FINAL REPORT for APN PROJECT
CBA2009-02CMY-Ishida

APN
Asia-Pacific Network for Global Change Research
CAPaBLE

- Making a Difference –

Scientific Capacity Building & Enhancement for Sustainable Development in Developing Countries

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

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

Project Reference Number: CBA2009-02CMY-Ishida
Final Report submitted to APN

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OVERVIEW OF PROJECT WORK AND OUTCOMES

Non-technical summary

The Global Earth Observation System of Systems Asian Water Cycle Initiative Observation Convergence and Data Integration (GEOSS/AWCI/OCDI) project was initiated under the framework of GEOSS/AWCI to develop an information system for promoting the implementation of integrated water resources management (IWRM). The project follows up the data focus of the IIWaDATA project (ARCP2007-02CMY) and focuses on water cycle data collection, sharing, exchanging, and management at the regional level in Asia in cooperation with national governments, institutes and research communities, and also international organizations.

The GEOSS/AWCI/OCDI project involves 20 participating countries and 18 river basins in the Asia-Pacific region, and has an International Coordination Group (ICG) which consists of national representatives of participating countries, experts from research institutes, universities, and a space agency for planning and coordinating the GEOSS/AWCI/OCDI activities. It has four working groups (flood and landslides, drought and water scarcity, water quality, and climate change) to study common requirements and solutions of local issues. Demonstration projects in the mentioned basins are being implemented with support of various funding sources. A strong capacity building program has been developed and implemented to support the demonstration projects.

The GEOSS/AWCI/OCDI project has been significantly contributing to the development of the Data Integration and Analysis System (DIAS) that was launched in 2006 as part of the 3rd Basic Program for Science and Technology of Japan.

GEOSS/AWCI/OCDI has greatly contributed to the reception of the Japan Water Prize in 2010 for its contribution to international cooperation for water resource management.

Objectives

The aim is to develop an information system of systems for promoting the implementation of integrated water resources management (IWRM) through data integration and sharing as a basis for sound decision making of national water policies.

The project contributes to the AWCI objectives that include:

1. To develop Integrated Water Resources Management (IWRM) approaches;
2. 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;
3. To construct a comprehensive, coordinated and sustained observational system of systems, such as prediction systems and decision support capabilities, under the GEOSS;
4. 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.

Amount received and number years supported

The Grant awarded to this project was:
US$ 3 7,500 for Year 1 2008/2009:
US$ 3 7,500 for Year 2 2009/2010:

Activity undertaken

1. Series of meetings and workshops including representatives of participating countries, research institutes and international organizations, that have led to the:

- Implementation of the GEOSS AWCI Implementation Plan, in particular the data focus
- Implementation of the GEOSS AWCI Demonstration Projects at the nominated 18 river basins in the participating countries
- Development and implementation of the GEOSS AWCI Capacity Building program

2. DIAS data system development and implementation activities:
   The project has been contributing to the Data Integration and Analysis System (DIAS) implementation through activities that have led to provision of the GEOSS/AWCI demonstration river basin in-situ data by the member country representatives. These in-situ data have been requested for specific periods depending on possibilities of each country and demonstration project targets but at least spanning 2 years, preferably 2003 – 2004 that correspond to the enhanced observing period of the Global Energy and Water Cycle Experiment (GEWEX) Coordinated Enhanced Observing Period (CEOP) project. Most of the data have been submitted and quality checked and significant portion of the data have already been equipped with proper metadata to fulfill the high DIAS standards. These activities are continuing and the data have already been made accessible through the DIAS system as discussed in the main body of this report.

3. Organizing a water cycle sessions at the 3rd GEOSS Asia-Pacific Symposium in Kyoto, and 4th symposium in Bali, March, 2010, leading to discussing three thematic topics (Typhoon, cyclone, and induced floods; Drought; and Snow, glacier, and Glacier Lake Outburst Flood (GLOF)) and development of climate change impact assessment and adaption for demonstration river basins.

Results

GEOSS/AWCI/OCDI has been continuing as a great success of a regional cooperative framework for monitoring and predicting water related disasters and promoting efficient use of water resources. The International Coordination Group (ICG) meetings (4th ICG in Kyoto, February 2009, 5th ICG in Tokyo, December 2009, 6th ICG in Bali, March 2010 and 7th ICG in Tokyo, October 2010, respectively) were very well attended by scientists, water resources managers and policy- and decision-makers from 20 Asian countries, discussing implementation of the GEOSS/AWCI Implementation Plan, particularly the Demonstration Project (DP), Working Group (WG) activities, and a Capacity Building (CB) program.

As for data integration, more than 70% of expected demonstration basin data has been submitted and quality-checked and multiple studies have been carried out at these basins as part of the Demonstration Projects. Number of the Demonstration Projects being implemented with support from various funding sources is increasing. In addition, plenty of further data including in-situ and satellite observation data and model outputs is now available at DIAS, which was opened to public in 1 October 2010, and can be exploited for implementing the GEOSS/AWCI activities. Also, detailed hydrological models have been developed for the DPs of four river basins (the Tone River (Japan), Meghna River (Bangladesh), Pampanga River (Philippines), and Huong River (Vietnam). The usage of distributed hydrological model showed significant advantage of such modeling technique for water resource management and disaster risk reduction. JAXA has greatly contributed to the implementation of the Demonstration Projects through its Space Applications for Environments (SAFE) initiative. JAXA is also developing cooperation with the Asian Development Bank (ADB) to carry out Technical Assistance (TA) projects in Bangladesh, Philippines, and Vietnam, which will support implementation of the Demonstration Projects in these countries.

The AWCI WG activities have been evolved to better support the Demonstration Projects and the Capacity Building Program. Concrete activity plan of the 4th WG on Climate Change Impact and Adaption, which was established in the 3rd AWCI ICG meeting in Beijing, December 2008, was

developed. The WGs (flood, drought, water quality, and climate change) actively participated in the discussion on climate change impact assessment and adaptation in three target topic areas: 1. Typhoon, cyclone, and induced floods, 2. Drought, and 3. Snow, glacier, and GLOF. These discussions resulted in an implementation plan of concrete activities aimed toward climate change impact assessment and adaptation (CCAA) studies. Owing to the well populated DIAS archive including the demonstration basin data, global datasets and in particular climate projection model outputs, opportunities have arisen for these studies.

The GEOSS/AWCI CB program continues in successful implementation of a number of training modules that are based on identified needs in the region as well as individual countries. The web-based interactive repository of available modules and proposed seminars that was developed by UNU is a very supportive tool that facilitates better coordination in planning the events. Also web tutorials of individual training modules are being prepared and will be available through this website. The proposed further direction of the CB program is toward integration of research, capacity development and applications including capacity development programs for training a large number of competent persons and higher education research.

With above excellent accomplishments and progress, the participants of the 4th GEOSS Asian Pacific Symposium held in March 10-12, 2010, in Bali, Indonesia, agreed on the statement to the GEO ministerial summit , Beijing, in November 2010.

"Message to the GEO ministerial summit:

The Summit is requested to recognize the direction and achievements by GEOSS/AWCI as one of the most effective regional approaches for climate change adaptations and to endorse its activities in each country and the Asia-Pacific region in improving the efficiency of operational water resources management."

Relevance to APN's Science Agenda and objectives

Science Agenda – GEOSS/AWCI/OCDI focuses on specific science issues related to impacts of climate and water cycle variability on water resources as a way of addressing capabilities for sustainable development. It specifically contributes to the development and implementation of an effective and robust data integration scheme employed by DIAS, which is built up on existing techniques and reflects user requirements. This scheme is very supportive in addressing the said scientific and societal issues, and has also been acknowledged for contributing to the effective transfers of scientific knowledge to decision-makers in the Asian region. The project also exploits possibilities of advanced tools such as downscaling techniques coupled with hydrological models to address the IWRM issues in the demonstration basins in the GEOSS/AWCI countries.

Self evaluation

The project has been very successful in executing the GEOSS/AWCI Implementation Plan (http://monsoon.t.u-tokyo.ac.jp/AWCI/). Data collection, data quality check and data uploading were made for 18 river basins which form basis for data analysis and IWRM. Metadata and data collection and data quality check are progressing well. Applications of newly developed distributed hydrological models to the demonstration river basins showed significant advantage of such modeling technique for water resource management and disaster risk reduction. Number of demonstration projects, which are supported by various funding sources increased significantly. The project activities have expanded to cope with the climate change impact assessment and adaptation in the Asia-Pacific region. Efforts to match capacity building requirements of member countries and resources available within the AWCI communities are continuing. Concept of training modules which can be integrated for a training package to meet the capacity building requirements has been elaborated and is being implemented. Development of training modules and their integration for the

demonstration projects are being implemented. End-to-end system from observation to sound decision making for societal benefits for water resource management has been designed and is being implemented through the demonstration projects.

Potential for further work

The GEOSS/AWCI is a very challenging project to cover 18 river basins of 20 countries. With quite impressive progress in observation convergence and data integration with intensive cooperation of members, a basis for data analysis, model development and evaluation, and applications for demonstration projects has been consolidated. Further progress of demonstration projects can be expected being supported by various related programs and funding sources. While data integration and pilot projects are progressing very well being supported by WGs and capacity building program, focus is being shifted toward climate change impact analysis and adaptation taking into consideration an end-to-end approach from observations to sound decision making.

An implementation plan for climate change impact assessment and adaptation study for demonstration river basins as new activities was proposed at the 6th GEOSS/AWCI ICG meeting in Bali, March 2010 and discussed and outlined at the 7th ICG meeting in Tokyo, October 2010. The proposed activities are described in the White Paper on the GEOSS/AWCI Climate Change Impact Assessment and Adaptation (CCAA) Activity that is provided in the Appendix of this report. The opportunity for these CCAA activities have emerged owing to the data integration capacities of the DIAS system that provides access to relevant global climate model projections of CMIP3 project, and in-situ and satellite observations. In addition, the strong cooperative framework of GEOSS/AWCI that involves governmental representatives and collaborates with policy and decision makers has a great potential for transferring methodologies and knowledge resulting from the research phase into operation for promoting the IWRM approach and preparing climate change adaptation strategies. Efforts on such transfer have begun through inviting and involving experts on socio-economic issues related to water resources in the GEOSS/AWCI activities.

Publications

1. International peer-reviewed journal

(1) Wang, L., T. Koike, K. Yang, and P. Yeh (2009), Assessment of a distributed biosphere hydrological model against streamflows and MODIS land surface temperature in the upper Tone River Basin, Journal of Hydrology, 377, 21-34.

(2) Wang, L., T. Koike, D. Yang, and K. Yang (2009), Improving the hydrology of the Simple Biosphere Model 2 and its evaluation within the framework of a distributed hydrological model, Hydrological Sciences Journal, 54(6), 989-1006.

(3) Wang, L., C. T. Nyunt, T. Koike, O. Saavedra, L. C. Nguyen, T. V. Sap (2010), Development of an integrated modeling system for improved multi-objective reservoir operation, Frontiers of Architecture and Civil Engineering in China, 4(1), 47-55.

(4) Tamura, T., and T. Koike (2010), Role of convective heating in the seasonal evolution of the Asian summer monsoon, *J. Geophys. Res.*, **115**, D14103, doi:10.1029/2009JD013418.

(5) Tamura, T., Taniguchi, K., Koike, T. (2010), The mechanism of upper tropospheric warming around the Tibetan Plateau at the onset phase of the Asian summer monsoon, *J. Geophys. Res.*, **115**, D02106, doi:10.1029/ 2008JD011678.

(6) Wang, L., Z. Wang, T. Koike, H. Yin, D. Yang, S. He (2010), The assessment of surface water resources for the semi-arid Yongding River Basin from 1956 to 2000 and the impact of land use change. Hydrological Processes, 24, 1123-1132.

2. Domestic (Japanese) peer-reviewed journal

(1) Patricia Ann Jaranilla-Sanchez, Lei Wang, Toshio Koike (2010), ENSO influence on the 1982-2000 hydrological properties of the Pantabangan-Carranglan Watershed, Philippines, Annual Journal of Hydraulic Engineering-JSCE, 54, 19-24.

(2) Shrestha, M., L. Wang, and T. Koike: Investigating the applicability of WEB-DHM to the Himalayan river basin of Nepal, Annual Journal of Hydraulic Engineering, JSCE Vol. 54,55-60, 2010.

(3) Kentaro AIDA, Toshio KOIKE and Jiancheng SHI: DEVELOPMENT OF MULTI-POLARIZATION SAR ALGORITHM FOR SOIL MOISTURE IN PADDY FIELD, CAMBODIA, Annual Journal of Hydraulic Engineering, JSCE Vol. 55, 2011. (*Accepted, under revision*) .(in Japanese)

3. Promotion Video

GEOSS Asian Water Cycle (2010)

This video was introduced at the 5th Earth Observation Summit, Beijing, 5th November, 2010

References

GEOSS/AWCI Home Page (http://monsoon.t.u-tokyo.ac.jp/AWCI/index.htm)
DIAS Data Gateway Website (http://www.editoria.u-tokyo.ac.jp/dias/link/portal/english_index.html)
JAXA SAFE Initiative Home Page (http://www.eorc.jaxa.jp/SAFE/index.html)
JAXA Web Tutorial Using Past Trainings in Field of RS/GIS
(http://web-tutorials.tksc.jaxa.jp/index.html)
GEOSS/AWCI Capacity Building Repository Website (http://unufms.net:8080/seaside/gcs/AWCI)
(*further references below the full report on Pg. 33*)

Acknowledgments

In addition to the support from APN, which made this 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; Asian Institute of Technology (AIT), Thailand; Kasetsart University, Thailand.

TECHNICAL REPORT

Preface

While the bountiful Monsoon rain is an essential source of water in Asia, the variation of the water cycle may cause droughts and floods, and consequently, may be responsible for enormous human and economic damages. Better understanding the mechanism of this variation and improvement of its predictability is crucial for mitigating water-related disasters and promoting efficient use of water resources. Good data are a basis for any science and research activity and their accessibility is often a constraining factor. Accordingly, efforts aiming at effective collection, archiving, quality-checking, integration, and dissemination of water-related data and producing relevant information for decision-making are of tremendous importance for water cycle research and integrated water resources management in Asia.

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1. Introduction

1.1 Water Related Issues in Asia

The Asian monsoon, which is the largest water circulation system in the world, provides substantial water resources which supports the food production, energy generation, and even transportation in Asia, but also causes serious water related problems due to the large seasonal and inter-annual variability of the monsoon rainfall.

Floods, often associated with landslides and mudflows 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. In addition, a large seasonal and inter-annual variation of the Asian water cycle 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 as well as other factors like insufficient industry and sewage water treatment system, in particular in highly urbanized areas, also affects the water quality and ecosystem. 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 Asia.

Moreover, impacts of climate change on water resources and water-related hazards in Asia have already become evident, as both scientific observations and the experiences of the region's inhabitants confirm. Heavier rainfall events and larger interannual variations are predicted to be likely to happen according to the "radiative-convective equilibrium". The climate change is considered to make significant impacts on such the vulnerable region of Asia, where the percentage of completion of river developments is still critically low compared to the high potential of water-related hazards.

1.2 GEO, GEOSS, and GEOSS/AWCI

The need "to promote the development and wider use of Earth observation technologies" was proclaimed at the World Summit on Sustainable Development (WSSD) in 2002. 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. 1). "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*.

The water related issues in Asia 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 that are not only common within the region but also specific for the region. This was recognized by the 1st Asian Water Cycle Symposium (AWCS) held in Tokyo, November 2005, and an initiative at the regional level under the global GEOSS framework was proposed that would make maximum use of the Earth observations and the advanced capabilities provided by GEOSS to address

the water related issues in Asian countries. Subsequently through the APN-supported project IIWaDATA (Koike et al., 2008), the GEOSS Asian Water Cycle Initiative (GEOSS/AWCI: http://monsoon.t.u-tokyo.ac.jp/AWCI/) was formally established in January 2007.

