Introduction of Ven Te Chow Hydrosystems Laboratory at UIUC & Its Integrated River Basin Management Researches

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There has been a proverb, "When a leopard dies, he leaves his skin; a man, his reputation." The name of a laboratory at University of Illinois Urbana-Champaign (UIUC) can be the proverb's existing example, which was named as Ven Te Chow Hydrosystems Laboratory after a professor, Ven Te Chow. He has been a very well-know professor, researcher in the water resources engineering field. He got the degree of doctor at UIUC and had been a professor from 1951 to his death in 1981. All over the world, including Korea, his books such as "Applied Hydrology", "Open Channel Hydraulics", and "Handbook of Applied Hydrology" have been published up to now. He made a great contribution toward recognizing people the importance of water resources and solving various problems in this field. Now, he has been memorized as one of the most famous researchers in the water resources engineering field. Therefore, Department of Civil and Environmental Engineering (DCEE), UIUC has named the building for the Environmental Hydrologic and Hydraulic Engineering Program, Ven Te Chow Hydrosystems Lab as shown in Figure 1, to pay tribute to the memory of him.

Figure 1. Foreground of Ven Te Chow Hydrosystems Laboratory

The writer has been a visiting scholar at this laboratory since on December, 2006. Korea Research Foundation (KRF) has supported living cost and guaranteed my status. This institute has carried out the program that was made to help the researcher who holds a post-doctoral position, go abroad to study. My research topic is sustainable flood management considering integrated water resources operation in the context of river basin management. I had kept in touch with Ximing Cai, a professor of UIUC, in order to visit the laboratory and share information on river basin management. In recent years, he has presented several papers to the international societies concerning sustainable river basin management, interaction between social & economic system and water resources, reservoir optimal operation & decision support system, and so forth. I reviewed several his papers when I fulfilled a research concerning sustainable water resources management in Korea. Before contacting him, I had deep interest in his research. Now, I attribute the motive of communication with him to the internet and electrical

journal system. Here, I will introduce the faculty and facilities of Ven Te Chow Hydrosystems Lab, graduate program, and its researches concerning river basin management, to the members of Korea Water Resources Association (KWRA).

Ven Te Chow Hydrosystems Laboratory Program

Since I arrived here, I have taken classes related to my research, participated into Professor Cai's group meeting and seminar taken place by Professor Garcia, and kept in touch with some researchers related with my research topic. I have entered into the class offered by Prof. Song, Junho. He is the Korean, graduated from Seoul National University, and got the degree of PH. D at University of California at Berkeley. And, I have gotten along with officemates who have various interests and majors. My office member is four, including me: Dr. Greg Wilkerson, Dr. Hajime Naruse, and Dr. Richy Robertson. We have discussed about each other's research topic & major and introduced the country's culture and state of water resources. I heard from them this laboratory state and its related programs. And, I have experienced research activities with them and felt distinctive atmosphere by direct. And, I have seen several facilities and their movement. In this section, at first the Environmental Hydrologic and Hydraulic Engineering (EHHE) graduate program will be introduced and then, faculty and their recent researches. Finally, its facilities will be shown.

EHHE graduate program has been provided for preliminary engineers and researchers, including engineering knowledge concerning planning, design & management of water system, conservation of water resources & river basin, and river restoration and preservation. EHHE graduate program has been based on research area of Hydrosystems Lab: water supply system for municipal, industrial, and agricultural use; flood control and disaster mitigation; flood drainage of urban, highway, airport, and watershed; waste water treatment; use and conservation of surface water and wetland; soil erosion and sediment control; groundwater use, management, and remediation; reservoir and lake operation; hydrologic environment planning and management for climate change and human activity; hydropower generation and tidal & wave power generation; design of coastal structure. Table 1 shows graduate course programs. EHHE graduate program is provided for hydrologic and hydraulic engineers engaged into four areas such as the planning, design, operation, and management of surface & ground water systems, preservation and enhancement of river & watershed environment, design and construction of water control facilities, and conservation of water resources. As shown in Table 1, program courses are directly related to those study areas. Graduate students can choose the course regardless of grade level and the appropriate course in the related area in civil and environmental engineering.

