Asia-Pacific Network for Global Change Research

# International Integrated Water Data Access and Transfer in Asia (IIWaDATA) Project

**Final report for APN project: ARCP2007-02CMY**

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# International Integrated Water Data Access and Transfer in Asia (IIWaDATA)

**Project Reference Number: ARCP2007-02CMY**

**Final Report submitted to APN**

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## Overview of project work and outcomes

### Non-technical summary

In recognition of the need for accurate, timely, long-term, water cycle information as a basis for sound and effective water resources and risk management and with regards to the ongoing initiatives pursuing to meet this need, the IIWaDATA project initiated and contributed to the development of a sustainable scheme for water cycle data collecting, sharing, exchanging, and management at the regional level in Asia in cooperation with national governments, institutes and research communities and also international organizations that is consistent with the Global Earth Observation System of Systems (GEOSS), especially its Water theme component.

Through a series of meetings, the IIWaDATA project established a mutual consensus among the participating countries and international organizations that defines data sharing and exchanging policy and responsibilities for data processing, management and archiving. This strong cooperative framework has evolved into a large regional initiative recognized by the Group on Earth Observations (GEO) as a GEOSS activity: GEOSS Asian Water Cycle Initiative (AWCI). The IIWaDATA project further significantly contributed to the Data Integration and Analysis System (DIAS) that was launched in 2006 as part of the Earth Observation and Ocean Exploration System, which is one of five National Key Technologies defined by the 3rd Basic Program for Science and Technology of Japan.

### Objectives

The main objectives of the project were:

1. To establish a mutual consensus among the participating countries that defines data sharing and exchanging policy and responsibilities for data processing, management and archiving.

2. To develop/adapt and implement effective tools and advanced technologies for enhanced data collecting, management, integration and dissemination including: software for data processing, quality control, sophisticated database systems, data integration systems based on Internet technologies and capable of integrating data from diverse sources and various disciplines.

3. To develop/adapt and implement specific tools and methods for transformation of observation data and scientific knowledge into water resources and risk management relevant information including: advanced downscaling methods to successfully introduce the impact of the global climate change on water cycle processes at the local scale, technologies for information fusion to link together various features of the water cycle and other aspects of the Earth system and thus provide sound information for decision makers, visualization tools to help to translate the scientific information, etc.

### Amount received and number years supported

USD 86,000 (two years, 2006 - 2008)

### Activity undertaken

1. Series of meetings and workshops including representatives of participating countries, research institutes and international organizations, that led to the:
    - Establishment of the mutual consensus defining data sharing and exchanging policy and responsibilities for data processing, management and archiving that is outlined in the GEOSS AWCI Implementation Plan mentioned below.
    - Establishment of the GEOSS Asian Water Cycle Initiative (AWCI) that includes 19 Asian countries (Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Japan, Korea, Lao PDR, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Uzbekistan, Vietnam) and a

number of national and international organizations and cooperates with related projects on national and international level.
- Development of a capacity building program of GEOSS AWCI and initiation of its activities.
- Development of the GEOSS AWCI Implementation Plan.
- Initiation of the GEOSS AWCI Demonstration Projects at the nominated 18 river basins in the participating countries.

2. DIAS data system development and implementation activities including:
   - Support to the system development through providing platform for interaction between system software developers and a wide group of end users including scientists, water resources managers, as well as policy- and decision-makers.
   - Contribution to development of the data analysis, integration and visualization functions.
   - Demonstration of the system structure and capabilities at the IIWaDATA/AWCI meetings and workshops.
   - Initiating upload of AWCI demonstration project basins reference site data to the system database.

3. Work on development of downscaling techniques for producing local-to-regional scale information from larger-scale atmospheric General Circulation Model (GCM) data and prediction systems.

4. Organizing a special session on GEOSS AWCI and presentation of scientific papers at the 4th Conference of the Asia Pacific Association of Hydrology and Water Resources in Beijing, China, 3 – 5 November 2008.

**Results**

The project has achieved a real success in bringing together scientists, water resources managers and policy- and decision-makers from 18 Asian countries and establishing the mutual consensus among these countries and number of national and international organizations that defines data sharing and exchanging policy and responsibilities for data processing, management and archiving (hereinafter: Data Policy).

As a result of initial discussion that took place during the 1st and 2nd Asian Water Cycle Symposia (held in Tokyo, Japan, November 2005 and January 2007, respectively) and the 1st IIWaDATA International Task Team meeting (held in Bangkok, Thailand, September 2006), a strong collaborative framework was established that evolved into a larger regional initiative recognized by GEO and other international organizations and institutions as GEOSS activity: GEOSS Asian Water Cycle Initiative (AWCI), which has a longer-term outlook envisioning continued activities to help to mitigate water-related disasters and promote the efficient use of water resources.

The GEOSS AWCI Implementation Plan was developed that is based on the agreed to Data Policy. The Plan describes goals and objectives of AWCI and strategies towards achievement of these goals that include Demonstration Project (DP) approach coordinated with the Capacity Building (CB) program. DPs have been initiated and data submission to the DIAS database has begun. The AWCI CB program has started in cooperation with number of national and international organizations and institutions (e.g. Japan Aerospace Exploration Agency (JAXA), University of Tokyo, United Nations University (UNU), the International Centre for Water Hazard and Risk Management (ICHARM), Asian Institute of Technology (AIT), and others).

The project has helped in development/upgrading the DIAS system and begun to provide valuable hydrometeorological and other water-cycle related data to its database. Through the DIAS system, the data is freely available to anyone free of charge through the Internet.

The project has stimulated and supported development of downscaling techniques for producing local-to-regional scale information from larger-scale GCM data and prediction systems (e.g. advanced Distributed Hydrological Models (DHM)) and initiated implementation of these techniques in the GEOSS AWCI demonstration DPs.

The results of some of the GEOSS AWCI demonstration projects were presented at the AWCI special session of the 4th conference of the Asia Pacific Association of Hydrology and Water Resources in Beijing, China, 3 – 5 November 2008.

## Relevance to APN's Science Agenda and objectives

This project focused on the Asian water cycle variability within the context of a global climate and the impact of this variability on water resources, which is relevant to the "Climate" and "Use of resources" areas of the APN Science Agenda. While the data system developed with contribution from this project facilitates the research into the water cycle variation, an emphasis was also put on the component that enables improved transformation of the scientific knowledge to the decision-makers and supports the IWRM strategies for sustainable development of water resources.

The establishment of the strong collaborative framework (including 18 countries) that evolved into a large regional initiative, GEOSS AWCI, which also serves as a platform for enhanced interactions between scientists and policy- and decision-makers, is compliant with the APN Policy Agenda.

## Self evaluation

We feel that the project has been very successful. Especially the establishment of the GEOSS AWCI collaborative framework built upon the agreed to Data Policy rules and with a great potential for continued work on collecting and processing water cycle information as a basis for sound and effective water resources and risk management is an important achievement. Enhanced discussion facilitated by number of held meetings and workshops has led to a well structured GEOSS AWCI Implementation Plan that clearly describes the AWCI strategy including its CB program, collaboration with national and international organizations and institutions and their related on-going projects, and the demonstration project approach. Significant is also contribution to the DIAS data system. The project also supported work on the downscaling techniques and prediction system tools and adapt them for the use in the GEOS AWCI demonstration projects. It should be mentioned here that the demonstration projects in various countries are at different stage of development/implementation, which is caused by different situations in individual countries in terms of data collection and archiving strategies and policies for data dissemination, technologies and systems employed in the meteorological and hydrological forecasting, policies and methodologies used for water-related issues decisions and disaster mitigation, etc. These discrepancies are reflected in the individual approach to the demonstration projects and in the GEOSS AWCI capacity building program.

## Potential for further work

The IIWaDATA project established a framework and a consensus that are essential for effective collaboration on the regional level aiming at better understanding of the mechanism of variability in the Asian water cycle and improving its predictability, and furthermore interpreting the information applicable to various water environments in different countries in Asia, then helping to mitigate water-related disasters and promote the efficient use of water resources. Research, engineering, and capacity building activities focused on the above issues will continue under the established GEOSS AWCI as stated its Implementation Plan. In addition, similar collaborative frameworks are likely to be established in other regions of the world (e.g. Africa) in order to cope with the water cycle related challenges in a more effective way benefiting from the latest scientific knowledge, advanced technologies and international cooperation.

## Publications

The GEOSS/AWCI Implementation Plan (draft version, July 2007), available through the Internet at: http://monsoon.t.u-tokyo.ac.jp/AWCI/ and in the Appendix B below.

*The 4th Conference of the Asia Pacific Association of Hydrology and Water Resources, the AWCI special session*, Beijing, China, 2008. *Presentations:*

Bae, Deg-Hyo, A Comparative Study of Model-Driven Soil Moisture Estimates on the Chungju Demonstration Basin
Kumar, Rakesh, Flood Hazard Modeling and Flood Risk Zoning for a River Basin
Weerakoon, S.B., Flood Modelling in the Mahaweli River Reach from Kotmale to Polgolla
Sae-Chew, Winnai, A study of Disastrous Flash Flood in Khlong U-Tapao River Basin Utilizing a Combined Physical and Mathematical Simulation Model
Tinh, Dang Ngoc, An application of numerical weather forecast and satellite rainfall prediction to flood forecasting
Wang, Yi, Assessment of Soil Moisture Dynamics and Storm-induced Landslides Hazard in Forest Landscapes
Fukami, Kazuhiko, Experiences of Japan in flood risk management and the introduction of Integrated Flood Analysis System (IFAS)
Sukhapunnaphan, Thada, Appropriate flood warning system in Northern Thailand
Loebis, Joesron, Application of Distributed Hydrological Model for Mamberamo River Basin for Flood Assessment and Management
Saavedra, Oliver, Applications of a Distributed Hydrological Model to the AWCI Demonstration River Basins
Phonvisai, Phengkhamla, Decentralized Wastewater Management in Urban Area: Case Study in Vientiane Lao PDR
Hoque, Bilqis, Water Contamination and Realization of Millennium Development Goal (MDG) in Bangladesh: Where are we?
Kaihotsu, Ichirow, Surface Soil Moisture behaviors in the Mongolian plateau for the Last Six Years
Ai, Likun, Drought monitoring and studying in Monsoon Asia under the framework of Asian Water Cycle Initiative (GEOSS/AWCI)
Khanh, Duong Van, Current status of drought and water scarcity and the proposed issues for water resources management of Vietnam
Hilario, Flaviana, Climate Trends/Change in the Philippines
Lee, Byong-Ju, Climate Change Impact Assessments on Water Resources over the Chungju Dam Basin using Multi-Model Ensemble
Rahman Mafizur, Assessing Drought Scenario in Bangladesh

## References

See the Reference section below the Technical Report on page 27.

## Acknowledgments

In addition to the support from APN, which made the IIWaDATA project possible, we would like to thank the following organizations and institutions for their scientific and technical contribution as well as financial and in-kind support to the activities undertaken by this project and for their continued collaboration with AWCI.

Ministry of Education, Culture, Sports, Science, and Technology (MEXT), Japan; University of Tokyo, Japan; Japan Aerospace Exploration Agency (JAXA), Japan; United Nations University (UNU); the International Centre for Water Hazard and Risk Management (ICHARM), Japan; Office for Coordination of Climate Change Observation (OCCCO), Japan; Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan; Asian Institute of Technology (AIT), Thailand; Kasetsart University, Thailand; and others.

# Technical Report

## Preface

About 60% of the world population lives in Asia, and their various social activities including agriculture depend on the bountiful Monsoon rain. At the same time, the water cycle variation in Asia can be the cause of droughts and floods, and consequently, may be responsible for enormous human and economic damages. We need to better understand the mechanism of variability in the Asian water cycle and to improve its predictability, and furthermore to interpret the information applicable to various water environments in different countries in Asia, then to help to mitigate water-related disasters and promote the efficient use of water resources.

## Table of Contents

# 1. Introduction

## 1.1 Water Related Issues in Asia

More than 60% of the world population live in Asia associated with the rapid economic growth. The Asian monsoon, which is the largest water circulation system in the world, provides substantial water resources which supports to the food production, energy generation and even transportation in Asia, and causes serious water related problems due to the large seasonal and inter-annual variability of the monsoon rainfall.

Floods are very serious common problems in Asia. More than 80% of the loss of human lives by flood in the world occurs in Asia. The expansion of urbanization in Asia is accelerating flood economic damages considerably. Since many Asian countries locate in the tectonic zones, landslides and mudflows are also common natural disasters in Asia.

The Asian monsoon usually provides rich water environment. At same time, its large seasonal and inter-annual variation sometimes leads to severe drought damages in the water consuming societies. The high rate of the population increase is exhausting the water resources and the water scarcity would be a serious issue in the near future.

Excessive water use also affects the water quality and ecosystem. Especially, severe health effects have been observed in populations drinking arsenic-rich water over long periods in some of Asian countries, including Bangladesh, China, India, and Thailand. Over the last decade, it has been recognized that healthy aquatic ecosystems provide tangible economic and social benefits. It is important to understand the drivers and status of ecosystem degradation and the need for watershed restoration in order to improve water productivity across the Asia.

The global warming is changing the water cycle. Heavier rainfall events and larger interannual variations are predicted to be likely to happen according to the "radiative-convective equilibrium". Global warming is considered to make considerable impacts on such a vulnerable region, Asia, where the percentage of completion of river developments is still critically low compared to the high potential water-related hazards.

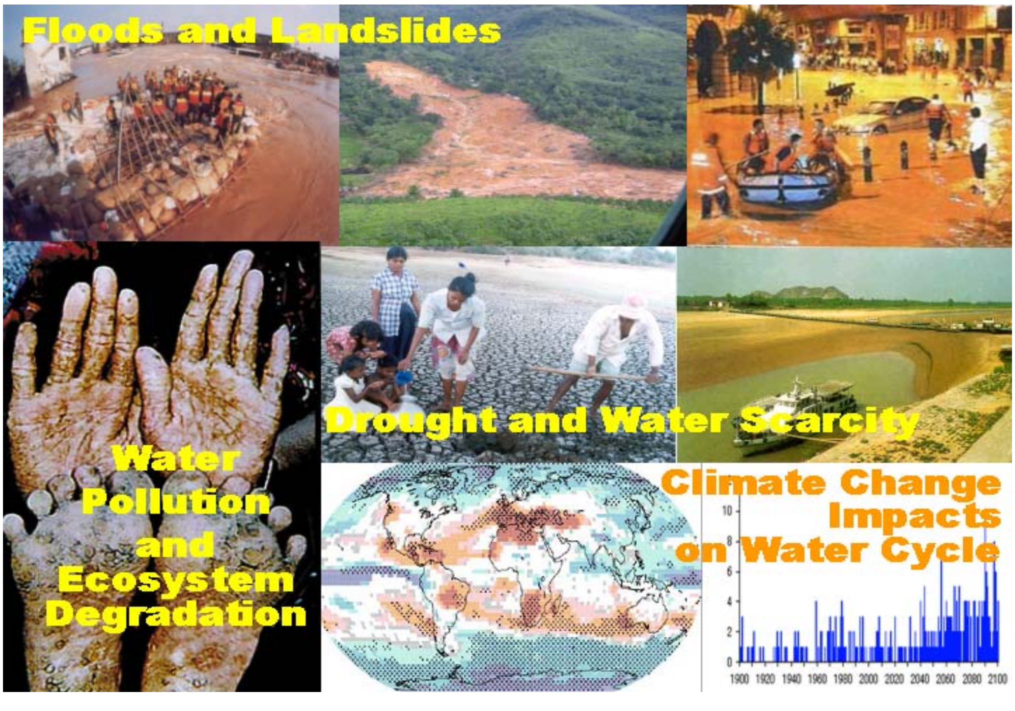

**Figure 1: The Water-related Issues in Asia**

## 1.2 GEO and GEOSS

At the World Summit on Sustainable Development (WSSD) in 2002, world leaders proclaimed the need "to promote the development and wider use of Earth observation technologies." Following the discussions at the Earth Observation Summits held in Washington DC and Tokyo, the Brussels Summit established the Group on Earth Observation (GEO) and endorsed the 10 Year Implementation Plan for the Global Observation System of Systems (GEOSS). The goal of GEOSS is to achieve comprehensive, coordinated, and sustained observations of the Earth system to improve monitoring of the changing state of the planet, increase understanding of complex Earth processes, and enhance the prediction of the impacts of environmental change. GEOSS will meet the need for all nations to benefit from access to timely, quantitative, and high-quality long-term global data and information as a basis for sound decision making (Fig. 2). "Improving water resource management through better understanding of the water cycle" is one of the nine socio-benefit areas, including *Disasters, Human Health, Energy Management, Climate Variability and Change, Water Cycle, Weather, Protection of Ecosystems, Agriculture,* and *Conserving Biodiversity*.

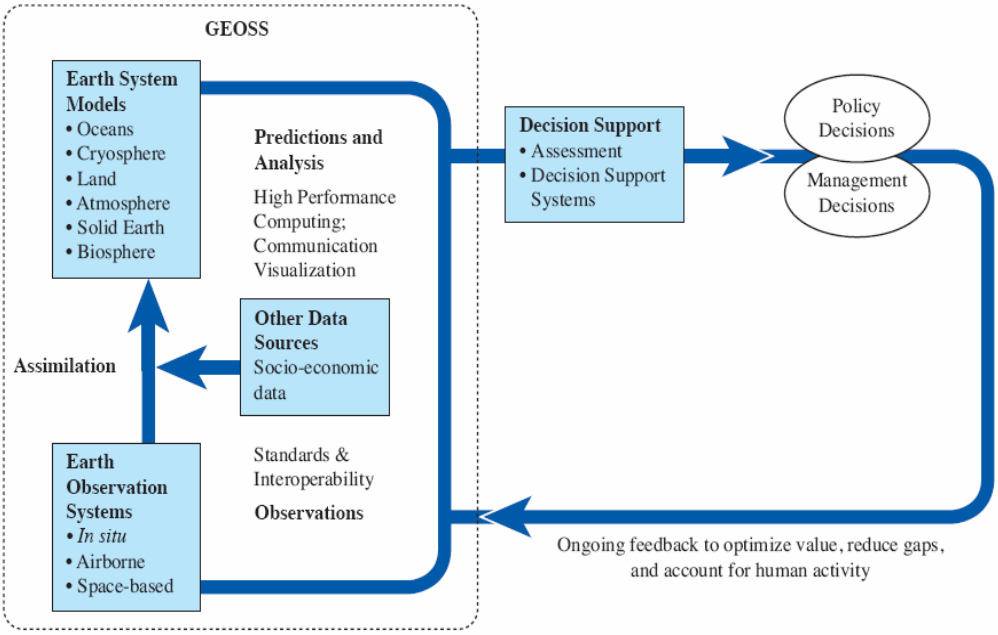

**Figure 2: Structure of GEOSS Functions**

## 1.3 Motivation for the IIWaDATA Project and Objectives

The water related issues in Asia outlined above are common to many countries and are in many cases trans-boundary. Therefore international cooperation on the regional level is essential for successful coping with these issues. With coming of GEOSS, the benefit of international collaboration is even more profound. Since the issues in Asia are not only common within the region but also specific for the region, it is obvious that an initiative at the regional level under the global GEOSS framework will be most effective in dealing with these issues while making maximum use of the Earth observations and the advanced capabilities provided by GEOSS. The compliance with the GEOSS framework and its objectives is crucial as it means the adherence to: (i) convergence and harmonization of observation activities, (ii) interoperability arrangements, and (iii) effective and comprehensive data management, the three essentials for efficient exploitation of the Earth observation for further research as well as for decision support.

In order to initiate such regional collaboration, the IIWaDATA project was proposed with following guiding goals and objectives.

Guiding goals:

1. To improve knowledge and enhance prediction of the Asian water cycle variation through integrated observation systems and advanced data management and processing capabilities that will assure an easy access to relevant data in the proper format and to the desired extent to research communities;
2. To make a contribution toward the sustainable human development in the region through development of methods and tools for effective transformation of global and regional observation information and scientific knowledge into information relevant for local water resources and risk management and facilitated transfer of such information to national policy- and decision-making groups.

Specific objectives:

1. Establishment of a mutual consensus among the Asian countries that will define data sharing and exchanging policy and responsibilities for data processing, management and archiving;
2. Establishment of an observation convergence strategy in the Asian region;
3. Development/adaptation of effective tools for enhanced data collecting and data management including: software for data processing, quality control and format conversion, sophisticated database systems, and other tools;
4. Development/adaptation of advanced technologies for data integration and data dissemination to research groups including: data integration systems based on Internet technologies and capable of integrating data from various sources such as satellite, in-situ, and model output data, metadata schemes following ISO standards, etc.;
5. Development/adaptation and implementation of specific tools and methods for facilitated transformation of observation data and scientific knowledge into water resources and risk management relevant information including: advanced downscaling methods to successfully introduce the impact of the global climate change on water cycle processes at the local scale, technologies for information fusion to link together various features of the water cycle and other aspects of the Earth system and thus provide sound information for decision makers, visualization tools to help to translate the scientific information, etc.

## 2. Methodology, Approaches, and Implementation Strategy

### 2.1 Establishment of GEOSS AWCI

The collaborative framework that has evolved into the regional GEOSS Asian Water Cycle Initiative (AWCI) had been established through a series of meetings and workshops. One of the first events was the 1st Asian Water Cycle Symposium (AWCS) held in Tokyo, November 2005, where representatives of hydrological and meteorological organizations and science communities in Asia gathered together, and began to discuss about how to address the water-related issues in Asia in cooperative ways by making maximum use of GEOSS. It was the initial step of the IIWaDATA project.

The participants of the Symposium recognized the common water-related issues and socio-economic needs as described in Introduction (section 1.1). They shared ideas on the large natural variation of the Asian monsoon and the big impacts of the human activities in Asia as their backgrounds. To address these issues, they considered that well coordinated scientific and operational challenges and efforts should be launched by making maximum use of the GEOSS, which is leading convergence and harmonization of observation activities, interoperability arrangements, and effective and comprehensive data management. Then, they agreed to establish a basic plan for "Asian Water Cycle Initiative (AWCI) contributing to GEOSS" and to organize an International Task Team (ITT) for drafting an Implementation Plan.

The full development of the ITT activities in 2006 was also stimulated by acceptance of the IIWaDATA project proposal by APN in April 2006. The 1st ITT meeting was organized in Bangkok, Thailand, in September 2006 following the International Workshop on Capacity Building "Earth Observations in the service of Water Management" held at the same venue. Based on the discussions at these events, a baseline of the Implementation Plan for the GEOSS AWCI was formulated that focused on observation convergence, data integration, and information sharing.

This baseline was proposed and fully approved at the 2nd Asia Water Cycle Symposium (AWCS) in Tokyo, in January 2007. In addition, the need for a well-defined capacity building program of GEOSS AWCI was recognized and a basic framework of such program proposed. The GEOSS AWCI goals and strategic implementation was then summarized in the following:

> *By facilitating "observation convergence, data integration, information sharing" and promoting "capacity building", GEOSS AWCI is aiming for:*
>
> 1) *Development of an information system of systems for promoting the implementation of integrated water resources management (IWRM);*
> 2) *Making a bridge between the data and information from the global scale to a river basin scale for sound decision making; and shifting from research activities and achievements to operational use for contributing to societal benefits.*

Also, an effective organization of the AWCI activities was discussed and this discussion resulted in adopting two approaches: "demonstration approach" and "working group approach". The demonstration approach meant to begin with small-scale projects and to show early success stories to stakeholders after intensive implementation. As the first step, one river basin was selected from each participating country as a target of a Demonstration Project (DP). The working group (WG) approach reflected the wide range of water-related issues in Asia and yielded three WGs including: (i) Flood and Landslides, (ii) Drought and Water Scarcity, and (iii) Water Quality. Each WG covers the both main GEOSS AWCI foci, i.e. "observation convergence, data integration, information sharing" and "capacity building" and is strategically involved in DPs.

Another key feature of GEOSS AWCI is "adopting and adapting existing capabilities and close collaboration with related on-going projects", which is perceived as the most effective approach. Therefore a number of national research institute and international organization experts were invited to the Symposium and presented various on-going activities and projects and available capabilities that were suitable for collaboration with and application for the GEOSS AWCI activities. Following the Symposium, a survey was carried out to identify available resources for capacity building and existing capabilities for adopting in the GEOSS AWCI activities.

In order to assure proper coordination of the AWCI activities and continue with preparation of the AWCI Implementation Plan, the Symposium established the International Coordination Group (ICG) consisting of the nominated national representatives, the elected WG co-chairs, invited experts, and the GEOSS AWCI Secretariat members.

The 1st ICG meeting was held in Bali, Indonesia, in September 2007, where progress of each country as well as WG activities was reported and the contents and procedure of the DP implementation plan were discussed. The baseline of the AWCI Implementation Plan that was expanded and updated at the 2nd AWCS in January and this event was confirmed and a timeline for the full plan document development was outlined.

The structure of the full AWCI Implementation Plan was presented, discussed, and agreed on at the 3rd Asian Water Cycle Symposium that was held in Beppu, Japan, December 2007 as one of the open events of the 1st Asia-Pacific Water Summit. The first draft of the Plan then followed and was also introduced at the 1st APN and GEOSS

AWCI Scoping Workshop held in Tokyo, Japan, in April 2008. The GEOSS AWCI website was opened shortly after the 3rd AWCS in Beppu and includes the latest draft of the Implementation Plan as well as presentation material from the related events. The site is available at: http://monsoon.t.u-tokyo.ac.jp/AWCI/.

## 2.2 Observation Convergence , Data Integration, and Information Sharing

### *Observation Convergence*

Observation convergence, one of the key GEOSS aspects, is essential for making possible advanced research into the water cycle phenomena and for transformation of the scientific findings into the information usable for policy- and decision-makers to develop effective policies and make sound decisions in an Integrated Water Resources Management (IWRM) manner.

GEOSS AWCI approach for converging earth observation satellites, in-situ reference site networks, and operational observation systems, for integration of the observed data, numerical weather prediction model outputs, geographical information, and socio-economic data, and for dissemination of usable information is adopted from and designed in cooperation with the Coordinated Energy and Water Cycle Observations Project (CEOP) of the Global Energy and Water Cycle Experiment (GEWEX), World Climate Research Programme (WCRP) (http://www.ceop.net).

The data obtained at the CEOP reference sites in tropics, semi-arid regions, and high mountain areas in Asia is provided to GEOSS AWCI. Even though there are big varieties in observation elements, data format, and recorded interval of the original reference site data, CEOP can provide well quality checked data with a unified format in cooperation with the site observers by using a Web based Quality Control (QC) and format conversion system.

Data from sensors on board Earth observation satellites in various orbits, polar/geostational or sun-synchronous/non-sun-synchronous, around the Earth can be integrated to provide hydrological information, water vapor, cloud, rainfall, soil moisture, and snow, at all spatial scales from local to global and temporal ones from diurnal to decadal. Moreover, model output from many Numerical Weather Prediction (NWP) centers is provided. Ten operational NWP centers and two data assimilation centers are currently contributing to this component of CEOP.

Figure 3: GEOSS AWCI Observation Convergence

In addition to the above data provided by CEOP, meteorological and run-off data, dam operation data, geographical information including topography, land cover, and land use, population and socio-economic data are collected in the GEOSS AWCI DP river basins.

***Data Integration and Analysis***

As originally produced by the various sources, the data is in a wide variety of formats and structures. In response to this situation there was recognition of need for data management systems for the collection, sharing and provision of data from which users can obtain precisely the data they need, whenever they want it and in formats familiar to the science community. It is essential to transform observation data into scientifically and socially relevant information through the systematic collection and integration of data, merging of essential related information, and building of systems for sharing this knowledge on an international basis. In cases in which large amounts of heterogeneous observation data are handled, this data along with socioeconomic and other related data must be dealt with systematically in order to produce useful scientific knowledge and translate it into information pertinent to users.

In response to this need, CEOP had developed a prototype data integration, analysis, and dissemination system (Ikoma et al., 2007a,b,c); that has been further elaborated and expanded into the Data Integration & Analysis System (DIAS), which was launched in 2006 as part of the Earth Observation and ocean Exploration System, which is one of five National Key Technologies defined by the 3rd Basic Program for Science and Technology of Japan. DIAS, which is now also functioning as the CEOP centralized data integration system, provides cooperative opportunities for constructing GEOSS AWCI data archives, and developing data integration and analysis functions (Fig. 4). Specialized system architecture enables the management of large amounts of complex Earth Observation data in an information-rich era. Various observed data and numerical model outputs can be easily integrated. Targeted data can be selected by date and region. Analyzed output can be visualized on a display wall. Results can also be visualized in the 3D format.

