geoelectrical and electro-magnetic; interpretation; drilling and rock sampling; geophysical logging; pumping tests - types of test, field procedures and analysis.
- Groundwater networks: design considerations.

Data collection and processing:

- Data collection: types of recording; codes; registration; transfer; recording interval length
- Data processing: error detection; correction and data reduction; processing.
- Data storage: files and data bases; examples of software; data base management.

2.2 Supporting material

Relevant publication of the World Meteorological Organization, UNESCO, Food and Agricultural Organisation of the United Nations and the International Standards Organization along with lecture materials prepared in-house.

2.3 Teaching methods

The practical nature of the content ensures that the formal lecture component is balanced by exercises, computer workshops and hands-on demonstrations of instruments and observational practices. The taught components are supplemented by study visits to authorities in the region with responsibilities for maintaining both national and/or international observational networks.

2.4 Language capacity

This course is available in English, French, Spanish and Russian.

3. COURSE ORGANIZATION

3.1 Course duration

The standard course covers a period of two weeks, including field work and field visits. However, both shorter events to a more restricted syllabus and longer events with a more in-depth treatment of certain aspects can be developed according to the specification of a client.

3.2 Participant numbers

The course is designed for between 18 and 24 participants, but larger numbers can be catered for by special arrangement.

3.3 Participant requirements

The course is intended for young professionals in the water and environment sectors. However, the course can also be followed by senior managers who require an overview of current practices and future trends.

3.4 Course Venue

The course requires a lecture room, large enough to seat all participants. It should be equipped with an overhead projector and slide projector.

3.5 Suggested course combinations

Courses: 1, 3, 4, 8

3.6 Institutions offering this course

There are a number of research and teaching organizations which collaborate with UNESCO and WMO, who are able to offer this course. Information on available courses can be obtained from:

Division Water Science UNESCO 7 Place de Fontenoy Paris 75700 France	<i>Contact:</i> Andras Szöllösi-Nagy Tel: + 33 1 45 684 002 Fax: + 33 1 45 675 869
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Hydrology Division WMO 41 Av Giuseppe-Motta P O Box 2300 CH-1211, Geneva 2 Switzerland	<i>Contact:</i> John L. Bassier Tel: + 41 22 730 81 11 Fax: + 41 22 734 23 26 Email: dkraemer@www.wmo.ch
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COURSE 8
SEDIMENT QUALITY MONITORING AND ASSESSMENT

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To build awareness of the critical role of sediment (suspended and bottom sediment) in the transport of nutrients, metals and organic contaminants in freshwater systems, and to provide practical methodologies for monitoring for the quality of sediments and their environmental impacts.

1.2 Objectives

- To identify the types of global and regional environmental issues that are linked to sediment transport.
- To improve understanding of the science of sediment production and transport from the perspective of sediment chemistry and environmental concerns.
- To emphasize the profound differences between sediment quantity and sediment quality from the perspective of sampling and analysis.
- To show how uncertainty in data programmes can lead to alternative and less costly sampling technique.
- To demonstrate new sampling techniques that improve water quality information for pollution management and control
- To strengthen technical capacity for improved monitoring and assessment of important environmental parameters.

1.3 Target audience

Senior water quality managers, senior field and laboratory personnel.

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Sediment and chemical pollutant transport - Global and regional issues.

Relationship between sediment and water quality.

MODULAR TRAINING PROGRAMME

2.1 Course content (continued)

Science of sediment and environmental chemistry from a pollution management perspective.

Sediment transport, including types of sediment loads, discharge relationships, hysteresis, rating curves, use of proxy data.

Techniques of sampling: conventional methods, method of differences, centrifugation, passive samplers, etc..

Designing sediment quality sampling programmes: variability and uncertainty, uncertainty in sediment & water quality data, use of "loadings" for environmental management.



Point and non-point source management: concentration and dilution effects, distance effects (where to sample), lake bottom sediments, bed versus suspended sediment sampling.

Picking sampling locations and taking samples: river sites -- surface vs depth sampling, lateral mixing, bank (edge) effects, differences between sampling for sediment quality versus sediment quantity.

Comparative environmental chemistry and toxicology of sediments and of water samples.

COURSE 8: SEDIMENT QUALITY MONITORING AND ASSESSMENT

2.2 Supporting material

Chapman, D. (ed.) (1996) *Water Quality Assessments*. 2nd Edition. Chapman and Hall

Ongley E.D., *Agriculture and Water Quality*. FAO.

2.3 Teaching methods

The primary material is provided as a lecture course. Depending upon the client's needs, a field program can be included that will demonstrate actual sampling technique. The field component will depend upon access to appropriate field apparatus. In some cases, this course is provided as a training programme to agencies which have acquired suitable field apparatus for sampling of suspended sediments for water quality purposes.

2.4 Language capacity

This course is available in English only.

3. COURSE ORGANIZATION

3.1 Course duration

The basic lecture course is one week in duration. Field component, if requested, is an additional week.

3.2 Participant numbers

The lecture course can accommodate any number of persons up to a maximum of 25. Any field component that the client may wish will be restricted to 10 persons.

3.3 Participant requirements

Participants should have technical responsibilities and an appropriate background in chemistry, sedimentology, hydrology or biology.

MODULAR TRAINING PROGRAMME

3.4 Course venue

The one-week lecture course requires a lecture room equipped with overhead projector.

The field component will depend upon access to appropriate field apparatus. The institution offering this course should be consulted concerning field apparatus.

3.5 Suggested course combinations

Courses: 1, 3, 4, 7

3.6 Institutions offering this course

NWRI	<i>Contact:</i> GEMS/Water Programme Office
P O Box 5050	Tel:+1 905 336 6440
Burlington	Fax:+1 905 336 4582
Ontario L7R 4A6	Email:gems@cciw.ca
Canada	

COURSE 9
FIELD BIOMONITORING

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To develop an understanding on the potential role of biological monitoring in a monitoring framework for the assessment of water quality and to demonstrate that the information needs for policy making necessarily include an assessment of pollution impact on biological systems both to safeguard the environment and protect human health.

1.2 Objectives

- To examine the information needs for water quality management and identify the need for monitoring for environmental protection and impact assessment
- To demonstrate the response of organisms to stress at biochemical, individual, population and ecosystem level and promote the use of these responses as biomarkers and bioindicators of anthropogenic induced changes.
- To compare the information provision from physico-chemical monitoring and biological monitoring and consider the desirability for robust low-cost biological techniques for environmental quality assessment
- To promote the development of rapid bioassessment of water quality as a tool for water quality management using appropriate biological parameters.
- To promote the use of biological early warning systems to protect drinking water supplies.
- To promote the use of biological monitoring to protect water quality in rivers, lakes and wetlands of international conservation status.

1.3 Target audience

Professionals in diverse areas of water management, including drinking water supply and the pollution control, protection, conservation, and sustainable development of river, lakes, reservoirs and wetlands. Environmental consultants, NGOs and the University sector.

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Principles of Environmental Monitoring and the design of monitoring programmes. Information needs for water quality management and the role of biological monitoring.

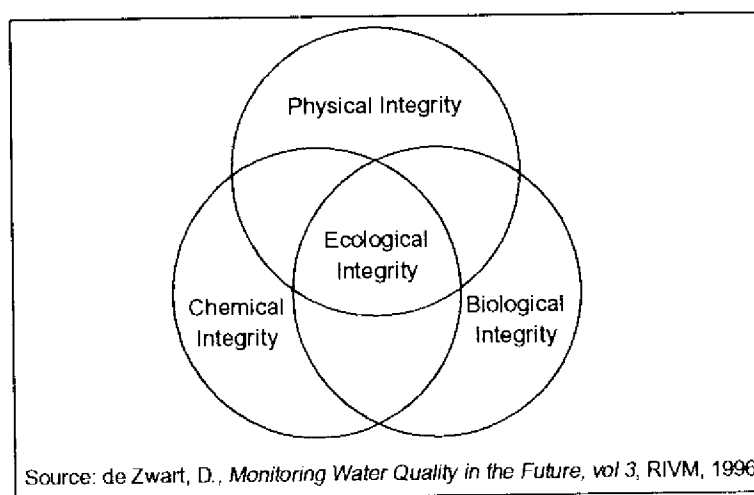
Response of organisms to stress and the measurement of environmental stress at individual, population and ecosystem level

Biological laboratory techniques for water quality assessment - Biomarkers, bioassay and toxicity testing

Biological field techniques for water quality assessment - principles of bioindicators, sampling methodology. Microbiological indicators of water quality. Plant indicators of water quality - phytoplankton and macrophytes. Animal indicators of water quality - zooplankton, vertebrates and fish.

Biological Information for Water Quality Management. Data Analysis and handling and reporting. Biological Standards for Water Quality Uses. Rapid bioassessment techniques. Early Warning Systems - principles and current methodologies.

Biological Information for the Environmental Impact Assessment of new water management plans - reservoirs, dams, regulated rivers and for the conservation and sustainable development of water resources.



2.2 Supporting material

Chapman, D (ed) (1996) *Water Quality Assessments*. (2nd Edition). Chapman and Hall

Ministry of Housing, Spatial Planning and the Environment (1995) *Monitoring Water Quality in the Future 3 Biomonitoring*. The Hague, Netherlands. 83pp

Biological Monitoring Handbook for GEMS/Water. WHO, Geneva (in preparation)

Biological Monitoring of Environmental Contaminants: Animals, MARC Technical Report 37 (1990) GEMS - Monitoring and Assessment Research Centre, London UK

2.3 Teaching methods

The course is designed on a framework of presentations to provide the information base for discussions, working groups, laboratory and field exercises. Key elements in international events will be the opportunity to consider case studies brought by participants and for the opportunity for participants to share experience with colleagues from other countries and sectors.

2.4 Language capacity

This course is available in English only.

3. COURSE ORGANIZATION

3.1 Course duration

The course may be taken as a one week or a two week event. The one week event is primarily a lecture/seminar/discussion based course. Field work and laboratory practical work are integrated components of the two week course. The course is flexible in content and can be designed to meet specific user needs.

3.2 Participant numbers

The optimum number of participants for this course is 15 although numbers of up to 30 can be accommodated.

MODULAR TRAINING PROGRAMME

3.3 Participant requirements

Participants should be either technical or managerial staff actively involved in the implementation or development of water quality assessment programmes. A scientific background is desirable but not essential.

3.4 Course Venue

The one-week lecture course requires a lecture room equipped with overhead projector. The two-week course will in addition require transportation for the field trip and laboratory space for the practical components.

3.5 Suggested course combinations

Courses: 1, 4, 15

3.6 Institutions offering this course

MARC	<i>Contact:</i> Peter Williams
The Old Coach House	Tel:+ 44 171 376 1577
Campden Hill	Fax: +44 171 937 5396
London W8 7AD	E-Mail: udba124@kcl.ac.uk
United Kingdom	

NWRI	<i>Contact:</i> GEMS/Water Programme Office
P O Box 5050	Tel:+1 905 336 6440
Burlington	Fax:+1 905 336 4582
Ontario L7R 4A6	Email: gems@cciw.ca
Canada	

COURSE 10
BIOASSAY LABORATORY OPERATIONS

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To show how the laboratory testing of chemicals forms a key part of the chemical management process.

1.2 Objectives

- To describe the toxic behaviour of chemicals in relation to their chemical structure and physio-chemical properties.
- To demonstrate the response of organisms to toxic stress and consider how this may be investigated by toxicity testing and bioassay.
- To demonstrate the principles of bioassay and methodologies for short and medium term bioassay experimentation.
- To teach the general principle of toxicity testing under specified laboratory conditions and to develop and design toxicity tests for acute, chronic and life-time tests.
- To illustrate the concepts of threshold levels, synergism, bioaccumulation and biomagnification.
- To relate laboratory toxicity tests to exposure, pathways and safe limits and develop the concepts of standards and compliance.
- To demonstrate the value of rapid toxicity tests and field kits for the identification of toxic stress.
- To demonstrate the linkage between bioassay and management procedures

1.3 Target audience

Professionals or trainee professionals in diverse areas of water management including drinking water supply and environmental protection. Agriculturists, fishery officers and compliance and enforcement monitors.

2. COURSE PROGRAMME AND DESIGN

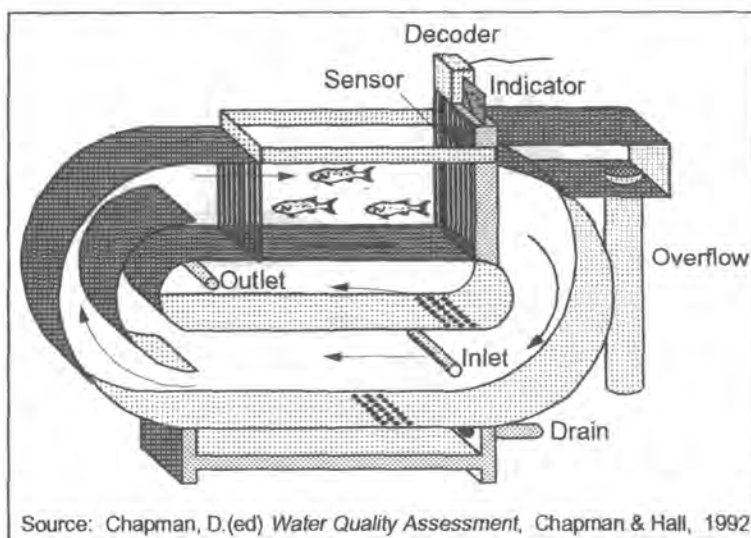
2.1 Course content

Principles of toxicology - dose response behaviour of individuals, populations and communities to toxic stress. Behaviour of toxic chemicals in relation to physio-chemical properties.

