

# Proceeding of GWSP Asia Meeting

August 29-31, 2005  
Kyoto, Japan



## PREFACE

Contrast between dry and humid condition/area is clear in Monsoon Asia, therefore the effect of climate change on the water cycle in regional scale is serious problem for the future water issues in Asia, such as shortage of water resources, water quality degradation, water hazard, and so on. Human impact on water cycle in Asia is another huge pressure for water issues because population increase and concentration occurs rapidly in Asian countries.

The Global Water System Project (GWSP) is a newly established joint project of DIVERSITAS, an international programme of biodiversity science, the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme (IHDP) and the World Climate Research Programme (WCRP). These four global change programmes form the Earth System Science Partnership (ESSP). Over the past few decades, environmental science has produced insights into the linkages, interconnections and interdependencies in the global water cycle. The various human and physical, biochemical, and biological facets of the cycle make up the global water system. This is especially true in Asian regions because of huge human impacts.

In this first GWSP-Asia meeting, we try to make a network of water related studies and institutes in Asian countries, and to link the GWSP (Global Water System Project) to develop the understanding and knowledge on future potential human impacts and climate changes effect on water issues in Asia. We discuss new facts, new information, new methodologies, and new trends, related to water issues in Asian countries as well as water conflicts, policy making process, and capacity building in Asia. Hot spots studies are also discussed to demonstrate both impacts of climate change and human activities on water cycle in Asia.

The meeting was held on August 29-31, 2005, at CO-OP In Kyoto, Japan. Throughout the three days discussion at the first GWSP-Asia meeting, we have reached to the following conclusions;

- (1) We recognized the following hot spots study areas in Asia;
  - (a) Effects of dam on water cycle, material cycle, and ecosystem in the basin,
  - (b) Water and biogeochemical flows in the coastal zone with high population, and
  - (c) Effects of land cover/use changes on physical and biogeochemical flows in the monsoon climate, and
- (2) We need common data bases for the hotspot study areas mentioned above and water related issues in Asia, and networks of interdisciplinary water studies of WCRP, IGBP, DIVERSITAS and IHDP, should be made among the Asian research groups to link with GWSP groups, and
- (3) Working groups on hotspot study area will lead to make first version of each database within a year, and a platform should be made soon to exchange information and establish database.

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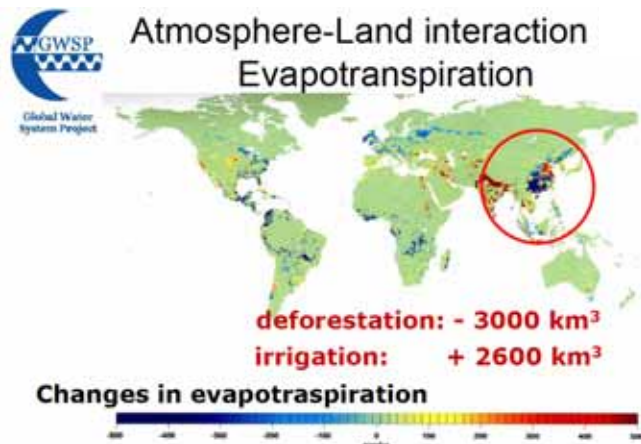
**Database and hotspot studies in Asia**  
**-Magnitude and Mechanisms of Change -**  
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**1. Land –Atmosphere Interactions**

Studies on Land-Atmosphere Interactions have been done in Asian areas under the research frameworks of IGBP (International Geosphere Biosphere Program), GAME/GEWEX, and others. Previous studies on the estimations of evapotranspiration changes due to human activities show that the most increased ET by irrigation and most decreased ET by deforestation were found in Asian areas (Fig. 1, Gordon, 2003).

Establishment of precipitation database in Asian region has been progressed with GAME data. Soil wetness data is compiling with the modeling of land-atmosphere coupling and field observations under the GSWP (Global Soil Wetness Project).

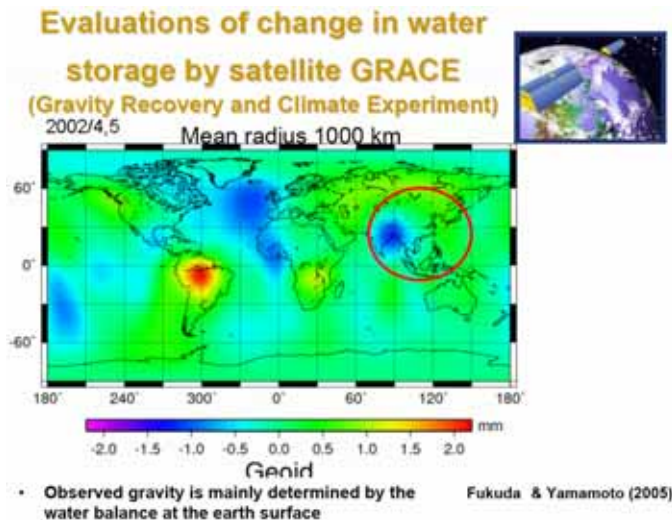
Integrated changes in water storage may be able to evaluate by satellite GRACE (Gravity Recovery and Climate Experiment). Continental water resources play an important role for economical development, as well as for their impacts on climate changes. Unfortunately, no complete global and accurate database of *in situ* measurements of water table variations exists. An alternative to this problem exists if one turns to new satellite data that offer a systematic and global coverage mapping of the Earth's surface properties, such as monitoring of continental water levels of rivers, lakes and flood plains by radar altimetry and detection of water mass storage changes using accurate GRACE (Gravity Recovery and Climate Experiment) gravimetry.



**Fig. 1** Changes in evapotranspiration due to human activities as deforestation and irrigation (Gordon et al., 2003).

Successfully launched in mid-March 2002, the goal of GRACE satellite mission is to measure the spatio-temporal variations of the Earth's gravity field to high accuracy (~1 cm in terms of geoid height) and a spatial resolution of ~200-300 km for a nominal period of five years. For the first time, GRACE provides global monitoring of the tiny time-variations of the gravity field that are due to the redistribution of fluid masses at the surface of the Earth (Fig. 2).

Groundwater depression occurs drastically in many Asian areas including the northern China Plain. GRAPHIC (Groundwater Resources Assessment under the Pressure of Humanity and Climate Change) project (UNESCO, 2005) will evaluate the



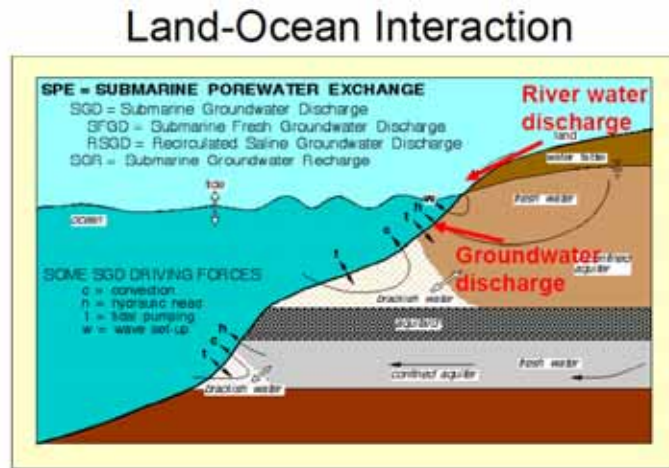
**Fig. 2** Evaluations of change in water storage by satellite GRACE (Yamamoto et al., 2005)

regional/global groundwater issues such as the effects of climate changes and human activities on groundwater. The

structure of the GRAPHIC project has been divided into; (A) Subjects; thematic, cross-region issues (1:Recharge, 2:Discharge, 3:Storage, 4:Quality, 5:Management), (B) Methods; methodological approaches (1:Database and Monitoring, 2:Satellite GRACE (Gravity Recovery and Climate Experiment), 3:Modeling and Simulation, 4:Paleohydrology), and (C) Regions; representative geographical areas, where pilot studies including Asia will be made.

## 2. Land –Ocean Interactions

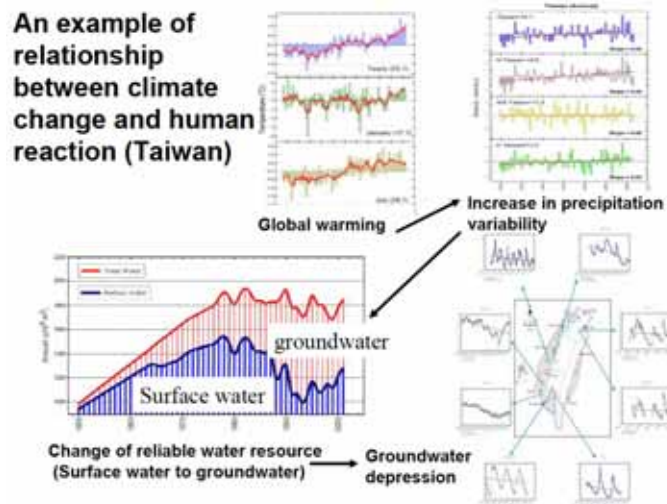
Studies on water related issues in the coastal zone have been done in LOICZ/IGBP, SCOR, IOC/IHP, IAEA and others. River discharge is a major pathway for discharge from land to the ocean in the global water cycle. Rivers are highly visible open channels that discharge water from great distances inland, and their contributions to the oceans are easily quantifiable. Another important source of continental freshwater to the oceans is direct groundwater discharge, which occurs as springs and seeps on continental margins, usually at or below the water surface (Moore, 1996, Burnett et al., 2001, Taniguchi et al., 2002, Fig. 3). Direct groundwater discharge per unit length of coastline could be very significant as a discharge process, because the length of coastline where groundwater discharge occurs is very great, and will occur whether or not rivers are present. Therefore Submarine Groundwater Discharge (SGD) is increasingly recognized as an important pathway for water and dissolved material from the land to the ocean. Integration of the studies on Atmosphere – Land Interactions and Land-Ocean interaction are needed for understanding water cycle in the basins.



**Fig. 3** Water exchange processes near the coastal zone (Taniguchi et al., 2002)

## 3. Water-Human Relationships

Increases in the variation of precipitation due to global warming have caused the changes in reliable water resources (from surface water to groundwater) in some Asian countries. Taiwan is now using more groundwater because of the decrease in reliability using surface water stored behind dams (Fig. 4). This is an example of the water-human relationships under the condition of climate change in Asia. Another example of water –human relationship is a subsidence. Subsidence due to excessive groundwater pumping has occurred repeatedly in large Asian cities after an increase in water resources demand. Changes of water resources from groundwater to surface water supplies have been initiated in many cases, yet subsidence has still not stopped in many areas. This has resulted in a serious danger of flooding in many coastal cities of Asia. On the other hand, although land subsidence in the Tokyo and Osaka areas have ceased due to

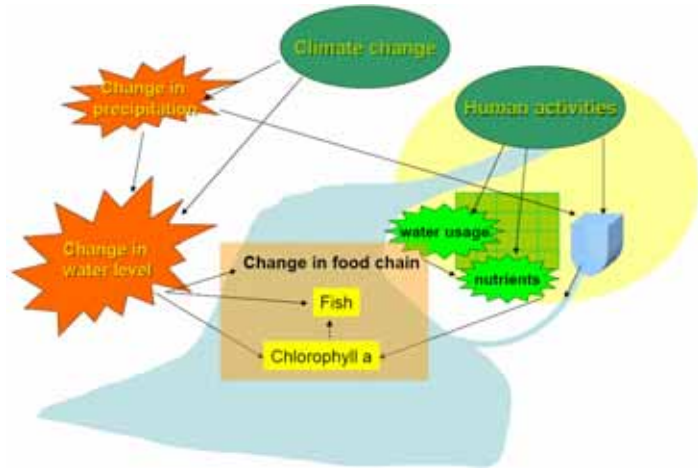


**Fig. 4** Relationship between climate change and subsurface water degradation though human decision (Chung-Ho Wang, 2004, Taniguchi, 2004)

regulation of groundwater pumping, the associated increase in groundwater level has caused new types of damages by buoyant force to the underground infrastructures (e.g., subways) which were constructed during the drawdown period .

#### 4. Water-Ecosystem relationship

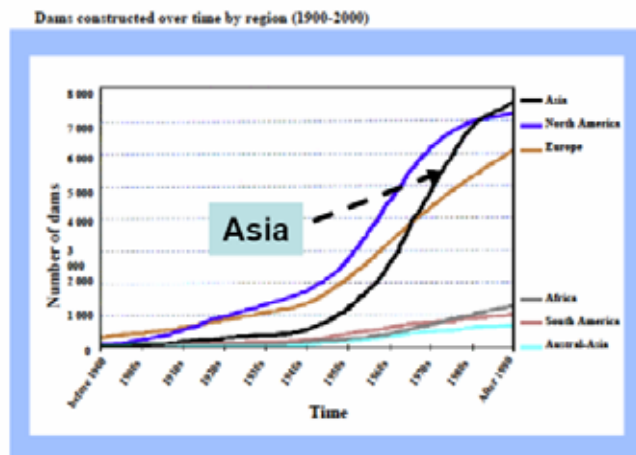
Climate change may alter the precipitation and water level near the wetland, estuary, and coastal zones. Human activity increases nutrient loads to the river and oceans. Both climate change and human activity may cause the change of ecosystem (Fig. 5). For instance, increased nutrient loads to the freshwater bodies by human activities causes eutrophication, red tide and/or algal bloom. Although the processes of changes in relationship between water quantity and water quality are relatively clear, however, the relationship between changes in water quantity/quality and ecosystem is still not clear, and strongly recommended to be studied. This is particularly true in Asia, because huge pressure of increases in population and nutrient loads to the fresh water bodies.



**Fig. 5** Relationship between water and ecosystem under the conditions of climate change and human activities (Kawabata, 2005)

#### Hot spot study areas in Asia

Contrast between dry and humid condition/area is clear in Monsoon Asia, therefore the effect of climate change on the water cycle is serious problem in Asia, such as shortage of water resources, water quality degradation, water hazard, and so on. Human impact on water cycle in Asia is another huge pressure for water issues because population increase and concentration occurs rapidly in Asian countries, in particularly at the coastal zone. Increased population requires the additional water resources and pressure of making dam (Fig. 6). Therefore, the following subjects may be the hotspot study areas in Asia from the point of view of interdisciplinary water studies of WCRP, IGBP, DIVERSITAS and IHDP;



Source: ICOLD, 1998. Note: Information excludes the time-trend of dams in China

**Fig. 6** Change in number of dam

- (a) Effects of dam on water cycle, material cycle and ecosystem in the basin,
- (b) Water and biogeochemical flow in the coastal zone with high population, and
- (c) Effects of land cover/use changes on physical and biogeochemical flow in the monsoon climate.

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**GWSP-ASIA MEETING**  
**Capacity Building and GWSP Policy Linkages**  
Presentation by Eric Craswell on behalf of Felino Lansigan

**Introduction**

The GWSP-Asia meeting should take the initiative to establish a networking of Asian institutes with the aim of pursuing the GWSP agenda in the region. This network (which can be informal initially but can be formalized later on) can focus on at least three aspects, namely: (a) data and information sharing and exchange; (b) capacity building of young scientists in Asia; and (c) science-policy linkage and advocacy.

This meeting provides a forum to discuss and plan out specific activities for capacity development in Asia involving young scientists in the region through advance institutes, training and research workshops as well as curriculum development, and production of innovative teaching materials on global water system science. The meeting can also address the necessary initiatives appropriate for the region to facilitate science-policy dialogues as well as linkages between global water system and local and regional water problems including the issue of water governance.

**Governance of Water Systems**

One of the focus topics for the School of Environmental Science and Management at the University of the Philippines in Los Banos is the classification and comparative analysis of water governance, in relation to impacts on the water system. We recognize especially the importance of resource conflicts in complex environments. Our starting point for understanding and managing water is a framework we developed for linking governance and science issues in water system and coastal areas.

Environments and resource regimes can be divided into three main elements: resources, uses and users. The two situations for each element are single and multiple. The resulting matrix provides a basis for analyzing the complexity of resource regimes. For example, at one end of the scale, 'home lots' represent a single resource with a single use and a single user. On the other hand, foreshores and watersheds represent multiple resources with multiple uses and multiple users. In between these extremes resource regimes such as communal springs and roads are single resources with multiple uses/users. These categories inevitably overlap, as do the conflicts over resource use. In the Philippines environmental and natural resource conflicts include: utilization, tenure and institutional conflicts as well as conflicts due to resource resilience and vulnerability. Referring to the resource regime matrix, the general rule is that conflicts over resources are high in cases where single or multiple resources have multiple uses and/or users. This analysis supports the conclusion that complex environments such as foreshores and watersheds have a high risk of conflicts and should be given priority in government studies and interventions.

The role of good governance to mitigate conflicts in complex resource regimes like coast areas and is shown in Figure 1.

Fig.1 Good Governance to Mitigate Conflicts in Complex ENR Regimes like Coastal Areas

Envl Issues	Tech'l Solutions	Governance Instruments	Governance Issues	Governance Interventions
Illegal Fishing	<i>ICMP</i>	<i>Licensing</i>	Legitimacy of Governance Institutions	"Supply" of & "Demand" for:
Over Fishing	<i>MPAs</i>	<i>Permitting</i>	Public Trust on Governance Institutions	<i>Transparency</i>
Illegal Settlements		<i>Open &amp; Competitive Bidding</i>		<i>Accountability</i>
Crowding	<i>Infra Dsgn</i>	<i>Contracting</i>	Credibility of Governance Institutions	<i>Participatory Decision &amp; Action Processes</i>
Risks and Hazards	<i>Coastal Investment</i>	<i>Investments</i>		<i>Harmonize state &amp; community systems of decision making</i>
		<i>Enforcement</i>		

### Capacity Building and Education

The object of educational efforts should be to promote global water system science in environmental resources management. Potential activities are listed below:

- Advanced research institutes on water system for scientists (with specific region-based case studies)
- Young scientist training-workshops and case studies
- Science-Policy fora on water system
- Global Water System Science in the Curriculum

### Proposed Strategy

To achieve the objectives described above, GWSP should:

- link and collaborate with other GEC projects with interest on Water Governance and Capacity Building, e.g. LOICZ on governance of freshwater and coastal systems.
- initiate a regional GWSP network of researchers (or institutions) with focus on governance, and/or education i.e. GWSP-Asia

## **Human Dimension in Long-term Water Resource Study: Use of “human influenced” scenarios in hydrological modeling**

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### **Introduction:**

Changes in environmental conditions, particularly those that may have significant impact on hydrological regime e.g. climate and land cover change, are driven by human activities. These changes are highly dynamic and can evolve at very fast rate, especially if compare to other factors or variables used in the hydrological study, such as river tributary network, soil property, terrain characteristic, etc. Furthermore, these changes could be, and in most cases are, independent to the past history, therefore, use of historical data analysis to project the future changes may not be appropriate approach or inadequate for the purpose of the study.

As human activity can greatly affect the hydrological regime, thus it has important role in the study of long term changes in surface water. However, to understand or speculate future human activity, which in most cases are driven by socio-economic changes, involve high uncertainty. Therefore, a plausible future, or “scenario”, may have to be imagined to use as foundation in the study of long term water resource study.

Some concerned questions regarding the study of long-term hydrological regime:

- How would climate change, which induced by human activities, affect hydrological regime in the watershed or river basin?
- How would future changes in land use/cover, which induced by socio-economic development activities, affect hydrological regime in the watershed or river basin?

### **Scenario-based study:**

Scenarios are images of the future, or alternative futures. They are neither predictions nor forecasts. Rather, each scenario is one alternative image of how the future might unfold. A set of scenarios assists in the understanding of possible future developments of complex systems. Scenarios help in the assessment of future developments in complex systems that are either inherently unpredictable, or that have high scientific uncertainties.

“Human influenced scenario” or “human driven scenario” in the analysis of long term hydrology study is the storyline about future condition of human activities or socio-economic condition which can be used to generate 2 major scenarios that are the major inputs for hydrological modeling technique - climate change scenario and land use/land cover change scenario. These storylines are descriptions of future condition which are based on a number of factors that are internally consistent and put together according to some scientifically acceptable logics. These scenarios may be considered as ways to describe the ‘Future’ which could be something to compromise between projection and prediction. In order to derive the future climate scenario and future land use/land cover scenario, it may or may not use mathematical models, but mathematical technique usually has more advantage for generating scenarios since it can put together large number of factors and processes in quantitative way.

An example of the use of socio-economic development scenario is the Intergovernmental Panel on Climate Change (IPCC)’s Special Report on Emissions Scenarios that creates number of plausible future which produce different levels of Greenhouse Gas (GHG) and result in different climate change scenarios which can then be used to analyze the future change in hydrological regime of the watershed or river basin. Different future socio-economic scenarios will lead to different future climate conditions (or climate scenarios), which will then be used in the analysis of future changes in hydrological conditions in the region. These scenarios will help in understanding of the range of the changes in hydrological regime of the watersheds. The illustration below shows example of result from hydrological modeling analysis which base on number of climate scenarios.

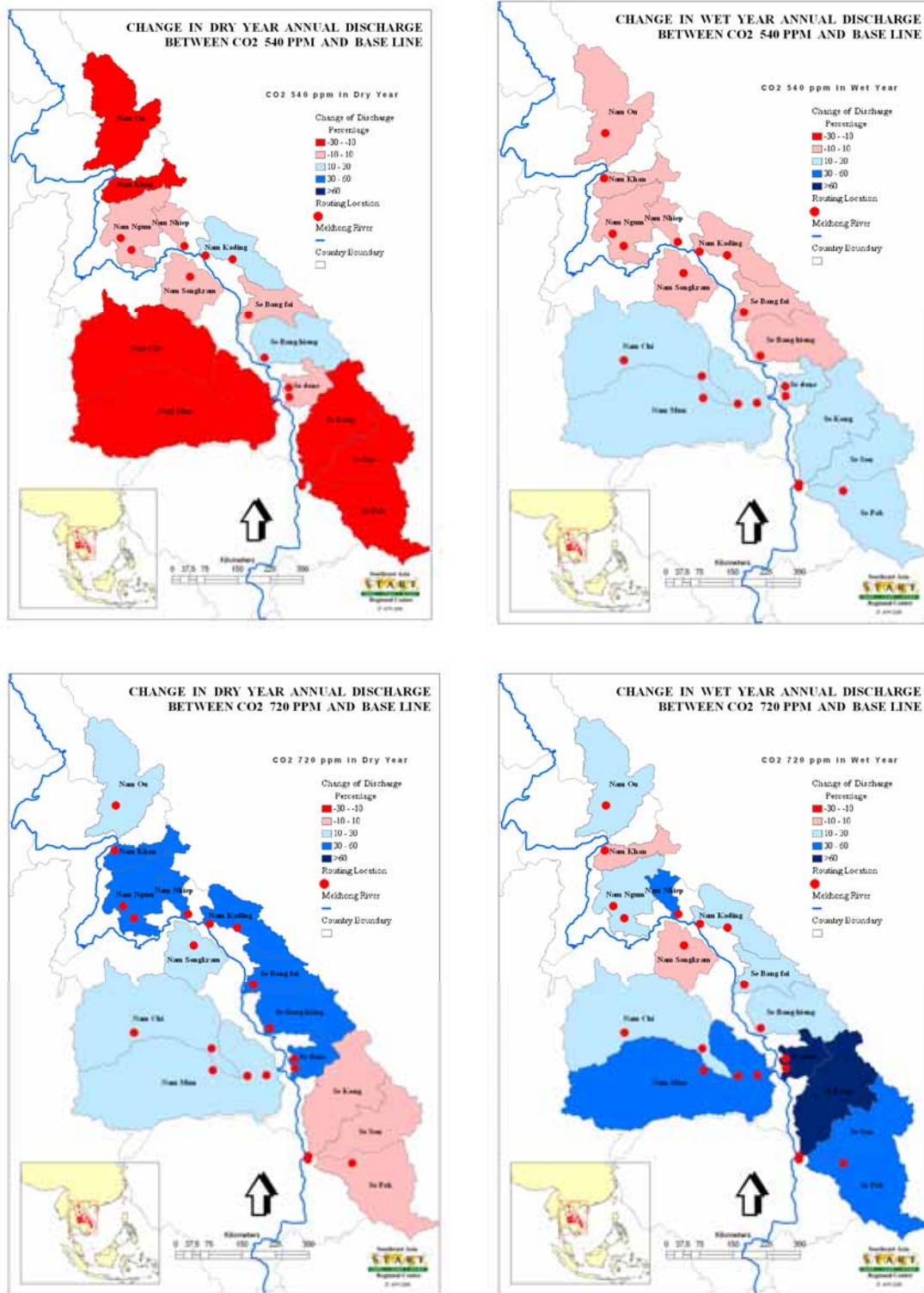


Figure 1: Example of results from hydrological modeling analysis which shows different future discharge of the major sub-basins of Mekong River in Lao PDR and Thailand which is impact of climate change from different climate scenarios.  
 Source: Assessment of Impact and Adaptation to Climate Change (AIACC) - AS07 regional study

In addition to the climate change scenario, another major dynamic factor that will make significant impact on surface water condition is the land cover change, which can be seriously and quickly changed by human activities. The analysis of future land cover change scenario can also be analyzed based on socio-economic change scenario. The example of the following socio-economic development scenario shows different plausible future land cover characteristics. Each socio-economic development direction will cause different change in the pattern of future land use / land cover in the region. The development under “Food Bowl” scheme may result in the land cover that will have lesser tree but more patchy in pattern. However, on the contrary, the development toward the “Agro-Forest” scheme may result in the regional land cover that has more trees but less patchy in pattern, in other words, even though region tends to have more tree but they would be scattered throughout the region. On the other hand, the development toward the “Field and Fallows” will cause the region to have less tree and also less patchy in pattern, while the development under “Parks, Cities and Fields” scheme will result in land cover with more trees and also more patchy in pattern. These socio-economic development scenarios will be foundation for GIS analysis in order to derive future land cover scenarios that can be used as input into hydrological modeling for further analysis.