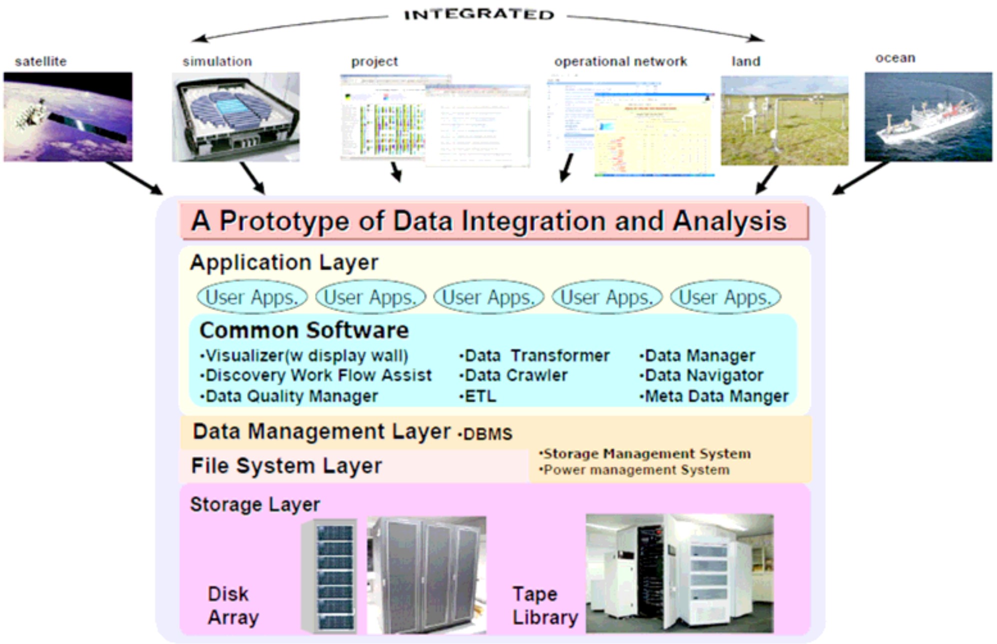

**Figure 4: GEOSS AWCI Data Integration System**

An ontology system enables users to find target data and information from diverse data sources. To find data with similar meanings, it is often necessary to clarify the terminology. The ontology system learns the definition. If a data name is not clear, keywords can be input to yield several candidate data names. Standardized metadata are needed for exploring data, confirming its meaning and quality, and to enable it to be widely shared. A Standardized Metadata Model is now under development in cooperation with the international standardization communities in order to assure full interoperability of the DIAS system. The GEOSS AWCI interoperability arrangements are shown in Figure 5. In addition to the satellite, reference site and model output metadata design developed under by CEOP, a river basin metadata design effort has been initiated by GEOSS AWCI that allows for proper inclusion of the GEOSS AWCI river basin data into the database and making them fully interoperable with other datasets.

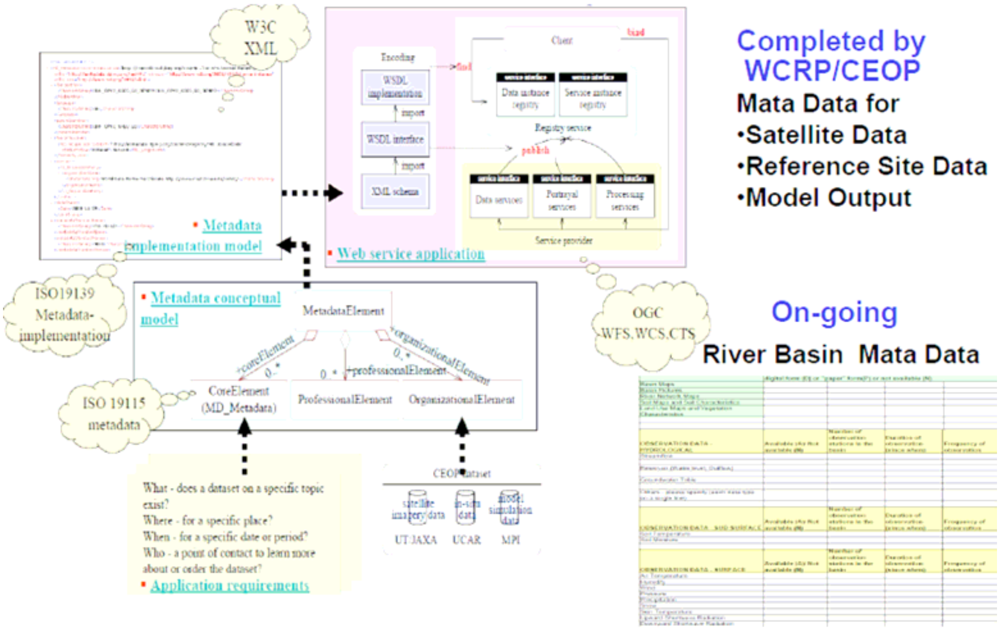

**Figure 5: GEOSS AWCI Interoperability Arrangement**

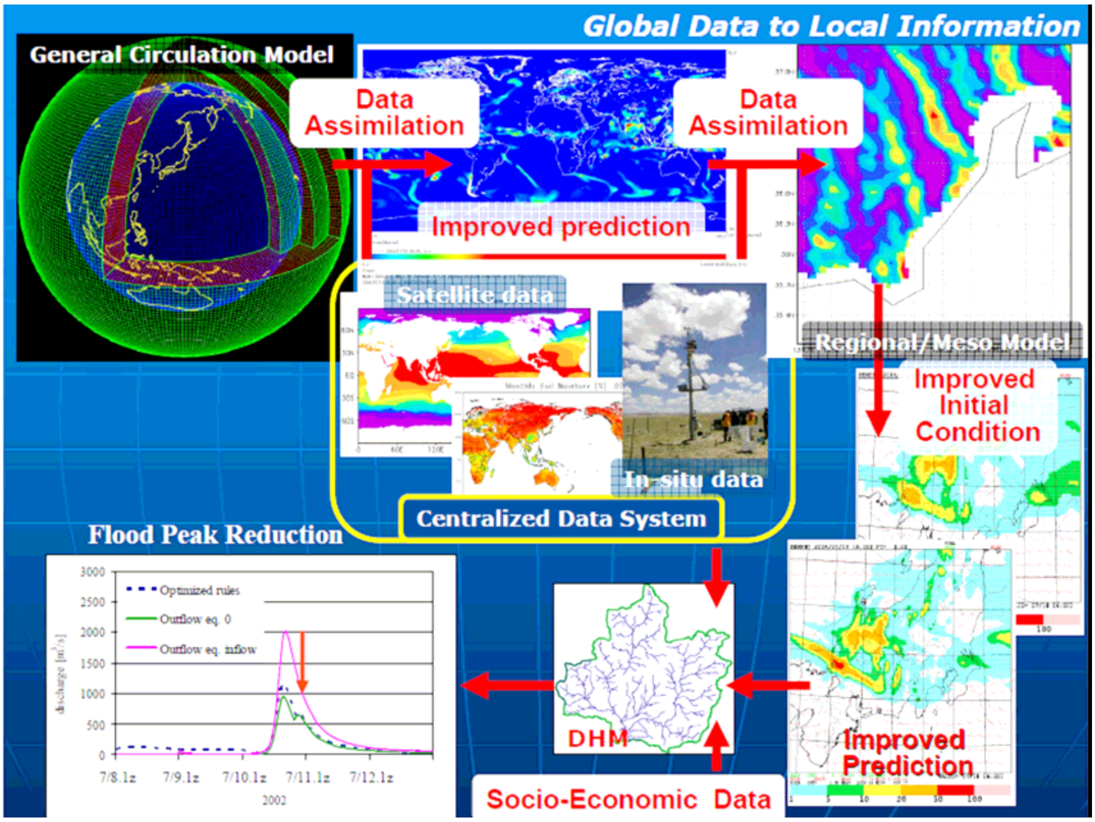

**Figure 6: GEOSS AWCI Downscaling Process**

### *Downscaling*

Water-related hazards usually occur as causes and consequences of large water cycle fluctuations at scales of global and regional, while disasters and damages due to the hazards happen through strong linkage with human activities in a local scale. The observations and predictions of the water-related hazards and their damages are also enhanced by combining global earth observation and prediction systems and local information. In this context, "downscaling" of water cycle from global to regional and to local is one of the key integration functions that need to be implemented by GEOSS AWCI.

General Circulation Models (GCMs) currently used for predicting weather and climate have a coarse spatial resolution, which cannot capture the details of orography and land use or resolve important cyclonic disturbances or similar-sized circulation features. This precludes an accurate representation of precipitation on scales of individual grid boxes. The method for producing local-to-regional scale information from larger-scale GCM data is called "downscaling" (Fig. 6). In order to make maximum use of the global earth observation and prediction, GEOSS AWCI in cooperation with international science communities and research institutions (a) adopts and adapts existing downscaling techniques and (b) develops a new dynamical downscaling system coupled with satellite-based data assimilations (Boussetta et al. 2008) and distributed hydrological models (Wang et al., 2008; Saavedra et al., 2006; Saavedra et al., 2008a, b, c). Through the use of the downscaling procedures, GEOSS AWCI can disseminate usable information in a river basin scale or less for decision making on disaster mitigation and water resources planning.

### *Data Release and Dissemination Guidelines*

The basis for the GEOSS AWCI collaborative framework that was established by the IIWaDATA project is the mutual consensus among participating countries and international organizations that defines data sharing and exchanging policy and responsibilities for data processing, management and archiving. Such consensus was outlined and confirmed at the early stage of the GEOSS AWCI formation, by the 2nd Asian Water Cycle Symposium Tokyo in January 2007.

Since the large part of the GEOSS AWCI data, including the reference site and satellite data and the NWP model outputs, are provided by WCRP/GEWEX/CEOP, it was appropriate to adopt and adapt the CEOP Data Release and Dissemination Guidelines for release and dissemination of GEOSS AWCI data. The following GEOSS AWCI Data Policy was outlined at the 1st ITT Meeting in Bangkok in September 2006 and fully proposed and agreed to at the 2nd AWCS in Tokyo, January 2007.

### *GEOSS AWCI Data Release and Dissemination Guidelines*

*1) Release of Data in Compliance with WMO Resolution 40 (CG-XII) and WMO Resolution 25 (CG-XIII)*

GEOSS AWCI archives meteorological, hydrological, and related data and products in Asia for addressing the common water-related issues in Asia. Any policy for release and dissemination of GEOSS AWCI data should principally comply with the WMO policy, practice and guidelines for the exchange of meteorological, hydrological, and related data and products, as embodied in Resolution 40 of the Twelfth WMO Congress 1995 (CG-XII), and Resolution 25 of the Thirteenth WMO Congress 1999 (CG-XIII); that is, free and unrestricted exchange of essential data and products.

The no-restriction principle shall in particular mean that no financial implications are involved for the GEOSS AWCI data exchange. GEOSS AWCI *data providers* shall transfer their obtained data to the Data Integration and Analysis System (DIAS) free of charge. Also, GEOSS AWCI data archived at the DIAS shall be offered free of charge to GEOSS AWCI *data users*.

*2) No Commercial Use or Exploitation*

It is understood that all GEOSS AWCI data shall be delivered to *data users* only for scientific studies and operational uses designed to meet GEOSS AWCI objectives. Commercial use and exploitation by neither the *data users* nor the DIAS is prohibited, unless specific permission has been obtained from the *data providers* concerned in writing.

*3) No Data Transfer to Third Parties*

One restriction which will be imposed on all *data users* concerns the re-export or transfer of the original data (as received from the DIAS archive) to a third party. Such restriction shall apply to all categories of GEOSS AWCI data, and is in the best interests of both the data providers and the potential users. Unrestricted copying of the original data by multiple, independent users may lead to errors in the data and loss of identity of its GEOSS AWCI origin and is strictly prohibited.

DIAS will offer GEOSS AWCI data to potential *data users* through electronic means, (e.g. the internet) or other designated media (e.g. CD ROMs). The DIAS shall install technical means to keep protocol on all data transfers to *data users* thus maintaining a catalogue of all *data users*, and the data files they have obtained.

*4) Timing for Release of GEOSS AWCI Data from the DIAS Archive*

The timing issue clearly involves some conflicting aspects. The *data user* will obviously be interested in obtaining data as soon as possible after the time of measurement. The data provider as well as the DIAS will wish to ensure the highest attainable quality of the data. The latter will generally be time consuming, particularly in view of the shortage of manpower in many cases.

It is suggested that all GEOSS AWCI data shall be categorized into *real-time use* (category 1), *standard* (category 2), and *enhanced or experimental* (category 3) data. *Real-time use* data shall be open in real- or near-real- time base. *Standard* data shall be freely open after the basic turn-around period of six months. *Enhanced or Experimental* data shall be freely open after a prolonged turn-around period of 15 months at maximum.

*5) Acknowledgement and Citation*

Whenever GEOSS AWCI data distributed by DIAS are being used for publication of scientific results, the data's origin must be acknowledged and referenced. A minimum requirement is to reference GEOSS AWCI and the DIAS. If only data from one river basin (or a limited number of river basins) has been used, additional acknowledgement to the river basin(s) and its (their) maintaining institutions or organizations shall be given.

Maintaining continuous, high-quality measurements, performing quality and error checking procedures, and submitting data and related documentation to the DIAS will require substantial financial and logistical efforts of the *data providers*. The necessary support for these *data providers'* activities originate from a variety of international, national and institutional sources. The DIAS shall make proper reference to all GEOSS AWCI *data providers* and, if required, to their funding sources.

*6) Co-operation between Data Users and Providers*

*Data users* of GEOSS AWCI data are encouraged to establish direct contact with the *data providers* for the purpose of complete interpretation and analysis of data for publication purposes. This is in particular recommended for category 2 data.

*7) Co-Authorship*

Co-authorship of *data users* and *data providers* on papers making extensive use of GEOASS AWCI data is justifiable and highly recommended, in particular, if *date providers* have responded to questions raised about the data's quality and/or suitability for the specific study in question, or have been involved in directly contributing to the paper in other ways. It is highly recommended that any *data user* should contact the responsible person of the data provider and ask him/her if he/she wants to become co- author, or if an acknowledgement would be sufficient. If co-authorship is requested, the *data provider* and the *data user* should establish a basis for collaboration.

*8) GEOSS/AWCI Publication Library*

Whenever GEOSS/AWCI data distributed by DIAS are being used for publication of scientific results, the author(s) shall sent a copy of the respective publication, preferably in electronic form, to the DIAS in order to build up a GEOSS/AWCI publication library. DIAS will maintain this library and will it make public, for example via DIAS's web site, for a continuous monitoring of the GEOSS AWCI data applications and GEOSS AWCI's achievements in general.

## 2.3 Capacity Building Program

### *Goal and Objectives*

The goal of the Capacity Building (CB) program of GEOSS AWCI is to facilitate and develop sustainable mechanisms for the countries in Asia Pacific region to use advanced earth observations systems, associated data and tools for water cycle research and water resources management under GEOSS framework.

The specific objectives of the program are to develop capacities of the Asian countries including:

1) Techniques for downscaling regional and global information to basin scale and to improve accuracy required by operational water management applications through a combination of numerical forecasting and fusion of local observations;
2) Reliable and efficient tools for conversion of the available observations and data to useful information for flood management employing data transformations, interpolation, classification, and estimation algorithms.
3) Methodologies for conversion of information to water resources management applications, both for operational use and scenario based assessments for planning purposes.

The initial focus areas of the program have been selected as floods, water quality and droughts.

### *Target groups*

The GEOSS AWCI CB program recognizes three main target groups:

1) Researchers & Scientists, where the emphasize is customizing existing knowledge to suit local conditions supported by global experiences;
2) Professionals & Practitioners, which focuses on introducing new methodologies, tools and standards;
3) Administrative & Local government officials, who are to be provided an overview of existing technology and science.

Different capacity development tools and programs will be combined to reflect the relevant emphasize and coverage for each target group.

### *Methodology*

The program is being developed and used concurrently in support of applications in 18 Asian river basins proposed to be studied within GEOSS AWCI demonstration projects for clarification of basin water cycle and the development of appropriate water management practices. The training and capacity development program consists of elements such as short term training & long term training, online training materials, examples or modules, research opportunities, technical advise on existing projects, access to data and access to software. It emphasizes sustainability and the need to customize technologies to suit local conditions by carefully setting up teams in each country made up of leading educational and research institutes and responsible government organizations that would function as core teams to ensure the future development and enhancement of the methodologies and incorporation of them to national programs.

***Institutions***
United Nations University (UNU), Tokyo, Japan will coordinate the CB program of AWCI in collaboration with the University of Tokyo, JAXA, ICHARM, AIT and other regional and national academic, research and governmental institutes that are identified though a resource survey.

***Conceptual Diagram***
The approach of the GEOSS AWCI CB program is depicted below for capacity development in flood risk reduction as an example.

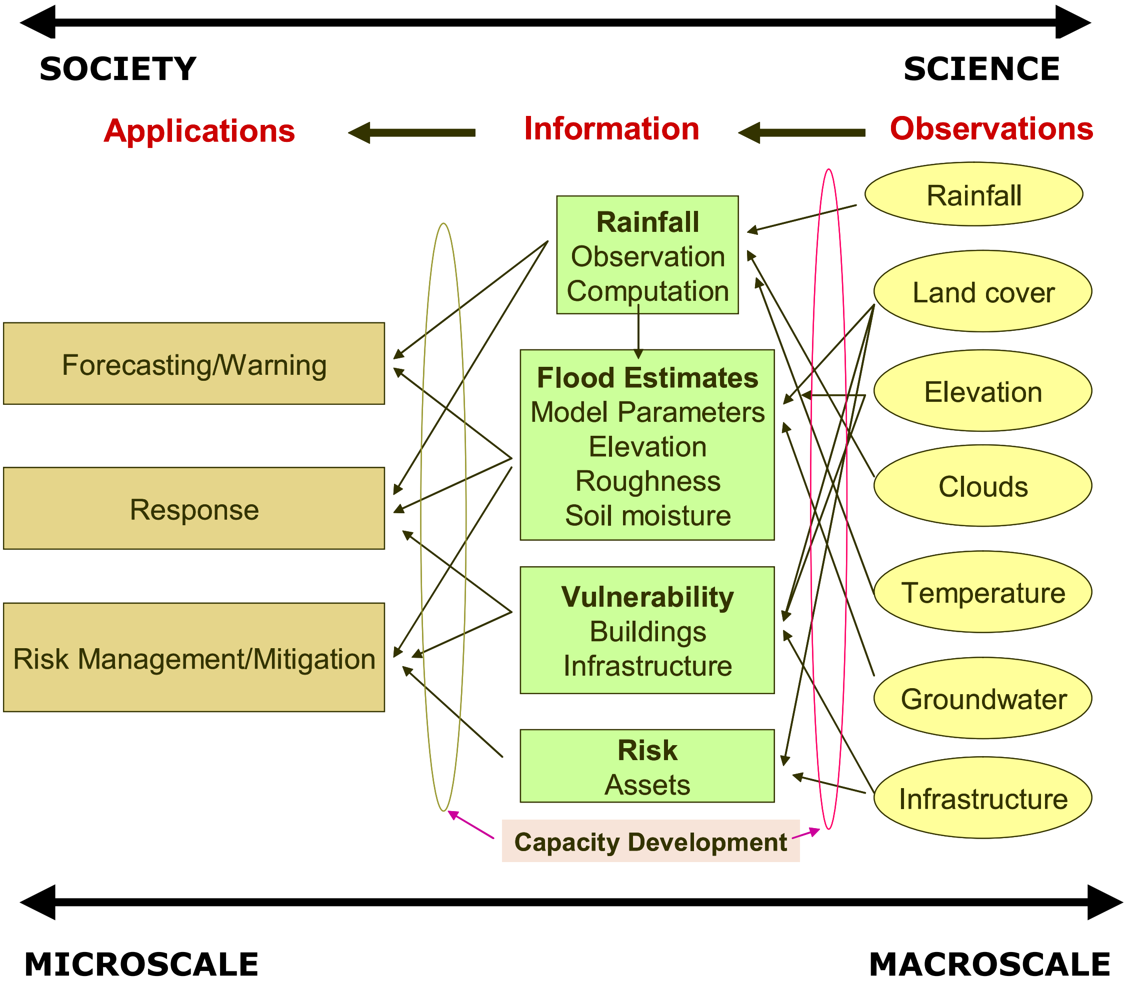

**Figure 7: Conceptual Diagram of Flood Risk Reduction Capacity Development**

### 2.4 Demonstration Projects

***Demonstration Approach***
GEOSS AWCI is a new challenge to lead in the solution of the water-related problems. It is effective to start with small-scale projects and to show early success stories to stakeholders after intensive implementation. As the first step, one river basin was selected from each participating country as a target of a demonstration project (DP), according to the following criteria:

1) Importance of the basin from the viewpoint of the socio-economic benefit area and hydrological sciences
2) Minimum requirement of data availability:
    a. Data type: rainfall, streamflow, weather station data (air temperature, wind speed, pressure, humidity);
    b. Spatial density of observation stations: according to the WMO standards but local specifics are to be considered;
    c. Watershed characteristics information.
3) Highly expected data:
    d. Upper air observation is highly recommended;
    e. Near-real time data availability is highly recommended;
    f. Ground water and water quality data availability are essential for the river basins where those problems should be addressed.
4) Size of the watershed: 100 km$^2$ – 1,000,000 km$^2$

So far, 18 river basins were selected as DP targets. The location of the DP river basins are shown in Figure 8 (Please note that the 18th basin in Malaysia, Langat river basin, has not been included in the figure below).

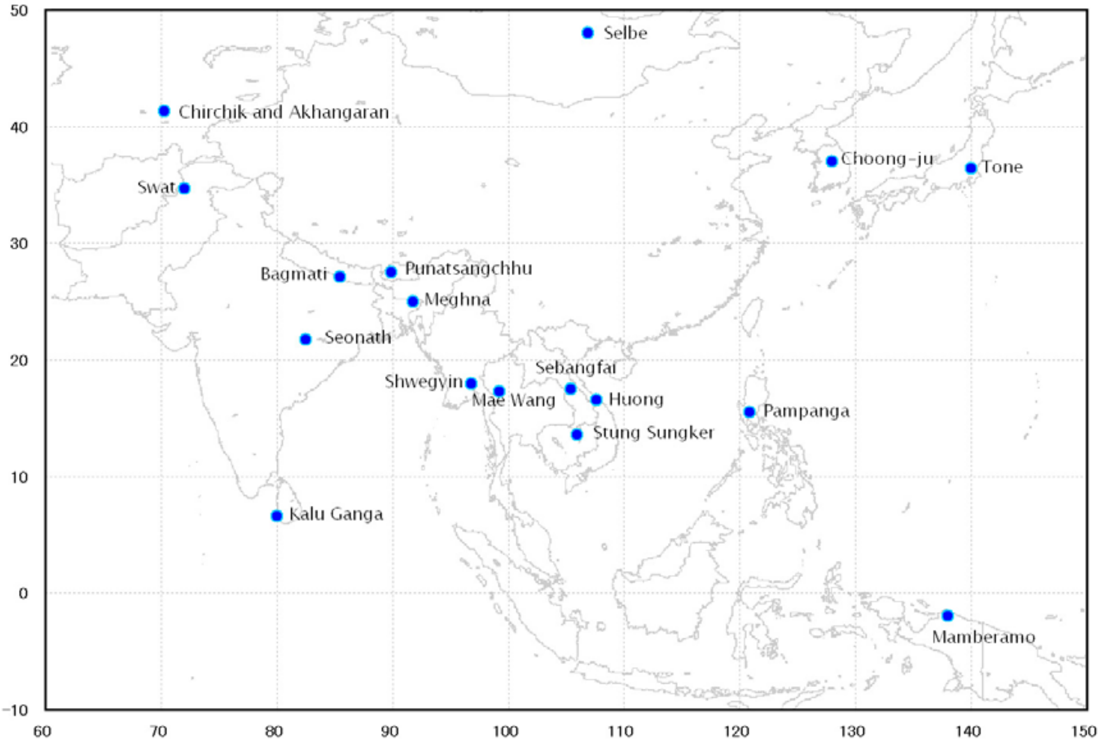

**Figure 8: Location of the demonstration river basins**

Once a DP river basin was selected for each country according to the requirements described above, each country representative was asked to fill out a basin template that attempted to retrieve a description of the nominated DP basins and their implementation plans in 5 key sections as described below.

1) <u>Background, targeted issues and objectives</u>
In this section a brief introduction to the river basin including major issues, latest event when the issue was evident, targets to be addressed through demonstration, and objectives are included.

2) <u>River basin characteristics</u>
A brief description of basin characteristics including climate regime, topographical feature, dominant land use and soil type, and socio-economic information is provided in this section. Moreover, the geographic coordinates (longitude and latitude), which

enclose the basin, were requested. Additionally, a river basin map in a JPEG format was to be provided in order to illustrate the basin extension, river network and available observation stations.

3) Observation system

A template chart was provided asking for a number of stations available in the basin for the most relevant and expected variables. The location of observation sites was included in the river basin map according to the possibility of each representative.

4) Models, GIS, Data Integration Systems, and Prediction Systems

In this section, the available hydrological and meteorological models, GIS, data integration systems, and prediction systems are included. Also, the current means of flood and/or drought forecasting and water quality monitoring is mentioned.

5) Implementation Schedule of the Demonstration

This template timeline chart was proposed to propose an implementation schedule of the demonstration. The activities selected in the chart are the most representative in order to meet the goals of our approach.

The above DP river basin information has been already submitted by 18 countries as summarized in Table 1 below.

**Table 1: GEOSS AWCI DP Rive basins**

| **Country** | **River Basin** | **Area**[km$^2$] | **Main Issues** | **DP Objectives** |
|---|---|---|---|---|
| Bangladesh | Meghna | 61,021 | Floods, Drought | Flood forecasting using DHM |
| Bhutan | Punatsangchhu | 13,263 | Floods | Adequate flood warning system |
| Cambodia | Sangker | 2,961 | Floods | Study of an impact of flash floods and IWRM practices |
| India | Seonath | 30,760 | Floods | Quantitative precipitation forecast (QPF) and probability of precipitation (PP) |
| Indonesia | Mamberamo | 78,992 | Floods | Flood forecasting |
| Japan | Tone | 3,300 | Floods | Forecast of optimal dam operation using QPF |
| Korea | Chungju-dam | 6,662 | Floods | Optimal dam operation and flood risk reduction using forecast |
| Lao PDR | Sebangfai | 8,560 | Floods | Reduce flood impact and IWRM |
| Malaysia | Langat | 2,350 | Floods, Drought, Water Quality | Impacts of climate change on water resources and reservoir inflow and water intake forecast |
| Mongolia | Selbe | 303 | Floods, Drought, Water Quality | IWRM practices |
| Myanmar | Shwegyin | 1,747 | Floods | Early warning system for floods |
| Nepal | Bagmati | 3,700 | Floods, Water Quality | Effective flood and rainfall prediction system |
| Pakistan | Swat | 5,894 | Floods, Drought, Water Quality | Flood forecasting and water quality assessment |
| Philippines | Pampanga | 10,540 | Floods | End-to-end approach in IWRM |
| Sri Lanka | Kalu Ganga | 2,720 | Floods | Minimize flood damages by using DHM & remote sensing (RS) |
| Thailand | Mae Wang | 600 | Floods | Flood forecast and early warning |
| Uzbekistan | Chirchik - Okhangaran | 20,160 | Floods | Adequate warning system for floods |
| Vietnam | Huong | 2,830 | Floods | Efficient flood warning system |

The full two page summaries in a unified format for all of these DP river basins are available in the GEOSS AWCI Implementation Plan that is included in Appendix B.

## 2.5 Working Groups

As it was mentioned in Section 2.1, GEOSS AWCI organizes three working groups: flood and landslides, drought and water scarcity, and water quality. Each WG covers both of the AWCI foci "observation convergence, data integration, information sharing" and "capacity building" and is strategically involved in demonstration projects. Since the 1st ITT meeting in Bangkok in September 2006, each of the GEOSS AWCI related events organized breakout sessions devoted to these working groups. During the breakout sessions at the 2nd AWCS in Tokyo, in January 2007, the participants discussed and outlined WG strategic plans that are aligned with the GEOSS AWCI DP approach as well as the CP program.

### *Flood and Landslides WG*

The goal of this WG is to build up a scientific basis for sound decision-making and developing policy options for most suitable flood risk management for each country and region in Asia, through the full utilization of new opportunities on global, regional and in-situ dataset under the scheme of GEOSS AWCI.

To attain the goal, it is necessary to provide methodologies, tools and basic datasets to derive such required information to improve real-time flood forecasting system for short-term crisis management (objective #1) and to assess flood risk and vulnerability and then to make flood scenarios for long-term integrated flood risk management (objective #2).