Since its establishment, GEOSS/AWCI has been directly contributing to the GEOSS Water socio-benefit area through the Water tasks; namely WA-06-02: Droughts, Floods and Water Resource Management, WA-06-07: Capacity Building for Water Resource Management, WA-08-01: Integrated Products for Water Resource Management and Research. The GEOSS/AWCI has been acknowledged as one of the early GEOSS achievements for the 2007 GEO Cape Town Ministerial Summit and as one of the six success story showcases for the 2010 GEO Beijing Ministerial Summit.

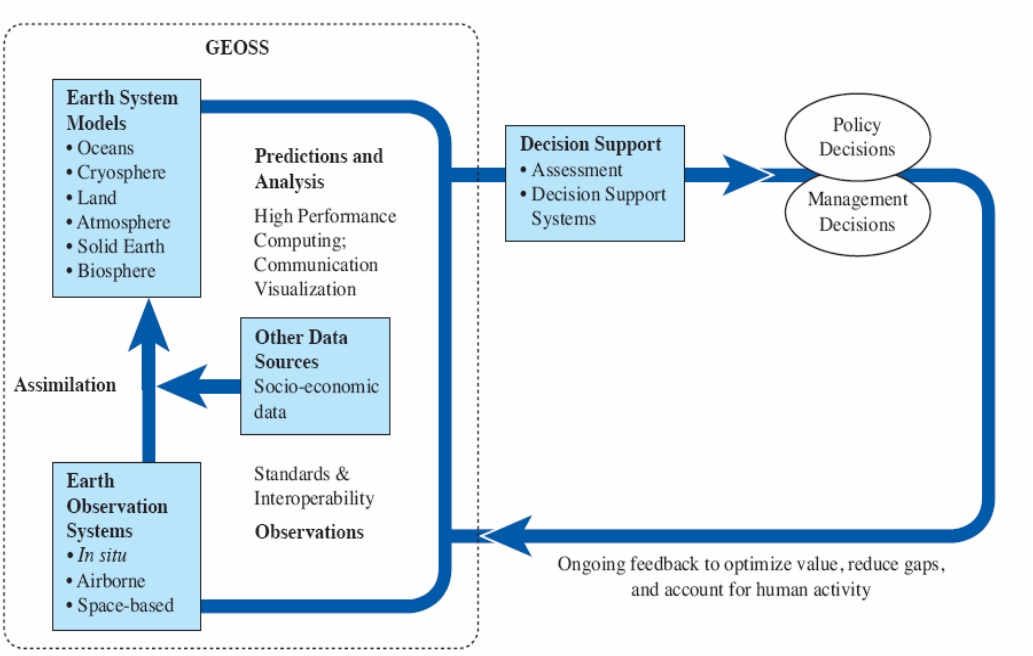


Figure 1: Structure of GEOSS Functions

1.3 Background of the GEOSS/AWCI/OCDI Project and Objectives

The compliance of GEOSS/AWCI 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. After successful establishment of GEOSS/AWCI, endorsing its Implementation Plan and launching its activities in 2007, it became evident that special efforts would be needed that would be dedicated to the data issues, in particular observation convergence and data integration in order to support the GEOSS/AWCI research activities and practical exploitation of the gained knowledge that would led to development and implementation of integrated water resources management approaches. Building up on the existing projects and activities dealing with the data acquisition, management, archiving, and integration and through cooperation of relevant organizations (JAXA, UT), the GEOSS/AWCI/OCDI project was proposed with following goals and objectives:

Guiding goals:

1. To develop 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.

2. 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.

Specific objectives:

1. 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;
2. To construct a comprehensive, coordinated and sustained observational system of systems, such as prediction systems and decision support capabilities, under the GEOSS;
3. 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.
4. To develop Integrated Water Resources Management (IWRM) approaches;

2. Methodology

2.1 GEOSS/AWCI framework, goals, and approaches

The GEOSS/AWCI/OCDI project has taken advantage of an effective regional collaborative framework that has evolved under the GEOSS/AWCI through a series of meetings and workshops. The GEOSS AWCI goals and strategic implementation have been 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.

The GEOSS/AWCI has been developed based upon the 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 initially three WGs including: (i) Flood and Landslides, (ii) Drought and Water Scarcity, and (iii) Water Quality. Later the fourth WG on Climate Change Adaptation has been added. 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 (Fig. 2, Fig. 3). Another key feature of GEOSS AWCI is "adopting and adapting existing capabilities and close collaboration with related on-going projects".

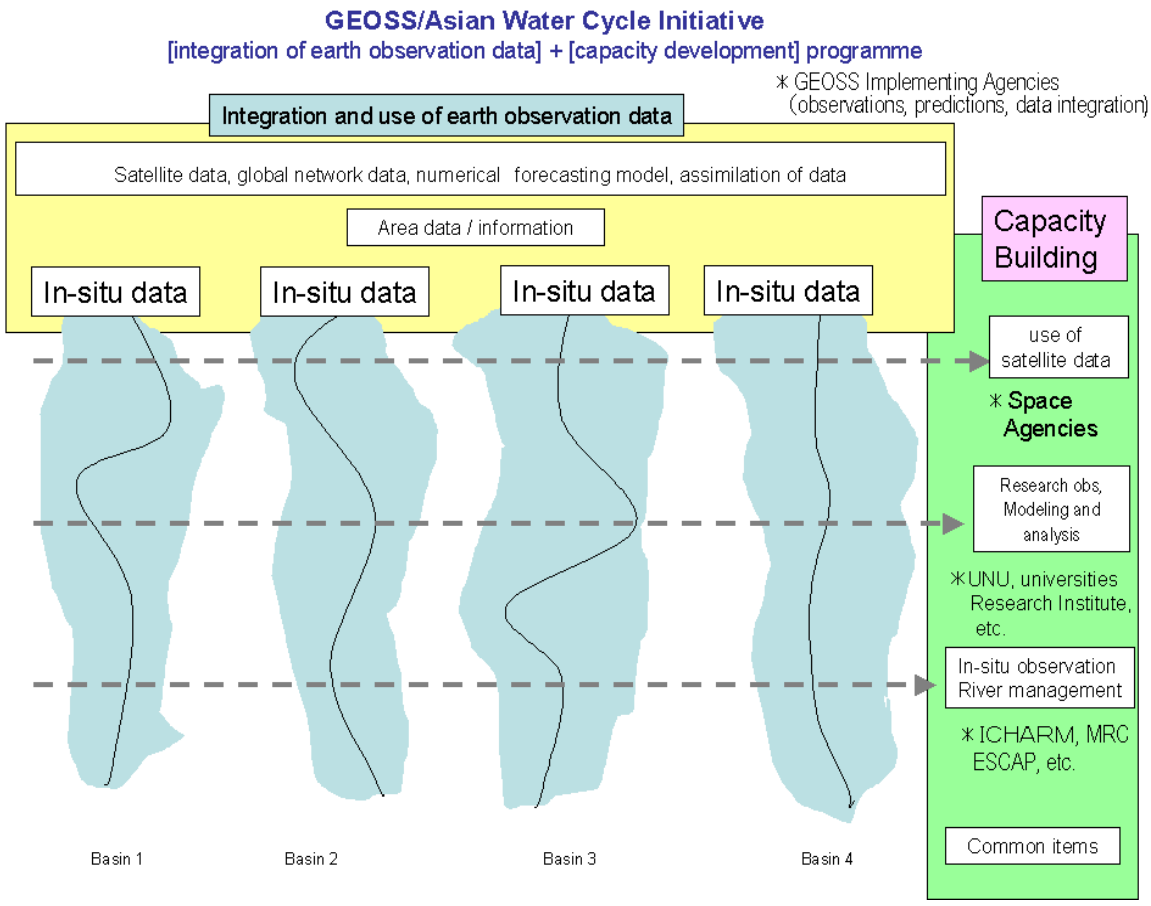


Figure 2: GEOSS AWCI Structure

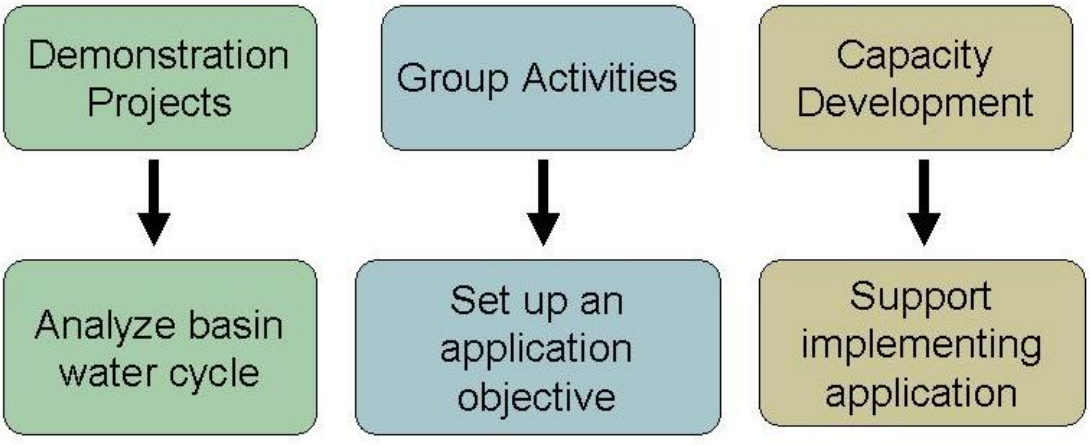


Figure 3: Linkages among GEOSS/AWCI demonstration projects, working group activities and capacity development.

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. Up to now, seven ICG meetings have been held out of which the following five events were held for the GEOSS/AWCI/OCDI under the GEOSS/AWCI/OCDI project.

3rd ICG in Beijing, October 2008
4th ICG in Kyoto, March 2009
5th ICG in Tokyo, December 2009
6th ICG in Bali, March 2010
7th ICG in Tokyo, October 2010

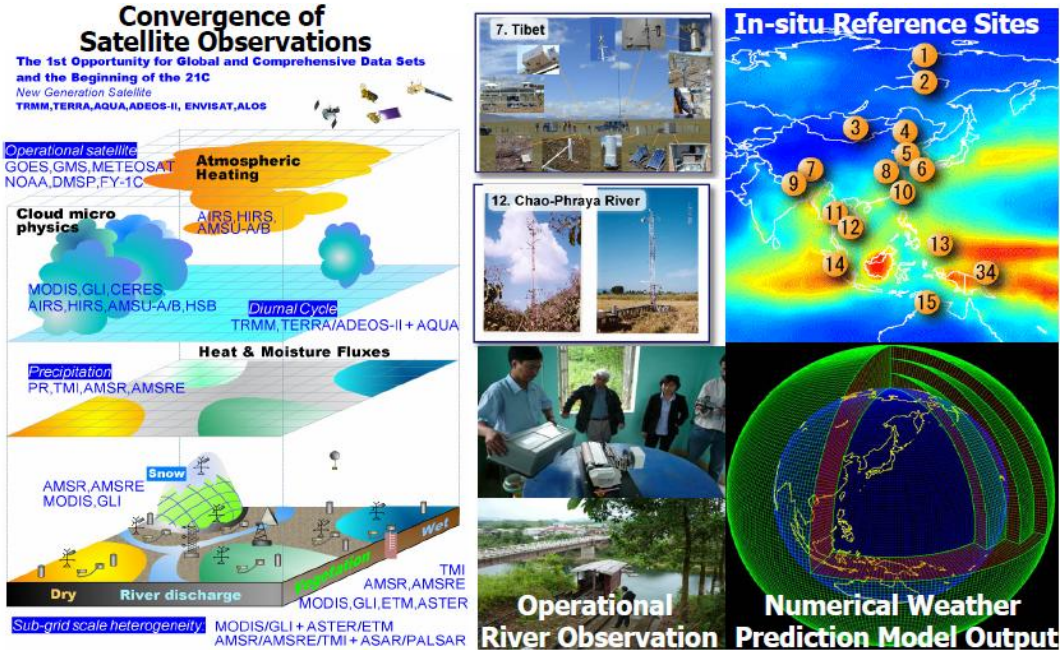


Figure 4: GEOSS/AWCI Observation Convergence

2.2 Observation Convergence, Data Integration, and DIAS

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 has been 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).

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.

The OCDI project has been implementing this approach under the GEOSS/AWCI in cooperation with DIAS, JAXA, and 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. Using the said web-based data upload and QC system, river basin data providers have been submitting data, checking their quality, and registering associated metadata to the DIAS system. Accordingly, the DP river basin data can be combined with the data provided by CEOP and other relevant data providers for comprehensive hydrological and water resources studies.

Data Integration and Analysis

As originally produced by the various sources, the data is in a wide variety of formats and structures and thus data management systems are needed 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 also 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 response to this need, CEOP had developed a prototype data integration, analysis, and dissemination system 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 was opened to public on 1 October 2010 (http://www.editoria.u-tokyo.ac.jp/dias/link/portal/english_index.html), is now functioning as the GEOSS/AWCI archive with data integration and analysis functions (Fig. 5). JAXA has contributed more than 2 millions scenes of various satellite data (Fig. 6). Specialized system architecture enables the management of large amounts of complex Earth Observation data in an information-rich era.

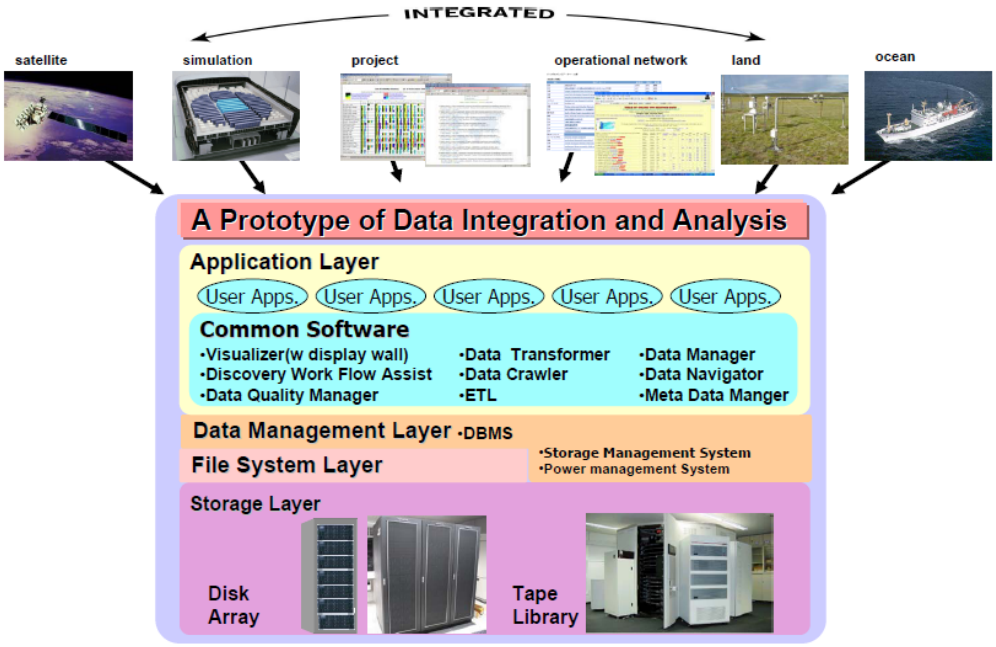


Figure 5: GEOSS AWCI Data Integration and Analysis System (DIAS)

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.