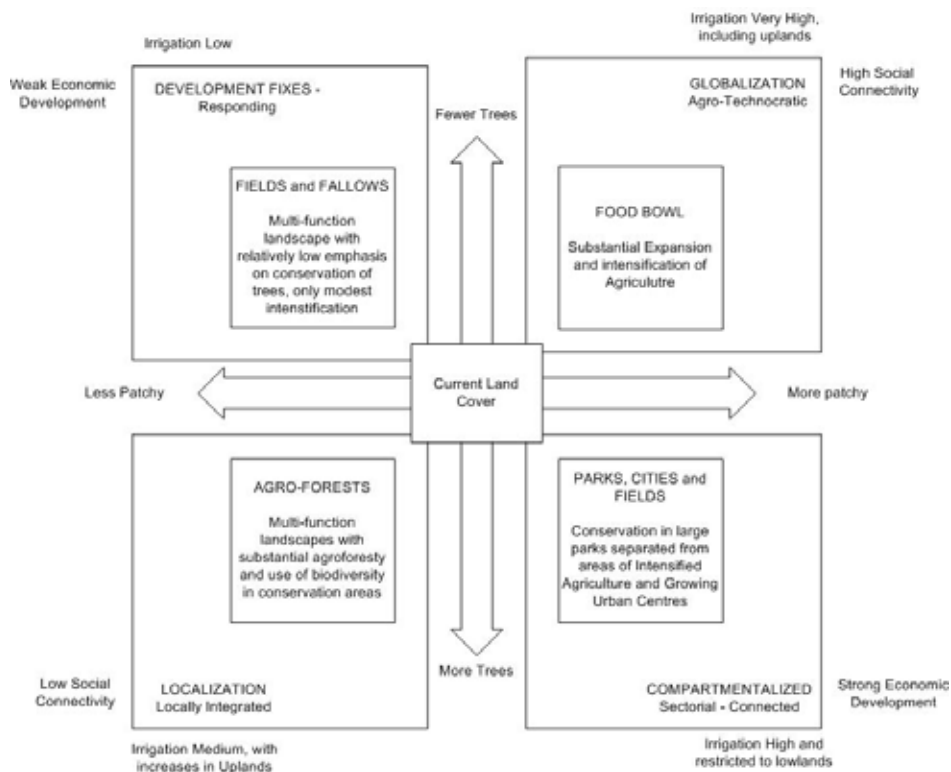


Figure 2: Example of conceptual socio-economic development scenario and its impact on future land cover change, developed by Dr.Louis Lebel, Unit for Social and Environmental Research Chiang Mai University, as part of Assessment of Impact and Adaptation to Climate Change (AIACC) AS07 regional study.

The climate change and land cover change may have significant impact on future hydrological regime. The analysis of future hydrological regime on long term timescale may have to take both land cover change and climate change scenarios into the analysis. The result of the analysis that couples both types of scenario will be series of possible future hydrological regimes of the watershed that shows the range of fluctuation in discharge level. In addition, as there is level on uncertainty associates to the scenario, the use of multiple scenarios is encouraged in order to get a more robust result from the analysis.

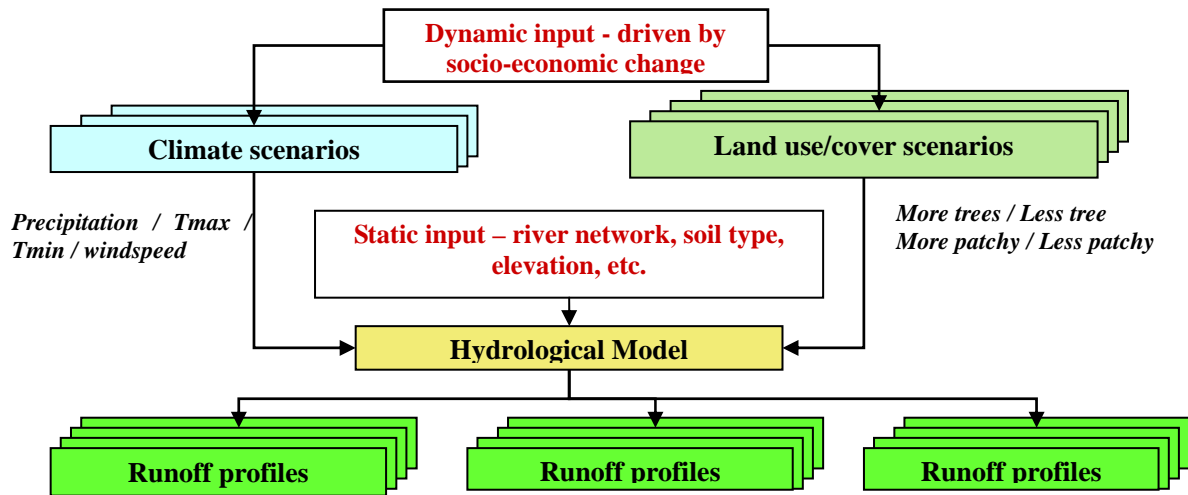


Figure 3: Conceptual framework for long-term hydrological change study, which based on human driven scenarios.

Lastly, human dimension in water resource study is not only taken as cause of future changes in hydrological regime, but more importantly, how the future society may be affected by such change.

Water demand can also be generated based on the socio-economic development scenarios in order to use as base for vulnerability and adaptation assessment on future changes. Series of future possible water management policy can then be developed upon this assessment on multiple scenarios.

Summary: Needs for collaboration

The study of long term change in hydrological regime would require collaboration due to the following reasons:

- This study will be an integrated study which will be multi-disciplinary in nature, therefore, would need collaboration from natural or physical scientist to collaborate with social scientist in the study.
- This approach of study could involve a lot of work, therefore, collaboration among groups of researcher may be required in the following areas:
  - Share effort in the development of multiple scenarios in order to come up with robust analysis result. Each research team may develop different set scenarios and share the developed scenarios for further analysis by each team.
  - Share effort in analysis because the combination of scenarios in the analysis will result in series of analysis, which may require large research capacity. In addition, the study may also need multiple tools, which each research group may have special expertise in, to test scenarios and to come up with more robust analysis result. Joint analysis effort may also bring better analysis result as different data set can be used in the analysis and the result can be compared at the regional level.
- Many changes may occur or have effect at regional scale; therefore, collaboration from each country in the region may be required in the contributing of input to the scenario development process in order to come up with a feasible and realistic scenario.

## **GWSP-related Activities in Japan**

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### **1. Organizations relevant to GWSP activities in Japan**

There are a number of relevant organizations and networks that are engaged in GWSP-related activities in Japan, among which the representative ones are as follows:

- Research Institute for Humanity and Nature (RIHN), Ministry of Education, Culture, Sports, Science and Technology (MEXT)
- University of Tokyo
  - Institute of Industrial Sciences (IIS)
  - Center for Climate System Research (CCSR), etc.
- University of Kyoto
  - Disaster Prevention Research Institute, etc.
- University of Nagoya
  - Hydrospheric Atmospheric Research Center (HyARC), etc.
- University of Yamanashi
  - 21st Century Center of Excellence (COE) for Research and Education on Integrated River Basin Management in Asian Monsoon region
- Universities of Tsukuba, Tohoku, Hokkaido, Kyushu and many others
- Public Works Research Institute (PWRI)
- National Institute for Environmental Studies (NIES)
- Council for Science and Technology Policy, Cabinet Office
  - Water Cycle Initiative

### **2. Networks relevant to GWSP activities in Japan**

There are a number of research networks that are relevant to GWSP activities. One is a permanent governmental type, another is a research project based and the other is of research society.

#### **2.1 Science Council of Japan**

Within Science Council of Japan, Japan National Committee for GWSP is formed. The current chair is Dr. Makoto Taniguchi of RIHN.

- Japan Council of Sciences, Liaison Committee on PWSP (Chair being Makoto Taniguchi)

#### **2.2 Networks of funded research projects**

The other group of networks are of the research projects that are active while the research funds are available. The representative ones are as follows:

- Council for Science and Technology Policy, Cabinet Office -Water Cycle Initiative
- Core Research for Environmental Science and Technology (CREST), JST – Changes in Global Water Cycle
  - Under this initiative, there are more than 20 research projects are formed and several hundreds researchers are organized. the chair is Dr. Katumi Musiaka of Fukushima University.

The other funding sources include:

- Special Coordination Funds for Promoting Science and Technology, MEXT
  - Ex) Mekong River Ecological Monitoring (MeREM)
- Research Revolution 2002 (RR2002) Human, Nature and the Earth Coexistence Project, MEXT
  - Seven projects relating to climate and water resources prediction are on the way.
  - Ex) Model development for estimating water resources change due to human and natural modification in the Asian Monsoon Region
- Post-GAME (GEWEX Asian Monsoon Experiment) including CEOP (Coordinated Enhanced Observation Period)

The original GAME successfully ended in May 2005 and its follow-up project with new

objectives including CEOP is planned and widely supported to official endorsement by GEWEX SSG. Its name is still under discussion.

- Japan PUB (Predictions in Ungaged Basins)  
International Association of Hydrological Sciences (IAHS) initiated this research as a policy relevant science driven project of hydrology for 2003-2012 decadal focus of the association.
- GEOSS (Global Earth Observation System of Systems)  
13 GEOSS research projects are underway.

### 3. GWSP-related High Priority Research Areas in Japan

As a country of disasters and highly industrialized and urbanized society, the following are examples of GWSP-related priority areas in Japan.

- Integrated Water Management
  - Flood & sediment management, disaster mitigation
  - Water supply, drought, water quality management
  - Groundwater conservation
  - Human impacts on regional water circulation
  - Impact of man-made/natural lakes on water and nutrient circulation, Dam options and other alternative means
- Climate modelling, Climate change impacts on river runoff
- Conservation of biodiversity and natural environment
- Hydrological function of paddy fields
- Sustainable forest management, function of forests
- Database Establishment (Climate, hydro, land/water use, eco-system)

### 4. Some remarks to the implementation of GWSP

- There are many individual researchers engaged in GWSP-related agenda in Japan in addition to organizations mentioned above. The inclusion of those independent researchers, especially in the fields of social sciences and ecology is important.
- Capacity building dimension needs to be highlighted by the GWSP planning. It is science driven and unavoidably centered in developed countries. But if science is not carried out together with researchers in developing countries, it just help broadening the science divide rather than closing it.
- Japanese research funds have strong emphases on predictions and managerial solutions but rather weak in identifying the background nature of problems where research should start.
- GWSP is science-driven but not directly policy relevant to providing solutions which may encounter difficulties when proposing research funds.
- Japanese WCRP and IGBP related activities have very weak linkage with Biodiversity and Human Dimension researchers. Major efforts are necessary to include those researchers and organizations and their networks. There has been lack of communication and understanding so that the tradition has to start from the basis. In this sense, it is necessary to establish a common inter-disciplinary basis of work sharing and evaluation.
- Thus GWSP is very important in Japanese science.

## **Report from Chinese National Committee for ESSP GWSP (CNCGWSP)**

Changming Liu (Chinese Academy of Science)

The CNCGWSP has been established since last November in 2004. This was noticed during first GWSP SSC meeting held at Bonn in February 2005. Also the CNCGWSP, information set up in the GWSP's website. CNCGWSP is under leadership of Profs Liu, Xia and Wu has taken active part in the GWSP organized activities since then.

1. Selection of CNCGWSP members of 30 from various institution in China;  
The first CNCGWSP meeting was held in Beijing (Meeting place: Institute of Geographical Sciences & Natural Resources Research, Chinese Academy of Science, Anwai, Datun Road, No.11A, 100101) on August 4 and Dr. Charles Vorosmarty was invited to meeting with his presentation about ESSP GWSP ideas, which was very helpful to the participants of the CNCGWSP. Beijing, China A meeting agenda is as follows:

Title 1: Introduction of GWSP & related activities

Major Speakers: Prof. Changming Liu: Welcome Address

Prof. Charles J. Vörösmarty: GWSP Introduction

Title 2: Activities of the Chinese National Committee of GWSP

Major Speakers Prof. Shuhua Liu: on Atmosphere

Prof. Jun Xia: on Water Cycle

Prof. Renhua Zhang: on Ecology

Title 3: Discussion on cooperation issues on GWSO, IGOW

2. As a representative of CNCGWSP, Professor Changming Liu attended the meeting of GWSP Asia and GWSP SSC meeting at Kyoto on 29 August – 3 September 2005.
3. The CNCGWSP jointly with organized one day session with IAMS Conference held on August 3. There were 30 presentations dealt with water cycle and water resources.
4. The CNCGWSP had a discussions with Dr. Charles J. Vörösmarty about interaction and cooperation between China and US and worked out preliminary suggestions as follows:

The Chinese and United States National Committees (CNC and USNC, respectively) for the GWSP agree to begin work on a joint intercomparison project involving large and diverse drainage basins and/or geographically contiguous regions across both North America and Eastern Asia. The goals for these joint studies are to:

- (1) Create integrated, high resolution, geospatial data sets depicting the key physical, biogeochemical, biodiversity, socio-economic elements of each target basin, and that have analogues at the global scale; include both historical and to the degree possible operational (near real-time) observational products
- (2) Perform a series of intercomparison & validation exercises with both the regional and global data sets
- (3) Identify gaps in understanding, opportunities for developing new joint data sets, and develop a design strategy regional water system monitoring systems (reported to GEOSS and NCHS-Observatories)
- (4) Design first generation of linked regional models, integrated multiple-scale hydrological modeling approaches and apply to decade-scale forecasts of water system state to mid-century
- (5) Begin formulating regional-scale "lessons-learned" drawing-out the interdisciplinary linkages apparent in each application domain
- (6) Host a four-week summer exchange program at the Chinese Academy of Sciences (Beijing) and at the National Center for Hydrologic Synthesis (University of California, Berkeley) for

PhD students and post-doctoral fellows participating in this project

The CNC and USNC agree to begin these joint activities on a series five (5) candidate basins on each continent, each in spatial extent from 100,000 to 300,000 km<sup>2</sup>. ). Each has major and unique combinations of climate and direct human impacts that define the character of regional water supply, water quality, interactions with human systems, and stress on natural ecosystems.

The Chinese basins are provisionally identified to include:

- HaiHe River Basin and Northern China Plain in semi humid & semi-arid region(300,000 km<sup>2</sup>; severe water stress. groundwater depletion and pollution)
- Heihe River in arid & semi-arid region (130,000 km<sup>2</sup>; western inland basin with oasis and GW depletion)
- Northern reaches of the Huanghe (Yellow) (portion of 800,000 km<sup>2</sup>; strong climate gradients, regional drought, oversubscription of water demand)
- Poyang Lake Basin in humid region (300,000 km<sup>2</sup>, representing 5 tributaries of the Yangtze w/major water quality problems)
- Songhua River (556,800km<sup>2</sup>; humid region with rapid climate change enabling recent agricultural expansion).

Now the CNCGWSP is taking active part in GWSP related research proposals regarding GWSP Asia with Japan RIHN (Dr. Makoto Taniguchi) and other project such as Twinning Basins from Europe.( Claudia Pahl-Wostl). Also possible cooperation with Australia (Professor Frank Larkins, Deputy Vice-Chancellor (Research), the University of Melbourne).

## Past and Current Research on Water with Human Dimension in Thailand

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### **Abstract:**

Human impact on water cycle has been a rather rapidly related issues in Thailand while water related assessment in this decade did turn us into new facts, trends, methodologies and information. International collaboration diversified us from empirical methodology to spot on policy making, capacity building, conflict management in water cycle and etc.,

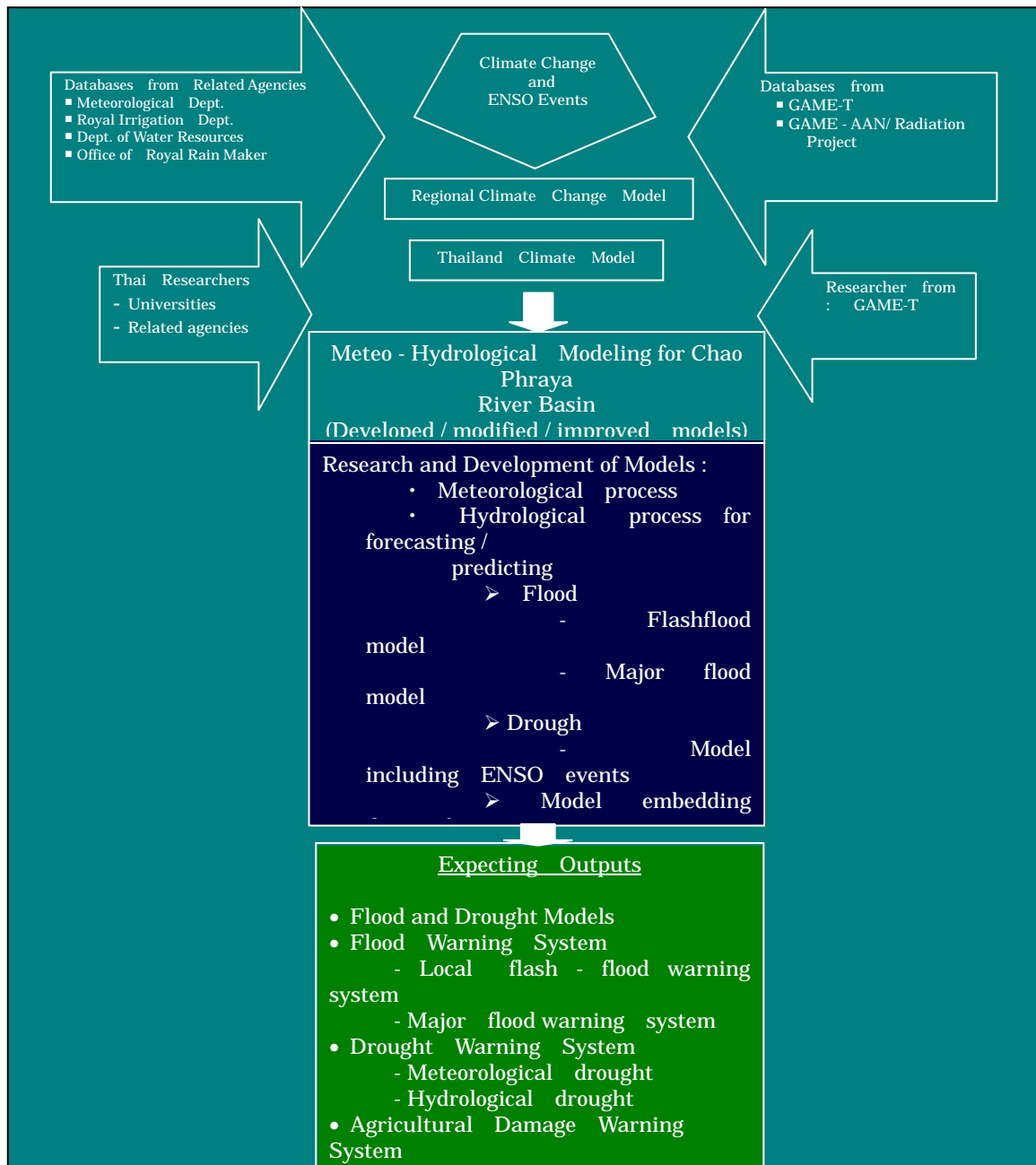
Though Thailand has many sectors dealing with water resource data base, except continuous genuine adroitness on research and development to systematically discipline water usage confliction and relieve regional flood and drought disasters which directly effected to human society and natural environment. Faculty of Engineering, Kasetsart University has been national historical leading reputed in environmental water resource especially on research and development project since 1954. Besides, Our institute has been long supported and organized many national projects on resource management, we have been strengthening our water concern community concurred into Hydro-informatics membrane system since 1995 through GEWEX/GAME-T/GAME-Chaophraya project which encouraged our alliance to energetic activate on several hydroinformatics sytem, satellite assessment, fresh water biodiversity and etc. In acadamic point of view, obvious aspects in Thailand are challenged with genuine dicision supporting system not only for water governance and adaptive capability but also magnitude and machanisium alteration.

Water membrane system in Thailand suppose to do more and more essential in exposer, sensitivity, resilience, vulnerability on water management and scenario prediction that effected to ecosystem and human dimension.

Keywords: GEWEX/GAME-T/GAME-Chaophraya, POST-GAME, TJ-HIEC

## Past and current researches:

Mentally faith, the technical cooperation is a rather essential bilateral directness to reach multiplication intention among Asian society. Since 1995, Thai environmental water researchers have been supported and encouraged from GEWEX/GAME-T/GAME-Chaophraya project and did succeed a plenty of assessment, policy and governance as shown in figure 1.