Principles of ecotoxicology - exposure pathways, bioavailability. Acute and chronic impacts of toxic chemicals on organisms, bioaccumulation, biomagnification.

Design of toxicity tests and bioassay. Preliminary screening. Static batch and continuous tests. Choice of organisms, water, chemicals, etc. Thresholds, safe limits, standards and compliance. Data handling. Quality control.

Practical toxicity testing in the laboratory or simulation experiments and data sheets. Practical bioassay-eutrophication analysis. Use of microcosms and mesocosms. Acute, chronic and life cycle tests.



The use of bioassay for screening purposes.

Advances in *in-situ* toxicity testing - Microtox, Rotifer toxkits, scope for growth. Early warning toxicity testing eg. Daphnia, Fish, Molluscs, etc. Use of toxicity testing for risk management of toxic chemicals.

COURSE 10: BIOASSAY LABORATORY OPERATIONS

Methods of toxic chemical management. Risk Assessment, Life Cycle Analysis and Ethics of Toxicity testing.

Construction of a bioassay facility; design requirements

2.2 Supporting material

Chapman, D (ed) (1996) *Water Quality Assessments*. 2nd Edition. Chapman and Hall Ltd., London.

Monitoring of Water Quality in the Future, Volumes 1-5. Ministry of Housing Spatial Planning and the Environment (1995), The Hague, Netherlands.

Biological Monitoring of Environmental Contaminants: Plants. MARC Technical Report 32 (1986) GEMS-Monitoring and Assessment Research Centre, London.

Biological Monitoring of Environmental Contaminants: Animals. MARC Technical Report 37 (1990) GEMS-Monitoring and Assessment Research Centre, London.

2.3 Teaching methods

The course is a mixture of lectures and discussion periods with illustrative information as data sheets, videos and practical laboratory experiments. The extent of laboratory work will depend on the equipment available at the site of the event.

2.4 Language capacity

This course is available in English only.

3. COURSE ORGANIZATION

3.1 Course duration

This course is 10 days in duration. A 5 day version covering selected items is also available.

MODULAR TRAINING PROGRAMME

3.2 Participant numbers

The optimum number of participants for this course is 12 but could be increased depending on laboratory provision and practical requirements.

3.3 Participant requirements

Participants in the course need a scientific background, preferably involving the handling of chemicals and the performance of bench chemistry. Some familiarity with statistics would be an advantage.

3.4 Course venue

The course venue must have adequate laboratory facilities to undertake bioassay experiments. A lecture theatre with slide projector and video are also required.

3.5 Suggested course combinations

Courses: 2, 14, 16

3.6 Institutions offering this course

NWRI	<i>Contact:</i> GEMS/Water Programme Office
P O Box 5050	Tel:+1 905 336 6440
Burlington	Fax:+1 905 336 4582
Ontario L7R 4A6	Email:gems@cciw.ca
Canada	

MARC	<i>Contact:</i> Peter Williams
The Old Coach House	Tel:+ 44 171 376 1577
Campden Hill	Fax: +44 171 937 5396
London W8 7AD	E-Mail: udba124@kef.ac.uk
United Kingdom	

***COURSE 11
LABORATORY ESTABLISHMENT
AND OPERATIONS***

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To provide an understanding of the practical application of the elements that contribute toward the design, establishment and operation of a successful analytical laboratory. To develop an appreciation of the continuous interaction of design, maintenance, training and quality procedures from planning to routine operation of a laboratory.

1.2 Objectives

- To describe the issues that should be considered during the planning and design of the laboratory including the interaction and communication between laboratories and between laboratories and administrative areas, to introduce appropriate safety features, including containment, ventilation and rest areas.
- To describe the procedures for the acquisition of equipment and materials; the importance of adequate equipment maintenance and service agreements; stock control, rotation and stock issue.
- To highlight the issues involved with staff recruitment; to promote the importance of appropriate training for laboratory staff and managers and to develop ideas for career development.
- To promote the use of internal and external quality assurance and control methods for the efficient processing of samples. The application of control methods to all parts of the analytical process will be discussed as well as the need to maintain quality standards in all administrative support.

1.3 Target Audience

The course has been designed for laboratory facility managers and for senior laboratory personnel.

MODULAR TRAINING PROGRAMME

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Building design; public and staff access; reception and distribution; laboratory design for the safe and efficient handling of samples; safety and containment.

Developing systems of approved suppliers for construction, equipment and consumables purchase.

Equipment selection; equipment purchase and service agreements; in-house maintenance, cleaning and calibration; routine safety checks.

Materials purchase, small quantities and bulk purchase; storage and storage records; stock rotation; control of stock issues.



Laboratory management; management training; staff appraisal; strategies for motivation.

Staff recruitment; advertising and interviews; appointments; introductory courses and safety awareness training; career development and staff training.

Quality control and assurance systems; design and implementation; application to quality management systems, customer services, sample analysis and reporting.

Waste disposal methods; safe disposal of hazardous wastes; identification of waste streams; disposal of clinical wastes.

2.2 Supporting material

Howard, G., Lynch, J. and Pedley, S. *Establishing and equipping laboratories in developing countries*. 2nd Edition (in preparation). WHO.

Lund, U.(ed), *Manual on Analytical Quality Control*. (in preparation). WHO.

2.3 Teaching methods

The course will involve a mixture of formal teaching and presentations. Group discussion and role play exercises will be used to supplement and reinforce the formal input.

2.4 Language capacity

This course is available in English only.

3. COURSE ORGANIZATION

3.1 Course duration

This course is of 10 working days duration.

3.2 Participant numbers

The optimum number of participants is between 12 and 16, however larger numbers can be accommodated.

3.3 Participant requirements

The participants should be senior technical staff, with several years experience in analytical laboratories, who may be transferring to laboratory management,

or:

the participants should be familiar with the routine operation of analytical laboratories and analytical methods. Some experience of managing small teams would be advantageous.

MODULAR TRAINING PROGRAMME

3.4 Course Venue

The course requires a lecture room, large enough to seat all participants. It should be equipped with an overhead projector and slide projector.

3.5 Suggested course combinations

Courses: 1, 12, 13, 17

3.6 Institutions offering this course

Robens Institute	<i>Contact:</i> Jennie Lynch
University of Surrey	Tel:+44 1483 259209
Guildford GU2 5XH	Fax:+44 1483 503517
Surrey	Email: rbs1jl@surrey.ac.uk
United Kingdom	

COURSE 12

ADVANCED LABORATORY MANAGEMENT

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To provide a framework wherein managers of established laboratories can make effective choices in lab operations and apparatus in order to increase laboratory efficiency and reliability through modernization.

1.2 Objectives

- To provide a comprehensive understanding of modern laboratory management practices.
- To demonstrate new trends in instrumentation and to provide the basis for selecting analytical apparatus to reduce equipment costs.
- To demonstrate alternative choices and/or optimization of analytical technique to achieve greater efficiencies.
- To provide a planning framework for modernization of laboratory systems.



1.3 Target Audience

Laboratory managers, section heads, water quality programme supervisors.

2. COURSE PROGRAMME AND DESIGN

2.1 Course Content

Core content includes:

- sampling handling, logging, and control
- standard operating procedures (SOP's)
- choice of alternative analytical procedures to achieve greater efficiency
- performance-based analysis versus prescribed analytical methods
- method validation and verification
- new trends in instrumentation and analysis; choice of instrumentation
- laboratory information systems
- principles of automation
- choices of quality control and quality assurance protocols - in-lab and national, laboratory audits
- Good Laboratory Practices (GLP)
- Chain of custody
- record keeping and document control
- Toxicity Identification Evaluation (TIE) & Environmental Effects Monitoring
- uses of analytical data: human health risk assessment, ecological risk assessment, policy setting, etc.
- laboratory and analytical accreditation/certification, performance studies
- laboratory safety
- alternative models for government and private sectors in laboratory programmes.

Note: The content is normally customized to the particular needs of the client and can be supplemented with specific items.

2.2 Supporting Material

Custom written handouts.

COURSE 12: ADVANCED LABORATORY MANAGEMENT

2.3 Teaching methods

This is a lecture, workshop and demonstration programme. Normally it is held in one or more advanced government or private sector laboratories where economies of scale, automation, and instrument choice can be demonstrated. The course is designed to familiarize managers with the concepts and choices that can be made to modernize laboratories.

2.4 Language capacity

This course is available in English only.



3. COURSE ORGANIZATION

3.1 Course duration

Normally, a two week period and includes several site visits. It can be extended when specific techniques requested by the client are included in the course. It may also be extended to include specific consultation by the trainer in efficiencies that can be achieved in the client's laboratory. By eliminating site visits the core material can be compressed into one week.

MODULAR TRAINING PROGRAMME

3.2 Participant numbers

Maximum of 10.

3.3 Participant requirements

Participants should be established laboratory managers, section heads or water quality programme supervisors.

3.4 Course Venue

Normally at the trainer's laboratory in Canada. The lecture material can be given at the client's location, however demonstrations are not possible.

3.5 Suggested course combinations

Courses: 2, 10, 14, 16

3.6 Institutions offering this course

NWRI	<i>Contact:</i> GEMS/Water Programme Office
P O Box 5050	Tel:+1 905 336 6440
Burlington	Fax:+1 905 336 4582
Ontario L7R 4A6	Email: gems@cciw.ca
Canada	

VKI	<i>Contact:</i> Ulla Lund
Agern Allé 11	Tel: +45 42 865211
DK-2970 Hørsholm	Fax: +45 42 867273
Denmark	Email: uol@vki.dk

COURSE 13
QUALITY ASSURANCE IN LABORATORY MANAGEMENT

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To describe the main principles of quality assurance as applied at the laboratory level, to highlight the importance of producing reliable results and to foster cooperation between laboratories of a similar nature in order to improve the quality and comparability of analytical data.

1.2 Objectives

- To introduce the participants to the purpose, principles and potential benefit of quality assurance programmes.
- To make participants aware of the potentials and limitations of internal quality control in quality management in laboratories and the correction of errors and improvement of analytical quality.
- To enable participants to establish an Internal Quality Control programme in their own laboratories to improve data precision and accuracy.
- To assist the participants in identifying objectives for quality control and quality assurance programmes in their own laboratories.

1.3 Target Audience

Managers of smaller laboratories, Staff at Section head level in larger laboratories. Any staff with responsibility for preparing reports containing laboratory data.

2. COURSE PROGRAMME AND DESIGN

2.1 Course Content

The purpose of quality assessment and quality control, the quality system and the nature and sources of errors.

Good laboratory record keeping, sample tracking and report preparation.

Establishing quality systems for laboratory use; accreditation of laboratories.

MODULAR TRAINING PROGRAMME

2.1 Course Content (continued)

Standard operating procedures, documentation preparation.

Choice of analytical methods, validating methods, establishing method precision and accuracy and instrument calibration.

Precision and accuracy monitoring, controlling analytical quality and rejection criteria for data.

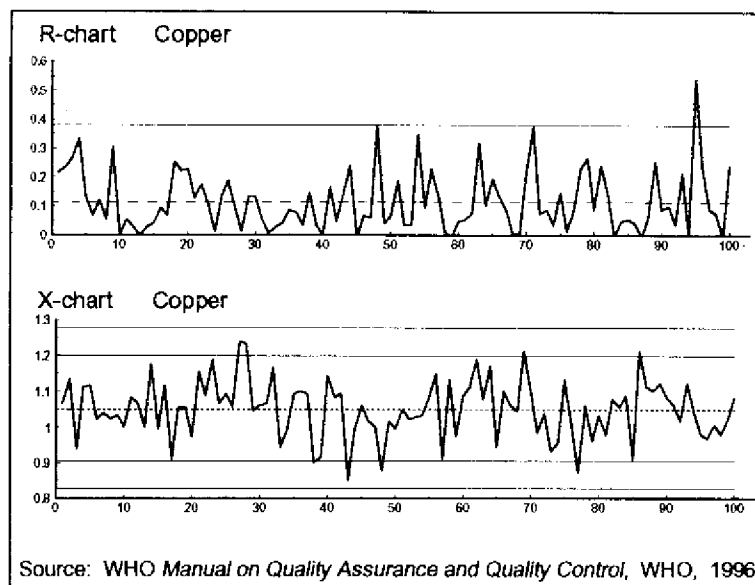
Statistical interpretation of internal quality control data and the background for statistical analysis.

Sample and data handling, correction of errors and improving analytical quality

The use of data from internal quality control for day-to-day check of analytical results.

Preparation of laboratory quality assurance action plans.

Principles of external quality assessments; types of external quality assessments, and; uses of EQA data.



2.2 Supporting material

Lund, U. (ed) (1996) *GEMS/Water Analytical Quality Control - Training Course Manual*. VKI.