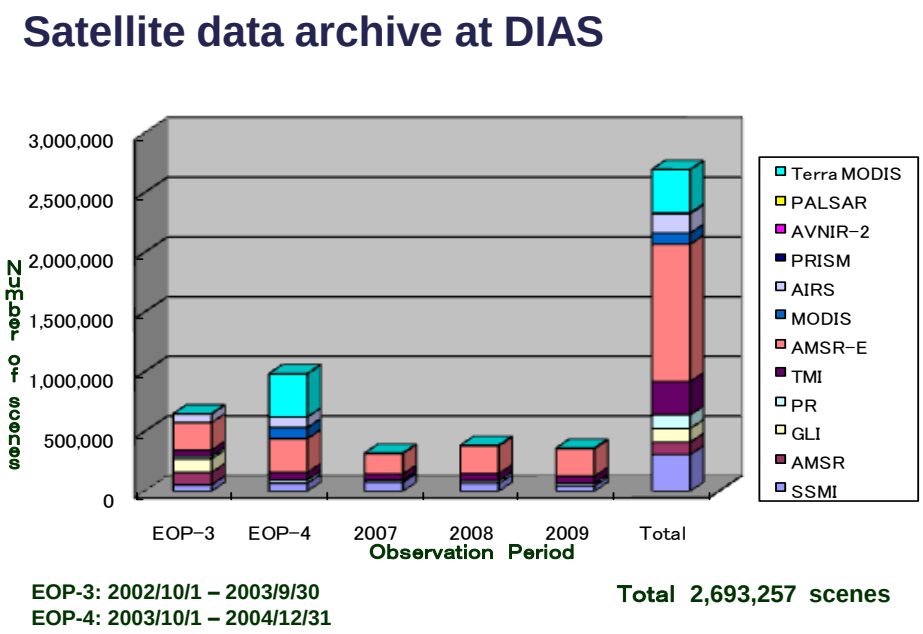


Figure 6: Satellite data archive at DIAS

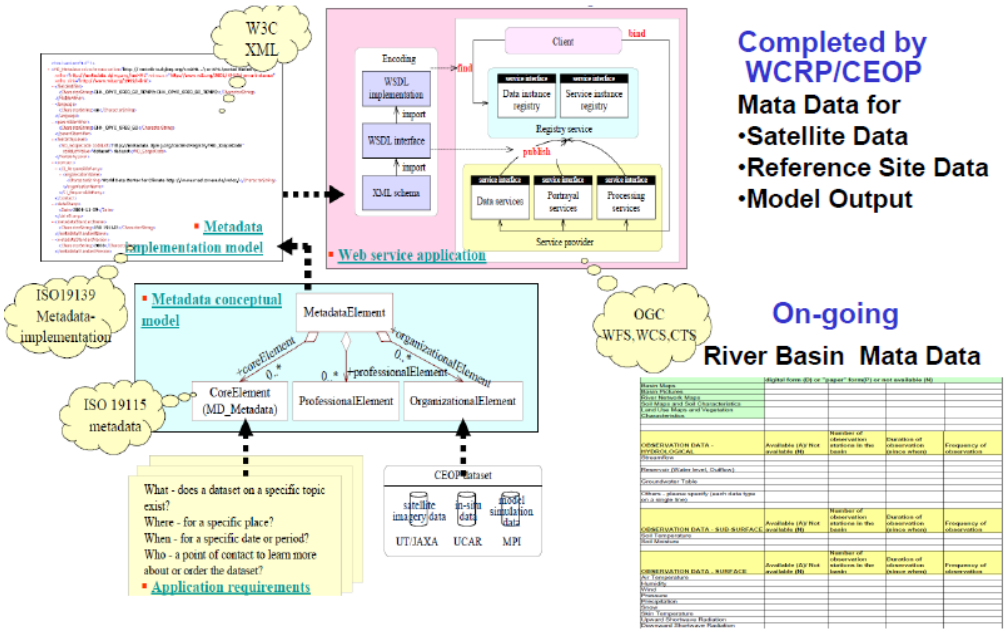


Figure 7: GEOSS AWCI Interoperability Arrangement

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 7. 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.

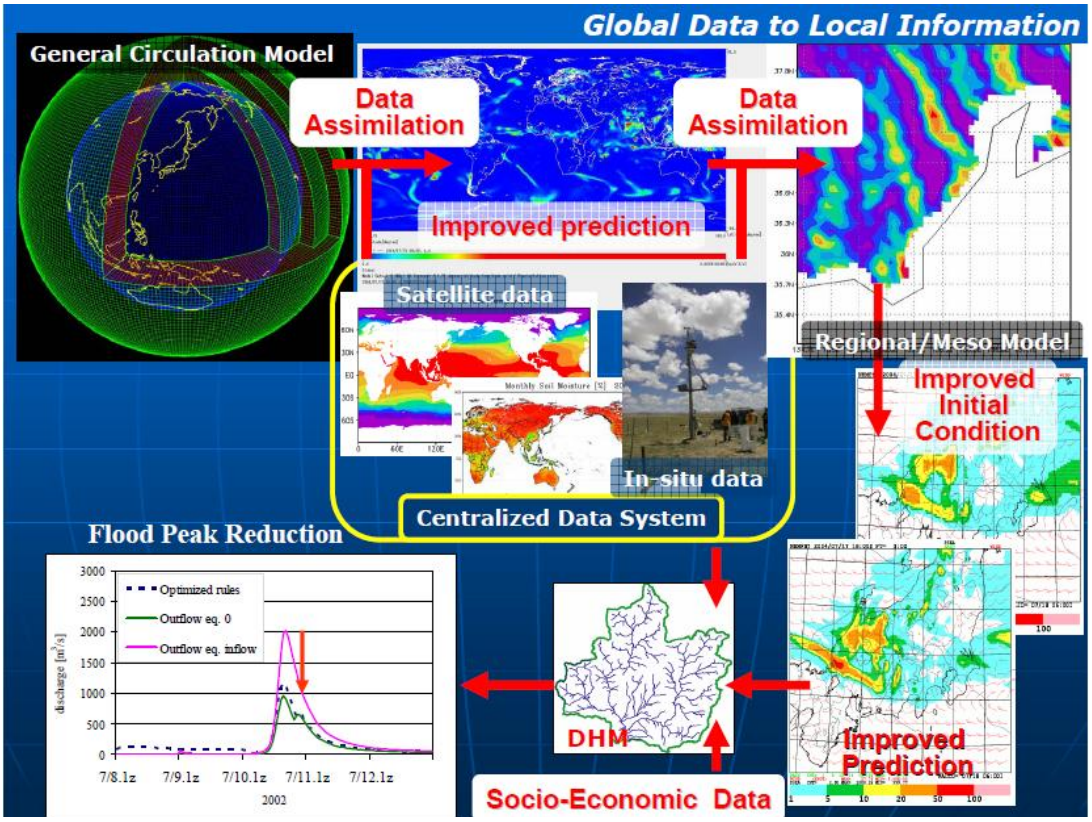


Figure 8: GEOSS AWCI Downscaling Process

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. 8). 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). 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.

2.3 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, stream flow, 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 have been selected as DP targets. Locations are shown in Figure 9. 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) <u>Observation system</u>

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) <u>Models, GIS, Data Integration Systems, and Prediction Systems</u>

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.

Figure 9: AWCI Demonstration Project river basins

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 Demonstration Project 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	Gilgit	26,200	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

More information on the DP river basins is available through the GEOSS/AWCI website at: http://monsoon.t.u-tokyo.ac.jp/AWCI/index.htm.

2.4 Capacity Building

Goal and Objectives

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

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.
4) Climate change assessment methods and adaptation strategies.

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 have been combined to reflect the relevant emphasize and coverage for each target group. The OCDI project has focused on the capacity development in the field of data acquisition, management, archiving, integration, and dissemination.

Methodology

The program has been and continue to be developed and used concurrently in support of various GEOSS/AWCI activities including applications in 18 Asian river basins proposed to be studied within demonstration projects and the Climate Change Assessment and Adaptation (CCAA) Study proposed in 2010. 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 advising 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 has been coordinating 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 through 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.

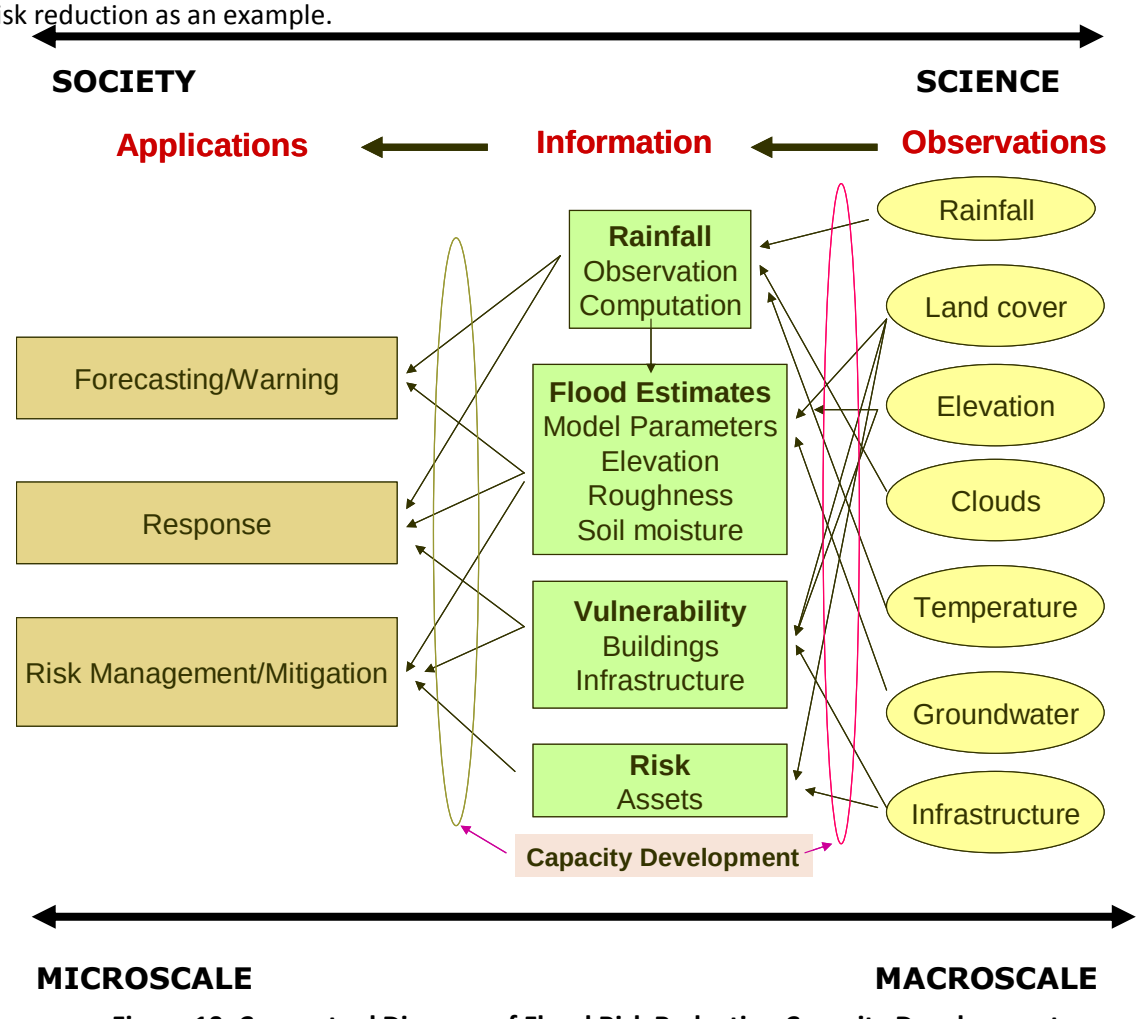
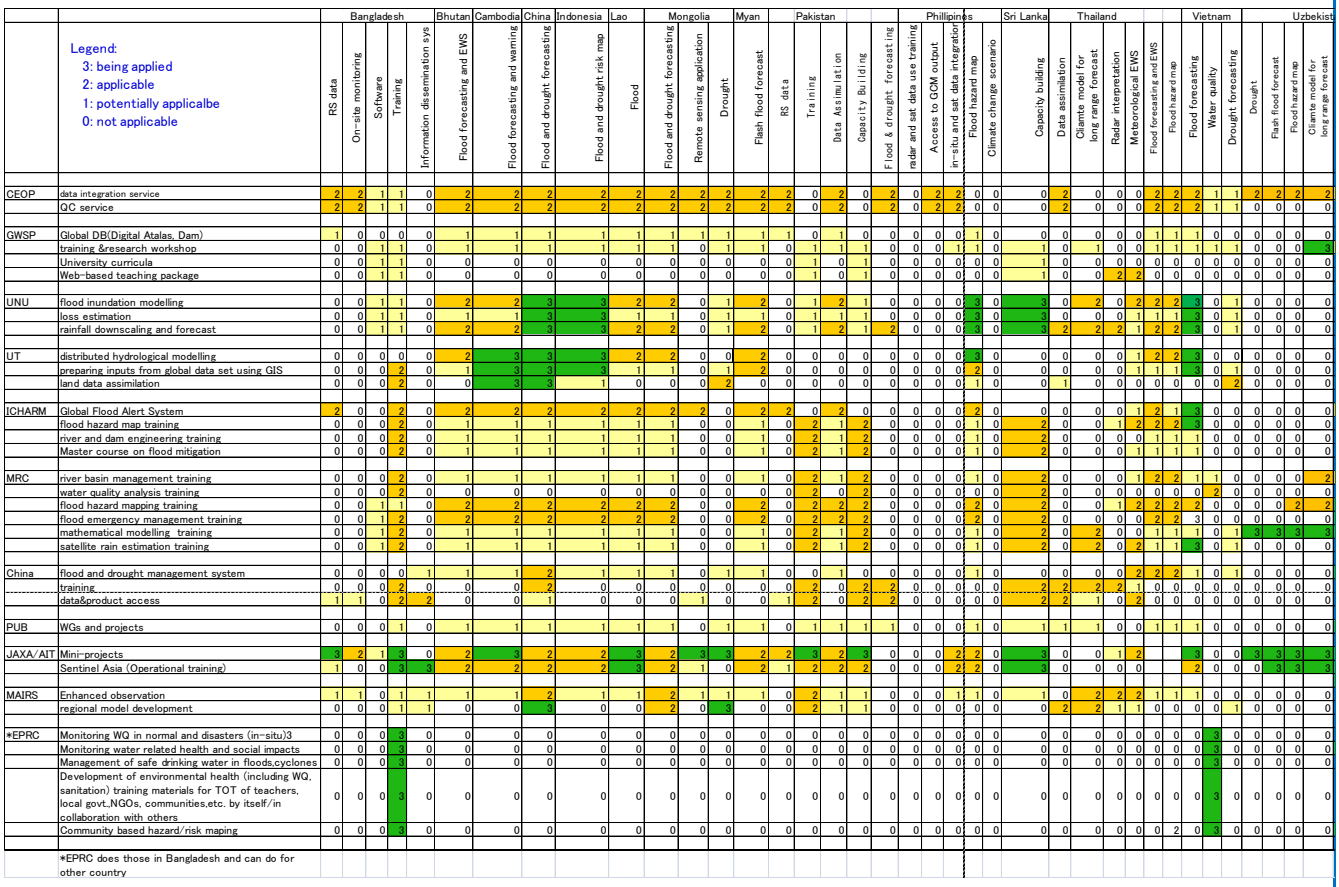


