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Collaborative Engineering and Hydroinformatics: The Hydroasia Experience

COLLABORATIVE ENGINEERING AND HYDROINFORMATICS: THE HYDROASIA EXPERIENCE

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ABSTRACT

The HydroAsia program is jointly developed by EuroAquae consortium, Tropical Marine Science Institute Singapore, Incheon University, DPRI-Kyoto University, Beijing University of Technology and Asian Institute of Technology. HydroAsia is dedicated to the students involved in several master degrees specialized on the water management and the hydro-technologies. Following the HydroEurope example [www.hydroeurope.org], the objectives of HydroAsia is to promote, in a global vision, the key concepts, the methodologies, the tools and the good practices which are today essential for a sustainable water management. Modern Information and Communication Technology (ICT) offers today the opportunity to explore and to promote a new dimension in the engineering activity: the collaborative work of team-partners residing at different locations and working at different time using the Internet as common working and communication platform. The HydroAsia is focused on a real case study – urban flooding - based in Incheon, Korea and is promoting the use of a collaborative platform where the most advanced modelling technology is made available for all participants [www.hydroasia.org].

Keywords: collaborative engineering, hydroinformatics, modelling, ICT, training, Asia.

1. INTRODUCTION

Modern Information and Communication Technology (ICT) offers today the opportunity to explore and to promote a new dimension in the engineering activity: the collaborative work of team-partners residing at different locations and working at different time using the Internet as common working and communication platform (Gourbesville, 2004 & 2006). Collaboration in this environment demands for new skills and a new "technological culture" to be generated just by doing. This is a worldwide challenge where in future experts and engineers from different countries with different languages, different mentalities as well as different specialization and professional experience have to collaborate in research, teaching and practice.

To promote the methods and the tools of the collaborative engineering in the hydroinformatics field, it is essential to implement this approach in the educational and

training processes (Gourbesville, 2006). Several successful experiences have been initiated during the last years and one of the most significant is Hydro-Web run by the Brandenburgische Technische Universität in Cottbus [http://www.hydro-web.org] since 1999. Since 2002, a new project called HydroEurope - an Intensive Programme within the Socrates/Erasmus framework [http://europa.eu.int/comm/education/programmes/socrates] of the European Commission - has been initiated by the University of Nice - Sophia Antipolis (France) with six partners:

- Brandenburgische Technische Universität Cottbus - BTUC (Germany),
- Budapest University of Technology and Economics - BUME (Hungary),
- Universitat Politècnica de Catalunya - UPC (Spain),
- Newcastle University – NU (United Kingdom)
- Ecole Polytechnique Federale de Lausanne - EPFL (Switzerland)
- Vrije Universiteit Brussel - VUB (Belgium).

HydroEurope [http://www.hydroeurope.org] is following the way opened by Hydro-Web and is dedicated to the students involved in 7 master courses specialized on hydroinformatics, water management and hydro-technologies. This activity is now a compulsory part of the different curricula and is associated to credits (ECTS) (Gourbesville, 2006). The EuroAquae consortium [http://www.euroaquae.org] is developing and supporting this action with the vision to promote additional regional partnerships in order to create a global worldwide network.

Following this first successful program, a group of five Asian institution in partnership with the HydroEurope institutiosn have decided to initiate the development of HydroAsia in 2006. The participating institutions are:

- Tropical Marine Science Institute / National University of Singapore (Singapore)
- University of Incheon (Korea)
- Water Resources Research Center - DPRI, Kyoto University (Japan)
- Beijing University of Technology (China)
- Asian Institute of Technology (Thailand)

As for HydroEurope, the objectives of HydroAsia are to promote, in a global vision, the key concepts, the methodologies, the tools and the good practices which are today essential for a sustainable water management. The use of hydroinformatics methods and tools allows today, to improve significantly the technical diagnostic and the management strategies. However, performances and limits of tools have to be understood by the engineers in charge of the projects. Today, the problems related to water are more and more complex and must be analyzed in a global way and with the right tools. The sophistication of the situations imposes to reconsider the way of working: new practices, new tools, new technologies, new ways of collaboration.

