



Water and Environment Centre

Master of Science
Integrated Water Resources Management
2010 - 2012

Republic of Yemen
Sana'a University
Water and Environment Centre



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Foreword



The Water and Environment Centre was created in 1999 at Sana'a University. In 2004, the WEC moved to a new building, and activities were conducted to develop an educational and research programme. In the past years, the WEC has grown into a centre that provides information, advice and teaching programmes to the Yemeni water sector. A newspaper article in 2009 named the WEC as a centre of 'new water thinking'.

For Sana'a University, the WEC has proven to be a centre of 'new educational thinking' as well. The approach of an interdisciplinary programme, where the centre acts as an umbrella, requesting input into the programme from the departments and faculties at Sana'a University, proves to be successful. We are happy to see a steady stream of MSc students following the programme at the WEC, and wish the centre many more years of new thinking.

Sana'a, December 2009

Prof. Dr. Khaled Tamim
Rector Sana'a University
Republic of Yemen



In 2004, the Water and Environment Centre started the development of an MSc programme on Integrated Water Resources Management (IWRM). The result of a 5-year process is described in this document. The curriculum has been developed, improved, adjusted and evaluated based on input of lecturers, advisors and students. This document describes the overall curriculum objectives, the course objectives, and the expected competencies when students have successfully graduated from the programme. In addition, we have included a description of the Water and Environment Centre, which provides the boundary conditions for this excellent curriculum.

Countless discussions by many people have led to the educational and research activities at the centre. Although we present the curriculum description as a finished product, an educational programme on a topic of water management is never finished. New activities, thoughts and insights are continuously incorporated in the programme. We will continue this process of innovation with the help of the Yemeni water sector, the international community, and above all, the graduates from the programme.

Sana'a, December 2009

Prof. Dr. Abdulla S. Babaqi
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Acknowledgements

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In the period 2004-2009 they kindly financed the project: 'Strengthening the Water and Environment Centre of Sana'a University and its Programme in Integrated Water Resources Management' (NPT/YEM/036).

The project was conducted by a consortium led by Wageningen University, the Netherlands. Other partners included Delft University of Technology, Cairo University, MetaMeta and Euroconsult.

A large number of experts contributed in their specific field of knowledge. We thank them and all the Yemeni staff for their intensive and motivated inputs.

Chapter 1 Integrated Water Resources Management

1.1 Introduction

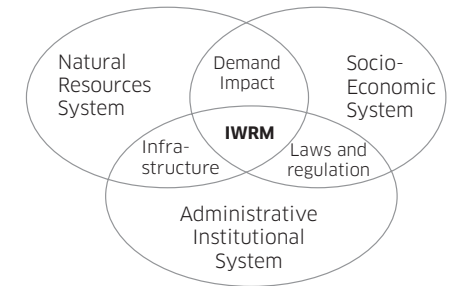
Optimal problem analyses and solutions are not reached by disciplinary approaches, but by comprehensive analyses from different points of view within different levels of scale. Integrated Water Resources Management (IWRM) includes a full spectrum of items related to water management, including social, legal and economical aspects. This approach is a reaction on the conventional 'command and control' approach which used to dominate traditional water management. The Government of Yemen uses IWRM as their water management framework and international donors are requesting activities to fit within this framework.

In the water-scarce Republic of Yemen, IWRM is used as a method to improve water use and thus to better balance water supply and demand (e.g. NWSSIP, 2005-2009). IWRM should, however, not be seen as a magic solution that creates more water.

1.2 What is IWRM?

Our vision IWRM can have multiple interpretations, depending on the level of implementation. To come to a universal support on the concept of IWRM the Dublin principles are formulated. These are:

- Fresh water is a finite and vulnerable resource, essential to sustain life, development and environment.
- Water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels.



- Women play a central part in the provision, management and safeguarding of water.
- Water has an economic value and all its competing uses should be recognized as an economic good.

Those principals include both horizontal and vertical integration. Different disciplines as well as different policy scales are included and approached from a broad perspective. Because of the broadness of the Dublin principles and the vagueness of definitions on IWRM it is necessary to define the important elements in IWRM better. Here, we will discuss each of the interacting components related to IWRM alone in order to get a clearer understanding of the IWRM concept (see figure).

Administrative-Institutional System

IWRM can be implemented at a vertical as well as at a horizontal level. Vertical implementation of IWRM is integration in the 'chain of command'. This includes international conventions, national ministries, but also governance at the field level

(e.g. water user associations). An example of vertical integration is when policy makers at the ministry communicate their thoughts on how integrated water resources management should be implemented to the field level. The horizontal implementation of IWRM is between different disciplines at the same level, for example technical engineering water manager who thinks of the implementation of a drinking water pump with a technology that allows everyone to use this pump, avoiding traditional or religious barriers that could exclude one specific group of the population.

The integrated approach aims at a polycentric, horizontal governance structure. At the higher level this means the breaking down of some of the traditional barriers between different ministries. In Yemen, this has resulted in the formation of a new Ministry of Water and Environment, covering all water related issues except irrigation in agriculture, which remains under the Ministry of Agriculture and Irrigation. Another implementation of IWRM currently in the planning phase is expressed through a National Water Sector Strategy and Investment Plan (NWSSIP, 2005), which aims at streamlining the strategies and investments in all water related issues in the Republic of Yemen.

Going down to the field level, IWRM is more an awareness activity that aims to make water users realize how water is used and what can be done at the user level to conserve both water quantity and water quality. On this level, IWRM stresses the

need of stakeholder participation. Common tools for reaching participation of users are multi-stakeholder platforms (MSP) and water users associations (WUA). Stakeholders are all who use the resource, and all who will be affected by the implementation of interventions. Horizontal, cross-sectoral analysis identifies emergent problems and integrates policy implementation from different disciplines.

The intersphere of the Legal Administrative System and the Socio-Economic System

Water development initiatives (policies, programmes, projects) often depend on forms of legal regulation as a major instrument to achieve a certain goal. Attention to the role of law and norms in development policies and interventions has been rapidly increasing. This is especially the case with regard to the social-legal dimensions of natural resource use and management. Natural resource management strategies often entail the introduction of new laws, principles and procedures in contexts generally characterized by legal complexity. Some difficulties resulting from this complexity is the translation of the generic complex law into actions, as well as the need for capacity to enforce the laws. The IWRM perspective shows that those laws can not be implemented without concerning the different functions that water can accomplish, and the impact that the legal administrative system will have on different actors. Public participation could be a tool to ensure the applicability of the rules and regulations on the socio-economic system. In Yemen, the National Water



Resources Authority (NWRA) is the main institute to implement the water law into actions and enforcement.

Socio-economic System

Public participation in water management creates commitments and willingness to act among different players and it brings new viewpoint and ideas, which enable policy makers to think out of the(ir) box. The fundamental rationale for undertaking public participation is to ensure the effective implementation of the water management plans and achievement of their environmental objectives, as well as to increase local awareness and involvement in water quality and quantity savings. Approaches to public participation for groundwater management in Yemen can be found in the Community Water Management Project (CWMP) and the Participatory Water Management Project (PWMP).

A gender sensitive approach to water

“The programme is in English. This improves our English language and helps us to continue our PhD study and research in an international setting.”

Akram Al-Namory,
student of the programme

management should not be limited to an understanding of the different roles of men and women. The IWRM scope is broader; it tries to mainstream gender concerns by developing replicable strategies for enhancing gender sensitive approaches and empowering women.

A comprehensive understanding of all stakeholders and their relations can be achieved by open, shared information sources that fill gaps and facilitate integration. This can concern information management between different sectors or scales, as well as the information transfer from institutions to users. CARE-Yemen is one of the institutes that focus on this part of the IWRM sphere.

The intersphere of the Socio-Economic System and the Natural Resources System

The socio-economic system and the natural resource system interact in relation to water management. Water users demand a certain quality and quantity of water from the natural resource system, and at the other hand, the natural resource system can limit users in their practices. A clear understanding of the demand of all actors concerned in water issues is needed in order to implement successful and sustainable interventions.

These interventions can have impacts on the natural resources system which might easily be overlooked, either because the impact is far from the location of the impact in space or in time. As in many water resources development projects the broader spectrum of environmental impacts are not fully considered, environmental impact assessments

are not conducted on a regular basis. As a result, some water resources development projects have suffered from unexpected negative environmental impacts. To minimize possible negative impacts of future water resources projects, the need for an effective management tool exists by which ancillary impacts on environment might be included in the project planning process.

The Natural Resources System

The water cycle is basic knowledge, needed to understand the effects and interactions between actors and systems. The IWRM approach aims at an understanding of interactions between resources on a basin level. This basin management concept enables a look at the whole water chain and the possibility to reuse water for different functions.

The impact of social activities on the natural resources system is obvious. Drinking water has become greatly affected as well as our ability to use water for recreational purposes. In Yemen, most regions are dependent on 'old' groundwater, thus mining reservoirs filled in the past. In order to combat water pollution, we must understand the problems and become part of the solution. Natural resources must also be considered as a water user. Coastal zone ecosystems are often fragile systems balancing between salt water and fresh water availability.

The intersphere of the Natural Resources System and the Administrative Institutional System

The overall objectives of the Yemen



government are to focus on the traditional water harvesting system in the mountain terraces and to increase public awareness to optimally benefit from rainy water seasons. Planners and engineers need a clear understanding of the dynamics in the natural resources system and a comprehension of the demands of the end-users to design water allocation infrastructure at an appropriate scale. IWRM promotes a decentralized governance system for the infrastructure. Preferably, the end design comes from diverse sources. When users pay for water and its infrastructure, they are ought to be more concerned with the operation and the maintenance. Diversifying financial resources, using a broad set of private and public instruments, enables to spread risks and finance integrated projects which include different scales and sectors.

Many issues in IWRM do not easily fit in one of the systems; they rather slightly touch upon different elements. This IWRM framework should only be seen as a method to enable us to clarify the concept. It helps to check whether no important IWRM elements are overlooked, and it helps in defining important topics to teach in the MSc-curriculum.

1.3 Translation to education and teaching

Taken into account the above mentioned interactions, it is necessary for students to gain a basic knowledge on disciplinary topics which have a stake in the natural resource system, socio-economic system and administrative institutional system and its interspheres. These topics include: law, governance, economics, sociology, hydrology, engineering, institutions. Without having a basic understanding of these disciplines the complex interactions can not be understood. This does not mean that the disciplinary courses taught at the WEC are not taken into account the broader picture: the relation to IWRM and links to other 'sub domains' is always visible.