From technological point of view, it has became possible to set those objectives, based on recent scientific achievements on climatology, meteorology and hydrology in the Asian monsoon regions such as those of the WCRP GEWEX Asian Monsoon Experiments (GAME) and on satellite-based observation of rainfall, physical & socioeconomic quantities of earth surfaces and numerical weather reanalysis, downscaling & prediction. It is, however, indispensable to consider the disparity in existing resources and capabilities among different countries/regions as well as their varied needs and environments.

Considering the disparity of capabilities of countries in Asia, a demonstration project at one of the GEOSS AWCI DP river basins nominated for flood issue study (see Section 2.4) is coupled with capacity development offered by advanced global-change research network activities and organizations in Asia. The framework of GEOSS AWCI has already incorporated cooperation with the Coordinated Energy and Water Cycle Observation Project (CEOP), Integrated Global Observing Strategy Partnership (IGOS-P), Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative (MAHASRI) as a part of Global Energy and Water Cycle Experiment (GEWEX) of WCRP, Prediction in Ungaged Basins (PUB) of International Association of Hydrological Sciences (IAHS), and others.

### *Drought and Water Scarcity WG*

The drought and water scarcity study is mainly based on the observation of precipitation, temperature and soil moisture by now, such as various drought indices and moisture indices. The satellite products have not been widely used since lack of capacity building in many Asian countries. Under the support of JAXA and Tokyo University, the retrieved soil moisture dataset from satellite remote sensing products are being used in the Drought WG activities, and the related countries collaborators validate this data set by using the in-situ observation of soil moisture, precipitation and temperature. The main objectives of the Drought WG are:

1. To share and improve the drought monitoring capability in various Asian countries such as China, Pakistan, Thailand, Nepal and Philippines

2. To set up a drought monitoring and research network in related Asian countries.
3. To help developing the early warning system of drought hazard in related countries.

Drought indices are widely used in monitoring and studying the drought, such as Standardized Precipitation Index (SPI), Palmer Drought Severity Index (PDSI), Crop Moisture Index (CMI), Surface Water Supply Index (SWSI). These indices are mainly based on the ground observations of precipitation, temperature and soil moisture. But the standards of definition of these indices differ in different countries and regions. In addition, the capability of monitoring the drought is variable according to the spatial and temporal resolution of observation stations in different countries and regions.

Because of the complexity of a soil type, vegetation type, ground water deposit, and irrigation in the area, soil moisture is a key indicator of drought monitoring besides precipitation and temperature in the GEOSS AWCI Drought WG activities. JAXA and University of Tokyo are helping to develop a set of soil moisture dataset in specific regions targeted by the WG activities in participating countries. Optical and microwave remote sensing datasets are being used. In many studies, microwave products have many advantages in case of bare soil surfaces, especially in dry area. Optical products, such as NDVI and LAI are usually used for full cover vegetation area to understand the vegetation and soil processes. For partial vegetation cover area, optical and microwave products are being both used in getting the high resolution soil moisture data. The University of Tokyo and JAXA are leading activities in retrieving the remote sensing data. The Asian Institute of Technology, Thailand, proposed a drought index called Temperature Vegetation Dryness Index (TVDI) that is calculated from satellite derived vegetation index (NDVI) and surface temperature. TVDI index is will be used to monitor the drought in various countries of Asia.

The participants from participating countries have begun to provide the ground observation dataset of temperature, precipitation, soil moisture, etc. For example, Shanxi province of China is chosen as the typical research area for drought monitoring in China. Shanxi is a typical semi-arid region with average precipitation about 500mm per year, and it is influenced by drought hazard severely under the global warming and human activity (carbon emission and intensive agriculture). The summer precipitation decreased about 15% in last thirty years, There are 108 observing stations in whole area of Shanxi (150,000 km$^2$). The meteorological variables (T, P, W, P, etc.) are observed four times per day. The soil temperature and moisture observation is taking place once per ten days, and 32 stations among 108 are having soil observations every five days. Available observations suggest that the dry areas are not always corresponding to the low precipitation. Accordingly, the monitoring of drought severity will be more accurate if the information of soil moisture and temperature is included in the monitoring methodology. It may also be related to other factors like topography and irrigation. Other typical drought areas will be selected in Mongolia, Pakistan, Vietnam, Thailand and Nepal and similar studies carried out under the GEOSS AWCI framework.

### *Water Quality WG*

The overall goal of the Water Quality WG is to contribute towards sustainable management and development of water and health. The main objective is to conduct a phased research on the scopes of institutions to develop appropriate water quality monitoring program for domestic water in developing countries in Asia and disseminate the results. The specific objectives during the first phase include:

1. Analysis of the roles, capacities, practices, policies, methods (and indicators), synergies, and needs in monitoring WQ by main water concerned institutions in Bangladesh, Pakistan and Vietnam, who were actively involved and in the water quality WG deliberations and plan preparations. Other countries

participating in the GEOSS AWCI activities are expected to join the water quality team in the near future.
2. Identification and comparison of the common and specific problems as well as the related best approaches in water quality monitoring in the said three countries.
3. Conducting of a formative/indicative research to investigate preliminary appropriate water quality monitoring options for domestic water by in-situ and satellite measurements based on selected specified indicators.
4. Incorporating the results and experiences gained here into and establishing of closer collaboration with other activities of GEOSS AWCI.
5. Develop policy recommendations on how the institutions and countries can make attempts for appropriate water quality monitoring in the three countries in particular and in other countries of the region in general.

The methodology includes analyses of national and international literatures and, regional information exchange/discussion/result finalization at 2-3 regional meetings among collaborating countries as well as quarterly consultations among the investigators and activity leaders over the internet.

The main information to be collected include: existing WQ monitoring program and indicators (during flood and other periods), policies, roles and responsibilities by the institutions, needs, capacities, best practice case studies, opportunities at national and international perspectives, and other issues. The meetings will also include invited papers by water quality experts and GEOSS AWCI representatives from other countries.

## 3. Results & Discussion

In recognition of the need for accurate, timely, long-term, water cycle information as a basis for sound and effective water resources and risk management and with regards to the ongoing initiatives pursuing to meet this need, the IIWaDATA project initiated and contributed to the development of a sustainable scheme for water cycle data collecting, sharing, exchanging, and management at the regional level in Asia in cooperation with national governments, institutes and research communities and also international organizations.

### 3.1 Establishment of regional collaboration – GEOSS AWCI

The project activities began with series of meetings that targeted and achieved establishment of a regional collaborative framework focusing on the water-related issues. The basis for effective collaboration at the regional level is the mutual consensus on data collection, archiving, dissemination, and sharing that was built along the Data Policy document adopted from the CEOP project and adapted for the needs of the project activities (see Section 2.2). This consensus, which is an important achievement of this project, was accepted by representatives of 19 collaborating countries at the 2nd Asian Water Cycle Symposium in Tokyo.

While the said consensus including Data Policy was accepted without any objection from the participating countries, its practical implementation in terms of data provision to the common data archive at the Data Integration & Analysis System (DIAS) has proven to be more demanding task than expected. Especially in this initial stage of demonstration projects, the data provision process requires continuous communication between the data archive mangers and individual data providers. The last GEOSS AWCI ICG group meeting in Beijing, November 2008 suggested, that further demonstration and explanation of the data upload procedure to the DIAS database would be needed to expedite the data submission process.

The initial IIWaDATA activities soon expanded beyond its original scope and a large, long-term regional initiative was established that was recognized by international organizations and institutions as GEOSS Asian Water Cycle Initiative (AWCI). This is another significant success of the IIWaDATA project. The scope of GEOS AWCI is summarized below and schematically depicted in Figure 9.

> *GEOSS AWCI promotes observation convergence by making seamless access to the data from earth observation satellites, in-situ reference site networks, and operational observation systems, integrates the observed data, numerical weather prediction model outputs, geographical information, and socio-economic data, and disseminates usable information for sound decision making of water resources management against flood and landslide, drought and water scarcity, water pollution and ecosystem degradation, and impacts of the climate change on water.*
>
> *GEOSS/AWCI enforces capacity for a broader community to generate, interpret and utilize value-added products from the observations, beyond training of qualified technical personnel to operate the observing instruments, by coordinating requests from participating countries and potential capabilities of supporting organizations and on-going and/or planed projects.*
>
> *GEOSS AWCI International Coordination Group (ICG) consisting of international science communities, space agencies, and water-related ministries and agencies of the participating countries, takes a strategic demonstration approach. By showing success stories created through demonstration projects to decision makers, GEOSS AWCI will shift the emphasis from scientific challenges to operational applications to yield the societal benefits and establishes confirmed water management infrastructure against the water related problems.*

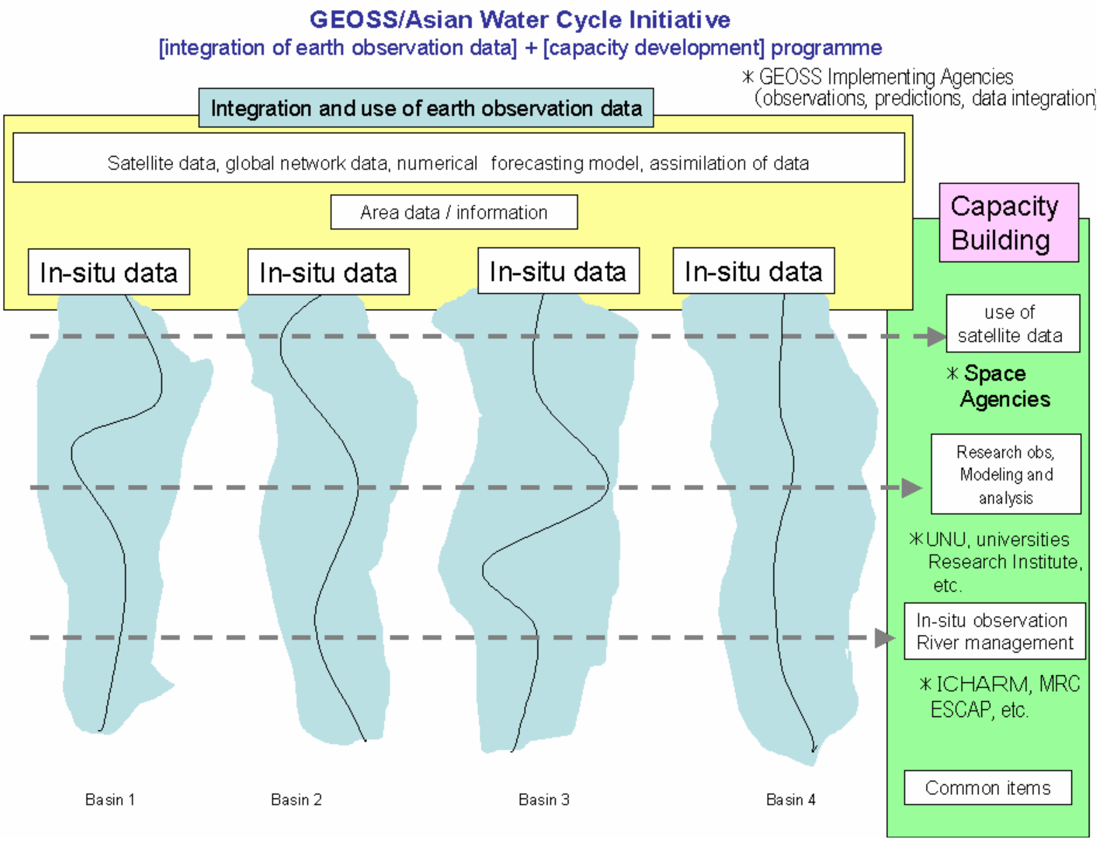

**Figure 9: GEOSS AWCI Structure**

### 3.2 Data Integration and Analysis System (DIAS)

The IIWaDATA project activities also contributed to the Data Integration and Analysis System (DIAS), developed as part of the Earth Observation and Ocean Exploration System, which is one of five National Key Technologies defined by the 3rd Basic Program for Science and Technology of Japan. The University of Tokyo, one of the members of GEOSS data integration analysis alliance is leading DIAS. DIAS supports GEOSS AWCI to realize observation convergence, data integration and data and information sharing. Diverse and large-volume Earth observation data is archived by a well-managed data infrastructure where user can explore targeted data and information and analyze and integrate them easily and effectively. A metadata directory system, coupled with ontology systems of dictionary and geographical information, supports users to understand the meaning of the data and information across various disciplines and geographical locations.

DIAS system also provides user-friendly on-line tools for data providers that simplify and expedite the data submission procedure and enable interactive and detailed data quality assessment and corrections of data already in the DIAS database (Ikoma et al. 2007a,c; Tamagawa et al. 2007a,b, 2008).

The IIWaDATA project brought people together and provided opportunities for exchanging ideas and information between the system developers and system users (scientists, water resources managers and policy- and decision-makers) and thus the developers had the valuable end user feedback. Furthermore, introducing a new structure of the datasets into the system – all relevant and available data within a river basin including the basin and river network characteristics – stimulated and contributed to the further enhancement of the system metadata models. The key contribution to DIAS and through it to all of its users is, of course, the provided data itself. As mentioned above, the data provision process has begun but it is still in the initial stage and thus the amount of data already available in the system is very limited. We suppose this will significantly improve in the near future, at least within 2009.

### 3.3 Downscaling techniques and tools and capacity building for IWRM practices

The IIWaDATA project has contributed to the downscaling system that is being developed at the University of Tokyo and is based on dynamical downscaling approach and includes land-atmosphere satellite data assimilation system (Boussetta et al. 2008) and advanced distributed hydrological models (DHM) (Wang et al., 2008; Saavedra et al., 2006; 2008a,b,c). The further development will also benefit from the complex datasets provided by the GEOSS AWCI participating countries. Especially the hydrological data including streamflow are crucial for DHM validations.

The project has also contributed development of a distributed hydrological model that incorporates optimization scheme for dam operation (Saavedra et al. 2006; 2008a,b,c). This model was applied to the Tone River (Japan), Meghna River (Bangladesh), Pampanga River (Philippines), and Huong River (Vietnam) as initial steps of the GEOSS AWCI demonstration projects. The results were presented at the 4th Conference of the Asia Pacific Association of Hydrology and Water Resources in Beijing, China, November 2008 and showed the usefulness of the DHM applications as a reference tool for water resources management. For example, dam operation in upper Tone river showed effective flood reduction downstream and replenishment of water at reservoirs. Meghna River model was set-up using Global data set and TRMM data, which showed useful for flood forecast. Optimal dam operation was achieved maximizing the hydroelectricity production in Philippines. Flood and flood inundation simulation of Huong River was reached.

The project has triggered discussions on capacity building needs vs. available resources and provided opportunity for country representatives and science and technical experts to meet and exchange information and ideas and to identify what and where the needs are and what and where are the available resources. This activity has resulted in formulation of a complex capacity development program of GEOSS AWCI as explained in Section 2.3. Various activities under this program have already been undertaken, e.g. DHM training courses in cooperation with the University of

Tokyo; a number of Sentinel Asia miniprojects provided by JAXA have been devoted to the GEOSS AWCI activities, and others.

## 4. Conclusions

The IIWaDATA project activities were aimed at:

1. Improving knowledge and enhancing prediction of the Asian water cycle variation through integrated observation systems and advanced data management and processing capabilities that would assure an easy access to relevant data in the proper format and to the desired extent to research communities;
2. Making a contribution toward the sustainable human development in the region through development of methods and tools for effective transformation of global and regional observation information and scientific knowledge into information relevant for local water resources and risk management and facilitated transfer of such information to national policy- and decision-making groups.

The initial step of the project was establishment of a solid collaboration framework at the regional level that would make the striving for above aims possible. The project organized several meetings, usually in conjunction with related events, which provided opportunity for extensive and intensive deliberations among a large group of government representatives, scientists, practitioners, and experts with experiences from various fields but with common interest in the Asian water cycle variations and their impact on water resources and water-related risk management. The extended discussion on the mutual consensus regarding the data collecting, archiving, dissemination, and sharing and on the structure of the collaborative framework lasted about one and half year. Nevertheless, this proved to be a good investment that yielded a strong and long-term coordinated effort that has been recognized by international organizations as GEOSS Asian Water Cycle Initiative (AWCI). Establishment of GEOSS AWCI, which currently includes 19 Asian countries and a number of national and international organizations and research institutions, development of the GEOSS AWCI Implementation Plan, and initiation of its activities aiming at the above goals is the key achievement of this project.

In parallel with the efforts dedicated to the establishment of GEOSS AWCI, the project was involved in and contributed to the Data Integration and Analysis System (DIAS), which is an essential tool enabling the proposed advanced research studies and activities focusing on effective transformation of observation information and scientific knowledge into information relevant for local water resources and risk management. Development of other important tools including downscaling techniques and advanced hydrological models was also supported by the project.

At the very beginning of the project activities, it was realized that a coordinated capacity building program is indispensable for successful accomplishments of the stated objectives. The GEOSS AWCI CB program was developed based on the identified needs in individual countries and available resources within GEOSS AWCI group.

## 5. Future Directions

GEOSS AWCI has a great potential for long-term continuation in activities initiated by the IIWaDATA project and implementation of further activities and projects contributing to the IIWaDATA goals.

The GEOSS AWCI Demonstration Projects have been launched and are expected to be completed by the end of 2011 (see the GEOSS AWCI Implementation Plan draft in Appendix B). Based on the DP results, further activities will be proposed that will be focused on moving from research to operational phase in terms of water resources and risk management.

Also the GEOSS AWCI capacity development program activities are on-going as proposed in the Plan. The working groups have proposed research- and capacity building-oriented projects to the APN CAPaBLE and ARCP programs and three projects have been accepted and are currently on-going:

ARCP2008-13NMY-Fukami

***Flood Risk Management Demonstration Project (phase 1) under the Asian Water Cycle Initiative for the Global Earth Observation System of Systems (FRM/AWCI/GEOSS)***

This project will contribute to GEOSS within the context of the GEOSS Work Plan for 2007–2009: (i) WA-06-07: Capacity Building Program for Water Resource Management. It will support the work of flood risk reduction research of AWCI, which will assess regional vulnerability of natural and human systems from floods under changing environmental conditions and will contribute to the development of policy options for appropriate local and regional responses. The project will also contribute directly to enhancing regional cooperation, strengthen interactions between scientists and policy- makers and improve scientific and technical capabilities of Asian region nations, fitting very well with the APN activity framework. Training programs on the use of tools and data will form the basis for capacity development activities.

CBA2008-12NMY-Ishida

***The Global Earth Observation System of Systems Asian Water Cycle Initiative Observation Convergence and Data Integration (GEOSS/AWCI/OCDI)***

Recognizing the commonality in water-related issues and socio-economic needs of the Asia-Pacific region, a well coordinated regional challenge, GEOSS/AWCI/OCDI has been organized in cooperation among the 18 countries in Asia. This project aims to protect life and property from damages of the water-related issues in Asia, develop integrated water management approaches for addressing the various water-related issues comprehensively and effectively, and to share timely, quality, long-term information on water quantity and quality and their variation as a basis for sound decision-making of national water policies and management strategies. It will also promote regional approaches which can lead to coordinated efforts for observation and prediction, based on common ideas on the water-related issues in Asia.

CBA2008-05NMY-Ailikun

***The Capacity Building for Drought Monitoring and Studying in Monsoon Asia under the Framework of Asian Water Cycle Initiative (AWCI)***

The drought study is mainly based on the observation of precipitation, temperature and soil moisture, such as various drought index and moisture index. The satellite products have not been widely used because of lack of capacity building in many Asian countries. Under the support of Japan Aerospace Exploration Agency (JAXA) and Tokyo University, the retrieved soil moisture dataset from satellite remote sensing products will be used in this project, and the respective collaborators will validate this data set by using the in-situ observation of soil moisture, precipitation and temperature. AWCI GEOSS will coordinate this regional activity, along with the flood and water quality groups.

Moreover, the established consensus on data sharing supposes continued data provision to the DIAS system, at least by the end of demonstration projects but intention is to extend the data submissions beyond 2011 based on the results from the demonstration projects.

In addition, activities on downscaling techniques and water resources and risk management tools are continuing at collaborating national and international organizations and institutions (e.g., University of Tokyo, United Nations University, ICHARM, AIT, etc.) and under the existing cooperative projects (e.g. CEOP).

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## Appendix A: Glossary of acronyms

| | |
|---|---|
| AIT | Asian Institute of Technology |
| AWCS | Asian Water Cycle Symposium |
| AWCI | Asian Water Cycle Initiative |
| CB | Capacity building |
| CEOP | Coordinated Energy and Water Cycle Observations Project |
| CMI | Crop Moisture Index |
| DHM | Distributed Hydrological Model |
| DIAS | Data Integration and Analysis System |
| DP | Demonstration Project |
| GCM | General Circulation Model |
| GEO | Group on Earth Observations |
| GEOSS | Global Earth Observation System of Systems |
| GEWEX | Global Energy and Water Cycle Experiment |
| IIWaDATA | International Integrated Water Data Access and Transfer in Asia |

| | |
|---|---|
| IWRM | Integrated Water Resources Management |
| ICHARM | International Centre for Water Hazard and Risk Management |
| JAXA | Japan Aerospace Exploration Agency |
| LAI | Leaf Area Index |
| MEXT | Ministry of Education, Culture, Sports, Science, and Technology |
| OCDI | Observation Convergence and Data Integration |
| NDVI | Normalized Difference Vegetation Index |
| NWP | Numerical Weather Prediction |
| PDSI | Palmer Drought Severity Index |
| PP | Probability of Precipitation |
| QPF | Quantitative precipitation forecast |
| RS | Remote Sensing |
| SPI | Standardized Precipitation Index |
| SWSI | Surface Water Supply Index |
| TVDI | Temperature Vegetation Dryness Index |
| UT | University of Tokyo |
| UNU | United Nations University |
| WCRP | World Climate Research Project |
| WMO | World Meteorological Organization |
| WSSD | World Summit on Sustainable Development |

**Appendix B: GEOSS AWCI Implementation Plan**

Draft

Implementation Plan for

# Global Earth Observation System of Systems Asian Water Cycle Initiative (GEOSS/AWCI)

# Preface

Water comprises the most basic and critical component of all aspects of human life and is an indispensable component of the global life support system. On the whole, the water environment is characterized by the hydrological cycle, including floods and droughts. The widespread scarcity, gradual destruction and aggravated pollution of water resources in many regions have triggered a range of water crises. Nowadays, many water related problems particularly drinking water pollution are reported in various Asian countries. Health damage due to arsenic polluted drinking water is one of such problems. There is an urgent need for international cooperation to overcome the problems and secure the safe and sustainable groundwater utilization. Additionally, global climate change and atmospheric pollution could also have an impact on water resources and their availability.

About 60 % of the world population lives in Asia, and their various social activities including agriculture depend on the bountiful Monsoon rain. At the same time, the vast water cycle variation in Asia can be the cause of droughts and floods, and consequently, may be responsible for an enormous amount of human and economic damage.

To establish a comprehensive, coordinated and sustained earth observation scheme, an agreement for a 10-Year Implementation Plan for a Global Earth Observation System of Systems, known as GEOSS, was reached at the Third Earth Observation Summit held in Brussels, in February 2005; on that occasion the Group on Earth Observation (GEO) was also formally established. "Improving water resource management through better understanding of the water cycle" has been agreed to as one of the targeted societal benefit areas of GEOSS.

Our goal is to better understand the mechanism of variability in the Asian water cycle and to improve its predictability, and furthermore to interpret the information applicable to various water environments in different countries in Asia, then to help to mitigate water-related disasters and promote the efficient use of water resources.

## CONTENTS

## Summary

There is a rapidly growing concern about the common water issues, including flood and landslide, drought and water scarcity, water pollution and environmental degradation, climate change impacts in Asia.

Based on the regionally common and sharable ideas on the water-related issues in Asia and their natural and socio-economical backgrounds, a well coordinated regional challenge, "Asian Water Cycle Initiative (AWCI) Contributing to GEOSS", has been organized in cooperation among 18 countries in Asia based on the series of discussions since 2005 just after the GEO established.

The AWCI develops an information system of systems for promoting the implementation of integrated water resources management (IWRM) through data integration and sharing and improvement of understanding and prediction of the water cycle variation as a basis for sound decision making of national water policies and management strategies.

The objectives for AWCI are defined as follows:

- to develop Integrated Water Resources Management (IWRM) approaches;
- to share timely, quality, long-term information on water quantity and quality, and their variation as a basis for sound national and regional decision making;
- to construct a comprehensive, coordinated and sustained observational system of systems, such as prediction systems and decision support capabilities, under the GEOSS;
- to develop capacity building for making maximum use of globally integrated data and information for local purposes as well as for observation and collecting data.

The AWCI is a new type of an integrated scientific challenge in cooperation with meteorological and hydrological bureaus and space agencies. Its uniqueness is described as follows:

- Effective combination of the architecture and data and the capacity building;
- Advanced data infrastructure availability including a river basin meta-data registration system, a data quality control interface, and data-integration and downscaling methods;
- A clearly described data sharing policy agreed among the participating countries;
- Strong linkage among science communities, space agencies, and decision makers;
- Well coordination between the research communities and operational sectors with clear strategy for transferring scientific achievements to operational use;
- Effective cooperation with international projects and cooperative frameworks.

"Improving water resource management through better understanding of the water cycle" is one of the nine societal benefit areas of GEOSS. GEOSS/AWCI is a regionally cooperative contribution to this socio benefit area.

# 1. Background and Origin of this Plan

## *1.1 Water-related issues in Asia*

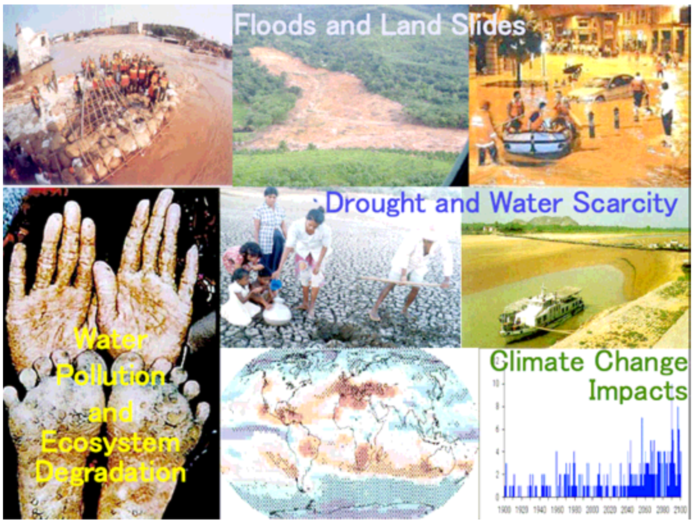
More than 60 percentages of the world population live in Asia associated with the rapid economic growth. The Asian monsoon, which is the largest water circulation system in the world, provides substantial water resources which supports to the food production, energy generation and even transportation in Asia, and causes serious water related problems due to the large seasonal and inter-annual variability of the monsoon rainfall.

Floods are very serious common problems in Asia. More than 80 percent of the loss of human lives by flood in the world occurs in Asia. The expansion of urbanization in Asia is accelerating flood economic damages considerably. Since many Asian countries locate in the tectonic zones, land slides and mud flows are also common natural disasters in Asia.

The Asian monsoon usually provides rich water environment. At same time, its large seasonal and inter-annual variation sometimes leads to severe drought damages in the water consuming societies. The high rate of the population increase is exhausting the water resources and the water scarcity would be serious issues in the near future.

Excessive water use also affects the water quality and ecosystem. Especially, severe health effects have been observed in populations drinking arsenic-rich water over long periods in some of Asian countries, including Bangladesh, China, India, and Thailand. Over the last decade, it has been recognized that healthy aquatic ecosystems provide tangible economic and social benefits. It is important to understand the drivers and status of ecosystem degradation and the need for watershed restoration in order to improve water productivity across the Asia.

The global warming is changing the water cycle. Heavier rainfall events and larger interannual variations are predicted to be likely to happen according to the "radiative-convective equilibrium". Global warming is considered to make considerable impacts on such a vulnerable region, Asia, where the percentage of completion of river developments is still critically low compared to the high potential water-related hazards.