For post process among environment water scientists, leading Thai researchers from universities and institutes would propose to more innovative communication system to virtually genuine water related membrane system in order to combine principle and actual assessment together with methodology and scenario prediction that might effect to ecosystem and human dimension as shown in figure 2

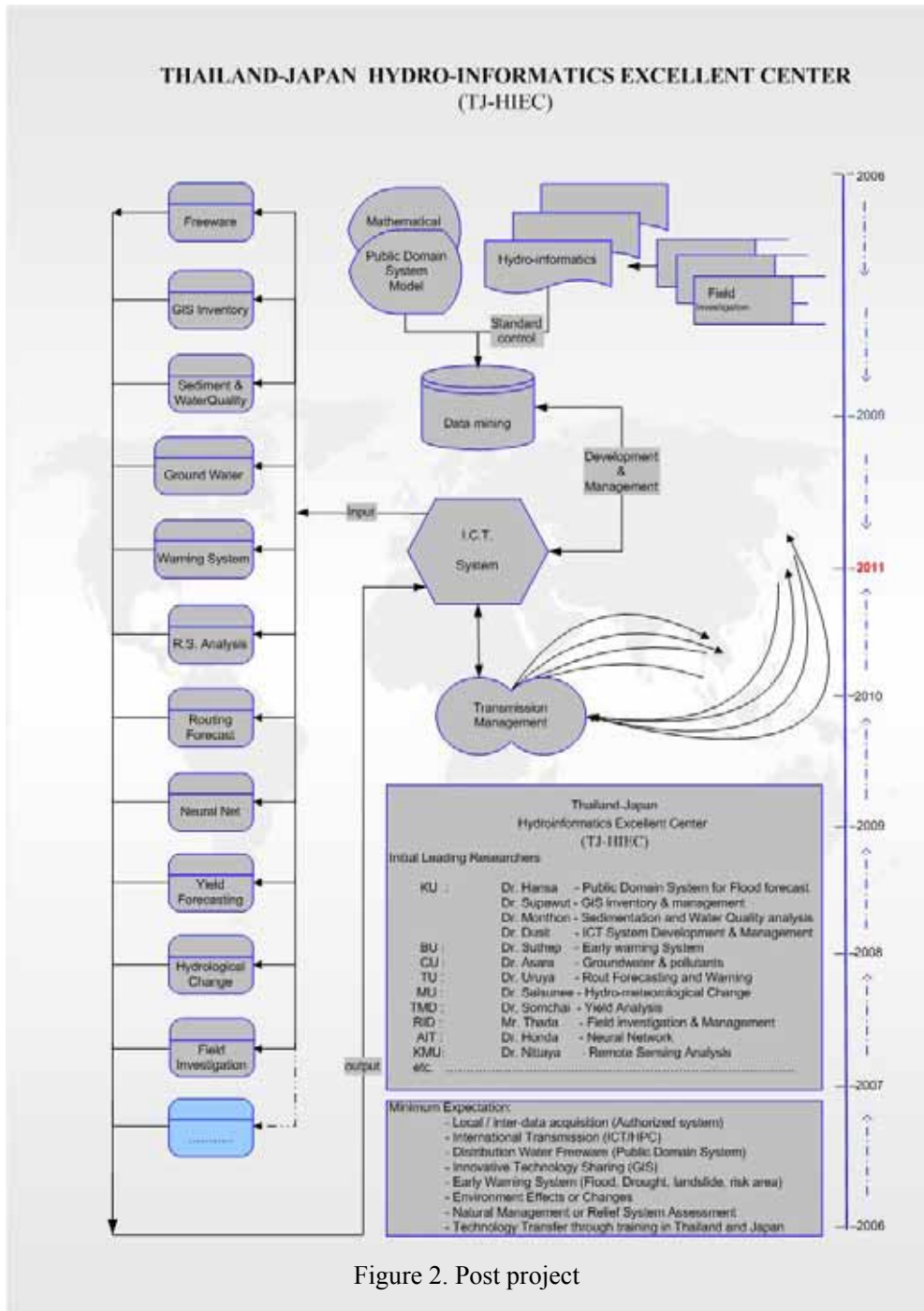


Figure 2. Post project

## **ACKNOWLEDGMENTS:**

RM-GIS center has been consistently subsidized under Faculty of Engineering, Kasetsart University. Together with GAME-Chaophraya research project, National Research Council of Thailand and viscous bountiful diversity from The University of Tokyo, Tokyo, Japan, did directly concern to project success.

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## **Current Water Resources development and research activities in Viet Nam**

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### **I. Introduction**

Vietnam has more than 2000 river all together in its river network, of which there are 9 big river systems with catchment area over 10,000km<sup>2</sup>. On average, total annual flow discharge is over 800 billion m<sup>3</sup>, of which 300 m<sup>3</sup> is generated in the country and 500m<sup>3</sup> comes from outside of the country. However, rainfall is distributed unevenly in term of location and time of an year. Statistical data shows that 70-75% of annual rainfall appears in 3-4 months (June-October) and in contrary, in 3 of the driest months (December- February of the next year) the rainfall comprises only 5-8% of annual figure. With regarding geography factor annual rainfall differs from 1,200mm to 4,000mm. This uneven distribution of rainfall is the most critical reason to cause many water related problems: flood and waterlogging in rainy season and drought in dry one. The Government of Vietnam has paid big attention to manage and development of water resources as a key natural resource and agriculture sector is the biggest user of this resource.

To make best use of water resources for national economic development, the Government has allocated high percentage of annual budget for construction of infrastructure, such as; reservoirs, dams, pumping stations, irrigation networks... Agriculture is the biggest water user in Vietnam. Up to now, for agricultural development, there are about 180 irrigation companies with some 20,000 staff to manage big existing infrastructure to ensure irrigation for 3 millions of cultivated land, drainage of summer crop for 1.6 millions ha of natural land in Northern part of Vietnam, prevention of salinity for 0.7 ha in coastal range and improvement of about 1.6 millions ha of acid sulfate land in Mekong delta. Irrigation and drainage is widely recognized in Vietnam as the first important factor for agricultural development and alleviation of poverty.

### **II. Some Challenges in Vietnam Water resources sector**

1. Demands for water in various sectors will increase in term of quality and quantity, as a result of economic growth and implementation of the Government policy for industrialization of the country which need to manage water resources more effectively in order balance between supply and demand but not make deterioration of water quality
2. Because of deforestation and severe climatic change for the last latest years and other reasons water availability has been changed toward to unfavorable trend. Serious water shortage in dry season and flood and waterlogging in wet season are more often with highly dangerous level.
3. Fast economic development has created negative impact to environment leading to serious problems of water quality deterioration.
4. There is a lack of clarity in the roles and responsibilities of the public agencies that plan and manage the country's water resources in the rapidly changing institutional, especially to implement new water resources law issued in 1998.
5. Current water management at irrigation and drainage management companies is at low level and very poor which is the most important reason that efficiency of irrigation and drainage systems is very low, on average 50-60% compared to designed capacity. Many irrigation and drainage systems are old and deteriorated badly which need to upgrade and rehabilitate in both physical infrastructure and management skill.
6. Existing irrigation and drainage systems need to change to meet requirement of national cropping diversification.

### **III. Main Research Priorities in irrigation and drainage for sustainable agricultural development**

## **1. Study of integrated water management measures for improvement of efficiency of the existing irrigation and drainage systems**

High technology as computer modelling, informatics technology, Supervisory Control and data acquisition (SCADA), GIS, automation... has been applying in company with introducing new institutional arrangement and PIM approach. This is an important approach because Agriculture is the biggest water user and improvement of water use in this sector will be good impact for national scale.

In order to introduce new and high technology to irrigation and drainage company successfully, training for improvement of knowledge to managers and staff of the irrigation and drainage company is a key need. Therefore in any research or transfer of new high technology, sufficient activities of training and knowledge dissemination should be emphasized.

Integrated measures include changes in both of technical and new policy with institutional arrangement which are consistent with each other. All these factors must be carry out in a comprehensive research project.

One of the important steps for implementing research on this topic is to evaluate and identify current problems of irrigation and drainage systems. Therefore measure for overcoming may be selected correctly. Currently, ADB is supporting us to evaluation of efficiency of drainage pumping station investment in the Red River Delta. Outcome of this research activity will help decision makers in preparing strategy and alternative plan for investment of high cost drainage facilities.

## **2. Development of guideline for evaluation and criteria of modernization of irrigation and drainage infrastructures.**

Nowadays, due to the fact that irrigation and drainage infrastructures are badly deteriorated and owing to support of international donors, Vietnamese Government has launched a big program of upgrade and modernization of irrigation and drainage infrastructures in different regions of Vietnam: the Red River Basin, Mekong River Delta, Central region... ADB and WB have provided hundreds millions of USD for this program. This is a good opportunity for the water resources sector to replace structures of old and conventional styles by new modernised ones which enable to simplify operation and management procedure. However, due to various reasons, of which there are lacks of information, guideline and design standards on modernisation of hydraulic structures, especially structures for water control, many hydraulic structures were rehabilitated remaining the same styles or very little changes to those constructed in 60's decade. In fact, changes in design process are always taken place slowly, so it is not surprised to many cases that hydraulic structures constructed in 80's-90's decades do not differ much from those in 50's-60's decades.

It is good for decision makers, designers and managers to make best use of investment for upgrade and modernisation if there is a research project conducted study on review and evaluation of literature, information and experience of modernisation hydraulic structures available in the world and in Vietnam; analysed advantages and disadvantages of each type of structures; demonstrated the modernised structures in practice and prepared guideline or a set of design criteria. It would be very useful for designers to include modern changes to their design of new structures.

It is important to success the modernisation of the irrigation and drainage systems if we can identify current problems find the right solutions to them and have sufficient fund and technical facilities to realize these solutions into practice. In order to have it we need to carry out research and experiment.

## **3. Application of modern and water saving irrigation technology for high valuable dry crops in mountainous, central and High land (Tay Nguyen) regions.**

Up to now, in Vietnam almost irrigation and drainage systems have been constructed for rice cultivation. Irrigation of dry crops has not been paid sufficient to. Nowadays, because of

marketing mechanism, in many regions overall country, mainly in mountainous, central and Tay Nguyen regions, cultivated areas of high valuable dry crops, as: horticulture, coffee, tea... has been increasingly developed which is consistent with new national policy to encourage process of cropping pattern diversification toward to best use of local natural potentials.

Demand of irrigation of the dry crops come from farmers is increasing day to day. This is because it is widely to realise that irrigation plays an important role for increase of yield and production of the high valuable dry crops and water in such regions is scare in dry season. Currently, as a result of big changes of global climate, drought and flood happen more frequently and severely. In fact, even lacks of experience, there are many farmers who pay money by themselves to facilitate irrigation of their farms, for example: for irrigation of coffee in High land of Tay Nguyen, for teas and fruit trees in North mountainous area... In Vietnam, there is lack of experience and technology of irrigation practice for dry crops, many type of modern irrigation equipment has not been popular in Vietnam. Therefore it is necessary to undertake study, application and demonstration of modern and water saving technology for further extension in Vietnam. It is also important to conduct study of crop water requirement and other needs for dry crops which have not been studied sufficiently in the past.

#### **4. Study and Development of water price and water related policy**

Good maintenance plays a key factor for sustaining a long life of any structures. At present, to manage huge hydraulic asset, the Government has established hundreds of irrigation and drainage companies with several tens thousand of managers and workers. Main financial source to cover operation and maintenance of the irrigation and drainage systems is revenue from water fee (or irrigation). For uncertainty of climatic conditions the Government provide certain subsidy for irrigation and full subsidy for drainage. Irrigation water fee is charged based on irrigated area. At the same time, different provinces issued different rate of water fee but all are rather low. Therefore, it is very common that revenue of an irrigation and drainage company from water fee is insufficient to recover the system running costs, resulted in very low fund allocated for maintenance works. Consequently, irrigation and drainage structures are quickly deteriorated.

A part from technical measures, human resources and institutional arrangement, it is clear that in order to manage water resources and assist irrigation and drainage companies in good management of their systems to meet requirements of sustainable development, determination of precise water price plays a critical role. This is because when correct water price or correct price of its service is available irrigation and drainage companies enable to prepare a long term strategy of Operation and Maintenance for sustainable development and water users also recognise needs of using water in saved and efficient ways, on the other hand if the Government has policy of subsidise to farmer it also may quantify clearly responsibility of contribution from farmers and government to the irrigation companies to run the systems.

Up to now, there are many scientists who pay attention to study of water price issue but the results do not meet requirements of the practice. May be one of the reasons of slow development of water price in Vietnam is the lack of experience in this issue in marketing mechanism and water has not been recognised widely in society as a good. Therefore, we need support from international expertise in this issue. If IPTRID can formulate a joint research project to conduct study for development of water price it would be more chance to succeed and consequently, water price will have a good impact to improvement of management approach in irrigation and drainage companies.

#### **IV. Conclusion**

Viet Nam is a nation experiencing rapid change, which is greatly impacting the use of its natural resources - particularly land and water. Changes of climatic conditions and others for the last decades have impact to changes in regional and national scale of water resources. Therefore many changes are needed in water sector for better use of this important national resources. An important action is to take active research to minimize negative impact to water resources.

## **GWSP-related Activities in Indonesia**

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### INTRODUCTION

Water resources management currently facing problem with increasing complexity along with the population growth followed by fast increasing socio-economic activities. This increasing of population demanding more water supplies for public, however, excessive use will only result in decreasing support from the water resources itself that is the decrease of water supply. The phenomenon of water resources degradation can be clearly observed from the increasing sensitivity of river flow, river bed and other water courses as well pollution that endangered any the creatures living inside the environment.

The following table compares in summary form the present paradigm with the new one, which is propose in this paper.

<b>No.</b>	<b>Obsolete</b>	<b>New Paradigm</b>
1.	Water is considered a public good.	Water is considered an economic good.
2.	Water supply is a welfare activity.	Water supply is an economic activity.
3.	Decision making is centralized in government offices.	Water allocation is a decentralized activity.
4.	Administrative regulation of water supply	Water is considered an economic instrument.
5.	Bureaucratic allocation of water to user	Stakeholders participate in allocation of water.
6.	A proliferation of agencies tries to administer water.	There is one single transparent agency at the National level, for oversight.
7.	Water licenses granted in isolation	Conjunctive use of groundwater and surface water.
8.	Confused and inefficient organizational structure.	Water administration fully accountable to public.
9.	Water developments for single use only.	Integrated development for multiple uses.
10.	Water administration base on political subdivisions of country.	Water administration base on river basin units.
11.	Water distribution is heavily subsidized and is a heavy drain on national budget.	The user pays, thus freeing government funds for other purpose

### PRESENT CONDITION

Problems presented above already been a serious warning and encourage government to establish policy and strategy that involve all related parties (stake holders) including all government institutions, related sector, profession organization, and non-governmental organization, therefore all parties may work together hand-in-hand to end the water resources degradation. Tough water has the nature of renewable resources, following its hydrology cycle flowing from upstream to downstream without any administration nor politics boundary, its use as well sustainability are heavily influenced by politic, social, and economic condition of society surrounding the water resources area. Therefore, it requires integrated solution that is to integrate natural system with the availability of natural resources both

quantities and qualities along with social system with resources user as dominant factor. However, these two system integration alone will not sufficient, therefore it require inter sector interaction involving all related parties (stake holders) to manage integrally especially for three fields; water shade management; water resources management; environment management. Three institutions will execute those three activities with different responsibility though related one another. Therefore the management of these fields needs to be executed simultaneously in one frame policy integrated management and approved by all related institution by involving the participation from all stake holders.

The critic level of water resources environment support availability can be described on explanations as follow:

1. The increasing of critical river basin from 13,1 million ha now becomes 18,5 million ha as the result of forest development. Therefore with critical river basin, increasing from 22 areas become 59 areas. These result in the decreasing stream flow availability to store water, which leads to very sensitive debit fluctuation, also erosion and sedimentation that cause the increasing of the water courses.
2. Long dry season caused by global climate mode which influencing food production in significant quantity.
3. The sharp increasing of water quality in water courses as the result of pollution, which leads to the increase of water supply processing cost and negative impact for public sanitation and endangered of water biota.
4. The degradation of river bed as the result of sand and rocks mining in many productive rivers cause structural, function and infrastructure damage alongside the rivers.
5. The increasing of sedimentation as the result of erosion from river basin in upstream area, household garbage in urban area, tailing, and land development which already caused river morphology changes. The decreasing of stream flow capacity, which result in ecosystem damage and threat of flood disaster.
6. Ground water mining which exceed the natural availability therefore the restore of water into mined area cause land subsidence and sea water intrusion on several rural and urban area.

Water resources sector also facing problem of long term investment and the increasing challenge and complexity in management, that without any effective management will become bigger economic development obstacle and food supply stability. Such problems may be caused by negative impact of population growth, urbanization and industrialization. Among main problems are follows:

1. Local scarcity of water allocation in vary sector as result of increasing non-irrigation sector demand.
2. Insufficient clean water supply since infrastructure and clean water management institution not able to serve the public fast growing demand.
3. Water pollution from urban, industrial and mining waste cause negative impact and reducing the availability of water in sufficient quality.
4. The limitation of operation fund and maintenance for existing infrastructures as well investment to add more infrastructures to fulfill the growing demand of water.

Such investment mentioned above require high investment cost, therefore it require effort to improve institutional frame of work, planning and management as well increasing participation and more involvement from stake holders.

#### **Relevant Organisations and Networks**

- Meteorology and Geophysics Agency (MGA), Jakarta
- Research Centre for Geotechnology (RCG), Indonesian Institute for Sciences - Bandung
- Centre for Agriculture(CA), Department of Agriculture, Bogor
- Centre for Meteorology and Geophysics (CMG), Bogor Institute of Agriculture, Bogor
- Geological Research and Development Centre (GRDC), Bandung

### **High Priority Research Areas**

- Integrated Water Resources Management
- Climate Change Impacts on River Runoff
- Land Cover Changes

### **Potential Areas of Collaboration**

#### **MGA and GWSP**

- Assessment of Rainfall Intensity
- Theme 1 – Magnitudes and Mechanisms of Change: Activity 1.1 (Water Governance and the GWS), Activity 1.3 (Climate change and the GWS), Activity 1.4 (Water diversions and the GWS)
- Theme 3 – Resilience and Adaptation: Activity 3.1 (Water Requirements for Nature and Humans), Activity 3.2 (The Nature of Adaptive Capacity of the Global Water System), Activity 3.3 (Approaches to Enhance Adaptive Capacity), Activity 3.4 (The Provision of Ecosystem Goods and Services).

#### **RCG and GWSP**

- Assessment of Groundwater Pollutions
- Theme 1 – Magnitudes and Mechanisms of Change: Activity 1.1 (Water Governance and the GWS), Activity 1.2 (Land cover changes and the GWS), 1.3 (Climate Changes and the GWS).
- Theme 2 –Linkages and Feedbacks: Activity 2.1 (Linkages at Differences Spatial Scales), 2.2 (Legacy of Human and Natural Interactions).
- Theme 3 – Resilience and Adaptation: Activity 3.1 (Water Requirements for Nature and Humans), Activity 3.2 (The Nature of Adaptive Capacity of the Global Water System), Activity 3.3 (Approaches to Enhance Adaptive Capacity), Activity 3.4 (The Provision of Ecosystem Goods and Services).

### **CA and GWSP**

- Assessment of Water Supply
- Theme 1 – Magnitudes and Mechanisms of Change: Activity 1.1 (Water Governance and the GWS), Activity 1.2 (Land cover changes and the GWS), 1.3 (Climate Changes and the GWS), 1.4 (Water Diversions and the GWS), 1.5 (Nutrient and Sediment Transport and the GWS).
- Theme 2 –Linkages and Feedbacks: Activity 2.1 (Linkages at Differences Spatial Scales), 2.2 (Legacy of Human and Natural Interactions).
- Theme 3 – Resilience and Adaptation: Activity 3.1 (Water Requirements for Nature and Humans), Activity 3.2 (The Nature of Adaptive Capacity of the Global Water System), Activity 3.3 (Approaches to Enhance Adaptive Capacity), Activity 3.4 (The Provision of Ecosystem Goods and Services).

### **CMG and GWSP**

- Assessment of Rainfall Distribution
- Theme 1 – Magnitudes and Mechanisms of Change: Activity 1.1 (Water Governance and the GWS), Activity 1.2 (Land cover changes and the GWS), 1.3 (Climate Changes and the GWS), 1.4 (Water Diversions and the GWS), 1.5 (Nutrient and Sediment Transport and the GWS).
- Theme 2 – Linkages and Feedbacks: Activity 2.1 (Linkages at Differences Spatial Scales), 2.2 (Legacy of Human and Natural Interactions).
- Theme 3 – Resilience and Adaptation: Activity 3.1 (Water Requirements for Nature and Humans), Activity 3.2 (The Nature of Adaptive Capacity of the Global Water System), Activity 3.3 (Approaches to Enhance Adaptive Capacity), Activity 3.4 (The Provision of Ecosystem Goods and Services).

## GRDC and GWSP

- Assessment of Groundwater Aquifer
- Theme 1 – Magnitudes and Mechanisms of Change: Activity 1.1 (Water Governance and the GWS), Activity 1.2 (Land cover changes and the GWS), 1.3 (Climate Changes and the GWS), 1.4 (Water Diversions and the GWS), 1.5 (Nutrient and Sediment Transport and the GWS).
- Theme 2 – Linkages and Feedbacks: Activity 2.1 (Linkages at Differences Spatial Scales), 2.2 (Legacy of Human and Natural Interactions).
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## **Effect of Land Use Change on Catchments Runoff**

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### **Abstract**

The purpose of this study was to identify and assess the impact of land use change on catchments runoff of Sg Langat basin, a rapidly developing part of Malaysia. Two sub catchments with a size of 389 km<sup>2</sup> and 1251 km<sup>2</sup> and with relatively long and good daily hydrological data was chosen as a case study. The rainfall-runoff model (NAM) was able to simulate observed hydrographs well during the reference period. The validated model was then subsequently applied to provide runoff prediction, which would occur in the absence of land use change. The preliminary analyses indicated a decrease in the annual runoff for both sub catchments. Simultaneously, land use changes between the reference and testing periods were also conducted using remote methodology. The 1990 to 2001 land use matrix indicated a more than 5 fold increase in urban category mainly at the expense of agriculture land.

### **Introduction**

The influence of land use change particularly forests and forest clearing on water supplies have long been a cause of concern (Bosch and Hewlett, 1982; Hibbert, 1967; Bosch and Hewlett, 1982; Bruijnzeel, 2004). The worldwide studies above concluded that water yield increased with deforestation and the rate of increase generally grows in tandem with the amount of biomass removed. Similar conclusion was also made by Abdul Rahim Nik (1988) with regard to conversion of forest to plantations (oil palm and cocoa) in Malaysia. On the other hand, there are also reports of springs and steams drying up during dry seasons after tropical forest removal (eg. Hamilton & King, 1983; Valdiya & Bartarya, 1989; Pereira, 1989). More recently in assessing the impact of land use change on catchment runoff in Zimbabwe, Lorup, *et al* (1998) found that all the six catchments studied showed a decrease in the annual runoff.

It is interesting to note that most all of the experiments above involved paired catchments with relatively small area of less than 100 hectares and mainly involved commercial logging of the forest and conversion of forest to either plantation or grassland. None of the experiments has look at the impact of multiple land cover and land use change especially urbanization towards surface hydrology.

### **Study Area**

This study involved Sg. Langat basin lies within the economically active and fast urbanizing Klang Valley, in which sit both the commercial and administrative capital of Malaysia i.e. Kuala Lumpur and Putrajaya respectively. (Figure 1). These developments have attracted migration and rapid rise in the population of the area, hence necessitated further provision of basic infrastructures and amenities. Hence this study attempted to evaluate the impact of urbanisation towards stream flow of two sub catchments namely Sg Langat-Kajang and Sg.Langat –Dengkil.

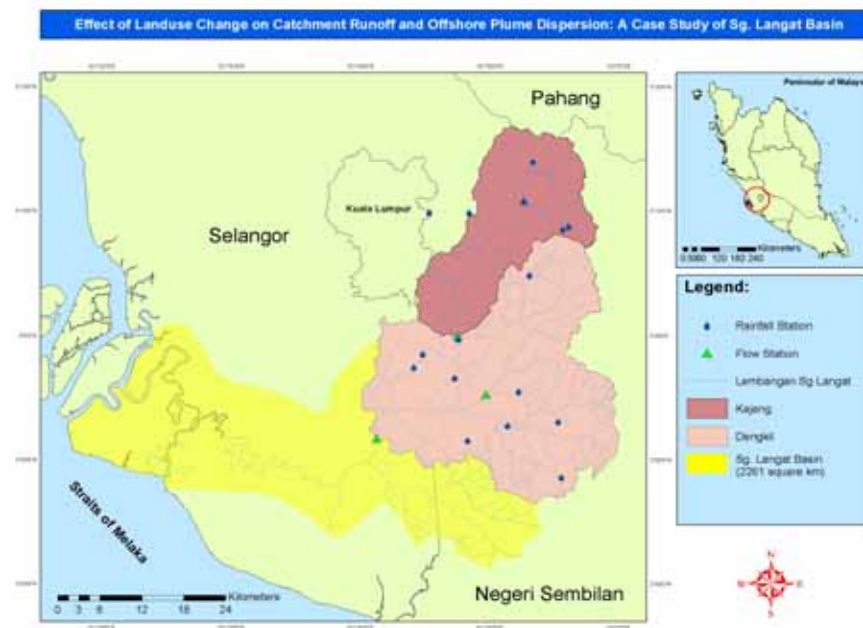


Figure 1 : The Study Area

## **Methodology**

The overall methodology used in the study has been adapted from the generalized methodology for distinguishing between the effects of human impact and climate variability derived from Refgaard et. al. (1989). Rainfall runoff model, NAM developed by Nielsen & Hansen (1973), was used to calibrate, validate and simulate flows of the sub catchments during reference and test period. A Land use change during the two periods was detected through satellite image (Landsat TM) processing under six major land use categories.

## **Preliminary Result**

### **Rainfall-Runoff Model**

The results from the model simulation during tests periods for the two sub catchments are summarized in Table 1, while Table 2 shows the land use change of Sg Langat-Dengkil sub catchment between 1990 and 2001.