Complex interactions between sub domains are clearly visible in the management of coastal zones, watersheds and groundwater. Therefore, the second semester uses the management of these as integrated courses in which a combination of subjects comes together in one area. As the Dublin principles state, 'fresh water is a finite and vulnerable resource essential to sustain life, development and environment', thus evaluating the impact on the (future) functions and the users of water is essential. Therefore, the course Environmental Impact Assessment is included. To use water more sustainable, and to include the finite aspect of water sources, the water chain concept is included in the Water Chain course, including multiple (re) uses from the same source.



“During the July workshop in Wageningen we had meetings with students from the Master study International Land and Water Management. During our discussions, we noticed the advantages of our own study program. The strong points of the WEC-IWRM program in Yemen are: IWRM Program contains multidisciplinary information about water problems in Yemen. This means that the whole set of courses in total include most of the water problems faced by Yemen.

Wael Ishaq Alderwish,
student of the programme

Chapter 2

The construction of the MSc-Programme

2.1 Vision on education

The interrelationship between education and work should be constructive. To obtain this competency-based education is a prerequisite as otherwise there is the risk that the world of work and the educational system do not interact, and both parties do not listen to each other. Competency-based education is concentrated on the usefulness of the content of education, the process of learning and the outcome of the total study curriculum instead of the traditional education system which is mainly based on teaching activities.

The world of work has changed in the past years towards a world of work in which people have many careers in which several competencies are needed. Skills, such as entrepreneurship, teamwork and the like, start to become increasingly important in education.

Competencies offered at the university should match to the needs of the society in which the student will find his or her profession in order to build a sustainable system in which education forms a base for development of a country. In this context, competencies are the set of abilities of the student to make use of knowledge, skills and attitudes expected of them in the everyday work in the Yemeni water sector and elsewhere.

For this reason the WEC study curriculum is developed with a strong focus on the demands in the current water sector in

which the IWRM framework plays a central role. Students will be guided to acquaint knowledge which is applicable in Arab regions. Though, the curriculum does not only consist of gaining knowledge on important water issues. It uses the broad definition of learning; the scope is on all the competences that students need in their profession. The development of skills such as report writing and basic computer skills will be facilitated, as well as the ability to work in teams and to have a problem solving attitude.

The main objective of the MSc education in IWRM is to obtain an approach of thinking, analyzing and solving problems in stead of repeating text book approaches to non-text book problems. To allow this 'problem oriented learning' to develop in a student group of different backgrounds, basic text book knowledge on a variety of topics is needed to allow the students to understand the language of the different disciplines.

The programme is taught in English, as this allows students to access international literature. In their further career, English is a pro, and will help to communicate with different stakeholders in the (international) water sector.

2.2 Target group

As the target group of this study programme is the Arab region, examples and case studies are not only focused on Yemen, but choose a broader focus.



2.3 Expectations for graduates

WEC wants to contribute to the highly required practical solutions to water security issues. It wants to accelerate and broaden the flow of workable ideas and solid knowledge in water management in Yemen. As such it wants to make the work of the University relevant to one of the major challenges in the country and beyond. WEC thus provides a linkage based on IWRM principles between academic knowledge and skills at Sana'a University and the agencies responsible for water development and management in Yemen.

Students entering the programme have a BSc-degree from a range of technical and non-technical disciplines. Many have work experience in the water sector and are selected on motivation. When graduated from the IWRM study curriculum, students should have developed

competencies which are in line with those objectives of WEC. Graduated students are expected to be able to contribute practical solutions to water security issues in Yemen. They will find employment opportunities in research, consultancy and policy agencies, and therefore they need a solid, interdisciplinary knowledge on water management. At the same time, the label 'MSc' requires an academic approach to problems, allowing students with the skills and motivation to continue for PhD research.

Graduate profiles

In order to define clearly what competencies a graduate should have to function well in his/her future job, WEC has elaborated six job profiles of sectors in which graduates are likely to find their future work (Box 1). The competencies needed for those job profiles will be taught during the curriculum.

Box 1

- 1) Private sector job profile. A student with ambitions to work in the private sector is likely to find a position in a consultancy company. Within this job, he/she will get short-term assignments about problems in the water sector which are defined by the government or donor NGO's. He/she should find a suitable solution, and in order to do so, he/she has to know how to conduct an Environmental Impact Assessment, how to apply economy and how to solve issues of competing water use. To come to practical solutions, it is highly important that the graduate knows how to translate knowledge into practice and how to function as a team member.
- 2) Government - policy level - job profile. A student with ambitions to work in the government on a policy level is likely to apply for a function at the government at a national level. He/she will be involved in policy making, and therefore, should have good knowledge on the IWRM concept. He/she should set some priorities, among which the issue of gender and water, and a good management of groundwater resources. In order to function well, the graduate should think strategically, plan effectively and know how to translate knowledge into practice. He/she should have an attitude of responsibility towards the community to develop policies beneficial for the whole society.
- 3) Government - implementation level - job profile. A student willing to implement policies from the national government is likely to work within local governments, translating the policies into actions. To do so, the graduate should be good in strategic thinking and effective in planning. Within this job profile, attitudes play an important role. The attitude of the graduate should be to take responsibility towards the community, to be ethical and to take responsibilities. The graduate should also be motivated to promote gender aspects in water management.
- 4) NGO - policy level - job profile. A graduate who is motivated to work on the development of policies of (international) NGO's should be able to recognize social problems and reflect on current policies. As such, he/she should have the ability to coordinate and communicate with different disciplines, think strategically and reflect critically on new points of view. To translate new viewpoints into policies, he/she should be able to write proposals and reports and moderate stakeholder platforms. To do this well, enthusiasm, a feeling of responsibility towards the community and the environment, openness to new points of view and the willingness to promote gender aspects are vital.
- 5) NGO - implementation level - job profile. Local NGOs work on the implementation of projects within the field. A graduate who will work in a local NGO should feel a responsibility towards the community and the environment, be flexible and be able to negotiate.
- 6) Academic research job profile. A student who is motivated to do research in an academic setting is likely to apply for a PhD position. He/she will have to be able to carry out all phases in a research project to successfully finish a PhD project. The graduate should be able to interpret data, and to report findings. He/she should be creative, and apply ethics in his/her activities.

Chapter 3

Structure and organisation of the MSc-programme

3.1 Planning and schedule

The WEC MSc programme on IWRM is a full-time 4 semester programme. Students are expected to work 40 hours per week, partly in self-study.

In the first semester, students will develop a basic knowledge on the disciplines hydrology, environment, agriculture, sanitation and waste water treatment, water use in rural and urban areas, economics, water policy and rights, public participation and gender.

In the second semester students develop skills to integrate these different disciplines. The courses in which this is done are Environmental Impact Assessment; Water Chain Management; Integrated Groundwater Management; Integrated Watershed Management and Integrated Coastal Zone Management. Those courses are more practice-oriented, and knowledge from the first semester will be used.

In the third semester students will work in groups on the diploma project, in which students prepare a study and develop advices. This project is quite similar to what would be expected in a job in the private sector. The student receives a diploma after successful completion of the 3 semesters. If eligible the student could proceed for an MSc degree in the 4th semester.

In the fourth semester, students work on an individual thesis research, which reflects the academic status of the programme.

For more detailed information on the contents, learning goals and organisation of individual courses, we refer to the course descriptions as given in Part C of this document.

3.2 Organisation

The MSc programme at WEC has been developed since 2005 and started its first year in 2006. A selected team of teaching staff from different departments at Sana'a University was trained in the concept of IWRM. Supported by international experts courses were developed, as well as teaching material. During the following years several workshops and individual meetings and trainings were organized to further develop the contents of the courses. Course material was evaluated during 2008 and improvements were made where needed.

3.3 Quality Control

Quality control of an educational system occurs at multiple levels, and at different stages during an educational programme. The WEC uses a quality control system for the centre, the curriculum, individual courses, and student work.

The WEC is embedded in Sana'a University through different committees. The University Council is the highest committee of the University overseeing the activities of the WEC as well as other centres and faculties. The WEC director is a representative in the University Council.

The WEC also has its own council, chaired by

the rector of Sana'a University. Members are representatives of three main contributing faculties (Engineering, Agriculture and Basic Sciences), as well as representatives of the Ministry of Water and Environment (MWE) and Agriculture and Irrigation (MAI). The water sector specialist from the Royal Netherlands Embassy (RNE) is a member, as well as the WEC director and heads of departments within the WEC. The WEC Council oversees activities of the WEC in the fields of education, research and consultancy.

The WEC Scientific Committee consists of staff members from WEC and contributing faculties. The tasks of the Scientific Committee are to evaluate student admissions, student exam results, and student thesis work.

An academic Advisory Committee consisting of three professors of two Dutch Universities and the WEC director has supervised the development of the MSc curriculum on Integrated Water Resources Management (IWRM). The committee has given advise on the educational aspects and research activities and directions of the WEC.

During the curriculum development, several plenary meetings have been conducted to ensure the input of all lecturers involved in the programme. These meetings were designed to ensure a clear insight in each of the courses' place within the overall education curriculum, to reduce overlap between the courses, and to identify gaps

within the curriculum. The meetings were at the same time moments of reflection on the curriculum, to ensure that it provides the information, skills and attitudes needed in Yemen's water sector.

Individual course development has been supported and evaluated by external lecturers from Dutch and Egyptian Universities. Courses have been evaluated with the input of students, and student evaluations will continue to be conducted throughout the WEC's teaching.

Chapter 4 Brief history of the WEC

In May 1998, the University Council of Sana'a University approved the establishment of the Water and Environment Centre through the creation of the position of a Centre director. A founding document and by-laws for the WEC were approved by the University Council in May 1999.

In September 1999, the rector of Sana'a University issued a decree appointing a centre director. The first WEC Council meeting was held in November 1999. The WEC's first official activity was the organisation of an opening seminar in Sana'a in October 2000. The WEC continued teaching a Diploma/MSc curriculum in the fields of Water Resources Management, Hydraulic Engineering and Sanitary and Environmental Engineering. This programme was conducted from 1996 to 2002 and was started at the Faculty of Engineering – Civil Engineering department.

In June 2004, the WEC moved from an office at the Faculty of Engineering to a separate building, creating more opportunities for inter-disciplinary input from multiple faculties at Sana'a University. A new educational programme was developed based on the concept of Integrated Water Resources Management (IWRM). The first group of students in this new programme started in February 2006. The programme is currently running with a fourth group of MSc students.