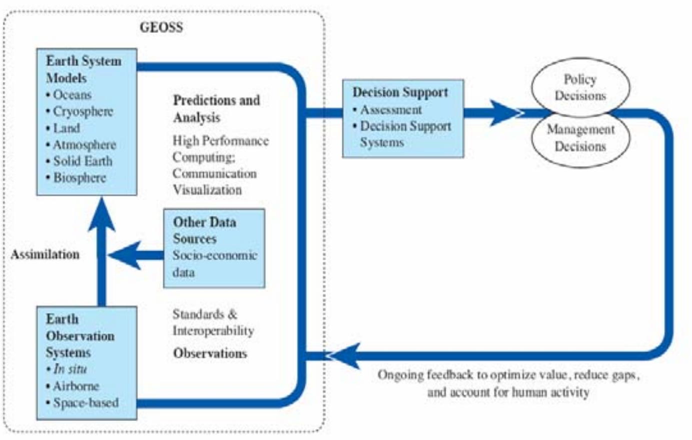
*The Water-related Issues in Asia*

### 1.2 GEO and GEOSS

At the World Summit on Sustainable Development (WSSD) in 2002, world leaders proclaimed the need "to promote the development and wider use of Earth observation technologies." That vision built on the outcomes of landmark environmental summits. The need for coordinated Earth observations, and the concept of GEOSS itself, has also been consistently reinforced by G8 Summits. The G8 nations in 2003 at Evian made a clear commitment to strengthen international cooperation on global Earth observations, and reinforced this commitment through the 2005 Gleneagles Plan of Action and the 2007 Summit in Heiligendamm.

Following the discussions at the Earth Observation Summits held in Washington DC and Tokyo, the Brussels Summit established the Group on Earth Observation (GEO) and endorsed the 10 Year Implementation Plan for the Global Observation System of Systems (GEOSS). The goal of GEOSS is to achieve comprehensive, coordinated, and sustained observations of the Earth system to improve monitoring of the changing state of the planet, increase understanding of complex Earth processes, and enhance the prediction of the impacts of environmental change. GEOSS will meet the need for all nations to benefit from access to timely, quantitative, and high-quality long-term global data and information as a basis for sound decision making. "Improving water resource management through better understanding of the water cycle" is one of the nine socio-benefit areas, including *Disasters, Human Health, Energy Management, Climate Variability and Change, Water Cycle, Weather, Protection of Ecosystems, Agriculture,* and *Conserving Biodiversity*.

*Vision of GEOSS*



*Structure of the GEOSS Functions*

### 1.3 Asian Initiative

Under the framework of GEOSS, representatives of hydrological and meteorological organizations and science communities in Asia gathered together, and began to discuss about how to address the water-related issues in Asia in cooperative ways by making maximum use of GEOSS.

At the 1st Asian Water Cycle Symposium (AWCS) in Tokyo, November, 2005, the participants recognized the common water-related issues and socio-economic needs as described above. They shared ideas on the large natural variation of the Asian monsoon and the big impacts of the human activities in Asia as their backgrounds. To address these issues, they considered that well coordinated scientific and operational challenges and efforts should be launched by making maximum use of the GEOSS, which is leading convergence and harmonization of observation activities, interoperability arrangements, and effective and comprehensive data management. Then, they agreed to establish a basic plan for “Asian Water Cycle Initiative (AWCI) contributing to GEOSS” and to organize an International Task Team (ITT) for drafting an implementation plan for demonstration projects.

Based on the discussions at the first ITT meeting and the International Workshop on Capacity Building "Earth Observations in the service of Water Management", both held in Bangkok in September 2006, a baseline implementation plan for the GEOSS/AWCI demonstration projects was proposed at the 2nd AWCS in Tokyo, in January 2007. The symposium fully approved the baseline idea and established the International Coordination Group (ICG) consisting of the national representatives and the working group co-chairs for promoting the cooperative activities.

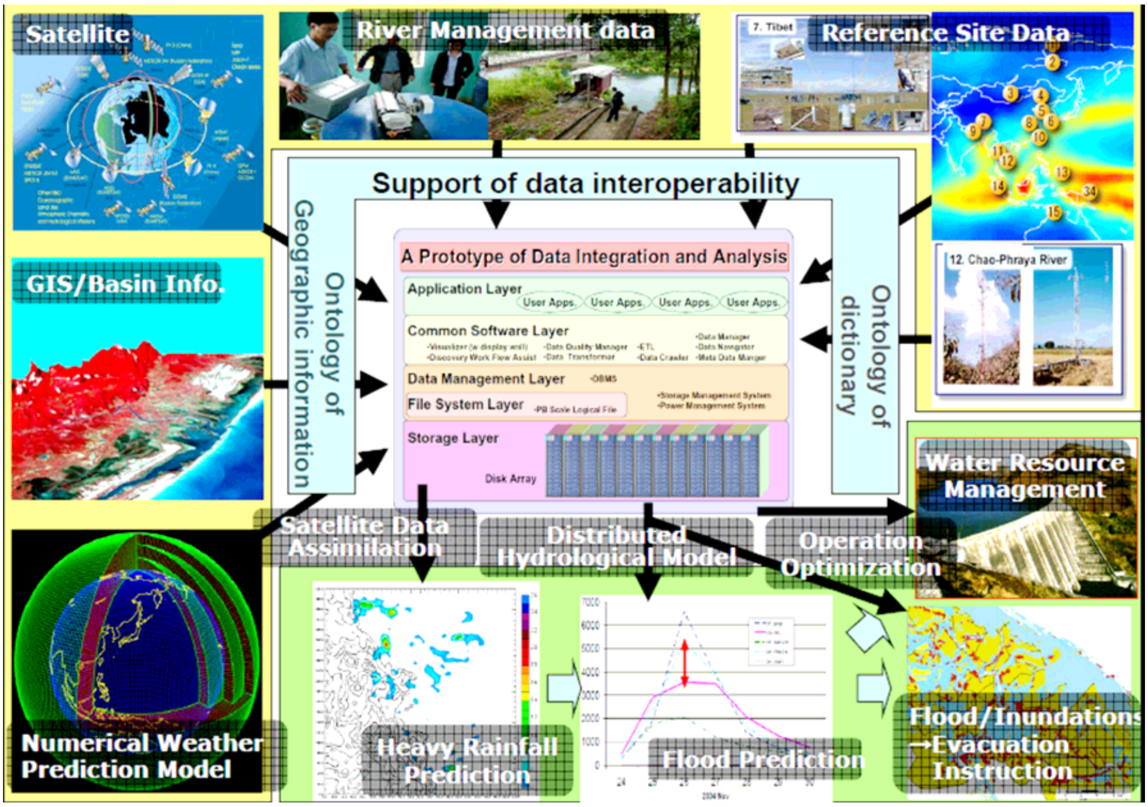
The 1st ICG was held in Bali, in September 2007. The update of each country activity was reported and the contents and procedure of the demonstration project implementation plan were discussed, following the confirmation of the baseline implementation plan.

*AWCI Preparation Meetings*

## 2. Scope

GEOSS/AWCI promotes observation convergence by making seamless access to the data from earth observation satellites, in-situ reference site networks, and operational observation systems, integrates the observed data, numerical weather prediction model outputs, geographical information, and socio-economic data, and disseminates usable information for sound decision making of water resources management against flood and landslide, drought and water scarcity, water pollution and ecosystem degradation, and impacts of the climate change on water.

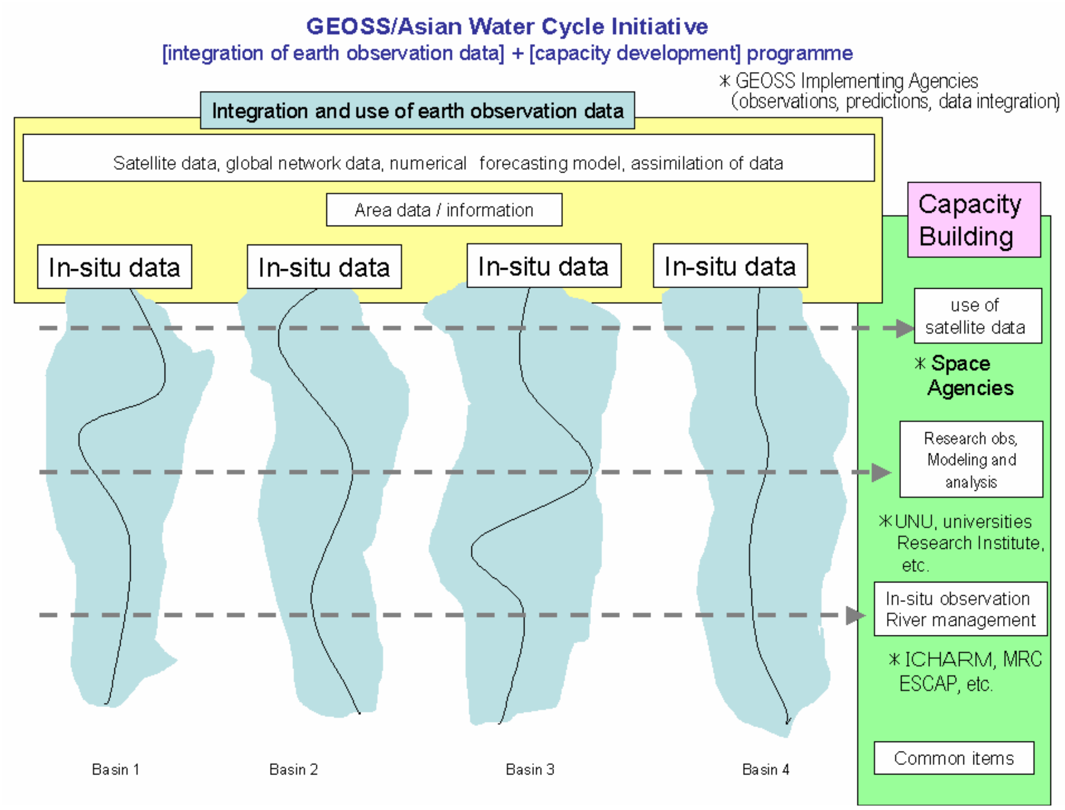
The Data Integration and Analysis System (DIAS) at the University of Tokyo, one of the members of GEOSS data integration analysis alliance, support GEOSS/AWCI to realize observation convergence, data integration and data and information sharing. Diverse and large-volume Earth Observation data is archived by a well-managed data infrastructure where user can explore targeted data and information and analyze and integrate them easily and effectively. A meta data directory system, coupled with ontology systems of dictionary and geographical information, supports users to understand the meaning of the data and information across various disciplines and geographical locations. A clearly described data policy is approved for promoting a regional collaboration to address the common water-related issues in Asia.



***GEOSS/AWCI Observation Convergence, Data Integration, and Information Sharing***

GEOSS/AWCI enforces capacity for a broader community to generate, interpret and utilize value-added products from the observations, beyond training of qualified technical personnel to operate the observing instruments, by coordinating requests from participating countries and potential capabilities of supporting organizations and on-going and/or planed projects.

GEOSS/AWCI International Coordination Group (ICG) consisting of international science communities, space agencies, and water-related ministries and agencies of the participating countries, takes a strategic demonstration approach. By showing success stories created through demonstration projects to decision makers, GEOSS/AWCI will shift the emphasis from scientific challenges to operational applications to yield the societal benefits and establishes confirmed water management infrastructure against the water related problems.



*GEOSS/AWCI Structure*

## 3. Observation Convergence, Data integration, and Information Sharing

### *3.1 Observation Convergence*

GEOSS/AWCI converges earth observation satellites, in-situ reference site networks, and operational observation systems, integrates the observed data, numerical weather prediction model outputs, geographical information, and socio-economic data, and disseminates usable information for sound decision making of water resources management in cooperation with Coordinated Energy and Water Cycle Observations Project (CEOP) of the Global Energy and Water Cycle Experiment (GEWEX), World Climate Research Programme (WCRP).

The data obtained at the CEOP reference sites in tropics, semi-arid regions, and high mountain areas in Asia is provided to GEOSS/AWCI. Even there are big varieties in observation elements, data format, and recorded interval of the original reference site data, CEOP can provide well quality checked data with a unified format in cooperation with the site observers by using a Web based Quality Control (QC) and format conversion system.

Data from sensors on board Earth observation satellites in various orbits, polar/geostational or sun-synchronous/non-sun-synchronous, around the Earth can be integrated to provide hydrological information, water vapor, cloud, rainfall, soil moisture, and snow, at all spatial scales from local to global and temporal ones from diurnal to decadal.

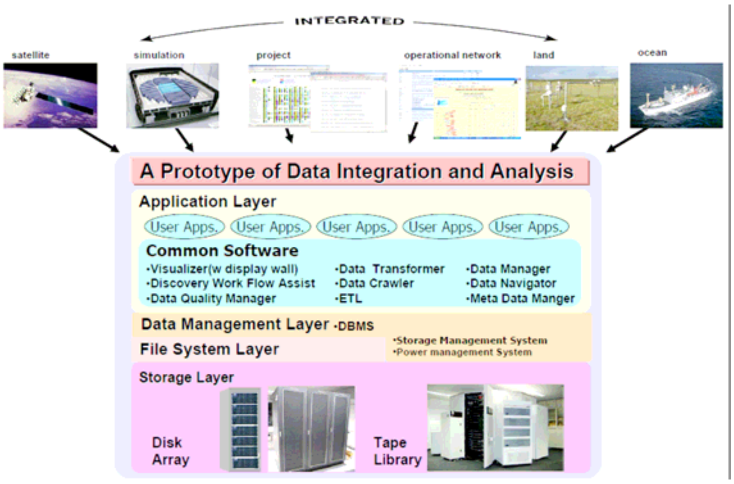
Model output from many Numerical Weather Prediction (NWP) centers is provided. Ten operational NWP centers and two data assimilation centers are currently contributing to this component of CEOP. To assist with the organization of this activity, a CEOP Model Output Management Document was drafted as a guide for the participating centers to use in setting up their processes for meeting their commitments to CEOP.

In addition to the above data to be provided by CEOP, run-off data, dam operation data, geographical information including topography, land cover, and land use, population and socio-economic data are collected in the river basins targeted by GEOSS/AWCI.

*GEOSS/AWCI Observation Convergence*

### *3.2 Data Integration and Analysis*

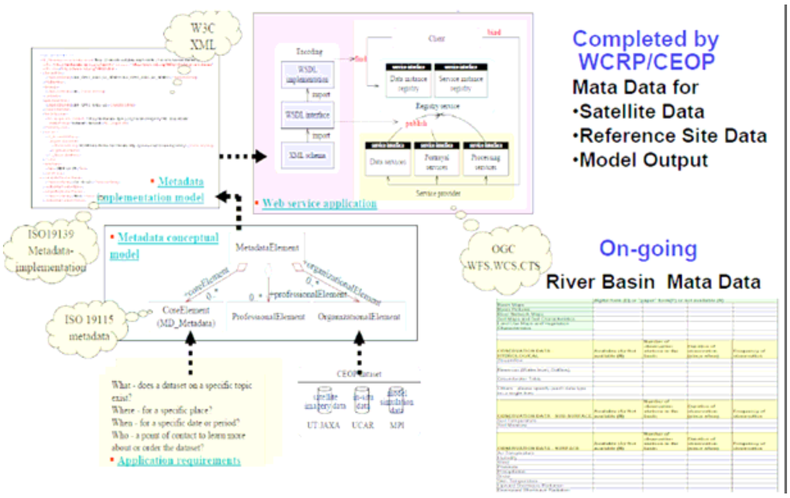
DIAS, which is functioning as the CEOP centralized data integration system, provides cooperative opportunities for constructing GEOSS/AWCI data archives, developing data integration and analysis functions, and develops the required. Specialized system architecture enables the management of large amounts of complex Earth Observation data in an information-rich era. Various observed data and numerical model outputs can be easily integrated. Targeted data can be selected by date and region. Analyzed output can be visualized on a display wall. Results can also be visualized in 3D.



*GEOSS/AWCI Data Integration System*

An ontology system enables users to find target data and information from diverse data sources. To find data with similar meanings, it is often necessary to clarify the terminology. The ontology system learns the definition. If a data name is not clear, keywords can be input to yield several candidate data names. Standardized meta data are needed for exploring data, confirming its meaning and quality, and to enable it to be widely shared. A Standardized meta data model is now under development in cooperation with the international standardization communities.

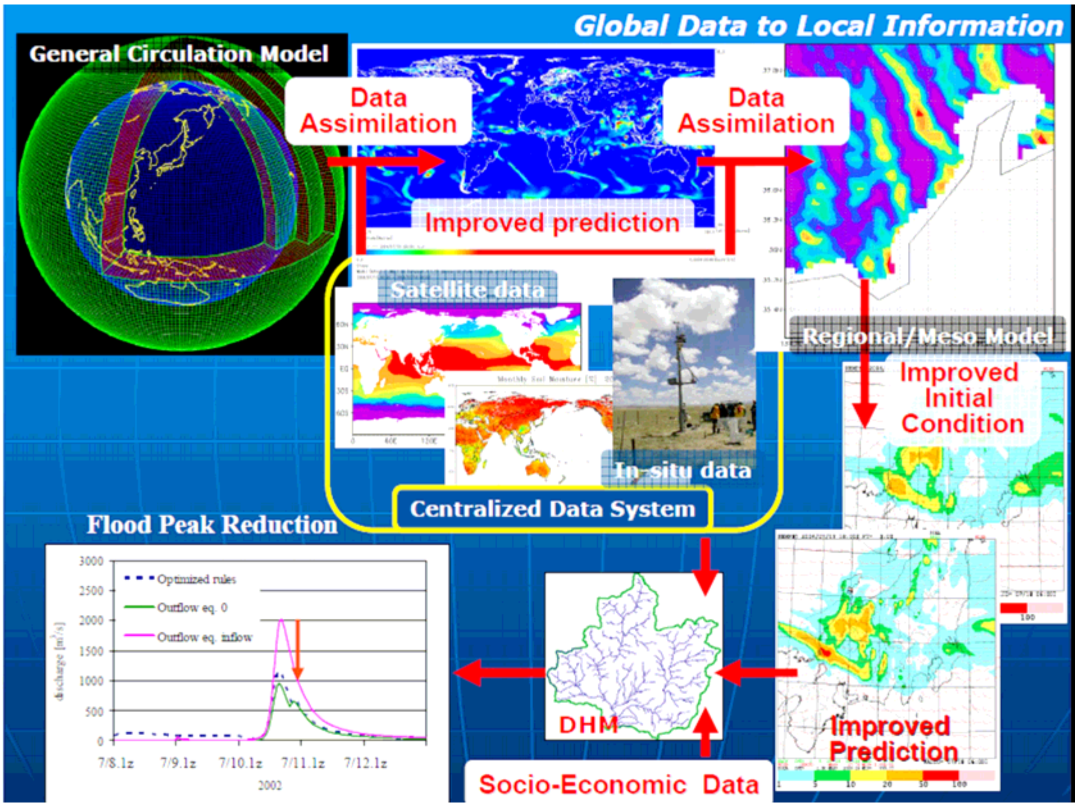
Water-related hazards usually occur as causes and consequences of large water cycle fluctuations at scales of global and regional, while disasters and damages due to the hazards happen through strong linkage with human activities in a local scale. The observations and predictions of the water-related hazards and their damages are also enhanced by combining global earth observation and prediction systems and local information. In this context, "downscaling" of water cycle from



*GEOSS/AWCI Interoperability Arrangement*

global to regional and to local is one of the key integration functions of the GEOSS/AWCI.

General Circulation Models (GCMs) currently used for predicting weather and climate have a coarse spatial resolution size, which cannot capture the details of orography and land use nor resolve important cyclonic disturbances or similar-sized circulation features. This precludes an accurate representation of precipitation on scales of individual grid boxes. The method for producing local-to-regional scale information from larger-scale GCM data is called “downscaling”. GEOSS/AWCI makes maximum use of the global earth observation and prediction, develops a downscaling system coupled with satellite-based data assimilations and distributed hydrological models, and disseminates usable information in a river basin scale or less for decision making on disaster mitigation and water resources planning.



*GEOSS/AWCI Down-scaling Process*

### *3.3 Data Release and Dissemination Guidelines*

The large part of the GEOSS/AWCI data including, the reference site and satellite data and the NWP model outputs, are provided by WCRP/GEWEX/CEOP. It is thus appropriate that any policy for release and dissemination of GEOSS/AWCI data should principally follow the CEOP Data Release and Dissemination Guidelines.

*1) Release of Data in Compliance with WMO Resolution 40 (CG-XII) and WMO Resolution 25 (CG-XIII)*

GEOSS/AWCI archives meteorological, hydrological, and related data and products in Asia for addressing the common water-related issues in Asia. Any policy for release and dissemination of GEOSS/AWCI data should principally comply with the WMO policy, practice and guidelines for the exchange of meteorological, hydrological, and related data and products, as embodied in Resolution 40 of the Twelfth WMO Congress 1995 (CG-XII), and Resolution 25 of the Thirteenth WMO Congress 1999 (CG-XIII); that is, free and unrestricted exchange of essential data and products.

The no-restriction principle shall in particular mean that no financial implications are involved for the GEOSS/AWCI data exchange. GEOSS/AWCI *data providers* shall transfer their obtained data to the Data Integration and Analysis System (DIAS) free of charge. Also, GEOSS/AWCI data archived at the DIAS shall be offered free of charge to GEOSS/AWCI *data users*.

*2) No Commercial Use or Exploitation*

It is understood that all GEOSS/AWCI data shall be delivered to *data users* only for scientific studies and operational uses designed to meet GEOSS/AWCI objectives. Commercial use and exploitation by neither the *data users* nor the DIAS is prohibited, unless specific permission has been obtained from the *data providers* concerned in writing.

*3) No Data Transfer to Third Parties*

One restriction which will be imposed on all *data users* concerns the re-export or transfer of the original data (as received from the DIAS archive) to a third party. Such restriction shall apply to all categories of GEOSS/AWCI data, and is in the best interests of both the data providers and the potential users. Unrestricted copying of the original data by multiple, independent users may lead to errors in the data and loss of identity of its GEOSS/AWCI origin and is strictly prohibited.

DIAS will offer GEOSS/AWCI data to potential *data users* through electronic means, (e.g. the internet) or other designated media (e.g. CD ROMs). The DIAS shall install technical means to keep protocol on all data transfers to *data users* thus maintaining a catalogue of all *data users*, and the data files they have obtained.

*4) Timing for Release of GEOSS/AWCI Data from the DIAS Archive*

The timing issue clearly involves some conflicting aspects. The *data user* will obviously be interested in obtaining data as soon as possible after the time of measurement. The data provider as well as the DIAS will wish to ensure the highest attainable quality of the data. The latter will generally be time consuming, particularly in view of the shortage of manpower in many cases.

It is suggested that all GEOSS/AWCI data shall be categorized into *real-time use* (category 1), *standard* (category 2), and *enhanced or experimental* (category 3) data. *Real-time use* data shall be open in real- or near-real- time base. *Standard* data shall be freely open after the basic turn-around period of six months. *Enhanced or Experimental* data shall be freely open after a prolonged turn-around period of 15 months at maximum.

*5) Acknowledgement and Citation*

Whenever GEOSS/AWCI data distributed by DIAS are being used for publication of scientific results, the data's origin must be acknowledged and referenced. A minimum requirement is to reference GEOSS/AWCI and the DIAS. If only data from one river basin (or a limited number of river basins) has been used, additional acknowledgement to the river basin(s) and its (their) maintaining institutions or organizations shall be given.

Maintaining continuous, high-quality measurements, performing quality and error checking procedures, and submitting data and related documentation to the DIAS will require substantial financial and logistical efforts of the *data providers*. The necessary support for these *data providers'* activities originate from a variety of international, national and institutional sources. The DIAS shall make proper reference to all GEOSS/AWCI *data providers* and, if required, to their funding sources.

*6) Co-operation between Data Users and Providers*

*Data users* of GEOSS/AWCI data are encouraged to establish direct contact with the *data providers* for the purpose of complete interpretation and analysis of data for publication purposes. This is in particular recommended for category 2 data.

*7) Co-Authorship*

Co-authorship of *data users* and *data providers* on papers making extensive use of GEOASS/AWCI data is justifiable and highly recommended, in particular, if *date providers* have responded to questions raised about the data's quality and/or suitability for the specific study in question, or have been involved in directly contributing to the paper in other ways. It is highly recommended that any *data user* should contact the responsible person of the data provider and ask him/her if he/she wants to become co- author, or if an acknowledgement would be sufficient. If co-authorship is requested, the *data provider* and the *data user* should establish a basis for collaboration.

*8) GEOSS/AWCI Publication Library*

Whenever GEOSS/AWCI data distributed by DIAS are being used for publication of scientific results, the author(s) shall sent a copy of the respective publication, preferably in electronic form, to the DIAS in order to build up a GEOSS/AWCI publication library. DIAS will maintain this library and will it make public, for example via DIAS's web site, for a continuous monitoring of the GEOSS/AWCI data applications and GEOSS/AWCI's achievements in general.

## 4. GEOSS/AWCI Capacity Development Framework

### *4.1 Goal and Objectives*

The goal of the capacity development program of the GEOSS/AWCI is to facilitate and develop sustainable mechanisms for the countries in Asia Pacific to use advanced earth observations systems, associated data and tools for water cycle research and water resources management under GEOSS framework.

The specific objectives of the program are to develop capacities of the Asian countries for;

1) Downscaling regional and global information to basin scale and to improve accuracy required by operational water management applications through a combination of numerical forecasting and fusion of local observations.
2) Identify reliable and efficient tools to convert the available observations and data to useful information for flood management through data transformations, interpolation, classification and estimation algorithms.
3) Conversion of information to water resources management applications, both for operational use and scenario based assessments for planning purposes.

The initial focus areas of the program have been selected as floods, water quality and droughts.

### *4.2 Target groups*

The program recognizes three main target groups as;

1) Researchers / Scientists where the emphasize is customizing existing knowledge to suit local conditions supported by global experiences

2) Professional / Practitioners which focuses on introducing new methodologies, tools and standards
3) Administrative / Local governments officials to provide an over view of technology and science

Different capacity development tools and programs will be combined to reflect the relevant emphasize and coverage for each target group.

### *4.3 Methodology*

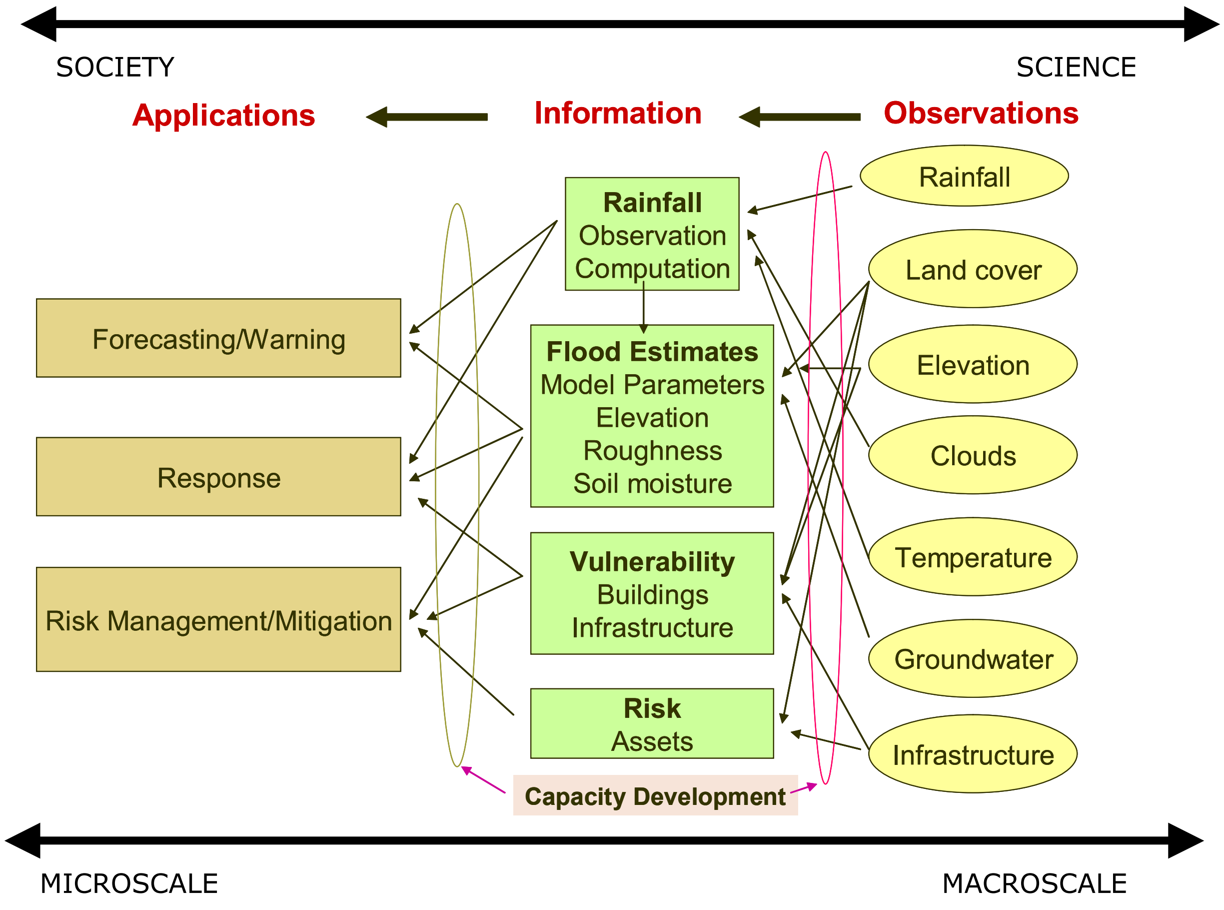
The program will be developed and be used concurrently in support of applications in 19 Asian Basins proposed to be studied within the Asian Water Cycle Initiative for clarification of basin water cycle and the development of appropriate water management practices. The training and capacity development program consist of elements such as short term training/long term training, online training materials, examples or modules, research opportunities, technical advise on existing projects, access to data and access to software. It will emphasize on sustainability and the need to customize technologies to suit local conditions by carefully setting up teams in each country made up of leading educational and research institutes and responsible government organizations that would function as core teams to ensure the future development and enhancement of the methodologies and incorporation of them to national programs.

