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European Networking for Education and Training in Water Engineering and Science:

Use of New Information and Communication Technologies

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Abstract: To face a general and growing worldwide «water crisis», a new paradigm for sustainable water management has been defined. It takes into account not only traditional technical reliability and economic efficiency, but also environmental impacts and social equity. Education, public sensitisation and training are essential instruments to implement this new paradigm for sustainability. After defining the new needs for education in the water sector, networking as a means to promote education and training by UNESCO and the European Union (EU) is reviewed. Activities and achievements of the EU Thematic Network (ETNET) for WATER/ENVIRONMENT are presented and details given of two specific pilot projects using new Information and Communication Technologies (ICTs), namely TEST-EAU and TEST-EAU Pro.

Key words: water management, sustainability, education, training, public sensitisation, new technologies

1. INTRODUCTION

Education and human capacity building have been recognised as the most significant factors for sustainable socio-economic development. At the Rio World Summit in 1992, a special role was assigned to education and training between the instruments for implementing the various items of the Action Plan, known as Agenda 21. More specifically the task was defined as "to promote education, public sensitisation and training". In this context three main objectives were set. Firstly to redirect education towards sustainable development. Secondly to raise public awareness regarding the interaction between human activities and the environment, and finally to promote vocational education and training in order to ensure that every citizen can find a job and thus actively participate in social activities.

These objectives are equally valid for education and training in the water sector. A general and growing worldwide «water crisis» is particularly serious in some areas, such as the Mediterranean, which has been affected by droughts and reduction of renewable water resources as a result of a possible climate change. This is not simply a quantitative crisis, even though several countries are reaching the limits of their resources, but also a qualitative crisis due to pollution of water resources, all aspects having institutional and social repercussions. According to the World Bank, 40% of the world's population already faces chronic water shortages. It is estimated that about 1 billion people are without drinking water and many more do not have direct access to water supply. Additionally water is becoming increasingly polluted in many parts of the world. Fewer sources of clean water are available and the cost of developing new sources of water is going to increase tremendously. It is estimated that about 10 million people die annually from diseases related to dirty water.

To face the global water crisis, a different philosophy has emerged in water related professions, aiming to take into account not only technical and economic reliability, but also environmental risks and social equity. The formulation of new methodologies integrating technical, economic,

environmental and social issues is a challenge towards a new paradigm for sustainable water management.

The importance of water education and training for sustainable water management was emphasized during the 2nd World Water Forum, held in The Hague in March 2000. As a result, UNESCO and other international organisations (UNDP, World Bank Institute, UNU/INWEH, IHE-Delft) developed a strategy paper named "WET Water – Education - Training: Towards a strategy on human capacity building for integrated water resources management and service delivery." The main objectives of this initiative were (1) to create collaborative clusters in order to implement innovative education and training programmes, (2) to review best practices and institutional arrangements for WET and (3) to articulate the needs for WET (demand) and the means to satisfy the needs (supply).

Networking as a means of promoting water education and training is an idea that has also been used by UNESCO in its Chair and university partnership programme called UNITWIN. This programme supports regional collaborative structures of higher education institutions, in order to exchange experience and knowledge and implement solutions in different areas, including the sustainable use of water. The water related network INWEB (International Network of Water-Environment Centres for the Balkans), connecting 10 partners from universities and water agencies from all the Balkan countries, was recently created as a UNESCO UNITWIN network. INWEB is coordinated by the author of this paper as UNESCO chair-holder at the Aristotle University of Thessaloniki.

The European Union has also been very active in promoting education and training at European scale. In 1996 the European Commission – Directorate for Education and Culture launched the Thematic Network Projects (TNPs), which continue to date. Under the SOCRATES/ERASMUS programme, the objective of the TNPs was to create European collaborative networks around different disciplines in order to test new methods for education and training and to link academic institutions to professional activities through specific projects. Between 1996 and 1999 the European Thematic Network (ETNET) for WATER/ENVIRONMENT successfully developed four specific projects. ETNET - ENVIRONMENT/WATER, known since 2000 as ETNET 21 for ENVIRONMENT/WATER, is now a network of more than 100 European universities and other institutions focusing mainly on the relation between the learning process and research and technological developments.

After reviewing the new needs in water related education, this paper briefly describes some of the most important achievements of this European network and presents two pilot projects that have been initiated through this network.

2. NEW NEEDS FOR EDUCATION IN THE WATER SECTOR

Traditional water related disciplines and professions have mainly a scientific and technical background. When examining the current developments in these various disciplines, it is clearly widely accepted that water resources management in the information society has become a complex technico-social process. Issues of technical and economic reliability cannot be separated from concern for environmental protection and social equity. From a scientific and engineering point of view, the apparent changes in the criteria to be considered and the methodologies to be used in water resources management may indicate a shift to a new scientific and professional paradigm, a term explained by T. Kuhn (1962).