Prof. Dr. Abdulla S. Babaqi describes the centre as one of “new water-thinking,” stressing the need to bring all parties involved in the water sector together to successfully address the water issue for the country's development, in integrated water resource management.

Chapter 5 WEC in the water world

The public water sector in Yemen is governed by the Ministry of Water and Environment (MWE) and the Ministry of Agriculture and Irrigation (MAI). Several institutes fall within these ministries, including the National Water Resources Authority (NWRA), National drinking Water and Sanitation Authority (NWSA), Local water supply and sanitation Corporations (LC) and the General Authority for Rural Water Supply (GARWSP).

The WEC targets these ministries and institutes with the MSc programme on IWRM, as well as with short courses. Academic research at the WEC focuses on policy support. Through the creation and collection of spatial datasets in its GIS lab, the WEC aims to maintain an unbiased database for policy support and implementation. A library at the WEC is aiming to maintain international literature available for the Yemeni water sector.

The private water sector in Yemen includes drinking water companies and consultancy firms. The oil and gas industry in Yemen also relates to water management, since exploitation of natural resources like oil and gas is often related to drilling in or through groundwater basins. Discussions and analyses of sustainable use of natural resources has many parallels with the oil and gas industry.

WEC targets the Yemeni water sector through academic research and invited



research (consultancies). A collection of important studies conducted in recent years is shown in Annex 1.

The WEC maintains a wide network with regional and international universities and institutes (Annex 2) to stay up-to-date with current visions and insights in water management, as well as to contribute to the international water resources discussions. National, regional and international workshops are attended and organised by WEC staff (Annex 3).

Annex 5 depicts the organisational structure of the WEC, showing its insertion in Sana'a University and contacts with the water sector.

Chapter 6 Facilities at WEC



6.1 General

The Water and Environment Centre is located at the premises of Sana'a University. It has modern, well equipped offices, a lecture room, internet access and its own car park. WEC has its own support staff, while the lecturers in the programme are all employed by Sana'a University (Annex 4).

6.2 Library

WEC has its own library with a wide selection of recent books, reports and theses related to the field of Integrated Water Resources Management (IWRM) and specific disciplines as Hydrology, Groundwater, Hydraulics, Soils, Policy, Gender, Agricultural water management, Water supply and sanitation and Water quality.

Through internet connection the library has access to relevant reports of national and international water related institutions. A set of links to websites related to IWRM, arranged on topic as databases, directories, electronic books, international institutions, journals, newsletters and software is available.

The programme has equipped the nearby central library of Sana'a University with 10 computers for educational purposes. The students are trained in basic skills including search on internet and how to judge the value of internet retrieved information. The students are made familiar with the library and are stimulated to make use of it for their thesis work.

6.3 GIS lab

A computer laboratory with the infrastructure to support access to spatial datasets exists at the WEC. The GIS-lab provides students and staff with 20 computers equipped with modern GIS-software (ArcGIS 9.2 + Tools). The lab also is equipped with facilities to process hardcopies (scanner) and to produce maps, posters, etc. (plotter). The GIS lab offers data access especially to water and water management related topics. Data include well inventories, Yemen-wide infrastructure data, surface elevation, rainfall, satellite imagery, land use, etc. Moreover the lab offers a wide range of training material, instructions on how to create, use and analyse spatial data sets and several GIS-related publications. Basic and advanced courses using mainly Yemeni data have been developed and are part of the MSc curriculum. They are conducted as separate tailor made courses.

6.4 Field Equipment

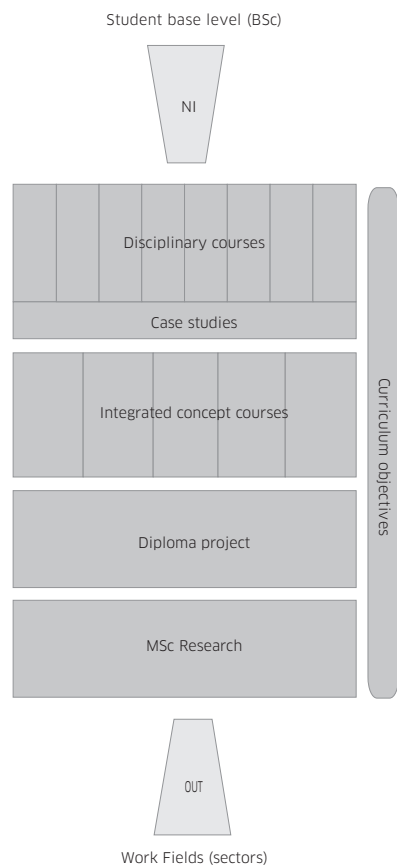
The WEC maintains an extensive set of field research equipment. Four rain gauges have been located in Sana'a basin, and the WEC maintains a standard weather station. Field analysis equipment is available for several soil quality and nutrition parameters, and instruments are used to measure soil physical parameters, like soil moisture changes, bulk density, and hydraulic conductivity. Water quality field measurement sets are available for drinking water and irrigation water analysis,

including pH and oxygen content, and flow meters to measure runoff streams or irrigation supply flows. Groundwater level monitoring instruments are used, both manually and making use of data loggers.

Chapter 7

Course descriptions

In this Chapter information is given on the courses taught at WEC. For each course there is a description of size, contents, learning goals, lecturers and other information.



The course descriptions are ordered per semester.

7.1 Semester 1. Introductory courses

1. Introduction to Integrated Water Resources Management
2. Introduction to Hydrology
3. Report Writing and Basic Computer Skills
4. Water and Environment
5. Hydrology of Yemen
6. Water Use in Agriculture
7. Water Issues in the Arab Region
8. Water Rights and Policies
9. Water Value and Economics
10. Water and Public Participation
11. Water and Gender
12. Water Use in Urban and Rural Areas
13. Sanitation and Wastewater Treatment
14. IWRM Case Studies

7.2 Semester 2. Integrating courses

15. Integrated Watershed Management
16. Water Chain Management
17. Integrated Groundwater Management
18. Integrated Coastal Zone Management
19. Environmental Impact Assessment

7.3 Semester 3. Diploma project

20. Skills Development
21. Diploma Project

7.4 Semester 4. MSc-thesis

22. Master Thesis

Introduction to Integrated Water Resources Management

Semester No. 1

Course No. 1

Credits 40 hours

Course Coordinator

Prof. Dr. Abdulla Babaqi

Lecturer(s)

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Contents

IWRM focuses more on water resources management than on water resources development. IWRM is an approach that combines technical, social, legal, economical and political aspects of water management in a multi-disciplinary manner. IWRM is an approach that involves multiple stakeholders to find a common acceptable solution to water management problems.

IWRM is a concept that people need to be aware of and that needs continuously creative applications in water resources problems. IWRM does NOT create more water! It uses the existing water resources better.

Assumed prior knowledge

- General knowledge about water

Follow-up courses

- This course is an introduction to the study programme, and as such links with all courses in the first, second, third and fourth period to which the IWRM topic will relate.

Objectives

The main objective of this course is to teach the

basics of good water management, while at the same time considering technical, social, political, legal, etc constraints and to develop students with skills and knowledge that they can apply in the context of the Yemeni water sector.

After the course students will:

- know what are the main important issues related to the development, use and management of the world's water resources;
- be able to explain what the differences are between traditional ways of water management and integrated water resources management;
- know the definition of IWRM; be able to mention and explain [f]actors in IWRM and know what is the relation between IWRM and [dimensions of] sustainability;
- be able to apply the knowledge of this course to other courses they will follow later in the programme and interrelate them to IWRM; be able to apply IWRM concept in his job.

Organisation of the course

Lectures	20 hours
Group work	10 hours
Excursion	5 hours
Individual exercises and self study	5 hours
Total	40 hours
Individual preparation for exam	10 hours

Examination

- Written exam (50%)
- Group work (20%)
- Excursion report (10%)
- Exercises (10%)
- Attendance (10%)

Literature

- WEC Course reader 'Introduction to IWRM'

Introduction to Hydrology

Semester No. 1

Course No. 2

Credits 40 hours

Course Coordinator

Dr. Abdulla Noaman

Lecturer(s)

Dr. Alkhateeb Al-Kebsi

Dr. Abdulla Noaman

Contact information

abnoman@hotmail.com

After the course, students have a comprehension of:

- the hydrologic cycle;
- hydrometeorology;
- precipitation;
- evaporation and evapotranspiration;
- infiltration and runoff;
- rainfall-runoff relations;
- groundwater aquifers;
- physical properties of aquifers;
- groundwater flow principles.

Skills:

- be able to interpret and analyse basic hydrological data;
- be able to calculate water balances (watershed).

Attitude:

- Awareness of many water resources quantity and quality problems.

Organisation of the course

Lectures	20 hours
Group work	5 hours
Excursion	5 hours
Individual exercises and self study	10 hours
Total	40 hours
Individual preparation For exam	10 hours

Examination

- Written exam (70%)
- Reports and homework (20%)
- Attendance (10%)

Literature

- WEC-course reader 'Introduction to Hydrology'
- Chaw 'Applied hydrology'
- Todd 'Groundwater hydrology'
- Groundwater and drainage (ILRI)

Contents

Hydrology is the science which deals with terrestrial waters, their occurrence, circulation and distribution on our planet, groundwater aquifers, aquifer types and properties. Students will learn how to make up a water balance and special attention is paid to hydrologic data availability, collection and monitoring networks.

The course contains the topics of precipitation, groundwater resources, evaporation, surface water resources, rainfall runoff relations and floods.

Assumed prior knowledge

- Introduction to IWRM (semester 1)

Follow-up courses

- Hydrology of Yemen (semester 1)
- Integrated Groundwater Management (semester 2)
- Integrated Watershed Management (semester 2)

Objectives

To provide an understanding of the indispensable principles of hydrology and the main processes in the water cycle.

Report Writing and Basic Computer Skills

Semester No. 1

Course No. 3

Credits 40 hours

Course Coordinator

Dr. Bilkis Zabara

Lecturer(s)

Dr. Bilkis Zabara

Contact information

khalmoy@y.net.ye

Organisation of the course

Lectures	4 hours
Group work	6 hours
Individual exercises and self study	30 hours
Total	40 hours
Individual preparation for exam	10 hours

Examination

- Evaluation on the basis of the exercises (90%)
- Attendance (10%)

Literature:

- WEC Course reader 'Report writing and basic computer skills'
- WEC library includes several references to develop these skills
- Internet search is another source of information.

Contents

The basic skills that will be taught in the first semester are: library/internet use, reading and writing reports and summaries, ethics of scientific writing, computer skills and research methodology, self learning skills and presentation methods.