Allard, M. (ed) (1992) *GEMS/WATER Operational Guide*. 3rd Ed. UNEP, WHO, UNESCO & WMO.

de Esparza, M. L. (1995) *Manual de Control de Calidad Analitica del Laboratorio del CEPIS*. CEPIS, Lima.

2.3 Teaching methods

This course uses a mixture of lectures to provide background information and practical sessions to carry out quality control and quality assurance techniques. Several workshop and working group sessions will also be held.

2.4 Language capacity

This course is available in English, French and Spanish.

3. COURSE ORGANIZATION

3.1 Course duration

10 days.

3.2 Participant numbers

The optimum numbers of participants are 16 to 20.

3.3 Participant requirements

Participants should be experienced laboratory personnel, used to producing data from routine analytical techniques, and being responsible for reporting that data.

3.4 Course Venue

This course requires a lecture room equipped with an overhead projector and laboratory space for the practical sessions.

MODULAR TRAINING PROGRAMME

3.5 Suggested course combinations

Courses: 1, 11, 14, 15.

3.6 Institutions offering this course

Robens Institute	<i>Contact:</i> Jennie Lynch
University of Surrey	Tel:+44 1483 259209
Guildford GU2 5XH	Fax:+44 1483 503517
Surrey	Email: rbs1jl@surrey.ac.uk
United Kingdom	

VKI	<i>Contact:</i> Ulla Lund
Agern Allé 11	Tel: +45 42 865211
DK-2970 Hørsholm	Fax: +45 42 867273
Denmark	Email: uol@vki.dk

CEPIS	<i>Contact:</i> Sergio Caporali
Casilla Postal 4337	Tel: + 51 1 437 1077
Lima 100	Fax: + 51 1 437 8289
Peru	Email: sccaporal@cepis.org.pr

COURSE 14
ADVANCED QUALITY ASSURANCE
AND INTER-LABORATORY COMPARISON

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To demonstrate how the use of Quality Assurance techniques can improve inter-laboratory consensus agreement, and improve the efficiency of multi centre studies such as water quality monitoring programmes.

1.2 Objectives

- To describe the role of External Quality Assessment (EQA) in promoting consensus agreement of inter-laboratory data.
- To illustrate suitable models for EQA programmes, and describe their implementation.
- To discuss the concept of Data Quality Objectives, and their importance in study management.
- To examine the importance of data quality and consensus to data interpretation and decision making.

1.3 Target Audience

Senior Laboratory Managers and managers of national or regional data gathering projects.

2. COURSE PROGRAMME AND DESIGN

2.1 Course Content

Revision of basic principles of quality assurance and quality control, and; benefits and limitations of both EQA and internal quality control (IQC) systems.

The design and implementation of EQA and inter-laboratory comparison

Principles and use of Data Quality Objectives(DQOs).

Relationship between DQOs and laboratory analytical performance.

MODULAR TRAINING PROGRAMME

2.1 Course Content (continued)

Establishment of DQOs (workshop session).

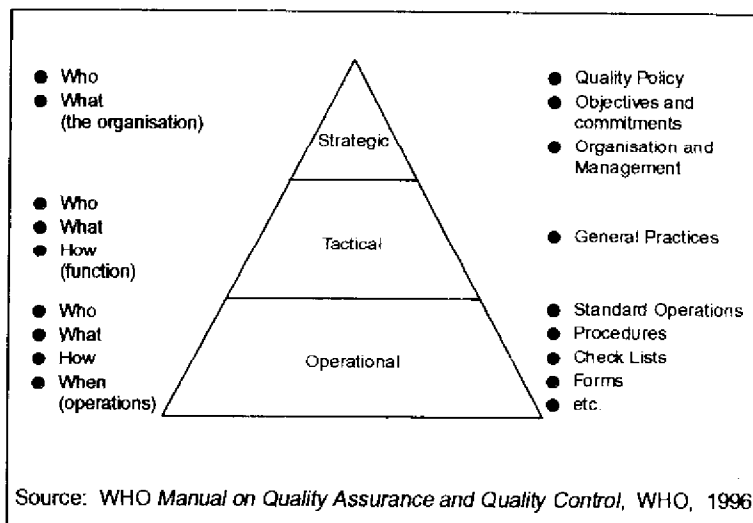
The role of Quality Assurance in Multi Centre Studies and the need the for routine data quality control.

Data interpretation and decision making

Implementation of EQA programmes at national and regional levels.

Inter-laboratory networking and communication.

Data Interpretation and presentation.



2.2 Supporting material

Lund, U. (ed) (1996) *GEMS/Water Analytical Quality Control - Training Course Manual*. VKI.

Allard, M. (ed) (1992) *GEMS/WATER Operational Guide*. 3rd Ed. UNEP, WHO, UNESCO & WMO.

de Esparza, M. L. (1995) *Manual de Control de Calidad Analitica del Laboratorio del CEPIS*. CEPIS, Lima.

2.3 Teaching methods

This course will be taught through a mixture of lectures and practical sessions. Workgroups and working group sessions will also be used.

2.4 Language capacity

This course is available in English and Spanish.

3. COURSE ORGANIZATION

3.1 Course duration

Five days.

3.2 Participant numbers

The optimum number of participants for this course is between 8 and 16.

3.3 Participant requirements

Participants should have either attended the Basic QA Course or have demonstrable experience in the use of QA systems.

3.4 Course Venue

This course requires a lecture room equipped with an overhead projector and laboratory space for the practical sessions.

3.5 Suggested course combinations

Courses: 12, 16

3.6 Institutions offering this course

Robens Institute	<i>Contact:</i> Jennie Lynch
University of Surrey	Tel:+44 1483 259209
Guildford GU2 5XH	Fax:+44 1483 503517
Surrey	Email: rbs1jl@surrey.ac.uk
United Kingdom	

MODULAR TRAINING PROGRAMME

VKI
Agern Allé 11
DK-2970 Hørsholm
Denmark

Contact: Ulla Lund
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COURSE 15
WATER QUALITY MANAGEMENT SOFTWARE:
RAISON/GEMS

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To provide a low-cost and user-friendly capability to store, manipulate, analyze, display and report upon water quality data, using the software package "RAISON/GEMS". This fully integrated software package was developed specifically by the GEMS programme for the types of standard data assessments carried out by water quality agencies.

1.2 Objectives

- To enhance capabilities for data mobilization for water quality assessment and management using the simple, PC-based, RAISON/GEMS software.
- To teach and make operational the principles of water quality data management.
- To integrate maps (GIS) and data to form an integrated environmental information system.
- To develop the capability to design data "projects" and to carry out all functions of database development, analysis, statistics, graphics, and geo-referenced presentation.
- To achieve operational capability within one week.

1.3 Target audience

All persons associated with data analysis and interpretation

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Introduction to environmental information systems

RAISON/GEMS introduction, installation and configuration

Project/snapshot creation; site file creation, spreadsheet operations, map editing

MODULAR TRAINING PROGRAMME

2.1 Course content (continued)

Modular functions: statistics, graphics, reporting

Examples of applications to water quality management



2.2 Supporting material

RAISON/GEMS Users Guide.

2.3 Teaching methods

The course is a workshop format, where each trainee works on his/her own data following each segment of the course.

2.4 Language capacity

This course is available in both English and Spanish.

3. COURSE ORGANIZATION

3.1 Course duration

This course is of 5 days duration.

3.2 Participant numbers

10 persons (one person per computer)

3.3 Participant requirements

Participants should have some basic knowledge of PC software (eg. database, spreadsheet, etc.)

3.4 Course venue

Any location, providing the necessary number of computers (10), etc. can be made available.

3.5 Suggested course combinations

Courses: 1,3,16.

3.6 Institutions offering this course

NWRI	<i>Contact:</i> GEMS/Water Programme Office
P O Box 5050	Tel:+1 905 336 6440
Burlington	Fax:+1 905 336 4582
Ontario L7R 4A6	Email: gems@cciw.ca
Canada	

COURSE 16
ENVIRONMENTAL INFORMATION MANAGEMENT
AND DECISION-SUPPORT SYSTEMS

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

Recent developments in information technology now provide powerful, yet easily used capabilities to public agencies for seamless integration of data (maps, data, text, graphics, photos/video, etc.), expert knowledge, and a wide range of "tools" for the purpose of modelling/prediction, analysis and decision-making of complex environmental concerns. Through neural net techniques, this technology explicitly assesses uncertainty in the analysis, and conveys alternative options to the decision-maker. The aim of the course is to acquaint information experts with these developments so that they can better use current technology for decision purposes. The demonstration platform is the RAISON FOR WINDOWS Decision-Support software package.

1.2 Objectives

- To provide the basis for choosing cost-effective and User-friendly Environmental Information Systems (EIS) that meet the needs of the agency/user.
- To provide sufficient information on new EIS components, such as Expert Systems, Neural Nets, uncertainty analysis, knowledge domains, etc. that Users can evaluate the application of these technologies for problem solving.
- To discriminate between modelling techniques, advisory techniques, etc., and the relative strengths and weaknesses of such techniques.
- To demonstrate PC-based, Workstation-based, and WWW (World Wide Web = Internet) applications.
- To demonstrate a wide range of environmental applications in fields as diverse as: managing water quality by biological objectives, watershed management and decision-making, ground-water management, and acid rain policy options.

1.3 Target audience

Professionals responsible for developing or using environmental information systems and who wish to move beyond GIS.

MODULAR TRAINING PROGRAMME

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Environmental Information System components: GIS, databases, GUI linkages, Expert Systems, Neural Networks, modelling, etc.

GUI linkages between components for seamless operations.

Methods for dealing with uncertainty in data, in predictions, etc.

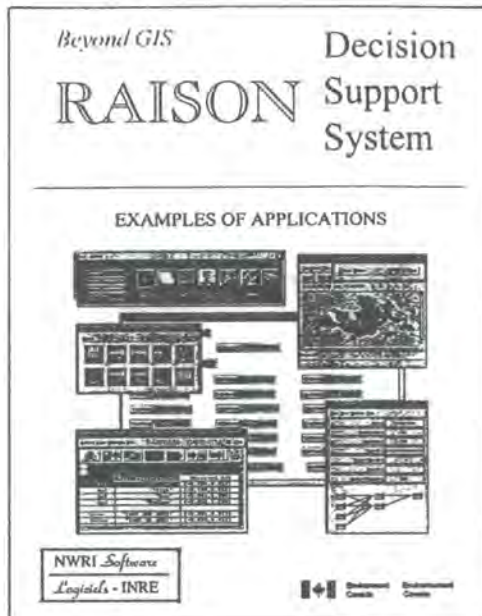
Building knowledge domains for application in decision-making.

Networking using the World Wide Web; distributed information systems.

Wide range of applications to demonstrate scientific, management decision-making, and policy advice at local, regional and national scales.

2.2 Supporting material

Handouts, systems manuals



2.3 Teaching methods

This is a workshop format. Participants will work on real systems using actual examples.

2.4 Language capacity

This course is available in English only.

3. COURSE ORGANIZATION

3.1 Course duration

This course is designed to familiarize participants with the many components of modern EIS systems. Core material is covered in one week, but may be supplemented by additional week(s) for system application for particular problems that are relevant to the User.

3.2 Participant numbers

The optimum number of participants is 10.

3.3 Participant requirements

Participants must have a good background in computer technologies and GIS.

3.4 Course venue

This course would usually be run either at the NWRI or VKI offices. Core material can be given elsewhere providing that computer facilities are adequate.

3.5 Suggested course combinations

Courses: 2, 10

3.6 Institutions offering this course

NWRI	<i>Contact:</i> GEMS/Water Programme Office
P O Box 5050	Tel:+1 905 336 6440
Burlington	Fax:+1 905 336 4582
Ontario L7R 4A6	Email: gems@cciw.ca
Canada	

VKI	<i>Contact:</i> Jorn Rasmussen
Agern Allé 11	Tel: +45 42 865211
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Denmark	Email: jar@vki.dk

COURSE 17
DRINKING WATER QUALITY
SURVEILLANCE AND CONTROL

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To emphasise the importance of the relationship between drinking water quality and human health and the need for surveillance of drinking water supply to ensure adequate supplies of drinking water are maintained to all sectors of society.

1.2 Objectives

- To demonstrate the links between drinking water quality and health and to identify diseases which can be directly caused by inadequate water supply.
- To define the microbiological, chemical and physical parameters of drinking water quality and to provide guidance on the relative importance of each. To demonstrate the use and derivation of quality guidelines and standards.
- To promote surveillance of drinking water supplies and to promote the inclusion of the five parameters of drinking water supply quality: quality, quantity, coverage, continuity and cost; in surveillance programmes.
- To promote the use of surveillance programmes as decision making tools in prioritising investment in water supplies and as a key operational element designed to maintain service quality standards and to implement action when required.
- To strengthen the knowledge of those responsible for protection of water sources and the treatment and supply of safe and adequate drinking water and to promote principles and actions for implementing and sustaining safe drinking water programmes.

1.3 Target audience

Professionals from the water supply, health or environment sectors. Ideally there will be a mixture of participants from all three sectors as this allows a greater degree of discussion.

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Water and health, the principal water related diseases, their incidence and mode of transmission; morbidity and mortality caused by water related disease worldwide; barriers to disease transmission; relative risks from chemical and bacteriological contamination of drinking waters.