2. HYDROASIA ORGANISATION

The objectives of HydroAsia are to promote trough the collaborative work and, in a global European vision, the key concepts, the methodologies, the tools and the good practices which are today essential for modelling activities dedicated to a sustainable water management. The application of the concepts and the tools is made through a case study: the flood management in the Incheon Gyo watershed located in the center of Incheon city, Korea.

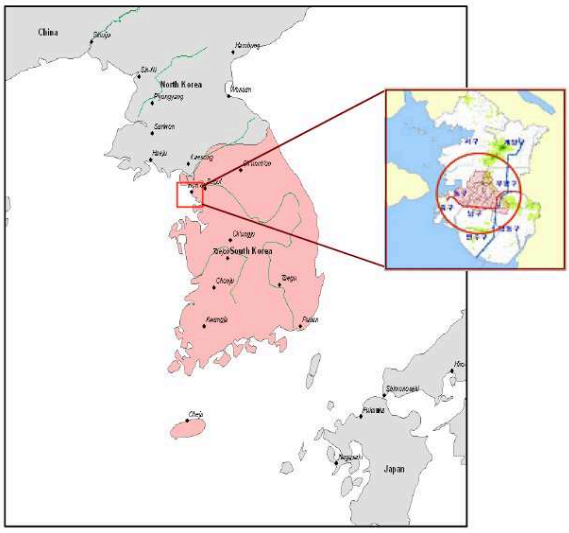

Figure 1: Location of the Incheon Gyo watershed.

This example allows the participants to realize a collaborative work during 2 months and to have the opportunity to conclude this collaboration with a face-to-face period of a weeks in Incheon. The participants are distributed in several international teams - 5 teams in 2008 - which gather people from the different participating locations. During the two first months, the teams have to produce a hydrological analysis for an extreme event, the flood of August 1997 which has induced major flooding and damages. To achieve this task, the participants have to collaborate together to define a methodology for this analysis and for the hydraulic modelling of the drainage network system.

The face-to-face period – a weeks in Incheon in August - is used to finalize the results, to discuss the validation of the models, to compare the quality and the limits of the chosen methodologies and the proposed solutions. Moreover, the participants have the opportunity to complete the engineering dimension with the social demand of the public and the decisions makers in several presentations and meetings.

HydroAsia's approach is dedicated to promote good practices in modelling activities, and oriented to the paradigm proposed in 2003 by Cunge (Cunge, 2003 & Guinot, 2003) where the modelling process is defined as 3 stages: instantiation, validation and exploitation runs. The specific case used for HydroAsia by the complexity of the involved processes – runoff, flooding, drainage system, … - and the uncertainty associated to the majority of the available data (rainfalls, water levels, discharges) is a perfect example to underline the necessity to proceed with a critical and comparative analysis in the modelling activities.

3. THE COURSE PROJECT

The study case is a based on the situation of the Incheon Gyo watershed and on the recurrent flooding problems observed in the urbanized area. The project is focused on a flood analysis an don the definition of potential engineer solutions in order to avoid major flooding in case of heavy rainfall events.