The development of skills such as report writing and basic computer skills will be facilitated, as well as the ability to work in teams and it will be stimulated to have a problem solving attitude.

Assumed prior knowledge

- Basic computer use.

Follow-up courses

- Developed skills are needed and further practiced during the case studies (semester 1), diploma project (semester 3) and thesis research (semester 4).

Objectives

To improve the basic skills of students needed for the course work, case studies and MSc research. To develop skills needed in research, self learning, consulting and policy jobs.

Water and Environment

Semester No. 1

Course No. 4

Credits 40 hours

Course Coordinator

Dr. Jalal Awadh

Lecturer(s)

Dr. Jalal Awadh

Prof. Dr. Abdulla Babaqi

Contact information

jalalawadh@hotmail.com

Contents

The water aspects of the environment include:

- practices to protect and improve water quality;
- improvements of impacts from urban and rural systems on water;
- management practices to efficiently use resources and improved environment.

This approach includes groundwater as well as surface water. Students will gain knowledge on water quality and standards, pollution, eco-toxicology and goods and services of nature.

Assumed prior knowledge

- Basic knowledge in chemistry

Follow-up courses

- Water Use In Urban And Rural Areas (semester 1)
- Sanitation And Wastewater Treatment (semester 1)
- Coastal Zone Management (semester 2)
- Integrated Watershed Management (semester 2)
- Water Chain Management (semester 2)
- Environmental Impact Assessment (semester 2)

Objectives

In respect to knowledge, the student should understand the following:

- types of water pollution;
- water quality parameters and standards;
- effects of water quality and quantity on the environment in Yemen.

In respect to skills, the student should be able:

- to identify polluted types of water;
- to collect and analyze water samples and identify the source of basic characteristics (physical, chemical and micro-biological) pollution;
- to suggest the solutions for preventing pollution to safe health and life.

In respect to attitude, the student should be able:

- to show that the environment is an important aspect in integrated water resources management.

Organisation of the course

Lectures	16 hours
Field / Laboratory	8 hours
Excursion	8 hours
Individual exercises and self study	8 hours
Total	40 hours
Individual preparation for exam	10 hours

Examination

- Written exam (50%)
- Laboratory report (20%)
- Exercises (20%)
- Attendance (10%)

Literature

- WEC Course reader 'Water and Environment'

Hydrology of Yemen

Semester No. 1

Course No. 5

Credits 40 hours

Course Coordinator

Dr. Abdulla Noaman

Lecturer(s)

Dr. Naif Abu Lohom

Dr. Abdulla Noaman

Contact information

abnoman@hotmail.com

Contents

The course hydrology of Yemen pays attention to the hydrological, geological and meteorological setting of Yemen.

The course contains the following topics:

- The hydrology of watersheds in Yemen;
- Water resources in Yemen;
- Geological setting and type of aquifers;
- Agro ecological systems, climate and climatic zones in Yemen;
- Monitoring networks.

Assumed prior knowledge

- Introduction to Hydrology (semester 1)
- Introduction to IWRM (semester 1)

Follow-up courses

- Integrated Groundwater Management (semester 2)
- Integrated Watershed Management (semester 2)

Objectives

After following the course students are expected to:

- understand wadi hydrology processes;
- be able to identify the hydrological and geological processes and patterns in watersheds in Yemen;
- be able to identify the geological units and geographical settings in the watersheds in Yemen;
- be able to calculate the water balance on watershed level and on country level and know which hydrological data is needed for this;
- know what the situations of the water resources in Yemen are;
- know what the major issues and problems concerning data availability and quality are.

Organisation of the course

Lectures	20 hours
Group work	5 hours
Excursion	5 hours
Individual exercises and self study	10 hours
Total	40 hours
Individual preparation for exam	10 hours

The exercise and group work include:

- Calculation of the water balance on a country level
- Handling a water problem (case study Sana'a basin)

Examination

- Written exam (70%)
- Reports and exercises (20%)
- Attendance (10%)

Literature

- WEC Course reader 'Hydrology of Yemen'
- Todd 'Groundwater Hydrology'

Water Use in Agriculture

Semester No. 1

Course No. 6

Credits 40 hours

Course Coordinator

Dr. Abdul-Rahman Al-Eryani

Lecturer(s)

Dr. Abdul-Rahman Al-Eryani

Contact information

eryaniabdulrahman@yahoo.com

Contents

This course deals with the possibilities and the risks of irrigated agriculture and the development of agriculture in the Yemen context. Plant-soil-water-atmosphere relationships, crop water requirements and irrigation schedules will be studied, using the computer model Cropwat.

On-farm level irrigation methods will be dealt with, as well as their performance.

In the broader context soil measurements will be carried out and water use efficiency will be evaluated by the students.

Assumed prior knowledge

- Basic knowledge on hydrology

Follow-up courses

- Water Chain Management (semester 2)
- Integrated Watershed Management (semester 2)

Objectives

After the course, participants will have knowledge on and insight in:

- the relationship between irrigation and food production on global and regional field level;
- the relationship between irrigation technology and its social context and other forms of water uses;
- the relationships in the plant-water-soil-atmosphere system.

After the course, participants will be able to: determine crop water requirements and irrigation water demands;

- evaluate irrigation practices, methods and schedules of field irrigation;
- use software about design and evaluation of field irrigation.

Organisation of the course

Lectures	20 hours
Group work	5 hours
Field / Laboratory	5 hours
Excursion	5 hours
Individual exercises and self study	5 hours
Total	40 hours
Individual preparation for exam	10 hours

Examination

- Written exam (70%)
- Reports and exercises (20%)
- Attendance (10%)

Literature

preparation for exam WEC Course reader 'Water use in agriculture'

Water Issues in the Arab Region

Semester No. 1

Course No. 7

Credits 40 hours

Course Coordinator

Dr. Naif Abu Lohom

Lecturer(s)

Prof. Dr. Abdulla Babaqi

Prof. Dr. Mohammed Al-Eryani

Prof. Dr. Ashraf Ghanem

Dr. Naif Abu Lohom

Contact information

naifgeo@gmail.com

Contents

With case studies the status of IWRM in the Arab region is reviewed, as well as trans-boundary water resources, water competition and the concept of virtual water. Institutional aspects will have a central role in this topic.

Specific subjects include: Water availability and water scarcity; Integrated water resources management; Trans-boundary water resources / conflict resolution; Water pollution and water quality degradation; Water competition and virtual water; Food security and self sufficiency; Supply management vs demand management; Privatization and public private partnerships; Water Pricing and Cost Recovery; Arab Water Council and other Arab Water Organisations.

Assumed prior knowledge

- Introduction to IWRM

Follow-up courses

- Courses in next semesters. Most specifically, the case study course and the diploma project deal

with this issue, as in these courses students are requested to work on a selected case study in which water issues in the Arab region have a central role.

Objectives

In respect to knowledge, the student should have an understanding of:

- water resources distributions and limitations in the Arab Region;
- water balance of the different countries in the Arab Region;
- water quality aspects and management in the Arab Region;
- the different IWRM initiatives in countries of the Arab Region;
- issues of trans-boundary water management;
- the application of the concept of water foot print and virtual water;
- different tariffs systems in the Arab region;
- Arab and international organisations and networks on water.

In respect to skills, the student should be able to:

- develop a country level water balance for Arab Region countries;
- apply the concept of virtual water to different water demanding uses;
- review the water allocations compared to available resources in a country.

In respect to attitude, the student should have:

- an appreciation for the importance of IWRM in the Arab Region;
- a drive to employ non-conventional water resources and make use of available opportunities in the region;
- a feeling of responsibility towards safeguarding the scarce water.

Water Rights and Policies

Organisation of the course

Lectures	20 hours
Group work	6 hours
Individual exercises and self study	14 hours
Total	40 hours
Individual preparation for exam	10 hours

Examination

- Written exam covering topics offered during lectures (25 %)
- Oral exam to evaluate depth of understanding (25 %)
- Exercises (20%)
- Reading material ahead of lecture (10%)
- Input into group discussions in class (10 %)
- Attendance (10 %)

Literature

- WEC Course reader 'Water Issues in Arab Regions'
- Academic articles related to the subject
- Media articles related to the subject

Semester No. 1

Course No. 8

Credits 80 hours

Course Coordinator

Dr. Fadhl Al-Nozaily

Lecturer(s)

Dr. Mohammed Al-Hamdi

Mr. Awadh Bahamish

Contact information

drfadhl@yahoo.com

Contents

The course 'Water governance and law' is split in two parts, namely water rights and law, and the second part institutions and policy. The first part, on rights and law discusses issues such as: property regimes (state, private, common property), customary law and legal pluralism, bundles of rights, water allocation and conflict resolution. This course discusses these topics in the Yemeni context: the parts of Yemen legislature structure which are relevant for water management will be handled, as well as its water laws and implementation.

The second part, institutions and policy, discusses the sets of rules structuring relationships by determining actions in certain direction of environmental policy making. Environmental policy theories will be discussed, as well as policy instruments and policy evaluation methods will be introduced.

Assumed prior knowledge

- Introduction to IWRM
- Water Issues in the Arab Region

Follow-up courses

- Integrated Watershed Management (semester 2)
- Water Chain Management (semester 2)
- Integrated Coastal Zone Management (semester 2)

Objectives

After completion of the course, the students will:

- have an insight in the institutional structure, legislations and water rights in Yemen;
- know the Yemen water policy and its constrains of implementation;
- be able to analyze, design and evaluate water policy/governance strategies;
- be able to execute case studies on solving problems of water governance in the field.

Organisation of the course

Lectures	24 hours
Group work	36 hours
Individual exercises and self study	20 hours
Total	80 hours
Individual preparation for exam	20 hours

Examination

- Written exam (50%)
- Group work report (40%)
- Attendance (10%)

Literature

WEC Course reader 'Water rights and policies'

Water Value and Economics

Semester No. 1

Course No. 9

Credits 60 hours

Course Coordinator

Dr. Mohammed Al-Hebshi

Lecturer(s)

Dr. Mohammed Al-Hebshi
Second lecturer

Contact information

malhebshi@hotmail.com

Contents

Economics deals with the efficient allocation of resources. In the context of water management these resources include: capital, labour and natural resources. The key question is who produces or consumes what, where, when and for whom?

Economy of water deals with scarcity and prices of water and the allocation of water by market or government. Interactions between economics and environment will be handled, as well as the market mechanism, scarcity and prices, and policy instruments. The circular flow model of economic activity, including producers and consumers, supply and demand will be discussed and attention will be paid to cost benefit analyses with applying examples from deferent regions in Yemen.