The WHO Guidelines for drinking water quality, their basis and application; establishing national drinking water quality standards; monitoring of the other parameters of drinking water supply standards - quantity, coverage, continuity and cost.

Monitoring water quality and selection of parameters and the relation to monitoring type; the use of indicator bacteria for routine monitoring; key properties of indicator bacteria and the most commonly used indicators; the critical water quality parameters - thermotolerant coliforms, chlorine residual, pH and turbidity.



Analytical techniques for microbiological, chemical and physical drinking water quality monitoring; the use of membrane filtration and MPN techniques for microbiological monitoring; new techniques for microbiological analysis; principal techniques for measuring chemical and physical quality of water; laboratory and on-site methods, their applications and selection of techniques.

2.1 Course content (continued)

Sanitary inspections of water supplies and critical evaluation of system vulnerability; how to conduct a rational sanitary inspection; developing sanitary inspection forms; training other to carry out sanitary inspection; sanitary inspection as a operation and maintenance tool.

Linking surveillance programmes to water supply improvement and the selecting appropriate remedial and preventative actions; surveillance as a management tool; using surveillance to improve design, construction, operation and maintenance of water supplies.

Water treatment processes and disinfection of water supplies; monitoring treatment performance and optimisation of treatment; the multiple barrier principle; assessing treatment efficiency; selection of treatment processes.

Source protection and resource management; the need for integrated approaches to water quality protection; local, regional and national protection of water resources; the need for adequate sanitary completion; protecting resources.

Human resource development in surveillance; assessing training needs and capacities; achieving training for sanitary inspectors, laboratory staff and management; awareness raising in communities.

Information management in water supply surveillance and the use of computerised data management systems; and decision making and prioritisation of action.

Institutional arrangements and legal frameworks for the water supply sector; defining responsibilities and remit of agencies; interaction between the surveillance agency and water suppliers; interaction between surveillance agency and resource management agency; defining surveillance policies.

Providing sustainable water supply services; financial management and planning of drinking water supply and surveillance and the link to protection of drinking water quality.

2.2 Supporting material

World Health Organization (1997) *Guidelines for Drinking Water Quality Volume 3, 2nd edition.*

Tebbutt, T (1992) *Principles of Water Quality Control* 4th Edition, Pergamon.

MODULAR TRAINING PROGRAMME

Howard, G. and Bartram, J. (eds) *Surveillance and Monitoring Water Quality in Urban Areas of Developing Countries (draft manual)*. In preparation.

2.3 Teaching methods

The emphasis of this course is to balance practical training with analysis and discussion of the issues related to surveillance. Thus a mixture of presentations, group discussions and practical work is undertaken. There is a substantial fieldwork component to this course to allow familiarisation with surveillance methods. Several group projects will also be undertaken to allow participants to develop their understanding of water supply surveillance and improve their decision making.

2.4 Language capacity

This course is available in English, French and Spanish.

3. COURSE ORGANIZATION

3.1 Course duration

The course is a two week event including field visits. A shorter one week event which covers some aspects included in this course is also available.

3.2 Participant numbers

The optimum number of participants for this course is 15, although numbers of up to 24 can be accommodated.

3.3 Participant requirements

Participants should be either technical or managerial staff and be reasonably senior within their organization, with considerable experience.

3.4 Course venue

The course requires a lecture room equipped with OHP; transport facilities for the field visit and laboratory space for the practical exercises.

COURSE 17: DRINKING WATER QUALITY SURVEILLANCE & CONTROL

3.5 Suggested course combinations

Courses: 1, 4, 5, 11, 13, 15

3.6 Institutions offering this course

Robens Institute	<i>Contact:</i> Jennie Lynch
University of Surrey	Tel:+ 44 1483 259209
Guildford	Fax:+ 44 1483 503517
Surrey GU2 5XH	E-mail: rbs1jl@surrey.ac.uk
United Kingdom	

WHO	<i>Contact:</i> Richard Helmer
CH-1211 Geneva 27	Tel: + 41 22 791 3761
Switzerland	Fax: + 41 22 791 4127
	Email: helmerr@who.ch

COURSE 18
WATER POLLUTION CONTROL:
REGULATORY AND TECHNOLOGICAL APPROACHES

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To provide participants with an understanding of a range of tools and regulatory instruments and their application which will enable them to address water quality problems and contribute to better water resource management in a rational approach.

1.2 Objectives

- To contribute to better water pollution management through applying knowledge on relevant tools and instruments available to managers and decision-makers within water pollution control.
- To provide an overview of available and relevant tools and instruments for water pollution control.
- To highlight the advantages and disadvantages of different tools, and of the significance of the local circumstances in which they are to be applied.
- To relate the application of different tools for water pollution control to water resource management needs and to specific water quality problems.

1.3 Target audience

The course is directed towards professionals within the water pollution sector (engineers, biologists, hydrologists, etc.). Managers and staff employed in governmental organizations (both local and national level) are envisaged to be the main target groups.

2. COURSE CONTENT AND DESIGN

2.1 Course content

The course will provide the background for recent development trends within integrated water pollution management. The concepts, framework and guiding principles for water pollution management emerging from Agenda 21 and the preparatory conferences on freshwater issues will be dealt with as the basis for decision on which tools and instruments can best serve the purpose of

MODULAR TRAINING PROGRAMME

achieving rational water pollution management, given the local social, economic and other relevant circumstances. Principles for selection and combination of tools will be discussed. Important management tools and instruments that will be covered by the course are:

- *Regulatory instruments.* Regulations are the supporting rules of the relevant legislation and specify the current policies, priorities, standards and management procedures that apply.
- *Economic instruments.* The main types of economic instruments applicable in a water pollution context include resource pricing, effluent charges, product charges, subsidies/removal of subsidies and non-compliance fees.
- *Monitoring systems.* The actual design of an operational and adequate monitoring system must from the beginning take account of the requirements of the additional management tools that are considered to be used for enhanced water pollution control. This implies that the complexity and size of monitoring area, number of variables and frequency of monitoring must be balanced against the available resources.
- *Water quality standards.* Standards for ambient water quality are commonly designated according to the intended use of the water resource, while effluent standards are usually based on either the fixed emission standard approach or the environmental quality standard approach.
- *Water quality models.* Models may be understood in a broad sense as any deterministic theory of cause-effect relationship which is able to quantify a specific water pollution problem, ranging in complexity from simple models based on simple loading compilations to advanced computerized ecological models.
- *Environmental impact assessment.* EIA can provide decision makers with the best quantitative information available, regarding intended as well as unintended consequences of particular investments and alternatives, the means and costs to manage undesirable effects, and the consequences of taking no action.

2.2 Supporting material

Helmer, R & Hespanol, I (1997) Water Pollution Control: A guide to the use of water quality management principles. (Published on behalf of WHO, UNEP, WSSCC) E & FN Spon, London.

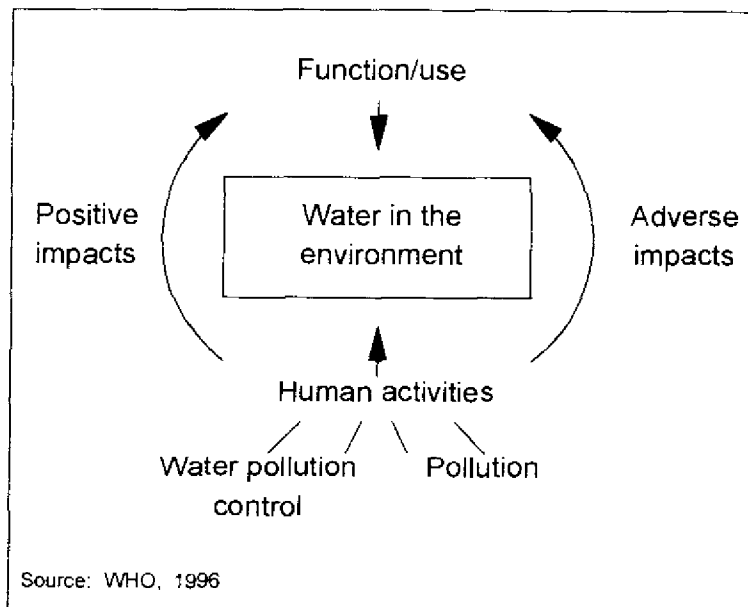
2.3 Teaching methods

The course will consist of lectures combined with plenary discussions and case studies.

Introductory lectures will be given, in order to set the stage and focus the discussion. Subsequent discussions will draw heavily on participants' own experiences, background and local problems.

2.4 Language capacity

This course is available in English only.



3. COURSE ORGANIZATION

3.1 Course duration

The course of 5 days duration.

3.2 Participant numbers

The course is suitable for 5 to 15 participants.

MODULAR TRAINING PROGRAMME

3.3 Participant requirements

The participants would be expected to have some experience from assignment within the water pollution control sector.

3.4 Course venue

This course requires a lecture room equipped with overhead projector.

3.5 Suggested course combinations

Courses: 1, 3, 4, 5, 6, 17

3.6 Institutions offering this course

VKI	<i>Contact:</i> Jorn Rasmussen
Agern Allé 11	Tel: +45 42 865211
DK-2970 Hørsholm	Fax: +45 42 867273
Denmark	Email: jar@vki.dk

WHO	<i>Contact:</i> Richard Helmer
CH-1211 Geneva 27	Tel: + 41 22 791 3761
Switzerland	Fax: + 41 22 791 4127
	Email: helmerr@who.ch

COURSE 19
RAPID INVENTORY TECHNIQUES AND
ASSESSMENT OF WATER POLLUTION SOURCES

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To strengthen regional and national environmental management by providing tools for the collection and analysis of information on water pollution sources and to facilitate future collaboration in environmental management at regional and national levels.

1.2 Objectives

By the end of this course, participants will:

- Understand and be able to apply selected models of wastewater inventories.
- Understand and be able to apply selected models for the assessment of quality of lakes, rivers and coastal waters.
- Understand the process the process of planning and execution of environmental studies.
- Understand the organizational, definition, collection, cross-checking and processing of field data and the production of relevant reports for policy makers and strategic planners.

1.3 Target audience

Participants should be engaged in water quality management, relevant teaching or research related to water quality issues in the public or private sectors.

2. COURSE PROGRAMME AND DESIGN

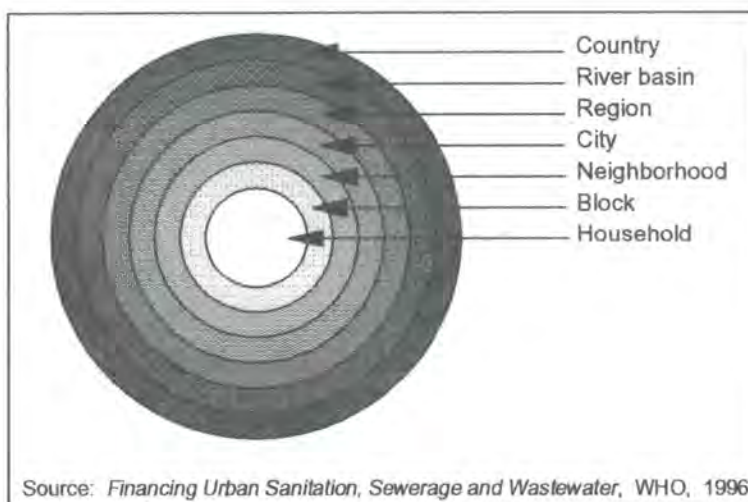
2.1 Course Content

Source inventory techniques: alternative source inventory approaches, including modelling and monitoring; the WHO/UNEP/UNIDO/IAEA Rapid Assessment approach, and; combined approaches to inventories.

2.1 Course Content (continued)

The WHO/UNEP/UNIDO/IAEA Rapid Assessment of liquid waste inventories: estimation methods for wastewater volume and the most common quality criteria (Biochemical Oxygen Demand, total suspended solids, total nitrogen, total phosphorous and other source-specific pollutants), by source type. These will cover: agriculture (eg livestock production); manufacturing (food, paper, printing and publishing, wood products, industrial chemicals, base metal processing and beverage industries); electricity production; transport (eg airports), and; community and social services (eg sewers, septic tanks and swimming pools).

Water quality modelling: environmental sensitivity of wastewater receiving bodies; models for the quality of lakes (including eutrophication, conservative substances, non-conservative and phosphorous pollutants); models for the quality of rivers (including critical BOD loadings, conservative, non-conservative and microbial pollutants), and; models for the quality of coastal waters (including empirical models for outfall sizing, eutrophication in closed bays or harbour basins).



Environmental management issues: definition of strategy objectives; definition of criteria of effectiveness; screening of control options; sensitivity analysis; assessment of costs and efficiencies; formulation of appropriate strategies, and; the systems analysis approach.

Study implementation aspects: resource requirements; definition of study areas, and; data acquisition.

