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PEOPLE-CENTRED APPROACHES TO WATER AND ENVIRONMENTAL SANITATION

Multimedia e-Learning on technologies for efficient water use

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One of the Millennium Development Goals is "To ensure environmental sustainability", with a special task dedicated to halve by 2015 the proportion of people without sustainable access to safe drinking water. This task collides with alarming studies that, for instance, foresee an acute water shortage in India and other Asian countries by 2050. In this conflicting context we present ED-WAVE, a developing project funded by the Asia-Link Programme, participating six countries (India, Sri Lanka, Thailand, Greece, Spain and Finland). Its goal is to create a sustainable international cooperation framework and to develop a multimedia tool for e-Learning on technologies for conservation, reclamation and reuse of natural resources. We therefore use IT tools aimed at improving people's education, including analysis of current water use status in Asia and Europe, review of potential technological interventions, simulation of impacts of specific technology interventions and translation of knowledge into electronic teaching material.

Introduction

Rising population, rapid urbanisation, growing industrialisation and expanding agriculture combined with contamination from untreated sewage and industrial effluents has severely stressed both water quality and availability in several Asian countries. For instance, India is predicted to face an acute water shortage by 2050. The situation is further compounded by a serious pollution threat from grossly inadequate sewage treatment capacity that is only 10% of the wastewater being generated presently (Pachauri and Batra, 2001). The situation is similarly worrying in other Asian countries such as Sri Lanka (UNEP, 2001) or Thailand (ONEP, 2001). Further, limited or non-existent industrial effluent treatment, particularly in small and medium scale enterprises as well as excessive use of fertilisers and pesticides in agriculture has contributed to severe water quality deterioration. Particularly vulnerable are ecologically fragile and sensitive areas especially those located in the proximity of tourist and heritage sites. Thus in view of rising demand coupled with shrinking freshwater resources, water conservation, recycle and reuse assumes enhanced significance.

The situation in Europe is equally alarming with nearly one-fifth of the river basins already experiencing severe water stress. This figure is estimated to increase to one-third by 2070, with climate change also contributing to reduced water availability in south-eastern Europe (CESR, undated). In particular, two of the partner countries viz. Spain and Greece are already categorised as high water stress areas (Angelakis, 1995).

Helping through education

Several colleges and universities in the target countries offer graduate programmes (mainly Masters degree) in environmental engineering, management or science in general. However, the curriculum is typically academic and is not geared towards real-life applications. Within the workforce, there is insufficient awareness among most industries, technical service providers and environment practitioners regarding the range of wastewater treatment options that can be adopted and tailored to suit a given enterprise. In developing countries, technology is often imported but rarely adapted to suit local conditions. Further, the focus is on hardware ignoring factors like skills and training. In view of the alarming water situation, it is imperative to incorporate training on water-use efficiency as a part of the existing curriculum, particularly using examples from real life situations. This will provide better preparation to understand and appreciate opportunities for adopting technological innovations for water reuse applications. In addition, this will improve industry-academia interaction, thereby generating new inputs for practically relevant research.

The specific objectives of the ED-WAVE project (WAVE, undated) are to develop a model for using IT-based tools for e-learning and training on practical measures to mitigate environmental degradation, focusing on water pollution; to promote exchange of knowledge between Asia and EU regarding water treatment technologies, practices and needs; to provide insights into globally relevant research, consequently fostering co-operation among European and Asian higher education institutions; lastly, contribute to the development of appropriate interdisciplinary programmes in the partner institutions in areas of wastewater reclamations and reuse.

The outcome of ED-WAVE will therefore facilitate eventual adoption of measures to mitigate water pollution thereby improving public and ecosystem health. Further, an improved environment will impact positively upon the quality of life of the local communities.

Implementation of the ED-WAVE project

The project is divided into six different tasks, which are briefly described as follows:

Study of water status

This study involves a review of existing water use status and practices in both domestic and industrial sectors. In the latter category, water intensive industries as well as those generating large volumes of wastewater are chosen. This includes industries relevant to the target countries such as pulp and paper mills, food and beverage units including alcohol distilleries, tanneries, textile and garment manufacturing units, rubber and latex products manufacturing units and metal finishing industries. Particular attention is paid to such industrial activities in water scarce areas as well as locations lacking adequate treatment facilities.

The study, covering examples from partners countries, focuses on different aspects such as water consumption patterns, cost of supply water, water sources and discharge routes, wastewater treatment practices, cost of effluent treatment and discharge, quality profile of water and wastewater, growth in demand trends, existing legislation on wastewater reclamation and reuse and wastewater reclamation and reuse applications including reuse of domestic wastewater for agricultural purposes.