Assumed prior knowledge

- Introduction to IWRM (semester 1)
- Water Rights and Policies (semester 1)

Follow-up courses

- Integrated Groundwater Management
- Environmental Impact Assessment

Objectives

- to understand the basic concepts of economic scarcity, efficiency, equity, sustainability;
- to understand market failure, including externalities;
- to understand the difference between private cost and social cost;
- to be able to calculate the total cost of water for specific case studies;
- to understand the differences between cost, price and value;
- to understand the concept of discounting;
- to be able to calculate the optimal use and allocation of water for specific case studies.

Organisation of the course

Lectures	20 hours
Group work	10 hours
Excursion	10 hours
Individual exercises and self study	20 hours
Total	60 hours
Individual preparation for exam	15 hours

Examination

- Written exam (60%)
- Term Paper (30%)
- Attendance (10%)

Literature:

- WEC Course reader 'Water value and economics'

Water and Public Participation

Semester No. 1

Course No. 10

Credits 40 hours

Course coordinator

Dr. Naif Abu Lohom

Lecturer(s)

Dr. Taha M. Taher
Dr. Eshraq Al-Eryani
Dr. Naif Abu Lohom
Dr. Bilkis Zabara

Contact information

naifgeo@gmail.com

Contents

This course covers the formation of water users associations and water boards for the management of water resources. Issues such as the process of forming these groups, selection of participants, encouraging participation and undertaking stakeholder analysis are discussed. The course addresses the relation between these bodies and the government on one hand and the community and water users on the other.

Steps of preparing a community action plan are presented. Different interaction and communication techniques are presented.

Case studies from Yemen, presenting success but also failure stories, are presented. Problems facing these groups in the Yemeni context and strategies to overcome these problems and maximize the benefits towards better water management, equitable use, public involvement and sustainability are addressed. The course involves a student project on community participation.

Assumed prior knowledge:

- Water Rights and Policies (semester 1)
- Water and Gender (semester 1)

Follow-up courses

- In all the courses in the second semester the role of stakeholders and their participation will have a major role, for which this course is a base.

Objectives

- In respect to knowledge, the students should after the successful completion of the course:
- understand what is meant by public participation (definition, success and failure factors) and be able to explain why public participation is important for solving IWRM issues in Yemen;
 - be able to mention and explain governance styles and related roles of stakeholder groups;
 - be able to distinguish different techniques for public participation;
 - be able to mention and describe subsequent stages and steps in developing community action plans.

In respect to skills, the students should after the successful completion of the course:

- be able to conduct a stakeholder analysis;
- be able to develop shared objectives of a community action plan in a multi-stakeholder platform;
- be able to work in small groups and present findings of the group work;
- be able to facilitate a stakeholder participation workshop.

In respect to attitude, the students should after the successful completion of the course:

- appreciate the importance of public involvement for better water management;
- have gained a higher sense of responsibility towards the society;
- have gained a confidence in the ability of the community to participate in providing solutions for its problems.

Organisation of the course

Lectures	14 hours
Group work	8 hours
Excursion	5 hours
Individual exercises and self study	13 hours
Total	40 hours
Individual preparation for exam	10 hours

Examination

- Written exam (50%)
- Group work and exercises (40%)
- Attendance (10%)

Literature

- WEC Course reader 'Water and Public Participation'

Water and Gender

Semester No. 1

Course No. 11

Credits 40 hours

Course Coordinator

Dr. Husnia Al-Kadri

Lecturer(s)

Dr. Husnia Al-Kadri

Dr. Bilkis Zabara

Contact information

husniaalkadri@yahoo.com

Assumed prior knowledge

- Introduction to IWRM (semester 1)
- Water and Public Participation (semester 1)

Follow-up courses

- Integrated Watershed Management

Objectives

To enhance the capacity of the students to mainstream gender in IWRM projects and programmes, specifically by explaining the concept of gender through gender awareness exercises and to promote a gender attitude at professional level to be part of the practice of IWRM professionals.

Contents

Gender is about a set of relations which define the social function on the basis of sex-gender. As it is a social, not biological construction, it's a changeable issue which includes power relations.

A gender sensitive approach to water management allows demonstrating management of water. This should not be limited to an understanding of the different roles of men and women, but it should promote an understanding of when and how these roles need to change in order to allow equal participation in decision-making by men and women.

The focus is on mainstreaming gender concerns by developing replicable strategies for enhancing gender sensitive approaches and empowering women. Gender is a cross-cutting issue. To make gender mainstreaming successful it has to be at the design stage. At national policy level support must be given to develop a gender strategy both for water services and water resources management. At the local level, gender mainstreaming approaches are implemented within the community structures as well as within the private sector.

In respect to knowledge, the course will facilitate an understanding of gender and gender analysis in general and gender-related concepts in the context of IWRM in particular.

In respect to skills, objectives are:

- to provide the students with practical ground to gender analysis and IWRM;
- to apply gender analysis to IWRM process, whereby the students will be provided with the tools to undertake analysis of IWRM policies, projects, programmes and strategies from gender perspectives;
- to provide practical tools for situational assessment and planning;
- to learn to use gender approaches during design and throughout implementation of IWRM and any other water-related project.

In respect to attitude, the course:

- promotes gender equality and equity in water sector;
- makes students aware of the differences between men and women in their access to and control over natural resources, such as water.

Water Use in Urban and Rural Areas

Organisation of the course

The methodology of this module is interactive and participatory. It uses group work and discussion that acknowledges and respects the knowledge of students through analyzing case studies.

Lectures	20 hours
Group work	10 hours
Excursion	5 hours
Individual exercises and self study	5 hours
Total	40 hours
Individual preparation for exam	10 hours

Examination

- Written exam (80%)
- Analyzing case studies and reading (10%)
- Attendance (10%)

Literature

- WEC Course reader 'Gender and Water'

Semester No. 1

Course No. 12

Credits 40 hours

Course Coordinator

Dr. Mansour Haidera

Lecturer(s)

Dr. Mansour Haidera

Contact information

mhaidera@hotmail.com

Contents

This course starts with subjects related to drinking water and its health aspects. The focus will be on quality parameters, its standards and guidelines and water born diseases.

The quantity and the quality of the available freshwater will be further examined, but also socio-economic aspects play a role in topics such as affordability, water demand, household needs and the management of resources.

The technical aspects of production and distribution and water treatment will be discussed at the end, finalizing with water conservation measures on different levels.

Assumed prior knowledge

- Hydrology of Yemen (semester 1)
- Water and Environment (semester 1)
- Water and Public Participation (semester 1)

Follow-up courses

- Sanitation and Wastewater Treatment (semester 1)
- Water Chain Management (semester 2)

Objectives

After the course students will have the following competencies:

In respect to knowledge:

- know the urban water cycle, health aspects and water born diseases;
- know the quality of various conventional water resources;
- know the guidelines of drinking water quality and the treatment scheme to be applied;
- know various unconventional water resources;
- know how to quantify for domestic use and design distribution systems;
- know socio-economic aspects that play a role in terms of water affordability, household needs and the management of resources.

In respect to skills:

- planning and design of water allocation in Yemen;
- planning and design of (extensions of) water distribution systems;
- planning and design of (extensions of) water treatment systems;
- handling water problems (case study from Arab regions and Yemen).

Organisation of the course

Lectures	20 hours
Excursion	4 hours
Individual exercises and self study	16 hours
Total	40 hours
Individual preparation for exam	10 hours

Examination

- Written exam (60%)
- Exercises (30%)
- Attendance (10%)

Sanitation and Wastewater Treatment

Literature

- WEC Course reader 'Water Use in Urban and Rural Areas'
- 'Drinking Water-Principles and Practice', Technical Facets, TU Delft, The Netherlands
- Trifunovic (1994). 'Water Transport and Distribution'. Lecture notes IHE, Delft, The Netherlands
- WHO Seminar Pack For Drinking-Water Quality

Semester No. 1

Course No. 13

Credits 40 hours

Course Coordinator

Dr. Fadhl Al-Nozaily

Lecturer(s)

Dr. Fadhl Al-Nozaily

Contact information

drfadhl@yahoo.com

Contents

Sanitation and wastewater treatment are important for human health and environment. In the first week of this course the relation between IWRM and sanitation and wastewater treatment, the importance of wastewater characteristics in human health, wastewater treatment and reuse will be discussed.

The course will deal more in-depth with sewerage systems and wastewater treatment technologies. Both the selection of proper technology and the understanding of the technology will play a central role.

Case studies illustrate the theory, both in urban and rural areas. A laboratory visit will emphasize on the equipments and analysis applied for wastewater characteristics analysis.

Assumed prior knowledge:

- Water and Environment (semester 1)

Follow-up courses:

- Water Chain Management (semester 2)
- Environmental Impact Assessment (semester 2)

Objectives

At the end of this course, the participants should understand:

- the relation between sanitation and IWRM;
- the different sources and nature of wastewater constituents;
- decentralized – versus centralized sewerage systems;
- wastewater treatment technology;
- selection criteria of suitable wastewater treatment technology based on local circumstances;
- costs involved (investment, O&M).

At the end of this course, the participants should achieve the following skills:

- be able to distinguish between a clean and polluted environment;
- be able to select the proper technology using right selection criteria;
- realize that the wastewater characteristics are different from city to city and from country to country.

At the end of this course, the participants should achieve the following attitude:

- feel responsible towards the clean environment;
- feel responsible towards the proper selection of the wastewater treatment plants in terms of operation and maintenance.

Organisation of the course

Lectures	20 hours
Group work	4 hours
Excursion	8 hours
Individual exercises and self study	8 hours
Total	40 hours
Individual preparation for exam	10 hours

As group work the students are asked to make a comparative analysis on e.g.:

- case studies for different cities (Sana'a, Taiz, Hodeidah, Mahweet, Yarim, Dhamar, rural areas);
- flow sheets of different wastewater characteristics, network and wastewater technologies;
- technological performance of the various systems for each group.

Examination

- Written exam (50%)
- Exercises and reports (40%)
- Attendance (10%)

Literature:

- WEC Course reader 'Sanitation and Wastewater Treatment'

IWRM Case Studies

Semester No. 1

Course No. 14

Credits 60 hours

Course Coordinator

Dr. Bilkis Zabara

Lecturer(s)

Dr. Bilkis Zabara and supervisors

Contact information

khalmo@y.net.ye

Objectives

- To apply basic skills gained in the first semester as report writing and team work;
- To apply the knowledge gained in the first semester on a case study project.