2.2 Supporting material

Tutors Guides:

World Health Organization (1994). *One Week Training Workshop in Assessment of Sources of Air/ Water and Land Pollution - A Tutor's Guide/Part One: Workshop Organization and Lecture Notes.*

World Health Organization (1994). *One Week Training Workshop in Assessment of Sources of Air/ Water and Land Pollution - A Tutor's Guide/Part Two: Exercise Material and Evaluation Questionnaires.*

World Health Organization. *Tutor's Guide Software.*

Background reference documents (to be distributed to each participant):

World Health Organization (1993). *Assessment of Sources of Air, Water and Land Pollution/Part One: Rapid Inventory Techniques in Environmental Pollution, Report WHO/PEP/93.1-A.*

World Health Organization (1993). *Assessment of Sources of Air, Water and Land Pollution/Part Two: Approaches for Consideration in Formulating Environmental Control Strategies, Report WHO/PEP/93.1-B.*

Additional background reference documents:

Chapman, D (1996) *Water Quality Assessments 2nd Edition*, Chapman & Hall.

Stuckey, D. and Hamza, A. (1983), *Management of Industrial Wastewater in Developing Nations*, Pergammon Press, Oxford.

Stiff, M.J (1980), *River Pollution Control*, Ellis Harwood Limited, Chichester.

Carmichael, J.B., Strzepek, K.M. and UNIDO (1987), *Industrial Water Use and Treatment Practices*, Cassell Tycooly, Philadelphia.

Middlebrooks, E.J. (1979), *Industrial Pollution Control, Volume 1: Agro-Industries*, John Wiley & Sons, New York.

2.3 Teaching methods

The course is designed to be participatory and relies primarily on problem-solving exercises and group discussions supported by technical presentations. Participants will have an opportunity to use computerised versions of models described in course material. Raw sets of data will be analyzed and processed in small groups with plenary discussion sessions to review group work.

2.4 Language capacity

This course is available in English only.

3. COURSE ORGANIZATION

3.1 Course duration

The course is designed for five working days. Two days are dedicated to the Rapid Inventory Techniques and three to management approaches including modelling exercises.

3.2 Participant numbers

The optimum number of participants for this course is about 15. A total of 25 participants should not be exceeded.

3.3 Participant requirements

Participants should have an appropriate qualification in a related discipline and have a good basic technical knowledge of waste disposal and environmental monitoring and assessment. Reasonable proficiency in english is required.

3.4 Course venue

The course requires a room large enough to seat all participants and should have the following equipment: overhead projector; one pocket calculator per participant, and; a minimum of one computer (386 DX or larger) per two to three participants.

3.5 Suggested course combinations

Courses: 1, 2, 5, 18

3.6 Institutions offering this course

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Switzerland	Fax: +41 22 791 4127
	Email: helmerr@who.ch

COURSE 20
WASTEWATER USE IN
AGRICULTURE AND AQUACULTURE

1. SCOPE AND PURPOSE OF THE COURSE

1.1 Aim

To enable developing countries to implement or upgrade agricultural, aquacultural and agro-forestry wastewater reuse schemes which are safe and environmentally sound and adapted to local technical, socio-economic and cultural conditions.

1.2 Objectives

By the end of the course participants will:

- Be aware of the health, environmental, institutional, economic and technical considerations to be taken into account when implementing or upgrading the operation of wastewater reuse schemes.
- Understand the basis for the establishment of national standards and codes of practice for the use of wastewater.
- Be aware of the need to promote the reuse of wastewater in a safe and environmentally sound manner.
- Understand the concepts and techniques for planning wastewater use in the context of integrated water resources management.
- Be aware of the requirements for phased implementation of wastewater reuse and the planning requirements at pilot and large-scale project levels.

1.3 Target audience

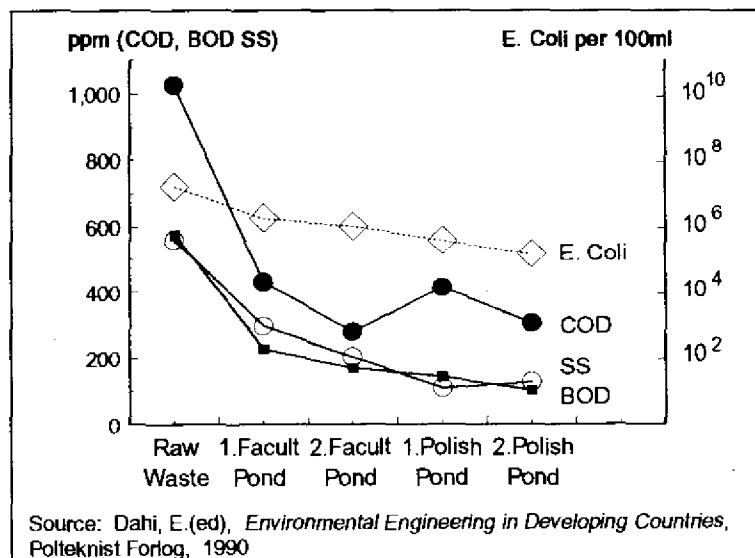
This course is designed for professionals likely to be involved in policy making, planning and operation and management of wastewater reuse schemes. This will include participants from engineering, health, environment, agricultural, legal and economics background.

2. COURSE PROGRAMME AND DESIGN

2.1 Course content

Wastewater in the context of integrated water resource planning: national water resources (sectors involved, current policies and programmes); future demands; water deficits and conflicting water demands and uses; review of country and regional specific practices of wastewater reuse, and; options for integrated water resources development.

Health and nutritional aspects: WHO guidelines for wastewater reuse in agriculture, aquaculture and agro-forestry; measures for health protection; crop selection for wastewater reuse; control of human exposure to wastewater; development and control of vectors, and; availability of adequate medical facilities to treat diseases potentially associated with wastewater reuse.



Technical aspects: wastewater characteristics; wastewater collection; wastewater treatment; sludge treatment, and; irrigation methods. (Possibly need to expand - eg. refer to problems with sprinkler irrigation, mention sludge treatment options, use of low-cost technologies).

Environmental aspects: basic soil characteristics; soil types and their suitability for wastewater reuse; problems with soils; risks of groundwater pollution, and; attenuation of pollutants in the sub-surface environment.

2.1 Course content (continued)

Agronomy and agriculture: FAO guidelines (for what?); soil characteristics for plant growth; soil-plant-water relationships; crop characteristics - permanent wilt point, plant water requirements; crop yields, and; selection of crops.

Economic aspects: economic advantages of wastewater reuse; costs of monitoring wastewater reuse; cost-benefit analysis; maximising economic advantage, selection of reuse strategies; wastewater as an economic good; establishing tariff structures for wastewater reuse, and; private sector roles.

Socio-cultural and religious aspects: socio-cultural perceptions of wastewater reuse; religious perceptions of wastewater reuse; acceptability of wastewater reuse in agriculture and aquaculture, and; balancing socio-cultural and economic considerations.

Legal and institutional aspects: institutional frameworks for wastewater reuse; identifying key players (authorities) and defining responsibilities; optimising institutional arrangements; defining national and regional policies for wastewater reuse; establishing national standards and guidelines for wastewater reuse, and; regulatory functions and enforcing standards.

Research and development needs: selection of appropriate methods of wastewater reuse; wastewater treatment options; crops suitable for reuse; fish breeds with maximum economic potential in wastewater reuse in aquaculture; application methods in agriculture, and; health related standards.

Monitoring and evaluation: health related monitoring of wastewater reuse; environmental monitoring of wastewater reuse schemes; evaluation of health and environmental impacts; assessment techniques, and; evaluating economic impacts of wastewater reuse.

2.2 Supporting material

Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture, Report of a World Health Organization Scientific Group, Technical Report No. 778, WHO, Geneva, 1989.

Wastewater Treatment and Use in Agriculture, Pescod, M.B., Irrigation and Drainage Paper No. 47, FAO, Rome, 1992.

Impacts of Wastewater Use and Disposal on Groundwater, British Geological Survey Hydrogeology Group, Foster, S.S.D., Gale, I.N. and Hespanhol, I. BGS, WHO, ODA, Technical Report WD/94/55, 1994.

2.2 Supporting material (continued)

Khanna, P. (ed) (1996) *Manual on Wastewater Reuse in Agriculture and Aquaculture*, NEERI, Nagpur.

Khanna, P. (ed) (1996) *Tutor's Guide on Wastewater Reuse in Agriculture and Aquaculture*, NEERI, Nagpur.

Hespanhol, I., *Guidelines and Integrated Measures for Public Health Protection in Agricultural Reuse Systems*, Aqua, vol 39, No. 4, pp237-249, 1990.

Rowe, D.R. and Abdel-Magid, I.M. (1995), *Handbook of Wastewater Reclamation and Reuse*, Lewis Publishers, New York.

Hespanhol, I. and Prost, A.M.E., *WHO Guidelines and National Standards for Reuse and Water Quality*, Wat. Res. vol 2, No. 1, pp119-129, 1994.



2.3 Teaching methods

The course is designed to actively involve the participants in discussions on planning activities related to wastewater reuse and guideline preparation. The course will be taught through a mixture of: presentations on all relevant topics; case studies prepared in advance by participants; working group discussions on country and region specific situations; plenary discussions on wastewater reuse, and; field visits to appropriate treatment facilities and wastewater applications in agriculture.

2.4 Language capacity

This course is available in English and Spanish.

3. COURSE ORGANIZATION

3.1 Course duration

This course is designed to last for one week, including a field visit.

3.2 Participant numbers

The workshop should be attended by a maximum of 20 participants.

3.3 Participant requirements

Participants should be educated to degree level in an appropriate discipline. No prior knowledge of wastewater reuse is essential.

3.4 Course venue

The workshop requires a lecture room, large enough to seat all participants. It should be equipped with an overhead projector. Transport facilities should be organised for the field visit.

3.5 Suggested course combinations

Courses: 1, 2, 5,18

3.6 Institutions offering this course

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	Email: helmerr@who.ch

PART III

SUGGESTED MODULAR PACKAGES

SUGGESTED MODULAR PACKAGES

Introduction

In the previous section of this Guide, detailed course descriptions have been given for a total of 20 courses covering different aspects of water quality. Each of these courses is a self-contained unit which can be delivered independently but also constitutes a *module* of the GEMS/WATER training programme. Combinations of several modules will meet the training needs of specific target groups.

Different professional groups, water agencies and countries will have different training need and priorities and therefore may wish to select a number of the courses described to produce a coherent training strategy. Overleaf are given some examples of possible module combinations which will provide guidance of suitable approaches to training provision for targeted groups of professionals.

The combinations presented overleaf cover areas where training will support:

- the initiation of monitoring or development of monitoring;
- the optimisation of monitoring programmes and development of more advanced monitoring techniques;
- monitoring and management of the quality of surface water resources;
- monitoring and management of the quality of groundwater resources;
- monitoring undertaken by water supply and sanitation agencies for quality control of drinking water and effluent;
- monitoring undertaken by regulatory agencies to ensure that drinking, natural and waste waters meet national quality standards;
- improvement and expansion of analytical and data management capacities.

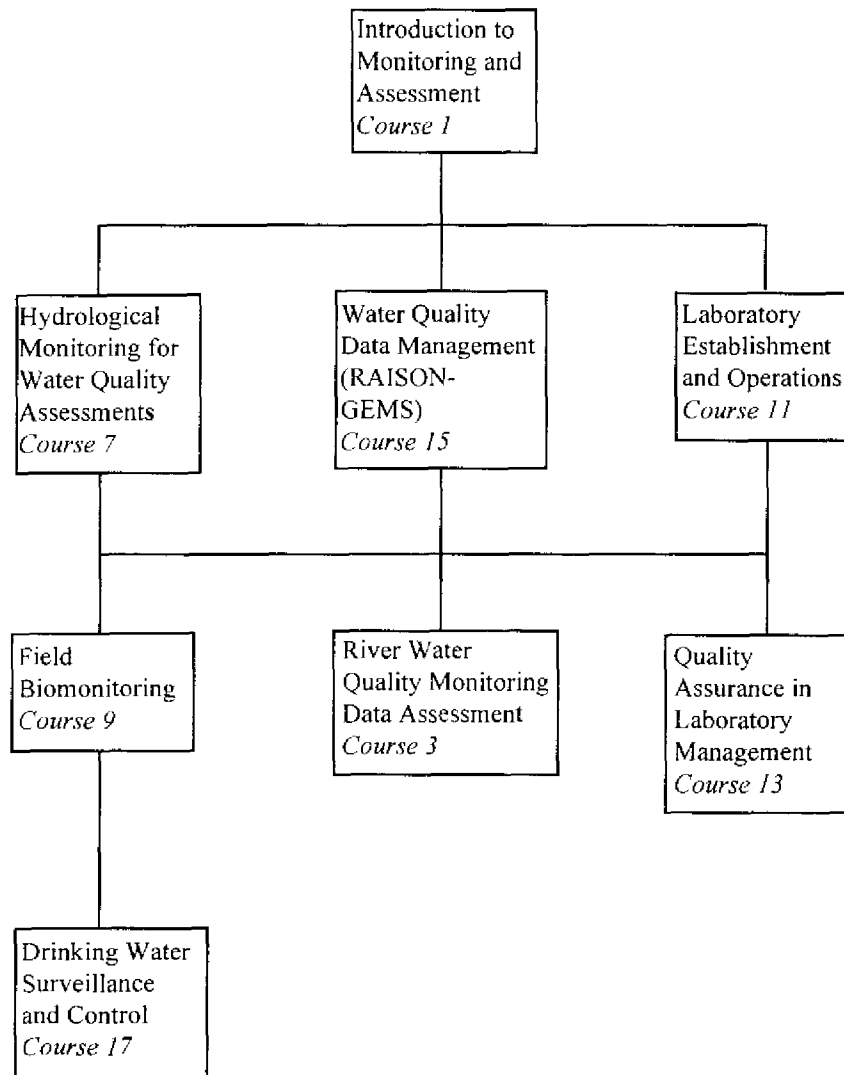
However, it should be stressed that these are only examples and that the modules presented in the Guide can be brought together in any number of different combinations to provide tailor made training packages meeting specific needs.