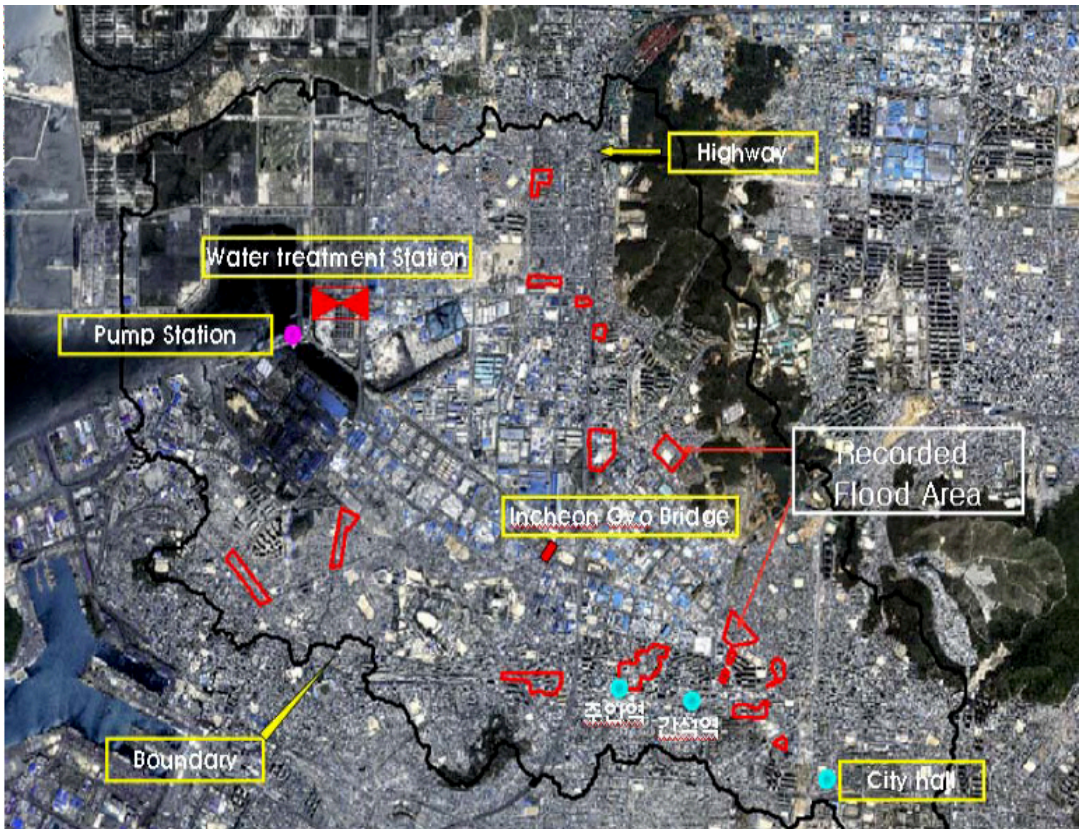

Figure 2: Incheon Gyo watershed drainage network system.

Incheon Gyo watershed has an area of 34km², with a length of 8km. Elevation of the Incheon Gyo watershed which is linked with Yellow Sea through two retention ponds, is varying from 6 m to 5.4 m. The slope of Incheon Gyo watershed is very mild (S = 0.01%) and the drainage is slow. The land use of the watershed is almost an urbanized area including a reclamation region. So, this watershed has a 81.4% of impervious surface and the drainage network system is complex and not well organized.

Due to the big tidal variation – about 9 meters – in the Yellow sea, the sea water level has an effect on the drainage of the watershed: waters can reach the sea mainly during the low tide. This situation represents a major difficulty during the heavy rainfall events season – mainly August – and could induce some flooding into the city. Incheon Gyo watershed has had a flood for five consecutive years [1997 -2001].

The course project deals with the flood analysis recoded during August 1997 in Incheon Gyo. The goals of the study to realize for each team are the evaluation of the capacity of the existing sewer network system, the analysis of flood and the discussion to solve the problems.

The project has several main tasks (work packages):

- runoff analysis based on rainfall data and DEM analysis;
- simulation of Incheon Gyo watershed for the flood August 1997;
- validation of simulation results by measurement data;
- discuss recommendations for management of Incheon Gyo watershed Discuss alternative solutions for flood prevention in the lower valley of the river;
- project performance in team work based on Web-based Collaborative Engineering;
- reporting of all project work as Web documents.

The data files for the case study are stored in the Data section and are provided to all the teams:

- the watershed is described by a digital elevation model (DEM); Land use and

vegetation for this DEM are given for the different grid sizes;
- data from the flood August 1997, drainage system network data (network, cross sections, weirs, manholes, pipes, boundary conditions) for 1D models like Mouse, Hydroworks, Sobek or Isis as well as guides for flow resistance parameter estimation;
- rainfall data for the flood period;
- spatial distribution of rainfall over the Incheon region;
- discharge and water level data are given for 1997 at the downstream boundary.