Evaluation of treatment technologies

This second activity involves review of potential technological interventions leading to improved water efficiency through conservation, reclamation and reuse. The technologies covered broadly fall into two categories:

- High-tech technologies: more appropriate for developed countries or large scale industries. Such technologies include activated sludge systems by themselves or combined with coagulation or filtration, membrane bioreactors and membrane processes (microfiltration, ultrafiltration and nanofiltration).
- Low-tech technologies: more appropriate for developing countries or rural communities, as well as small and medium scale enterprises. These include aerobic and facultative ponds, anaerobic bioreactors, constructed wetlands, intermittent sand filters or a combination of low-level treatment with subsurface irrigation.

Mapping the technology options onto the water needs in the selected sectors, different aspects have been examined, such as scope for improving existing treatment technologies, including possible process simplification; long-term operation characteristics in terms of throughput and treated water quality, system reliability and cost effectiveness of the proposed technologies; potential for introducing state-of-the-art treatment technologies; identification of the barriers and constraints in the adoption of options for water reclamation and reuse; effect of reclaimed wastewater quality standards on the required treatment schemes and local priorities and preferences including acceptance of recovered wastewater.

Process modelling

This activity covers the simulation of impacts of specific technology interventions on water use; modelling the effect of a particular technology and its operating conditions on parameters such as throughput, quality characteristics and energy use; optimisation of flowsheet, location and flow of recycle streams and operation economics; simulation of options for water reuse to create closed loops in the selected processes; determination of process sensitivities and predicting the effect of intervention on a whole system and development of operating strategies.

Visualization

A key aspect in this educational project is the visualization of all the processes, to ensure a correct understanding. This includes visualising the raw data from previous activities, creating virtual scenarios and allowing the user to see the impact of specific technology interventions. Another important educational feature is to allow the user to select a combination of operating parameters for any given process and then observe the simulated outcome.

Integration of course contents

The following specific courses will be fully completed once the project is finished:

- Technologies for efficient water use
- Modelling and visualisation of water treatment processes
- Efficient water and energy use in pulp and paper industry
- Computer graphics and new technologies in environment education.

Training

Training workshops will be held in multiple locations. The training will be aimed at professionals from educational and research institutions, environmental practitioners, technical service providers, potential end users from various industries and municipal bodies, local governments, environmental agencies and policy makers responsible for technical education and e-Learning.

The ED-WAVE tool

The ED-WAVE tool for e-learning consists of four modules (see figure 1):

- Reference Tool (RT): provides the detailed information about the selected wastewater treatment technologies.

- Case Study Manager (CSM): maintains and manages a database from the various real-world cases.
- Treatment Adviser (TA): it is an expert system that generates optimal treatment sequences to tackle any given wastewater situation, based on analyzing the information stored on the CSM database.
- Process Builder (PB): lets the user build custom treatment sequences. It also visualizes the sequences obtained by the TA expert system.

Conclusions and results

A multidisciplinary international consortium has been formed, made up by universities and research centers in three Asian countries (India, Thailand and Sri Lanka) and three European countries (Spain, Greece and Finland). The combined efforts of all the partners aim at reducing and /or preventing water stress both in Asia and Europe, specially in the least developed Asian countries, by developing a multimedia e-learning tool to help educate people at all levels. Extensions to other areas (such as Africa) would be straightforward given the general approach of the project.

The study of water use status has been completed, compiling data for different sector such as distilleries, pulp and paper mills, tanneries, municipal wastewater treatment plants, rubber and latex, textile and garment and metal finishing industry. Each sector covers details of the background, process scheme, wastewater generation and characteristics, wastewater treatment and environmental norms. The study also provides standards and legislation from international, European and local sources for wastewater discharge and reuse with respect to municipal wastewater.

Together with the general study, a detailed evaluation of different treatment technologies has been carried out. This evaluation has identified twenty-one different wastewater treatment technologies, grouped in five types: pre-treatment (screening and grit removal), primary treatment (sedimentation, coagulation, flocculation, septic tank and imhoff tank), secondary treatment (activated sludge, trickling filter, anaerobic lagoons, aerobic lagoons, facultative lagoons, rotating biological contactor, intermittent sand filters and constructed wetlands), advanced treatment (membrane filtration, membrane bioreactors, activated carbon adsorption) and disinfection (chlorination and ultra-violet treatment).

The project is currently in its final dissemination phase. The next page contains several pictures of the results obtained this far. Photograph 1 shows a screenshot of the actual ED-WAVE tool. Photographs 2 through 5 show several frames of the multimedia, interactive animations developed for the tool, using 3D and 2D technologies, as well as code scripting and data visualization techniques.