Organisation of the course

Lectures	6 hours
Group work	44 hours
Individual exercises and self study	10 hours
Total	60 hours
Individual preparation for exam	10 hours

Lectures are organized as group discussions.

Students work in small groups. Each group has a supervisor, who guides the group through the project. The group work includes students presentations (colloquia).

Examination

- After final presentation, students are evaluated on basic skills and on contents by supervisor(s).

Literature

- Use can be made of the WEC course readers of the first semester
- Library and internet

Contents

Students in a group of 3-5 select a problem in water management and write a report on this problem, trying to provide an inventory of information needed to solve the problem, and provide possible solutions. In the report, the students also indicate what information obtained in the first semester they are using to come to a comprehensive analysis. Students apply what they have learned during the course Basic Skills, as scientific writing, ethics, presenting, computer and language skills etc. Students will be supervised by 1-2 lecturers and present their case at the end of the semester.

Assumed prior knowledge

- Basic skills
- First semester courses in general

Follow-up courses

- The courses in the second semester will provide the students with different tools to integrate IWRM knowledge, and as such, follows up on the case studies course.

Integrated Watershed Management

Semester No. 2

Course No. 15

Credits 212 hours

Course Coordinator

Dr. Taha M. Taher

Lecturer(s)

Dr. Taha M. Taher

Dr. Abdulla Noman

Dr. Mohammad Al-Hebshi

Dr. Abdul-Rahman Al-Eryani

Dr. Sharafaddin Saleh

Dr. Mahasen Munibari

Contact information

tmtahiri@y.net.ye

Contents

Watershed management is the process of guiding and organizing land, water and other resource usage in a watershed, ensuring the sustenance of the environment. In this process, it is important to recognize the interrelationships between land use, soil-water and slope of terrain. The unifying focus in watershed management is in how various human activities affect the relationship between water and other natural resources. Integrated Watershed Management provides a basis for actions concerning the development and conservation of the natural resources.

During the course hydrological processes of the watershed will be studied, including a workshop on watershed modelling and calculation exercises. Monitoring and information needed for an integrated watershed management plan will be discussed.

The socio-economics and the institutional system will be a part of the second half of the course, including user functions, the existing legal framework and an environmental impact assessment of the watershed system. A separate chapter will be

spend on agriculture in watershed management, as this plays an important role for water conservation. All subjects contain student assignments, and the course will end with selected case studies and an excursion.

Assumed prior knowledge

- Water and Environment (semester 1)
- Introduction to Hydrology (semester 1)
- Hydrology of Yemen (semester 1)
- Water Rights and Policy (semester 1)
- Water and Public Participation (semester 1)

Follow-up courses

- Environmental Impact Assessment

Objectives

After the course students should:

- know what the Integrated Watershed Management concept is about and what its important issues in Yemen are;
- be able to identify hydrological processes and patterns in watersheds in Yemen;
- be able to identify ecosystem functions and related goods and services in the watersheds in Yemen;
- know which user functions and land use patterns in Yemen's watershed cause pressures on the natural system and know what the socio-economic value of those user functions are;
- know the contents of relevant laws and regulations, control mechanisms and their strengths and weaknesses;
- be able to identify social, technological, economic and institutional management options and tools to solve IWM issues;
- know which information is needed in IWM and how to obtain this information by monitoring and research programmes;
- be able to analyse the upstream intervention actions and its downstream effects.

Organisation of the course

Lectures	87 hours
Group work	8 hours
Excursion	24 hours
Individual exercises and self study	93 hours
Total	212 hours
Individual preparation for exam	50 hours

Examination

- Written exam (90%)
- Attendance (10%)

Literature

- WEC Course reader 'Integrated Watershed Management'

Water Chain Management

Semester No. 2

Course No. 16

Credits 106 hours

Course Coordinator

Dr. Mansour Haidera

Lecturer(s)

Dr. Mansour Haidera

Dr. Fadhl Al-Nozaily

Dr. Abdul-Rahman Al-Eryani

Dr. Bilkis Zabara

Contact information

mhaidera@hotmail.com

Contents

A water chain approach allows linking different uses and users of water in a logical and stepwise framework, with due attention to quantity and quality of water. The approach helps to think along the line of the water flow and touches different disciplines.

Typical water chains are:

- The urban water chain, with issues such as domestic water supply, sewage collection, wastewater treatment and subsequent use in agriculture and environment.
- The rural water chain, in which drainage water, sometimes mixed with wastewater, is used as water source for irrigation.

In this course, the water chain approach will specifically be applied to wastewater use in agriculture. It would be the most appropriate basis to come to an integrated design of water measures ultimately supporting environmentally safe agricultural production in urban areas and downstream.

Assumed prior knowledge

- Water Use In Agriculture (semester 1)
- Water and Environment (semester 1)
- Sanitation And Wastewater Treatment (semester 1)
- Water Use In Urban And Rural Areas (semester 1)
- Water Rights And Policies (semester 1)
- Water and Gender (semester 1)
- Water and Public Participation (semester 1)

Follow-up courses

- Environmental Impact Assessment (semester 2)

Objectives

At the end of this course the students should:

- understand the concept of the (reverse) water chain and its relation to the water cycle and the processes by which the Water Chain is composed;
- be able to use and apply the disciplinary knowledge acquired in the first semester on the concept of the Water Chain;
- be able to work and think in a problem oriented and interdisciplinary way;
- be able to design a water chain, applying a bottom-up approach (reverse water chain approach) in which technical, social, and economic aspects are incorporated in an urban and rural setting;
- have sufficient knowledge of and insight in the different processes in order to make well-considered choices in respect to in-house sanitary services (mixed, separated); industrial discharges; wastewater collection (e.g. centralized; decentralized; location); wastewater treatment technology; treated effluent distribution; agricultural application; irrigation water management.

Organisation of the course

Lectures	52 hours
Group work	20 hours
Excursion	8 hours
Individual exercises and self study	26 hours
Total	106 hours
Individual preparation for exam	25 hours

For the group assignments the students are divided in groups of 3-4 persons to work on the water chain exercise. The exercise comprises the question to determine wastewater effluent quality for predefined wastewater use; and the use of multi criteria tool analysis for selecting a wastewater technology alternative taking into consideration socio-economic aspects.

Examination

- Written exam (60%)
- Exercises (30%)
- Attendance (10%)

Literature

- WEC Course reader 'Water Chain Management'

Integrated Groundwater Management

Semester No. 2

Course No. 17

Credits 106 hours

Course Coordinator

Dr. Alkhateeb Yahya Al-Kebsi

Lecturer(s)

Dr. Alkhateeb Yahya Al-Kebsi

Dr. Naif Abu Lohom

Contact information

aalkebsi@yahoo.com

Objectives

To provide knowledge and understanding of the principles of groundwater concepts, groundwater exploration, extraction, evaluation, management and developments. To be able to use and manage groundwater safely and perennially (sustainable).

Organisation of the course

Lectures	46 hours
Group work	10 hours
Excursion	20 hours
Individual exercises and self study	30 hours
Total	106 hours
Individual preparation for exam	25 hours

Examination

- Written exam (50%)
- Exercises, group work, homework, reports (40%)
- Attendance (10%)

Literature

- WEC Course reader 'Integrated Groundwater Management'
- Todd, Groundwater Hydrology
- Well drilling reports (from the field)
- Software
- Groundwater and drainage (CD) (ILRI)

Contents

IGWRM is the science which deals with the basic concepts of groundwater hydrology, groundwater parameters, principle of groundwater hydraulics, basic groundwater equations, well (drilling, design, cleaning, development and rehabilitation), pumping test methods, seawater intrusion, groundwater exploration, groundwater legislation.

Assumed prior knowledge

- Water and Environment (semester 1)
- Introduction to Hydrology (semester 1)
- Hydrology of Yemen (semester 1)
- Introduction to Hydrology (semester 1)
- Water Rights and Policies (semester 1)
- Water Use in Agriculture (semester 1)
- Water Use in Urban and Rural Areas (semester 1)

Follow-up courses

- None

Integrated Coastal Zone Management

Semester No. 2

Course No. 18

Credits 106 hours

Course Coordinator

Dr. Mohammed Mahdi Abubakr

Lecturer(s)

Prof. Dr. Abdulla Babaqi

Dr. Mohammed Mahdi Abubakr

Dr. Naif Abu-Lohom

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Assumed prior knowledge

- Water and Environment (semester 1)
- Introduction to Hydrology (semester 1)
- Hydrology of Yemen (semester 1)
- Water Rights and Policy (semester 1)
- Water and Public Participation (semester 1)

Follow-up courses

- None

Objectives

To teach the basics of coastal zone management, while at the same time considering marine and coastal ecosystems status, technical, social, legal constraints and setups.

Contents

Integrated coastal zone management deals with questions such as maintaining a favourable shoreline morphology and a productive eco system. Transport of coastal sediments along the shoreline can bring serious effect on harbours, navigation channels and landing sites. Meanwhile marine ecosystems provide a range of benefits including, fish, timber and fuel wood from mangroves and medicinal plants and constitutes wildlife habitats, and coral reefs are very important for tourism. The diversity of actors and the many functions that the coastal zone includes demands for an integrated approach which will be central in this ICZM course. The need and the benefits for this integrated approach will be discussed, as well as the important functions and the processes which take place in the coastal zone. The functioning of the socio-economic and institutional system will be evaluated, and it will be discussed which information is needed. Students will be taught about monitoring and indicators, as well as management strategies and instruments. This course includes an excursion, which will be a one-week study tour to the coastal regions, where project and activities on coastal zone management will be visited.

In respect to knowledge:

- know the concept of ICZM and the important ICZM issues in Yemen;
- know what role IWRM can play in the sustainable management of coastal zones in Yemen;
- understand how the user functions cause pressure on the natural system;
- know which information is needed in ICZM and how to obtain this information by monitoring and research programmes;
- know the contents of relevant laws and regulations, control mechanisms and their strengths and weaknesses.

In respect to skills, be able to:

- identify the user functions, forces and processes in the coastal zones of Yemen;
- apply the principles of IWRM to sustain development in the coastal zones of Yemen;
- mention some social, technological, economic and institutional management options and instruments to solve ICZM issues;
- couple disciplinary subjects and levels with each other.

Environmental Impact Assessment

In respect to attitude:

- openness for other disciplines and views;
- team worker attitude;
- curiosity, creativity and flexibility;
- willingness to travel outside Sana'a.