In recent years special attention has been paid to institutional and social approaches in water resources management (Ganoulis et al., 1996). The institutional or administrative framework may be perceived as being the set of state owned agencies or private enterprises dealing with production, distribution and treatment of water.

Of particular importance is their scale of operation (local, regional or state), their degree of autonomy from the central administrative body, and the involvement of different water stakeholders in the decision making process. The administrative systems and water laws and regulations,

together with social perception on the use of water and traditions involved, make the issue of water resources management very complex. From the perspective of the engineering profession, the challenge mainly concerns aspects of methodology.. To develop an integrated methodology it is necessary to define a new conceptual framework or in other words, to shift to a new scientific paradigm (Ganoulis, 2001; 1994).

Markets in the water - environment- sector are growing fast all over the world. In Europe, it is estimated that for water services alone (water supply and sewage collection and treatment), the market counts for approximately 14 billion Euros per year. For the period 1990-1994 the European Commission reported a 4% growth in water related jobs. This figure is variable among the member states of the European Union.

In France for example, the job creation potential of the water industry is encouraging. Of the 280,000 environment-sector jobs identified by the IFEN Institute in 1997, water offered the most openings, 26% (95,000) of the total (Maincent, 1998).

In the water sector more than anywhere else, supply and demand are often out of balance. There is no standard educational pathway into the industry. Prospective employees must study either chemistry, or the environment, or biology, or development, because water is not a simple commodity; managing it involves a range of different skills and professional qualifications, as can be seen from the range of jobs on offer in water resources development in general.

Another mismatch is how high people scale the educational ladder. Companies are currently looking for technicians and field operators rather than overspecialised graduates, a fact not fully realised by students. Companies may react in one of two ways - they may prefer people with general qualifications, or specialists. Schools and colleges must respond to or even anticipate corporate needs, without falling into extremes of specialisation or all-embracing general syllabuses. With the globalisation of economic activities companies prefer evidence of an international profile, and an ability to adapt to other cultures and languages.

Together with the development of economic activities, professional needs are changing and require particular efforts to be made in education and training. Because the current educational system cannot cope with new professional demands, the gap between the professional training system and actual current professional needs is widening.

This gap may be reduced by the acquisition of new skills and new knowledge through extensive use of new Information and Communication Technologies (ICTs). In today's world, the use of new ICTs for education and training, such as networking and distance learning is an emerging challenge and a new opportunity (Van de Beken et al., 1999). ETNET for ENVIRONMENT/WATER has investigated this idea in several pilot projects, two of which were funded by the European Union and are presented below.

3. ACHIEVEMENTS OF ETNET FOR ENVIRONMENT - WATER

During its first phase 1996-1999 the ETNET for ENVIRONMENT/WATER developed the following four specific projects:

(1) *Continuing Education and Training for Professional Developments*
(2) *The European Postgraduate Degrees in Hydrology and Water Management*
(3) *Open Distance Learning (ODL) for Water, and*
(4) *A European Paradigm for Integrated Water Management*

In defining the contents of this new paradigm (Ganoulis, 2001), the author, who also was the co-ordinator of this project, benefited greatly from the experience and views expressed by many colleagues participating in the network.

Since 2000, ETNET has developed five Specific Projects *(SPs)*. The three "vertical activities" are:

SP-I: Teaching Resources
SP-II: Distance Learning Opportunities

SP-III: Virtual Laboratories
The two "horizontal" activities are:
SP-IV: European Platform for Doctoral Students and Young Scientists
SP-V: Quality Assessment, Dissemination and Sustainability

The overall objective of ETNET 21 is to create new opportunities in order to link education, research and professional developments in the water sector.

4. EXAMPLES OF PILOT PROJECTS

New ICTs have been used in two pilot projects promoted by ETNET for ENVIRONMENT-WATER and funded by the EU. The first project, entitled TEST-EAU aims to evaluate and validate the basic knowledge on environment / water that any responsible European citizen should have. The second project, namely TEST-EAU Pro, deals with more specialised professional knowledge and skills. Several case studies from particular water related situations were developed.

In TEST-EAU questions are structured in three different modules of tests (qualitative, quantitative and reflection), which are available on the Internet. The questions are about environmental issues and conflicts arising from interactions between man, water, and ecosystems. In order to stimulate further reading, questions are presented positively, providing an explanation of the context for any specific question, an on-line glossary, correction of wrong answers and links to other web sites in order to obtain more information. The general structure of TEST-EAU is shown in Fig. 1.