### *4.4 Institutions*

United Nations University, Tokyo, Japan will coordinate the capacity development program of AWCI in collaboration with the University of Tokyo, JAXA, ICHARM, AIT and other regional and national academic, research and governmental institutes that are identified though a resource survey.

### *4.5 Conceptual Diagram*

The approach of capacity development program is depicted for capacity development in flood risk reduction as an example.



## 5. Strategic Implementation

By facilitating "observation convergence, data integration, information sharing" and promoting "capacity building", GEOSS/AWCI is aiming for;

1) developing an information system of systems for promoting the implementation of integrated water resources management (IWRM);
2) making a bridge between the data and information from the global scale to a river basin scale for sound decision making; and
3) shifting from research activities and achievements to operational use for contributing to societal benefits.

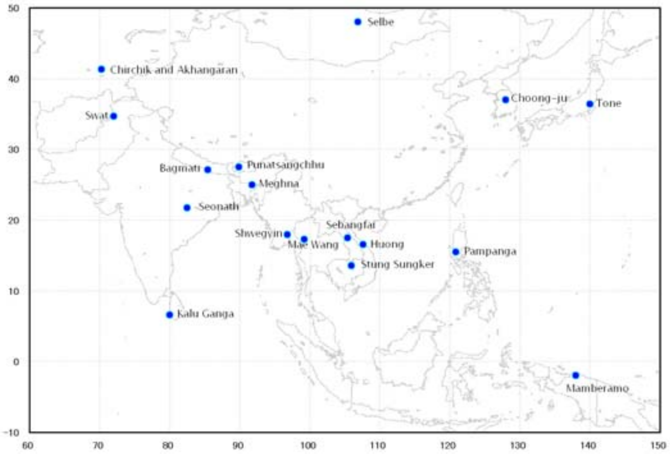
To achieve these objectives, GEOSS/AWCI adopts two approaches, "demonstration approach" and "working group approach".

### *Demonstration Approach*

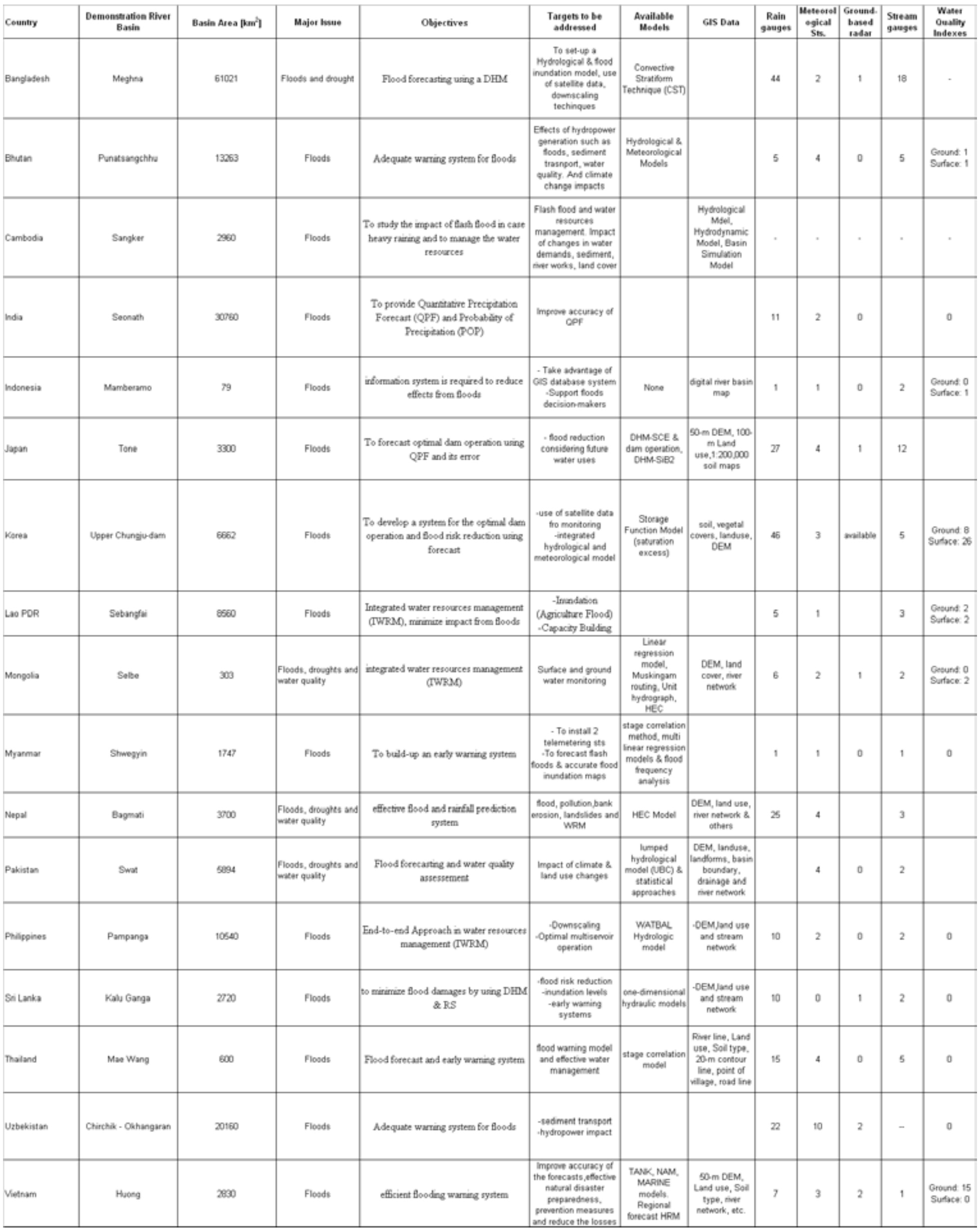
GEOSS/AWCI is a new challenge to lead in the solution of the water-related problems. It is effective to start with small-scale projects and to show early success stories to stake holders after intensive implementation. As the first step, one river basin is selected from each participating country as a target of a demonstration project, according the following criteria:

1) Importance of the basin from the viewpoint of the socio-economic benefit area and hydrological sciences
2) Minimum requirement of data availability:
    a. Data type: rainfall, streamflow, weather station data (air temp., wind speed, pressure, humidity)
    b. Spatial density of observation stations: according to the WMO standard but local specifics to be considered;
    c. Watershed characteristics information
3) Highly expected data:
    a. Upper air observation is highly recommended
    b. Near-real time data availability is highly recommended;
    c. Ground water and water quality data availability for the river basins where those problems should be addressed.
4) Size of the watershed: 100 km$^2$ – 1,000,000 km$^2$

So far, 17 river basins are selected as demonstration project targets. The location and summary of the demonstration project river basins are shown as follows:



*Location of the demonstration river basins*



| Country | Demonstration River Basin | Basin Area [km$^2$] | Major Issue | Objectives | Targets to be addressed | Available Models | GIS Data | Rain gauges | Meteorological Sts. | Ground-based radar | Stream gauges | Water Quality Indexes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bangladesh | Meghna | 61021 | Floods and drought | Flood forecasting using a DHM | To set-up a Hydrological & flood inundation model, use of satellite data, downscaling techinques | Convective Stratiform Technique (CST) | | 44 | 2 | 1 | 18 | - |
| Bhutan | Punatsangchhu | 13263 | Floods | Adequate warning system for floods | Effects of hydropower generation such as floods, sediment trasnport, water quality. And climate change impacts | Hydrological & Meteorological Models | | 5 | 4 | 0 | 5 | Ground: 1<br>Surface: 1 |
| Cambodia | Sangker | 2960 | Floods | To study the impact of flash flood in case heavy raining and to manage the water resources | Flash flood and water resources management. Impact of changes in water demands, sediment, river works, land cover | | Hydrological Mdel, Hydrodynamic Model, Basin Simulation Model | - | - | - | - | - |
| India | Seonath | 30760 | Floods | To provide Quantitative Precipitation Forecast (QPF) and Probability of Precipitation (POP) | Improve accuracy of QPF | | | 11 | 2 | 0 | | 0 |
| Indonesia | Mamberamo | 79 | Floods | information system is required to reduce effects from floods | - Take advantage of GIS database system<br>-Support floods decision-makers | None | digital river basin map | 1 | 1 | 0 | 2 | Ground: 0<br>Surface: 1 |
| Japan | Tone | 3300 | Floods | To forecast optimal dam operation using QPF and its error | - flood reduction considering future water uses | DHM-SCE & dam operation, DHM-SiB2 | 50-m DEM, 100-m Land use,1:200,000 soil maps | 27 | 4 | 1 | 12 | |
| Korea | Upper Chungju-dam | 6662 | Floods | To develop a system for the optimal dam operation and flood risk reduction using forecast | -use of satellite data fro monitoring<br>-integrated hydrological and meteorological model | Storage Function Model (saturation excess) | soil, vegetal covers, landuse, DEM | 46 | 3 | available | 5 | Ground: 8<br>Surface: 26 |
| Lao PDR | Sebangfai | 8560 | Floods | Integrated water resources management (IWRM), minimize impact from floods | -Inundation (Agriculture Flood)<br>-Capacity Building | | | 5 | 1 | | 3 | Ground: 2<br>Surface: 2 |
| Mongolia | Selbe | 303 | Floods, droughts and water quality | integrated water resources management (IWRM) | Surface and ground water monitoring | Linear regression model, Muskingam routing, Unit hydrograph, HEC | DEM, land cover, river network | 6 | 2 | 1 | 2 | Ground: 0<br>Surface: 2 |
| Myanmar | Shwegyin | 1747 | Floods | To build-up an early warning system | - To install 2 telemetering sts<br>-To forecast flash floods & accurate flood inundation maps | stage correlation method, multi linear regression models & flood frequency analysis | | 1 | 1 | 0 | 1 | 0 |
| Nepal | Bagmati | 3700 | Floods, droughts and water quality | effective flood and rainfall prediction system | flood, pollution,bank erosion, landslides and WRM | HEC Model | DEM, land use, river network & others | 25 | 4 | | 3 | |
| Pakistan | Swat | 5894 | Floods, droughts and water quality | Flood forecasting and water quality assessement | Impact of climate & land use changes | lumped hydrological model (UBC) & statistical approaches | DEM, landuse, landforms, basin boundary, drainage and river network | | 4 | 0 | 2 | |
| Philippines | Pampanga | 10540 | Floods | End-to-end Approach in water resources management (IWRM) | -Downscaling<br>-Optimal multiservoir operation | WATBAL Hydrologic model | -DEM,land use and stream network | 10 | 2 | 0 | 2 | 0 |
| Sri Lanka | Kalu Ganga | 2720 | Floods | to minimize flood damages by using DHM & RS | -flood risk reduction<br>-inundation levels<br>-early warning systems | one-dimensional hydraulic models | -DEM,land use and stream network | 10 | 0 | 1 | 2 | 0 |
| Thailand | Mae Wang | 600 | Floods | Flood forecast and early warning system | flood warning model and effective water management | stage correlation model | River line, Land use, Soil type, 20-m contour line, point of village, road line | 15 | 4 | 0 | 5 | 0 |
| Uzbekistan | Chirchik - Okhangaran | 20160 | Floods | Adequate warning system for floods | -sediment transport<br>-hydropower impact | | | 22 | 10 | 2 | – | 0 |
| Vietnam | Huong | 2830 | Floods | efficient flooding warning system | Improve accuracy of the forecasts,effective natural disaster preparedness, prevention measures and reduce the losses | TANK, NAM, MARINE models. Regional forecast HRM | 50-m DEM, Land use, Soil type, river network, etc. | 7 | 3 | 2 | 1 | Ground: 15<br>Surface: 0 |

***Summary of the demonstration project river basins.***

***Working Group Approach***

GEOSS/AWCI organizes three working groups; flood, drought, and water quality. Each WG covers both of "observation convergence, data integration, information sharing" and "capacity building" and address to the demonstration river basins in a strategic way.

*1) Flood WG*

The goal of the flood WG is to build up a scientific basis for sound decision-making and developing policy options for most suitable flood risk management for each country and region in Asia, through the full utilization of new opportunities on global, regional and in-situ dataset under the scheme of AWCI (contributing to GEOSS), which was established in 20051).

To attain the goal, we need to provide methodologies, tools and basic datasets to derive such required information to improve real-time flood forecasting system for short-term crisis management (objective #1) and to assess flood risk and vulnerability and then to make flood scenarios for long-term integrated flood risk management (obj. #2).

From technological point of view, it has been becoming possible for us to set those objectives, based on recent scientific achievements on climatology, meteorology and hydrology in the Asian monsoon regions such as those of GAME (GEWEX Asian Monsoon Experiments, WCRP) and on satellite-based observation of rainfall, physical & socioeconomic quantities of earth surfaces and numerical weather reanalysis, downscaling & prediction.

It is, however, indispensable for us to consider the disparity in existing resources and capabilities among different countries/regions as well as their varied needs and environments. Flood WG constructs an international/inter-organizational cooperative field to promote research on a "demonstration project" for each different study basin to build up the first successful implementation about the one or two above objective(s) and to make it a good showcase to strengthen appropriate interactions among scientists and policy-makers and to provide scientific input (corresponding to Policy Agenda of APN Strategic Plan) for the real implementation of the systems all over the flood-prone areas in Asia.

Considering the disparity of capabilities of countries in Asia as above, the demonstration project will be coupled with capacity development offered by advanced global-change research network activities and organizations in Asia. The framework of AWCI contributing to GEOSS has already incorporated with the Coordinated Energy and Water Cycle Observation Project (CEOP), Integrated Global Observing Strategy Partnership (IGOS-P), Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative (MAHASRI) as a part of Global Energy and Water Cycle Experiment (GEWEX) of WCRP, Prediction in Ungaged Basins (PUB) of International Association of Hydrological Sciences (IAHS), and so forth

Organizations related to global climate change having potential to provide AWCI with technical supports have been also participated in this proposal such as the University of Tokyo, Japan Aerospace Exploration Agency (JAXA), the United Nations University (UNU), Kasetsart University of Thailand, Asian Institute of Technology (AIT), the International Centre for Water Hazard and Risk Management (ICHARM), Mekong River Commission Secretariat (MRCS) and so forth.

Those will facilitate the development of research infrastructure and the transfer of know-how and technology for flood forecasting system (objective #1), flood risk assessment and flood scenario generation (objective #2) in this proposed project. These activities will lead to improving the scientific and technical capabilities of nations in the regions of Asia in terms of hydrological forecasting and planning.

### *2) Drought WG*

GEOSS/AWCI is collaborating among 18 Asian countries in sharing the ground observational data, and trying to support the information exchange and improve the technology of drought monitoring and studying among these Asian countries. The main objectives of this project are:

- To share and improve the drought monitoring capability in various Asian countries such as China, Pakistan, Thailand, Nepal and Philippines
- To set up a drought monitoring and research network in related Asian countries.
- To help developing the early warning system of drought hazard in related countries

The drought study is mainly based on the observation of precipitation, temperature and soil moisture by now, such as various drought index and moisture index. The satellite products have not been widely used since lack of capacity building in many Asian countries. Under the support of JAXA and Tokyo University, the retrieved soil moisture dataset from satellite remote sensing products will be used in these projects, and the related countries collaborators will validate this data set by using the in-situ observation of soil moisture, precipitation and temperature. The GEOSS/AWCI will be in charge of coordinate this regional activity, along with the flood and water quality groups

Drought indices are wildly used in monitoring and studying the drought, such as Standardized Precipitation Index (SPI), Palmer Drought Severity Index (PDSI), Crop Moisture Index (CMI), Surface Water Supply Index (SWSI). These indices mainly based on the ground observations of precipitation, temperature and soil moisture. But the standards of definition of these indices are differed from countries and regions. In addition, the capability of monitoring the drought are various according to the spatial and temporal resolution of observation stations in different countries and regions.

Because of the complex of soil type, ground water deposit. irrigation and vegetation type in the area, soil moisture will be a key indicator of drought monitoring besides precipitation and temperature in this project. JAXA (Japan Space Agency) and University of Tokyo will help developing a set of soil moisture dataset in specific region we are interested in for related countries. Optical and microwave remote sensing datasets will be used in this project. In many studies, microwave products have many advantages in bare surface, especially in dry area. Optical products, such as NDVI and LAI are usually used for full cover vegetation area to understand the vegetation and soil processes. For partly vegetation cover area, optical and microwave products will be both used in getting the high resolution soil moisture data. The University of Tokyo and JAXA will lead in retrieving the remote sensing data. The Asian Institute of Technology, Thailand, proposed a drought index called Temperature Vegetation Dryness Index (TVDI) is calculated from satellite derived vegetation index (NDVI) and surface temperature, TVDI index will be used to monitor the drought in various countries of Asia

The participants from related Asian countries in GEOSS/AWCI will provide the ground observation dataset of temperature, precipitation and soil moisture et al. For example, Shanxi province of China is chosen as the typical research area for drought monitoring in China. Shanxi is a typical semi-arid region with average precipitation about 500mm per year, and it is influenced by drought hazard severely under the global warming and human activity (carbon emission and intensive agriculture). The summer precipitation decreased about 15% in last thirty years, There are 108 observing stations in whole area of Shanxi (150,000KM2). The meteorological observations (T,P,W,P etc) are four times per day. The soil temperature and moisture observation are taken place per ten days, and 32 stations among 108 are having soil observations per five days. Figure 1 shows the summer precipitation (a), 10cm soil moisture in summer (b), and the distribution of 108 stations in Shanxi (blue dot). We could find the dry areas are not always matches the low precipitation, the monitoring of drought severity will be more accurate if we include the information of soil moisture and temperature. It may related to other factors like topography and irrigation. Under the framework of GEOSS/AWCI, we will choose other typical areas in Mongolia, Pakistan, Vietnam, Thailand and Nepal.

### *3) Water Quality WG*

The goal is to contribute towards sustainable management and development of water and health. The main objective is to conduct a phased ( 2- 3 years) research on the scopes of institutions to develop appropriate water quality monitoring program for domestic water in developing in Asia and disseminate the results. The specific objectives during the first year (as this proposal is detailing out first year) will include:

- Analysis of the roles, capacities, practices, policies, methods (and indicators), synergies, and needs in monitoring WQ by the water concerned main institutions in Bangladesh, Pakistan and Vietnam.
- Identification and comparison of the common and specific problems as well as the related best approaches in WQ monitoring in the three countries
- Conducting of a formative/indicative research to investigate preliminary appropriate WQ monitoring options for domestic water by in-situ and satellite measurements based on selected specified indicators.
- Incorporating the results and experiences gained here into the GEOSS/AWCI
- Suggest policy advice on how the institutions and countries can make attempts for appropriate WQ monitoring in the 3 countries in particular and in other countries of the region in general.

The methodology will include analyses of national and international literatures and, regional information exchange/discussion/result finalization in regional meeting among collaborating countries. There will be three multiple country/regional meetings. The first meeting will be between Co-chairs and lead organizations finalize the investigation tools about preliminary WQ indicators by in-situ and satellite methods. It will be done in the University of Tokyo.

The first regional meeting (RG-1) will be among Bangladesh, Pakistan, Vietnam, and Japan to finalize and agree upon the country level data collection plan, tools and reporting guidelines. It will be done in Bangladesh. The main information to be collected will include: existing WQ monitoring program and indicators (during flood and other periods), policies, roles and responsibilities by the institutions, needs, capacities, best practice case studies, opportunities at national and international perspectives, and other issues. The final regional meeting (RG-2) will include: presentation of all the results by the 3 countries, presentation of invited papers by the investigators and participants from other 7 developed and developing countries, finalization of the draft results, development of technical and policy recommendations for the countries and outline of the final report among representatives from various institutions.

The activities under the specific objective # iii about the preliminary WQ options will be done between RG-1 and RG-2. The indicative results and experiences gained will be discussed in the final regional consultations to suggest its further testing and/or other possibilities in Bangladesh as well as in the other countries in the following years or by other projects. In addition to the multi-country meetings (consultations in person), there will be planned quarterly consultations among the investigators and chairs over internet.

## 6. International Cooperation and Project Management

To promote international cooperation and project management, GEOSS/AWCI established the International Coordination Group consisting of a national representative of each member country, working group co-chair, invited experts and secretariat.

***Country Representative***

Bangladesh: Abdul Quadir (Bangladesh Ministry of Defense)
Bhutan: Karma Chhophel (Hydro-met Services)
Cambodia: So Im Monichoth (Department Hydrology and River Works)
China: Qian Mingkai (Huaihe River Commission, Ministry of Water Resources)
India: Surinder Kaur (India Meteorological Department), Rakes Kumar (National Institute of Hydrology)
Indonesia: Joesron Loebis (Research Institute for Water Resources)
Japan: Toshio Koike (The University of Tokyo)
Korea: Deg-Hyo Bae (Sejong University)
Lao: Chanthachith Amphaychith (Lao National Mekong Committee)
Malaysia: Ahmad Jamalluddin Shaaban (National Hydraulic Research Institute of Malaysia)
Mongolia: Davaa Gombo (Institute of Meteorology and Hydrology )
Myanmar: Tin Yi/Tun Lwin (Dept. of Meteorology and Hydrology)
Nepal: Shiv Kumar Sharma (Department of Water Induced Disaster Prevention)
Pakistan: Bashir Ahmad (Water Resources Research Institute/ National Agriculture Research Center)
Philippines: Flaviana Hilario (PAGASA/DOST)
Sri Lanka: S. B. Weerakoon (University of Peradeniya)
Thailand: Thada Sukhapunaphan (Ministry of Agriculture and Cooperatives)
Uzbekistan: Sergey Myagkov (Hydrometeorological Research Institute)
Vietnam: Dang Ngoc Tinh (National Hydro-meteorological Forecasting Center)

***WG Co-chairs:***

K. Fukami/S. Herath (Flood)
Ailikun/A. Dolgosuren (Drought)
B. Hoque/ H. Furumai (Water Quality)

***Invited Experts:***
C. Ishida (Satellite), D. Yang (Hydrological Model), V. Hansa (Integration)

***AWCI Secretariat:***
A. Goda, P. Koudelova, O. Saavedra, K. Tamagawa, K. Taniguchi, K. Umezawa, K. Misawa

## 7. Implementation Plans for the Demonstration Projects

Once the demonstration river basin was selected for each country according to the requirements described in Chapter 5, each country representative was asked to fill out a basin template. This template attempts to retrieve a description of reference basins and their implementation plans in 5 key sections as described below.

### 1) Background, targeted issues and objectives

In this section a brief introduction to the river basin including major issues, latest event when the issue was evident, targets to be addressed through demonstration, and objectives are expected.

### 2) River basin characteristics

A brief description of basin characteristics including climate regime, topographical feature, dominant land use and soil type, and socio-economic information was asked. Moreover, with the geographic coordinates in longitude and latitude which encloses the basin was requested. Additionally, a river basin map in JPEG format was asked to illustrate the basin extension, river network and the observation stations.

### 3) Observation system

A template chart was provided in order be filled out with number of stations available in the basin for the most relevant and expected variables. The location of observation sites is included in the river basin map according to the possibility of each representative.

### 4) Models, GIS, Data Integration System, Prediction System

In this section the available hydrological and meteorological models, GIS, data integration systems, prediction systems are targeted. Also, the current means of flood and/or drought forecast and water quality monitoring.

### 5) Implementation Schedule of the Demonstration

This template timeline chart was proposed to propose an implementation schedule of the demonstration. The activities selected in the chart are the most representative in order to meet the goals of our approach.

From next page please find a two-page basin template for each of the following 17 countries respectively:

Bangladesh/Bhutan/Cambodia/India/Indonesia/Japan/Korea/Laos/Mongolia/Myanmar/Nepal/Pakistan/ Philippines /Sri Lanka/Thailand/Uzbekistan/Vietnam

**Country**: Bangladesh **River basin name:** Meghna **Basin Area:** 61021 [$km^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

Natural disasters like flood and drought occurs almost every years in Bangladesh. In recent years (2004 and 2007) the occurrence of flood in this basin hampers the development of the country. Moreover, there is a shortage of observational data hampers proper monitoring of flood situation and utilization of forecasting techniques. The inundation areas are widely extended through the country.

*1.2 Major issues (Please use a circle):* [✓ Floods] [✓ Droughts] Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date: major floods on 2004.07.24 and 2007.08.04

*1.4 Targets to be addressed through demonstration (up to 3):*

To set-up a Hydrological & flood inundation model, use of satellite data and downscaling techniques

*1.5 Objective:* The main goal is to achieve flood forecasting using a Hydrological model and inundation areas in order to obtain an optimal flood warning system and evacuation plan.

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* -24, 480, 3817

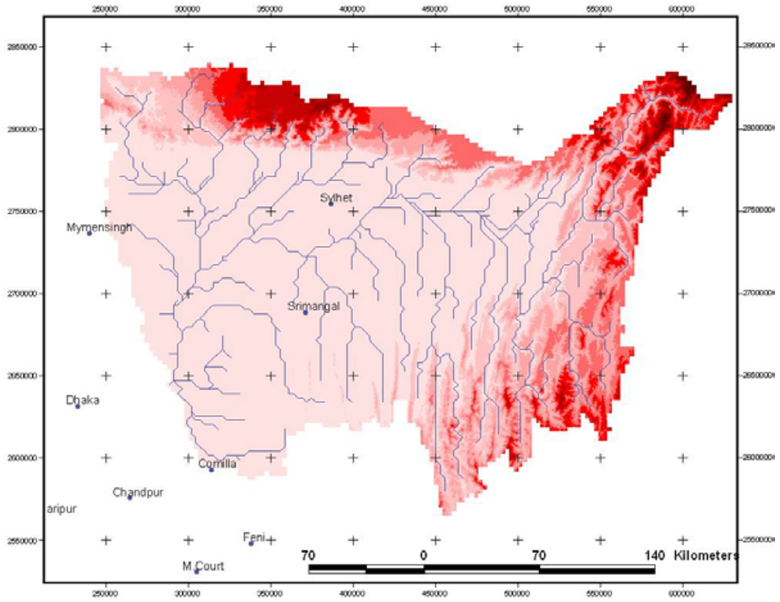
*2.3 Annual average rainfall of about [mm]:* At Meghalaya Hills higher 3000

*2.4 Dominant land use:* agriculture and forest

*2.5 Dominant soil type:* loam-clay

*2.6 Geographic coordinates [Lon, Lat]:* from 90.5° to 92.5° E, from 23.25° to 25.25°

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 2 | Stream flow | 18 |
| Humidity | 2 | Reservoir (Water level, Outflow) | 38 |
| Wind | 2 | Groundwater Table | |
| Pressure | 2 | Evaporation | 2 |
| Precipitation | 44 | Soil Temperature | 2 |
| Snow Depth | | Soil Moisture | 2 |
| Skin Temperature | RCM data | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | RCM data | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | RCM data | Pilot Balloon | 1 |
| Upward Long wave Radiation | RCM data | Radiosonde | |
| Downward Long wave Radiation | RCM data | Radar | 1 |
| Net Radiation | RCM data | **Water Quality** | **Number** |
| Sensible Heat Flux | RCM data | Groundwater quality indicators | |
| Latent Heat Flux | RCM data | Surface water quality indicators | |
| Ground Heat Flux | RCM data | **Others** | **Number** |
| CO2 Flux | | Ground Water Well | 20 |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* -------------

*4.2 Land Surface Scheme:* ----------- Meteorological model: Convective Stratiform Technique (CST)

*4.3 List of digital GIS data at fine resolution (besides global data set):*

*4.4 Data integration system:* -----------

*4.5 Type of Prediction system and Downscaling technique:* CST, flood forecasting and warning center

*Used mainly for:* [✓ Floods] Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | → | → | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | → | → | | |
| Improvement of in-situ observation network system | → | → | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | → | → | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | → | → | | |
| Capacity building on Floods, Droughts & Water Quality | | → | → | → | → | → | → | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country:** Bhutan **River basin name:** Punatsangchhu **Basin Area:** 13,263 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

The river basin is the second largest in Bhutan and very important from an economic point of view. Punakha-Wangdue is one of the most fertile valleys. In addition, the biggest hydropower plants are also planned in this basin. On the other hand, the frequent glacier melt increases the risk of glacial lake outburst floods (GLOF) and then decreasing flow in the rivers afterwards.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date: flood due to glacial outburst in October 1994

*1.4 Targets to be addressed through demonstration (up to 3):*

-Flood forecast

-Impacts of the hydropower generation

-A sediment transport study

*1.5 Objective:* Determination of an adequate warning system for floods and assist in monitoring the flow regimes in the rivers due to climate change.