Organisation of the course

Lectures	25 hours
Excursion	20 hours
Individual exercises and self study	61 hours
Total	106 hours
Individual preparation for exam	25 hours

Examination

- Written exam (50%)
- Excursion report (10%)
- Case study report (30%)
- Attendance (10%)

Literature

- WEC Course reader 'Coastal Zone Management'

Semester No. 2

Course No. 19

Credits 106 hours

Course Coordinator

Dr. Fadhl Al-Nozaily

Lecturer(s)

Dr. Fadhl Al-Nozaily

Dr. Ashraf Ghanem

Dr. Hussein Al-Guneid

Dr. Bilkis Zabara

Contact information

drfadhl@yahoo.com

Contents

During the course, the process of an EIA will be discussed, followed by regulations and decision making aspects of EIA. Students will learn about project evaluations and post-project activities and the limitations of EIA will be reviewed. The theory will be applied on field trips and case studies.

EIA is a process created to integrate environmental considerations and stakeholder involvement into decision-making. The EIA process has five main features that make it unique and effective.

These include:

- Description of the project and affected environment, and identifying project class according to World Bank and Yemen Environmental Protection Agency;
- Identification of project alternatives and screening for possible negative impacts of different alternatives during all project phases;
- Identifying and recommending appropriate mitigation measures for adverse project impacts;
- Involvement of stakeholders through public participation process during all EIA steps;
- Establishing monitoring and evaluation.

Assumed prior knowledge

- Water and environment (semester 1)
- Introduction to hydrology (semester 1)
- Water rights and policies (semester 1)
- Sanitation and wastewater treatment (semester 1)
- Water and Public Participation (semester 1)

Follow-up courses

- None

Objectives

The student should have an understanding and knowledge on:

- the components of an EIA and the processes of an EIA;
- how to setup and manage an EIA team;
- the regulations governing EIA in Yemen and abroad.

In respect to skills, the student should be able to:

- identify impacts of water resources development projects and prioritize these impacts;
- identify project alternatives and classify projects into the groups A, B, C;
- to fill out EIA form for project types A and B;
- to prepare the components of an EIA study related to his/her discipline;
- to prepare a management plan;
- to prepare mitigation measures;

In respect to attitude, the student should:

- have a responsibility towards the environment and the community;
- appreciate the importance of public involvement;
- have the affinity of minimizing negative environmental impacts and maximizing positive ones.

Organisation of the course

Lectures	30 hours
Group work	18 hours
Excursion	16 hours
Individual exercises and self study	42 hours
Total	106 hours
Individual preparation for exam	25 hours

Examination

- Written exam (50%)
- Excursion report (10%)
- Exercises (10%)
- Group work (20%)
- Attendance (10%)

Literature

- WEC Course reader 'Environmental Impact Assessment'
- EPA law for Yemen; World bank EIA assessment guidelines; UNDP lecture notes on EIA; Larry Canter 'Environmental Impact Assessment'

Skills Development

Research planning and writing, presentation, advanced computer skills

Semester No. 3

Course No. 20

Credits 320 hours

Course Coordinator

Dr. Bilkis Zabara

Lecturer(s)

Several (topic related)

Contact information

khalmoy@y.net.ye

- use time efficiently;
- define the project cycle and how to carry this out.

Organisation of the course

Lectures	80 hours
Group work	10 hours
Individual exercises and self study	230 hours
Total	320 hours
Individual preparation for exam	80 hours

Examination

- Topic related tests (40%)
- Exercises (40%)
- Attendance (20%)

Literature

- WEC Course reader 'Skills Development'
- Use of library and internet

Contents

This course consists of the following modules: time management; project management; proposal writing; remote sensing and GIS, statistics, public awareness, communication skills, Participatory Rural Appraisal (PRA).

Assumed prior knowledge

- Basic skills (semester 1)

Follow-up courses

- During the diploma project and master thesis research these skills can be practiced.

Objectives

This course is developed to prepare the students for individual research work.

The students will know how to:

- set up a research planning;
- write research proposals and reports;
- apply advanced computer skills for research applications;
- collect, process, analyze and interpret data;
- design and implement awareness campaigns;
- communicate;

Diploma Project

Semester No. 3

Course No. 21

Credits 320 hours

Course Coordinator

Dr. Bilkis Zabara

Lecturer(s)

Dr. Bilkis Zabara + supervisors

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khalmo@y.net.ye

Contents

Students are divided into groups. Each group will work on a problem in water management and write a report on this problem, trying to provide an inventory of information needed to solve the problem, and provide possible solutions. In the report, the students also indicate what information obtained in the first and second semester they are using to come to a comprehensive analysis of the problem. This is executed on a larger scale than the case study course, as these cases are bigger. The students will be supervised by one or two supervisors. They will participate in a colloquium to discuss general issues faced during the research to share experiences.

Assumed prior knowledge

- Knowledge on different integrated approaches to analyze water management cases
- Basic disciplinary knowledge
- Skills from the 1st and 2nd semester

Follow-up courses

- None

Objectives

This course is designed for the students to apply the knowledge obtained in the previous semesters to an actual integrated water resources problem.

- Students should be able to conduct a research (methodology, analyzing problems, go through all steps of research cycle);
- Students should be able to apply report writing, analyzing and interpreting data, group work and presentation skills on a research project;
- Scientific writing attitude, including ethics.

Organisation of the course

Lectures	6 hours
Group work	157 hours
Individual exercises and self study	157 hours
Total	320 hours
Individual preparation for exam	80 hours

Examination

- Group report (100%) – specified in spreadsheet (individual skills and group work skills, contents)

Literature

- Use can be made of the WEC course readers of the first and second semester
- Library and internet

Master Thesis

Semester No. 4

Course No. 22

Duration at least 6 months

Course Coordinator

Dr. Bilkis Zabara

Lecturer(s)

All lecturers

Contact information

khalmo@y.net.ye

Contents

Each student will select his/her topic based on an IWRM approach. Each student will work on a problem in water management and write a proposal on this providing an inventory of information needed to come to solutions. The topic should preferably reflect the problems indicated in his/her work place.

Students will apply the knowledge and skills gained in the first 3 semesters. Students participate in colloquia through out the research period to share knowledge and experience with other students.

Students are supervised by 1-2 supervisors with competencies related to the student research.

Assumed prior knowledge

- Knowledge on different integrated approaches to analyze water management cases
- Basic disciplinary knowledge
- Other skills from the 1st and 2nd semester
- Diploma project experience

Objectives

The thesis should solve a problem in his/her field of work. The student should apply the knowledge of IWRM in his work field. This thesis will help the student to get promoted in his career.

After carrying out the master research a student should:

- have more knowledge on his/her specific topic;
- be able to use communication skills, information collection, data analyzing and interpreting and presenting;
- be able to carry out an individual research project based on IWRM concepts;
- be able to translate academic research into practice;
- have the attitude to approach a water management issue from an integrated point of view and to approach this in a critical manner.

Examination

- Passed or not passed

After writing the thesis the student will defend the research and be evaluated according to written thesis and discussion.

List of Annexes

Annex 1. Research projects with participation from WEC

Annex 2. WEC Networks and co-operation

Annex 3. Workshops hosted by WEC

Annex 4. Teaching staff at WEC

Annex 5. Organisational structure

Annex 1 Research projects with participation from WEC

Climate Change Effects on Agriculture in Yemen (2009).

Building on Indigenous Knowledge for Water Demand Management (Old Sana'a City) (2006-2008).

Analysis of Private Water Providers in Urban and Peri-Urban Areas in Sana'a (2009).

Pilot study on UASB (Upflow Anaerobic Sludge Blanket) (2007-2008).

Participatory Water Management Project (2009-2012).

Adapting to water scarcity for Yemen's vulnerable communities -Sana'a, Sada'h and Aden Areas (2007-2008).

Community Water Management Project (2005-2009).

Evaluating the Health and Socioeconomic Impacts of Colloidal Silver Impregnated Ceramic Filters in 4 Villages in Amran Governorate. (2007-2008).

Options for Changing the Economic Incentive Structures for Groundwater Extraction in Yemen (2008)

Well Inventory of Sana'a Basin (2002-2004).

Hydro-Geological and Water Resources Monitoring and Investigations (Sana'a Basin) (2006-2008).

Satellite Analysis of Cropping and Irrigation Water Use Project (SACIWUP) (2000-2001).

Appropriate Low Cost WWT Technology for Yemen Rural Areas, Sadah, Abs, Damt (2006-2008).

Characterization of Sana'a Basin and Selection of Sub Basin(2000-2001)

Rural water quality study in three areas in Yemen (Abyan, Ibb and Hajjah) (2006-2008).

Annex 2 WEC Networks and co-operation

WEC confers a vital role to partnerships. It adds value to many of the institute's activities and is essential in linking global knowledge to local sector agendas, and for improving regional and international collaboration. WEC is an active member of the following organization and networks:

AREN - Arab Region Ecotechnie Network
PoWER - Partnership for Water, Education and Research
AwarNet - Arab Water management Network
CapNET - Capacity building Network
Arab Water Council
IHP - International Hydrological Program
WHNET - Wadi Hydrology Network
GWA - Gender and Water Alliance

WEC has established co-operation with highly qualified public institutions, and private organization to involve several regional and international organizations which include:

Wageningen University, the Netherlands
Cairo University, Egypt
Technical University of Braunschweig, Germany
Technical University of Dresden, Germany
Technical University Delft, the Netherlands
Birzeit University, Palestinian Authority
NanJing Hydraulic Research Institute, China P.R.
Regional Center for Urban Water Management, Iran
UNESCO-IHE Institute for Water Education, the Netherlands
Free University of Berlin

Active relations are also reflected in tight cooperation through projects funded by international organizations as the World Bank, the Dutch Government represented by NUFFIC, German organizations as GTZ, DED and BGR, and the Japanese Fund.

Local active relations are mainly with the water sector including the Ministry of Water and Environment (MWE), Environmental Protection Authority (EPA), the Local Water and Sanitation Cooperation and its branches, the General Authority Rural Water Projects (GARWSP), Sana'a Basin Project, the Ministry of Agriculture and Irrigation (MAI) including several projects, the Ministry of High Education and Scientific Research, different Faculties of Sana'a University, the Social Fund for Development (SFD), and other.

Annex 3 Workshops hosted by WEC

The Water and Environment Centre at Sana'a University has ample experience in hosting workshops, conferences and seminars.

ToT Workshop on Environmental Awareness, funded by Inwent, implemented by the regional IUCN office (Amman), Sana'a, Yemen, 4-8 October 2009.

Closing Workshop for Community Water Management Project, funded by the World Bank, implemented by WEC, Sana'a, Yemen, 24 June 2009.