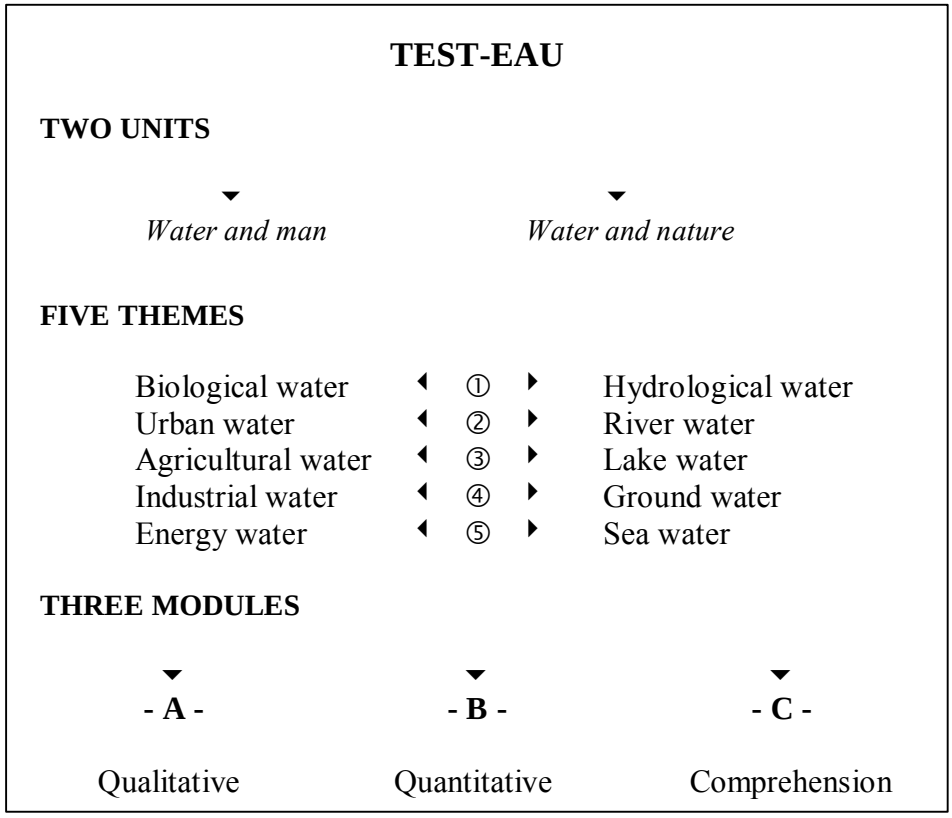

Figure 1. General structure of TEST-EAU.

Each of the three modules (qualitative, quantitative and reflection/comprehension), consists of two units:

- Water and Man and
- Water and Nature

For each unit there are five themes (Fig.1) namely
- biological, urban, agricultural, industrial and energy water for unit 1 and
- hydrological, river, lake, sea and ground water for unit 2

Questions are designed to demonstrate personal skills while avoiding duplication. They are progressive, interactive and user friendly.

4.1 Target groups

Potential users of the test include the following
- Professional associations in water distribution and wastewater collection
- Local authorities and companies in water supply and wastewater treatment
- Associations for environmental protection
- Students and teachers in secondary education
- Adults in professional training

4.2 Type of questions

The following types of questions are included in the tests
- MCQ: Multiple choice questions
- True or false
- Target objects on images
- Drag and drop
- Fill in blank spaces

The description of different case studies and related questions were developed in TEST-EAU Pro.

For every test, a set of questions is randomly selected from a large database, located on different servers (three-tier architecture, suitable for multilingual applications). Instead of scrolling the screen, questions are presented on an intuitive graphic interface containing navigation buttons, multimedia presentations, a glossary, and links to other web sites.

In order to target different groups of users, the contents of the tests are structured at three different levels: 1) elementary, 2) intermediate and 3) advanced.

4.3 Software and interaction

«TEST-EAU» is cross-platform independent and may run in any computer system that can support a fourth generation Web-Browser such as Intel/Win95-Intel/WinNT running Netscape's Communicator >= 4.0 or MS IE. >= 4.0, and all Unix systems supported by Netscape i.e. Unix, HP-UX, AIX, Sun Solaris, SunOs, Intel/Linux and last but not least Macintosh Power Pc/68k).