It is recommended that when combinations of modules are being planned, that careful consideration is given to the overall structure of the training package desired, the numbers and nature of the target audience and the aims and objectives of the training package. It is important that training is provided which is focused on specific requirements, but that also address the overall training needs of organizations and countries in a coherent and comprehensive manner.

MODULAR TRAINING PROGRAMME

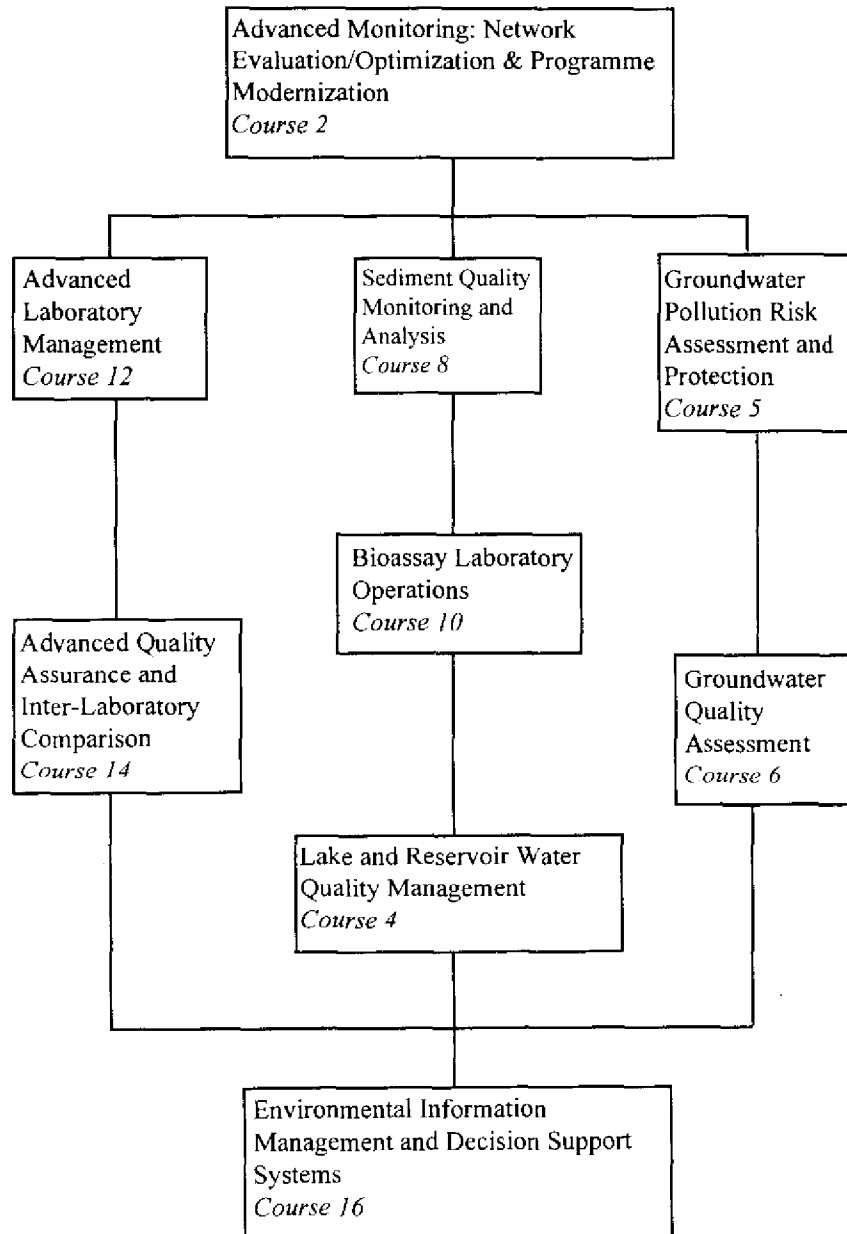
If further advice is required on setting training objectives, designing training programmes and selecting appropriate modules combinations, advice may be sought from experienced staff in the participating institutions listed in this Guide. All these institutions have the expertise and experience to provide impartial and clear guidance on developing training to meet the needs of all levels of staff.

SUGGESTED MODULAR PACKAGES



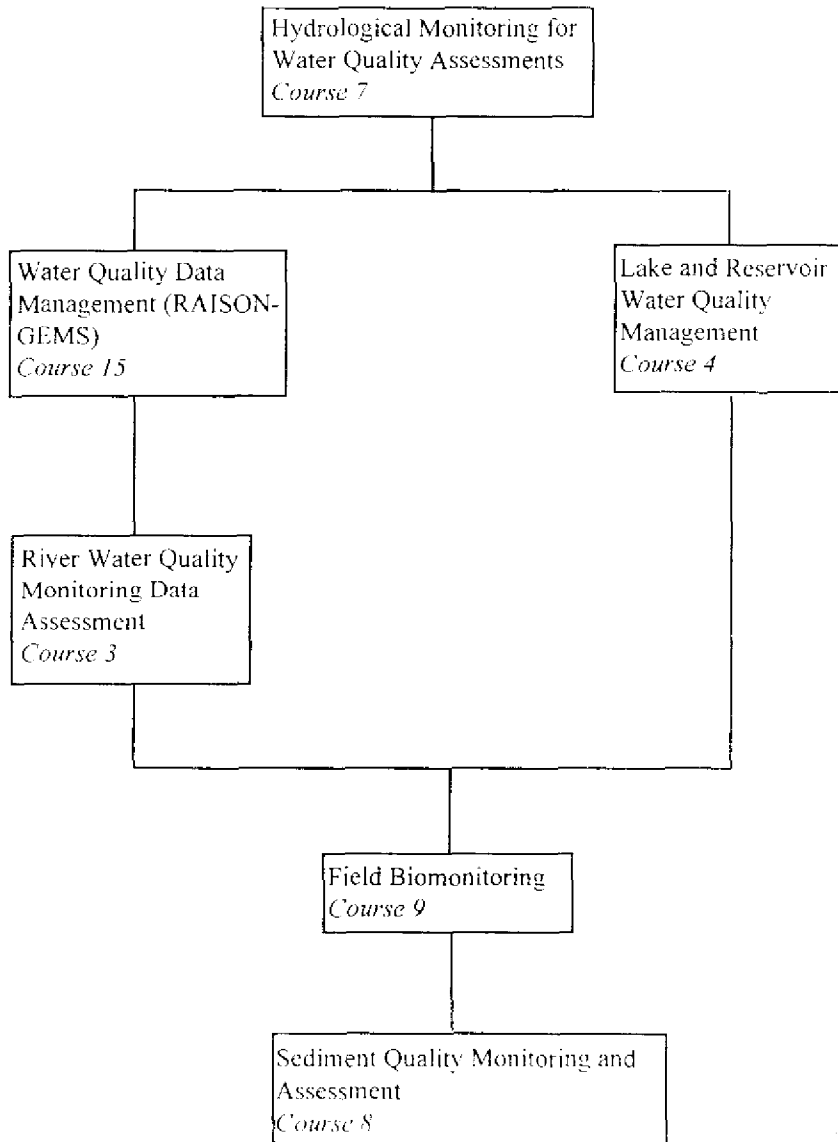
***SUGGESTED MODULE COMBINATIONS IN COUNTRIES
INITIATING NATIONAL MONITORING PROGRAMMES***