EHHE faculty is composed of eight professors, two affiliated professors, and three emeritus professors. As shown in Table 2 and Figure 2, eight professors have various areas of research interest. As mentioned earlier, Professor Ximig Cai has interest in sustainable river basin management, optimal water resources management, integrated water resources-economic modeling, and so forth. Professor Macelo H. Garcia was the advisor of Professor Choi, S. U. at Yeonsei University. He is in charge of proceeding Environmental Hydrology and Hydraulic Engineering Seminar at UIUC. He has various experiences in the field of river mechanics, sediment transport, sedimentation engineering, and

Table 1. Graduate course programs (Department's homepage)

Intermediate level courses	Advance level courses	Related courses
- Environmental Systems Analysis, I - Surface Hydrology - Environmental Fluid Mechanics - Hydraulic Analysis and Design - Urban Hydrology and Hydraulics - Groundwater - Decision and Risk Analysis - Civil Engineering Special Topics	- Environmental Systems II - Hydroclimatology - Open-Channel Hydraulics - Mixing in Environmental Flows - Sediment Transport - Environmental Hydrology and Hydraulic Engineering Seminar - Environmental Hydrodynamics - Stochastic Analysis of Ground Water Flow and Transport - Stochastic Hydrology-Modeling of Ground-water Flow and Solute transport - Thesis Research - Inviscid Flow - Viscous Flow - Experimental Fluid Mechanics - Turbulence	- Construction Cost Analysis - Solid and Hazardous Waste - Ecological Quality Engineering - Biomonitoring - Environmental Engineering Principles, Physical - Water Quality Engineering - Environmental Engineering Principles, Chemical - Environmental Engineering Principles, Biological - Stream Ecology - Structural Dynamics - Soil Mechanics and Soil Behavior - Applied Soil Mechanics - Computer Methods - Systems Methodology and Network Techniques - Water Quality Control Processes I - Water Quality Control Processes II - Earthquake Engineering - Earth Dams

environmental hydraulics. He have presented papers concerning sediment entrainment from riverbeds, flow and transport in vegetated channels, mechanics of oceanic turbidity currents, and dynamics of mudflows in mountain areas. One of professors in hydraulics, Gary Parker presented three papers concerning geo-morphology on the internationally well-known journals, one paper on "Nature" and two papers on "Science", respectively. Professor Barbara S. Minsker is a woman and has research interests in environmental systems analysis and investigating improved methods for modeling complex environmental systems. And, she has applied machine learning approaches such as genetic algorithms, decision trees, support vector machines, and artificial neural networks, for searching innovative and cost-effective solutions to complex environmental problems.

In the recent, she has studied about the establish-

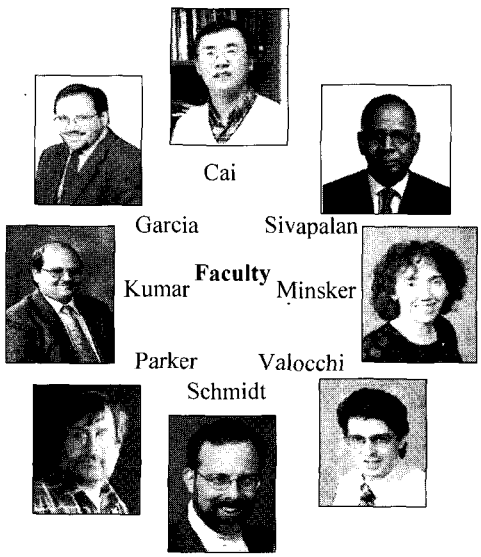

Figure 2. Faculty of EHHE

ment of research community using cyber-infrastructure. Arthur R. Schmidt is one of professors who use hydraulic experimental facilities. He has interest in sur-

Table 2. Each faculty's research interests (Department's homepage)

