Capacity Building in IWRM: The IWRM MSc Curriculum at the Water and Environment Centre, Republic of Yemen.

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Abstract

Integrated Water Resources Management (IWRM) is an interdisciplinary approach to water resources management, as opposed to water resources development. In developing an MSc curriculum at the Water and Environment Centre (WEC) at Sana'a University in the republic of Yemen, three goals were defined. The first goal is to integrate the knowledge and skills developed at the different faculties at Sana'a University into an integrated teaching curriculum. The second goal is to meet the demands from the Yemeni water sector, such that graduates have the skills and knowledge required for their future jobs. The third goal is to make the IWRM curriculum institutionally and financially sustainable, such that it can continue to be part of the Sana'a University MSc Program. The development of the IWRM MSc curriculum is done in a participative way, using support of other international universities, to ensure that the complete 2-year program of the curriculum is a coherent package, and not a collection of individual classes. The first semester is designed to develop the same level of knowledge for the inflow students, who will likely have a variable background. The second semester is designed to teach integration of knowledge and skills on the topic of water management. The third and fourth semester are designed to improve research skills and finish the MSc with thesis work. The program will start at the end of 2005, but the process of development of the curriculum has already developed a common sense of integration in Water Resources Management with lecturers from multiple disciplines.

Introduction

Integrated water resources management (IWRM) is generally seen as a solution to water management problems. In Europe, the European Water Framework Directive is a means to implement IWRM in order to improve the water quality of surface waters (EU-Water

Framework Directive, 2000). In the water-scarce Republic of Yemen, IWRM is seen as a method to improve water use and thus to better balance water supply and demand (e.g. NWSSIP, 2005). IWRM should, however, not be seen as a magic solution that creates more water.

IWRM can have multiple interpretations, depending on the level of implementation (e.g. Verhallen and Huisman, 2001). IWRM can be implemented at a policy scale, thus breaking down 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.

IWRM can also be implemented at field level. In this case, 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.

The implementation of IWRM is sometimes expressed as horizontal and vertical implementation (e.g. GWP, 2005). The horizontal implementation is between different disciplines at the same level, for example technical engineering water management with social aspects of water management at the level of project implementation. One could think 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 group of the population. Vertical implementation of IWRM is integration in the "chain of command", for example policy makers at the ministry who communicate their thoughts on how integrated water resources management should be implemented to the field level.

The Water and Environment Centre (WEC) at Sana'a University is currently developing an MSc curriculum and a Professional Diploma course on IWRM. In this paper, we aim to describe the philosophy of the curriculum development, as well as the process of the curriculum development.

Aim of IWRM Education in Yemen

Yemen currently has a good educational program in disciplinary technical topics. For example the BSc program at the Faculty of Engineering provides classes in hydraulics, waste water sanitation, fluid mechanics etc. This BSc Program educates about 180 students each year.

This disciplinary knowledge is necessary in Yemen, but not sufficient for the future. Water engineering aspects are very important for the development of water resources,

but, especially in arid and semi-arid areas, water resources management is becoming more important than water resources development. Management needs more knowledge and skills than technical alone. Conflict prevention and solution is, for example, an important aspect of water management, which can occur at multiple levels. Water demand management between sectors (urban, industry, agriculture, environment and recreation) is a continuous state of potential conflicts, which are often discussed at the governmental levels (e.g. ministries, governorates), as well as in society as a whole (e.g. environmental action groups, NGO's, research institutes) while water distribution in an irrigation system can have potential conflicts between neighboring farmers. Through good management, especially under water scarce conditions, these conflicts can be avoided or diffused.

Good management is not easy to teach. It cannot be expressed in equations or formulas. There is not a single handbook that can be applied for all possible field conditions. Good management is much more an idea; something that people need to be aware of, and something that needs continuous creative applications.

The MSc curriculum on Integrated Water Resources Management (IWRM) aims to teach the basics of good water management, while at the same time indicating the constraints that good management has to consider. For this reason, basic disciplinary knowledge is needed on water resources (e.g. hydrology), as well as knowledge on how to integrate knowledge from different disciplines. The Water and Environment Centre (WEC), at Sana'a University, Republic of Yemen, is currently in the process of developing this curriculum. The WEC has a unique position within the university structure, since it is not a single faculty. Through its 'coordinating' position, the WEC can invite lecturers from different faculties at Sana'a University to aid in developing and implementing an integrated curriculum. In this manner, it can really bring together a mixture of different disciplines.

Another goal of the IWRM program is that it develops students with skills and knowledge that are applied to the Yemeni water sector. The curriculum should therefore not be developed from the supply side (university) but from the demand site (Yemeni water sector).

A final (practical) goal of the program is that it should be a sustainable program, both institutionally as well as financially. A program that can only exist through external funding (either through donor finances, university input or private gifts) is not financially sustainable, and has a high risk of failure when the external funding would not materialize. Also, a curriculum that is dependent on a high level of inputs from outside of the university also runs a risk of failure when this external input would not materialize. Institutional and financial sustainability are therefore included in the development of the IWRM curriculum.