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):* dominated by the monsoon

Very Humid Humid [✓ Temperate] Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 200(min), 6500(max)

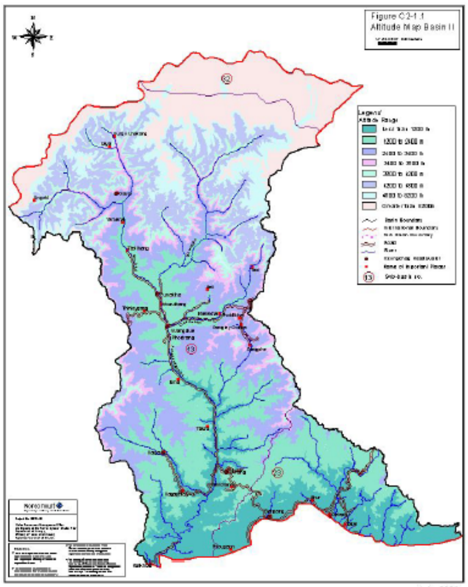
*2.3 Annual average rainfall of about [mm]:* 500 at foothills and above 5000 in upper reaches

*2.4 Dominant land use:* agriculture

*2.5 Dominant soil type:* it varies

*2.6 Geographic coordinates [Lon, Lat]:* E 89°21′-90°24′ ; N 26°42′- 28°18′

*2.7 River basin map [JPEG] with location of major observation sites:*



July, 2003

## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 17 | Stream flow | 5 |
| Humidity | 17 | Reservoir (Water level, Outflow) | |
| Wind | 4 | Groundwater Table | |
| Pressure | | Evaporation | 5 |
| Precipitation | 17 | Soil Temperature | 5 |
| Snow Depth | 3 | Soil Moisture | |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | |
| Net Radiation | 4 | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | 1 |
| Latent Heat Flux | | Surface water quality indicators | 1 |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* available

*4.2 Land Surface Scheme: ------------* *Meteorological model:* available

*4.3 List of digital GIS data at fine resolution (besides global data set):* available

*4.4 Data integration system: ------------*

*4.5 Type of Prediction system and Downscaling technique: ------------*

*Used mainly for:* Floods Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Cambodia **River basin name:** Sangker **Basin Area:** 2961[$km^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

It is one of the tributaries of Tonle Sap Lake, located in Battambang Province at southwest of Cambodia. Two hydropower stations are under planned at its upper basin. The middle basin is covered with mixed agriculture and urban area and suffered from flash flood. The downstream region is inundated for 6month in a year by the flood from Tonle Sap Lake and floating rice is cultivated.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date:

*1.4 Targets to be addressed through demonstration (up to 3):*

- Impact of changes in the demands of water intake and dams → basin simulation model
- Impact of changes in climate, water resources, land cover → hydrological model
- Impact of changes in the canal level, sediment, flooding, river works → hydrodynamic model

By using the three model outputs, the impacts on the environment and socio-economics will be addressed.

*1.5 Objective:* To studies the impact of flash flood in case heavy raining and to manage the water resources

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

[✓ Very Humid] Humid Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):*

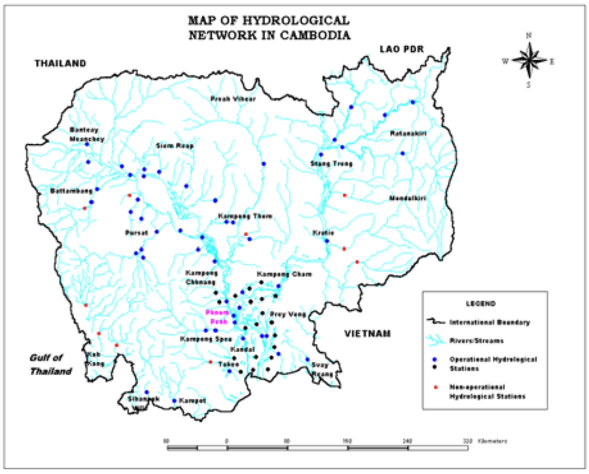
*2.3 Annual average rainfall of about [mm]:*

*2.4 Dominant land use: cultivation*

*2.5 Dominant soil type:*

*2.6 Geographic coordinates [Lon, Lat]:* 102.5 to 104.0E, 12.5 to 13.5 N

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | available | Stream flow | available |
| Humidity | available | Reservoir (Water level, Outflow) | |
| Wind | available | Groundwater Table | |
| Pressure | | Evaporation | |
| Precipitation | available | Soil Temperature | |
| Snow Depth | | Soil Moisture | |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | |
| Net Radiation | available | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* SWAT, IQQM, ISIS

*4.2 Land Surface Scheme:* *Meteorological model:*

*4.3 List of digital GIS data at fine resolution (besides global data set):* DEM with 50 m grid resolution

*4.4 Data integration system:* Sharing Hymos Databas

*4.5 Type of Prediction system and Downscaling technique:*

*Used mainly for:* [✓ Floods] Droughts Water Quality Monitoring [✓ IWRM]

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: India **River basin name:** Seonath river **Basin Area:** 30,760 [$km^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

It is the largest tributary of Mahanadi basin. It rises in the Chandrapur district of Maharashtra at an elevation of about 532m and meets Mahanadi river after traversing a distance of about 383km.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date:

*1.4 Targets to be addressed through demonstration (up to 3):*

*1.5 Objective:* The objective of the project is to provide Quantitative Precipitation Forecast (QPF) and Probability of Precipitation (POP) of the basin by downscaling technique (MOS, PPM, neural network etc) using the NWP model products and other data to the station/basin level. The accuracy of QPF should be high enough so that it can be used in flood forecasting model (at least 80%).

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):*

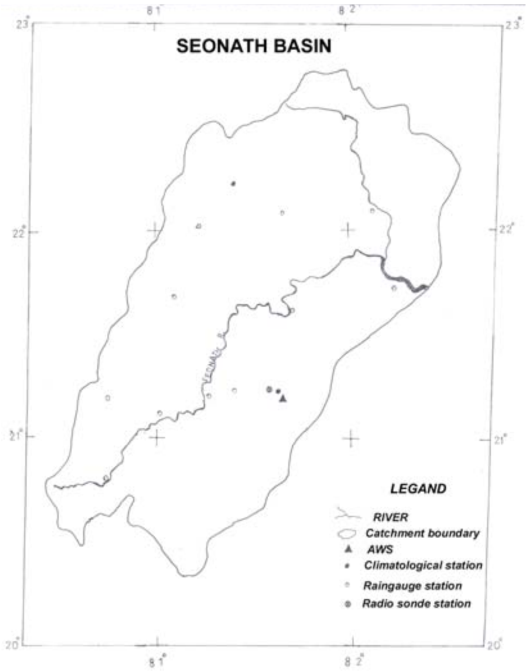
*2.3 Annual average rainfall of about [mm]:*

*2.4 Dominant land use:* cultivation (72%)

*2.5 Dominant soil type:*

*2.6 Geographic coordinates [Lon, Lat]:* 80.5 to 82.5 E, 20 to 23N

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| SURFACE | Number | HYDROLOGICAL | Number |
|---|---|---|---|
| Air Temperature | 2 | Stream flow | |
| Humidity | 2 | Reservoir (Water level, Outflow) | |
| Wind | 2 | Groundwater Table | |
| Pressure | 1 | Evaporation | 1 |
| Precipitation | 11 | Soil Temperature | 1 |
| Snow Depth | | Soil Moisture | 1 |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | 1 |
| Downward Long wave Radiation | | Radar | |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:*

*4.2 Land Surface Scheme:* *Meteorological model:* available

*4.3 List of digital GIS data at fine resolution (besides global data set):*

*4.4 Data integration system:*

*4.5 Type of Prediction system and Downscaling technique:*

*Used mainly for:* [✓ Floods] Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | — | — | — | → | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | | | | | | — | → |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Indonesia **River basin name:** Mamberamo **Basin Area:** 78992 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

Annual flood is occurred during rainy season and nowadays also during drought season, due to Indonesia lay on the monsoon climate zone. Regarding to that, information system is required to inventory and process data about flood occurrence as information for decision-maker to take the right action in managing the flood.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date: -----------------------------

*1.4 Targets to be addressed through demonstration (up to 3):*

-Take advantage of GIS database system

-Support floods decision-makers

*1.5 Objective:* A system is required to forecast floods in order to reduce their effects

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):* monsoon

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 0, 5000

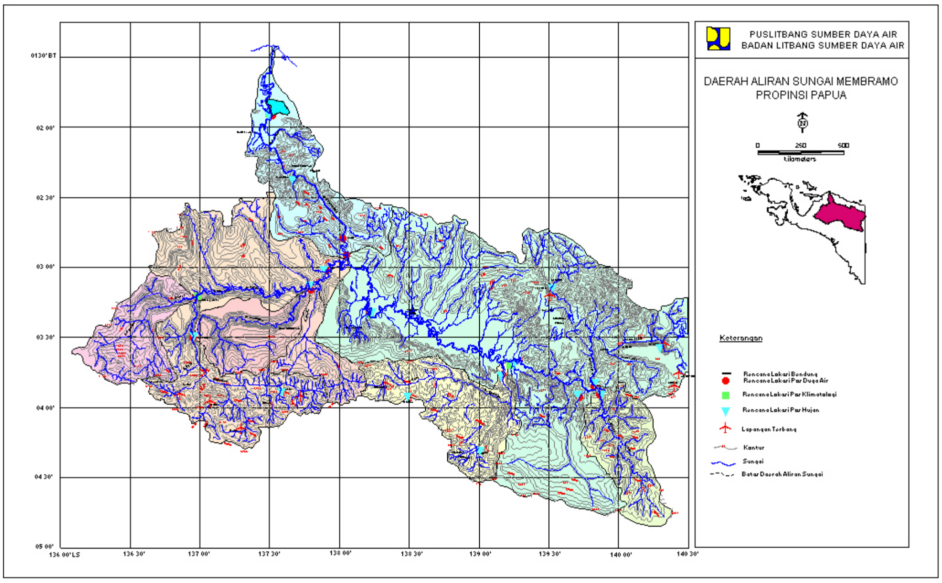
*2.3 Annual average rainfall of about [mm]:* 3500 to 5000

*2.4 Dominant land use:* upper tropical forest; while swamps in lowlands

*2.5 Dominant soil type:* ---------------

*2.6 Geographic coordinates [Lon, Lat]:* 136.3º through 140.82º E; 1.45º through 4.53º S

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 1 | Stream flow | 2 |
| Humidity | 1 | Reservoir (Water level, Outflow) | |
| Wind | 1 | Groundwater Table | |
| Pressure | 1 | Evaporation | |
| Precipitation | 1 | Soil Temperature | |
| Snow Depth | | Soil Moisture | |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | |
| Net Radiation | 1 | **Water Quality** | **Number** |
| Sensible Heat Flux | 1 | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | 1 |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model: ----------*

*4.2 Land Surface Scheme: ---------* *Meteorological model: ----------*

*4.3 List of digital GIS data at fine resolution (besides global data set):*

-digital river basin map

*4.4 Data integration system: ----------*

*4.5 Type of Prediction system and Downscaling technique:*

*Used mainly for:* Floods Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | → | → | → | → | → | | | |
| Data integration system (input data preparation, quality check) | → | → | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | → | → | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | → | → | | | | |
| Parallel testing of the system at operational stage | | | | | → | → | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Japan **River basin name:** Upper Tone River **Basin Area:** 3300 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

It is located in the northern headwaters of the Tone river basin. The Tone river is a very important source of water supply, irrigation and power generation for the Tokyo area. Therefore its management is crucial for the region. According to Japan Meteorological Agency (JMA), the trend of frequency and intensity of heavy rainfall in this region has been increasing on average from 1961-2001.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date: Sep. 1947, 171 mm/h caused by a typhoon, 1.6 million people affected

*1.4 Targets to be addressed through demonstration (up to 3):*

A system able to 1) reduce flood peaks at downstream and 2) replenish water levels in reservoirs after a flood event by using quantitative precipitation forecast will be developed. The error forecast will be also considered by the bets means.

*1.5 Objective:* Release schedule of dams during extreme events does not follow manual, rather the experiences of dam operators are required. Therefore, a system that can support them will be developed.

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 100, 1020, 2500

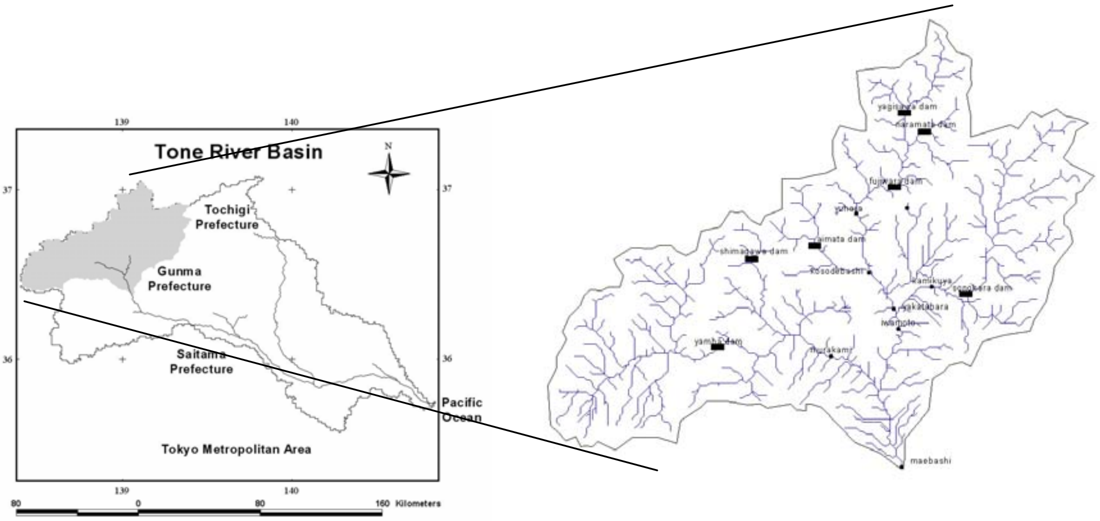
*2.3 Annual average rainfall of about [mm]:* 1500mm

*2.4 Dominant land use:* forest (79.3 %) and grasslands (9.5 %)

*2.5 Dominant soil type:* forest soil (56%), black soil (22%), high permeable s. (15%)

*2.6 Geographic coordinates [Lon, Lat]:* 138.2º to 139.6ºE, 36.2º to 37.2º N

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 4 | Stream flow | 12 |
| Humidity | 4 | Reservoir (Water level, Outflow) | 6 |
| Wind | 4 | Groundwater Table | |
| Pressure | 4 | Evaporation | |
| Precipitation | 27 | Soil Temperature | |
| Snow Depth | 1 | Soil Moisture | |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | 1 |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* GBHM

*4.2 Land Surface Scheme:* SiB2 *Meteorological model:* Meso-scale Grid Point Data (MSM-GPV)

*4.3 List of digital GIS data at fine resolution (besides global data set):* 50-m DEM, 100-m digital land use, digitized 1:200,000 soil maps, hydrological thematic maps (slope, river network, and soil depth)

*4.4 Data integration system:*

*4.5 Type of Prediction system and Downscaling technique:*

Used mainly for: [✓ Floods] Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | → | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | — | — | — | → | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | — | — | — | — | → | | |
| IWRM plan development of floods, droughts & water quality | | | | — | — | — | — | → |

**Country**: Korea (Republic) **River basin name:** Upper Chungju-dam **Basin Area:** 6,662 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

There has been significant damages from floods and flash floods in Korea. In addition to flood control works, some other non-structural countermeasures should be considered. The study area is located at the middle-east of Korean Peninsula. It is an upper part of South Han River and the outlet is at Chungju-dam, which is the largest multi-purpose dam in South Han River basin.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date:

*1.4 Targets to be addressed through demonstration (up to 3):*

1) the use of satellite data for flood and drought monitoring and prediction for enhancement of the existing system; 2) utilization of an integrated hydrological and meteorological forecast system for the optimal dam operation and flood risk reduction.

*1.5 Objective:* understanding of the regional and global water cycle mechanisms in case of climate change.

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

Very Humid Humid [✓ Temperate] Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 0, 1561

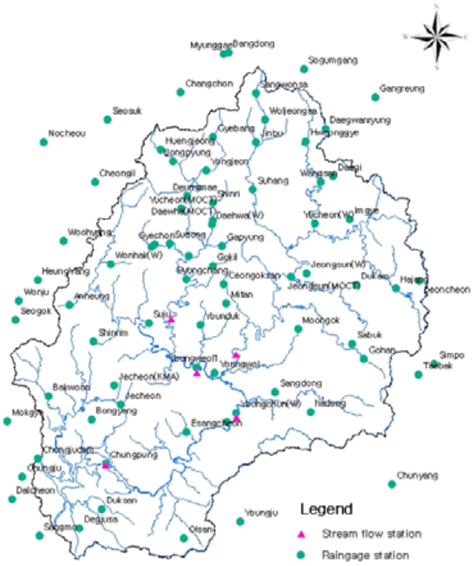
*2.3 Annual average rainfall of about [mm]:*

*2.4 Dominant land use:* mountain covered by coniferous and deciduous forests.

*2.5 Dominant soil type:*

2.6 Geographic coordinates [Lon, Lat]: 127.92 to 129.02 E, 36.79 to 37.82 N

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 3 | Stream flow | 5 |
| Humidity | 3 | Reservoir (Water level, Outflow) | 1 |
| Wind | 3 | Groundwater Table | |
| Pressure | 3 | Evaporation | 3 |
| Precipitation | 46 | Soil Temperature | 3 |
| Snow Depth | 3 | Soil Moisture | |
| Skin Temperature | 3 | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | available |
| Net Radiation | 3 | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | 8 |
| Latent Heat Flux | | Surface water quality indicators | 26 |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. odels, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* Storage Function Model

*4.2 Land Surface Scheme*: Meteorological model: The global data assimilation and prediction system (GDAPS) for GCM models and the regional data assimilation and prediction system (RDAPS) for regional climatic models

*4.3 List of digital GIS data at fine resolution (besides global data set):* various data such as soil, vegetal covers, landuse, DEM, etc.

*4.4 Data integration system:*

*4.5 Type of Prediction system and Downscaling technique:*

Used mainly for: [✓ Floods] Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Lao PDR **River basin name:** Sebangfai River **Basin Area:** 8560 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

It is located in Khammouane Province. At the source, the river flows from the Vietnam border in the southeast-northwest direction to Boualapha District and changes direction to the west to Mahaxay District and then turns from the northeast-southwest into the Mekong. With an annual increase of 2.6%
since 1990, the total population in the basin is estimated to reach 192,200 in 1998.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date:

*1.4 Targets to be addressed through demonstration (up to 3):*

1) Capacity building of the staffs of Department of Meteorology and Hydrology in making a more accurate flood forecasting and analysis; 2) Assessment of the current conditions of hydro-meteorological stations; 3) discussion on how to improve the current data transmission system and the operation and maintenance of these stations

*1.5 Objective:*

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

[✓ Very Humid] Humid Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 150 vs. 1397

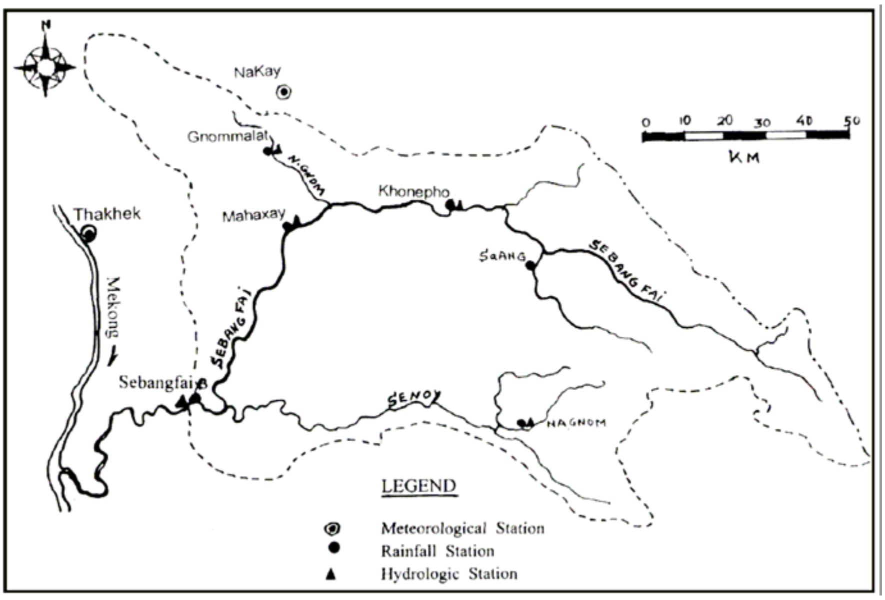
*2.3 Annual average rainfall of about [mm]:* 2300

*2.4 Dominant land use:* forest (59 %), paddy (20 %), upland crops (10 %)

*2.5 Dominant soil type*: Mesozoic, Cretaceaus, Jurassic and Palaezoic

*2.6 Geographic coordinates [Lon, Lat]:* 105 to 106.5 E, 17 to 18 N

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 1 | Stream flow | 3 |
| Humidity | 1 | Reservoir (Water level, Outflow) | |
| Wind | | Groundwater Table | |
| Pressure | | Evaporation | 1 |
| Precipitation | 5 | Soil Temperature | 1 |
| Snow Depth | | Soil Moisture | |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | 2 |
| Latent Heat Flux | | Surface water quality indicators | 2 |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:*

*4.2 Land Surface Scheme:* *Meteorological model:*

*4.3 List of digital GIS data at fine resolution (besides global data set):*

*4.4 Data integration system:*

*4.5 Type of Prediction system and Downscaling technique:*

*Used mainly for:* Floods Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Mongolia **River basin name:** Selbe **Basin Area:** 303 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

It is located in center of Mongolia, in the north of Ulaanbaatar. It is the upper basin of the Tuul Stream basin (6300km$^2$). From mid of 90th, settling area and population have been rapidly increasing. Following the human activities, individual house building, paved areas, groundwater wells and livestock pasture are in creasing. Also forest cut and cultivation took place in some extend.

*1.2 Major issues (Please use a circle):* [✓ Floods] [✓ Droughts] [✓ Water Quality]

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date:

*1.4 Targets to be addressed through demonstration (up to 3):*

1) Environmental degradation (vegetation, soil degradation, deforestation and rapid urbanization impacting on surface and ground water regime and interaction mechanism, ground water contamination, water scarcity and flood control)

2) Surface and ground water monitoring and modeling to assist better management in light of anthropogenic influences and climate change impact and flood control.

3) Assistance of the development of information systems for promoting the implementation of integrated water resources management (IWRM) in the Selbe and Tuul Stream Basins.

*1.5 Objective:*

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

Very Humid Humid Temperate [✓ Semi-arid] Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):*

*2.3 Annual average rainfall of about [mm]:*

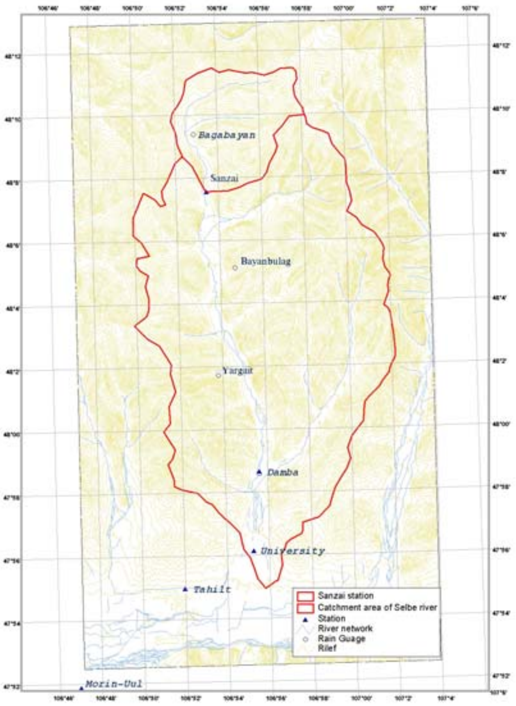
*2.4 Dominant land use:* forest (59%), urban, pasture

*2.5 Dominant soil type:* brown and podosor

*2.6 Geographic coordinates [Lon, Lat]:*

106.8 to 107.0E, 47.9 to 48.3 N

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| SURFACE | Number | HYDROLOGICAL | Number |
|---|---|---|---|
| Air Temperature | 2 | Stream flow | 2 |
| Humidity | 2 | Reservoir (Water level, Outflow) | |
| Wind | 2 | Groundwater Table | Not yet defined |
| Pressure | 2 | Evaporation | |
| Precipitation | 6 | Soil Temperature | 1 |
| Snow Depth | 1 | Soil Moisture | 1 |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | 1 (Ulaanbaatar, 0800LT & 2000LT) |
| Downward Long wave Radiation | | Radar | 1 |
| Net Radiation | 1 | **Water Quality** | **Number** |
| Sensible Heat Flux | 1 | Groundwater quality indicators | Not yet defined |
| Latent Heat Flux | 1 | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* Linear regression model, Muskingem flood routing, Unit hydrograph model

*4.2 Land Surface Scheme:* *Meteorological model:*

*4.3 List of digital GIS data at fine resolution (besides global data set):* DEM, river network, topography

*4.4 Data integration system:*

*4.5 Type of Prediction system and Downscaling technique:*

Used mainly for: Floods Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | — | — | — | — | — | — | — | → |
| Data integration system (input data preparation, quality check) | | | | | — | — | — | → |
| Improvement of in-situ observation network system | | — | — | — | — | — | → | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | — | — | — | — | — | → | |
| Scenario Studies: Land use change analysis, dry periods, etc. | — | → | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | — | — | — | — | — | → | | |
| Parallel testing of the system at operational stage | | | | | — | — | — | → |
| IWRM plan development of floods, droughts & water quality | | | | | — | — | — | → |

**Country**: Malaysia **River basin name**: Langat **Basin Area**: 2,350 [km²]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

Langat River Basin is one of the four major basins in Selangor State. Langat Dam is the major source of domestic water supply for Kuala Lumpur, Putrajaya and areas adjoining to it. Groundwater extraction for industrial use is the minor water source of the basin. The Malaysian Government Administrative Centre Putrajaya is located at the centre of the basin.

*1.2 Major issues (Please use a circle):* [✓ Floods] [✓ Drought] [✓ Water_Quality]

*1.3 Latest event when the issue was evident according to above one(s):*

Severe drought and water crisis in 1998

*1.4 Targets to be addressed through demonstration (up to 3):*

- Impact of climate change and land use change on hydrology, water resources and socio-economic activities (HydroClimate Model)
- Impact of changes in the demands of water intake and dam (Basin Simulation Model)
- Impact of changes in the sediment, river level, flooding, river networks (Hydrodynamic Model)

*1.5 Objective:* The main goal is to achieve reservoir inflow and water intake forecasting, flood and drought forecasting, and the impact of climate and land use changes on the resources, environment and socio-economics of the basin.