Name	Position	Research Interests
Ximig Cai	Assistant Professor	River basin planning and management, drought management, international water resources development, integrated water resources-economic modeling, geographic information system and spatial statistics, large-scale system optimization
Marcelo H. Garcia	Chester and Helen Siess Professor	Environmental hydraulics, sediment transport, river mechanics, density currents, turbulent boundary-layer flows, moveable-bed modeling
Praveen Kumar	Associate Professor	Large scale hydrologic process, hydrometeorology and hydro-climatology, multi-scale variability of surface hydrologic processes, wavelet transform
Gary Parker	Professor	River mechanics and morphology, river engineering, mechanics of two phase solid fluid flow, turbidity current, oceanic sedimentation, submarine debris flows
Barbara S. Minsker	Associate Professor	Environmental systems analysis, risk and uncertainty in decision making, machine learning, ground water monitoring and remediation design
Arthur R. Schmidt	Research Assistant Professor	Hydrometry, open channel hydraulics, urban hydrology, risk and reliability analysis for water resources and environmental engineering
Murugesu Sivapalan	Professor	Predictions in ungauged catchments, understanding and interpreting variability of runoff processes and underlying climate-soil-vegetation-topography controls, investigating interactions between runoff processes, and chemical and biological processes
Albert J. Valocchi	Professor	Groundwater hydrology, groundwater contamination, mechanical modeling

face water hydraulics and hydrology, especially improving measurement of flows and its reliability analysis. Professor Albert J. Valocchi has interest in mathematical modeling of pollutant fate and transport in porous media, with applications to groundwater contamination and remediation.

And, he specializes in the development and application of models that couple physical, geochemical, and microbiological processes. Professor Murugesu Sivapalan has several research interests in hydrology, which are focused on space-time variability of runoff process, interactions among climate, soil, vegetation, and topography, chemical & biological processes, and predictions of both water quantity and quality in ungauged watershed. Professor Praveen Kumar has research interests in the areas of hydro-climatology, geomorphology, and hydrologic information systems. Especially, He has studied about non-linear interactions among sub-processes at large scale.

Facilities of Ven Te Chow Hydrosystems Laboratory

The fundamental research of this Lab involves research into the how and why of hydraulics and hydrology. The Lab has investigated fundamental research topics such as the influence of waves and ripples on object burial and discontinuous density currents. These research results have been applied to applied research, of which the purpose to apply fundamental research to solving real-world problems. The Lab's applied research topics include bank erosion control with bend-way weirs, density currents in the Chicago River, designing safe canoe chutes, and so forth. In order to conduct these experiments, various hydraulic facilities have been installed since in 1970, when the Hydrosystems Laboratory was in service.

The area of this building is approximately 11,000 square feet. The facilities available in the laboratory consist of several flumes, a stratified flow tank, a water

tunnel, and several physical models. The largest tilting flume can be readily adapted to be used as a wave tank and for sediment transport studies. A set of twin volumetric tanks is also available for calibration of flow metering devices. For measurement and data record, there are assortment of current meters, sediment concentration probes, conductivity probes, a laser-based flow visualization system, a high-speed video camera, and so forth. For in-situ data acquisition and analysis, several personal computers and workstations have been installed and operated. And, for accessing to the College of Engineering machine, auxiliary laboratory facilities have been served. These computer systems are connected by a high-speed network to the supercomputers.

Figure 3 and 4 show at this Lab largest tilting flume and physical hydraulic model of the Chicago River, respectively. This tilting flume is 49.0 m long, 1.83 m wide, and 1.22 m deep. The drive system is hydraulic,

Figure 3. Physical model for Chicago River (Lab's homepage)

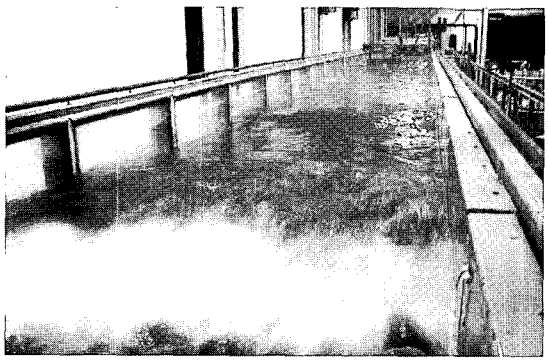

Figure 4. Large Tilting Flume(Lab's homepage)

with a maximum velocity of 2 m/s, a maximum acceleration of 6 m/s2. Chicago River Model, one of physical hydraulic models at this Lab, was built to analyze the occurrence of density currents in the Chicago River. The physical model has a horizontal scale of 1 to 250 and a vertical scale of 1 to 20. This distortion is needed to have measurable flow depths at the laboratory. The lab has done applied research using this model studying density currents in Chicago River.