MODULAR TRAINING PROGRAMME

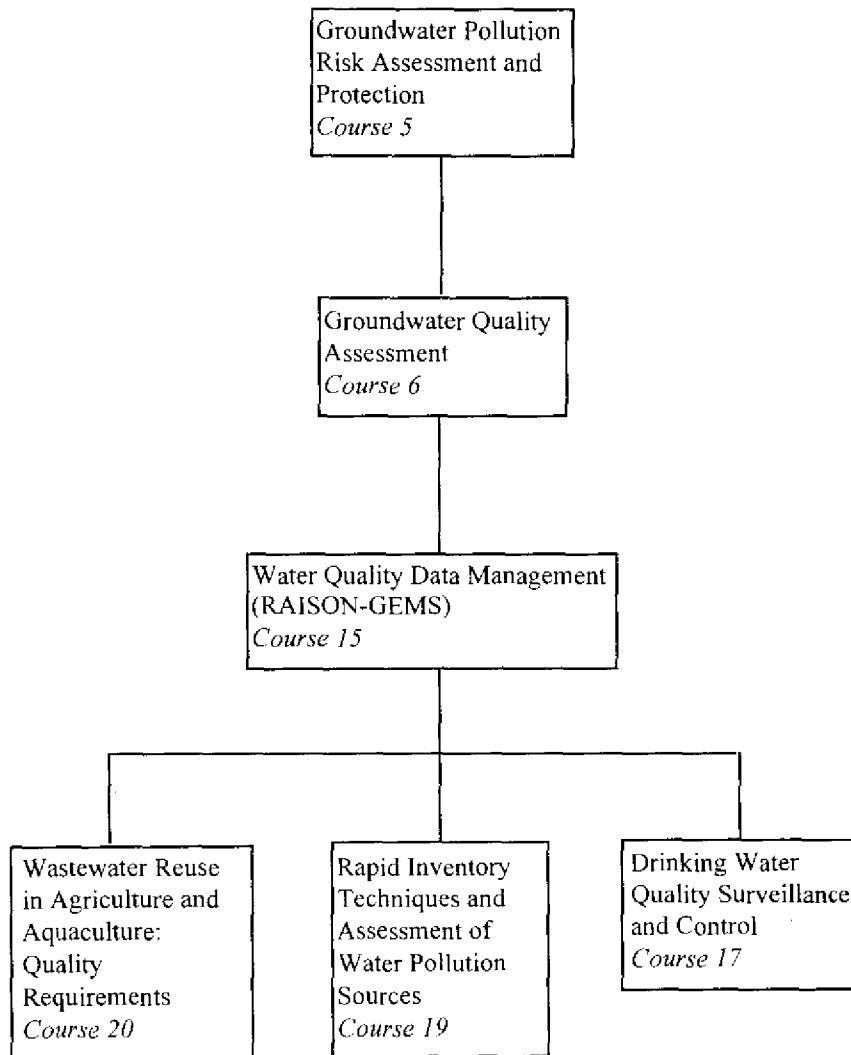


***SUGGESTED MODULE COMBINATIONS IN A COUNTRY
AIMING TO IMPROVE AND UPDATE ESTABLISHED
MONITORING PROGRAMMES***

SUGGESTED MODULAR PACKAGES

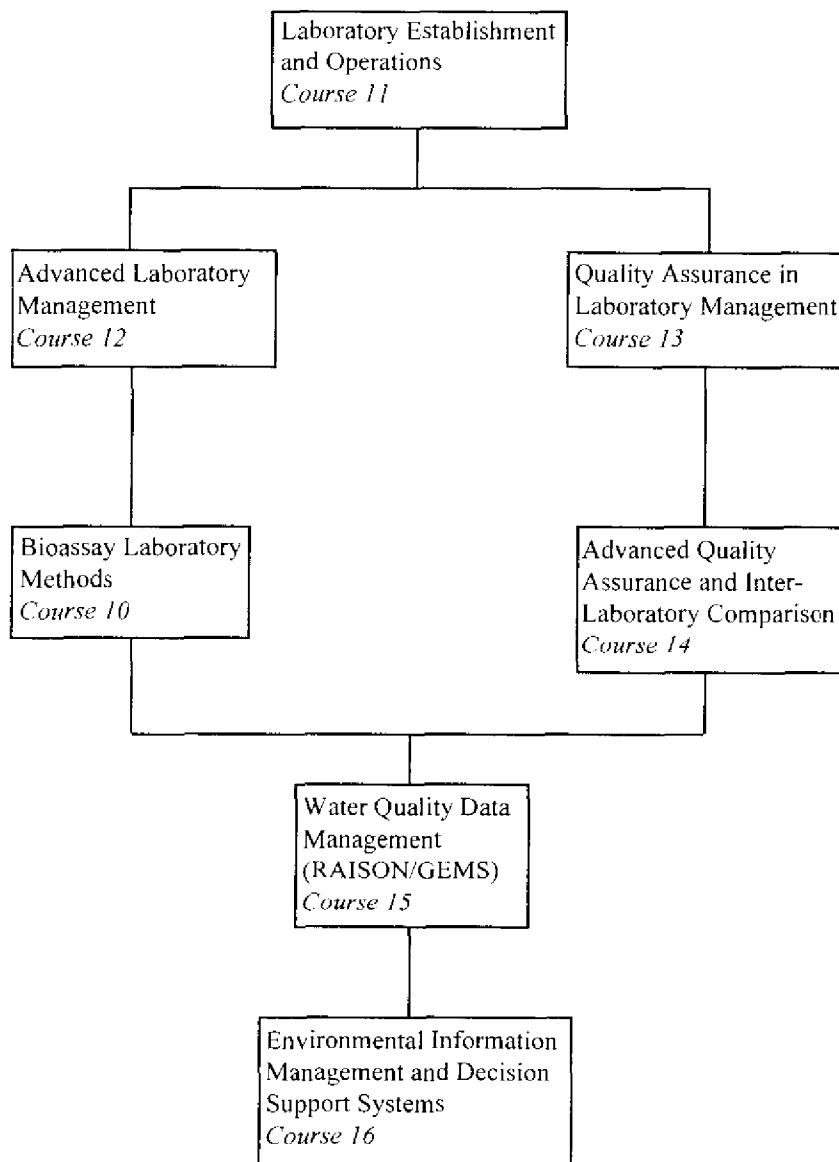


SUGGESTED MODULE COMBINATIONS FOR SURFACE WATER QUALITY MONITORING AND MANAGEMENT

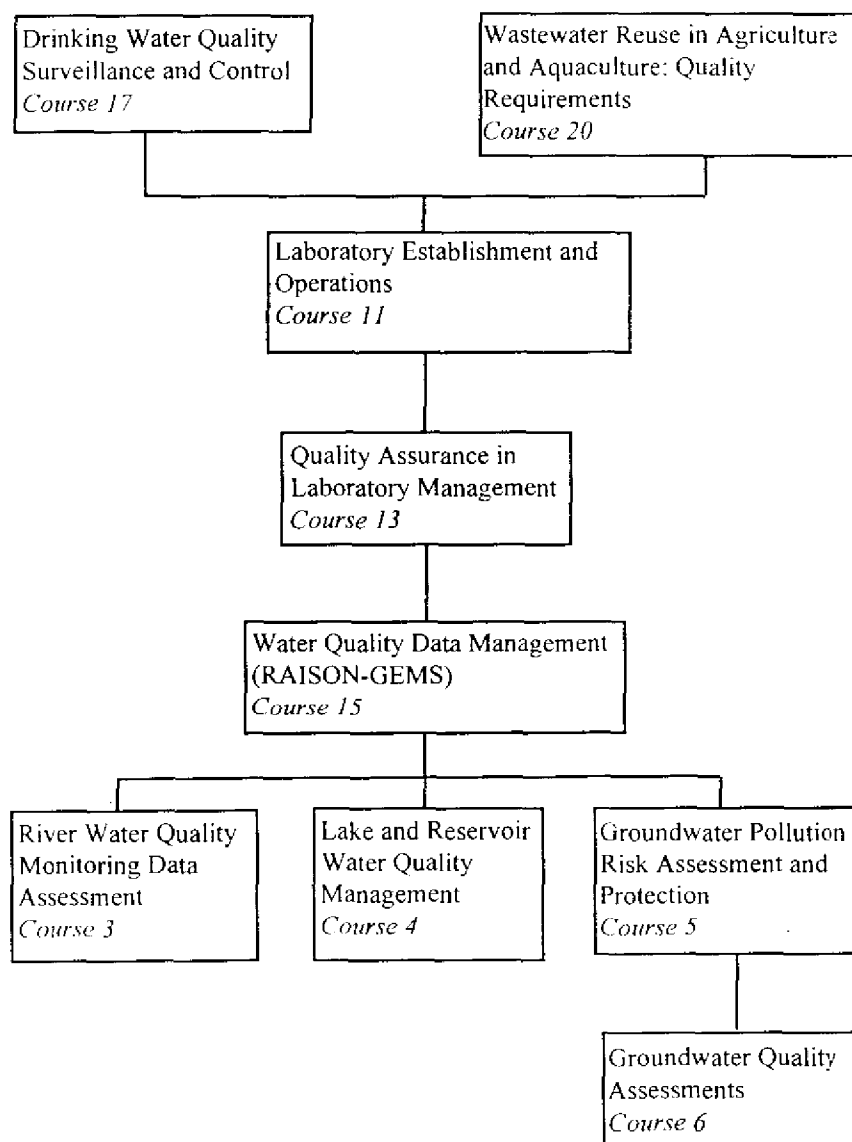


**SUGGESTED MODULE COMBINATIONS FOR
GROUNDWATER QUALITY MONITORING
AND MANAGEMENT**

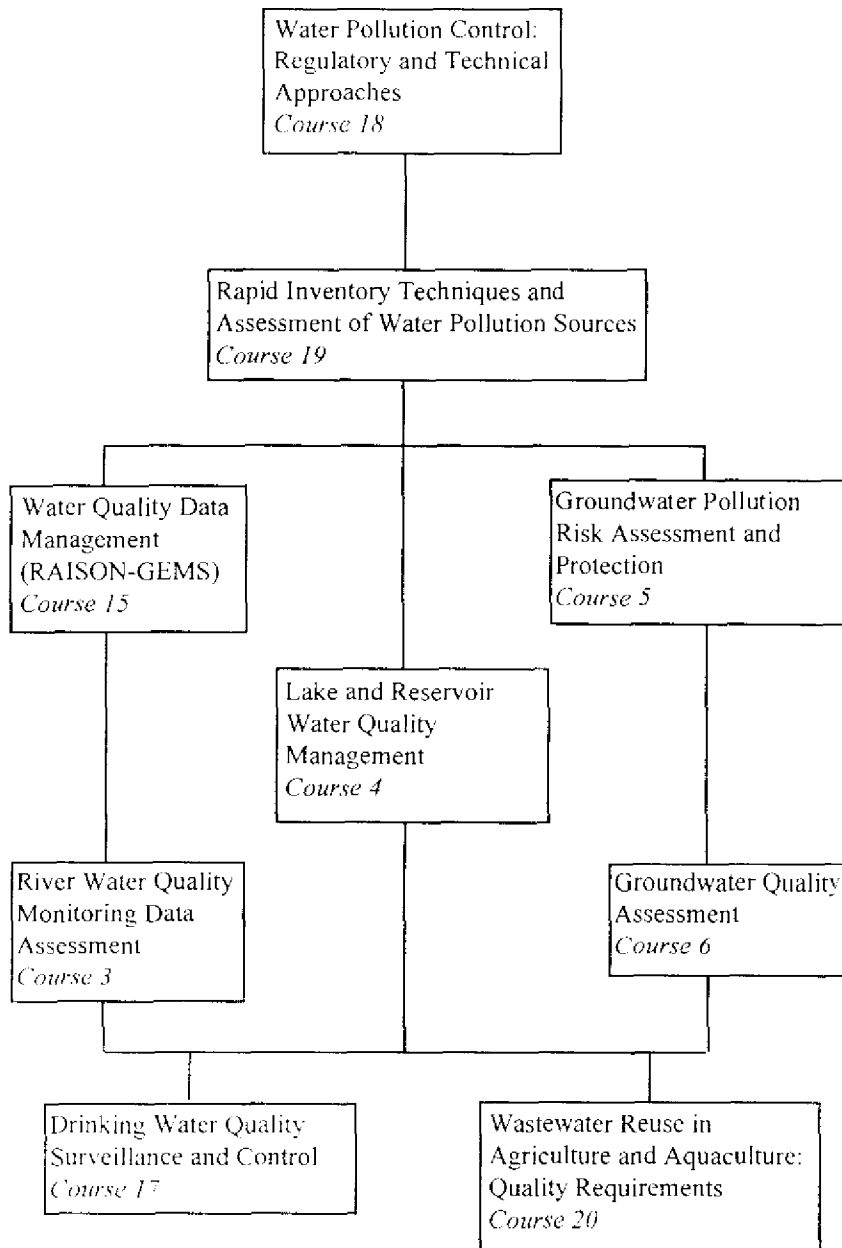
SUGGESTED MODULAR PACKAGES



SUGGESTED MODULE COMBINATIONS FOR IMPROVING AND EXPANDING ANALYTICAL AND DATA MANAGEMENT CAPACITIES



***SUGGESTED MODULE COMBINATIONS FOR
WATER SUPPLY AND SANITATION AGENCIES***



***SUGGESTED MODULE COMBINATIONS FOR
REGULATORY AGENCIES***

PART IV

*UN AGENCIES AND COLLABORATING INSTITUTIONS IN THE
GEMS/WATER TRAINING PROGRAMME*



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United Nations Environment Programme (UNEP)

To address the protection and conservation of water resources, UNEP established its integrated Water Branch. A primary role of the Water Branch is to assist decision-makers, particularly in developing countries, to:

- develop capacity for implementing environmentally-sound and sustainable management and use of their freshwater resources and coastal areas;
- raise public awareness and support for sustainable water use, and actions to solve water problems of all types;
- assist riparian governments sharing transboundary waters to avoid water-related conflicts; and
- generate interest on the part of the donor community to support basin-wide action programmes.

As part of their remit in the water field, UNEP has proposed an equity-led approach to the sustainable management and use of freshwater resources. UNEP also implements the "Environmentally-Sound Management of Inland Waters" programme (EMINWA). This programme considers water management in an integrated and holistic manner, addressing both economic and ecological factors influencing the water system on a drainage-basin scale. The UNEP Water Programme is structured in an integrated manner to facilitate assessment, diagnosis, management and strategic planning of all water resources.

UNEP also provides assistance in the form of development and assessment of practical economic tools to manage water resources in an efficient manner. UNEP also is compiling information and experience on a regional scale on alternative technologies for augmenting freshwater resources in developing countries, and in countries with economies in transition.

For almost two decades, UNEP, through its GEMS/Water Programme, has been involved in water quality monitoring and assessment projects at the global, regional and sub-regional level. The objectives of the GEMS/Water Programme are threefold: (i) to provide assessments of freshwater pollution issues to governments and water resources managers; (ii) to study global pollution and its movement via rivers to the oceans; and (iii) to strengthen national water quality monitoring activities in developing countries.



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World Health Organization (WHO)

Enabling countries and municipalities to deal with their urban health, environment and development situations in a more forward-looking comprehensive and integrated manner is the main objective of the Urban Environmental Health (UEH) Programme. It also focuses on promoting the incorporation of health-and environment considerations in national and municipal policies.

UEH's activities and programmes in the field of water quality assessment and water management include:

- GEMS/WATER monitoring and assessment of freshwater quality within the programme of water resource quality; the information produced by this programme can constitute a basis for comprehensive safeguarding of urban water resources and control of potential pollution sources;
- Supporting improvement in water supply and sanitation, as part of municipal health plans;
- Developing guidelines for the safe use of water, e.g. drinking water guidelines and wastewater reuse in agriculture; assisting countries in developing their national codes of practice in the safe use of water;
- Providing know-how on low cost water treatment technology;
- Assisting countries in identifying priorities within the programme of comprehensive urban environmental pollution management; the application of the WHO rapid assessment methodology of pollution sources is a component of this support.

Within these programmes, numerous training courses and capacity-building workshops have been organized.



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***United Nations Educational, Scientific
and Cultural Organization (UNESCO)***

UNESCO's International Hydrological Programme (IHP) is at the centre of scientific efforts to improve basic knowledge of the global hydrological cycle and encourage proper water management. The IHP was formed by an inter-Governmental Council set up by the General Conference of UNESCO in 1975, as the logical extension of the International Hydrological Decade.

The Council had responsibility to define priorities and supervise IHP programmes. To date, 140 countries have established National Committees and the IHP works with these Committees as well as non-Governmental Organizations.

The IHP's mandate is to develop the scientific and technological capacity for rational water resource management on a global scale. Central to this mandate is to improve national capacity to monitor and manage freshwater resources.

Water resource assessment and monitoring is moving away from the engineering-led era into one characterized by 'eco-hydrology'. The state of water resources is now linked directly to global, regional and local environmental change. Since water is one of the key elements which make life on Earth possible, it is imperative that it is managed properly for the benefit of all. In taking a more ecological approach to water resource management, policy makers and resource scientists are able to look at the wider implications of land use practices which contribute to the degradation of water supplies.

The IHP is now entering in the Fifth Phase (IHP-V): 1996-2001. The themes of IHP-V are:

- Global hydrological and biogeochemical processes.
- Ecohydrological processes in the surficial zone.
- Groundwater resources at risk.
- Strategies for water resources management in emergency and conflict situations.
- Integrated water resources management in arid and semi-arid zones.
- Humid tropics hydrology and water management.
- Integrated urban water management.
- Transfer of knowledge, information and technology (KIT).



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World Meteorological Organization (WMO)

The World Meteorological Organization (WMO) is the inter-Governmental organization and specialized agency of the United Nations dealing with meteorology, hydrology and climatology. Among its six technical programmes is the Hydrology and Water Resources Programme whose objective is:

To apply hydrology to meet the needs for sustainable development and use of water and related resources to the mitigation of water-related disasters and to effective environmental management at national and international levels.

The programme deals, among other things, with instrumentation, observations, data processing, networks, forecasting, modelling and standardization in hydrology. It provides the basis for scientific and technical studies and for the application of hydrological information to hydraulic design, water management and mitigation of extreme events. The programme also deals with global environmental issues such as impacts of climate variability and change on water resources.

Activities include: the preparation of technical reports, formal guidance material and technical regulations; the convening of a variety of scientific and technical meetings; organization of training courses; the maintenance of various data bases; and work conducted directly with national Hydrological Services to upgrade their facilities and services.