Table 1 : Preliminary Result of Sg Langat-Kajang &amp; Dengkil Sub Catchment Runoff Determination

	SgLangat-Kajang		Sg Langat-Dengkil	
	Reference Period (1978-1984)	Testing Period (2000-2002)	Reference Period (1978-1984)	Testing Period (2000-2002)
Average Annual Rain (mm)	2,353	2,435	2,281	2,400
Average Annual Observed Runoff (m3)	328,170,240	283,604,976	1,009,783,280	979,408,800
Average Annual Simulated Runoff (m3)	318,517,056	399,036,000	980,010,580	1,289,018,880
Diff Bet Obs and Simul Runoff	9,653,184	(115,431,024)	29,772,700	(309,610,080)
% Diff bet. Obs & Simul Runoff	2.9%	-40.7%	2.9%	-31.6%

Table 2 : Summary of Land Use Change for Sg Langat-Dengkil Sub Catchment (1990 – 2001)

Land use categories	1990		2001		Different (Ha)	% Different (Gain/Loss)
	(Ha)	%	(Ha)	%		
Forest	45,598.41	36.4%	44,366.40	35.5%	(1,232.01)	<b>-2.7%</b>
Urban	2,606.13	2.1%	16,549.38	13.2%	13,943.25	<b>535.0%</b>
Agriculture	67,833.09	54.2%	55,285.74	44.2%	(12,547.35)	<b>-18.5%</b>
Water bodies	1,142.45	0.9%	1,459.88	1.2%	317.43	<b>27.8%</b>
Grassland	2,463.75	2.0%	903.87	0.7%	(1,559.88)	<b>-63.3%</b>
Bareland	5,499.81	4.4%	6,578.37	5.3%	1,078.56	<b>19.6%</b>

The above result indicated fairly substantial reduction of runoff for both sub catchments and at the same time preliminary determination of Sg Langat Dengkil sub catchment show a five fold increase of urban land use mainly at the expense of agriculture presently accounting for 13.2% of the sub catchment from 2.1% previously. Though the reduction of forest was relatively small in term of percentage, it is nevertheless quite substantial in term of hectarage. The next step in this study is to use general statistical methodology to relate the changes of runoff to the land use above.

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## **Water Resources of India and GWSP**

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### **Water Resources of India**

India is a vast country that has 16% of world's population, 4% of world's freshwater resources, and only 2% of world's land. Average annual precipitation for India is estimated to be 4000 km<sup>3</sup>. Precipitation is caused by South-West and North-East monsoons, shallow cyclonic depressions, disturbances and local storms. The South-West (summer) monsoon lasting from June to Sept. yields nearly three-quarter of the annual precipitation which is nearly 3000 km<sup>3</sup>. This confinement of precipitation to a relatively short season makes irrigation imperative for reliable agricultural production and necessitates river regulation.

Average annual flow in Indian rivers has been estimated to be 1953 km<sup>3</sup> but due to topographic and other constraints, utilizable annual surface water potential is 690 km<sup>3</sup>. Further, the replenishable groundwater = 432 km<sup>3</sup>. Thus the total utilizable water resources for the country are of the order of 1122 km<sup>3</sup>.

### **STORAGES IN INDIA**

Storage capacity created by the existing major and medium projects is about 177 billion cubic m (BCM). The projects that are under construction and minor projects add up to another 146 BCM, yielding a total storage of 323 BCM. Sedimentation is a problem in India and the likely loss of storage capacity by silting by the year 2050 is estimated at 53 BCM. Thus, net availability would be about 270 BCM. Estimates show that in order to regulate the river flows to the desired extent, about 450 BCM of storage would be needed. Presently, India has 4000+ large dams.

The culturable area in India is 186 million ha, the net sown area is 140 million ha, and the irrigated area is 90 million ha. For the country, the ultimate irrigation potential is 140 million ha.

### **Major Challenges for Water Managers**

For those who are responsible for planning and management of water resources in India, the major challenges are:

- To secure water for people,
- To secure water for food production, and
- To protect vital ecosystems.

While attaining the above, decision makers have to:

- Deal with time and space variability,
- Manage risks,
- Create awareness and understanding,
- Forge political will to act, and
- Ensure collaboration across sectors and boundaries.

### **MAJOR POLICY INITIATIVES**

The major policy initiatives that are necessary for optimum and sustainable management of water resources are:

- Conservation & Regulation of Water Resources,
- GW Management,
- Water Quality Conservation and Environment Restoration,

- Inter Basin Water Transfer,
- Watershed Management,
- Developing Hydrological Information System,
- Adaptation to Climate Change Impacts,
- Other Strategies:
  - Recycle and reuse,
  - Public involvement,
  - Rainwater harvesting, and
  - Capacity building,

### **High Priority Research Areas**

Priority research areas in the field of water resources for India are:

- Assessment of water availability (with spatial and temporal distribution),
- Flood and drought management,
- Water quality modelling and management,
- Integrated water resources development and management,
- Impact of climate change on water resources,
- Predictions in ungauged basins, and
- Interlinking of rivers.

### **Potential Areas of Collaboration**

Following a list of potential areas under the GWSP programme where Indian researchers can contribute:

- Activity 1.2: Impact of LU-LC changes and management practices on water resources
- Activity 1.3: Assessment of water resources at basin scale and impact of climate change
- Activity 3.1: Estimation of Environmental Flow Requirement (EFR)
- Activity 4.1: Building the GWSP Information base
- Activity 4.2: Developing GWSP lexicon
- Activity 4.3: Developing world water models and analyzing scenarios
- Activity 5.2: Capacity building – regional studies
- Activity 5.3: Water education – organizing workshops and training courses

## **What can Hong Kong contribute to the GWSP?**

*David Dudgeon, Department of Ecology & Biodiversity, The University of Hong Kong, Hong Kong SAR, China*

Hong Kong is a city of 7 million people situated on the coast of southern China, bordering Guangdong Province. It has a highly seasonal monsoon climate, characterised by pronounced wet and dry seasons. With only around 1100 km<sup>2</sup> of land area, and despite the presence of 17 reservoirs (total capacity 586 million m<sup>3</sup>) Hong Kong has insufficient natural water-gathering grounds to meet local demands for water, and much (78% of demand or 760 million m<sup>3</sup>) must be met by imported water purchased from China. The source is the Dongjiang (or East River), a major tributary of the Pearl River (Zhujiang); it is the most important river in Guangdong (98% of the course is within the provincial boundaries) with annual discharge of approximately 30 billion m<sup>3</sup> providing water supplies for around 36 million people. Water is transported to Hong Kong over a distance of 83 km, much of it through a covered aqueduct. Prior to 2001 it flowed through an open channel but concerns about pollution, which is epidemic in the rivers of southern China due to limited sewerage infrastructure and poorly-regulated waste discharge, led to the construction of a new system that would reduce the chances of contamination en route. This arrangement was initiated in the 1960s, after droughts reduced domestic supplies in Hong Kong to only 4 hours of waters every 4 days. Since then, the amounts provided have increased (reaching 1.1 billion m<sup>3</sup> in 1994) and the supply to Hong Kong has been assured. This has taken place because of the economic benefit derived by Guangdong from the sale of water and has continued despite the occurrence of a serious drought (the worse in over 50 years) in Guangdong during 2004-05 that led to water rationing and closure of hydropower stations. The situation in Guangdong became so serious that more than 750 million m<sup>3</sup> of water was diverted 1,336 km from southwestern China increase the volume of the Dongjiang so as to prevent saltwater intrusion from contaminating drinking water. Such problems, combined with the rapid rate of economic growth and prosperity of Guangdong, will place greater demands on water supplies. One possible consequence will be increasing competition for Dongjiang water, and it remains to be seen if Hong Kong will continue to enjoy the plenitude it now receives.

Against this background, it is evident that Hong Kong's long-term sustainability will depend upon events affecting the water system in Guangdong Province, as well as in the wider context of China and the region, and it is therefore rather surprising that, to date, little attention has been paid to issues of water supply in the territory. This is not to say that the matter does not receive attention. Government departments that include water in their portfolios include the Water Supplies Department (WSD), Drainage Services Department (with a particular responsibility for flood control and stream channelization), the Environmental Protection Department, and the Agriculture and Fisheries Department. Non-government organizations such as Greenpeace, the Conservancy Association, and World-wide Fund for Nature have periodically raised community concerns about the quality of water from China, but Hong Kong's drinking water is treated to the highest international standards and the WSD does an excellent job in that regard. However, research on water in the region, both the need to sustain supplies of drinkable water and the increased anthropogenic impacts on biodiversity and ecosystems services offered by fresh waters in southern China, have received only limited attention. Academic expertise on this topic is largely confined to the University of Hong Kong (HKU), although this is only one of seven universities in the territory. For example, there only experts in freshwater ecology or biodiversity are at HKU, and water issues are a major focus of the HKU Civil Engineering Department.

In recognition of the inevitability of long-term change in the patterns of water consumption and supply in Guangdong Province, Hong Kong and southern China, HKU has begun a collaborative, interdisciplinary effort to develop expertise and to provide information that will guide policy and decision makers on the sustainability of water. The Departments of Earth Science, Ecology and Biodiversity, Civil Engineering, and Geography are, at the time of writing, making plans to combine their research strengths and facilities to research climate change and sustainable water in Hong Kong

and the Pearl River Delta region. They aim to develop an integrated approach to these problems, as it is clear no single discipline can fully address the issues involved.

Climate change is an issue of growing global importance but has received little attention in Hong Kong. It is intended that HKU researchers and international colleagues will work together to summarise the latest research in global climate change and to project ecosystem responses and changes in the water system of the Asia-Pacific Region and Hong Kong in response to various climate change scenarios. Two workshops will be organised, and a volume published on the likely impacts of climate change scenarios for Hong Kong and necessary adaptive responses by government and citizens. The workshops would also identify key areas of research requiring cross-disciplinary expertise. This would be the first serious attempt to develop practical means of mitigating climate change impacts in Hong Kong.

Climate change will impact water supplies, ecosystem processes and will interact with the effects that human activities are having on fresh water. HKU academics will work with colleagues in Guangdong Province to investigate environmental aspects of water quality and availability in the Pearl River Basin, especially the Dongjiang. It is anticipated that this collaboration will begin with an international symposium and two joint exploratory research projects, with the aim of developing topics for collaborative interdisciplinary research. Given the rate of growth and expansion of urban conurbations in southern China, there will inevitably be stress placed on existing water resources. It is therefore timely that HKU has initiated research on climate change and sustainable water. As this initiative develops, there is potential for activities at HKU to make significant contributions to virtually all elements of the GWSP Science Framework and Implementation Activities. In many ways, Hong Kong and its densely populated human-dominated environs is a 'worst case scenario' for the future of Asian environments. It will provide an object lesson in the problems of maintaining sustainable freshwater for a global megacity, and information generated may well be of considerable importance to the long-term development of GWSP-Asia and the GWSP as a whole.

## **GWSP-Asia Presentation from Singapore**

by  
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### **GWSP-related activities in Singapore**

A number of organizations and institutions in Singapore are concerned with the issues related to water and have dedicated groups or centers devoting resources to conduct research in the water field. A listing of relevant organizations and networks are as follows:

- Public Utilities Board (PUB)
  - o Centre for Water and Wastewater Technology (CWWT)
- Nanyang Technological University (NTU)
  - o Environmental Engineering Research Centre
  - o Institute of Environmental Science and Engineering
- National University of Singapore (NUS)
  - o Centre for Water Research
- Stanford- PUB-NTU Clean Water Programme
- Singapore Water Association

These organizations and institutional programmes have identified some critical areas of concern to Singapore and a listing of high priority areas of research are:

- Aquifer Storage and Recovery (ASR)
- Water Quality Analytic (WQA) Study
- Membrane Separation and Treatment (MST)
- Desalination

Research in these priority areas are currently conducted with research funding made available through government and academic institutions. For example, a S\$10 million funding is currently supporting the Singapore Stanford Partnership research programme which involves researchers from Stanford University (USA), Nanyang Technological University and the Public Utilities Board.

### **Potential Areas of Collaboration with GWSP-Asia**

The following are potential areas of collaboration between the various institutions and networks in Singapore with GWSP-Asia:

#### **PUB/NTU/GWSP –Asia**

Projects that could be of interest include:

- Marina Bay Barrage Project
  - this project involves the damming up of an estuarine area and conversion of the Marina Bay into a water resource area. They will be interest in the ecological changes and the impacts of the change of saline water to fresh water.
  
- Theme A1-4: Water Diversion and the GWS. Analysis and quantification the consequences of the damming of an estuary. Investigations into changes in ecosystem, water quality, sediment transport, etc.

PUB/NTU/NUS/GWSP-Asia

The above institutional network can be involved in the capacity building effort identified in the GWSP Science Plan. The following could be considered:

- Dialogue, capacity building and educational programmes
- Organization of workshops
- Establishment of a Young Scientist/Researcher Programme in collaboration with other well know water institutions such as International Water Association (IWA) based in United Kingdom
- Initiation and conduct of specific educational programmes and training courses related and of interest to GWSP –Asia

## **Carbon Cycles in the Fluvial and Oceanic Systems of Southeast Asia: Establishment of the South China Sea Regional Carbon Pilot Project**

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Alarming as it is, human intervention in the carbon cycle over the last two centuries has caused anthropogenic carbon fluxes to become comparable in magnitude to major natural fluxes in the global carbon cycle. All the while, river basin development, most notably from the construction of dams and irrigation systems, has had a profound impact on riverine inputs of freshwater and carbon to the oceans.

Given these facts, the export of carbon to the atmosphere and oceans from fluvial systems will most certainly be severely affected. Besides this, and put into simple terms, the more seriously freshwater outflow and the buoyancy effect are reduced by damming, the more likely it is that the continental shelves will operate under a much less efficient biological pump and that fish production will decrease accordingly.

On a global scale, approximately 40% of the freshwater and particulate matter entering the oceans is transported by the ten largest rivers, and this is in the form of a buoyant plume on the open shelves. The situation we must confront, however, is that the number of large dams has increased a startling sevenfold since 1950, and within the next few decades, to make matters worse, more than 20% of total global river flow to the seas may be dammed or diverted.

The main goal of the South China Sea Regional Carbon Project is to form a team to develop several theories regarding carbon cycle dynamics and fisheries productivity in the SCS region, with a focus on biogeochemical dimensions and fisheries along with their interactions and feedback. The activities are as follows:

- Rapid assessment - literature review of the SCS regional carbon cycles.
- Enhanced understanding of space-time patterns in contemporary carbon cycles.
- Training programmes for scientists in the SARCS region.
- Consequences of regional reservoir and water diversion developments to the carbon cycle.
- Emergent properties of the coupled human-carbon-water-fishery system.
- Evolution of future aquatic carbon sources and sinks through the 21st century.

### Completed Projects

PIs	Project Title
G. Wattayakorn, (Thailand), W.C. Burnett (USA) and M. Taniguchi (Japan)	Contribution of carbon and nutrient species into SE Asian waters via submarine groundwater discharge
T. Kusumastanto (Indonesia)	Chlorophyll-a and phytoplankton abundance under monsoon variation in South China Sea
H. Tri (Vietnam)	Quantifying and predicting carbon fluxes and fishery sources in Red River basin
X.X. Lu, D. Higgitt and S.C. Liew (Singapore)	Modeling spatial and temporal dynamics of sediment and carbon delivery to the South China Sea
A. Snidvongs, (Thailand) and P. Inthapanya (Laos)	Organic carbon and carbonate chemistry in Nan Theun Basin; A baseline study before dam construction.
J.Y. Lou	Burial in lakes and riverine transport of carbon in Taiwan
L.J. Cheng	Catch fluctuation of tuna long line fisheries in relation to oceanographic and climate in South China Sea

### Ongoing Projects

PIs	Project Title
C.T.A. Chen and C.R. Wu	Carbon cycles in the fluvial and oceanic systems of Southeast Asia (CASA)
S. Lin	Sulfate reduction and organic carbon burial in the South China Sea Delta and continental shelf sediments
S.L. Wang	Air-Sea CO <sub>2</sub> flux study in the shelf of the northern South China Sea
S.S. Yang and C.C. Chung	Carbon dioxide and methane fluxes of river, lakes and sediments
B.J. Tsuang	Development of a coupled atmospheric and ocean model for South China Sea Climatic and Environmental Simulations
C.R. Peng	Submarine discharge of groundwater
Edvin Aldrian	The Brantas Catchment Water and Carbon Cycle
Lee Choon Weng	The Carbon Flux Through Bacteria in Coastal Waters East of Peninsular Malaysia
Gil S. Jacinto	Pathways of Nitrogen Enrichment from the Catchment to the Coast and its Effect on Coastal Water Productivity
David Higit and Xixi Lu	Human Impacts on Water, Carbon and Sediment Fluxes in the Southeast Asian Region: Modeling and Field Approaches
Anond Snidvongs and Jeffrey Richey	Future Trajectories in the Delivery of Water and Carbon Across the Landscapes of Southeast Asia to the South China Sea
Penjai Sompongchaiyakul	Carbon, Nutrients and Water Fluxes of the Tapi River and Songkhla Lake Watersheds

### Hydrological changes in response to human activities in China

## **A possible collaboration/coordination between WCRP and GWSP in Asia - suggestions from GAME (GEWEX Asian Monsoon Experiment) –**

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### **1. Role of World Climate Research Programme (WCRP)**

WCRP was established in 1980, under the joint sponsorship of the International Council for Science (ICSU), the World Meteorological Organization (WMO), and the Intergovernmental Oceanographic Commission (IOC) of UNESCO (since 1993). The objectives of the programme are to develop the fundamental scientific understanding of the physical climate system and climate processes needed to determine to what extent climate can be predicted and the extent of human influence on climate.

Important tasks of WCRP are, to promote new research observation projects, to promote development of new climate/earth system models, to produce and release new data sets for climate studies with free & unrestricted exchange bases (for scientific communities), and to contribute to international societies through prediction & application projects. Further information on WCRP is obtained from <http://www.wmo.ch/web/wcrp/wcrp-home.html>

### **2. Global Energy and Water Cycle Experiment (GEWEX)**

GEWEX is one of the major sub-programs of WCRP. is a program to observe, understand and model the hydrological cycle and energy fluxes in the atmosphere, at land surface and in the upper oceans. GEWEX is an integrated program of research, observations, and science activities ultimately leading to the prediction of global and regional climate change. The goal of the GEWEX is to reproduce and predict, by means of suitable models, the variations of the global hydrological regime, its impact on atmospheric and surface dynamics, and variations in regional hydrological processes and water resources and their response to changes in the environment, such as the increase in greenhouse gases. Further information on GEWEX is obtained from <http://www.gewex.org/>

### **3. GEWEX Asian Monsoon Experiment (GAME)**

GAME was implemented as part of GEWEX (Hydrometeorology Panel) for about 10 years from 1996 to 2005. The objectives of GAME are, understanding role of Asian monsoon and its hydrological cycle in the global climate system with full energy and hydrological feedback processes (as an up-scaling issue), and improvement of regional/basin scale hydrological cycle and water resources in monsoon Asia (as a down-scaling issue).

A major foci for GAME are, what are fundamental land surface processes for the maintenance and variability of the Asian monsoon system. Through intensive and extensive observations, data analyses and modeling, new scientific results have been obtained, e.g., 1) important Role of complex topography system in development of convective systems, 2) fundamental role of diurnal cycle in energy and water cycling processes, and 3) important role of vegetation in controlling energy and water fluxes and related monsoon circulation systems. Huge data sets for understanding energy and hydrological processes of the Asian monsoon system have also been obtained, including the objectively-analyses GAME reanalysis data and satellite-based land surface and hydro-meteorological data over Eurasia and surrounding oceans. More information on GAME is available from <http://www.hyarc.nagoya-u.ac.jp/game/>

### **4. Future and new collaboration between WCRP and GWSP in Asia**

WCRP has started a new strategic framework for Prediction and observation of the Earth Climate System called COPES (Cooperative Observation and Prediction of Earth System). One of the main targets for the COPES is to assess and predict changes of the Asian monsoon system and its hydrological cycle, including those by the “global warming” and other anthropogenic changes. GWSP tasks, on the other hand, may be to assess impacts of these changes in water cycle, and to provide data & information of water-related land surface condition and changes.

Currently, a new initiative for promoting these studies in Asia are being planned under WCRP-related communities in Japan and other countries in Asia. This new initiative is tentatively called **Monsoon Asian Hydro-Atmosphere Scientific Research and prediction Initiative (MAHASRI)**. On the other hand, This Post-GAME program and the forthcoming GWSP-Asia should work and collaborate together to establish sustainable nature and society in monsoon Asia.

## **Global Earth Observation System of Systems (GEOSS)**

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Reliable supplies of fresh water are an essential ingredient for human prosperity and health, as well as ecosystem functioning. Water is an important, geo-socio-economic issue at local, national and global scales and changes in water resources are a part of the history of civilization. Both socially and economically, the impacts of water deficits and surpluses are large. Food security, well being, and ultimately economic and political stability depend upon the ability to provide reliable supplies of clean water. Rapid population growth and development pressures impose additional stresses on scarce resources. Drought turns such vulnerable situations into a crisis. Enhanced and timely information pertaining to water resources has the potential for increasing the development capability of many of these countries. As a result, there are increasing human, institutional, and infrastructure needs for access to and use of water cycle data in water resource management.

The 10 Year Implementation Plan for a Global Earth Observation System of Systems (GEOSS), which was endorsed at the Third Earth Observation Summit in Brussels in February, 2005, to realize a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations and information. GEOSS will meet the need for timely, quality long-term global information as a basis for sound decision making, and will enhance delivery of benefits to society. "Improving water resource management through better understanding of the water cycle" is defined as one of the nine key areas in GEOSS.

The vision for water cycle research and water resources management foresees observational systems, data assimilation, prediction systems and decision support capabilities being integrated into a system of systems that supports integrated water management. It will also enable closure of the water budget on regional and global scales to the point where effective management is possible across the globe. GEOSS will provide a process for the continuous evolution of the water cycle observing system. It will do this by inventorying and evaluating existing plans and new water cycle data needs, and the ability of observing systems to meet those needs. GEOSS will act as a conduit between the capabilities of national observing programmes, international scientific programmes and global conventions and policies, and will develop action plans to build capacities in developing countries. GEO will offer a framework for joint planning of expert systems for decision support where water information is an input (e.g. hydrologic prediction services) or is dependent on inputs from all other societal benefit areas. It will also coordinate the development of a capacity building plan for the use of Earth Observation data (satellite, surface and subsurface data) for water management in developing countries.

## -A comparison between Yellow River and Pearl River

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### Abstract

Hydrological changes in response to human activities in China have become an issue since the 1950s, when many dams were built. The change process has accelerated in the last 25 years due to urbanization and economic development. The main human activities that cause hydrological changes in China are enumerated as:

1. Population increase
2. Urbanization
3. Land reclamation (deforestation, wetland development...)
4. Irrigation
5. Disposal of wastewater
6. Dam construction
7. River sand mining (as construction material)
8. Education, water management...

Items from 1 to 7 affect water cycle and water balance visibly and can be grouped straightforwardly as population, resource, environment and development (PRED) factors, while item 8 affects the hydrological change implicitly. Water resource and arable land per capita decrease as an obvious result of population increase, while the decrease rate for arable land is higher than that of water resource per capita since a swift urbanization. On the other hand, in order to keep food production per capita at a stable level for the sake of social security, much more water has been diverted or stored in the reservoir for irrigation. More and more wastewater and solid waste are disposed without treatment to the river or sea, causing the pollution of surface water and groundwater.

Hydrological change due to human activity varies from place to place, and the change in the arid and semi arid zone, e.g., the Yellow River was selected to compare with the change in the Pearl River, which is located in the subtropical and tropical zone. The main characteristics of two basins are given in Tab.1.

Main hydrological changes in the Yellow River are given as follows:

- Drying up in the channel of lower reach
- Suspended river
- Flooding risk
- Actual evapotranspiration increase
- Groundwater (refreshing processes)
- Less sediment transported to the delta
- Erosion?
- Water quality
- Pan evaporation decrease

Tab. 1 Main characteristics of water resource, population, arable land for the Yellow River and Pearl River, runoff and water resource was based on the data series of 1956-1979(WRHPDGI, 1989), while population was referred to the year of 1997(Liu and Chen, 2001).