Figure 10: Conceptual Diagram of Flood Risk Reduction Capacity Development



		Bangladesh				Bhutan	Cambodia	China	Indonesia	Lao	Mongolia			Myan	Pakistan				Phillipines			Sri Lanka	Thailand					Vietnam				Uzbekist
	Legend: 3: being applied 2: applicable 1: potentially applicalbe 0: not applicable	RS data	On-site monitoring	Software	Training	Information dissemination sys	Flood forecasting and EWS	Flood forecasting and warning	Flood and drought forecasting	Flood and drought risk map	Flood	Flood and drought forecasting	Remote sensing application	Drought	Flash flood forecast	RS data	Training	Data Assimulation	Capacity Building	Flood & drought forecasting	radar and sat data use training	Access to GCM output	in-situ and sat data integration	Flood hazard map	Climate change scenario	Capacity building	Data assimilation	Ollamte model for long range forecast	Radar interpretation	Meteorological EWS	Flood forecasting and EWS	Flood hazard map	Flood forecasting	Water quality	Drought forecasting	Drought	Flash flood forecast	Flood hazard map	Ollamte model for long range forecast
CEOP	data integration service	2	2	1	1	0	2	2	2	2	2	2	2	2	2	2	0	2	0	2	0	2	2	0	0	0	2	0	0	0	2	2	2	1	1	2	2	2	2
	QC service	2	2	1	1	0	2	2	2	2	2	2	2	2	2	2	0	2	0	2	0	2	2	0	0	0	2	0	0	0	2	2	2	1	1	0	0	0	0
GWSP	Global DB(Digital Atalas, Dam)	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0
	training &research workshop	0	0	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1	1	0	0	0	1	1	0	1	0	1	0	0	1	1	1	1	1	0	0	0	1
	University curricula	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Web-based teaching package	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	2	2	0	0	0	0	0	0	0	0	0
UNU	flood inundation modelling	0	0	1	1	0	2	2	3	3	2	2	0	1	2	0	1	2	1	0	0	0	0	3	0	3	0	2	0	2	2	2	3	0	1	0	0	0	0
	loss estimation	0	0	1	1	0	1	1	3	3	1	1	0	1	1	0	1	1	1	0	0	0	0	3	0	3	0	0	0	1	1	1	3	0	1	0	0	0	0
	rainfall downscaling and forecast	0	0	1	1	0	2	2	3	3	2	2	0	1	2	0	1	2	1	2	0	0	0	3	0	3	2	2	2	1	2	2	3	0	1	0	0	0	0
UT	distributed hydrological modelling	0	0	0	0	0	2	3	3	3	3	2	2	0	0	2	0	0	0	0	0	0	0	3	0	0	0	0	0	1	2	2	3	0	0	0	0	0	0
	preparing inputs from global data set using GIS	0	0	0	2	0	1	3	3	3	1	1	0	1	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	1	3	0	1	0	0	0	0
	land data assimilation	0	0	0	2	0	0	3	3	1	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0
ICHARM	Global Flood Alert System	2	0	0	2	0	2	2	2	2	2	2	2	0	2	2	0	2	0	0	0	0	0	2	0	0	0	0	0	1	2	1	3	0	0	0	0	0	0
	flood hazard map training	0	0	0	2	0	1	1	1	1	1	1	0	0	1	0	2	1	2	0	0	0	0	1	0	2	0	0	1	2	2	2	3	0	0	0	0	0	0
	river and dam engineering training	0	0	0	2	0	1	1	1	1	1	1	0	0	1	0	2	1	2	0	0	0	0	1	0	2	0	0	0	0	1	1	1	0	0	0	0	0	0
	Master course on flood mitigation	0	0	0	2	0	1	1	1	1	1	1	0	0	1	0	2	1	2	0	0	0	0	1	0	2	0	0	0	1	1	1	1	0	0	0	0	0	0
MRC	river basin management training	0	0	0	2	0	1	1	1	1	1	1	0	0	1	0	2	1	2	0	0	0	0	1	0	2	0	0	0	1	2	2	1	1	0	0	0	0	2
	water quality analysis training	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0
	flood hazard mapping training	0	0	1	1	0	2	2	2	2	2	2	0	0	2	0	2	2	2	0	0	0	0	2	0	2	0	0	1	2	2	2	2	0	0	0	0	2	2
	flood emergency management training	0	0	1	2	0	2	2	2	2	2	2	0	0	2	0	2	2	2	0	0	0	0	2	0	2	0	0	0	0	2	2	3	0	0	0	0	0	0
	mathematical modelling training	0	0	1	2	0	1	1	1	1	1	1	0	0	1	0	2	1	2	0	0	0	0	1	0	2	0	2	0	0	1	1	1	0	1	3	3	3	3
	satellite rain estimation training	0	0	1	2	0	1	1	1	1	1	1	0	0	1	0	2	1	2	0	0	0	0	1	0	2	0	2	0	2	1	1	3	0	1	0	0	0	0
China	flood and drought management system	0	0	0	0	1	1	1	2	1	1	1	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	2	2	1	0	1	0	0	0	0
	training	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	2	0	2	2	0	0	0	0	0	2	2	2	2	1	0	0	0	0	0	0	0	0	0
	data&product access	1	1	0	2	2	0	0	1	0	0	0	1	0	0	1	2	0	2	2	0	0	0	0	0	2	2	1	0	2	0	0	0	0	0	0	0	0	0
PUB	WGs and projects	0	0	0	1	0	1	1	1	1	1	1	0	1	1	0	1	1	1	1	0	0	0	1	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
JAXA/AIT	Mini-projects	3	2	1	3	0	2	3	2	2	3	2	3	3	2	2	3	2	3	0	0	0	2	2	0	3	0	0	1	2			3	0	0	3	3	3	3
	Sentinel Asia (Operational training)	1	0	0	3	3	2	2	2	2	3	2	1	0	2	1	2	2	2	0	0	0	2	2	0	3	0	0	0	0			2	0	0	0	3	3	3
MAIRS	Enhanced observation	1	1	0	1	1	1	2	1	1	2	1	1	1	0	2	1	1	0	0	0	0	1	1	0	1	0	2	2	2	1	1	1	0	0	0	0	0	0
	regional model development	0	0	0	1	1	0	0	3	0	0	2	0	3	0	0	2	1	1	0	0	0	0	0	0	0	2	2	1	1	0	0	0	0	1	0	0	0	0
*EPRC	Monitoring WQ in normal and disasters (in-situ)3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
	Monitoring water related health and social impacts	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
	Management of safe drinking water in floods,cyclones	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
	Development of environmental health (including WQ, sanitation) training materials for TOT of teachers, local govt.,NGOs, communities,etc. by itself/in collaboration with others	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
	Community based hazard/risk maping	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0
	*EPRC does those in Bangladesh and can do for other country																																						

Figure 11: GEOSS/AWCI Capacity Building Needs vs. Rsources Matrix

Needs vs Resources analysis

Capacity building needs and requirements are being regularly analyzed from discussions and presented material at the ICG meetings. At the same time, resources available in the AWCI participating agencies are also surveyed to see how needs can be met by the available resources. The analysis is indicating that the portion of the needs met by the resources has been increasing. The analysis has also suggested that it would be possible and beneficial to plan training sessions to be held immediately after the ICG meetings or as a part of these. Such events took place as follows:

(5th ICG meeting, Tokyo, December 2009)
Joint Training Workshop on the Application of Remote Sensing Products on Drought Monitoring in Asia

(6th ICG meeting, Bali, March 2010)
Short training course “Data quality check and meta data registration”
Short training course “Flood management”

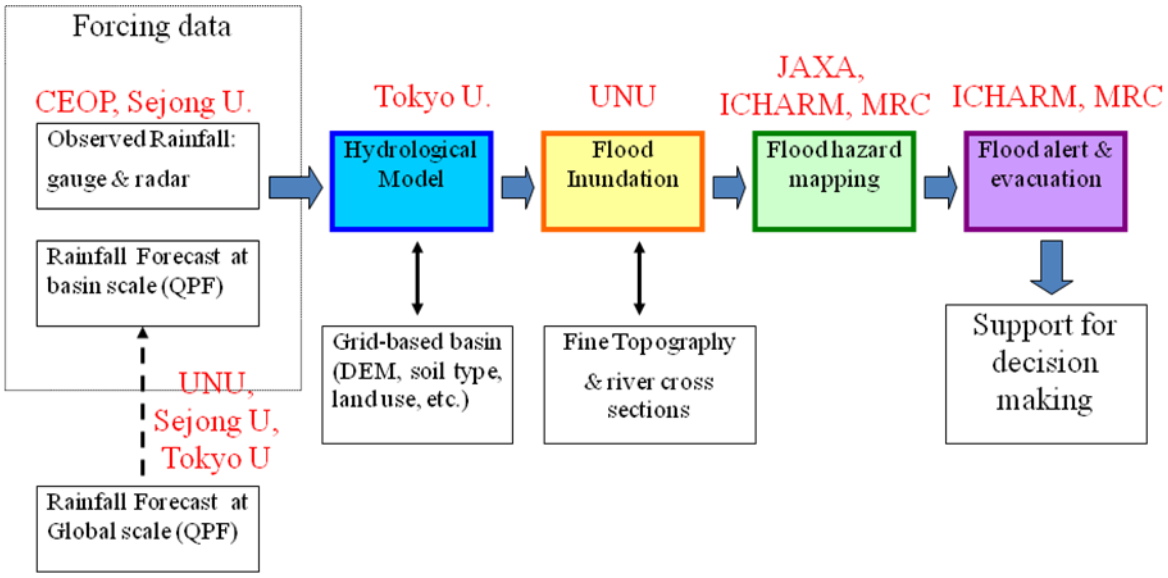


Figure 12: GEOSS/AWCI module based capacity building program

Module based capacity building program

Capacity building needs vs. resources analysis lead to a concept of module based capacity building program. This is a concept to meet specific capacity building with combination of capacity building modules provided by the AWCI agencies. The concept is shown in Figure 12.

On-line repository of available modules

An on-line repository of available training modules had been devised by the UNU team and could be accessed and edited by all AWCI members (http://unufms.net:8080/seaside/gcs/AWCI). It includes a module information template for organizations to provide information on available training modules. Any proposed training module should include the following items:

1. Title
2. The component of the flood problem the module would solve
3. Suggested duration
4. Expected number of participants and the maximum number allowed
5. Data to be prepared by participants in advance
6. Type of facilities (please list OS and min. ram for PC machines)
7. Any background training the participants are expected to have
8. Resources to be prepared in country by hosting agencies to carry out training seminar
9. Any other materials providing detailed descriptions of the modules
10. Availability (tentative and if possible) schedule for 2009-2010 (2011)

Four basic types of training modules were recognized including:

- *Type A:* Multi-country teams, use local data sets, long duration, generally a two-phase program.
- *Type B:* Demonstration data set. Short duration and participants are multi-country teams.
- *Type C*: Site (local) data for training and application. Participants are all from the host country.
- *Type D*: Training using a demonstration data set in a country. Program is of short duration and participants are all from the host country.

2.5 Working Groups

As it was mentioned in Section 2.1, GEOSS/AWCI organizes four working groups, each of which covers both of the AWCI foci "observation convergence, data integration, information sharing" and "capacity building" and is strategically involved in demonstration projects.

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 local in-situ dataset under the scheme of GEOSS/AWCI. Specifically, the group has been addressing the following objectives: (i) continuing in-situ observations to get enough validation data; (ii) converting observations and data, both through space-borne platforms and data integration initiatives, to usable information for flood reduction; (iii) improvement of quantitative forecasts for coupled precipitation - flood-forecasting systems; (iv) facilitating risk assessment through the provision of scenarios and data for exposure estimation, validated with the archived & analyzed data; (v) developing capacity building tools for shifting the demonstration systems to operational.

Enhancement and utilization of regional cooperation using the resources and knowledge available at various specialized institutions has been a common practice. While a demonstration project of each member country is promoted according to its own specific objectives, identified problems in the demonstration projects are shared among the community and coped with through mutual cooperation. Information on resulting publications and other relevant materials is being collected and will be made available through the internet. Training programs on the use of tools and data (e.g. IFAS and GFAS training workshops in 2008 and 2009) is the basis for capacity development activities.

Drought and Water Scarcity WG

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.

The drought WG activities are closely linked with demonstration projects that primarily address hydrological drought phenomenon, i.e. lesser flow in streams than long-term average, yet other drought phenomena including meteorological, agricultural, and socio-economic droughts are closely related and can/will be covered by the drought-oriented DPs.

The group is working on a data bank including soil moisture, temperature and meteorological observation data from selected stations in Bangladesh, Mongolia, Pakistan, China, and Vietnam. In addition, supplementary data, in particular soil properties, are being collected where available. Further, the group is working on soil moisture retrieval and drought indices determination using remote sensing data, especially MODIS and AMSR-E data. Certain water quality issues associated with drought conditions have been identified and are the group plans to address some of these in collaboration with water quality group.

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 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.

A demonstration project in the Huong river basin in Vietnam had been initiated that focuses on sustainable water management in the basin and in particular in the Hue city including water quality issues under the flood conditions. In addition, a study on associations between drought and water quality in a rural coastal area in Bangladesh is being prepared and may be expanded to include climate change adaptation, health impacts, and other aspects if funds are available.

Climate Change WG

Climate Change WG was formed at the Beijing meeting in November 2008 its objectives include:

(i) historical observation data analysis for finding the evidence of climate change
(ii) future projections by GCM outputs from specific greenhouse gas emission scenarios, downscaling and hydrological model applications.

The focus is on the assessment of the impact on food security and water cycle. The group cooperates with the flood working group regarding capacity building for the data downscaling. A proposal of a climate change assessment project in the AWCI countries was submitted to APN ARCP 2009 and subsequently accepted (ARCP2010-13NMY: Climate Change Impact Assessment on the Asia-Pacific Water Resources under GEOSS/AWCI).

In addition, a new AWCI activity was proposed on Climate Change Assessment and Adaptation (CCAA) at the Bali meeting in March 2010 that involves all other working groups. The Climate Change group is leading and coordinating this effort.

3. Results & Discussion

3.1 Data Integration and Demonstration Projects (DPs)

Supported by the OCDI project activities, GEOSS/AWCI Demonstration Projects have achieved a significant progress since the beginning of their implementation in 2008. Updated status of the GEOSS/AWCI DP basins data submissions to the DIAS data system as well as the DP implementation progress are shown in Figure 13 and Table 2, respectively. More than 70% of expected demonstration basin data has been submitted and quality-checked and some of them have also complete metadata registered. JAXA has generated ALOS sensor (AVNIR-2, PRISM and PALSAR) path mosaic data sets covering 15 AWCI DP river basins. Multiple studies have been carried out at these basins using the submitted in-situ data and available satellite observations as well as model output data.

JAXA has greatly contributed to the implementation of the DPs through its Space Applications for Environments (SAFE) initiative. The SAFE aims at demonstrating usefulness to apply earth observation satellite datasets to solving local environmental issues and transferring the knowledge to the participating governmental agencies for practical use. Prototyping on water cycle and agriculture is being conducted in Cambodia in 2010, and prototyping onintegrated water resource management including flood risk reduction had been successfully finished in Vietnam and is being prepared in Pakistan. AXA is also developing cooperation with the Asian Development Bank (ADB) to carry out Technical Assistance (TA) projects in Bangladesh, Philippines and Vietnam. The TA projects will utilize earth observation satellite data for flood early warning system and also cellular phone to disseminate the warning information to the local residents, thereby contributing to the DPs in these countries.