Approach towards curriculum development

Through the aid of a Dutch government funded project (Nuffic, 2004), the WEC was able to secure the support of three universities and two private companies: Wageningen University and Technical University Delft in The Netherlands; Cairo University in Egypt; and the companies Arcadis Euroconsult and MetaMeta in The Netherlands. Eight lecturers from this consortium were selected to cooperate in the development of the IWRM curriculum with 16 selected lecturers from Sana'a University. The WEC maintains the overall coordination of the curriculum development and implementation.

Several steps were taken in the development of the curriculum to ensure that it was not just a list of disciplines put together, but a real interdisciplinary set of courses, forming a single curriculum on IWRM. The WEC management staff first selected suitable lecturers from the international consortium to support the development of the curriculum. Discussions were held with each lecturer to find the right mixture of subject knowledge and interdisciplinarity.

The selected lecturers then discussed together their thoughts on how an IWRM course should be composed. This discussion was held at the same time at the WEC with management staff and other lecturers at Sana'a University. Suggestions were made that, due to a high likeliness of a variety of backgrounds of students attending the curriculum, students should first be educated in some of the basic disciplines needed in water resources management. These basic disciplines included hydrology, economy, social aspects, and engineering, amongst others. It was also suggested that the curriculum should preferably be modular, such that topics in the curriculum can build upon previous classes, and that a clear development in the order of classes can be distinguished. The suggestion was made that after an initially disciplinary first semester, the second semester should be fully integrated, using the knowledge and skills obtained in the first semester.

It was further stressed that the coherence of the program should be very strong, since a danger in a multi-disciplinary approach is that one develops a basket with many classes but without inter-linkages. It was suggested that many case studies should be used in the courses, preferably about the same problems, but studied from different viewpoints.

A parallel step in the process of developing the IWRM curriculum was to include the Yemeni water sector in the process. The Yemeni water sector consist of ministries, research agencies, private companies, both as consultants as in water suppliers, implementing agencies, NGO's, development organizations and universities. A workshop was held in Sana'a were a broad field of representatives was invited. In this workshop, questions were asked to the attendants of what their needs for knowledge and skills from an IWRM education are, and what type of graduates they desire from the IWRM course. Discussions resulted in recommendations that the graduates should have a broad interdisciplinary view, but should not be lacking the basic disciplinary knowledge. A lack of current education on IWRM was indicated, and recommendations were made on topics that should be included in the new curriculum. The results of this workshop were

included in the curriculum development, and feedback of important contributors to the discussions were asked regularly during the continuing process of course development.

Since the development of the IWRM curriculum at the Water and Environment Centre is not the only activity on education in integrated water resources management in the world, other available material and courses were analyzed. These included the information from the Global Water Partnership (GWP, 2000), a CD with an introduction to IWRM developed at CAP-Net (CAP-Net, 2004), and short courses available through the Arab network AWARENET (AWARENET, 2005).

A next step in the curriculum development was to combine the results of the lecturer discussions in The Netherlands and in Yemen, the results of the input of the Yemeni water sector, and the materials developed by others into a curriculum fit for the Yemeni situation. This draft curriculum existed mainly out of the titles of the classes. The content of the classes was to be determined later by the group of combined consortium lecturers and Yemeni lecturers. The draft MSc curriculum was discussed in an Advisory Committee meeting that was setup for the Nuffic project, as well as with the rector of Sana'a University, and several deans and professors at the university.

After the separate meetings of international lecturers in The Netherlands, and the Yemeni lecturers in Sana'a, two combined meetings were held. During the first meeting, the international lecturers visited Sana'a University. During this visit, group meetings were held on the overall curriculum, and smaller teams worked on developing the contents of the individual classes. This resulted in a set of class descriptions that were evaluated by a curriculum committee. The task of this committee was to ensure the coherence of the classes, and to ensure that the second semester classes were interdisciplinary. Observations of this curriculum committee were send back to the teams of lecturers responsible for the individual classes.

Based on the discussions in small groups as well as plenary discussions some requirements for the new students were defined as well. Since the program has many topics to cover in a limited time span, it was decided that some of skills like basic computer skills and knowledge of the English language should be prerequisites. English was deemed a necessity, to prepare students for possible PhD programs, as well as to make the international literature on IWRM available to the MSc students.

A second combined effort was held in Wageningen, The Netherlands, when the Yemeni lecturers visited. During this period, the class material was developed and prepared. Comments from the curriculum committee were also incorporated in the class contents, and a final time table for the curriculum was developed.

In subsequent weeks, the curriculum was presented to Sana'a University, and a council of university representatives as well as representatives from the water sector not related to the university. Comments and remarks from this external council were included in the final version of the curriculum.

The IWRM curriculum

The curriculum has a total length of 2 years. These two years are divided into four semesters. The first and the second semester are mainly spent on courses, while the third semester is a combination of improving research skills and diploma work. The fourth semester is mainly used for MSc research.

The first two semesters are setup in such a way that lectures are given in the morning hours. The afternoon hours are used for discussions, exercises, questions and other class activities. Each day, there is time allotted for self study, reading the material and other non-plenary activities.