Major basins	Area* in %	Water resource* in %	Population* in %	Arable land* in %	Runoff coefficient	Water resource (m <sup>3</sup> per capita)
Yellow River	8.3	2.7	8.5	12.9	0.18	707
Zhujiang (Pearl)	6.1	16.7	12.1	6.7	0.52	3228

\*expressed as the ratio to total area, water resource, population and arable land of China respectively.

While main hydrological changes in the Pearl River are given as:

- Urbanization (>40%) >Water pollution
- Saline water intrusion
  - Lowering of the river bed due to sand excavation(3-8m in the last 40 yrs)
  - Inflow decreases (North Tributary 50% decreases, West Tributary 30-50% last year)
  - Discharge increases at the same water level
- Groundwater pollution
- Pan evaporation decreases

Conclusion

Land reclamation and water shortage are two keywords for the hydrological change in the Yellow River Basin, while water pollution and seasonal water shortage, urbanization are the keywords in the Pearl River Basin

References (not included)

# Monitoring of the Ground Water Variation in Urban area, by Combining GRACE Data and in-situ Gravity Measurement

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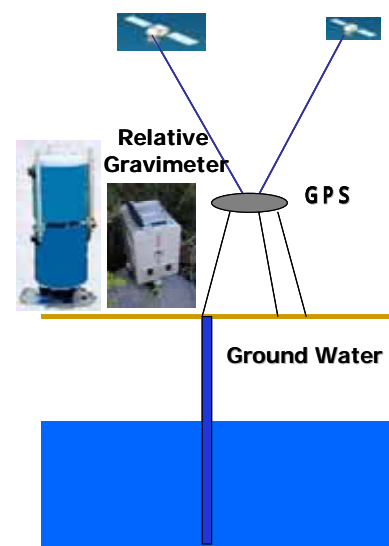
*Transformations of water resources between groundwater and surface water occurred in many cities depending on the development stage of urbanization. A project to evaluate ground water flow systems in and around the developing cities has started. In this project, for monitoring the ground water changes, we intend to employ a new technique of precise gravity measurements (relative and absolute gravity measurements) combined with GPS positioning. On the other hand, the monthly gravity field solutions derived from GRACE satellite are expected to reveal global water circulations. The data of surface gravity measurements include not only local gravity changes but also regional to global scale gravity variations. For estimating and removing such long wavelength gravity signals, we intend to utilize GRACE data for the correction of the surface gravity data.*

## 1. In-situ precise gravity measurements.

Because the spatial resolution of the satellite gravity data may be insufficient for the studies of urban scale phenomena, we will carry out precise gravity measurements in test areas. So far, not many but some gravimetric studies were conducted to monitor groundwater variations or to investigate hydrologic problems. The basic principle is simple. The gravity changes due to groundwater mass movements are measured as gravity changes by means of high precision gravimeters. An infinite water table of one meter thickness causes about 40 micro gals (10<sup>-8</sup> m/s<sup>-2</sup>) gravity changes. Thus the accuracy of 10 micro gals would be preferable for the hydrologic problems. Because it is not an easy task to achieve the accuracy of 10 micro gals by means of a spring-type relative gravimeter, for instance, Schintrex gravimeters, we propose a new method to combine absolute gravity measurements and relative gravity measurements. We employ a portable type absolute gravimeter with high precision for the measurements at some control points, and employ relative gravimeters of superior portability for the measurements at most points around the control points. By this way, we could strike a balance between accuracy and efficiency of the measurements.

Another point for the surface gravity measurements is that the effects of the ground surface movements. Because one cm vertical movement causes about 3 micro gals gravity changes, height changes at the gravity points should be measured with the accuracy of a few cm. For this purpose, we employ kinematic GPS surveys concurrently with the gravity measurements. Combining the absolute, and the relative gravity measurements as well as the GPS surveys, repeated measurements with an interval of one year will reveal secular groundwater changes in an urban area as the gravity changes.

## 2. GRACE data processing



**Fig. 1.** A schematic view of the in-situ gravity measurements.

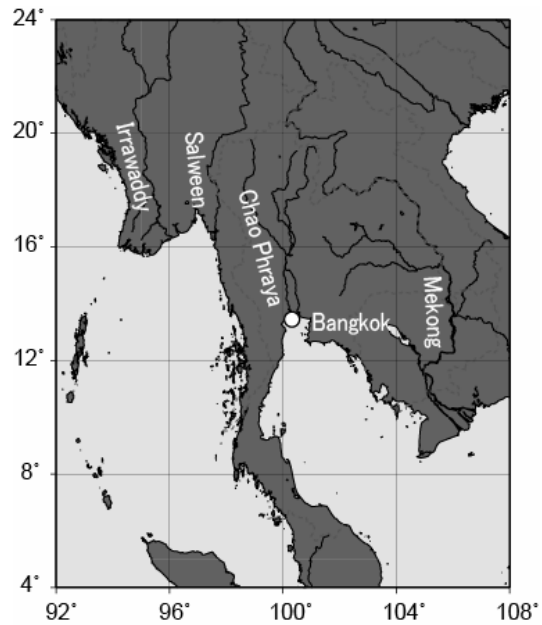
As a preliminary study, we estimated regional scale gravity changes around Bangkok from the GRACE monthly gravity field solutions. Because Bangkok is located at the lower region of Chao Phraya river basin, we primarily tried to detect the signal of mass variations in the basin. However the spatial scale of the basin may be too small to be detected by GRACE. Thus, for evaluating the applicability of the GRACE data, we estimated the mass variation of the combined area of Chao Phraya river basin and the neighboring 3 river basins, namely, Mekong, Salween and Irrawaddy river basins. The locations of the rivers are shown in Fig. 2.

Currently 22 data sets of GRACE Level 2 (near) monthly gravity field solutions up to degree/order 120 or 70 have been released. To obtain the gravity variations over the 22 period, the average of the 22 data solutions were subtracted from each of data sets. The derived variable components were truncated at degree and order of 70. For the recovery of the mass variations associated with the regions, regional spatial filters were designed on the basis of the Swenson and Wahr (2003). Applying the filter to each of the 22 data sets, surface mass variability was recovered.

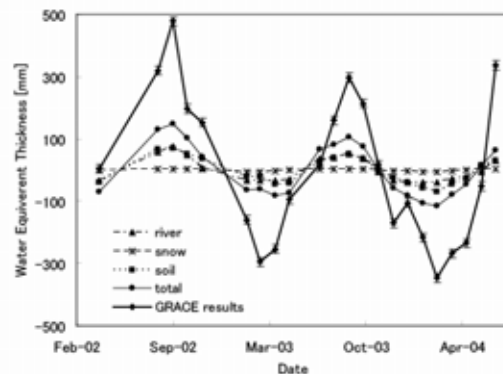
The terrestrial water storage data estimated by Japan Meteorological Agency SiB and GRivet model was used as the hydrological model for the comparisons with the GRACE data in the region. The model contains the components of soil moisture storage (top 1 m), snow storage (water equivalent) and river channel storage.

Fig. 3 shows the recovery of mass variations from GRACE data and the values estimated from the hydrological model in the combined area. The variations derived from GRACE solutions show good agreement with the model, especially in phases. On the other hand, the amplitude is about 2.5 times larger than that of the total (soil + snow + river) of the model. This disagreement is probably due to the effects of unmodelled ground water.

The results clearly show that GRACE data detected the relatively long wavelength mass variation over the combined area of Chao Phraya, Mekong, Salween and Irrawaddy rivers. By combining GRACE data with the precise gravity measurements on land, we expect that more accurate estimation of local and/or regional water variation should be possible.



**Fig. 2** Locations of Bangkok and Chao Phraya, Mekong, Salween and Irrawaddy river.



**Fig. 3** Mass variations over the combined area of Chao Phraya, Mekong, Salween and Irrawaddy river basin derived from GRACE solutions and the model.

## **Information Management for Long-Term Ecological Research (LTER) Network and Collaboration in East Asia-Pacific Region**

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My presentation is intended to give an example of collaborative efforts among countries in developing international research information management system by introducing the strategies of Long-Term Ecological Research (LTER) Networks in the U.S. and in East Asia-Pacific region. Although the information presented here are based only on the information gained from some literatures and on my personal communication with a number of USLTER personnel, I hope they will give some hints in the efforts for information management in GWSP Asia region, and possibly create opportunities for collaboration with LTER in the similar efforts.

Long-Term Ecological Research (LTER) Networks are networks of ecological researchers developing in many countries in the world starting from the United States in 1980. United States LTER (USLTER) was first established in 1980 by National Science Foundation to support research projects to study long-term ecological phenomena. Because of the recognition of the importance of the management of long-term research data by the funding agency from the start of the program, USLTER network has been giving a good deal of efforts in developing information management system as well as to the research activities. In Review Criteria for LTER Information Management Systems Version (2005), the Information Management System is defined as follows.

*The Information Management System at an LTER site encompasses hardware, software, and people to store and deliver scientific information (data and metadata, where data may include both tabular and spatial representations). The goal of an Information Management System is to support site and network science by (1) facilitating access to data and metadata by LTER scientists, the scientific community, and the public, and (2) by ensuring the integrity, security, and usability of those data and metadata for future generations.*

The information management of USLTER can be said to have highly well-developed systems in the area of ecological science. Some of the major database products developed by USLTER are, the integrated databases of climatic and hydrological monitoring data collected from numbers of monitoring stations over LTER sites (<http://www.fsl.orst.edu/climhy/>), the data catalogue that contains metadata for all the research data collected under various research themes at all LTER sites (<http://prairie.lternet.edu:8080/query/>), and site information database with comprehensive web interface (<http://www.lternet.edu/sites/>). Most of the data are shared online publicly. Another product that has been resulted from the USLTER's continuous efforts to provide convenient and standardized tools for ecological scientists and information managers is the Ecological Metadata Language (EML), a metadata language designed to be used to document ecological data. Creating metadata for documenting research data and maintaining the metadatabase is an essential process to ensure accessibility and usability of the data for a larger data-user population. EML, being based on XML (eXtensible Markup Language), a widely-used data format for documenting data, has strength in customizability and compatibility with many other XML-based metadata formats.

Currently LTER networks in various countries are connected as the International LTER (ILTER) network. East Asia-Pacific (EAP) regional IILTER network is the group of networks in neighboring countries in the name-sake region to ensure a closer cooperation between them. Current member

networks are Australia, China, China-Taipei, Mongolia, South Korea, and the unofficial members are Indonesia, Japan, Philippines, Vietnam, and Malaysia.

Although the development of information management systems in each country network in the EAP region vary in levels and generally far behind of USLTER, a cooperative movement to developing regional information management system to share the research data and facilitate synthesis of data collected in various countries in the region has been initiated. Three information management workshops were planned to share the experience in information management, to build a road map to the regional information management system, and to fill the technological gap between networks. At the first workshop held in July 2005 in Beijing, the adoption of EML as the standard metadata language for the regional information management system was agreed. In many member countries, not only EML, but the concept of metadata is still unfamiliar to most scientists. One of the difficulties that may be unique to cross-national database may be the language issues. It is not always possible to enforce the documentation of data only in an international standard language such as English when the data set contains words in local languages that may only make good sense being in the local language. While XML-based metadata language can easily accommodate multiple languages, it will still require some extra efforts to make the keywords searchable in two or more languages.

Based on the information I collected from several EAP region member networks and USLTER, some of the key factors to a successful development of information management can be: enforcement of information management by the funding agency, strong technical support by the network headquarter and between sites to fill the technological gaps, providing easy-to-use tools including metadata to the data handlers, strong encouragement to researchers to cooperate in data sharing, and setting strict data access policy to protect investigator's benefits.

The efforts of establishing cross-national research information management system are happening in long-term ecological research community as in many other scientific communities still with many hurdles to overcome. Although the type of data may be completely different, the type of efforts necessary for building such systems should be common regardless of the subject area. Sharing knowledge, experiences, and technologies among different disciplinary communities may facilitate standardization of some of the information management methods and data sharing possibility between wider disciplinary areas, helping the entire scientific community in future. I hope this information will help promote any form of mutual cooperation in development of information management system in GWSP-Asia community and LTER network.

Reference:

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Appendix:

US LTER web site can be reached at: <http://www.lternet.edu/>.

International LTER: <http://www.ilternet.edu/>.

# **Simulation of Water, Carbon and Nitrogen Dynamics over Watersheds**

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## **INTRODUCTION**

Water is a control factor of ecosystems in China, especially in northern China, where ecosystems are very fragile because of the shortage of water. With the rapid development of economy and growth of population, inhabitant life, industry, and agriculture have greater water demands in this region, but ecological water use has been ignored. Sharply decreasing allocation of ecological water has caused ecosystem deterioration, such as vegetation degradation, soil erosion, land desertification, and rivers and lakes drying up. At the same time, water quality become worse and worse due to intensive fertilizer use, and leaching from septic tanks, sewage, etc. In such a situation, there is an emergency need to support decision-making in ecological and environmental management. Typical issues include global change impact assessment, water resource allocation in a river basin, and environmental impact assessment of human activities in large river basins.

For sound management and decision making for sustainable development at the scale of large river basins, the catchment-based ecosystem assessment, emphasizing biophysical and hydro-biogeochemical processes and human interactions, is a key task, which objectives mainly focus on answering the following questions: 1) what are the major pressures to the catchment ecosystem? 2) What are the major impacts on the ecosystem services such as water and food supplying capacities, biodiversity, carbon and nitrogen sequestration capacity, flood control capacity, and so on? 3) What kind of policy and technological options can be implemented in order to achieve sustainability in the catchment ecosystem?

To answer the above questions, an integrated catchment-based model has been developed to estimate the spatial and temporal distributions of the water cycle, carbon cycle, elements and nutrient cycles, sediment transport as well as land productivity on regional and catchment scales.

## **METHODOLOGY**

In the National Institute for Environmental Studies (NIES), Japan, an integrated catchment-based eco-hydrology model (Nakayama and Watanabe, 2004) for water and material cycle has been developed. Meanwhile, an ecosystem model, BIOME-BGC (Running and Coughlan, 1988) has been modified and validated for various ecosystems by using the observation data in China, which results showed that anthropogenic forcing had an apparent effect on the water and carbon fluxes and sequestration capacity (Wang and Watanabe, 2005). Integration of these two models is very much powerful for us to simulate the water, carbon and nitrogen dynamics over watersheds in China. The model has been applied to both the Changjiang River and Yellow River catchments in China. The MODIS satellite data are used as the input parameters for simulating the interaction among atmosphere, vegetation, and soil. By using the integrated model, the future impacts on the ecosystem function of water, carbon and nitrogen cycle was predicted based on scenarios, such as the decrease in crop production due to water shortage, and the increase in temperature, soil erosion, and desertification due to the land use/cover changes.

## RESULTS AND DISCUSSIONS

The model simulated well the measured values of soil moisture, soil temperature, groundwater level, and river flow discharge throughout the year, showing that this model achieves a fairly high accuracy and that the mechanism of runoff is related to changes in soil texture, soil moisture, and groundwater level. Fig.1 shows that the model can simulate the river flow discharge of the Changjiang River better than that of the Yellow River, because that the water in the Yellow River are intensively disturbed by human activities.

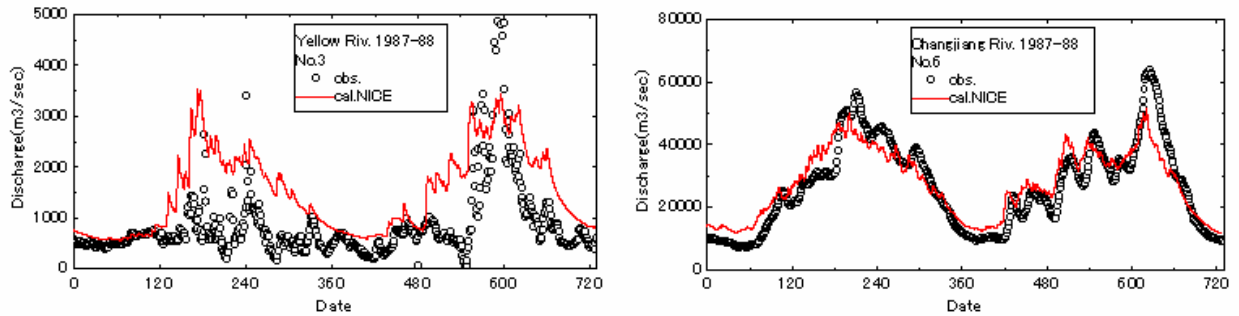


Fig.1 Simulation of river flow discharge of the lower reaches of the Yellow River (left) and the Changjiang River (right) in China (1987-1988)

In the real world, ecosystems are often disturbed intensively by anthropogenic and environmental change forces, such as irrigation, fertilizer application and the increase of CO<sub>2</sub> concentration. Simulation under the undisturbed scenarios is an important way to understand the potential plant growth as well as water, carbon and nitrogen exchanges without the impacts of human activities. Both the net CO<sub>2</sub> ecosystem exchange (NEE) and evapotranspiration (ET) simulated under the undisturbed scenario were lower than those simulated under the disturbed scenario and observed values. These results showed that enhanced atmospheric CO<sub>2</sub> concentrations and especially increased nitrogen application had a marked effect on the simulated water and carbon sequestration capacity and played a prominent role in increasing this capacity (Wang and Watanabe, 2005). Finally, we applied the integrated model to estimate the daily changes of carbon and Nitrogen fixation by vegetation using MODIS satellite data as inputs for both the Yellow River Basin and the Changjiang River Basin from 2001 to 2003. Fig.2 gives the annual accumulated carbon fixation in 2003 as an example.

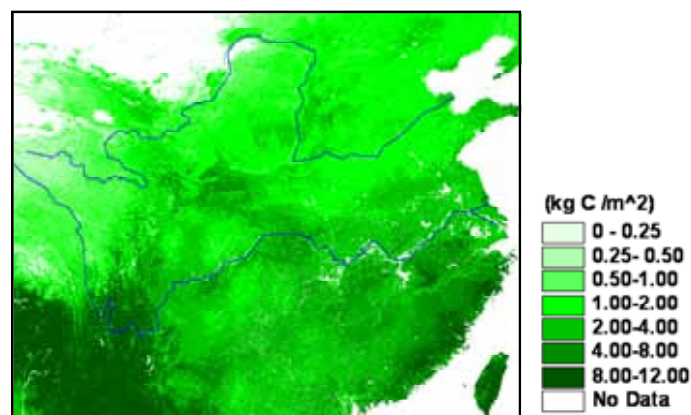


Fig.2 Estimated carbon fixation by vegetation by using MODIS satellite data as inputs for both the Yellow River Basin and the Changjiang River Basin in 2003

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## Diversity of viral-like agents to attenuate *Microcystis* bloom\*

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### Introduction

*Microcystis aeruginosa* is a common bloom-forming cyanobacteria in eutrophic freshwater environments, and it has harmful effects on animals and, potentially, human beings. Several different types of virus has been reported as algicidal agents for specific host species in marine and freshwater environments. However, there is no report of a virus infectious to *M. aeruginosa* because of the difficulty of isolating the viruses. We attempted to demonstrate the diversity of virus-like agents which infect *M. aeruginosa* in a hyper-eutrophic pond using pulsed-field gel electrophoresis (PFGE) which enabled size fraction of intact large DNAs and separating viruses in a natural community according to genome size without the viral isolation.

### Materials and Methods

Pond water (Matsuyam, Japan) was collected on 14 Oct., and 2 and 16 Dec. 2001, and transferred to a glass bottle to kill cellular microorganisms such as bacteria. The supernatant after settlement of chloroform was filtered through a GF-75 (normal pore size, 0.3  $\mu\text{m}$ , Advantec, Japan). The filtrate was inoculated into a bottle with axenic *M. aeruginosa*. The virus-host suspensions were then incubated at 25  $^{\circ}\text{C}$  under a 12-12 LD at 50-60  $\mu\text{E}^{-2}\text{sec}^{-1}$  for 7 days. To verify the algicidal effect of the inoculum on *M. aeruginosa*, the host cell density in each bottle was monitored during the incubation period by counting cell numbers using a microscope. To detect different virus types based on their genome size, viral DNA was extracted from the virus-host culture on 0 day and 7 days of incubation, the viral-host suspensions were filtered through GF-75 glass-fiber filters to remove host cells. The filtrates were concentrated by centrifugation. The concentrates were then treated with a mixture of DNase I and RNase A to digest cellular DNA and RNA released by lysis of *M. aeruginosa*. The virus samples were then transferred to Eppendorf tubes and centrifuged. Viral DNA was extracted by Proteinase K (100  $\mu\text{g ml}^{-1}$ ) to disrupt the viral proteins. DNA pellet was resuspended in 0.01 M Tris-Hcl (pH 8.0) and used for PFGE analysis. For PFGE analysis, viral DNA extracted from culture water was loaded onto gels using the CHEF-DR III system (Bio-Rad, USA). After electrophoresis, the gels were stained with SYBER Green I (Molecular Probes, USA) following the manufacture's protocol and were photographed using Lumi-Imager<sup>TM</sup> F1 (Roche Molecular Biochemicals, Germany). Identification of DNA size and determination of the fluorescence intensity of DNA bands were conducted using the Lumi-Imager<sup>TM</sup> F1 Workstation version 3.1 (Roche Molecular Biochemicals, Germany). Any DNA band that appeared on the PFGE photograph on day 7, and for which fluorescence intensity increased during the 7-day incubation of the virus-host suspension, was identified as a DNA band of a virus-like agent infecting *M. aeruginosa*.

### Results and Discussion

After 7 days, the cell density of *M. aeruginosa* had decreased approximately ten-fold when incubated with the cell-free viral, whereas it did not decrease in the control cultures. This indicates that the cell-free viral community contained agents responsible for the deaths of *M. aeruginosa*. The DNA fingerprint extracted from these cultures using PFGE showed, in total, ten different-sized bands (10-90 kb) which were not present on day 0. These DNA sizes were within viral genome sizes reported in previous studies. No *M. aeruginosa* DNA was detected in the PFGE samples by using hybridization analyses of the *M. aeruginosa* whole genomic DNA probe against these DNA bands. These data suggest

that multiple virus-like agents kill *M. aeruginosa* and could be involved in regulating the population dynamics of *M. aeruginosa* in natural environments.

#### Conclusion

We demonstrated the existence of diversity of virus-like agents killing *Microcystis aeruginosa* in a shallow hyper-eutrophic pond in Japan without specific virus isolation once in October and twice in December 2001.

\*An abstract of the submitted paper “Diversity of virus-like agents killing *Microcystis aeruginosa* in a hyper-eutrophic pond” by Honjo, M., Matsui, K., Ueki, M., Nakamura, R., Fuhrman, J. and Kawabata, Z. which is under reviewing.

# **Ecological impacts of hydrological changes in the Yellow River Basin, China**

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The Yellow River is the second largest river in China with drainage area of 752,443 km<sup>2</sup> and main courses of 5,464 km long. The Yellow River is known as the cradle of Chinese civilization. However, climatic changes and the intensified human activities have resulted in significant changes of hydrological cycle in the river basin. The hydrological changes have consequently shown great impacts on ecosystem of the river basin, which thereby has feedbacks to human society. The water related ecological problems nowadays have been obstacles for sustainable development in the Yellow River Basin and have attracted many attentions from researchers as well as decision makers.

## **1. Changes of hydrological cycle**

### ***1.1 Changes of hydrological regime***

The river flow of the Yellow River Basin has shown great changes during 1952 to 1997 (Huayuankou station). The surface runoff and groundwater runoff both have strong decreasing trends, with average annual change of  $-2.82 \times 10^8 \text{m}^3$  and  $-0.25 \times 10^8 \text{m}^3$  respectively. However, the most significant change of hydrological regime in the Yellow River Basin may be the frequently drained dry during 1970s to 1990s. During the periods, the lower reaches of the Yellow River had been drying up for 21 times, and had become more serious since 1990s when the phenomena appeared earlier and lasted for a longer time with the channel without any flow extending upstream.

### ***1.2 Changes of river system***

The Yellow River is a river with high intensity of human activities. During its long history of development, many artificial projects like canals, dikes, dams have been constructed to transfer water for irrigation, to protect flooding and to generate hydropower. Especially in the last 50 years, a great number of hydro-projects have been built to meet the need of socio-economic development within the Yellow River Basin and even outside regions. Thousands of reservoirs now locate within the basin with the storage capacity amounts to about 60 billion cubic meters, which is above the total annual runoff of the Yellow River (58 billion cubic meters). As a highly regulated river, the changed river systems have impacts on distribution of stream flow not only in time but also in space.