The programme is supported by the Hydrological Operational Multipurpose System (HOMS) which facilitates the transfer of technology between the Hydrological Services of countries. The Global Runoff Data Centre in Koblenz, which actively contributes to the work of GEMS/WATER, is maintained under the auspices of the programme and information on the identity and activity of national Hydrological Services is compiled under a computer-based system referred to as INFOHYDRO.

While external funds for support to individual countries have diminished in recent years, valuable resources are now being made available under the WHYCOS (World Hydrological Cycle Observation System) project for the development of regional networks that will collect and compile data on both the quantity and quality of water bodies in a number of areas in the World.



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British Geological Survey (BGS)

The British Geological Survey is the UK's national centre for earth sciences. Founded in 1835, the BGS is the world's oldest national geological survey. The survey's work relates directly to mineral, energy and groundwater resources, land use, geological hazards and the protection of the environment both onshore and offshore. Scientific research and development is undertaken in support of this work.

The survey's mission includes to:

- undertake strategic programmes in geoscience surveying, monitoring and related research;
- gather, analyze and disseminate geoscience information and knowledge, and provide technical advice to government, industry and the community on mineral, energy and groundwater resources, geological hazards and related aspects of land-use planning and the protection of the natural and man-made environment;
- undertake geoscientific programmes, including surveying, monitoring and R&D related to mineral, energy and water resources and the environment, and the provision, dissemination and exchange of geoscience information, within the European Union and worldwide in support of United Kingdom Government policy and United Kingdom industry, and for the benefit of countries wishing to develop and manage their resources and sustain their environment.

The Hydrogeology Group comprises over 40 scientists with wide experience of groundwater resource assessment and mapping; fluid flow in porous media; groundwater modelling, hydrogeochemical processes; and agricultural, urban and industrial pollution worldwide. Staff have access to the latest equipment and laboratory facilities and the National Groundwater Archive.

With access to extensive computing facilities and software and wide experience in groundwater modelling, the BGS Hydrogeology Group is well placed to apply and develop models to assist in the resolution of a wide variety of hydrogeology problems.



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CEPIS

The Pan American Centre for Sanitary Engineering and Environmental Sciences (CEPIS) is a multinational technological centre whose major aim is to provide technical and scientific cooperation in sanitary engineering and environmental sciences in the Americas Region. It focuses its cooperating strategy on promotion and development of programmes taking into account the need for interdisciplinary solutions for environmental problems and the institutional frameworks and socio-economic conditions of each Member State.

The programme areas under development by CEPIS include the following:

- a) improvement and surveillance of water quality for human consumption;
- b) water supply and sanitation;
- c) solid wastes;
- d) wastewater use for agriculture and aquaculture;
- e) environmental contamination, with emphasis on contamination of surface water, contamination of groundwater and hazardous wastes.

CEPIS also acts as a regional information and reference centre on environmental health issues and facilitates the exchange of information and communication amongst institutions and professionals within and outside the Region.

In addition, CEPIS works in the development of applied research both within the premises of the Centre and at the country level. Another major area of emphasis of the Centre is to support Member States in their human resources development programmes.

Information is disseminated by CEPIS in the form of publications, documents and reports which are available in Spanish and some in English. Nominal fees may be requested for some publications. Publications are not available on the internet, which is for communication only.

CEPIS Consulting services available to national agencies, research and educational institutions, and local governments within Member States of the WHO/PAHO American Region. Proposals should be directed to the WHO Representative of the requesting country.



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Jordan

CEHA

The World Health Organization Regional Office for the Eastern Mediterranean Centre for Environmental Health Activities (CEHA) is based in Amman, Jordan.

The primary mission of CEHA is to provide technical support for the strengthening of national capabilities and programmes in environmental health, acting as the technical arm of the Environmental Health Division of the WHO Regional Office for the Eastern Mediterranean. CEHA services are available to the countries of the Region.

CEHA carries out the following activities: human resources development; information exchange (CEHANET); technical cooperation; and, special studies and applied research. CEHANET provides access to its regional bibliographic data bases of technical information.

In providing training courses and arranging seminars and workshops, CEHA has put together Training and Learning Materials (TLM), covering areas such as the reuse of treated effluents.

Solid waste management is dealt with under CEHAs Rural and Urban Development and Housing programme.

Information disseminated by CEHA includes teaching and learning materials, documents and reports and is available in English, French and Arabic. Information is not available on the internet which is for communication only.

CEHA consulting services available to national agencies, research and educational institutions, and local governments within Member States of the WHO Eastern Mediterranean Region. Proposals should be directed to the WHO Representative of the requesting country.



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International Lake Environment Committee Foundation (ILEC)

The International Lake Committee (ILEC) was established as an NGO in 1986 to safeguard lake environments. ILEC's aim is to promote environmentally sound management of natural and man-made lakes worldwide through the encouragement of international research and facilitation of the exchange of knowledge. Since the initiation of the Training Course on Lake Water Quality Management in 1991, 56 participants from 26 countries have attended the course. Furthermore, since 1992 ILEC has provided support for the UNEP International Environmental Technology Centre.

Organized into three divisions (Planning, Research and General Affairs), the major activities of ILEC are:

- collection and organization of data on the conditions of lakes throughout the world
- organization of training seminars on regional development and lake environment conservation in developing countries
- preparation of guidelines for lake environment management
- assistance in the planning and organization of conferences on lakes and their environments
- financial contribution to enterprises that offer economic and technological assistance for lake environmental management in developing countries
- promotion of lake environmental education
- support for UNEP International Environmental Technology Centre
- publication of newsletters to publicize its activities and raise public awareness of lake environment conservation

Since its formation in 1986 ILEC has contributed to several major conferences on lake environments and in collaboration with UNEP, published the 'Data Book of World Lake Environments'. ILEC has also prepared guideline documents on: Lake Management; Lakeshore Management; Socio-economic Aspects of Lake Reservoir Management; and Toxic Substances in Lake Management.



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Monitoring and Assessment Research Centre (MARC)

The GEMS Monitoring and Assessment Research Centre was established in 1975 as an independent research institute with the aim of supporting international and intergovernmental organizations and national governments in addressing global, regional and local environmental issues. It is located at King's College London, University of London and is an Assessment Centre for the United Nations Environment Programme's Global Monitoring System (UNEP-GEMS) and a designated World Health Organization (WHO) Collaborating Centre for Environmental Monitoring and Assessment.

MARC's work programme is based on the understanding that effective environmental policy development and management require good information and data. MARC activities can be grouped into two main areas:

- environmental information: reporting and assessment of environmental status and trends for effective communication to various information users including policy makers, managers, the general public or scientists.
- capacity building to support national and regional activities on monitoring, assessment and the collection and use of environmental data.

MARC has acquired an international reputation for high quality assessment and reporting on global environmental issues. Recent outputs include the latest edition of the *UNEP Environmental Data Report* and the report *Urban Air Pollution in Megacities of the World*. MARC has also produced a series of technical publications including *Biological Monitoring of Environmental Contaminants (Plants)*, *Biological Monitoring of Environmental Contaminants (Animals)* and *Historical Monitoring*. MARC has an on-going Workshop Programme for Developing Countries which in recent years have taken place in Thailand, China, Malaysia, Brazil, Ecuador and Zimbabwe. MARC is linked to the Division of Life Sciences of King's College London and thus has access to wide-ranging practical research expertise in Ecotoxicology, Environmental Health and Environmental Resource Management.



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Canada

National Water Research Institute (NWRI)

The National Water Research Institute (NWRI) is Canada's largest freshwater research establishment. The Institute conducts a comprehensive program of research and development in the aquatic sciences. It carries out this program in partnership with water management agencies and water science communities in Canada and around the world.

NWRI conducts multidisciplinary, ecosystem-based research in response to regional, national and global environmental issues of importance to Environment Canada. Research is undertaken on emerging issues, such as the ecological effects of increased UV-B, persistent toxic substances and climate change, as well as long-standing priority issues such as Great Lakes water quality. The Institute's research creates new knowledge and understanding of aquatic ecosystems; and develops expertise on water quality issues important for sustainable resource use and the preservation of freshwater ecosystems.

NWRI is organized into the following four research branches:

- Aquatic Ecosystem Restoration Branch - remediation research in degraded and ecologically disturbed sites;
- Aquatic Ecosystem Protection Branch - research on toxic chemicals;
- Aquatic Ecosystem Conservation Branch - research on the ecological impacts of atmospheric change and aquatic ecosystem health and sustainable development;
- New Technologies Research Branch undertakes research, development and commercialization of promising new environmental technologies.

NWRI is a WHO and UNEP Collaborating Centre for freshwater quality monitoring and assessment. It manages the Global Data Centre of the GEMS/WATER programme and plays a major role in water quality monitoring, assessment and capacity building programmes world-wide. NWRI carries out scientific assessments of regional and global data, particularly in Latin America, and Asia and the Pacific. It provides scientific advice and assistance to many UN agencies, as well as providing training and a variety of products to enhance water quality monitoring and assessment in participating countries.



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India

NEERI

The National Environmental Engineering Research Institute (NEERI) is a premier Research and Development organisation in the domain of Environmental Science and Technology in India with its headquarters at Nagpur. It is one of the National Laboratories within the Council of Scientific and Industrial Research (CSIR), Government of India.

The Institute has nine Zonal Laboratories across the country through which the Institute participates in the resolution of regional environmental problems. The Institute has around 600 scientific and technical staff with a rich blend of multidisciplinary expertise and experience in physical, chemical and biological sciences, and engineering. A large number of Institute's engineers/scientists provide consultations to international organisations as members of expert committees.

Besides conducting front line research in the domain of environmental science and technology, the Institute disseminates its research through consulting services thereby providing optimal solutions to environmental problems faced by the industries, municipalities, urban and rural development authorities, and pollution control organisations in the country. The Institute also renders human resource development services to its clientele.

The Institute with a budget of Rs. 93 million from CSIR raised extra budgetary resource of over Rs. 120 million from these sponsored R&D activities during 1995-96.

The Institute has considerable capabilities and experience in the domain of environmental management encompassing:

- environmental monitoring
- environmental biotechnology
- hazardous waste management - environmental systems design, modelling and optimization
- environmental impact and risk assessment
- environmental policy analysis



Contact: Jennie Lynch
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Robens Institute

The Robens Institute of Industrial and Environmental Health and Safety (a part of the University of Surrey) was established in 1978 as a multidisciplinary, non-profit making research and consultancy organisation. Since that time, it has developed into Europe's largest University based health, safety and environmental organisation with an international reputation for its work in contributing to the protection of human health and the environment.

The Institute employs around 80 staff including experts in water quality monitoring, quality assurance, environmental and occupational health, microbiology, analytical chemistry, toxicology and organisational/environmental psychology; many of which are internationally recognised authorities in their field.

Through its Environmental Health Division, the Institute undertakes research and consultancy work on water quality monitoring and management across all five continents. Clients include government departments, industry, bilateral and multilateral aid agencies, regulatory bodies, non-governmental agencies, consumer and environmental associations. The Institute also has an active portfolio of training courses which are offered in-country and cover a wide range of water quality related issues.

Furthermore, the Institute is an active collaborator in the Global Environmental Monitoring System for Water (GEMS/WATER) and coordinated training and institutional strengthening for natural water quality monitoring in East, Central and Southern Africa and West Asia.

In recognition of its work in the field of drinking water quality monitoring the Institute was designated a World Health Organization Collaborating Centre for the Protection of Drinking Water Quality and Human Health in 1988; a status which was renewed in 1993 as a further recognition of the continued extent and quality of its work. The Institute currently coordinates the sub-Working Group on Monitoring and Assessment of the Rolling Revision of the Guidelines for Drinking Water Quality in conjunction with VKI.

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VKI Water Quality Institute

VKI Water Quality Institute is an independent R&D consultancy organization affiliated to the Danish Academy of Technical Sciences. Since its establishment in 1972, VKI has provided research and development and consultancy services in environmental planning and management of water, wastewater, soil and waste products.

VKI's five principal areas of activity are: water resources management; groundwater technology; integrated industrial pollution control; wastewater technology; and, coastal zone management. In order to address problems within this area, the following primary approaches and methodologies are applied: environmental impact assessment; monitoring and information technology; chemical, microbiological and ecotoxicological laboratory analyses; and, ecological modelling.

VKI, furthermore, undertakes capacity building and the transfer of know-how and technology. Training, consultancy and R&D programmes are undertaken independently or jointly with companies, institutes, and universities in and outside of Denmark. Since 1976, VKI has been an appointed National Reference Laboratory for Chemical Water Analyses, for the Danish EPA.

VKI has a staff of approximately 150, mainly graduate scientists, and operates from Copenhagen (Head Office) and Aarhus. VKI has implemented projects or conducted training activities in more than 50 countries, mainly in Europe, Africa and Asia. International activities account for some 40 per cent of the annual turnover.

In 1993, VKI was appointed WHO Collaborating Centre for Water Quality Assessment and Control. In 1995 VKI was made a UNEP Collaborating Centre for Freshwater Quality Monitoring and Assessment. The activities of the WHO collaborating centre are centred round the Guidelines for Drinking Water Quality and monitoring and assessment activities, particularly in relation to GEMS/WATER. Within GEMS/WATER the work is focused on methodology development, particularly for analytical quality assurance, and development, testing and implementation of ecological models.



GEMS/WATER