Different programming languages such as:
- Microsoft Visual Basic
- HTML, Dynamic HTML
- C++
- Java 1.1

were used at different stages of development of the system, and a combination of HTML, JavaScript and Java was finally adopted. If we define as a client the PC or terminal used for testing, TEST-EAU and TEST-EAU Pro are based on the new model of a thin client. This means that the software is located mainly on the server and is downloaded interactively any time the test is taken (Fig.2).

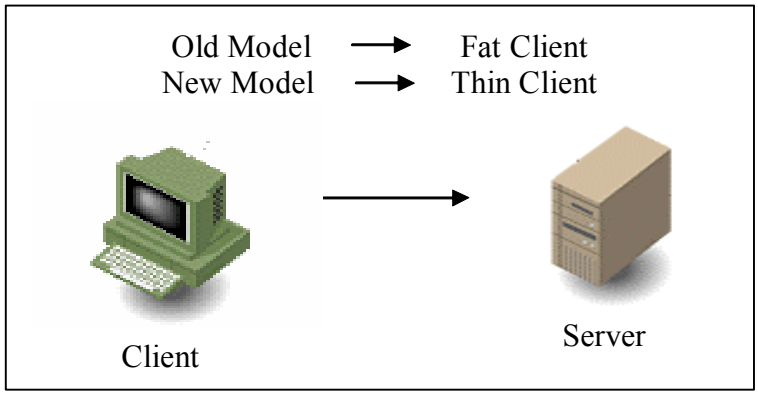

Figure 2. Client-server interaction.

4.4 Client and server models

The main characteristics of a fat or thin client model may be summarised as follows:
Fat Client
- Native application is developed on the client machine.
- Different versions should be provided for different clients.
- Distributing and maintenance problems.

Thin Client
- Client application is common for all different computing platforms.
- Application runs across networks.
- Distribution and maintenance is very easy (central to the server).

The thin client model has been adopted for TEST-EAU and TEST-EAU Pro.

4.5 Client - server communication

The server side software has the following characteristics
- A Java daemon (Test-Eau daemon) communicates with the RDBMS Data Base.
- Three-Tier Architecture is used. (Figure 3).
- Java is great for communication with Data Bases with the use of JDBC (natively or via ODBC)
- Data Base connectivity is transparent for the programmer.
- The server side can be easily ported to different architectures (Unix, WinNT).

Since the communication uses TCP/IP, TEST-EAU and TEST-EAU Pro can be deployed over LANs or the Internet.

New information and communication technologies may be used to improve education and training in water resources management. Acquisition of new knowledge and the development of new professional skills may be enhanced by means of tests and validation modules available on the Internet.

5. CONCLUSIONS

Integrating environmental and social issues into the engineering water management indicates a shift to a new scientific paradigm for sustainability. Effective networking for water education and training is a strategic instrument to promote and implement sustainable water management. UNESCO and the EU have already adopted networking for education, public sensitisation and training in water.

Examples are:

- INWEB: International Network of Water-Environment Centres for the Balkans (UNESCO UNITWIN and Chair)
- ETNET for ENVIRONMENT-WATER: European Thematic Network

The importance of using new ICTs in education and training is demonstrated by two EU funded pilot projects, called TEST-EAU and TEST-EAU Pro.

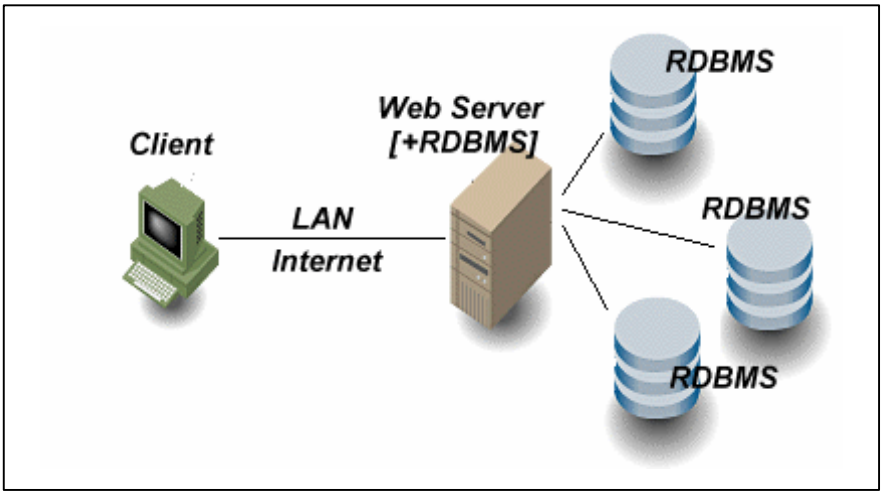

Figure 3. Internet structure of TEST-EAU.

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