## 2. River basin characteristics

*2.1 Climate regime (please use a circle):*

[✓ Very Humid] Humid Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 0m, 40m, 100m

*2.3 Annual average rainfall of about [mm]:* 2,470

*2.4 Dominant land use:* Agriculture, Urban Area and Forest

*2.5 Dominant soil type:* Sandy Clay

*2.6 Geographic coordinates [Lon, Lat]:* From E 101°17’ To E 101°53’; From N 2°40’ To N 3°09’

*2.7 River basin map [JPEG] with location of major observation sites:*

## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 11 | Stream flow | 6 |
| Humidity | 11 | Reservoir (Water level, Outflow) | 1 |
| Wind | 1 | Groundwater Table | 30 |
| Pressure | 1 | Evaporation | 7 |
| Precipitation | 35 | Soil Temperature | - |
| Snow Depth | - | Soil Moisture | - |
| Skin Temperature | - | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | 1 | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | 1 | Pilot Balloon | 1 |
| Upward Long wave Radiation | 1 | Radiosonde | 1 |
| Downward Long wave Radiation | 1 | Radar | 1 |
| Net Radiation | 1 | **Water Quality** | **Number** |
| Sensible Heat Flux | - | Groundwater quality indicators | 30 |
| Latent Heat Flux | - | Surface water quality indicators | 30 |
| Ground Heat Flux | - | **Others** | **Number** |
| CO2 Flux | - | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* -

*4.2 Land Surface Scheme:* - *Meteorological model:* -

*4.3 List of digital GIS data at fine resolution (besides global data set):* -

*4.4 Data integration system:* -

*4.5 Type of Prediction system and Downscaling technique:* -

*Used mainly for:* Floods Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | ─ | ▶ | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | ─ | ▶ | | |
| Improvement of in-situ observation network system | ─ | ▶ | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | ─ | ▶ | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | ─ | ▶ | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | ─ | ─ | ─ | ─ | ─ | ▶ | | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Myanmar **River basin name:** Shwegyin **Basin Area:** 1747 [$km^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within in four lines*

Shwegyin town is situated on the mouth of Shwegyin River and composed of 8 wards and 26 villages. It is about 42 miles from north to south and 19 miles from east to west. The high mountains are formed in northern and eastern part and plain areas are in the western and southern part of the basin. There are 5 rivers flowing through the township including Shwegyin River.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date: 2650 mm/40 hours 1997.08 30870persons, 6050 area of paddy field

*1.4 Targets to be addressed through demonstration (up to 3):*

To install two telemeter stations and receiving station in Shwegyin basin; To develop forecasting technique for flash flood; To develop accurate flood inundation maps using all available data including GIS data sources

*1.5 Objective:* To get early flood warning system for Shwegyin River Basin

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 12, 951, 1890

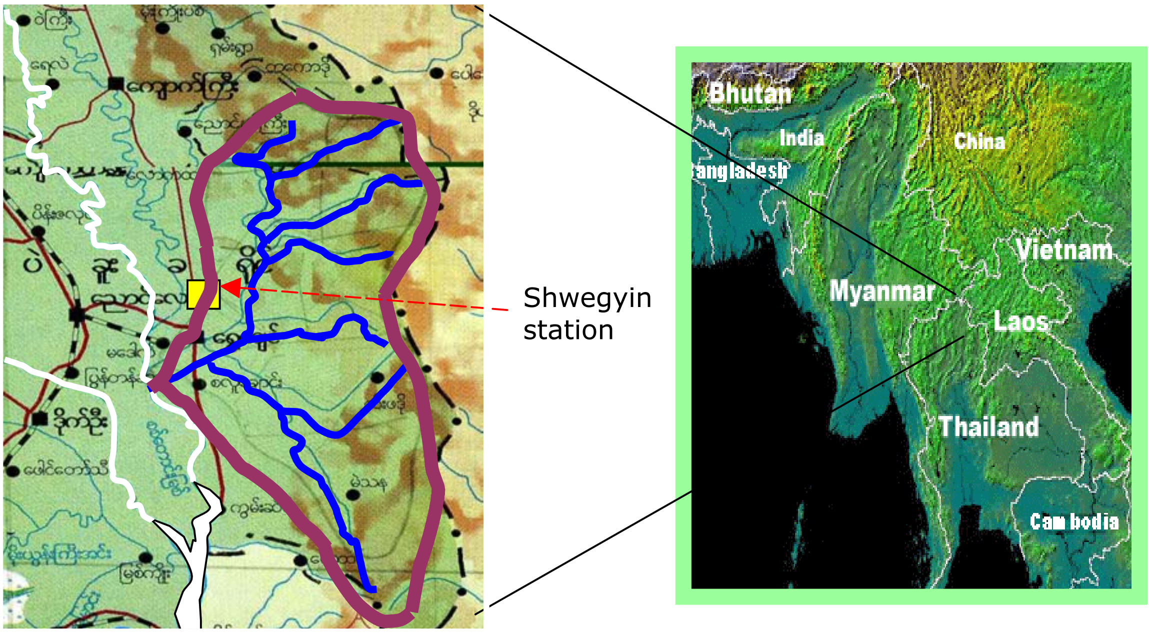
*2.3 Annual average rainfall of about [mm]:* 3552

*2.4 Dominant land use:*

*2.5 Dominant soil type:*

*2.6 Geographic coordinates [Lon, Lat]:* 96.75 to 97.167 E, 17.5 to 18.5 N

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| SURFACE | Number | HYDROLOGICAL | Number |
|---|---|---|---|
| Air Temperature | 1 | Stream flow | 1 |
| Humidity | 1 | Reservoir (Water level, Outflow) | |
| Wind | 1 | Groundwater Table | |
| Pressure | 1 | Evaporation | |
| Precipitation | 1 | Soil Temperature | |
| Snow Depth | | Soil Moisture | |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:*

*4.2 Land Surface Scheme:* *Meteorological model:* multilinear regression

*4.3 List of digital GIS data at fine resolution (besides global data set):*

*4.4 Data integration system:* Asynchronous (alphanumeric) Type - 3hourly

*4.5 Type of Prediction system and Downscaling technique:* flood frequency analysis, stage correlation

*Used mainly for:* [✓ Floods] Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | — | — | — | — | — | — | → | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Nepal **River basin name:** Bagmati **Basin Area:** 3700 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

Bagmati river originates from the southern slopes of *Shivapuri Lekh* at *Vagdhara*, north of Kathmandu. It flows towards south west from its origin and turns to west in Kathmandu city and emerges out of Kathmandu Valley at *Chovar*. The maximum flood discharge observed is about 11,000 m$^3$/sec.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts [✓ Water Quality]

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date: rain 540 mm on July 20, 1993 caused extensive damage, 200 deaths

*1.4 Targets to be addressed through demonstration (up to 3):*

- Reduce flood damages: bank erosion and inundation
- Reduce landslides and debris flows by means of landslides hazard mapping
- Water Pollution is crucial since it is used to meet the irrigation demand

*1.5 Objective:* to evolve an effective flood and rainfall prediction system including disaster management, resource management, resource allocation and environmental conservation.

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):* sub-tropical

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* Middle Mountain highest 2740 m

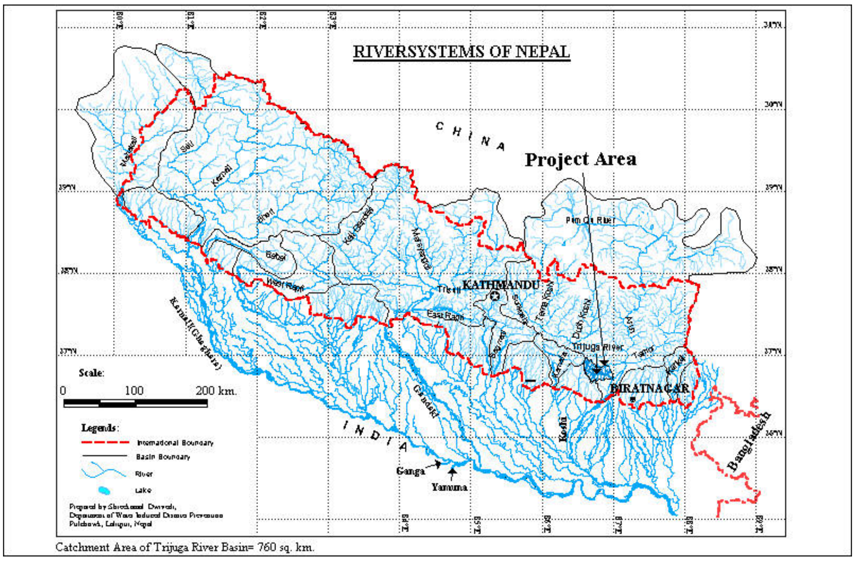
*2.3 Annual average rainfall of about [mm]:*

*2.4 Dominant land use:* forest

*2.5 Dominant soil type:* ----------

*2.6 Geographic coordinates [Lon, Lat]:* from 85º to 86ºE and 27.83º to 26.75º N

*2.7 River basin map [JPEG] with location of major observation sites:*



Catchment Area of Trijuga River Basin= 760 sq. km.

## 3. Observation system

| SURFACE | Number | HYDROLOGICAL | Number |
|---|---|---|---|
| Air Temperature | 11 | Stream flow | 3 |
| Humidity | 4 | Reservoir (Water level, Outflow) | |
| Wind | 4 | Groundwater Table | |
| Pressure | 4 | Evaporation | 2 |
| Precipitation | 25 | Soil Temperature | 2 |
| Snow Depth | | Soil Moisture | |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model*: HEC Model

*4.2 Land Surface Scheme:* --------------- *Meteorological model:* Not available

*4.3 List of digital GIS data at fine resolution (besides global data set):*

Transportation networks, contours, settlement area, administrative boundaries, land use, river system

*4.4 Data integration system:* Started archiving data sets such as LANDSAT, SRTM DEM

*4.5 Type of Prediction system and Downscaling technique:* On-going development, CDMA

*Used mainly for:* [✓ Floods] Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Pakistan **River basin name:** Swat **Basin Area:** 5894 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

Almost 70-90 % of the water in the Upper Indus River Basin comes from snowmelt and remote glaciers and precipitation during the monsoon season. Increasing water scarcity and pollution, environmental degradation including desertification, sedimentation, land sliding and water quality are increasing seriously in the Upper Indus Basin. Socio-economic conditions in the area are poor.

*1.2 Major issues (Please use a circle):* [✓ Floods] [✓ Droughts] [✓ Water Quality]

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date:

*1.4 Targets to be addressed through demonstration (up to 3):*

- Water resources assessment using in-situ and Remote Sensing data
- Impact of climate change on snow cover and glacier resources
- Impact of land use system changes on agriculture in response to climate change

*1.5 Objective:* Flood forecasting and water quality monitoring

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):* Affected by monsoon

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 750 to 5800 m.a.s.l.

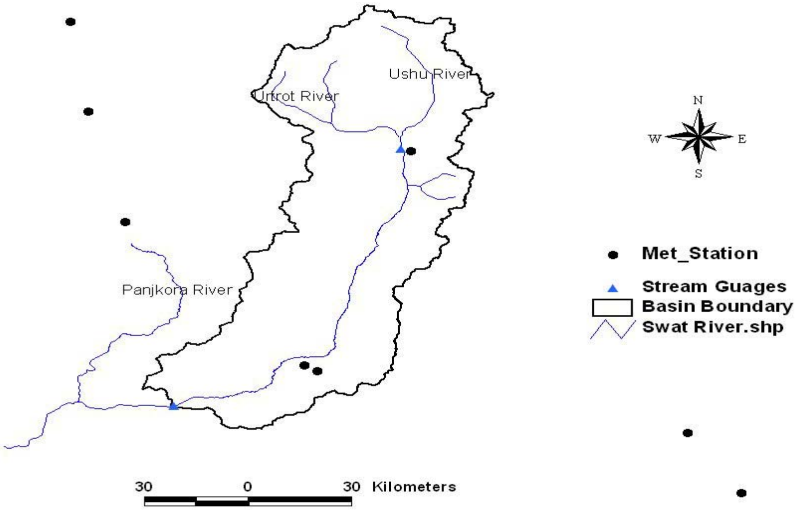
*2.3 Annual average rainfall of about [mm]:*

*2.4 Dominant land use:* upper mostly covered with snow and glaciers, some with lakes

*2.5 Dominant soil type:*

*2.6 Geographic coordinates [Lon, Lat]:* 71.9° to 72.87° E and 34.52° to 35.93° N

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | | Stream flow | 2 |
| Humidity | | Reservoir (Water level, Outflow) | |
| Wind | | Groundwater Table | |
| Pressure | | Evaporation | |
| Precipitation | 4 | Soil Temperature | |
| Snow Depth | | Soil Moisture | |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* lumped hydrological model (UBC) & statistical approaches

*4.2 Land Surface Scheme:* *Meteorological model:* ---------------

*4.3 List of digital GIS data at fine resolution (besides global data set):* DEM, landuse, landforms, basin boundary, drainage and river network, image based glacier/glacial lakes areas

*4.4 Data integration system:*

*4.5 Type of Prediction system and Downscaling technique:* statistical approaches for floods and drought indices are used.

*Mainly used for:* [✓ Floods] [✓ Droughts] Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | → | → | → | → | | | | |
| Data integration system (input data preparation, quality check) | → | → | → | → | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | → | → | → | → | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | → | → | → | → | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | | | | → | → | → | → |
| IWRM plan development of floods, droughts & water quality | | | | | → | → | → | → |

**Country**: Philippines **River basin name:** Pampanga **Basin Area:** 10540 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

It is the forth largest basin in the Philippines. The total length of the main river is about 260kilometers. The basin is drained through the Pampanga River and via the Labangan Channel into the Manila Bay. The main river is supported by several tributaries. It has a relatively low-gradient channel at the middle and lower sections. There are two dams within the river basin.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date:

*1.4 Targets to be addressed through demonstration (up to 3):*

Downscaling

Optimal multi-purpose reservoir operation

*1.5 Objective:* End-to-end approach in water resources management (IWRM)

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 100 - 1115

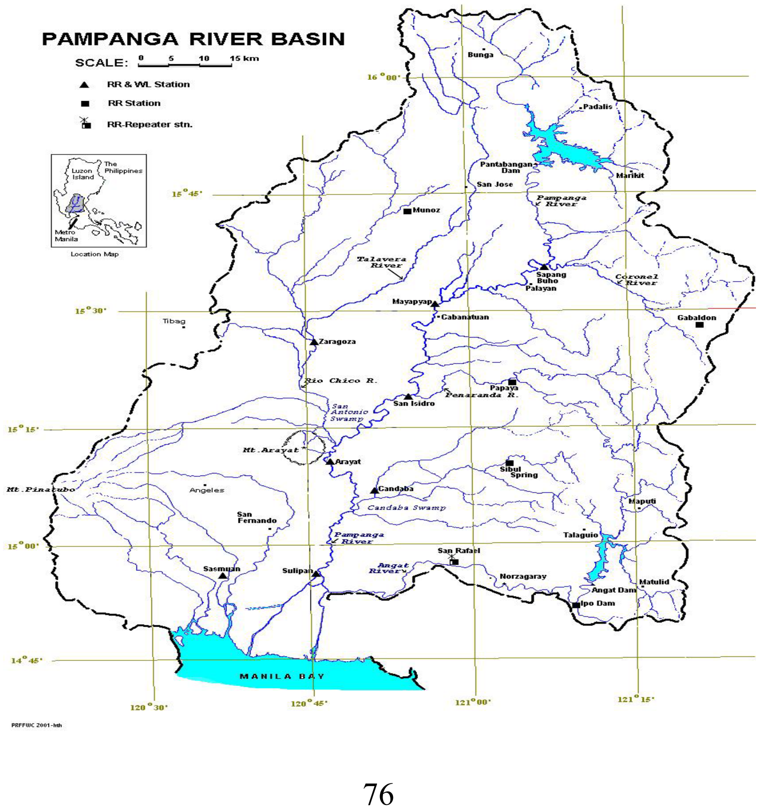
*2.3 Annual average rainfall of about [mm]:* 4200

*2.4 Dominant land use:*

*2.5 Dominant soil type:*

*2.6 Geographic coordinates [Lon, Lat]:* 120.5 to 121.5 E, 14.75 to 16.25 N

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 2 | Stream flow | 2 |
| Humidity | 2 | Reservoir (Water level, Outflow) | 2 |
| Wind | 2 | Groundwater Table | |
| Pressure | 2 | Evaporation | 1 |
| Precipitation | 10 | Soil Temperature | |
| Snow Depth | | Soil Moisture | |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* WATBAL Hydrologic model

*4.2 Land Surface Scheme:* *Meteorological model:*

*4.3 List of digital GIS data at fine resolution (besides global data set):*

*4.4 Data integration system:*

*4.5 Type of Prediction system and Downscaling technique:*

*Used mainly for:* [✓ Floods] Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Sri Lanka **River basin name:** Kalu Ganga **Basin Area:** 2720 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

The Kalu (River) Ganga basin located at the South-Western part of Sri Lanka. It is about 130 km long discharges into the Indian Ocean. The flood disasters continue in the basin due to climatic, hydrologic, topographic and land use characteristics in the basin. **.** There is a hydropower reservoir at one of the upper reaches. Population density in Kalutara and Ratnapura districts are 677 and 314 person/sq km.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

| District | Affected Families | Deaths | Houses destroyed | Houses partially damaged |
|---|---|---|---|---|
| Kalutara | 21,550 | 8 | 7,658 | 35 |
| Ratnapura | 47,756 | 137 | 5,726 | 6,902 |

*1.4 Targets to be addressed through demonstration (up to 3):*

-Flood risk reduction

-Identification of inundation levels

-Implementation of early warning systems based on real time flood forecasting

*1.5 Objective:* To minimize flood damages by using DHM & RS

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 2250

*2.3 Annual average rainfall of about [mm]:* 3000

*2.4 Dominant land use:* tropical rain forest

*2.5 Dominant soil type:*

*2.6 Geographic coordinates [Lon, Lat]:* 80 to 80.67 E, 6.4167 to 6.83 N

*2.7 River basin map [JPEG] with location of major observation sites:*

## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 1 | Stream flow | 2 |
| Humidity | 1 | Reservoir (Water level, Outflow) | |
| Wind | 1 | Groundwater Table | |
| Pressure | 1 | Evaporation | 1 |
| Precipitation | 10 | Soil Temperature | 1 |
| Snow Depth | | Soil Moisture | |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* one-dimensional hydraulic model

*4.2 Land Surface Scheme:* *Meteorological model:*

*4.3 List of digital GIS data at fine resolution (besides global data set):*

DEM, land use and river network

*4.4 Data integration system:*

*4.5 Type of Prediction system and Downscaling technique:*

Used mainly for: [✓ Floods] Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | → | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | — | → | | | | | |
| Parallel testing of the system at operational stage | | → | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Thailand **River basin name:** Mae Wang **Basin Area:** 600 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

Mae Wang Basin is one of the sub-basins of the Mae Ping Basin in Northern Thailand. Most of the basin is mountain area declining from west to east consists of the mixed unit of steep slope highland soil series.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date:

*1.4 Targets to be addressed through demonstration (up to 3):*

To install telemetering station for observation and collection of Hydro-meteorological data; For programming the flood warning model and effective water management

*1.5 Objective:* Flood forecast and early warning system

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 300, 1000, 2500

*2.3 Annual average rainfall of about [mm]:*

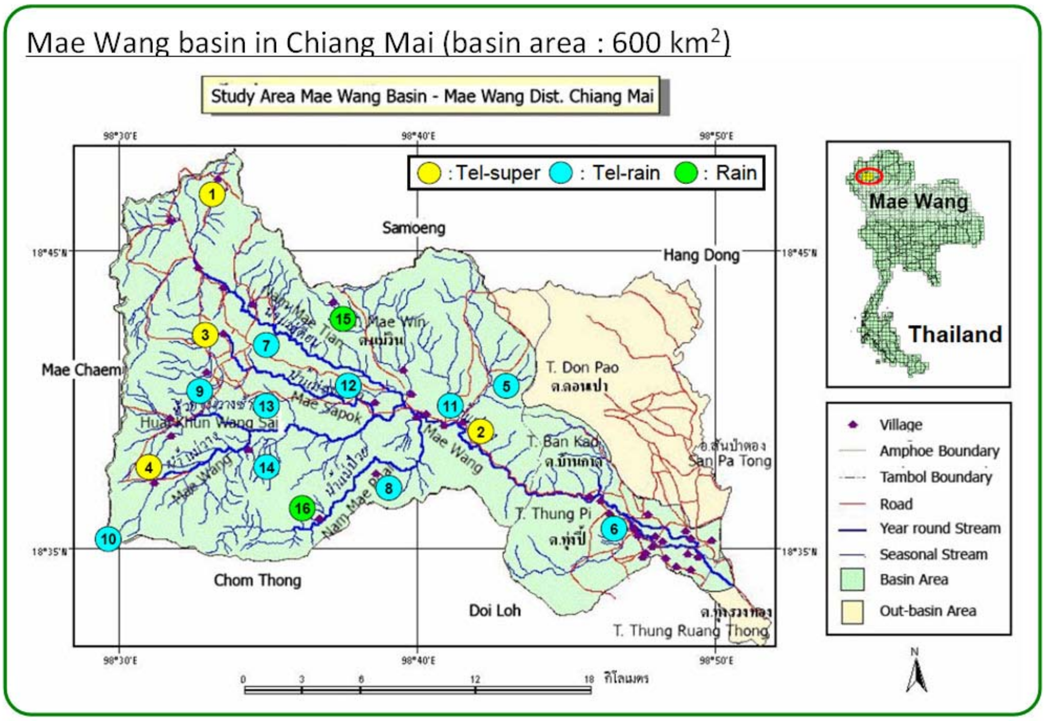
*2.4 Dominant land use:* forest and agriculture

*2.5 Dominant soil type:* mixed unit of steep slope highland soil

*2.6 Geographic coordinates [Lon, Lat]:* 98.5 to 98.83 E, 18.583 to 18.75 N

*2.7 River basin map [JPEG] with location of major observation sites:*

Site description 1 Hydrometeorological observation since May, 2006



## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 13 | Stream flow | 5 |
| Humidity | 4 | Reservoir (Water level, Outflow) | |
| Wind | 4 | Groundwater Table | 4 |
| Pressure | 4 | Evaporation | |
| Precipitation | 15 | Soil Temperature | 10 |
| Snow Depth | | Soil Moisture | 10 |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | 4 | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | 4 | Pilot Balloon | |
| Upward Long wave Radiation | 4 | Radiosonde | |
| Downward Long wave Radiation | 4 | Radar | |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* stage correlation model

*4.2 Land Surface Scheme:* SiBUC, MATSIRO *Meteorological model:* MM5

*4.3 List of digital GIS data at fine resolution (besides global data set):* River line, Land use, Soil type, 20-m contour line, point of village, road line

*4.4 Data integration system:* Water cycle information integrative system (UT)

*4.5 Type of Prediction system and Downscaling technique:*

*Used mainly for:* [✓ Floods] Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Uzbekistan **River basin:** Chirchik-Okhangaran **Basin Area:** 20160 [km$^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

It is Located in northeastern part of Uzbekistan. Snowmelt induced runoff of rivers of the Chirchik – Okhangaran basin comprised 60-90% of the total stream flow. In Chirchik -Okhangaran river basins have 19 hydropower stations. There are two rivers – Chirchik (161 km) and Okhangaron (223 km). River basin has 67 lakes with different genesis type. This basin has 2384.6 thousand people.

*1.2 Major issues (Please use a circle)*: [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date: Mudslide 1969, March

*1.4 Targets to be addressed through demonstration (up to 3):*

- Sediment transport
- Impacts of hydrological process and on hydropower generation
- To monitor the flow regimes in the rivers due to climate change

*1.5 Objective:* Determination of an adequate warning system for floods

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

Very Humid [✓ Humid] Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 400, 600, 4301

*2.3 Annual average rainfall of about [mm]:*

*2.4 Dominant land use:* agriculture

*2.5 Dominant soil type:*

*2.6 Geographic coordinates [Lon, Lat]:* 69.33 to 71.25 E, 40.167 to 42.25 N

*2.7 River basin map [JPEG] with location of major observation sites:*

## 3. Observation system

| **SURFACE** | **Number** | **HYDROLOGICAL** | **Number** |
|---|---|---|---|
| Air Temperature | 10 | Stream flow | |
| Humidity | 10 | Reservoir (Water level, Outflow) | 19 |
| Wind | 10 | Groundwater Table | |
| Pressure | 10 | Evaporation | **3** |
| Precipitation | 22 | Soil Temperature | 10 |
| Snow Depth | 23 | Soil Moisture | 3 |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | |
| Upward Long wave Radiation | | Radiosonde | |
| Downward Long wave Radiation | | Radar | 2 |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | 2 | **Others** | **Number** |
| CO2 Flux | 2 | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:*

*4.2 Land Surface Scheme:* *Meteorological model:*

*4.3 List of digital GIS data at fine resolution (besides global data set):*

*4.4 Data integration system:*

*4.5 Type of Prediction system and Downscaling technique:*

*Used mainly for:* Floods Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | **2008/I** | **2008/II** | **2009/I** | **2009/II** | **2010/I** | **2010/II** | **2011/I** | **2011/II** |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | | | | | | | | |
| Improvement of in-situ observation network system | | | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | | | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | | | | | | |
| Parallel testing of the system at operational stage | | | | | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | | | | |

**Country**: Vietnam **River basin name:** Huong **Basin Area:** 2830 [$km^2$]

## 1. Background, targeted issues and objective

*1.1 Brief introduction to the river basin within four lines*

Huong river basin belongs to Thua Thien Hue province in coastal of the Central Viet Nam. Huong river system contains 3 main rivers: Ta Trach, Huu Trach and Bo River. Huong River is short and steep runs from mountain to the low plain area. Time of concentration is short and river basin has low storage capacity. Floods and inundation often occur very quickly and severely.

*1.2 Major issues (Please use a circle):* [✓ Floods] Droughts Water Quality

*1.3 Latest event when the issue was evident according to above one(s):*

Variable/indicator & date: 2320mm/3day 1999.11

*1.4 Targets to be addressed through demonstration (up to 3):*

To improve accuracy of the forecast, effective natural disaster preparedness, prevention measures and reduces the losses

*1.5 Objective:* To get efficient flood warning system

## 2. River basin characteristics

*2.1 Climate regime (Please use a circle):*

[✓ Very Humid] Humid Temperate Semi-arid Arid Cold/Tundra

*2.2 Topography (minimum, average and maximum elevation):* 500 - 1000

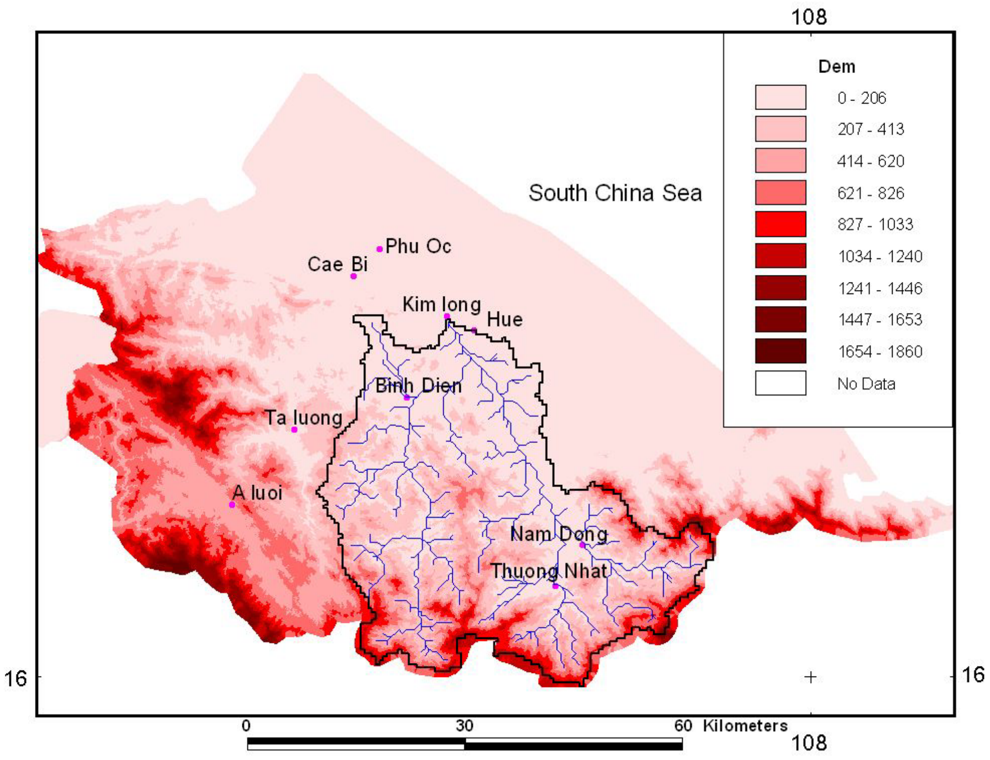
*2.3 Annual average rainfall of about [mm]:* 3000

*2.4 Dominant land use:* forests

*2.5 Dominant soil type:* erodible laterit soil

*2.6 Geographic coordinates [Lon, Lat]:* 107 to 108 E, 16 to 17 N

*2.7 River basin map [JPEG] with location of major observation sites:*



## 3. Observation system

| SURFACE | Number | HYDROLOGICAL | Number |
|---|---|---|---|
| Air Temperature | 3 | Stream flow | 1 |
| Humidity | 3 | Reservoir (Water level, Outflow) | 1 |
| Wind | 3 | Groundwater Table | |
| Pressure | 1 | Evaporation | 3 |
| Precipitation | 7 | Soil Temperature | 3 |
| Snow Depth | | Soil Moisture | 3 |
| Skin Temperature | | **Atmosphere** | **Number** |
| Upward Shortwave Radiation | | Planetary Boundary Layer Tower | |
| Downward Shortwave Radiation | | Pilot Balloon | 1 |
| Upward Long wave Radiation | | Radiosonde | 1 |
| Downward Long wave Radiation | | Radar | 2 |
| Net Radiation | | **Water Quality** | **Number** |
| Sensible Heat Flux | | Groundwater quality indicators | 15 |
| Latent Heat Flux | | Surface water quality indicators | |
| Ground Heat Flux | | **Others** | **Number** |
| CO2 Flux | | | |

## 4. Models, GIS, Data Integration System, Prediction System

*4.1 Hydrological model:* Multivariable regression, TANK, NAM, MARINE

*4.2 Land Surface Scheme:* *Meteorological model:*

*4.3 List of digital GIS data at fine resolution (besides global data set):*

50 m DEM, land use, soil type, river network etc...