## **2 Ecological impacts**

As a result of hydrological changes, a number of ecological problems have been induced as direct or indirect rewards. These rewards could appear immediately as quick response and gradually as slow response. The interaction between hydrological changes and ecosystems is very complicated as the systematic problems concerning micro and macro attributes. In such cases, some major disastrous impacts are briefing as follows.

### ***2.1. Raise of riverbed***

The Yellow River is also known for its high density of sediment. Because of the decreasing stream flow, there is now no enough water to carry the sediment to the sea. In 1950s, 80% of the sediment silted up in the floodplain but now great amount of sediment is silting up in the watercourse and makes the riverbed higher than the floodplain. The aggregated high riverbed will then raise flood water level in watercourse even higher than the floodplains and may cause a serious threat of flooding.

### ***2.2. Aggravation of water pollution***

Purification of the river would be weakened because of lower discharge. Aggravated water pollution will do harm to lives in the river and may also caused chronically pollution of crops irrigated

by the water. All of these events could cause health problems of the people who live along the river directly or indirectly as a severe disaster to the downstream residents

### ***2.3. Degradation of delta***

The water flows drained dry in the lower Yellow River makes its estuary in a condition of no water or low discharge during a certain period of a year. The subsequent problems in the delta areas are river shrinking, lacking of groundwater replenishment and aggrandizing the saline/alkaline soil.

### ***2.4 Reduction of biodiversity***

The imbalance of water has threatened the wildlife of the estuary wetland, where there are 8,000 aquatic species, more than one hundred kinds of wild animals and 180 kinds of birds. Ten species of fish are now facing the risk of extinction. It should be pointed out that the hydrological changes have accelerated the decreasing of biodiversity in the estuary of the Yellow River.

## **3. Countermeasures**

With the increasing concern about the ecosystem health of the Yellow River Basin, integrated water resources management has been accepted as an important approach to balance the conflicts between socio-economic development and eco-environmental protection in the region, among which the estimation of environmental flow is a vital issue. Integrated water resources management mean not just harmonizing the relationship among different aspects of water utilization, but also rational water resources allocation among regions from upstream to downstream taking both water quantity as well as water quality under consideration.

Since water consumption of agricultural sector accounts for above 92% of total water used, the development of water-saving agriculture would do great benefits to the improvement of ecological health in the river basin. Besides that, structural measures must be taken to enhance the availability of water resources. The western route of south-to-north water transfer project must be one of the potential structural measures.

**MAHASRI (Monsoon Asia Hydro-atmosphere Scientific Research Initiative)**  
**– Proposal for the Post-GAME Asian monsoon hydrometeorological program –**

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The international research program on water and energy cycle in Asian monsoon, named GAME (GEWEX Asian Monsoon Experiment :<http://www.hyarc.nagoya-u.ac.jp/game/>) successfully finished in March 2005. Through the GAME and other monsoon projects, our understanding on Asian monsoon has been substantially progressed. However, the researches from these projects also reveal, interannual, seasonal and/or daily forecasts of monsoon rainfalls, for instance, are still not satisfactory, and unpredicted floods and/or droughts occur in many places year by year in Asian monsoon region. In addition, the influence of ongoing global warming and human-induced atmospheric pollution and/or land cover/use changes on monsoon climate has yet not been fully understood. However, the scientific understanding, research strength, and scientific collaboration and organization from the GAME project do pave the way for investigation in the next stage program to improve the prediction of monsoon and its hydrological cycle.

To tackle these targets, many challenging issues have to be solved. In particular, better resolution of diurnal cycles, and their multi-scale interactions with intraseasonal variability are crucial for improving prediction of convection and precipitation. Seamless understanding of surface-atmosphere interaction, boundary layer processes and cloud/precipitation processes are essential for improving models, including cumulus parameterizations. Understanding of hierarchical structure of meso-scale system embedded in large-scale fields, mutual interaction between low level jet/moist convection and large-scale field over complex terrain and warm water pool will be particularly important for prediction of severe rainfall systems in East and Southeast Asia. In addition, a great role of vegetation and aerosols on atmospheric heating and cloud/precipitation system and monsoon circulations in Asia, has recently been pointed out, which GAME noted only partly. In addition, since GAME targeted mainly on land-atmospheric interactions, land-ocean-atmospheric interactions have not been fully understood yet. As for the regional foci, since GAME-Tropics targeted mainly monsoon processes in Indochina region, those of the whole tropical Asia including South Asia and Indonesian Maritime Continent also need to be studied. In a similar manner, more comprehensive study on East-Asian monsoon system may also be necessary. Furthermore, the processes in Asian winter monsoon should also be targeted, since they also relate with water cycle in the Maritime Continent.

In the final GAME International Conference in December 2004, the need for further research program on Asian monsoon was approved and its initiation was strongly recommended. The CEOP Phase-2 implementation/science is now being proposed, based on the unique capabilities of the coordinated observation, data archiving, and data integration, developed through the CEOP Phase-1. Very recently, the global climate research community has also agreed to have strong coordinated research framework, particularly on the Asian/Australian monsoon system both in observations and modeling/prediction (e.g., at the 1st Pan-WCRP Monsoon System Workshop held in June, 2005). Taking its huge and serious influence on human activity, WCRP has endorsed hydro-climate study of monsoon systems as a key component of COPES (Coordinated Observation and Prediction of the Earth System: <http://www.wmo.ch/web/wcrp/copces.html>), which is a new strategic framework of WCRP from 2005 to 2015.

On the other hand, both in Johannesburg Summit and UN Millennium Developing Goals (<http://www.un.org/millenniumgoals/>), solution of poverty and food problem, and develop global

partnership for sustainable development are located as important topics. Solution of water issue is the key for both issues, and accumulation of scientific understandings is highly anticipated to attain their objectives. Ten-year Implementation Plan for the GEOSS (Global Earth Observation System of Systems: <http://earthobservations.org>) has been started this year based on the agreement of the Third Earth Observation Summit, and new funding opportunities have emerged in Japan as well as in some other Asian countries.

However, research strategy on Asian monsoon which will be a successor of the GAME project has not been established yet. It will be very important in conjunction with GEOSS activities to develop studies on Asian monsoon by strengthening and promoting our partnership with Asian countries that has been cultivated through the GAME project.

Herein, we would like to propose an international program in Asia, focusing on establishing scientific basis of predicting hydro-climate monsoon system with intraseasonal to seasonal time-scale, including developing warning systems for droughts and flood conditions of regional or river-basin scales. The tentative title of this new program will be MAHASRI (Monsoon Asia Hydro-atmosphere Scientific Research Initiative). This program should undertake an essential role in WCRP activity in Asia in cooperation with CEOP, and will contribute to other related international initiatives, e.g., THORPEX, GWSP, IHP-PUB etc.

The tentative objective of MAHASRI is, "To develop a hydro-meteorological prediction system, particularly with the time scale up to a season, through the better scientific understanding of Asian monsoon variability".

The key scientific issues to be tackled will be:

- Atmosphere-ocean-land interactions in the Asian monsoon system
- Temporal interactions among diurnal, synoptic, intraseasonal and seasonal variabilities of Asian monsoon
- Spatial interactions among hydrometeorological phenomena of local, regional and continental scales
- Interactions of surface and boundary layer processes with convective cloud system
- Comparisons of hydro-meteorological characteristics within the Asian monsoon system
- Effect of human related activities (i.e., emission of aerosols and greenhouse gases, land-use/cover change) on hydro-meteorological variations in Asian monsoon regions
- Down-scaling and up-scaling processes with regional hydro-meteorological modeling and prediction
- Transferability of hydrological models and parameters for prediction of ungauged or sparsely observed basins
- Incorporation of new technologies for observation and computation

The following items will be achieved:

- Determine predictability and key components of Asian monsoon variability with a time scale up to a season for the development of a hydro-meteorological prediction system
- Develop a real-time monitoring and/or modeling capability for hydro-meteorological prediction and water management in specific river basins in Asian monsoon regions
- Develop integrated hydrometeorological database of Asian monsoon regions with data rescue

In the International cooperation strategies, it will facilitate and/or improve hydro-meteorological observations in Asian monsoon countries in conjunction with GEOSS. Cooperation with CEOP-II by observations, data and hydrometeorological studies in Asian monsoon is important component. Contribute IPY (International Polar Year) by conducting intensive observations in Asian monsoon region may be considered. Capacity building for observation, analysis, data-integration and modeling is

one of the most important things to be attained.

As for the regional foci, the following four regions will be focused, thus include so-called whole Asian monsoon region: 1. Tropics including India and the Indonesian maritime continent, 2. Tibet/Himalaya, 3. East Asia, 4. Northeast Asia

The tentative time schedule will be as follows:

September, 2005-September, 2006: Planning and preparation phase

September, 2006-March, 2011: Research phase

2006-07: Build-up new observation systems

2008: Intensive observation year in conjunction with IPY

March, 2011-March, 2012: Concluding phase

Since the planning of this new program has just started input from GWSP and other related programs related with hydrometeorology will be highly welcomed.

## Symptom and potential effect of nitrogen saturation in forested catchments in Japan

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### Abstract

Effects of nitrogen saturation on surface water quality are one of the major concerns of biogeochemical researchers in North America (Stoddard, 1994) and Europe (Skeffington, 1990). These effects have been often studied in the context of evaluation on effects of nitrogen deposition. Various definitions of nitrogen saturation proposed (1) nitrogen leaching through out the year (Aber, et al., 1989); (2) physiological N demand of primary producers is met and considerable nitrate leaching occurs (Tamm, 1991); and (3) N outputs exceed inputs over extended periods (Agren and Bosatta, 1988). Stoddard (1994) also pointed out that the most advanced symptoms of nitrogen saturation usually occur in regions with most elevated rates of N deposition. It can be stated that nitrogen saturation is one of major elements among the various effects acid rain. In Japan atmospheric input of nitrogen are currently elevated, especially in urban and environs, although SO<sub>2</sub> emission had markedly decreased after the governmental countermeasure had been substantially performed in the second half of 1970's. Several studies reported that a dominant anion in causative substances of acid rain is NO<sub>3</sub><sup>-</sup> rather than SO<sub>4</sub><sup>2-</sup> in Japan. Ohri and Mitchell (1997) showed that several forest watersheds in Northern central Japan are exhibiting nitrogen saturation. Mitchell et al. (1997) evaluated the status of nitrogen saturation of 24 Japanese sites. They pointed out high N mineralization, which is predisposed by high temperature and abundant soil moisture during growing season, as a causative factor of nitrogen saturation.

The biogeochemistry of nitrogen plays a critical role in affecting productivity and water quality of forested watersheds. The concept of "nitrogen saturation" has been used in evaluating anthropogenic influences, including elevated atmospheric nitrogen deposition, on forests. Few comparisons of nitrogen saturation have been made across a broad range of forest ecosystems. In the current study, we examined hydrobiogeochemistry of nitrogen of forested watersheds in Japan, Northeast America. Two distinct differences were found between watersheds in Japan compared with those in North America: 1) In Japanese watersheds, marked decreases of NO<sub>3</sub><sup>-</sup> concentration in surface waters during the summer growing season were not found and NO<sub>3</sub><sup>-</sup> concentrations sometimes increased especially in the summer at nitrogen saturated sites (Figure 1). This contrast with watersheds in North America was decreases in NO<sub>3</sub><sup>-</sup> concentration during the summer are commonly observed except those watersheds in advanced stages of nitrogen saturation. These differences in NO<sub>3</sub><sup>-</sup> concentration relationships between these regions can be attributed to climatic differences, with Japan having high precipitation and high discharge during the summer, while in many regions of North America lowest discharges are found in the summer. The climatic regime in Japan leads to high rates of mineralization and the rapid transport of NO<sub>3</sub><sup>-</sup> to streams in summer. 2) Japanese watersheds, even those with high NO<sub>3</sub><sup>-</sup> concentrations in surface waters, show little evidence of acidification due to their high base status. This is in contrast to sites in North America and Europe where increased NO<sub>3</sub><sup>-</sup> concentrations, especially during episodic events, results in stream acidification. However, in Japan high NO<sub>3</sub><sup>-</sup> concentrations in waters need to be evaluated with respect to other water quality concerns.

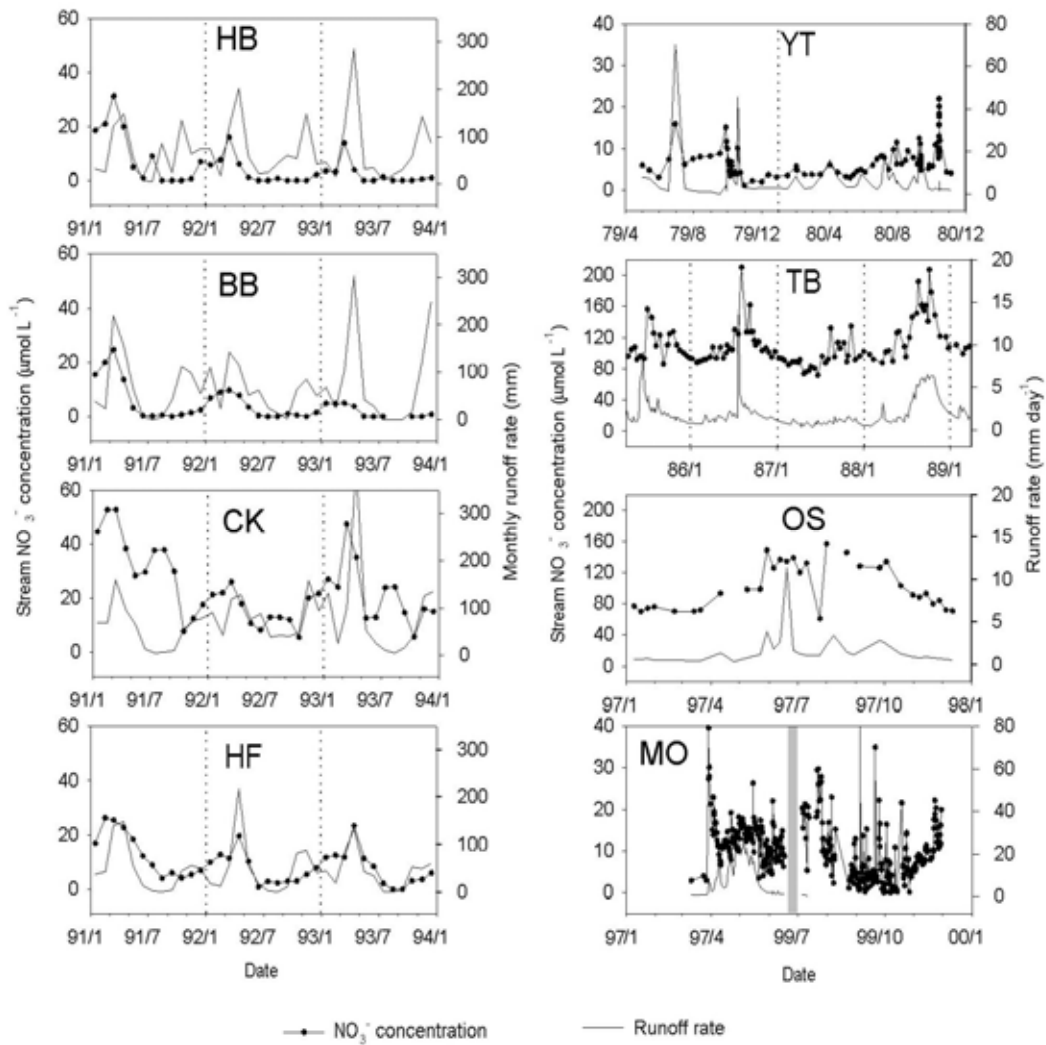


Figure 1. Seasonal variations of  $\text{NO}_3^-$  concentration and runoff rate. Four sites were selected from each northeast US and Japan (HB: Hubbard Brook, BB: Bear Brook, CK: Catskill, HF: Huntington Forest in United states and, YT: Yanagatani, TB: Tsukuba, OS: Ohyasan, MO: Moshiri). (after Ohte et al., 2001).

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**Introduction of multi-tracer approach to elucidate hydrological processes  
in a semi-arid region, eastern Mongolia  
- Products of isotope group of RAISE Project -**

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1. Isotopic variation of precipitation

For understanding mechanisms of precipitation variability causing severe droughts/floods, it worth quantifying contribution ratio of local and non-local water vapors to precipitation. We investigated characteristics of monthly/daily precipitation-isotopes over eastern Mongolia as a basic knowledge to assess the above. Temporal variation of precipitation isotopes, which has a dominant periodicity of 1-year, was considerably homogeneous in and around the Kherlen River basin. Local characteristics were not significant. Precipitation appears to be in isotopically equilibrium with water vapor within the atmospheric boundary layer (ABL). Considering a water-vapor-isotope result which suggests that contribution of locally evapotranspiring water vapor to that within the ABL is not dominant, great portion of precipitation (e.g., more than 80%) should be outside of the Kherlen River basin in origin.

2. Spatial and temporal variation of stable isotopes in atmospheric water vapor and subsurface water at grassland and forest sites

The source of atmospheric water vapor on the ground surface was investigated using stable isotopes of water in Kherlen River basin, eastern Mongolia. We observed stable isotopic compositions of atmospheric water vapor at the heights of 0.5 to 1000 m above the ground surface by aircraft and ground observations from June to October 2003. Also, soil water at the depths of 0.1 to 1.5 m, groundwater, stream water and plant water were also sampled and analyzed for stable isotopes. Seasonal variation trend of stable isotope in water vapor agreed well with that of precipitation at the grassland and forest sites. The ratio of transpiration rate to the evapotranspiration rate was estimated to be 60 to 73 % at the forest site, whereas that was estimated to be 49 to 58 % at the grassland site.

3. Groundwater flow system

We investigated recharge and flow system of groundwater in the semi-arid region of the Kherlen River Basin, using  $^2\text{H}$ ,  $^{18}\text{O}$ ,  $^3\text{H}$  and solute concentrations in groundwater, river, spring water and precipitation. The relationship between altitude and  $\delta^{18}\text{O}$  of river and precipitation suggests that the recharge altitude of Kherlen River would be from 1750 m to 2500 m which corresponds to the headwater of the basin. Considering the  $^3\text{H}$  concentration in river and groundwater, the residence time of river water should be much shorter than that of groundwater. Based on the stable isotope and Cl data on the groundwater, the precipitation with high amount and low isotopic ratio might preferentially recharge the groundwater, whereas small rainfall might be evaporated after the infiltration and not cause the groundwater recharge. It is probable that the groundwater would not have a contribution by a regional groundwater flow system. It is possible that the groundwater in the flat plain consisted mainly of a local groundwater flow system caused by topographical small relief.

We focus on the interaction between the groundwater and Kherlen River (catchment area: 40,095 km<sup>2</sup>) water considering the stream runoff and stable isotope data. The stream base flow discharge was measured in main stream and tributaries flowing into the main stream during a dry period in June 2004. The main stream runoff rate increased from 10.8 m<sup>3</sup>/s to 12.6 m<sup>3</sup>/s during a flow

of 300 km. A simple mass balance model including runoff rate and stable isotope ratio in the stream was used to estimate the inflow rate of the groundwater into the main stream. The inflow rate was estimated to be  $1.0 \text{ m}^3/\text{s}/58\text{km}$  in the upper stream, whereas that of lower stream was estimated to be  $2.6 \text{ m}^3/\text{s}/247\text{km}$ . Thus, approximately 10 % of the stream runoff was recharged by groundwater in the upper stream in the Kherlen River.

#### 4. Overland flow generation and surface erosion

The purpose of our research is to study and assess the state and the causes of soil erosion through the monitoring of overland flow and soil erosion. The study site locate 60-100 km east of Ulanbaatar. One site is Kherlen Bayaan Ulaan (KBU), and the other site is Baganuur (BGN). The drainage area of the watershed is 7.1 ha and 8.0 ha, and relative height is 105 m and 160 m, respectively. Parshall flumes and sediment traps were installed at the outlet of the catchments. Also we established 2 hillslope plots (50 m x 50 m) in each area in which one is surrounded by fences. Discharge flow plots were monitored by Parshall flumes, and tensiometers, raindrop impact sensors, wind velocities were also recorded. About 50 Soil cores were sampled in each catchments and Cs-137 analysis were conducted. The runoff peak in 2003 in KBU is greater than BGN. Through the Cs-137 analysis, long term soil erosion is very significant throughout the catchment in KBU, but deposition area were detected downslope of the catchment and lower overall erosion rate in BG. These data suggest the overlandflow erosion is significant in the study area, but importance of surface erosion varied between place to place.

#### 5. Difference in runoff process between steppe and forest-steppe sites

We compared the runoff process of steppe drainage basins with those of forest-steppe ones. The study sites (Gr and Sa) of forest-steppe areas locate about 30km east and north of Ulaanbaatar. The drainage area of drainage basin of Gr and Sa is  $1.7 \text{ km}^2$  and  $2.7 \text{ km}^2$  and relative height is 450 m and 500 m, respectively. Both sites are covered with coniferous forest and grassland. The steppe sites (KBU and BGN) locate 60-100 km east of Ulaanbaatar. The drainage area of the watershed is 7.1 ha and 8.0 ha, and relative height is 105 m and 160 m, respectively. The vegetation of steppe sites occurs more sparsely than that of forest-steppe sites. Parshall flumes were installed at the outlet of the drainage basins. Not only quick discharge with very steep rising limbs and recession curves, but also continuous runoff occurred in forest sites, whereas only quick discharge occurred in steppe sites associating with heavy rainfall. These facts imply that regolith layer acting as a flow path in forest-steppe sites generates continuous discharge, but only overland flow occurs in steppe sites.

This work has been supported by a CREST project (*RAISE*: The Rangelands Atmosphere-Hydrosphere-Biosphere Interaction Study Experiment in Northeastern Asia) of JST (Japan Science and Technology Agency).

# **Expectations from a Human Dimensions Perspective**

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## **Key Areas for Research on Adaptive Capacity and Governance of the GWS**

- Adaptive Capacity
  - What determines adaptive capacity at different scales?
  - Scenarios for change and possible implications
- Governance
  - Transition to more adaptive governance regimes
  - Understanding role of scales in multi-level governance
  - Need for global governance? (currently emphasis back to local scale)
  - Role of context and culture

## **Some GWSP-related Activities in Europe**

- Research under the umbrella of FP6
  - NeWater – New Approaches to Adaptive Water Management under Uncertainty ([www.newwater.info](http://www.newwater.info))
  - AquaStress – Integrated Options to Mitigate Water Stress
  - ASEM WaterNet - S&T cooperation between Europe and ASEM countries (network on governance)
  - The Human Dimension in Water Management – Project Cluster supported under FP5
- European Water Initiative
  - Policy process to support the Johannesburg targets for developing IWRM plans and increase access to safe drinking water and sanitation.

## **Potential Areas of Collaboration**

- Topics under Theme 1
  - 1.1 Water Governance and the Global Water System
- Topics under Theme 3
  - 3.2 The Nature of Adaptive Capacity of the Global Water System
  - 3.3 Approaches to Enhance Adaptive Capacity
- FTA - Global Governance
- Funding possibility under EU FP6
  - Twining basins between Europe and South-East Asia

## **Expectations for this meeting**

- Development of concrete idea for joint proposal on Twining Basins in IWRM (emphasis on governance) to be submitted early November 2005
- Ideas on potential collaboration on a project focusing on global governance - workshop (FTA) to be held spring 2006 with goal to identify research priorities and sources for funding

- Plan for capacity building with emphasis on human dimensions (e.g. summer schools, PhD exchange)
- Development of relationships to the Asian GWSP community as base for future exchange

### **Project Proposal Twinning Basins**

#### Contribution to GWSP Theme 3

- Adaptive capacity of human-environments systems and governance regimes at different scales
- Method development for regional comparative analyses and start to develop a data base
- Analyse need for governance/management at larger than basin scale

#### Contribution to GWSP networks

- Establish link to the emerging Asian GWSP network
- Strengthen capacity of the human dimensions research in the GWSP network in general, and GWSP Asia, in particular
- Establish link between GWSP and the IWRM community

#### Ongoing projects on which to build and links to the GWSP

- NeWater project on adaptive water management with basins in Europe, Central Asia and Africa (coordinated by USF, Osnabrück, Germany)
- The Yellow River project (coordinated by RIHN, Japan)
- M-Power project in the Mekong basin (coordinated by USER, Thailand)

It was decided to develop a project proposal (catchments – Mekong, Yellow River, Rhine, Guadiana) with Asian partners attending the GWSP Asia meeting to be submitted for funding to the European Commission. This proposal can serve as base for a global comparative analysis of basins and further comparative analyses of governance regimes in river basins and coastal zones (suggested by Felino Lansigan).