Adapting to Water Scarcity due to the Climate Change for Yemeni's Vulnerability Communities, Sana'a, Yemen, 17 June 2009.

Final Consultation Workshop (Inception Phase) on 'Stakeholder Dialog for Concerted Action for Conjunctive Use of Groundwater in Dhamar Governorate', funded by the Italian Government and implemented by WEC and the regional IUCN office (Amman), Sana'a, Yemen, 18 April 2009.
Curriculum Evaluation to Improve the IWRM Diploma/Master Programme at WEC, funded by the NUFFIC project (NPT/YEM/036), organized by WEC, Cairo University (Egypt) and Wageningen University (The Netherlands), Sana'a, 9-11 February 2009.

Participatory Planning for IWRM, funded by the Italian Government and implemented by WEC and the regional IUCN office (Amman), Sana'a, Yemen, 24-29 January 2009.

Political Economy of Water Demand Management in the MENA Region; the Case of Yemen, funded

by the International Development Research Center (IDRC) and organized by WEC, IDRC-Cairo Office and WaDiMena, Sana'a, Yemen, 7-8 July 2008.

Gender Mainstreaming in IWRM, funded by IDRC and implemented by WEC and the Gender Development Research and Studies Center (GDRSC, Sana'a University), Sana'a, Yemen, 6 July 2008.

The Evaluation of the Health and Socioeconomic Impact of the Silver Impregnated Ceramic Filters in Four Villages in Amran Governorate, funded by GTZ and organized by WEC and the Social Fund for Development (SFD), Sana'a, Yemen 21 June 2008. Options for changing the economic incentive structures for groundwater extraction in Yemen (LEI, the Netherlands and WEC), 27 May 2008.

A GDLN Training and capacity development on water demand management 'Savings and South-South Learning with China' (Video Conference), funded by the World Bank, organized by the World Bank Institute (WBI) and WEC, Sana'a, Yemen, 31 March-2 April 2008.

'IWRM in Amran Basin' by WEC students on the occasion of the World Water Day held in Amran, 22 March 2008.

7th Arab Region Ecotechnie (AREN) Meeting, funded by UNESCO Cairo office and organized by WEC, Sana'a, Yemen, 4-6 November 2007.
Expert group meeting on the 'Application of Indicators and Indices for Water Quality Management in the EXCWA Region' organized by WEC, MWE, EXCWA, GTZ and BGR, Sana'a, Yemen, 17-19 July 2007.

Annex 4

Teaching staff at WEC

Community Water Management: Looking Ahead Roles and Responsibilities, Sana'a, Yemen, 29 April 2007.

Expert group meeting on Municipal Waste Water Use for Irrigation, Sana'a, Yemen, organized by RCUWM (Teheran), Wageningen University (the Netherlands) and WEC, 4-7 November 2006.

Seminar on 'Some Anthropological Perspective on Issues of Water in Yemen' by Dr. Steven C. Caton, Director Center for Middle Eastern Studies/Harvard University, Sana'a, Yemen, 26 June 2006.

Seminar on 'Desalination of Seawater for Sana'a Basin Drinking Water using Concentrated Solar Power', Sana'a, Yemen, 28 May 2006.

Launching Workshop for Community Water Management Project, funded by the World Bank and implemented by WEC, Sana'a, Yemen, 27 February 2006.

Dr. Abdul-Rahman Al-Eryani is Assistant Professor at the Crop Science Department at the Faculty of Agriculture, Sana'a University. He holds a MSc and PhD degree from the Alexandria University, Egypt, where he did research on Pre-and post Heading Growth Traits, nitrogen use efficiency, and yield of some wheat genotypes. His specific teaching topics are statistics and experimental design, principles of field crop production, irrigation and fertilization of field crops, field crop production, physiology and ecology.

Dr. Eshraq Al-Eryani is Assistant Professor of Psychology at the Faculty of Art, Sana'a University. She got her PhD from Ain Shams University (Cairo, Egypt) and her MA from Sana'a University. Her research and teaching experience in communication is a valuable asset for programs that aim at influencing the attitudes of the general public or specific segments thereof (families, youth, farmers, voters) towards targeted social phenomenon, or issues relating to political participation, family planning, natural resource management.

Prof. Dr. Mohammed Al-Eryani has a MSc on Water resources management from University of Arizona and a PhD from Utah University, USA. He was deputy Minister of Higher Education and Scientific Research; Dean of the Faculty of Engineering and First Minister of Water and Environment. Currently he is Ambassador of Yemen in Germany.

Dr. Hussein Al-Guneid is a specialist in Environmental resources management. He has a BSc from Madras, India; MSc from Dundee, UK and PhD from the University of Sanford, UK. He was Secretary General of the Environmental Council, currently Deputy Minister of Environment in the Ministry of Water and Environment.

Dr. Mohammed Al-Hamdi is Assistant Professor at the Department of Civil Engineering at the Faculty of Engineering, Sana'a University. He got his MSc and PhD from IHE Delft and TU Delft, The Netherlands in Water Resources Management. He was the Deputy Minister for Water Affairs at the Ministry of Water and Environment and is currently working at the Economic and Social Commission for Western Asia (ESCWA) in Beirut, Lebanon.

Prof. Dr. Mohammed Al-Hebshi is an Agricultural Economist by profession and is the Head of the Agricultural Economic Section of Sana'a University. He studied in Egypt and the U.S.A. and was awarded PhD in Agricultural Economics at the Faculty of Agriculture, Cairo University, Egypt. Prof. Al-Hebshi lectures at the Department of Agricultural Economics & Extension, Faculty of Agriculture, Sana'a University.

Dr. Husnia Al-Kadri is Director of the Gender Development Research and Studies Center, GDRSC, at Sana'a University and Assistant Professor at Faculty of Medicine and Health Sciences. She holds a Ph. Degree in Endocrinology of Reproduction and Toxicology. She studied a number of years in France.

Dr. Alkhateeb Al-Kebisi is a Hydrogeologist working at the Earth and Environment Sciences Department in the Faculty of Science, Sana'a University. He obtained his MSc at Ohio University, Athens, Ohio, USA and his PhD from the Indian Institute of Technology, Bombay, India. He has a special interest in Groundwater modelling; Groundwater Recharge and Water Quality and Groundwater pollution.

Dr. Fadhil Al-Nozaily is Associate Professor at the Civil Engineering Department, Faculty of Engineering, Sana'a University in Civil, Water and Environmental Engineering. He holds a BSc in Civil Engineering at the KAU, Saudi Arabia. He did his MSc in Sanitary Engineering at the IHE-Delft, The Netherlands and holds a PhD from the IHE and University of Technology, Delft, The Netherlands.

Dr. Jalal Awadh is Assistant Professor at the Plant Protection Department at the Faculty of Agriculture, Sana'a University. He has got his MSc and PhD from the college of Agriculture, Zhejinag University, China. His specific research topic are pesticide residue analysis in water, soil and food, photo degradation of pesticides, marine environment pollution by POPs and PAHs, the fate of pesticides in the ecosystem and air pollution.

Prof. Dr. Abdulla S. Babaqi studied chemistry at Cairo University and the University of Arizona, USA. Apart from being a Professor of Chemistry at Sana'a University, Dr. Babaqi is Director of the Water and Environment Centre since 2000. He is a member of a number of committees and member of the Sana'a University Council.

Mr. Awad Bahameesh MSc is a freelance legal expert on environmental, water and maritime legislations. He has got his MSc in Law LL.M (Law of the Sea) University of Wales (UWIST) U.K. He shared in drafting legislation in the field of environmental protection, agriculture and irrigation, and water. He acted as a consultant for IUCN, UNDP, WB, FAO and several Yemeni ministries. His lecturing topics are maritime law, law of the sea at Aden and Sana'a Universities, respectively.

Dr. Mansour Haidera is Assistant Professor at the Civil Engineering Department, Faculty of Engineering, Sana'a University. He has a MSc degree from IHE-Delft, The Netherlands and a PhD from the University of Newcastle Upon Tyne-U.K. His specific research interest is in water resources management, climate change, Hydraulics, Sanitary and Environmental Engineering.

Dr. Naif Abu Lohom is lecturer and researcher at the Earth and Environmental Sciences Department of the Faculty of Science, Sana'a University. Specific Research Topics water resources including Hydrogeology, Geophysical Exploration, Water Quality, Groundwater Pollution, and Environmental Geology. He obtained his BSc degree from King Abdul-Aziz University, Saudi Arabia. He obtained his MSc and PhD degrees from the University of Pune, India.

Dr. Mohammed Abubakr Mahdi is Assistant Professor at the Department of Earth and Environmental Sciences at the Faculty of Science, Sana'a University. He got his MSc and PhD from the University of Wales, Wales, UK in the fields of Crustacean Biology and Benthology and Aquaculture, respectively. His special interest is Coastal Zone Management.

Dr. Mahassin Monibari is Assistant Professor at the Faculty of Agriculture, Sana'a University. She has got her MSc and PhD degrees at Cairo University and Ain Shams University, respectively. Her main research topics are watershed management, vegetable crop production and plant physiology.

Dr. Abdulla Noaman obtained his MSc degree at the Belarusian Academy in the Former Soviet

Union and his PhD from the Technical University, Braunschweig, Germany. Dr. Noaman works at the Civil Engineering Department at the Faculty of Engineering, Sana'a University, where he teaches Hydrology and water resources management. His research is on Wadi Hydrology and Water Harvesting.

Dr. Sharafaddin Abdullah Ahmed Saleh is Assistant Professor at the Faculty of Civil Engineering, Sana'a University. He has got his MSc degree from Sana'a University in collaboration with IHE, The Netherlands in "Sedimentation problems in head works and irrigation canals of Wadi Zabid". He got his PhD from Cairo University, Egypt on "Scour around bridge piles foundation in well graded sand in Wadis".

Dr. Taha Muhammed Tahir is an expert on Water Resources and Hydraulic Structures. He holds a MSc from Southampton University, Southampton, England and a PhD in Hydraulics and Water Resources, Department of Civil and Environmental Engineering at the same University. Dr. Tahir is lecturer and researcher in Water and Environmental Engineering Division, Civil Engineering Department, Faculty of Engineering, Sana'a University.

Dr. Belkis Zabara is Assistant Professor of Physical Chemistry at Sana'a University. She has her MSc and PhD from the Faculty of Science, Sana'a University and specialised on photochemistry. During her work she became an environmentalist with special attention to Waste management, Air pollution, Pollution of drinking water and a keen interest in educational matters.

Annex 5 Organisational structure