4. COLLABORATIVE ENGINEERING ENVIRONMENT

The collaborative approach induces a complete reorganisation of the engineering work. Clearly, the strategy must be based on the project methodology. This choice induces an integration of the different tools used in the project as for the scientific and technical aspects or for the team and budget management in a common environment that is defined as the Collaborative Engineering Environment (CEE). The purpose of HydroAsia following the experience initiated with HydroEurope since 2002, is to offer to the participants to become familiar with this Web based CEE and to learn how to work with. At the same time, the participants ahev the possibility to improve their understanding and practice of some of the main modelling systems issued by the industrial hydroinformatics providers like DHI, HR Wallingford, Deltares, Halcrow.

In the project and as in a classical engineering project, each team composed by "experts" with different competences and skills has to achieve several tasks which can be organised in two different groups:

- technical and scientific tasks applied in engineering for the flood management;
- organisational tasks which are related to team management, reporting and communication ("soft skills").

In this approach, the coordination is an essential point and the purpose of HydroAsia is to realise this action with the communication tools available in a Webbased environment. The collaborative Web platform used for HydroAsia as for HydroEurope has been developed from the Jahia environment [www.jahia.org], open source Java Content Management System. The environment has been developed with the XML approach and architecture, and uses the concepts of Content Management System (CMS): each document, described by metadata, can be dynamically used through the platform. The approach offers the possibility to manage the information without the formal presentation of this information. The information – documents, notes, files, pictures, reports, data files, … - is store in a single database that can be used for the different tasks of engineering and communication.

This environment offers the possibility of each team member to access immediately to the project and to the relevant information. The platform which is more oriented to the document management is completed with standard communication tools such as a specific embedded chat room, Adobe Connect, MSN Live, ICQ or Yahoo Messenger which offer the possibility to the participants to chat with video and sound and, more essential for engineering tasks, to share, remotely, applications and specific modelling systems.

Each team, composed with 6 to 7 participants from different locations, has a workspace where information and documents can be uploaded and shared among the team members and supervisors.

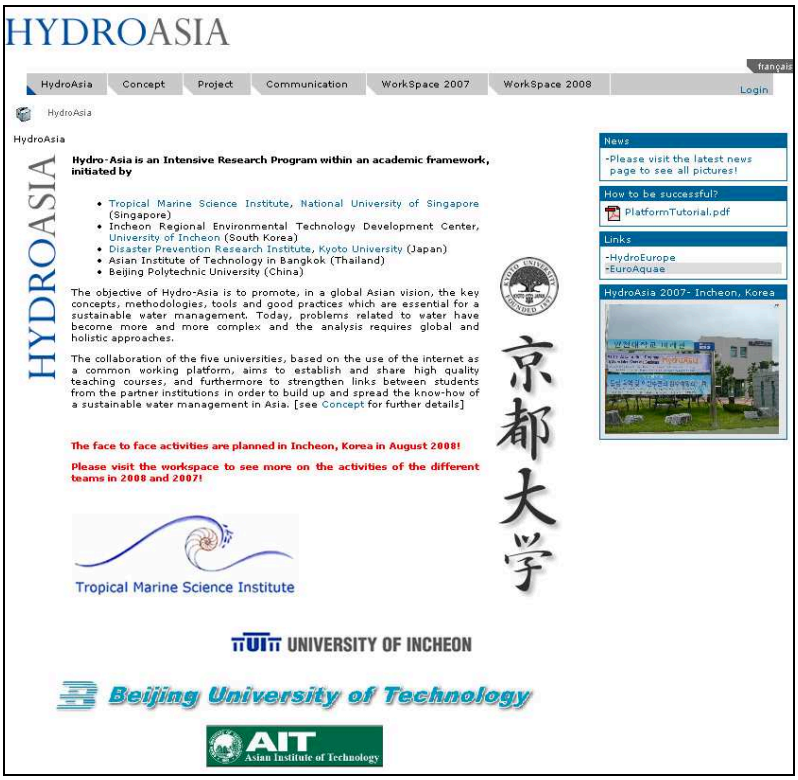

Figure 3: Collaborative platform for HydroAsia [www.hydroasia.org].