#	Country	Basin Name	Data Period	#of Sta.	#of Elem.	Basic Info	Data Uploadin	Quality Control (%) 0 10 20 30 40 50 60 70 80 90 100	Tota	Meta Data
1	Bangladesl	Meghna	2003/01-2008/12	9 (Daily)	3 (Ta, Pr, Discharge)	Complete	Complete		0	
2	Bhutan	Punatsangchhu	1989/01-2008/12	16 (Daily)	2 (Pr, Discharge)	Complete	Complete		1	
3	Cambodia	Sangker	2003/12-2010/0	8 (Hourly)	1, 10 (Pr, AWS)	Complete	Complete		100	
4	India	Seonath	2000/06-2004/12	30 (Daily)	2 (Pr, Discharge)	Complete	Complete		88	
5	Indonesia	Mamberamo	1958/01-2007/12	3 (Daily) (Monthly)	5 (Ta, RH, Pr, sun, ET)	Complete	Complete		100	On.
6	Japan	Tone	2002/12-2004/12	16 (Hourly)	6 (Ta, WS, WD, Pr, sun, Dis)	Complete	Complete		100	Comp.
7	Korea	Upper Chungju-dam	2003/01-2004/12	68 (Daily)	6 (Ta, RH, WD, Pr, sun, Dis)	Complete	Complete		100	
8	Lao PDR	Sebangfai				Ongoing				
9	Malaysia	Langat	2003/01-2004/12	24 (Daily)	(Pr, Dis, Ta)	Complete	Complete			
10	Mongolia	Selbe	2004/01-2006/12	8 (Daily)	4 (Ta, WL, Dis, Pr,)	Complete	Complete			
11	Myanmar	Shwegyin	2003/01-2004/12	1 (Daily)	3 (WL, Dis, Pr,)	Complete	Complete		100	
12	Nepal	Bagmati	2003/01-2004/12	22 (Daily)	4 (Ta, RH, Pr, WS)	Complete	Complete		100	
13	Pakistan	Gilgit	2000/01-2008/12	17 (Daily)	6 (Ta, RH, WD, WD, Pr, Dis)	Complete	Complete		1	
14	Philippines	Pampanga	1961/10-2005/12	4 (Daily) (Monthly)	3 (Pr, Dis, WL)	Complete	Complete		0	
15	Sri Lanka	Kalu Ganga	2003/01-2004/12	12 (Daily)	2 (Pr, Dis)	Complete	Complete		100	On
16	Thailand	Mae Wang	2006/05-2008/12	14 (10min)	3 (Ta, Pr, WL)	Complete	Complete		100	On
17	Uzbekistan	Chirchik-Okhangara	2003/01-2004/12	18 (Daily)	13 (Ap, Ta, DueTa, RH, WS, Pr, SD, SkinT, Sun, Dis,Aqueous_Tension, Blanket of Snow	Complete	Complete		100	On
18	Vietnam	Huong	2003/12-2008/12	8(Hourly, every event)	2 (WL, Pr)	Complete	Complete		100	On

Figure 13: Data archiving status for demonstration

Table 2: Status of GEOSS/AWCI demonstration projects

	Country	Basin Name	Status		
			Partners	Topics	Fundings
1	Bangladesh	Meghna	MD/BMD, BUET, JAXA, ADB	Flood/Storm Alarming by Mobile Phone	Technical Assistance(TA) projec with ADB funding is being prepared.
2	Bhutan	Punatsangchhu	Hydro-met Services, UT	Supporting to GLOF Prediction	to be expected
3	Cambodia	Sangker	MOWRAM/DHRW, UT, JAXA	Water management and Local Water Circulation	APRSAF/SAFE prototyping is conducted by JAXA in 2010
4	India	Seonath			
5	Indonesia	Mamberamo			
		Citarum, Solo, Brantas	MPW, UT, ADB	Climate Change Adaptation	Technical Assistance(TA) projec with ADB funding is being prepared.
6	Japan	Tone	MLIT, UT	Optimization al the dam operation for flood control and water use	DIAS
7	Korea	Upper Chungju-dam	National Project	Climate Change Adaptation	
8	Lao PDR	Sebangfai			
9	Malaysia	Langat	National Project	Climate Change Adaptation	
10	Mongolia	Selbe	Institute of Meteorology and hydrology, Mongolia, National Geo information center, IHP-Japan	Water balance monitoring, Use of Remote senising for land cover changes	Sciense and technology foundation, Mongolia,
11	Myanmar	Shwegyin			
12	Nepal	Bagmati	considering snow, glaciar, GLOF		
13	Pakistan	Gilgit	TMD, UT	Monitoring and prediction capability of snow, glacier and soil moisture	APRSAF/SAFE protoyping is being prepared by JAXA
		Indus	FFC, WAPDA, KUT	Water resources management for climate change adaptation	to be expected from JICA
14	Philippines	Pampanga	PAGASA, UT	Optimization al the dam operation for flood control and water use	to be expected
15	Sri Lanka	Kalu Ganga	University of Peradeniya, United Nations University, Irrigation Dept, Meteorology Dept	Adaptation to extereme floods caused by climate change, Weather Modelling and downscaling by GCM	Reseach facilities by University of Peradeniya, Scholarships to researchers by UNU, Data from Irrigation and Meteorology Departments
16	Thailand	Mae Wang	GAME-T	Flood Early Warning System	JEPP by MEXT
17	Uzbekistan	Chirchik-Okhangaran			
18	Vietnam	Huong	NHMS, MAHASRI	forecasting, warning capability for Central Region	3.7 M USD (2008-2013)
			NHMS, UT/GCOE	Flood-Water Quality- Health Public Awareness	to be expected

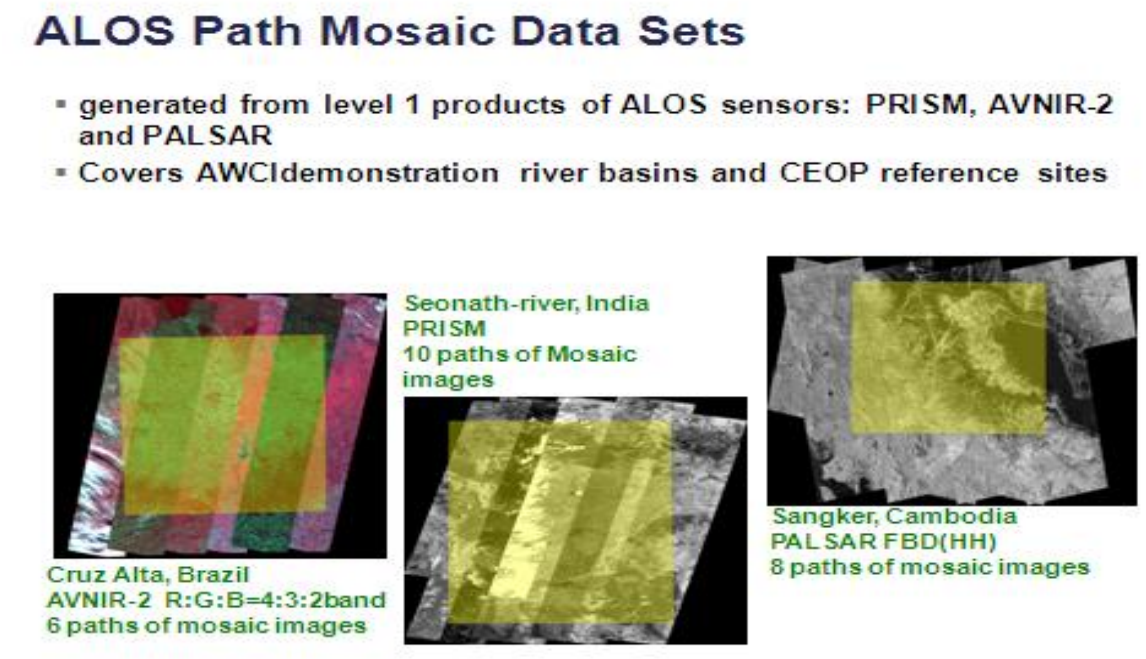


Figure 14: ALOS path mosaic data sets covering AWCI demonstration river basin

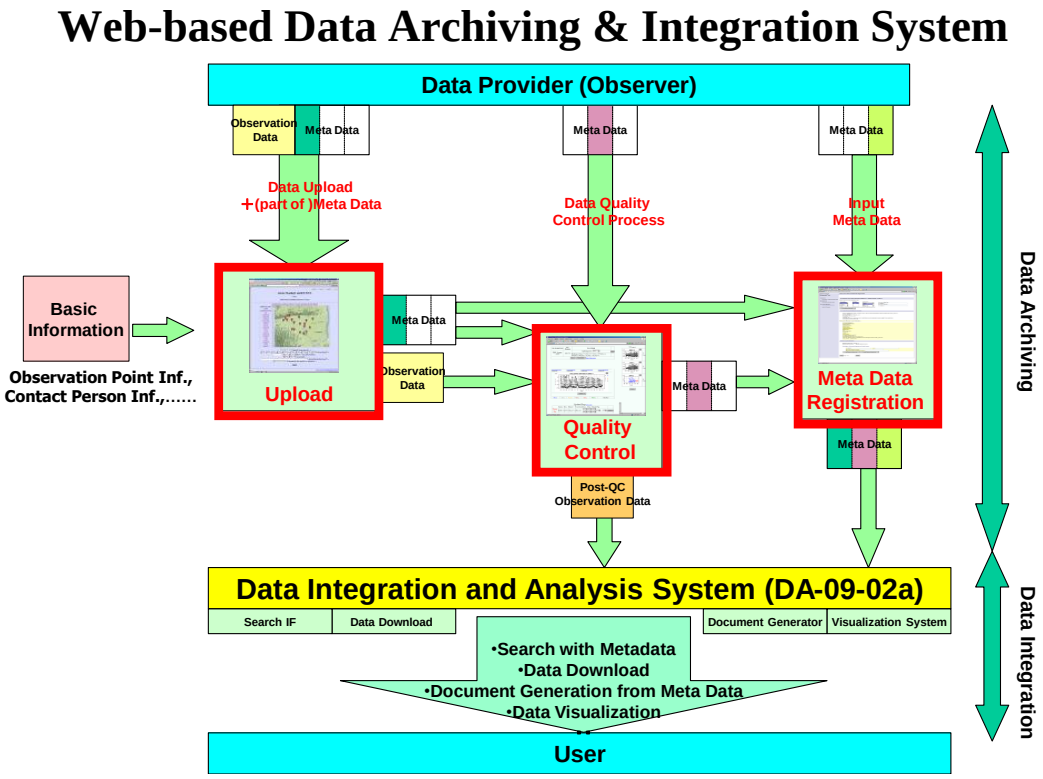


Figure 15: GEOSS/AWCI Data archiving and data integration process

In addition, opportunities for climate change assessment and adaptation studies in the AWCI participating countries were introduced that have arisen due to the DIAS stored data, especially climate projection models outputs.

3.2 Working Group activities

The 3rd GEOSS Asian Pacific Symposium, which was held in Kyoto, 4 – 6 February, 2009 included a special parallel session on "Water Cycle in the Asia-oceanic region" and a special interdisciplinary session on "Toward Actual Collaboration among Climate, Water Cycle, and Disasters" that were closely related to the AWCI activities.

Expanded collaboration among Water Cycle, Climate, and Disaster SBAs

Through the presentations and discussions of the GEOSS AP Symposium special "water" sessions, a possibility for expanded collaboration among the AWCI current activities focused on water cycle issues and other, closely related socio-benefit areas of GEOSS was sought. Water cycle and Climate related Disasters were identified as a suitable theme for such cooperation that is also common to all of the Asia-Pacific countries and the AWCI participating countries as it was reported at the meeting.

Four target topics and fields were defined based on the outcomes of the country reports on disasters that could be considered as the main areas for cooperation that included: (i) typhoon, cyclone, and induced floods, (ii) drought, (iii) cold surge, and (iv) snow, glaciers, and GLOF (glacial lake outburst flood). The 4th GEOSS/AWCI ICG meeting held in conjunction with the Symposium deliberated on each of the above target topics included the four items: (I) regional coordination framework; (ii) linkage to global coordination framework; (iii) building capacity; and (iv) planning strategy, considering the on-going and planned activities of AWCI. The discussion showed a great

interest in these activities oriented on water-related hazards, risks, and disasters as connected to the climate and its change, in particular due to the (i) typhoon – flood, (ii) drought, and (iii) snow, glacier and GLOF phenomena. The importance and possible severe impacts of cold surge and induced disasters was also recognized by the AWCI countries but was not identified as the highest priority theme to be addressed by AWCI at this stage.

Accordingly, the ensuing GEOSS/AWCI ICG meetings (5th, 6th, and 7th) addressed aside from the general AWCI working group and demonstration project progress and issues also the newly identified target topics emphasizing collaborative approach among Water, Climate, and Disaster SBAs.

1. Typhoon, cyclone, and induced floods

This theme has naturally strong linkage to the Flood working group and its targets and activities include: (i) to promote sharing state-of-the-art knowledge and capacity building so as to reduce and mitigate flood disasters caused by typhoons/cyclones, through the Flood WG activities of GEOSS/AWCI, (ii) to promote climate change impact analysis on flood disasters / water resources and policy-making for climate change adaptation strategy, (iii) to enhance integrated flood/water resources management based on combined use of a state-of-the-art model with GEOSS data and in-situ data, and (iv) to share long-term historical meteorological and hydrological databases to enhance climate change impact analyses and adaptation studies through GEOSS. To promote its activities the theme seek in particular for: (i) long-term historical extreme data (flood and low flow), (ii) most accurate DEM data (ASTER DEM), (iii) high quality in-situ hydrological data, and (iv) technical standards to determine a design flow (and/or rainfall) for planning river works.

The work on the above objectives was initiated in 2009 and has been progressing steadily as reported at the respective ICG meetings. The group have organized several workshops and training seminars on Integrated Flood Analysis System (IFAS) and Global Flood Alert System (GFAS) developed at the International Centre for Water Hazard and Risk Management (ICHARM), Japan in line with the objective (i). A plan for the climate change impact assessment and adaptation study focused on floods has been elaborated as described below in the Climate Change Assessment and Adaptation Study section as well as in the appended White Paper in Appendix 1. Collection of the hydrological and meteorological data continues through the AWCI demonstration projects focusing on flood issues.

2. Drought

The Drought theme has strong linkage with the Drought working group as it pursues four main objectives that include: (i) to build up a drought monitoring and researching network of member Asian countries, (ii) to share and improve the drought monitoring data/capability in various Asian countries, (iii) to make a collaboration with the demonstration projects studying climate change, and (iv) to help developing the early warning system of drought hazard in member countries. Work on objectives (i) and (ii) have considerably progressed using number of soil moisture observation stations in participating countries (Bangladesh, China, Mongolia, Pakistan, Vietnam) as well as satellite observation data (AMSR-E, MODIS). The data bank has been established and the soil moisture and temperature data from the selected stations in the participating countries are available upon request through the AWCI framework. The data from the bank has also been used in validation studies of the AMSR-E soil moisture measurement algorithm and in analyses of the obtained soil moisture and other data from a view point of a drought study in climate change.

The work on objectives (iii) and (iv) has begun in 2010 and is also progressing. The demonstration projects related to climate change and water quality associated with drought are being reviewed and

possibility for involvement are being identified to contribute to the assessment analyses and adaptation planning. In addition, numerical model studies are being carried out.

In addition, a proposal had been submitted to the 2009 APN CAPaBLE program and was approved in 2010. The project named "Drought monitoring system development by integrating in-situ data, satellite data and numerical model output" follows up on some of the OCDI project objectives on enhancing the observation convergence (in case of soil moisture data) and data integration and sharing.

3. Snow, Glacier, and GLOF

The Snow, Glacier, and GLOF theme had identified a need for scoping discussion among the involved members (Pakistan, Mongolia, Nepal, Bhutan, India, and Uzbekistan), related projects (CEOP-HE, CEOP Cold regions, ICIMOD), and experts in this field, which happened during the 6th and 7th ICG meetings and an associated teleconference. At the time of proposing the activities in 2009, the main constraints were (i) lack of longer-term, reliable in-situ observations of snow and glacier related quantities (snowfall, snow depth, snowmelt, glacier extent and its variability, glacier-melt…) and (ii) lack of appropriate hydrological models resolving snow and glacier associated phenomena (snowfall, snowmelt, glacier-melt) affecting the energy and water cycle in a basin.