Research Activity of Professor Cai's Group

Professor Ximing Cai is the Chinese. He received the degrees of B.C. in 1990 and M.S. in 1994 from Tsinghua University, China, respectively. And then, He got the degree of PH.D from University of Texas at Austin in 1999. He has experiences in working at the International Food Policy Research Institute (IFPRI) and the International Water Management Institute (IWMI), 1999 to 2003. He has research interest in large-scale system optimization, river basin planning & management, drought management, water resources economic & policy, geographic information system & spatial statistics, and international water resources development.

He has five students through doctoral course, including Mohamad Hejazi, Dingbao Wang, Jihua Wang, Ethan Yang, and Jiing-Youn, You as shown in Figure 5. They have participated into research activities of Professor Cai, separately. Dingbao has studied about the interaction of human and nature system in a river basin. He has performed a holistic water resources-economic model (HWEM) developed by Cai et al. and published the results in the journal. Figure 6 shows the conceptual configuration of the applied model. This model can be applied to conducting policy analysis:

prediction of economic and environmental consequence to economic incentives; searching a policy suitable for certain environmental conditions. Jiing-Youn has carried out the research projects concerning hedging policy for reservoir operation. He has found appropriate water policy, especially hedging rule, for coping with impacts related with social & economic change, hydrologic circulation change, human activity, and so forth. Mohamad has participated into the research concerning extracting primary variables for establishing reservoir operation rule. He intends to apply decision trees for determining monthly release of single reservoir and multi-reservoir system. Other students have participated into researches concerning river basin management, respectively.

As mentioned earlier, Professor Cai has research interest in water resources operation and management in a river basin. In the recent, he has developed a methodology of water resources management considering water spatial variability of water availability and satisfying human and ecological needs in the context of river basin. He has a plan of applying multiple objective optimization method to compromise the conflicts related to water resources use. In order to simulate hydrologic cycle, including water quantity and quality, several models are to be employed for

Figure 5. Members of Professor Cai's group

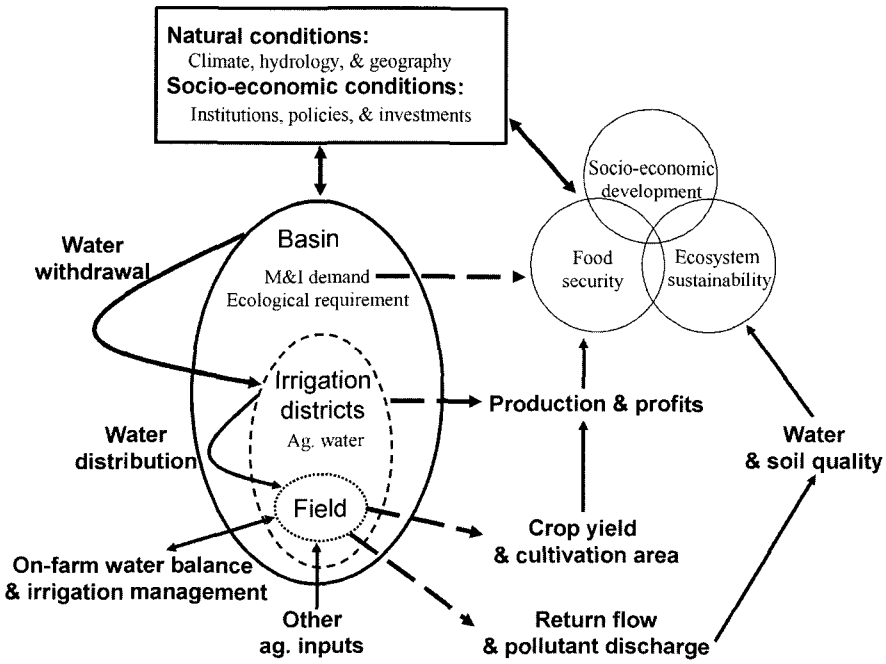

Figure 6. Configuration of water allocation processes and economic-environmental consequences (Cai and Wang, 2006)

the river basin. Finally, he intends to integrate these models and apply to decision making for river basin management. Professor Cai has also studied about water policy for sustainable water resource management. He participated into the researches for establishing the framework for sustainable river basin management. And, he applied a holistic water resources-economic model to policy analysis. In the recent, he has studied about water policies related to BMP, participation of the stakeholders, water availability, and so forth.