The first semester contains 14 classes, each approximately 40 study hours worth. The classes in the first semester have mainly a disciplinary approach. The second semester contains 5 classes, each approximately 110 hours worth. Each class in the second semester has a interdisciplinary approach. Class titles are shown in table 1.

Table 1: Class titles for IWRM Curriculum at Water and Environment Centre, Sana'a University, Republic of Yemen.

First semester	
1. Introduction to IWRM	40 hrs
2. Introduction to Hydrology	40 hrs
3. Report Writing and basic computer skills	40 hrs
4. Water and environment	40 hrs
5. Hydrology of Yemen	40 hrs
6. Water use in agriculture	40 hrs
7. Water value / economics	60 hrs
8. Water rights and policies	80 hrs
9. Water use in urban and rural areas	40 hrs
10. Gender and water	40 hrs
11. Water and public participation	40 hrs
12. Sanitation and waste water treatment	40 hrs
13. Water Issues in the Arab Region	40 hrs
14. IWRM case studies	60 hrs
Second semester	
15. Integrated Watershed Management	212 hrs
16. Water Chain management	106 hrs
17. Integrated Groundwater management	106 hrs
18. Integrated Coastal Zone management	106 hrs
19. Environmental Impact Assessment	106 hrs

Although the first semester is designed to obtain a similar level of knowledge and skills of all enrolled MSc students, some classes have been added to start the process of integrating knowledge. The introduction of IWRM at the beginning of the course will explain the ideas behind IWRM, but also the ideas behind the MSc curriculum, and the interdisciplinary integration process that is part of the curriculum. Basic skills are included to improve the quality of reports and presentations of the students, as well as to begin the development of research skills. Water issues in the Arab World, and the IWRM case study are classes where a first step is made to apply the disciplinary knowledge into understanding complex water resources management related problems.

The second semester is based on integrated concepts (Water chain management and Environmental impact assessment), as well as water management in different hydrological units (Watershed, groundwater, coastal zone).

The third semester includes individual student work on a diploma project. To prepare the skills needed for this project and the following MSc research, the students are also taught a series of basic (research) skills. The fourth semester is fully used for MSc thesis research

Conclusions

The curriculum will start at the end of 2005, thus no students have graduated from the program yet. However, the process of development of the curriculum has already developed a common interest for the lecturers involved in the program, both for the Yemeni lecturers as well as the international lecturers. In many curricula, a small committee develops the complete program, and individual lecturers are asked to contribute to the program based on their individual skills and knowledge. In the current development process, all the lecturers have been involved from the beginning in the development of the curriculum, thus ensuring that each one knows the content of the other classes in the course, and the coherence and common goal of the course is known.

There is no *sense of ownership* of the MSc program at the WEC and Sana'a University but there is *actual ownership* of the program. This ensures a high likeliness that the program will continue to develop in the coming years. This also results in the development of capacity at Sana'a University to absorb the concepts of IWRM. The final beneficiaries of this process will be the students, as well as the water sector in Yemen, hopefully resulting in the solution of several water management related issues.

The financial sustainability of the program still has to be proven, but a business plan was developed parallel to the development of the MSc curriculum. In the coming years, the business plan will need to be adjusted to eventually reach financial sustainability.

The response of the MSc curriculum to the demands of the water sector also still have to be proven. Once students graduate from this program, the employment rate of the students and their subsequent career development will be an indicator of the applicability

of the program to the needs of the water sector. However, several evaluation moments have been planned for the coming years, such that changes in the demand, or possible mismatch of supply and demand can be adjusted in the curriculum. It is expected, however, that the process of development of the curriculum will reduce the need for large adjustments in the coming years.

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Prof. Dr. Abdulla Babaqi is the Director of the Water and Environment Centre in Yemen, and co-director of the Nuffic-NPT project. Prof. Babaqi has many years of experience in education, and initiated the project to develop an MSc curriculum on IWRM at the WEC. In addition to managing the WEC, Prof. Babaqi teaches chemistry at the faculty of Science. He is also managing editor of the Sana'a University Journal of Science and Technology publication. Prof. Babaqi serves in several committees at Sana'a University and outside, and has attended many national and international meetings.

Dr. Huibers has many years of teaching and research experience at the department of Irrigation and Water Engineering of the Wageningen University. Dr. Huibers is the co-director of the Nuffic project and leads the supporting consortium. Dr. Huibers has supervised many MSc graduate students, and worked in many subjects and countries. His current research topic is on the use of wastewater in agriculture, especially under water scarce conditions.

Dr. Soppe is the project coordinator and advisor to the Water and Environment staff. He has several years of teaching experience at different universities (University of California - Davis; California State University – Fresno; Wageningen University and Research Centre), and in development and implementation of short courses. He recently joined the company WaterWatch, Wageningen, The Netherlands, specializing in regional and basin integrated water management using interpretation of remote sensing images and an energy balance. In his role as project coordinator, Dr. Soppe is involved in the development and implementation of the IWRM curriculum in cooperation with the staff from the Water and Environment Centre.