Overall it can be noted that the representation of the Human Dimension was quite weak in the GWSP Asia meeting. More efforts are needed to strengthen the capacity of human dimensions researchers and invite them to participate in this network.

## Summary of Theme 1 - Magnitudes and Mechanisms of Change

Chairs: Makoto Taneguchi and Arthur C.T. Chen

Secretary: David Dudgeon

The first presentation was by Chen Jianyao (Zhongshan University) who compared a variety of attributes of the water cycle in the Yellow River in the north of China and the Pearl River in the south. Major problems identified in the Yellow River were excessive extraction of water for increasing amounts of agricultural land, and per capita water availability was relatively low. Water availability in the south was much higher, and irrigation off-take was a much less important problem. However, lowering of the Pearl River bed for sand excavation (3-8 m in the last 40 years) has led to seawater intrusion at the mouth of the Pearl River causing local water shortages for some cities (e.g. Zuhai). Pollution from point and non-point sources are also very serious in the Pearl River, including pollution of ground water by (e.g.) poorly-designed landfill sites and septic tanks. In short, the main problems in the Yellow River the main problems are demands on the river arising from land reclamation for irrigated agriculture and absolute water shortage. For the Pearl River they are not absolute water shortage, but problems arising from saline intrusions and those associated with rampant urbanization leading to pollution of surface and ground waters.

Ururu Tsunogai (Hokkaido University) gave the second presentation and described the relevance of some geochemical techniques to the GWSP. These related to the input of trace gases (e.g. methane) to the water system, assessment of human impacts on water quality (specially nitrates through stable isotope analysis), and the development of oxygen isotope studies for tracing water cycles. Oxygen isotopes 17 and 18, plus the different isotopic forms of nitrogen, create characteristic isotopic signatures that allow separation of atmospheric or natural *versus* and human-derived sources of nitrate. This approach has only become available in recent years due to new, highly-sensitive analytical methods at Hokkaido University. Contributions could be made to activities related to climate change studies under topic 1.3, as well as geochemical monitoring at hotspots and determination of the source of nutrients and sediments transported to coastal zones relevant to topic 1.5.

In the third presentation, Yoichi Fukuda (Kyoto University) described how gravity measurements can be applied to the water cycles, especially ground water. These involve in situ measurements of gravity measurements combined with kinematic GPS data, plus utilization of satellite derived data (termed GRACE) for remotely estimating regional gravity signals of surface mass which is a surrogate variable for water volume. Gravimetry on land can directly detect changes in groundwater depth but subsequent changes in subsidence require the use of GPS systems, but this combination of local-scale approaches can accurately evaluate local (small-scale) ground-water change as a mass change. This will be applied to the study of groundwater in Bangkok and Jakarta. Regular (near-monthly) satellite observations can be applied at the basin-scale area to reveal mass changes in groundwater, with observations made on the Chao Phraya, Salween, Irrawaddy and Mekong. This approach is still at a preliminary stage, and although around 30 months of data have now been collected the data suggest that the gravity changes at the individual basin scale may be too small to detect from space with current GRACE technology. However, combining all drainage basins up to a larger scale, some understandable patterns begin to emerge revealing significant seasonal changes in groundwater levels. Together the two approaches may be able to reveal local small-scale changes in ground water as well as changes occurring over longer periods at much larger scales. Discussion among participants was

centred on the question of how mass-change signals from ground water in satellite data could be separated from surface water. It was explained that soil and ground water signals tend to comprise the main contribution to gravity changes and, when combined with appropriate models and data filtering, are unlikely to confound the signal indicating mass changes resulting from groundwater fluctuations.

Akiko Ogawa (RIHN and Kyoto University) gave the fourth presentation and described approaches to information management for the international LTER (Long-Term Ecological Research) Network in Japan and collaboration in the East Asia-Pacific Region (EAP). She began by describing the model of the United States LTER system, which provides a good example of how complex, long-term data should be managed. It was established in 1980, and now has 26 sites (co-managed by universities and US land agencies) involves >2000 scientist. It is coordinated by a network HQ established in New Mexico 1988, which plays an important role in information management and making it publicly accessible - this was a key element of the US LTER mandate from the very beginning (and is a criterion for award of funding). Some of the data (hydrology and meteorology) are centralized at US LTER Network HQ, but data collected by individual researchers are stored in a centralized database at each US LTER site; however, a meta-data catalogue is maintained at the Network HQ. In effect, the US LTER has evolved as a distributed database system, with Information Managers working at each site. These Managers meet regularly to share information on editing and development of new data-management tools, and provide mutual technical support. There is a data-access policy to protect investigators' rights to publication of their data that enhances trust and facilitates sharing. EAP-ILTER official members (who have committed long-term funding) are Australia, China, Taiwan, Mongolia and South Korea, with various unofficial members including Indonesia and Japan. Information management systems within the member countries are variable, but the Chinese Academy of Sciences has take steps to ensure that consistent data sets are collected and is progressive in this regard. A workshop of official and unofficial members of the EAP-ILTER was held this year to decide on a common database format (EML) and try to enhance coordination and support for information managers, and to consider how researchers can be supplied with easy-to-use data entry tools. Compatibility of data (and hence integration into meta-databases) will be a key issue for integration and sharing. Because hydrology is a crucial part of ecosystems through its role in material cycling, such information should be a crucial part of any LTER data set, and must be a key component of meta-databases.

The general discussion began by focusing on how we could integrate or synergise the various isolated or individual groups or networks that are dealing with land-use changes, hydrology, biodiversity, LTER, and so on, so that the GWSP-Asia group could move forward in a collective effort to collect, archive and share data along agreed lines devoted to a consensus theme of coordinated observations. Professor S.A. Matsura suggested that this could be an initial activity of GWSP under theme 1. However, it was immediately obvious that it was not clear what should be included in the initial database: what would be the best consensus theme? Various possibilities were raised, but will they were related to the GWSP activities, they were not closely focussed to the activities identified in the GWSP "Science Framework and Implementation" document (listed in Table 6-1 and on pages 33-35). Prof. Koe proposed that we focus our discussions on these and decide which activities should be a priority for the GWSP-Asia Group. This suggestion met with general agreement.

Group members indicated that some of the data relating to certain activities under theme 1 were already available for a number of Asian countries - for instance, those under A 1-2. Professor Alcamo suggested that this might provide an opportunity for GWSP-Asia members to come together and

formulate proposals for GWSP designated projects that might build upon and use existing data, and help fill in gaps. He emphasized that a range of activities were listed under Theme 1 in the *Science Framework and Implementation Activities* of GWSP, and that proposed activities could be tailored to fit in with on-going research activities. Professor Takeuchi indicated that most of the world's major dams were in China, India and Japan, and - because this is a unique regional feature - it should be a focus for the group both by evaluating the likely impacts of dams that are in place, and those that might be built (especially in China and India). Professor Jianyao Chen pointed out that the effects of the dams would likely depend on whether they were built for irrigation (often in lowlands) or hydropower (often in highland or far from human habitation). It was agreed that the effects of dams (including irrigation schemes) might be one focus on the group, and that attention should be paid in particular (but not only) to their indirect effects on coastal areas and marine ecosystems.

Ground water was identified as a key topic that was understudied in Asia, and could therefore provide another focus activity for the group. Professor Jain pointed out that increases in groundwater withdrawal has led to significant intrusion of saltwater in coastal areas of India, and excessive groundwater extraction has also taken place in northern and more arid regions of China. Professor Takeuchi emphasized that there was a need to consider societal drivers or constraints on groundwater use, and place its study in a broad context. Subsurface flows may provide significant nutrients from land to coastal waters, and so it may not be practical to separate studies of groundwater from their implications on coastal areas (and saline intrusion effects). If the group was to consider groundwater within its activities, Professor Jianyao Chen felt that a specific focus would be needed: possibly effects of pollution, or the consequences of excessive withdrawal.

Professor Takeuchi suggested that certain water cycle topics should be best addressed in Asia, and could include the effects of upstream land-use and consequences for nutrient and sediment transport on the coastal zone. Furthermore, that the changes in this regard that were taking place in Asia were likely greater than anywhere else on Earth. Professor Alcamo was of the view that this was well within the remit of GWSP activities, while Prof. Koe pointed out that the coastal mega-cities of Asia must also be impacting global water systems including freshwater and coastal ecosystems (this is relevant to activity 1.2). He added that the rate of change in land-use in Asia was unparalleled on Earth, and that this could provide a focus for our activities. Professor Alcamo reminded the group that 4 of the world's 10 global megacities were in Asia and that given ongoing urbanization, research on the impacts of megacities was an emerging research topic of world-wide interest. Professor Jain drew attention to the importance of long-distance water transfer (both virtual and real) for China and India in particular, and must be looked at in the context of the effects of water diversions.

To summarise, key areas that emerged from discussion were:

- The effects of dams, irrigation and long-distance transfers of (real) water in Asia (A 1-4)
- Impacts of urbanization, megacities, and extensive land-use change on the Asian water cycle

Remaining for discussion is how these topics will be integrated with study of coastal areas and groundwater, and whether the approach used will be hotspot-based or comprehensive.

Makoto drew attention to the need to develop databases on the water cycle in Asia that will integrate existing and developing databases on P, C, N, and contaminants (e.g. IHDP), biodiversity (e.g. DIVERSITAS), precipitation, river discharge, evapotranspiration (e.g. WCRP), coastal water, soil water, groundwater (e.g. IGBP), as well as various types of socio-economic data. Professor Alcamo pointed

out that some types of data (e.g. biodiversity) were poorly developed and could not easily be gathered using existing technologies (e.g. remote sensing), and that this should be a priority area. Professor Koe pointed out that data-base development was a priority cross-cutting activity for GWSP and it was suggested that it might be appropriate to establish a special group to discuss that initiative - this could be proposed during the afternoon plenary session.

Present:

Prof. J. Alcamo

Prof. S.K. Jain

Prof. J. Loebis

Prof. S.A. Matura (part only)

Prof. L. Koe

Prof A. Chen

Prof. J. Chen

Ms A. Ogawa

Prof. Y. Fukuda

Prof. U. Tsunogai

Prof. D. Dudgeon

Prof. M. Taniguchi

Prof. K. Takeuchi

## Summary: Theme 2 - Linkages and Feedbacks

The discussion of the participants in this group was brainstorming and opinion exchange regarding the around the issues of approach on the direction toward the encouraging the collaboration in research activity among the water resource research community in Asia. The discussion topic was around the following topic:

- What are the main linkages and feedbacks within the earth system arising from changes in the global water system?

### Discussion summary:

- Need to have better understanding on the research that has been or being studied. The research community may need to have better information or be able to search for the research topic or project that may be relevant to their work. This could lead to collaboration in the exchange of data set, tool & methodology, research result comparison, joint research activity, etc.
- If the collaboration may be encouraged, how we may focus the study in Asia and. Some of the common area of interest that the participants in the discussion group had brought up include:
  - To develop common framework – methodology, tools and dataset for use in the study of various geographic locations throughout Asia
  - To study the socio-economic changes or human activities that may affect water quality in specific area (also to what extent) which at the end may affect ecosystems and society.
  - To study the changes in water availability and water demand in specific area, which is driven by human activities or socio-economic changes. Also the changes in water management scheme, which may cause large scale water diversion across watersheds that will affect the ecological systems and society.
- In order to proceed toward the enabling of regional collaboration, following issues were raised as suggestion to GWSP Asia to take under consideration:
  - At the moment, collaboration cannot be defined. Collaboration should be result of the process over period of time. GWSP Asia may establish the process to encourage the collaboration, perhaps through theme specific workshop that link researchers together to form up collaboration and synthesize the results at the end of the collaboration.
  - As there still are needs to know who does what, where and how – suggest GWSP Asia to establish database or portal that can establish virtual community of researchers and facilitate the collaboration over time. Facilitating the sharing of tools, method and dataset, perhaps through the portal established by GWSP. The implementation of this concept may not necessary need to be a centralized database of such data set and tools, but to help lead the way to reach the owner of the data set, tool and methodology. The collaboration can be established in bi-lateral basis or among the group or researchers, but under facilitation of GWSP Asia.
  - Review the uniqueness of Asia, as far as water issue is concerned, and also gap in the water related research in Asia, in order to encourage the research on the missing pieces.

## Summary: Theme 3 -Dams, irrigation and diversions

### Preamble

Dam practices and the factors driving their construction vary within and between countries. Very few (if any) large dams are being planned in the North America and Europe. In Asia, the large and growing population combined with highly seasonal rainfall and need for economic development is driving the construction of dams. The needs and perceived benefits of dams in Asia are such that construction would certainly continue and thus there would be consequent influence on the global water system. Although opposition to dams due to perceived adverse impacts is also growing, inability to beneficially regulate rivers has led to excessive extraction of groundwater and associated problems.

In many regions, the local impacts of dams are well understood but the long-term, long-distance and cumulative impacts of dams are less appreciated partly because these have received limited attention. The term *cumulative impacts* includes two distinct outcomes:

- Life-cycle impacts describe the direct and indirect impacts of dams within the drainage basin and on receiving coastal waters, and
- Continental-scale impacts refer to the impacts of a group of dams on the regional/ global hydrologic cycle.

The effect of dams and their nature or construction and/or operation features are different in Asia than elsewhere in the world. Further, the cumulative impacts of dams in Asia are apparently higher than in other regions. In this connection, four overarching relevant issues are:

- Dams within a single country (or region) may be built for different reasons, can have different operation, local climate, socioeconomic conditions, and so on. Hence their impacts are likely to be different.
- The cumulative effect of large dams across Asia in terms of resettlement of people, submergence, sedimentation, nutrient storage/transport, evapotranspiration, local and regional biodiversity, etc. may be far in excess of impacts in other regions.
- The cumulative impacts of dams in Asia, superimposed on ongoing changes in land use /land cover and other landscape processes, have important implications on subsurface water, evapotranspiration, coastal ecosystems, and other aspects of the water cycle.
- There is a need to develop or transfer methods for assessing environmental consequences of dams (relates to capacity building) and to develop/transfer practices relating to dam-operation procedures that will minimize adverse impacts.

Benefits of dams to governments were widely known. Dam builders are also aware that dams could have negative effects but the overall view in Asia is that the benefits outweigh adverse impacts provided attention was paid to mitigate undesirable effects of construction and operation. Environmental impact assessments carried in past were rather short relative to the life of the dam. It is likely that long-term consequences of dams might not have been detected. In any case, these are not always well documented.

### Purpose

Holistic case studies are needed to understand the cumulative impact of dams on hydrology, ecology, evapotranspiration, food production, industrial and socio-economic development, nutrient transport, biodiversity, coastal zones, and so on. Studies of impact of dams integrate hydrology, ecology, social science, economics, and governance. Thus, they provide a unifying theme to study the global water

system and an opportunity to bring together disparate research groups.

The purpose of this working group is to identify and help in initiating studies on effects of dams, irrigation and long-distance transfers of (real) water in Asia on the local and global water system. A range of activities might be taken up: some with short-term (2-3 years) completion, and others with longer activity periods (up to 15 years). Potential studies will fall under activities 1.1, 1.4, 4.1, and 5.2 in the *Science Framework and Implementation Activities* of GWSP. This report has identified thematic working groups as a part of management structure of GWSP.

### **Other Tasks**

Two other tasks that have been identified by the WG are creation of database on dams and organization of a workshop.

#### **Creation of Database on Dams**

There is a need for an Asian database on planned and existing dams indicating location, purpose, size and other features, submergence, operating practices, benefits etc., and information on their impacts (if available). Creation of database is important for two reasons. This inventory will help identify the need and focus areas of studies that should be taken up to predict the individual or combined effects of different dams. Secondly, it may be possible to derive generalizations or predictions of dam effects from knowledge of their characteristics.

#### **Workshop**

In the GWSP-Asia meeting at Kyoto in Aug. 2005, it was also proposed to organize a workshop on the theme of this WG. The first goal of the workshop would be to summarize existing state of knowledge on current cumulate impacts of dams in Asia. The second goal would be to set and launch a research agenda for dams in Asia: what opportunities exist and where, invite and formulate proposals for addressing them, and suggest how they could be best implemented.

Since GWSP is primarily concerned with regional-scale issues, these would have priority at the workshop. The workshop participants would be mainly national representatives plus some experts to lead discussion on cross-cutting issues.

## **Summary: WG1 -Dams, irrigation and diversions.**

Chairman: Zen-ichiro Kawabata (RIHN)

Secretary: David Dudgeon

### Preamble

A key area for further elaboration that emerged from discussions on 30 August was:

- The effects of dams, irrigation and long-distance transfers of (real) water in Asia on the global water system (activity A 1-4 in the *Science Framework and Implementation Activities* of GWSP).

A major issue remaining for discussion is development of some specific proposals or activities. The issue of how this topic will be integrated with studies of coastal areas and groundwater (if at all, may be preliminary to consider the matter at this stage), and whether the approach used will be hotspot-based (e.g. case studies) or comprehensive (e.g. a regional overview). Both potential benefits and impacts of water-engineering structures would need to be considered. Whatever issues are framed for discussion, it was proposed that a range of activities might be developed extending for a period of up to 15 years, some with relatively short-term completion, and others with longer activity periods.

The chairman suggested that group members give an overview of the priorities that they see arising from dams and related developments in their regions.

### National reports

Prof. Chen reported on dams in Taiwan, noting that increasing public opposition to dam construction has led to excessive extraction of groundwater and subsidence. The Taiwanese government has been providing seed grants to support projects relating to carbon and water projects in Asia, which might

Prof. Otsubo informed the group about research at NIES (Japan) on eutrophication of dams, investigations showing that trapping of silica behind dams resulting in downstream changes in plankton communities.

Prof. O'Keefe described research on dams that had taken place in South Africa, explaining that because studies of dams integrated socioeconomics (benefits and costs), hydrology and ecology, they provided a unifying theme for studies of the global water system, and an opportunity for drawing together disparate research themes.

Prof. Chien reported that dams in Vietnam had been constructed in the past in response to water shortages and flood control (80% of annual rainfall occurs in the wet season) and that in recent years there was a well-developed environmental assessment scheme associated with planned dam constructions. Most of the newer dams were constructed for hydropower generation which, together with better water supplies to farmers (70% of population) and domestic consumers, would enhance livelihoods and fuel economic development. The Vietnamese government was aware that dams could have negative effects (resettlement of people, for example, and sedimentation), but some attention was being paid to provision of environmental flows during the dry season (in the Red River, for example). Overall, the Government view was that the benefits of dams outweighed their impacts provided that attention was paid to mitigation effects of construction and operation. Prof. Chien supplemented that environmental impact assessments were rather short relative to the life of the dam, so that long-term consequences of dams (such as the effects of sedimentation that can have impacts on coastal zones and

deltas) might not be detected. More attention also needed to be paid to consequences of resettlement of displaced persons. Profs. Chen and Jain supplemented further with information on human resettlement due to Dams in China and India (respectively).

Prof. Nagata spoke about the history of dam building in Japan, outlining the change from hydropower dams to multipurpose dams. Studies devoted to operations means of dealing with dam sedimentation were a priority of Japanese engineers, but flushing operations had detrimental impacts upon fishing in rivers and coastal zones. However, the technologies for dealing with sedimentation in Japanese rivers were now far more advanced than in many other Asian countries, although some problems (resettlement) remained common to all countries. The speaker also noted that dam-building could be the origin of international conflicts, such as has occurred between Bangladesh and India with regard to the Yangtze.

Prof. Naiman spoke briefly about the attitudes towards dam building and operations in North America, noting that no large dams were presently planned in the U.S. Operation of large dams in the U.S. was increasingly informed by environmental flow needs (partly due to the need to conform to prevailing environmental protection legislation), and construction of addition dams is now seen as too costly. Increased efficiency of energy usage by the public is being promoted as an alternative to further construction of large dams as this is more economically viable than engineering approaches to increase generating capacity. On the other hand, there has been pervasive building of small dams and ponds (for livestock, recreation or sport) across the U.S., but little is known of their environmental impacts, combined water storage capacity, and so on.

Prof. Jain explained that dam water storage capacity in India is over 170 km<sup>3</sup> and there are more than 4000 large dams. The large and growing population combined with the seasonal rainfall and need for economic development is driving the construction of even more dams, but societal opposition to dams, often associated with the need for resettlement, is growing. Inter-basin transfer of water from wetter to drier regions of India is planned. The need to consider the benefits and costs of dams to be considered fairly was stressed.

#### Further discussion

Prof. Alcomo asked whether the effect of dams and their nature or construction and/or operation features was different in Asia from elsewhere in the world. If the answer is 'no', then there is no need for further study. If the impacts are anticipated to be different, then more study (case studies) is needed. Secondly, it appears that the incremental effects (cumulative impacts) of dams in Asia is higher than in other regions: thus it is worth asking what the cumulative impact on ecology, evapotranspiration, hydrology, nutrient transport, coastal zones and so on. Thirdly, it may be important to focus on capacity building and transfer of the methodologies for dam assessment within GWSP from various parts of the world to Asia, or among different parts of Asia.

Professor Jain opined that dam practices and the factors driving their construction varied both within and between countries, while Prof. Chen reminded the group that sediment loads were high in Asian rivers, trapping of silicate was high, and N: P ratios were high (100:1 versus 16:1 elsewhere). The effects on riverine and coastal biodiversity (especially expansion of coastal 'dead zones') might be unique to the Asian region.

Prof. Naiman felt that a directory of existing dams (size, characteristics, impoundment areas and operation practices), including those dams that were planned, would provide a basis for looking at dams in order to predict the combined or individual effects of different types of dams. Prof. Chen pointed out that a constraint on such an activity is that many governments regard matters relating to dam planning as 'state secrets'. Prof. Alcomo opined that combining existing databases on dams with satellite imagery for measurement of impoundments would provide a good start for development of a regional directory by Asian scientists. Several members felt that this activity could take place under the aegis of a GWSP national office (or unit), although it was recognized that collection of data within countries (states or provinces) is not always easy.

The Chairman pointed out the dichotomy that Asian countries are still building more dams whereas in north-temperate regions operation of existing dams rather than construction impacts were receiving greater attention. The perceived benefits of dams in Asia were such that construction would certainly continue, and thus there would be consequent effects on the global water system. Prof. Chien opined that benefits of dams to governments were widely known, but that research on impacts of dams on (e.g.) biodiversity were less well known and research on this matter was needed. Prof. Alcomo stated that this provided further justification for the suggestion that capacity building and knowledge transfer based on experience of dam impact assessments in other regions. Prof. Chien expanded that constraints on investigations in parts of Asia also included a lack of funding and relevant equipment, and this tended to lead to over-optimistic assessment of benefit to cost ratios of new dams.

Prof. Naiman remarked that the local impacts of dams in many regions were well understood but the long-term, long-distance and cumulative impacts of dams were much less appreciated, and have received limited study. The Chairman reminded members that there were other human changes (such as land use alterations) that would exacerbate or magnify cumulative impacts of dams.

The Secretary reminded members of five overarching issues that arose during discussions thus far. These are set out below with modifications in the light of group members' comments.

- The cumulative effect of large dams across Asia in terms of nutrient storage/transport, evapotranspiration, local and regional biodiversity, etc. May be far in excess of impacts in other regions.
- The need for development or transfer of methods for assessing environmental consequences of dams (relates to capacity building), and to develop/transfer practices relating to dam-operation procedures that will minimize such impacts.
- The fact that dams within a single country (or region) can have be built for different reasons, and have differing operations or impacts because of local climate, socioeconomic conditions and so on.
- There is a need for a regional database on planned and existing dams indicating location, size, features, purpose, operating practices, etc., plus, if available, information on their impacts. This is important because it may be possible to derive generalizations or predictions of dam effects from knowledge of their characteristics.
- Whatever the cumulative impacts of dams in Asia, they will interact with ongoing changes in land use and other landscape-scale processes, with important implications for coastal ecosystems, subsurface waters, evapotranspiration and other aspects of the global water cycle.