*4.4 Data integration system:* HydroMet Data, Digital Hydrological database, Digital Meteorological database

*4.5 Type of Prediction system and Downscaling technique:* HRM, ETA and WBAR

Used mainly for: [✓ Floods] Droughts Water Quality Monitoring IWRM

## 5. Implementation Schedule of the Demonstration. Modify the arrows

| ACTIVITIES | 2008/I | 2008/II | 2009/I | 2009/II | 2010/I | 2010/II | 2011/I | 2011/II |
|---|---|---|---|---|---|---|---|---|
| Hydro-meteorological & water quality monitoring | | | | | | | | |
| Data integration system (input data preparation, quality check) | → | → | | | | | | |
| Improvement of in-situ observation network system | → | → | | | | | | |
| Setting-up a Distributed Hydrological Model (optional LSS) | | → | → | | | | | |
| Scenario Studies: Land use change analysis, dry periods, etc. | | | | | | | | |
| Capacity building on Floods, Droughts & Water Quality | | | → | → | | | | |
| Parallel testing of the system at operational stage | | | → | → | | | | |
| IWRM plan development of floods, droughts & water quality | | | | | → | → | | |

## Appendix C: Meetings

1st Asian Water Cycle Symposium, Tokyo, Japan, 2 – 4 November 2005: Agenda

### Asian Water Cycle Symposium

*The University of Tokyo, Tokyo, Japan, 2-4 November 2005*

***Guiding Goal***

To better understand the mechanism of Asian water cycle variability and to improve its predictability, and furthermore to interpret the information applicable to various water environments in different countries, then to help to mitigate water-related disasters and promote the efficient use of water resources.

**Objectives**

(1) Introduce planned and on-going demonstration projects and to discuss how to move toward observation convergence in Asia.

(2) Design a roadmap that will lead toward a GEOSS water data exchange and sharing policy as a first step for establishing an 'Asian GEOSS Water Initiative' and forging agreements on observation convergence, interoperability, and data management within the overall architecture of GEOSS.

**Wednesday, 2 November 2005:**

**8:30 – 9:00 Registration**

**9:00 – 9:30 1. Opening**

1.1 Chairman of Organizing Committee (K. Musiake)
1.2 GEO
1.3 Host Organizations
- *CSTP*
- *President of the University of Tokyo* (H. Komiyama)

**9:30 – 10:002. Introduction to GEOSS**

2.1 GEOSS
2.2 Ad-hoc GEO IPTT Water Cycle Topic Coordinator (R. Lawford)

**10:00 – 10:30 BREAK**

**10:30 – 11:30 3. Convergence of Observation**

3.1 Upgrades to the existing in-situ network
- *WMO*
- *UNESCO* (A. Szollosi-Nagy)
- *Others*

**11: 30 – 12:00 3. Convergence of Observation – continued**

3.2 Design of sophisticated in-situ observing system
- *FLUXNET*
- *ARM*
- *Others*

**12:00 – 13:00 LUNCH**

**13.00 – 14:00 3. Convergence of Observation – continued**

3.3 Satellite Observations

- *CEOS*
- *JAXA*
- *Others*

3.4 Coordination function for in-situ and satellite water cycle observations
- *GCOS*
- *IGWCO* (R. Lawford)
- *Others*

**14:00 – 15:30 4. Asian Demonstration Projects Dedicated to GEOSS**

4.1 Indonesia
4.2 India
4.3 Pakistan
4.4 Nepal

**15:30 – 16:00 BREAK**

**16:00 – 18:00 4. Asian Demonstration Projects Dedicated to GEOSS –continued**

4.5 Bangladesh
4.6 Sri Lanka
4.7 Malaysia
4.8 Vietnam
4.9 Thailand
4.10 Mekong Committee

**18:00 ADJOURN**

**18:30 Reception**

**<u>Thursday, 3 November 2005:</u>**

**9:00 – 10:304. Asian Demonstration Projects Dedicated to GEOSS –continued**

4.11 Philippine
4.12 Mongolia
4.13 China
4.14 Korea

**10:30 – 11:00 BREAK**

**11:00 – 12:30 5. Interoperability**

5.1 In-situ Data Archiving and Quality Check (S. Williams)
5.2 User Interface for In-situ Data Archive in Asia (K. Tamagawa)
5.3 Metadata (R. Shibasaki)
5.4 Global Mapping
5.5 Others

**12:30 – 13:30 LUNCH**

**13:30 – 15:30 6. Data Management**

6.1 ICSU/WDC (D. Clark)
6.2 Data Infrastructure for Earth Environmental Research (M. Kitsuregawa)
6.3 Distributed Data Integration System + Demonstration (O. Ochiai, B. Burford)
6.4 Centralized Data Integration System + Demonstration (T. Nemoto, E. Ikoma, M. Yasukawa)
6.5 Data Integration and Information Fusion (M. Takagi)
6.6 Others

**15:30 – 16:00 BREAK**

**16:00 – 18:00 7. International Science Programs/Projects**

7.1 GWSP
7.2 MAIRS (C. Fu)
7.3 WCRP (G. Wu)
7.4 Pan-WCRP Monsoon (T. Yasunari)
7.5 MAHASRI (J. Matsumoto)
7.6 CEOP (T. Koike)
7.7 PUB (K. Takeuchi)
7.8 ICHARM (H. Terakawa)
7.9 GFAS (R. Oki)
7.10 Others

**18:00 ADJOURN**

**Friday, 4 November 2005:**

**9:00 – 10:30 8. Discussion Session**

8.1 Convergence of Observation
- *How to define the components of GEOSS Water in Asia;*
- *How to converge or harmonize observation methods;*
- *How to promote the use of standards and references, inter-calibration, and data assimilation.*

**10:30 – 11:00 BREAK**

**11:00 – 12:30 8. Discussion Session – continued**

8.2 Interoperability
- *How to define and update interoperability arrangements, focusing on technical specifications for collecting, processing, storing, and disseminating shared data, metadata and products.*

8.3 Data Management
- *How to facilitate data management, information management, and common services*
- *How to promote data policies*

**12:30 – 13:30 LUNCH**

**13:30 – 14:30 9. Drafting Session**

**14:30 – 15:00 BREAK**

**15:00 – 16:30 10. Summary Session**

**16:30 – 17:00 11. Closing Session**

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1st AWCI International Task Team Meeting, Bangkok, Thailand, 25 September 2006; and the Workshop on Capacity Building in Asia: Earth Observations in the service of water management.
Agendas

## Agenda of the Asia Water Cycle Initiative (AWCI) International Task Team (ITT) Working Session; Monday 25 September 2006
## Rama Gardens Hotel, Bangkok, Thailand

**Monday 25 September 2006**

| | |
|---|---|
| 08:00 – 08:30 | Registration |
| 08:30 – 09:00 | Welcome Remarks, ITT members introduction |
| 09:00 – 10:00 | Introduction to the Asia Water Cycle Initiative and the International Integrated Water Data Access and Transfer in Asia (*Toshio Koike*) |
| *10:00 – 10:30* | *BREAK* |
| 10:30 – 12:00 | Country reports based on the questionnaire – 5 minutes for each country |
| *12:00 – 13:30* | *LUNCH* |
| 13:30 – 14:30 | Discussion – part 1: Demonstration project |
| *14:30 – 14:45* | *BREAK* |
| 14:45 – 15:45 | Discussion – part 2: Data policy |
| *15:45 – 16:00* | *BREAK* |
| 16:00 – 17:00 | Discussion – part 3: Inventory of available observations and data |
| *17:00 – 17:30* | *BREAK* |
| 17:30 – 18:30 | Summary discussion – basis for the AWCI Implementation Plan |
| *18:30* | *ADJOURN* |

We suppose that during the following three days of the Capacity Building Workshop, there will be opportunities to further discuss the above issues and thus provide sufficient basis for the draft proposal of the core of the Implementation Plan that should be thence discussed in individual participating countries.

"EARTH OBSERVATIONS IN THE SERVICE OF WATER MANAGEMENT"

## DAY 1- Workshop for Policy Makers

Tuesday, September 26, 2006

08:00 – 08:30 Registration

OPENING *(Chair: C. Ishida, Planning Manager , JAXA)*

08:30 – 08:45 Welcome (Prof. Sudip Rakshit, Vice President of Research, Local host_AIT)
Welcome (T. Takebayashi, Deputy Director, MEXT)
Welcome (H. Kozawa, Associate Executive Director, JAXA)

08:45 - 09:00 Keynote speech (Dr. Siripong Hungspreug, Director-General, Department of Water Resources, Ministry of Agriculture and Cooperatives, Thailand (TBC))

PLENARY 1: OVERVIEW *(Chair: C. Ishida, Planning Manager, JAXA)*

*Plenary one will provide an overview of the current state of water management issues in Asian countries. This session will highlight concerns and usage of technology and science in water management.*

09:00 – 09:15 Overview of GEO activities for Water and Capacity Building, and expectation of this Workshop (Antti Herlevi, Senior Programme Officer, GEO Secretariat)

09:15 – 09:30 Overview of IGWCO and its Capacity Building activities including the result of March Workshop (R. Lawford,Director, International GEWEX Project Office)

09:30 – 09:45 Report of activity on Asian Water Cycle Symposium (T. Koike,Professor, Department of Civil Engineering, University of Tokyo)
09:45 – 10:05 BREAK

PLENARY 2: CAPACITY BUILDING AND BEST PRACTICES FOR APPLICATIONS OF EARTH OBSERVATIONS FOR WATER MANAGEMENT- INTERNATIONAL AND REGIONAL PROGRAMS

*(Chair : T. Koike, Professor, Department of Civil Engineering, University of Tokyo,)*

*Observing systems including satellites for water management are providing success stories all over Asia. Plenary two will highlight some of those projects serving water management concerns in Asian countries.*

10:05 – 10:20 CEOS/TIGER (ESA(TBC))
10:20 – 10:35 GISTDA (Surachai, (TBC))
10:35 – 10:50 LAPAN (O. Roswintiarti, Head, Natural Resources and Environmental Monito)
10:50 – 11:05 JAXA/Earth Observation Program and Water Management Services (R. Oki, Senior Researcher,JAXA)
11:05 – 11:20 WMO (R. Lawford, Director, International GEWEX Project Office)
11:20 – 11:35 UN-ESCAP (Ti Le-Huu, Officer-in-Charge of Water Resources, Environment and Sustainable Development Division)
11:35 – 11:50 UNU (S. Herath, Senior Academic Programme Officer, UNU)
11:50 – 12:05 AIT (L. Samarakoon, Director, Geoinfomatics Center)
12:05 – 12:20 Mekong River Commission (Truong Hong Tien, Program Coordinator)

12:20 – 13:30 LUNCH

## PLENARY 3: CAPACITY BUILDING AND BEST PRACTICES FOR APPLICATIONS OF EARTH OBSERVATIONS FOR WATER MANAGEMENT- NATIONAL PROGRAMS

*(Chair: J. Matsumoto, Professor, Tokyo Metropolitan University)*

| | |
|---|---|
| 13:30 – 13:40 | Activities in Japan (T. Koike, Professor, Department of Civil Engineering, University of Tokyo) |
| 13:40 – 13:50 | Activities in Korea (D. H. Bae, Professor, College of Engineering,Sejong University) |
| 13:50 – 14:00 | Activities in China (L. Ai, Deputy Director, International Project Office of MAIRS) |
| 14:00 – 14:10 | Activities in Mongolia (D. Azzaya, Director,Institute of Meteorology and Hydrology) |
| 14:10 – 14:20 | Activities in Vietnam ( Thi Tan Thanh Nguyen, Deputy Director, Upper-Air Meteorological Observatory[TBC]) |
| 14:20 – 14:30 | Activities in Lao PDR (Somphanh Vittaya, Hydrologist, Deputy Chief of Hydrological Division) |
| 14:30 – 14:40 | Activities in Cambodia (Bunnavuth Ku, Assistant,National Committee for Disaster Management) |
| 14:40 – 15:10 | BREAK |

*(Chair: L. Samarakoon, ,Director,Geoinfomatics Center)*

| | |
|---|---|
| 15:10 – 15:20 | Activities in Myanmar (Tin Yi, Staff Officer, Department of Meteorology and Hydrology) |
| 15:20 – 15:30 | Activities in Malaysia (A. Majid, Malaysian Center for Remote Sensing) |
| 15:30 – 15:40 | Activities in Indonesia (Joesron Loebis, Chairman, Indonesian Hydrology Society) |
| 15:40 – 15:50 | Activities in Philippine (R. T. Perez, Wether Services Chief, Flood Forecasting Branch) |
| 15:50 – 16:00 | Activities in Sri Lanka (Nihal Rupasinghe, Chairman,Central Engineering Consultancy Bureau) |
| 16:00 – 16:10 | Activities in Bhutan (Nado Rinchhen, Deputy Minister, National Environment Commission) |
| 16:10 – 16:20 | Activities in Nepal (K. P. Sharma, Deputy Director General, Department of Hydrology and Meteorology) |
| 16:20 – 16:30 | Activities in India (R. Kumar, Scientist, National Institute of Hydrogy) |
| 16:30 – 17:00 | BREAK |
| 17:00 – 17:10 | Activities in Bangladesh (Sazed K. Chowdhury, Superentend Engineer, Bangladesh Water Development Board) |
| 17:10 – 17:20 | Activities in Pakistan (Muhammad Akram Kahlown, Chairman, Pakistan Council of Research in Water Resources) |
| 17:20 – 17:30 | Activities in Iran (Mohammad Javad Abedini, Faculty Member, Civil Engineering) |
| 17:30 – 17:40 | Activities in Uzbekistan (Sergey Myagkov, Deputy Director, Hydrometeorological Research Institute) |
| 17:40 – 17:50 | Activities in Russia (K. Valeriy, Deputy Head, Ministry of Natural Resources of Russia) |
| 17:50 – 18:00 | Activities in Central African Republic (M. Aline,GEO Member, Geosciences and Environment (TBC)) |

18:30 – 21:00 POSTER VIEWING AND RECEPTION

Days 2 and 3– Workshop for Earth observation providers and water resource managers

Wednesday, September 27, 2006

## PLENARY 4: AVAILABLE DATA, TOOLS AND OPPORTUNITIES

*(Chair: R. Lawford,Director,International GEWEX Project Office,(IGPO) [TBC])*
*While data assimilation provides an emerging method for drawing together data sets from various sources into a format that makes them easier to use in water management, new tools are becoming available that enable water managers to visualize the current and future effects of weather and human factors on water through mapping and graphing capabilities. Plenary four will provide examples of these techniques and show their application in different parts of the world, including Asian countries.*

| | |
|---|---|
| 08:00 – 08:20 | ICHARM (K. Fukami, Chief, Hydrogic Engineering Research Team) |
| 08:20 – 08:40 | MAHASRI (J. Matsumoto, Professor, Tokyo Metropolitan University) |
| 08:40 – 09:00 | PUB (S. B. Weerakoon, Associate Professor, University of Peradeniya) |
| 09:00 – 09:20 | JEPP (M. Yamanaka, Senior Scientist, Japan Agency for Marine-Earth Science and Technology(JAMSTEC)) |
| 09:20 – 09:40 | CliC in Asian Region (T. Ohata, Program Director, Japan Agency for Marine-Earth Science and Technology(JAMSTEC)) |
| 09:40 – 10:00 | CEOP (T. Koike, Professor, Department of Civil Engineering, University of Tokyo) |

10:00 – 10:30 BREAK

| | |
|---|---|
| 10:30 – 10:50 | MAIRS (L. Ai, Deputy Director, International Project Office of MAIRS) |
| 10:50 – 11:10 | ISRO Space Application Center (Y. V. N. Krishnamurthy, Head, Regional Remote Sensing Center) |
| 11:10 – 11:30 | Sentinel Asia (H. Kai,Associate Senior Engineer,JAXA) |
| 11:30 – 11:50 | River Basin Management (D. H. Bae, Professor,College of Engineering, Sejong University) |
| 11:50 – 12:10 | EWBMS: water resources monitoring and flow forecasting on the basis of geostationary satellite data (A. Rosema, Director, Environmental Analysis and Remote Sensing) |
| 12:10 – 12:30 | ITC: FROM "BUILDING CAPACITY" TO "BUILDING ON CAPACITY" (Ms. Marjan Kreijns) |

12:30 – 13:30 LUNCH

## WORKING GROUPS

*Three working groups will be convened to further discuss the topics below. The working groups are to identify available data and tools, and to propose a regional application project which contributes to GEOSS Water Management SBA. It is expected that this dialogue will be interactive. Participants are asked to make no prepared presentations, unless asked by the organizers, so that the working group will be an open, flowing discussion of ideas and sharing of concerns in these areas as they pertain to Asia.*

13:30 – 17:30 Break-Out Sessions

Working Group I: *Flooding (Co-Chairs: K. Fukami, Chief, Hydrogic Engineering Research Team + Tanka Kafel, Senior Project Researcher, Geoinformatics Center,AIT, Rapporture: H. Kai*, Associate Senior Engineer, JAXA *)*

Working Group II: *Drought (Co-Chairs: L .Ai*, *Deputy Director, International Project Office of MAIRS + D. Azzaya*, *Director, Institute of Meteorology and Hydrology, Rapporture: TBD)*

Working Group III: *Water Quality (Chair: Bilqis Amin Hoque, Chairperson and Head of Research, Environment and Population Research Center, Rapporture: S. Greb, Chief Hydrologist and a Member of IGOS-IGWCO, Department of Natural Resources)*

Thursday, September 28, 2006

PLENARY 5: REPORTS FROM WORKING GROUPS

*(Chair: R. Lawford, Director, International GEWEX Project Office [TBC], Rapporture: Tanka Kafel [TBC])*

*This plenary will serve as the reporting mechanism for the finds of the working group discussions of the previous day. This will facilitate an open, cross-section of ideas as participants comment on all three working groups; a Q&A session will be included.*

08:30 – 09:00 Report from Working Group I: *Flooding (Co-Chairs: K. Fukami +Tanka Kafel, Senior Project Researcher, Geoinformatics Center, AIT)*

09:00 – 09:30 Report from Working Group II: *Drought (Co-Chairs: L. Ai, Deputy Director, International Project Office of MAIRS + D. Azzaya, Director, Institute of Meteorology and Hydrology)*

09:30 – 10:00 Report from Working Group III: *Water Quality (Chair: Bilqis Amin Hoque, Chairperson and Head of Research, Environment and Population Research Center)*

10:00 – 10:30 BREAK

10:30 – 12:00 Discussion and wrap-up

CLOSING

12:00-12:10 Closing remarks (T. Koike, Professor, Department of Civil Engineering, University of Tokyo)

12:10 Adjourn

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$2^{nd}$ Asian Water Cycle Symposium, Tokyo, 9-10 January 2007: Agenda

## $2^{nd}$ Asian Water Cycle Symposium

*The University of Tokyo, Tokyo, Japan, 9-10 January 2007*

### *Guiding Goal*

Toward convergence of observation and capacity building for promoting the Integrated Water Resources Management (IWRM) approach through application of integrated earth observation data, model output, downscaling techniques to address local water resources management issues in a river basin.

### Objectives

To discuss a baseline implementation plan of the Demonstration Projects and respective proposals for the Demonstration Projects on nominated river basins in individual countries.

**Tuesday, 9 January 2007:**

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

**9:30 -- 9:45 1. Opening**

1.1 K. Musiake, Chairman of Organizing Committee
1.2 O.Ochiai, GEO Secretary
1.3 S. Sakamoto, MEXT
1.4 T. Koike, University of Tokyo

**9:45 -- 10:30 2. AWCI Activity Reports**
2.1 The 1st Asian Water Cycle Symposium and the International Task Team Meeting *T. Koike* (20min)
2.2 GEO/IGWCO Capacity Building *C. Ishida + 3 WG Co-Chairs* (25min)
**10:30 -- 10:45 BREAK**

**10:45 -- 12:00 3. A Baseline of GEOSS/AWCI Demonstration Projects**
3. 1 Objectives
3. 2 Criteria of candidate river basins
3. 3 Timeline
3. 4 Which data do we need?
3. 5 Data Policy
3. 6 Water and Sanitation Broad Partnership Initiative (WASABI) *M. Nishimura (Mofa)*
**12:00 -- 13:00 LUNCH**

**13.00 -- 15:00 4. Country Proposals (1)** (8min each)
4. 1 Bangladesh
4. 2 Bhutan
4. 3 Cambodia
4. 4 China
4. 5 India
4. 6 Indonesia
4. 7 Japan
4. 8 Korea
4. 9 Laos
4.10 Malaysia
4.11 Mongolia
4.12 Myanmar
**15:00 -- 15:30 BREAK**

**15:30 -- 16:40 4. Country Proposals (2)** (8min each)
4.13 Nepal
4.14 Pakistan
4.15 Philippines
4.16 Sri Lanka
4.17 Thailand
4.18 Uzbekistan
4.19 Vietnam

**16:40 -- 18:00 5. Cooperative Existing Projects, Programs, and Systems** (8min each)
5. 1 ICHARM *K. Fukami*
5. 2 UNU *S. Herath*
5. 3 MRC *T. H. Tien*
5. 4 JAXA *C. Ishida*
5. 5 JAMSTEC *T. Ohata*
5. 6 OCCCO (JACCO) *T.Fujitani*
5. 7 GWSP *C.Liu*
5. 8 CEOP *S.Williams*

**18:10 ADJOURN**
**18:30 Reception**

1st GEOSS AWCI International Coordination Group Meeting, Bali, Indonesia, 9 September 2007: Agenda

**Asian Water Cycle Initiative (AWCI)**
International Coordination Group (ICG)
Bali, Indonesia, 9 September 2007

***Objectives***
To move forward and implement the baseline idea approved at the 2nd Asian Water Cycle Symposium held in Tokyo, 9 – 10 January 2007, International Coordination Group (ICG) will discuss about a draft implementation plan through coordination of related activities.

**Sunday, 9 September 2007:**

**8:30 -- 9:00 Registration**
**9:30 -- 10:30 1. AWCI Activity Reports**
1.1 The 2nd Asian Water Cycle Symposium and the follow-up activities *T. Koike* (30min)
1.2 AWCI Capacity Building *C. Ishida* and *3 Co-Chairs* (30min)

**10:30 -- 12:00 2. Country Report: preparatory step for AWCI/ water topics** (5min each)
Bangladesh/Bhutan/Cambodia/China/India/Indonesia/Japan/Korea/Laos/Mongolia
Myanmar/Nepal/Pakistan/Philippines/Sri Lanka/Thailand/Uzbekistan/Vietnam

**12:00 -- 13:00 LUNCH**

**13:00 – 15:30 3. AWCI Implementation Planning**
3.1 Objectives
3.2 Convergence of Observation/Data Integration and Analysis/Information Sharing
3.3 Capacity Building
3.4 Country Activities

**15:30 – 16:00 BREAK**

**16:00 – 17:00 4. Scientific and Technical Topics**
4.1 River Basin Meta-data Design
4.2 Application Studies

**17:00 – 18:00 5. Discussion Summary and Way Forward**

**18:00 ADJOURN**

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3rd Asian Water Cycle Symposium, Beppu, Japan, 2-4 December 2007: Agenda

**Sunday, 2 December 2007**

| | |
|---|---|
| 8:30 – 9:00 | Registration |
| 9:00 – 9:20 | **1.Opening**<br>**1.1** K. Musiake, Chairman of Organizing Committee<br>**1.2** Y. Horikawa, JAXA |

|  |  |
|---|---|
| 9:20<br>–<br>10:35 | **2. AWCI Activity Reports**<br>**2.1** AWCI Capacity Building framework -S. Herath (30min)<br>**2.2** The first ICG, follow-up activities and proposals -C. Ishida and 3 Co-Chairs (45min) |
| 10:35<br>–<br>11:00 | BREAK |
| 11:00<br>–<br>12:15 | **3. Participating Organization Capacity Building Program (1)**<br>JAXA / AIT, China, ISRO, MRC, UNU (15min each) |
| 12:15<br>–<br>13:15 | LUNCH |
| 13:15<br>–<br>14:45 | **4. Country Report: GEOSS / AWCI “capacity building” program**<br>Bangladesh / Bhutan / Cambodia / India / Indonesia / Korea / Laos / Mongolia / Myanmar / Nepal / Pakistan / Philippines / Sri Lanka / Thailand / Uzbekistan / Vietnam (5min each) |
| 14:45<br>–<br>15:15 | BREAK |
| 15:15<br>–<br>18:15 | **5. GEOSS / AWCI “Capacity Building” Implementation Plan Development**<br>**5.1** Plenary session; Objectives and guidance<br>**5.2** Breakout sessions - Floods WG - Drought WG - Water quality WG<br>**5.3** Plenary session; WG reports and coordination |
| 18:15 | ADJOURN |

**Monday, 3 December 2007**

|  |  |
|---|---|
| 9:00<br>-<br>10:00 | **6. Review of revised draft of GEOSS / AWCI “Capacity Building” Implementation Plan** |
| 10:00<br>-<br>10:30 | BREAK |
| 10:30<br>-<br>11:30 | **7. Adoption of the GEOSS / AWCI “Capacity Building” Implementation Plan** |
| 11:30<br>-<br>12:00 | **8. Summary report of GEOSS / AWCI -T.Koike (30min)** |
| 12:00<br>-<br>13:00 | LUNCH |
|  |  |

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|---|---|
| 13:00<br>–<br>15:00 | **9. Country Report : GEOSS / AWCI “demonstration” projects**<br>Bangladesh /Bhutan / Cambodia / India / Indonesia / Korea / Laos / Mongolia / Myanmar / Nepal / Pakistan / Philippines / Sri Lanka / Thailand / Uzbekistan / Vietnam (8min each) |
| 15:00<br>–<br>15:30 | BREAK |
| 15:30<br>–<br>17:30 | **10. International cooperation and supports**<br>**10.1** Japan International Cooperation Agency (JICA) -S. Masuda (20min)<br>**10.2** Asian Development Bank (ADB) -K.E. K Seetharam (20 min)<br>**10.3** The Asia-Pacific Network for Global Change Research (APN) -Y. Imanari (20min)<br>**10.4** UNESCO / ICHARM -K. Fukami(20 min)<br>**10.5** JAXA’s Water Cycle Observation Program -C. Ishida (20 min)<br>**10.6** GSMaP -K.Okamoto (20 min)<br>**10.7** WCRP / GEWEX / CEOP -S. Benedict (20 min) |
| 17:30 | ADJOURN |
| 18:30 | RECEPTION |

**Tuesday, 4 December 2007**

| | |
|---|---|
| 9:00<br>–<br>10:00 | **11. AWCI Technical Reports**<br>**11.1** CEOP Data Management -S. Williams(15min)<br>**11.2** Information Grid for Water Cycle Study -N.Sahavechaphan(15 min)<br>**11.3** Distributed Hydrological Model -Y. Dawen(15min)<br>**11.4** DHM Applications -O. Saavedra (15mim) |
| 10:00<br>–<br>10:30 | BREAK |
| 10:30<br>–<br>12:20 | **12. Open Session "Toward Convergence -GEOSS / AWCI-"**<br>**12.1** GEOSS / AWCI Video Session (10min)<br>**12.2** WCRP / GEWEX and GEOSS-IGOS / Water -R. Lawford(20min)<br>**12.3** Current activities for flood forecasting enhancement in Korea -D-G. Bae(20min)<br>**12.4** Data Integration System Development -M. Kitsuregawa (20min)<br>**12.5** Ontology and Metadata -R. Shibasaki (20 min)<br>**12.6** Integrated Water Resources Management System -T. Koike (20 min) |
| 12:20<br>–<br>13:20 | LUNCH |
| 13:20<br>–<br>15:20 | **13. AWCI Implementation Planning**<br>**13.1** Objectives<br>**13.2** Convergence of Observation / Data Integration and Analysis / Information Sharing<br>**13.3** Capacity Building<br>**13.4** Country Activities |
| 15:20<br>–<br>15:50 | BREAK |

| | |
|---|---|
| 15:50 –<br>17:00 | **14. Discussion Summary and Way Forward** |
| 17:00 | ADJOURN |

## Appendix D

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