Activities to overcome these constraints have been undertaken that have progressed considerably by October 2010. A physically-based methodology has been developed for estimating snowfall and snowcover using observed precipitation and temperature data and snowcover derived from satellite data (MODIS). Also a scheme for snowmelt has been incorporated in the Water and Energy Budget Distributed Hydrological Model (WEB-DHM), which makes the WEB-DHM applicable to snow regions. In addition, work has been initiated on coupling this snow hydrological model with a glacier model that addresses the glacier-melt processes. Moreover, possibilities of exploiting further satellite data to monitor snow and glacier extents and processes are being investigated. These advancements have allowed for implementation planning of the Climate Change Assessment and Adaptation study focusing on the cold region issues as described below.

3.3 Climate Change Assessment and Adaptation (CCAA) Study

End-to-end approach to climate change assessment and adaptation

At the 4th GEOSS/AWCI ICG meeting in Kyoto, February 2009, representatives of AWCI participating countries reported a wide range of water-related risks associated with climate change and introduced their country activities focused on climate change assessment and adaptation strategies. The need of adaptation measures were understood by their governments and dedicated national climate change adaptation plans and strategies have been proposed and their implementation set off. Through the ensuing discussions that continued at the 5th ICG meeting in Tokyo, December 2009, a coordinated Climate Change Assessment and Adaptation Study under the GEOSS/AWCI framework was proposed and the recently established Climate Change working group took leadership in this activity.

Importance of bridging policy, science, and engineering arenas for effective collaboration was recognized that is essential for improving the efficiency of operational water resources management and for climate change adaptation plans preparation and implementation. A scheme diagram of "End to end approach on climate change adaptation" was developed (Fig. 16) that shows integration of scientific, engineering, and socio-economic approaches as supported by works done by individual working groups and which is a basic scheme of the roadmap of the GEOSS/AWCI climate change assessment and adaptation efforts.

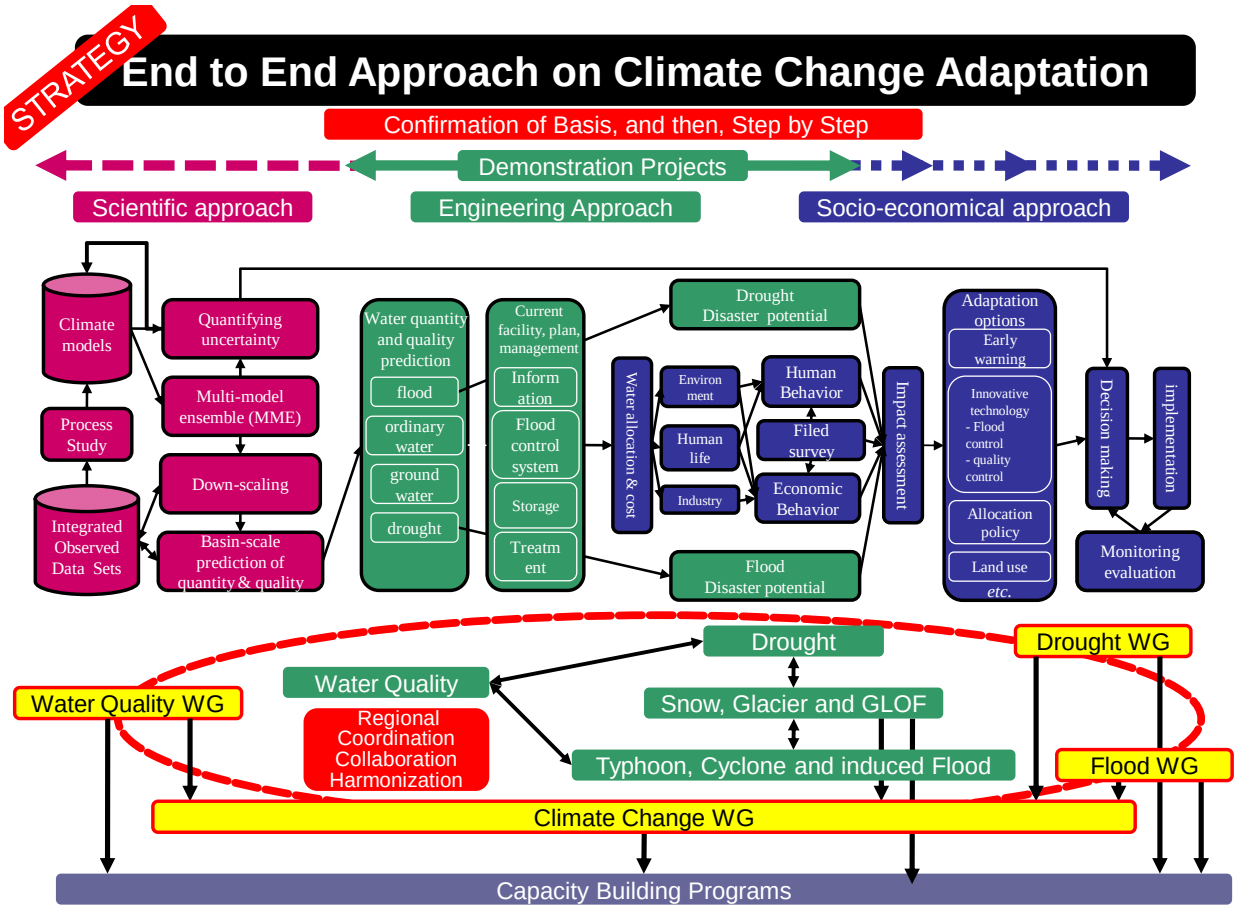


Figure 16: **Strategy of end-to-end approach to climate change adaptation**

Implementation Plan of the Climate Change Assessment and Adaptation Study

Implementation of CCAA activities was discussed in more details at the 6th ICG meeting in Bali, March 2010. It resulted in the flowchart displaying a possible approach toward assessing impacts of climate change using the CMIP3/20 and CMIP3/future climate projection scenarios (Fig. 17). Overall approach was divided in to three categories including (i) Climate drivers, (ii) Bio-physical drivers, and (iii) Socio-economic drivers. Subsequently, a White Paper on the AWCI CCAA study was drafted that was further discussed and elaborated at the 7th ICG meeting in Tokyo, October 2010 (see Appendix 1). The mission of this study is to set up a methodology for assessment of climate change impacts on water resources and water-related hazards that will be applicable in the AWCI countries and by using this methodology to carry out such assessment studies on the demonstration basins in each country focusing on the three identified areas including flood, drought, and snow, and glacier phenomena. The key objectives include:

1. To set up a methodology for quantifying uncertainty of climate projection focusing on forcing variables for hydrological models.
2. To set up a methodology for correcting bias of the projected forcing variables.
3. Produce projections of water resources and water hazard related variables by employing a proper hydrological model forced by the corrected projected forcings.
4. Assess the impacts of climate change on changes in water resources and water-related hazards.
5. Recommendations for adaptation strategy.

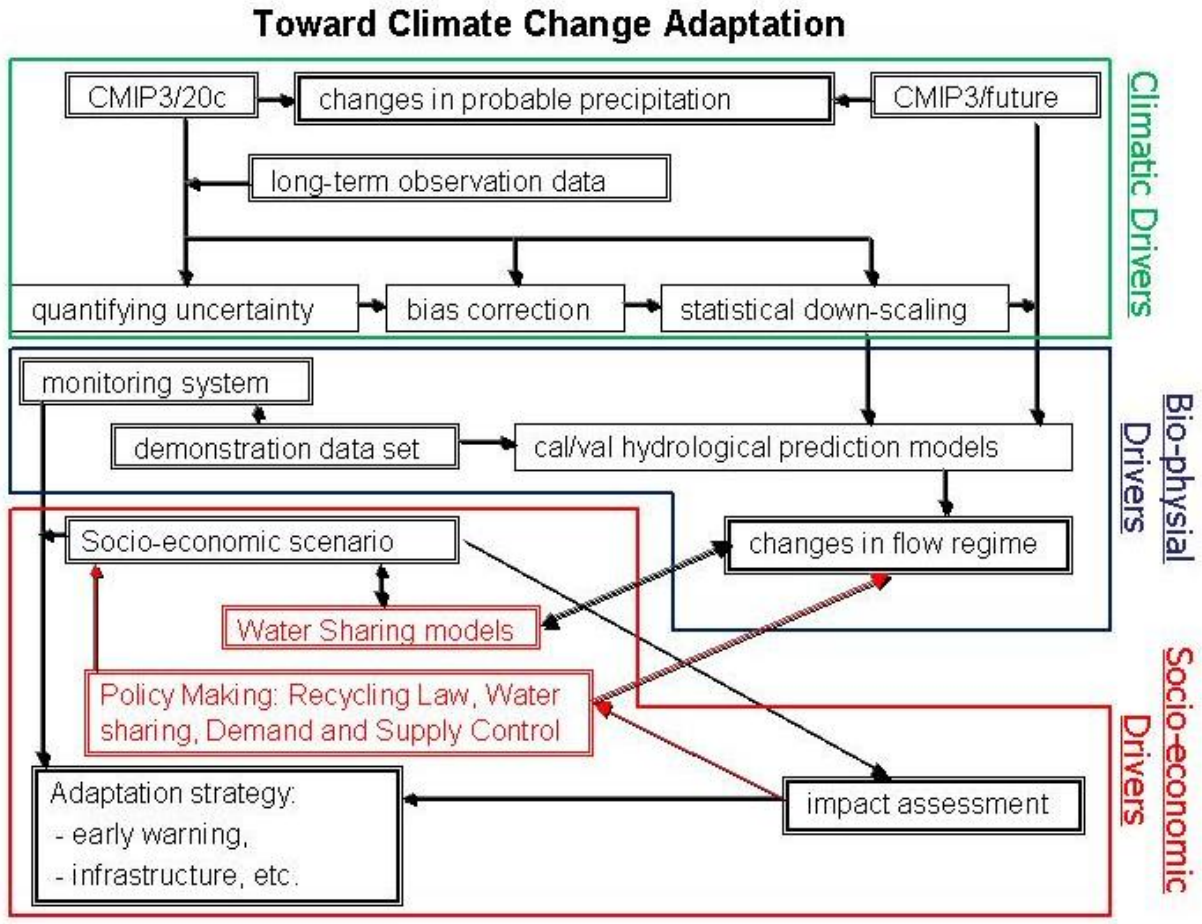


Figure 17: Flowchart of an implementation plan toward assessing impacts of climate change and preparing adaptation strategy

As mentioned above, a proposal to the APN ARCP 2009 program was submitted and accepted that is focused on "Climate Change Impact Assessment on the Asia-Pacific Water Resources under GEOSS/AWCI". Through this project, the AWCI CCAA study will be coordinated.

The need to cooperate with experts in socio-economic field had also been recognized and a team from the Institute of Water Policy, National University of Singapore, was invited to the 6th ICG meeting, Bali, March 2010, to introduce and explain mechanisms and processes by which governments translate the objectives of sustainable development into policy actions in a given policy environment. Focus was given to the relevance of science and technology inputs for policy making and also a relationship between climate change and urbanization and implications for city planning strategies was introduced. Also a tool designed for policy making for water management was introduced that was developed at the University of Kochi, Japan. It is a comprehensive system that encompasses number of components including water demand model considering public awareness, water supply model, hydrological model, social welfare logic model, and equilibrium analysis model that considers multiple water demand control measures such as infrastructure, pricing policy, laws and regulations, etc. Such a component will be required in the CCAA study to adequately regard socio-economic drivers as indicated in the flowchart.

3.4 Capacity Building

The project has kept updating the matrix of capacity building needs vs. available resources in the region 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 2.4 above. 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 training and Mini-projects to address regional environmental issues provided by JAXA (http://web-tutorials.tksc.jaxa.jp/index.html) have been devoted to the GEOSS/AWCI activities, and others.

Under the leadership of UNU, a repository of capacity building modules was developed. JAXA developed capacity building portal for its capacity building activities including the GEOSS/AWCI. Web tutorial (data and models) Development of web tutorials for the existing modules including theory, tutorial (data, models), and an example to be followed by a participant (providing results for comparison) is underway at UNU, JAXA and AIT. Short seminars were held at the time of ICG with lecturers from AWCI participating agencies which signifies that the AWCI community is already rich in resources to provide capacity building to other members.
Four basic types of training modules were recognized including:

- *Type A:* Multi-country teams, use local data sets, long duration, generally a two-phase program.
- *Type B:* Demonstration data set. Short duration and participants are multi-country teams.
- *Type C*: Site (local) data for training and application. Participants are all from the host country.
- *Type D*: Training using a demonstration data set in a country. Program is of short duration and participants are all from the host country.

Table 3: Table of the accomplished training activities relevant to the GEOSS/AWCI.

ORGANIZATION	COURSE	Bangladesh	Bhutan	Cambodia	China	India	Indonesia	Japan	Korea	Lao PDR	Malaysia	Mongolia	Myanmar	Nepal	Pakistan	Philippines	Sri Lanka	Thailand	Uzbekistan	Vietnam
ICHARM/PWRI	GEOSS-AWCI Seminar						**D**: 2008/7/2-3													
	JICA Seminar						**C**: 2009/2/2-3													
	WMO/IFNet/ICHARM							**A**: 2008/10/3-8												
	ICHARM/IFNet/ APN							**A**: 2009/8/3-7												
	ICHARM Seminar													**D**: 2009/8/26-27						
JAXA	Mini Project 2008	**A**		**A**						**A**										**A**
	Mini Project 2007	**A**								**A**			**A**	**A**			**A**			
	Mini Project 2006	**A**		**A**						**A**				**A**						
	1st Training	**B**		**B**		**B**	**B**		**B**	**B**		**B**	**B**	**B**		**B**	**B**	**B**		**B**
	2nd Training	**B**	**B**				**B**			**B**	**B**	**B**		**B**		**B**	**B**	**B**		**B**
	3rd Training	**B**		**B**		**B**	**B**		**B**	**B**		**B**	**B**	**B**		**B**	**B**	**B**		**B**
	4th Training	**B**	**B**				**B**			**B**		**B**	**B**	**B**		**B**	**B**	**B**		**B**
University of Tokyo EDITORIA	JICA 2008				**C**															
	UT-Winter 2009							**C**												
	UT-Summer 2009							**C**												
	JICA 2009				**D**															
	AWCI/SAFE 2008																			
	UT-Summer 2009						**D**													**D**
	AWCI, 2008							**C**												
	JICA 2008				**C, D**															
UNU-ISP	2007-2009				**A**									**A, D**		**A**	**A, D**	**A**		**A, D**
	2007-2009				**A**									**A, D**		**A**	**A, D**	**A**		**A, D**
	2007-2009				**A**									**A, D**		**A**	**A, D**	**A**		**A, D**

The overview of the accomplished training courses was presented that showed a wide range of activities provided by various organizations (Table 3). In addition other proposal for organizing so called Roving Seminars (type D) by several countries including Indonesia, Lao PDR, and Philippines were presented.

4. Conclusions

The GEOSS/AWCI/OCDI project activities were aimed at:

1. Developing 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.
2. Better understanding 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.

AWCI

GEOSS/AWCI has made a very significant progress and has been widely appreciated as successful regional cooperation model for GEOSS. It currently covers 18 river basins and includes 20 Asian countries and a number of national and international organizations and research institutions, implementation of the activities based upon the GEOSS/AWCI Implementation Plan, aiming at the above goals is the key achievement of this project. The AWCI has established a regional cooperative framework, demonstration projects, a database, models, and capacity building. It had initially started with data integration activities for the river basins as basis for river basin water cycle analysis, demonstration projects, then covered recognized capacity building needs. While efforts are continuing to reinforce its existing activities, it envisions end-to-end process of observation convergence to sound policy making. Demonstration projects are now covering climate change impact assessment and adaptation. Necessary data base of observation data, model output data, hydrological models are now available for such climate change analysis.