The Chairman asked members of their knowledge about organizations that could be involved in capacity building in the region, and who might be able to work with GWSP. Prof. Jain indicated that

there was substantial experience with dam-building and operation in India. Prof. Otsubo stated that Japanese workers had considerable experience with integrated assessments of dams, and had cooperated with engineers in China, but that there were obstacles to spreading this experience within Japan. Professor Nagata confirmed that there was considerable expertise within Japan. Prof. Chen informed members that there would be a series of two-week work)shops on 'Water and Carbon' held in Taiwan involving capacity building for scientists from China (mainly) and elsewhere in Asia.

Professor Alcomó proposed that the portmanteau term '**cumulative impacts**' be clarified by considering two distinct outcomes:

- '**life-cycle impacts**' that describe the direct and indirect impacts of dams within drainage basins and on receiving coastal waters, and
- '**continental-scale impacts**' that refer to the wider cumulative impacts of dams in the region.

Professor Jain suggested that the group could formulate a research proposal to investigate the cumulative impacts of dams in Asia through a series of case studies in different countries using consistent methods. He added that a workshop of around 30 people could be held under the aegis of GWSP-Asia in around one year, and it would involve exchanges of experience on the continental and life-cycle scale impacts of dams. Prof. O'Keefe supported this, adding that representatives from each country would contribute national experiences on the different types of dam impacts to the workshop. Prof. Jain stated that he was willing to assist in hosting the workshop, and Prof. Alcomó indicated that the SCC of GWSP might be able to help in approaching potential donors for funding. Prof. Jain also suggested that the proceedings of the workshop should demonstrate the 'state of the art' on cumulative impact assessment for dams, and that invitations to the workshop need not be confined to Asian researchers as it might be necessary to bring in expertise from other regions.

Prof. Alcomó suggested that further discussion should focus on the agenda of the workshop - its aims and objectives. Professor Naiman suggested that the working group begin by listing the topics to be included in the workshop taking account of social, hydrological and biodiversity dimensions, including individual case studies, and making a particular effort to bring in policy makers who would give an indication of future projections for dam building and environmental issue in government policy. Professor Jain stressed that workshop planning should occur in parallel with initial development of a database on dams in Asia, with version 1.0 to be made available at the workshop. Workshop attendance would involve mainly national representatives plus a smaller number of persons leading discussion on cross-cutting issues. Prof. Naiman reminded the group that GWSP is primarily concerned with regional-scale issues, and that these should have priority at the workshop; he advocated establishment of a Steering Committee for the workshop to begin planning of time, agenda and so on. There was unanimous agreement that this proposal should be taken to the subsequent plenary session, so as to include persons who were not members of the working group. Prof. O'Keefe suggested that at least one non-Asian member of GWSP be included in the Steering Committee, and he and Professor Jain agreed that the work of the Steering Committee might include planning activities beyond the initial workshop.

**One goal** of the workshop would be to summarize existing state of knowledge on current cumulative impacts of dams in Asia. A **second goal** would be to set and launch a research agenda for dams in Asia: what opportunities exist, outline proposals for addressing them, and indicate how they could be implemented.

*Tentative* topics for inclusion in the workshop included:

- hydrology;
- economics;
- societal aspects and resettlement;
- sedimentation and nutrients;
- ecology and biodiversity (plus environmental water allocations);
- interactions with climate change;
- reviewing and refining the Asian dam database version 1.0;
- future scenarios for dam development in Asia;
- scenarios for energy and agricultural development in Asia; and
- national policies plus wider political context of energy and economic development in Asia.

Working Group 1 members

J. Alcomo

A.C.T. Chen

N.V. Chien

D. Dudgeon

S.K. Jain

Z. Kawabata

K. Nagata

R. Naiman

J. O'Keefe

K. Otsubo

## Summary: WG2 -Working group on Mega City in the coastal zone/delta

Member:

Makoto Taniguchi (Chair), Research Institute for humanity and Nature, Kyoto, Japan

Jianyao Chen (Secretary), Zhongshan (Sun Yat-sen) University, Guangzhou, China

Eric T Craswell, GWSP-IPO, Center for Development Research

Claudia Pahl-Wostl, Osnabrueck University, Germany

Changming Liu, Institute of Geographical Sciences and Natural Resource Research, Chinese Academy of Sciences, China

Lawrence Koe, Environmental Engineering Research Centre, Nanyang Technological University, Singapore

Loebis Joesron, Hydrology, Research Institute for Water Resources, Indonesia

Hansa Vathananukij, Dept. of Water Resource Engineering, Faculty of Engineering, Kasetsart University, Thailand

The working group discussed first of all the proposal submitted to APN by Fansigan, and comments were given as follows:

-This proposal is basically policy-driven, could it be integrated with physical and chemical processes in Mega city

-Governance of water has actually an integrated view of both processes and policy

-Dynamic modeling and a new conceptual model is the methodology to couple policy and process perspective

-Country or region involved in the proposal: Philippine, Malaysia, Indonesia, Singapore, Thailand, Vietnam, Japan, Taiwan

-Since Fansigan has already got an APN project, he cannot be the PI for the new project. Laura David is the candidate PI.-The subject of the proposal is suitable for the support from GWSP and LOICZ, LOICZ and GWSP had a joint meeting, and shared potential area of cooperation, one of them is global governance of freshwater and coastal system, Mega city is fitting the interest of GWSP, LOICZ, Support from GWSP and LOICZ makes it easier to be accepted by APN.

Eric mentioned the output of this proposal, e.g., Vulnerability indicators, Thresholds Protocols and guidelines, Management strategies and governance structure.

The other subjects related to this working group were raised as:

-How about comparison of three or four mega city in Asia with a perspective of global implication. Both climate change and human activities at hotspot area has global implication in terms of water balance, nutrients. Mega city in the coastal zone is closely related to water trade (real or virtual) nationally or internationally and nutrients flux to the sea.

-Besides the fund for research, it is encouraged to apply fund from APN for workshop

-Hotspot area. •The delta area in Yellow River, Yangtze River, Pearl River, where several mega cities are located, e.g. 20 M in the Pearl (Hongkong, Guangzhou, Shenzhen, etc.

•Bangkok 10M

•Jakarta 8M

•Manila

•Calcutta

•Dhaka

- Karachi

- Tokyo

- Osaka

-Existing project, national fund and GWSP. 1) Linking the existing project to GWSP. Comparison of different basins, which may be funded nationally for an independent study, is a better subject for GWSP project for that global perspective is required

2) Comparison between Asian and European Basin is an interesting subject. Methodology for comparison of mega city is a priority

-Experiences from mega city of the developed countries, e.g., Japan could be helpful to the developing country in Asia. Development stage and water problem could be another interesting subject.

-Capacity Building in GWSP Asia.

- Advanced Institute for training of global and regional courses

- Bali meeting in Nov. 2005

- Experiences and lessons from international training course could be helpful. Contact IHP Jakarta etc.

- Network for database, IHDP information center, website for GWSP-Asia

- Commission for GWSP Asia

- Needs of training should be considered•2<sup>nd</sup> Workshop of GWSP Asia was proposed to be in Zhongshan (Sun Yat-sen) University, Guangzhou, China

## Summary: WG3 –Land Use/Cover Change

The discussion of the land use / land cover change (LUCC) group was around the issues of common area of interest and possible future research collaboration. The result of discussion is the suggestion on potential comparison study research project which may require regional collaboration across disciplines.

### Objectives of the study:

- To develop common framework – methodology, tools and dataset for use in the study of various geographic locations throughout Asia
- To understand how socio-economic changes or human activities may affect LUCC and result in changes in regional hydrological regime.
- To understand how changes in water availability and water quality, which may caused by LUCC driven by human activities as well as changes in water demand in specific area which may caused by socio-economic changes, may require different water management scheme.

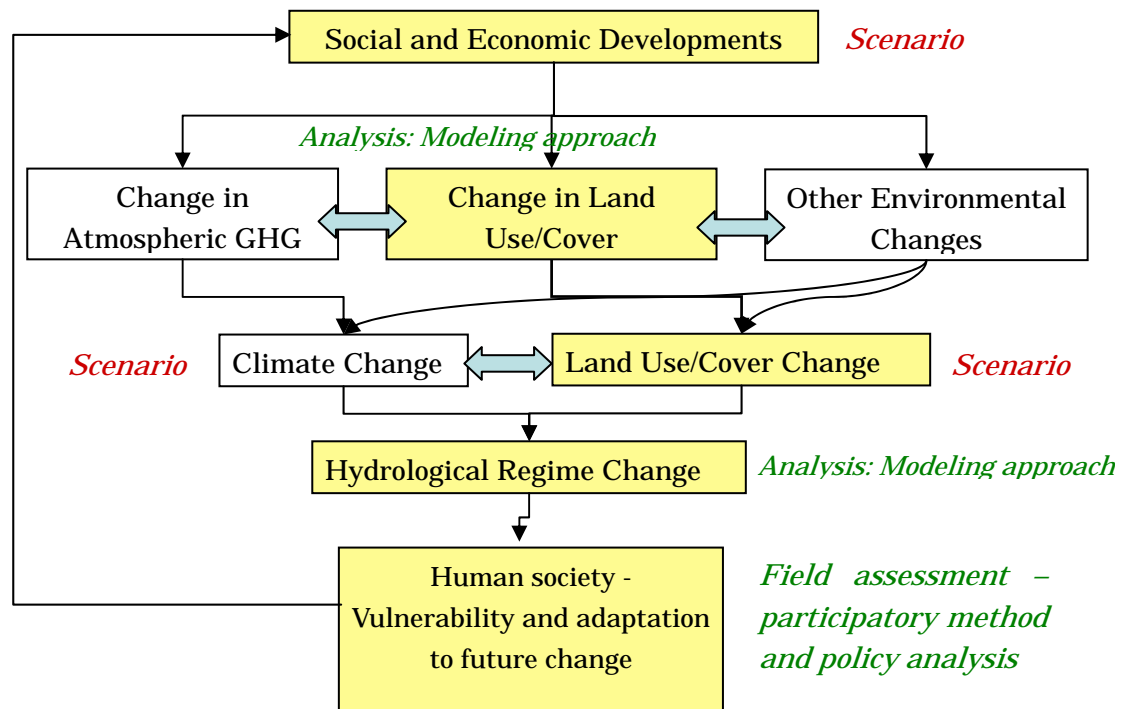
### Scope of study – Concept Note

Vulnerability of watersheds in Asia due to impact of drastic land cover change on hydrological regime from regional socio-economic development: Case studies in major watersheds e.g. Mekong River basin, Yellow River basin, etc.

Research Question / Theme	GWSP Science Theme
How have the changes in LUCC over the past few decades affected the regional hydrological regime?	Magnitude of Change
How will human activities under different socio-economic development schemes induce regional LUCC?	Linkages and Feedbacks
How will future LUCC affect regional hydrological regime?	Magnitude of Change
How will future climate change affect regional hydrological regime?	Magnitude of Change
How will different regional socio-economic development schemes affect the water demand / water utilization characteristic in the region (or in the watershed)?	Linkages and Feedbacks
What will impact of changing in hydrological regime affect human society?	Linkages and Feedbacks
What is the impact of changing in hydrological regime on ecosystem?	Linkages and Feedbacks
How changes in LUCC may affect local and regional climate pattern?	Linkages and Feedbacks & Magnitude of Change
What watersheds may be at risk from future changes in hydrological condition? - Water quantity and water quality	Resilient & Adaptation
What is the appropriate sustainable development policy to cope with future changes?	Resilient & Adaptation

Note: The highlighted topics are the primary area of interest under this discussion.

**Conceptual Framework:**



**Expected outcome**

- Future land use / land cover which may change from different regional development scheme
- Future hydrological condition based on different LUCC scenarios
- Identified “hot spot” or watershed(s) at risk from changing in hydrological regime
- Vulnerability of the systems and sectors to the changes in the future hydrological regime from different regional development schemes
- Adaptation options to cope with future risk(s) – feedback to policy makers for country or regional development plan for sustainable development

## **GWSP-ASIA MEETING**

### **Final Plenary Session**

Chair: Eric Craswell

Secretary: Marcel Endejan

#### **Working Group Reports**

The plenary session began with brief presentation of the final Working Group Reports; the presentations and discussions are summarised as follows:

##### *Working Group I – Dams*

This topic fits under Activity1-4, *Water Diversions in the Global Water System*, in the GWSP Scientific Framework and Implementation Activities. Participants agreed to cooperate in developing an information system and database that included a catalogue of the properties of dams in Asia, such as location, size, features, purpose, and operating practices. The first version of the database should be developed before the proposed Workshop on the cumulative impacts of dams in Asia. Participants strongly supported the Workshop which is proposed to be held in 2006 in India.

Prof. Liu pointed out the importance of dams in relation to water quality, flood prevention, the environment and its degradation, renewable energy resources, and impacts of different dam constructions on ecology. Eric Craswell suggested that these would be good ideas to include in the topic list for the workshop. He pointed out that in the USA dams were being decommissioned to improve the environment, and asked when in the future China or other Asian countries might reach the point of removing dams. Makoto Taniguchi responded that Asian countries should not go the same way the US, for example, went.

David Dudgeon suggested that an Organising or Steering Committee be appointed for the GWSP joint workshop on dams, and Joseph Alcamo, Jianyao Chen, Arthur Chen and Sharad Jain were initially nominated. Makoto Taniguchi pointed out the need to raise funds for the meeting, and Eric Craswell indicated that if proposal is endorsed by SSC, IPO could help with the organisation.

##### *Working Group II – Mega cities in the coastal zone/delta*

The proposal on Integrated Vulnerability Assessment of Coastal Areas in the Southeast Asia and East Asia Region, that Felino Lansigan had submitted to APN, provided the basis for the discussion. One participant noted that Laura David is the candidate now proposed to be Principle Investigator in the project. The topic of the proposal fits within the area for collaboration that was agreed between LOICZ and the GWSP in the LOICZ Open Science Conference held in June 2005. The APN project will be co-ordinated by the LOCZ regional office in Singapore. In the discussion, participants emphasised the importance of the topic and raised the need to plan a Workshop that linked the APN project to further GWSP activities, to define hotspot study areas in Asian cities, and to create a working commission for GWSP. Makoto Taniguchi said that we need a platform for the databases and pointed out that IHDP has a good database that could be used as a starting point, with a focus on the hotspots in Asian mega cities.

Jianyao Chen pointed out that the Conference in Guangzhou on water resources management in Asia planned for June 2006 could provide an opportunity for a GWSP workshop?

Makoto Taniguchi suggested that it might be possible to combine their Workshop with the workshop on dams.

Joseph Alcamo pointed out that whether a workshop or a concrete activity on mega-cities is planned, it is not an independent project from GWSP Asia but a link with Felino Lansigan's APN project on coastal zone vulnerability. There will be no decision necessary from the SSC on Felino's activity, but further discussion with him was needed about h.

#### *Working Group III – Land Use/Cover Change*

The topic concerned land-use cover change and its impact on climate. There is a need to develop a common framework including methodology, tools and datasets. The case studies should address major river basins such as the Mekong and the Yangtze River. The study is at the stage of a concept note with a quite comprehensive list of research questions which probably would be best addressed in a workshop. The effects of land use change on hydrology might already be a very comprehensive study, so the work could centre on identifying the most important drivers of land-use/cover change and calculating effects on hydrology? Further discussion was needed to clarify these issues.

### **Cross-Cutting Discussions**

#### *Capacity Building Items*

Jay O'Keefe explained that an Environmental Flows Capacity-Building Course was planned and supported by UNESCO-IHE, and what was needed was to get 20-40 people together in an Asian country to run a course. Topics covered include water engineering, informatics etc.

Eric Craswell asked about any special needs for training? GWSP will encourage and support training on multi- and interdisciplinary approaches and scaling issues, which could also be taken up by GWSP Asia. Claudia Pahl-Wostl said that capacity building is necessary to work in an interdisciplinary context, recognising that different words and languages are used. In this regard, the developing GWSP Lexicon is a part of the strategy to improve a common understanding of terms.

David Dudgeon pointed out that assessing the effects of different dam operation modes are not yet clear, and should be investigated in more detail using real measurements of important variables.

#### *Databases*

Liu Changming said that a database must be established for GWSP on a global scale.

Sharad Jain pointed out that Working Group I proposed to start with a database that then can be further developed and filled with data. It is more easy to get data from a researcher's own country. David Dudgeon suggested the steering committee develop and provide a template to be filled by individual members. Working group II could provide data on mega-cities. Marcel Endejan said that a database with projects and experts would be helpful to make available 1<sup>st</sup> contact information, 2<sup>nd</sup> metadata, 3<sup>rd</sup> datasets. UNESCO-IHP and the FRIEND database would be a good starting point.

Makoto Taniguchi indicated that RIHN will take the lead for and host the GWSP Asia homepage. A list with data sources in Asia will be developed and exchanged with Marcel Endejan who is responsible for the global GWSP information system.

### **Organisation of GWSP Asia**

Makoto Taniguchi said that the meeting proved to be a good vehicle to find common interests and common plans. The GWSP Asia committee could be discussed at the next GWSP SSC meeting. He does not like too much organisation, and feels that a committee is a good way (without getting too bureaucratic). Makoto suggested that we start with the Workshop committee and see how it evolves. He had no concrete opinion on establishing a special committee.

Arthur Chen said that a committee would be more serious and open easier access to funds.

Eric Craswell pointed out that there is already a structure: the Global project has a committee with 3 Asian members: Changming Liu, Taikan Oki, and Felino Lansigan. We might move to country representation and involvement of countries. Comments of the representatives from different Asian countries were then requested and recorded as follows:

India: It would be good to start as soon as possible.

Indonesia: good progress in this meeting and already a plan for the workshop. At next workshop we could have another GWSP Asia meeting and decide if it is necessary to have another committee.

Singapore: There must be a reason for forming structures/groups. In case for GWSP: we want to have a global programme – with a global committee. Would we also have a GWSP Africa? There has to be a purpose to form regional projects. GWSP is an ESSP programme. Might it be possible to follow the START offices structure for GWSP? Does it make sense to have two different organisations? In the world of internet the world is only one region and there is no reason for organising regional committees.

Vietnam: Funding is needed to establish bodies.

Malaysia: It is OK to represent water science for Malaysia and to help to spread GWSP issues in Malaysia – we can contact her or her colleague. Make it a loose organisation of countries interested in these topics. But there should be some structure: somebody has to be responsible, for example Japan, which can spread out. A Committee must be established. Somebody must be committed to do communication etc. Malaysia is willing to help. All countries have already established networks (South Asia and East Asia) via START. We can make use of this START network. Each country has its own committee for global change topics. APN offices also help to make proposals etc. (APN has also a website with relevant information, for example on funding opportunities.)

China: we need some committees for organising workshops, databases etc. Start as soon as possible.

Eric Craswell raised questions concerning the TOR, responsibilities, etc of any committee. He suggested that contact persons for further development of the GWSP Asia committee will be the representatives from the Asian countries at the current meeting. The GWSP SSC will discuss the issue of creating another committee (without funds for supporting secretariats, travel expenses, etc.). IHDP, IGBP and START already have national committees in different regions, which have to be taken into account.

Claudia Pahl-Wostl pointed out that the formation of groups should take account of the fact that social science is under represented in most of the committees. In any new committee, representatives from different scientific disciplines should be included.

Eric Craswell proposed that for the moment the individuals here would be the contact persons, and that further discussion and communication be done via Makoto Taniguchi.

The participants agreed to use the terms “GWSP Asia Network” – “GWSP Network Members” (instead of interim steering committee).

## Program

August 29

**Registration: 9:30-10:00**

*Morning: Plenary session* 10:00-12:00 (Chair : Eric Craswell (GWSP))

10:00-10:10 Welcome Address [Toshitaka Hidaka, Director-General of RIHN]

10:10-10:20 Introduction of the GWSP-Asia Meeting [Makoto Taniguchi]

10:20-10:40 Review of GWSP Science Plan [Joseph Alcamo]

10:40-12:00

- Purpose of the meeting from core team
  1. Data base and hot spots studies [Makoto Taniguchi] - Magnitude and Mechanisms of Change (GWSP Theme 1)
  2. Capacity Building and Policy [Ben S Malayang III] - Water Governance and Adaptive Capacity (GWSP Activities 1.1 and 3.3)
  3. Modeling and New Trend [Suppakorn Chinvanno] - Linkages and Feedbacks (GWSP Theme 2)

*Afternoon: Plenary session;* (Chair: Zen-ichiro Kawabata (RIHN))

Asian Scientists and SSC members

(1) Past and current research programs on water with human dimension in Asia (10 min each)

13:20-15:10

13:30-13:40 Japan (Kuniyoshi Takeuchi)

13:40-13:50 China (Liu Changming),

13:50-14:00 Thailand (Hansa Vathananukij),

14:00-14:10 Vietnam (Nguyen Viet Chien),

14:10-14:20 Phillipines (Ben S Malayang III),

14:20-14:30 Indonesia (Loebis Joesron),

14:30-14:40 Malaysia (S.A. Mastura),

14:40-14:50 India (Sharad Kumar Jain),

14:50-15:00 Hongkong (David Dudgeon)

15:00-15:10 Singapore (Lawrence Koe),

15:10-15:20 Taiwan (Chen-Tung Arthur Chen):

- Current research study on water resource in Asia. Brief presentation and discussion of what is being done (and by whom, when and expected outcome) of the research projects from all participants. (May also include the area of interest or project under planning stage, so the future collaboration may be initiated in this meeting)

(2) Expectations for GWSP-Asia from SSC members and others

15:40-16:00 Taikan Oki (GWSP-SSC)

16:00- 16:20 Robert Naiman: (GWSP-SSC)

16:20-16:40 Claudia Pahl-Wostl: (GWSP-SSC)

16:40-17:00 Tetsuzo Yasunari (WCRP)

17:00-17:20 Toshio Koike (GEOSS)

(3) Discussion on how small group should be broken up. 17:20-17:40

*Reception* 18:00-20:00

## August 30

*Morning* : Working Groups meet separately 9:30-12:30

### The following groups are tentative !!

WG 1 Magnitude and Mechanisms of Change (lead by Makoto Taniguchi and C-T Arthur Chen)	WG2 Water Governance and Adaptive Capacity (lead by Wang Qinxue and So Kazama)	WG3 Linkages and Feedbacks (Lead by Suppakorn Chinvanho and Shinjiro Kanae)
Presentations 1. Joseph Alcamo 2. C-T Arthur Chen 3. Jianyao Chen 4. Urumu Tsunogai 5. Yoichi Fukuda 6. Akiko Ogawa 7. 8. Discussion	Presentations 1. Claudia Pahl-Wostl 2. Itsu Adachi 3. So Kazama 4. Wang Qinxue 5. Kuni Otsubo 6. Ai Likun 7. 8. Discussion	Presentations 1. Robert Naiman 2. Shinjiro Kanae 3. Zen-ichiro Kawabata 4. Zheng Xongxing 5. Jun Matsumoto 6. Nobuhito Ohte 7. Maki Tsujimura 8. Discussion

- Small group break up for discussion on the theme issues, current activity, new finding, gap in research, linkage among research projects, common area of interest among researchers and research institutes, future potential collaboration, engaging policy maker into research activity, etc.

*Afternoon* 14:00- 17:00 (Chair: Marcel Endejan (GWSP))

- Working Groups report to **Plenary Session**

14:00-14:20 Working Group 1

14:20-14:40 Working Group 2

14:40-15:00 Working Group 3

- Report to plenary session on future possible potential collaboration among various research projects.

15:20-17:00

- Discussion

## **August 31**

*Morning* 9:30- 12:30

- **Working Groups** continue meeting and consider capacity-building, specific project proposals

WG 1: Specific project proposals on “Dam”

WG 2: Specific project proposals on “Mega city in coastal zone”

WG 3: Specific project proposals on “Land cover/use change in monsoon climate”

*Afternoon* 14:00-17:00 (Chair: Eric Craswell (GWSP))

**Plenary Session** for WG presentations of final plans and Conclusions

14:00-14:20: WG1

14:20-14:40: WG2

14:40-15:00: WG3

Discussion; 15:20-16:40

- Discussion on support required, timeline of implementation (of any activity that each small group may feel significant to share among participants),

Conclusion; 16:40-17:00

- Conclusion: Next step and milestone

### List of Participants

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