My Research Activity at UIUC

In the recent, due to urbanization and climate changes such as greenhouse effects and the El Nino effect, the frequency and magnitude of floods have increased all over the world. Especially, in Korea the loss of hundreds of lives and several billion dollars worth of property resulted from the floods caused by Typhoon Rusa in 2002 and Maemi in 2003. In order to overcome sufferings from water resources, including flood damage, in the recent sustainable river basin management has been attractive and important topic. Since reported in the late of 1980's, the concept of sustainable development has been considered in establishing the strategy of territory development. Sustainable development embraces several objective functions such as economical feasibility & efficiency, social acceptance & equality, and environmental soundness & conservation. Based on the concept of sustainable development, one should establish and carry out river basin management and flood protection policies that could be rated by future generations as appropriate.

In general, non-structural measures are known as they are in better agreement with the concept of sustainable development than others. These methods are more reversible, commonly acceptable, and environment-friendly. Area prone to flood is difficult to reach to the level of flood safety by structural means only. The measures for watershed or river basin are to be employed by consideration of its situation and characteristics. Site-specific measure, combination of structural and non-structural measures, is considered to be more proper solution. As shown in Figure 7, human activity links structural and non-structural measures and enhance the efficiency of measures. These measures include watershed & river basin management, laws & regulation, economic incentive, flood forecast-warning system, flood risk assessment, flood-related data management, and so forth.

It is needed to establish flood management strategy in a river basin in order to protect human and property from flood efficiently and effectively. It is to be fulfilled constantly, considering combination of structural and non-structural measure. Therefore, my research includes development of methodology for evaluating sub-basin's safety on flood and state of flood management in a river basin, analysis of effects of alternative flood control facility on flood management, and development of its operation methodology in flood season,

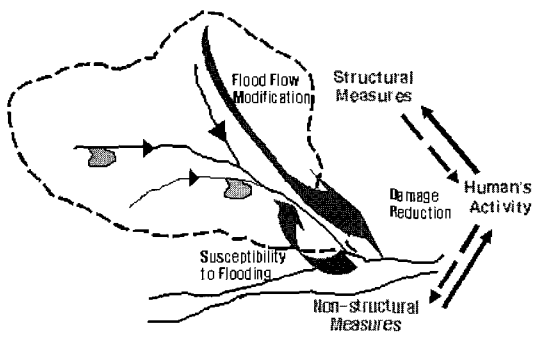

Figure 7. Conceptual configuration of flood management in a river basin

development of non-structural measures for enhancing flood management effectiveness of water resources facilities in a river basin. Finally, my research is oriented toward establishment of flood management strategy in the context of a river basin, including integrated water resource facilities operation and sustainable river basin management.

Hopefully, I expect to have good experience here in studying with internationally well-known experts on river basin management. And, I will introduce my experiences to them and try to gain synergy effects. For the time being, I will keep in touch with the members of KWRA and my colleagues at UIUC. When I go back, I will keep it in mind that I have felt here, and cherish the memory of studying with them.

References

Characklis G. W., Reed P. M., and Minsker B. S., 2007. The role of the system community in the National Science Foundation's environmental observatories, Journal of Water Resources Planning and Management, ASCE, pp. 1-3.

Homepage of Department of Civil & Environmental Engineering, http://cee.engr.uiuc.edu/.

Homepage of Ven Te Chow Hydrosystems Laboratory, http://vtchl.uiuc.edu/.

Ximing Cai and Dingbao Wang, 2006. Calibrating holistic water resources-economic models, Journal of Water Resources Planning and Management, ASCE, pp. 414-423.