DIAS

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. The DIAS data archive was opened to public on 1 October 2010 and thus the high-quality GEOSS/AWCI river basin observation data are now easily accessible through the DIAS portal at:
http://www.editoria.u-tokyo.ac.jp/dias/link/portal/english_index.html

Capacity building

The GEOSS/AWCI CB program was developed based upon the identified needs in individual countries and available resources within the AWCI group. Concept of CB modules were developed and depository of such available modules was constructed. Efforts are being made to fill the depository by the member agencies. Short CB training courses on data integration, data quality check, drought monitoring using satellite data, etc. were conducted.

End to end approach on climate change adaptation

End-to end approach to climate change adaptation was developed. Climate change impact assessment and adaption for each demonstration river basins are being studied based upon the GEOSS/AWCI data, tools and methods.

5. Future Directions

The GEOSS/AWCI continues to pursue its goals and follows up theactivities that were undertaken as a part of the OCDI project. The successful observation convergence and data integration scheme developed in support of the demonstration project activities is now being expanded for the emerging CCAA study. As part of DIAS, this scheme has a great potential for further expansion and through the data interoperability (due to an advanced metadata scheme) provides opportunities for the AWCI in-situ data integration with various data from other sources and enables effective exploitation of the data by wide communities.

The GEOSS/AWCI is now in transition from the more research-oriented phase to the more operation-focused phase. The success stories of the demonstration projects are being/will be presented to governmental representatives and policy makers of the AWCI member countries (e.g. at the GEO Plenary and Ministerial Summit at Beijing, 3 – 5 November 2010) and collaborative activities among research groups and policy/decision responsible institutions will be launched to implement the new approaches tested through the demonstration projects into operation. An example is the project between the University of Tokyo and the River bureau of Japan to implement an advanced dam operation optimization scheme for water resources management in the Upper Tone River basin that was tested as part of the AWCI program (Saavedra et al. 2009; Wang et. al 2009; Saavedra et al., 2010). The SAFE prototyping and ADB funded Technical Assistance projects promoted by JAXA are other efforts to transfer research-oriented activities to more operational focused services to contribute to the AWCI demonstration projects.

Also three GEOSS/AWCI projects were proposed in 2009 under the APN Regional Call for Proposals (ARCP) and Capacity Building/Enhancement for Sustainable Development in Developing Countries (CAPaBLE) programs and have been approved for funding in the years 2010/2011 and 2011/2012. The projects are:

1. River Management System Development in Asia Based on Data Integration and Analysis System (DIAS) under the GEOSS; project leader: Prof. Toshio Koike, Japan. ARCP2010-10NMY.

   The Project is designed under the GEOSS/AWCI framework and aims to develop an advanced river management system in member countries by exploiting the DIAS data and data integration capabilities. The system is based on integration of data from earth observation satellites and in-situ networks with other types of data, including numerical weather prediction model outputs, climate model outputs, geographical information, and socio-economic data to generate information for making sound water resources management decisions while taking global climate change into account. The system development thus includes:
   1. To develop a distributed hydrological model in each basin by integrated in-site and satellite data and model outputs.
   2. To predict river discharge by using observed and/or model prediction data.
   3. To develop optimization schemes for IWRM practices in each river basin.
   4. To evaluate impacts of climate change on water resources management of each river basin.
   5. To make design of measures for climate change adaptations.

   The specified tasks will be undertaken through cooperation among the countries and participating organizations providing expertise in hydrological and weather prediction modeling, satellite data use, climate change impact assessment, water resources management, etc.

2. Climate Change Impact Assessment on the Asia-Pacific Water Resources under GEOSS/AWCI; project leader: Prof. Deg-Hyo Bae, Korea. ARCP2010-13NMY.

   The objectives of this study are to evaluate the climate change impact assessments on water resources over the Asia-Pacific regions joining the Asian Water Cycle Initiative for the Global Earth Observation System of Systems (GEOSS/AWCI) and to promote the capacity building for climate change impact assessment technology. Two basic approaches are performed in this study: one is the analysis of past historical observation data to detect some climate change trends over more than 18 country regions; the other is the simulations of climate and water resources under the future greenhouse gas emission scenarios. A non-parametric Mann-Kendall's test and regression analysis are used for the former, while the GCM output with downscaling schemes and hydrologic models are used for the latter.

   In general, climate change impact assessments on water resources are conducted on two ways: One is the analysis of past historical hydrologic and meteorological observation data to detect some climate change trends; the other is the use of GCM outputs with downscaling and hydrologic models under the future greenhouse gas emission scenarios. The reasons for the necessity of this activity are: although several countries have developed their own methods for this impact assessment and provided local hydrologic impacts of climate change, their results include high uncertainties due to the inconsistent methodologies used and lack of model calibration/verification. From these reasons, sharing the common method and observation/simulation data for both climatology and hydrology is very important for climate change impact assessment on water resources including flood/drought over the Asia-Pacific regions. In line with these project objectives, we will work with both approaches.

3. Drought monitoring system development by integrating in-situ data, satellite data and numerical model output; project leader: Prof. Ichirow Kaihotsu. CBA2010-14NMY.

   Droughts have happened unexpectedly and been creeping into us in Asia and world wide. Drought has directly an influence on agriculture, energy production, transportation, tourism and recreation, forest and wild land fires, urban water supply, environment and human health. In order to take precaution against a drought, we have to urgently establish and develop of an integrating system of in-situ data, satellite ones and numerical model outputs. The integrating system brings us to greatly improve the techniques and knowledge of drought study. Drought, related to the water issue in AWCI/GEOSS implementation plan, is getting more and more concern from the publics and policy maker.

   The ground-based routine data in each country, satellite products and numerical model ones for drought studies have not been widely used since lack of capacity building in many Asian countries. The retrieved soil moisture dataset from satellite remote sensing (RS) products has been gradually providing for the AWCI drought working group, and the related countries collaborators will validate this data set by using the in-situ observation data. Furthermore, we are preparing to provide numerical model products to the related countries for drought studies. Scientists and operators in the related countries will be able to learn and acquire the analysis techniques of satellite data and numerical products and methods of monitoring and an early warning system of drought.

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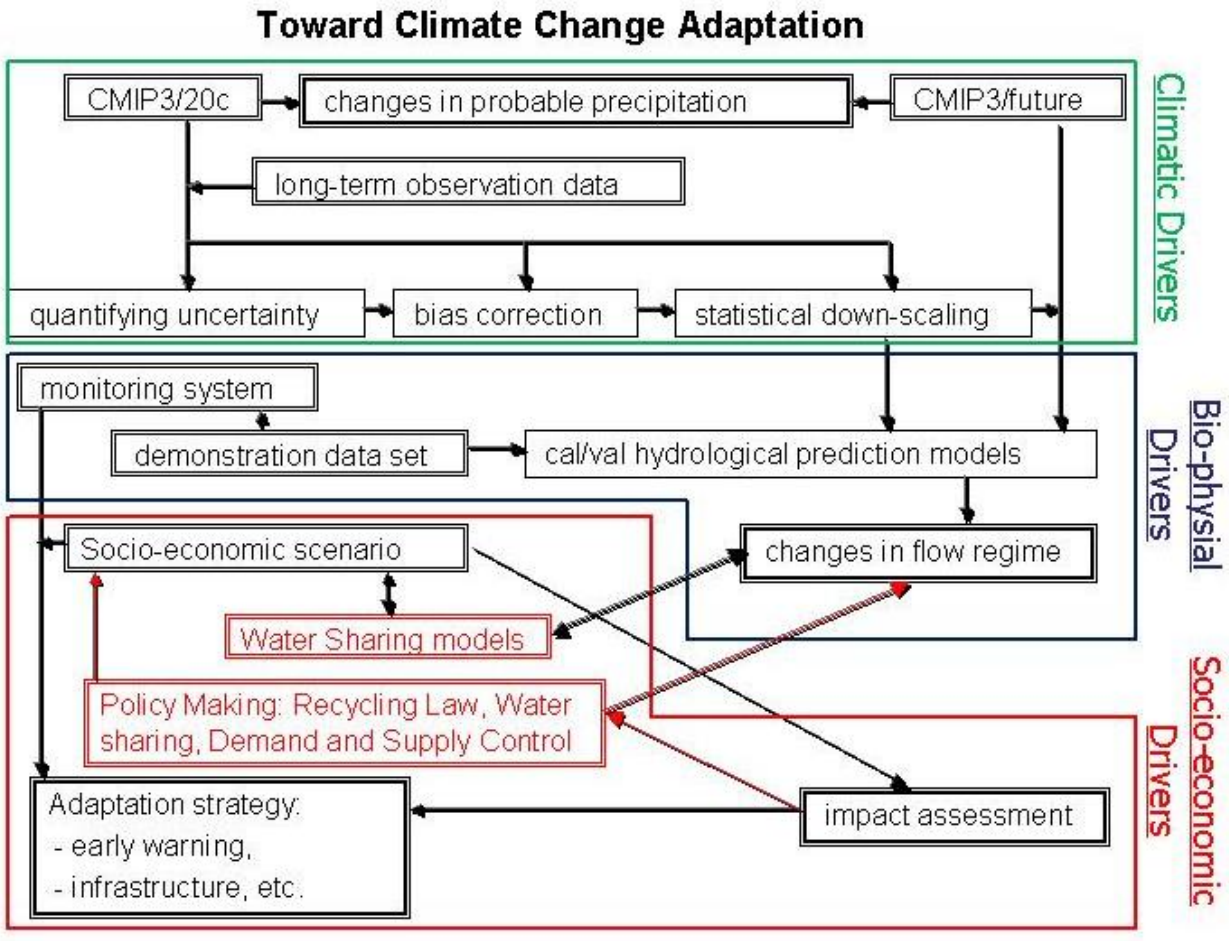
Appendices

Appendix 1

Whitepaper on the GEOSS/AWCI Climate Change Assessment and Adaptation Study

1. Background

Impacts of climate change on water resources and water-related hazards in the Asia-Pacific region have already become evident, as both scientific observations and the experiences of the region's inhabitants confirm. In confronting the risks and challenges posed by changing climate, it is essential to properly asses its impacts as a basis for identifying effective responses and developing adequate adaptation strategies.



Flowchart of an implementation plan toward assessing impacts of climate change and preparing adaptation strategy – resulting version from breakout group discussions.

In recognition of these challenges, the GEOSS Asian Water Cycle Initiative (AWCI) has proposed activities focusing on climate change impact assessment in three specific areas including flood, drought, and snow and glacier phenomena. At the 6th AWCI International Coordination Group (ICG) Meeting in Bali, March 2010, an approach toward assessing impacts of climate change using the

Climate Model Intercomparison Project (CMIP) data was proposed and accepted as illustrated in the chart below. This Whitepaper is an elaboration of that proposal.

2. Mission

The main goal of the proposed activity is to set up a methodology for assessment of climate change impacts on the water resources and water-related hazards that will be applicable in the AWCI member countries and by using this methodology to carry out such assessment studies on the demonstration basins in each country focusing on the three identified areas including flood, drought, and snow and glaciers phenomena.

3. Objectives

6. To set up a methodology for quantifying uncertainty of climate projection focusing on forcing variables for hydrological models.
7. To set up a methodology for correcting bias of the projected forcing variables.
8. Produce projections of water resources and water hazard related variables by employing a proper hydrological model forced by the corrected projected forcings.
9. Assess the impacts of climate change on changes in water resources and water-related hazards.
10. Recommendations for adaptation strategy.

4. Methodology

Step I for Climate & Bio-Physical Drivers

The activities will take an advantage of the CMIP3 (and later CMIP5) output including past simulations and future projections that are stored on the Data Integration and Analysis System (DIAS) of Japan. Close collaboration is envisioned with the AWCI project "Climate Change Impact Assessment on the Asia-Pacific Water Resources under GEOSS/AWCI" that is led by Prof. Deg-Hyo Bae, was approved for funding by APN in April 2010 and is currently beginning its activities (http://monsoon.t.u-tokyo.ac.jp/AWCI/projects.htm#change).

Approaches toward accomplishment of the listed objectives may differ according to the focus area, i.e. whether the phenomena under assessment will be related to flood, drought, or snow and glaciers.

1. Flood

Key mission for flood:
Impact analysis on PMF, flood frequency, dam safety, optimal dam operation, etc.

As heavy rainfall is the key factor in floods, the flood-oriented activities will focus on change in heavy rainfall events and associated changes in flood peaks. Using available long-term historical records (at least 20-years) of rainfall in the AWCI demonstration basins and the CMIP3 (or later CMIP5) precipitation outputs for the corresponding period, the uncertainty in CMIP precipitation outputs will be identified. Consequently, the bias in the daily rainfall data will be corrected in the model projections. The corrected data together with other forcing variables taken from the CMIP projections will be used to run suitable hydrological models in the demonstration basins that will generate projected river flow. The projected heavy rainfall events and flood peaks will be compared with the historical series and studied for possible trends and/or changes in intensity and frequency of occurrence.

Method:

1. Data registration of demonstration basin to DIAS
2. Capacity building for bias correction & downscaling – e.g. UNU seminar on downscaling in May 2011
3. Application of multiple (hopefully!) hydrologic models such as WEB-DHM, IFAS-PDHM or BTOP, any locally-used model at the demonstration basin, etc.

2. Drought

Key mission for drought:

1. To carry out a long term monitoring of soil moisture, precipitation, air temperature, and snow by in-situ and satellite with studying the definition of drought for climate change assessment.
2. To present an early warning system including seasonally forecasting for adaptations.

In case of drought, set of drought indices will be investigated. Similarly as for flood, available long-term historical records of rainfall and CMIP3 precipitation output will be analyzed, the uncertainty identified for heavy rain, moderate rain, and low rain events, and the bias corrected. The observed in-situ precipitation and JRA25 output will be used to force an adequate hydrological model (e.g. Web-DHM) in the demonstration basins to derive the drought indices for the historical period. Consequently, the projected forcing variables by CMIP3 including the bias-corrected precipitation will be used to force the hydrological model for the future period and projection river flow and basin states will be generated. Drought indices for the future period will be derived and compared with those for the historical period. Possible trends and/or changes in drought occurrence, severity and frequency of occurrence will be studied.

In addition to the above study involving numerical model experiments, the focus will also be on strengthening the monitoring system and data analysis of precipitation, soil moisture phonological elements, evapotranspiration, air temperature, land use, discharge, and groundwater.

3. Snow and Glaciers

Regarding the snow and glaciers focus, the abovementioned approaches are currently not applicable due to (i) lack of sufficient historical in-situ observation of snow and glacier variables (insufficient in terms of length of record, density of observation network, temporal resolution of the observation) and (ii) lack of adequate hydrological model coping with the snow and glacier processes. Since quantifying uncertainty and bias correction is difficult without long-term observation data, it is proposed to use satellite data for snow cover and glacier change monitoring, namely Landsat data and the high resolution ASTER GDEM. A statistical value of a snow covered area will be generated from the CMIP3 output for the historical period using a hydrological model designed for cold regions. This statistical value will be compared with such a value resulting from Landsat data and in this way the CMIP3 output will be evaluated and bias corrected.

Step II for Socio-Economic Drivers

To make a sound decision in water policy responding to changing political and socio-economic needs and demands under climate change, it is vital to develop a comprehensive risk assessment method that covers political and socio-economic aspects as well as natural scientific aspects. The method should be able to reflect the effects of climate prediction uncertainty in an appropriate way.

1. Risk Assessment

With the socio-economic background, it is important to develop a comprehensive assessment system that can quantify socio-economic impacts induced by climate change on comprehensive societal benefits, including complacency about the risks to life and environmental safety. To design an adaptive measure, it is necessary to evaluate currently available technology and its future direction, to consider the socio-economic and cultural characteristics of each target river basin, and then to quantify how much the risk to society can be reduced by combining various measures.