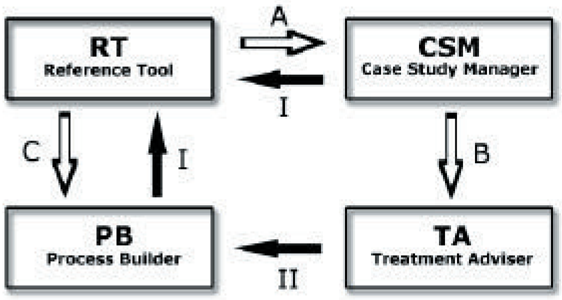


Figure 1. Structure of the ED-WAVE tool

***White arrows*: user interaction**

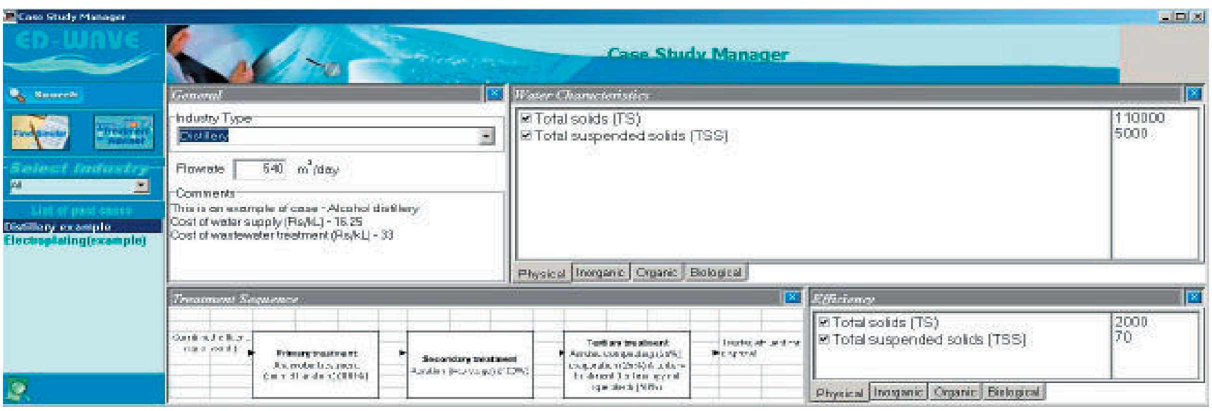
A. study real-world cases of wastewater treatment;
B. real-world cases not applicable;
C. build a scheme from scratch

***Black arrows*: internal tool communication**

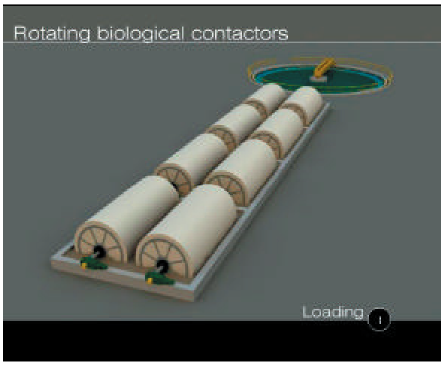
I. request for detailed information on selected technology;
II. generated sequences export

References

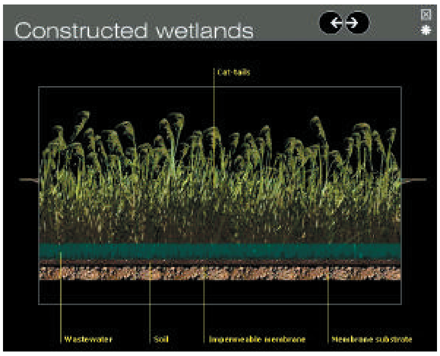
Angelakis, A. and Diamadopoulos E. (1995). Water Science and Technology. 32, 9-10, 267-272.



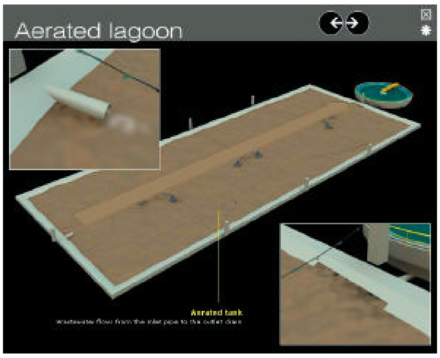
Photograph 1. Screenshot of the ED-WAVE tool



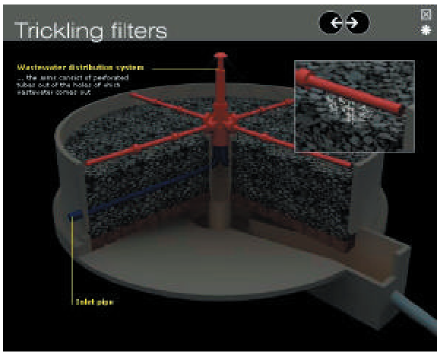
Photograph 2. Rotating biological contactors



Photograph 3. Constructed wetlands



Photograph 4. Aerated lagoon



Photograph 5. Trickling filters

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ED-WAVE: Education Tool for Training on Technologies for Efficient Water Use Using Virtual Application Sites (www.ed-wave.org)

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