Figure 4: Workspace for one of the participating teams.

To extent the functionalities of the platform, an "application server" based on a Windows Server architecture with all the modelling tools – Mike 11, Mike SHE, Hydroworks, ISIS, Sobek… - is available through the Remote Desktop functionality offered by Microsoft Windows protocol or TSWeb. This network computing solution allows to access to all the applications located on a server through the Remote Desktop command or a simple web browser. This last solution offers to all the participants the possibility to access, at any time and from any place, with a simple pc and a standard web browser to the full engineering environment composed with modelling, management and communication tools used for Hydro Europe.

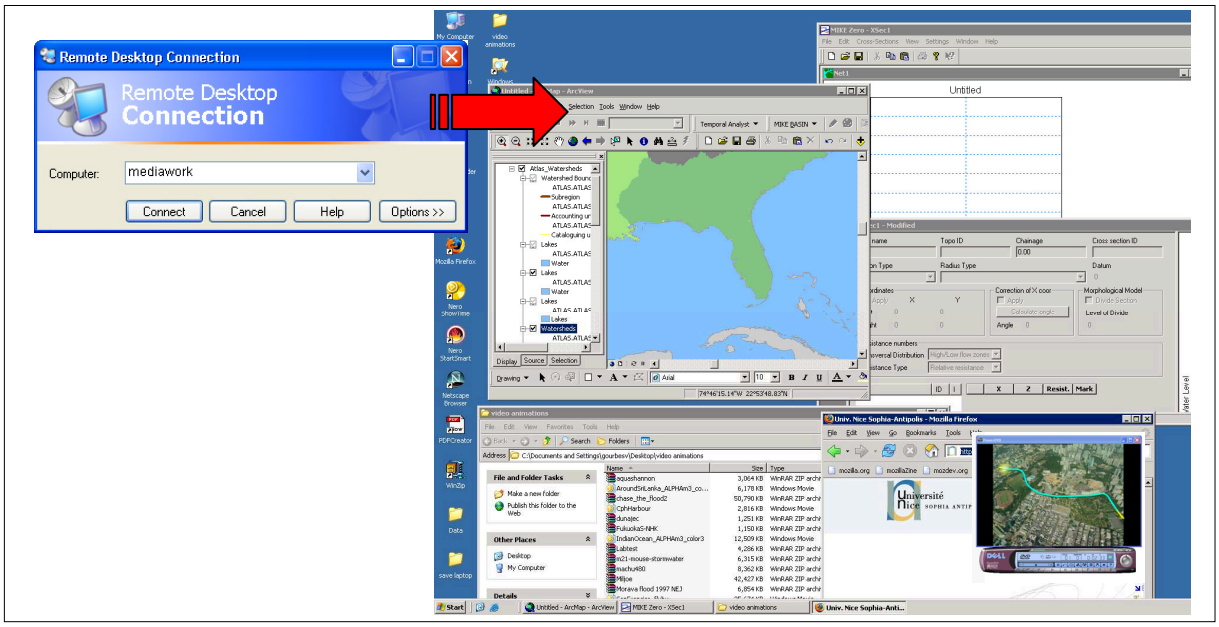

Figure 5: remote session offered to each participant through the Remote Desktop.

5. CONCLUSION

Training of collaborating in such CEE is a challenge that is achieved by the collaboration of the different academic partners in the HydroAsia project. The enthusiasm and the active participation during the last two years – with more than 30 participants each year [visit http://www.hydroasia.org/jahia/page9684_en.htm and the work space of each team] - have demonstrated all the interest and the efficiency of the approach. Moreover, the project contribute to create a community based on the concepts of good practices in hydroinformatics.

The implementation of such project in curricula represents a real challenge but at the same time, is an essential issue for the promotion and the everlastingness of hydroinformatics concepts and methodologies. In another dimension, the development of the functional architecture of the CEE used in HydroAsia as in HydroEurope, must be considered as a first step in the collaborative way for hydroinformatics engineering activities and more generally for the development and the promotion of virtual environments.

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