The first step will be to review existing studies in each participating country. Cooperation with experts on socio-economic studies in each country will be sought.

2. Multilayered Risk Management

We must identify and implement approaches that improve water security over a wide range of potential conditions, including current climate variability. Multilayered approaches, including both

structural and non-structural ones, should be promoted. Also early warning systems either for flood or drought or other water-related hazards are important elements of the scheme. Effective management as a whole can be achieved by shifting the capacities for specific purposes among existing reservoirs. Effective water demand management, including proper water distribution for different objectives of water use and negotiation among different stakeholders during severe drought, should be promoted. It is undoubtedly effective to control urban land use in flood plains and local low-lying lands where serious damage is caused by flooding and localized torrential rainfall respectively.

3. Governance

Adaptation measures involve a wide range of stakeholders. We must build the capacity of society to demonstrate resilience in the face of changing climate through strengthening the adaptation capacities of stakeholders of society as a whole for operationalizing the multilayered risk management with climate change adaptation measures. It is also important to recognize water quality as an inseparable determinant of sustainable environment and people's well being. It is important to establish a platform consisting of stakeholder organizations, experts, and academics at the early stages of planning where making decisions, sharing information, providing advice, and clarifying each organization's role are conducted.

5. Implementation strategy

For the step I, we had better take an aggregation approach on observation capability, data sets, data infrastructure, models, prediction capabilities and knowledge.

1. *Sharing observation capability*
2. *Sharing long tem data, especially long-term daily rainfall data and hourly data even short periods.*
3. *Sharing data infrastructure and climate projection data sets – an easy access to the GCM products needs to be provided.*
4. *Sharing hydrological models including down scaling methods.*
5. *Sharing regional characteristics of the climate change impacts on river flow regimes.*

For the step II, the shared ideas, data, experiences and knowledge should be applied to each demonstration river basin considering its locality.

6. Timeline

30 October 2010:	Proposing a river basin for the Climate Change Assessment and Adaptation (CCAA) study by each AWCI member country and providing information on the available observation.
30 November 2010:	Review of available bias correction and downscaling methods (Japan)
February 2011:	Data submission to DIAS
March 2011:	Workshop and training session on downscaling, bias correction, and hydrological modeling at the occasion of GEOSS AP Symposium and Asian Water Cycle Symposium
March - October 2011:	Conducting the step I activities – impact assessment (climate and bio-physical drivers
October 2011:	Discussion on socio-economic drivers and related activities, planning

Appendix 2: Meetings and workshops (agenda)

The 3rd International Coordination Group Meeting of the GEOSS Asian Water Cycle Initiative (AWCI)

Beijing, China, 6 November 2008

Objectives

To accelerate the GEOSS/AWCI coordination, especially on "Data Integration" and "Capacity Building", by reviewing and sharing the updated status of the GEOSS, the AWCI demonstration projects, and the related sciences.

Thursday, 6 November 2008:

9:00 – 11:00 1. Science Presentations and Country Reports

9:00 – 10:25 (Science presentations 9 minutes talk, 3 minutes Q&A)

0900 – 0912 Chanthachith Amphaychith (Lao PDR): *Flash Flood in the Mountainous Area of Lao PDR (the case study of Luangnamtha province)*

0912 – 0924 Irina Dergacheva (Sergey Myagkov) (Uzbekistan): *Assessment of Water Resources Change on the Aral Sea Basin under Possible Climate Change*

0924 – 0936 Dang Thi Mai (Vietnam): *Flood and Landslide in Central Part of VIETNAM*

0936 – 0948 Shiv Kumar Sharma (Nepal): *Moving Science Community to the Flood Affected Community: AWC Initiative*

0948 – 1000 Fadli Syamsudin (Indonesia): *Development of Climate Induced Flood Prediction System in Jakarta, Indonesia*

1000 – 1012 Jusoh Juhaimi (Ahmad J. Shaaban) (Malaysia): *Impact of Climate Change on the Hydrology and Water Resources of Peninsular Malaysia*

10:24 – 10:50 Country Reports: Demonstration Project Updates (1slide/2 minutes presentations)

Vietnam (Dang Ngoc Tinh)
Thailand (Thada Sukhapunnaphan)
Sri Lanka (S.B. Weerakoon)
Philippines (Flaviana Hilario)
Nepal (Shiv Sharma)
Myanmar (Tin Yi)
Malaysia (Juhaimi Jusoh)
Lao PDR (Chanthachith Amphayshicth)
Koera (Deg-Hyo Bae)
Indonesia (Joesron Loebis)
India (Rakesh Kumar/Surinder Kaur)
Bangladesh (Md. Abdul Quadir)

10:50 – 11:10 *BREAK*

11:10 – 12:40 2. GEOSS/AWCI Activity Reports (15min. each)

2.1 GEOSS Current Status
T. Koike

2.2 Capacity Building Activities
1) Indonesia J. Loebis
2) Bangladesh A. Quadir

2.3 WG Report
1) Floods K. Fukami
2) Droughts Ailikun
3) Water quality B. Hoque

12:40 – 13:40 *LUNCH*

13:40 – 14:10 3. A New WG on "Climate Change Impacts and Adaptation"

14:10 – 15:10 4. Meta-data and Data Archiving and Data Quality Check –demonstration

4.1	Updated Status of Data Integration	T. Koike
4.2	Meta-data Registry	H. Kinutani
4.3	Data quality check and archiving	E. Ikoma

15:10 – 15:30 BREAK

15:30 – 17:30 5. "Capacity Building" Implementation Plan Development

5.1	Plenary session; Objectives and guidance	S. Herath
5.2	Breakout sessions - Floods WG - Drought WG - Water quality WG - Climate Change WG	All
5.3	Plenary session; WG reports and coordination	

17:30 – 18:00 6. Discussion Summary and Way Forward T. Koike

18:00 ADJOURN

The 4th International Coordination Group Meeting of the GEOSS Asian Water Cycle Initiative (AWCI)

Kyoto, Japan, 6-7, February 2009
(http://www.editoria.u-tokyo.ac.jp/awci/4th/index.html)

Objectives

To accelerate the GEOSS/AWCI coordination, especially on "Data Integration" and "Capacity Building", by reviewing and sharing the updated status of the GEOSS, the AWCI demonstration projects, and the related sciences.

Friday, 6 February 2009:

12:30 – 13:30 Registration

13:30 – 14:00 1. Opening by Guest Speakers (8 min each)

1.1 *Jose Achache, Director, GEO Secretariat (TBD)*
1.2 Linda Anne Stevenson, *APN*
1.3 Hirota Tani, MEXT
1.4 Group Photo (6 min)

14:00 – 14:20 2. GEOSS/AWCI Overview and Meeting Objectives

T. Koike

14:20 – 15:00 3. Science Interaction Session – Land Use –

3.1 Paddy Field Monitoring by Satellite
W. Takeuchi
3.2 Global Irrigated Area Map (GIAM) and Global Map of Rainfed Cropland Areas (GMRCA)
P. S. Thenkabail

15:00 – 15:20 *Break*

15:20 – 17:30 4. "Capacity Building" Implementation Plan Development

4.1	Plenary session; Objectives and guidance	S. Herath and C. Ishida
4.2	Breakout sessions - Floods WG - Drought WG - Water quality WG - Climate Change WG	All
4.3	Plenary session; WG reports and coordination	

17:30 ADJOURN

Saturday, 7 February 2009:

9:00 – 11:00 5. Data Management

5.1	GEOSS/AWCI data archiving update	K. Tamagawa
5.2	Data loading and quality check	E. Ikoma
5.3	Meta-data Registry	H. Kinutani
5.4	Data Infrastructure – present situation and future prospects	M. Kitsuregawa

11:00 – 11:20 ***Break***

11:20 – 12:00 6. Scientific Reports

6.1	Land-Lake-Atmosphere Interaction and its Effects on Local Water Use	K. Tsujimoto
6.2	WEB-DHM and IWRM	L. Wang

12:00 – 13:00 ***Lunch***

13:00 – 14:30 7. Panel Discussion "Promotion of Water Quality Study"
H. Furumai, and Flood/Drought/Climate Change WG Chairs

14:30 – 15:00 8. Summary and Way Forward T. Koike

15:00 ADJOURN

The 5th International Coordination Group Meeting of the GEOSS Asian Water Cycle Initiative (AWCI)

Tokyo, Japan, 15-18, December 2009
(http://www.editoria.u-tokyo.ac.jp/awci/5th/index.html)

Objectives

To accelerate the GEOSS/AWCI coordination, we discuss how to cooperate and coordinate among different societal benefit areas, Climate, Water cycle and Disasters, and to make plans for carrying the ideas into actions and sharing implementation experiences.

Tuesday, 15 December 2009:

8:30 – 9:00 Registration

General Session

9:00 – 9:30 1. Opening
APN, MEXT, JAXA, ADB, JICA, The University of Tokyo
Group Photo

9:30 – 10:20 2. AWCI Activity Reports
2.1 Summary Report
2.2 Working Group Reports (Flood, Drought, Water Quality, Climate Change)

10:20 – 10:40 BREAK

10:40 – 12:00 3. "Capacity Building" Implementation Plan Development
UNU, JAXA, CAS-IAP

12:00 – 13:00 LUNCH

International Symposium Co-organized by IWRA and GEOSS/AWCI

13:00 – 17:30
Opening:
- Cecilia Tortajada (President, IWRA)
- Katumi Musiake (Chair, IWRA-Japan)
- Tosio Koike (Leader, GEOSS/AWCI)

Speeches:
- Yutaka Takahasi (IWRA-Japan)
- Asit Biswas (World Water Council)
- Jun Xia (IWRA Incoming President): "Water Issues and New Challenges in China"
- Soontak Lee (President, IAHE) "Integrated Water Resources Management in Korea"
- Rasul Ghulam (Pakistan Meteorological Department): T.B.D.
- Long Saravuth, So Im Monichoth (Ministry Of Water Resources And Meteorology of Cambodia), and Kumiko Tsujimoto (The University of Tokyo) "Water Cycle and Agricultural Activities during the Post-Monsoon Season in the Western Cambodia"
- T.B.D. (River Bureau, MLIT, Japan): "Application of Advanced Monitoring Systems Including X-Band Radar to River Basin Management"
- Toshiyuki Yoshioka (JWA): "NARBO and Integrated Water Resources Management"
- Yoshiyuki Imamura (ICHARM): T.B.D.

General Discussion
Closing

17:30 – 18:00 IWRA Special Session for Honoring Professor Yutaka Takahasi

18:00 – 20:00 GEOSS/AWCI-IWRA Joint Reception

Wednesday, 16 December 2009:

General Session *-continued*

9:00 – 17:00 4. Toward Actual Collaboration among Climate, Water Cycle, and Disasters

9:00 – 9:20 Summary of the Discussion in Kyoto and the Following Survey
9:20 – 10:50 4.1 Drought
Invited Talks
- Drought Monitoring and Drought Indices: Jie WEI (IAP-CAS)

Country Reports: China/ India/ Indonesia/ Laos /Uzbekistan

10:50 –11:00 BREAK

11:00 –12:30 4.2 Snow, Glacier and GLOF
Invited Talks
- Changes in Glacier in the World: Y. Hirabayashi (The University of Tokyo)
- GLOF: K. Fujita (Nagoya Univ.)

Country Reports: Bhutan/Nepal/ Mongolia /Pakistan

12:30 – 13:30 LUNCH

13:30 –15:30 4.3 Typhoon, Cyclone, and Induced Floods
Invited Talks

- Climate Change Impacts on Typhoon Y. Takayabu (The University of Tokyo)
- Typhoon and Flood : E. Nakakita (Kyoto University)

Country Reports: Bangladesh/ Cambodia/ Korea/ Malaysia/ Myanmar/Philippines/ Sri Lanka/Thailand/ Vietnam

15:30 –15:50 BREAK

15:30 –17:00 4.4 Climate Change Adaptations

Introductory Talks

- End to End Approach T. Koike (The University of Tokyo)
- Multi-disciplinary Approach D. Yang (Tsinghua University)
- Regional Approaches: ADB, APWF, JICA , APN
- National Approaches: Japan, Korea, Malaysia

17:00 ADJOURN

Thursday, 17 December 2009:

General Session *-continued*

9:00 – 10:00 5. Breakout Sessions for Harmonization
5.1 Climate Change Adaptations – Drought
5.2 Climate Change Adaptations – Snow, Glacier and GLOF
5.3 Climate Change Adaptations – Typhoon, Cyclone, and Induced Floods

10:00 –10:30 BREAK

10:30 – 12:00 6. Summary Session
6.1 Breakout Session Reports
6.2 Wrap-up

12:00 ADJOURN

12:00 – 13:30 LUNCH

Joint Training Workshop on the Application of Remote Sensing Products on Drought Monitoring in Asia

13:30-14:30: Introduction of ALOS mission (Dr. Takeo Tadono、JAXA EORC)

14:30-15:00 : BREAK

15:00-16:00: Introduction of AQUA/AMSR-E mission (Mr. Keiji Imaoka、JAXA, EORC)
16:00-17:00: Integrated Observation and Prediction of Water Cycle Coupled with Passive and Active Microwave Sensors (Prof. Toshio Koike, U. of Tokyo)
17:00-18:00: Introduction to HY-II satellite and Data Application (Dr. Qiang FENG, CEODE-CAS)

Friday, 17 December 2009:

Joint Training Workshop on the Application of Remote Sensing Products on Drought Monitoring in Asia *-continued*

9:00-10:30: Estimation of soil moisture by AMSR-E and its satellite algorithm basis and data assimilation (Dr. Hui Lu, U. of Tokyo)

10:30-11:00 : BREAK

11:00-12:00: Validation and observations of soil moisture by AMSR-E (Prof. Kaihotsu, I., Hiroshima U.)

12:00 – 13:30: LUNCH

13:30-15:00: Principle and methodology of microwave remote sensing soil moisture measurements (Prof. Jun WEN, CAREERI-CAS)

15:00-15:30 BREAK

15:30-17:00: Retrieval of soil moisture index from MODIS in dryland areas (Dr. Orn-uma Polpanich, AIT)

17:00-18:00: Drought monitoring and drought indices in dryland of China (Dr. Jie WEI, Ailikun, IAP-CAS):

18:00 ADJOURN

The 6th International Coordination Group (ICG) Meeting GEOSS Asian Water Cycle Initiative (AWCI)

Bali, Indonesia, 13 March 2010

(http://www.editoria.u-tokyo.ac.jp/awci/6th/index.html)

Objectives

To accelerate the GEOSS/AWCI coordination, we discuss how to promote regional cooperation and coordination on climate change adaptations.

8:30 – 9:00 Registration

9:00 – 9:20 1. Opening

Host Country

GEO Represetaive

H. Tani, Director, Ministry of Education, Culture, Sports, Science and Technology (MEXT)

Group Photo

9:20 –10:00 2. AWCI Activity Reports

2.1 Summary Report including Updates of the Demonstration Projects

2.2 Working Group Reports (Flood, Drought, Water Quality, Climate Change)

10:10 –10:25 3. Welcome a new member

Australia Dr Stuart Minchin

10:25 – 10:40 BREAK

10:40 – 11:40 3. "Capacity Building" Implementation Plan Development
S. Herath (UNU), C. Ishida (JAXA)

11:40 – 12:00 4. Socio-economic approach
S. Nasu (Kochi Univ.)

12:00 – 13:00 LUNCH

13:00 – 14:45 5. Implementation planning for climate change adaptations
- Basic Strategy
- Technical Approaches
- Political Approach

14:45 – 15:00 Break

15:00 – 16:00 6. Short Training Course 1: "Data quality check and meta data registration"

16:00 – 16:30 7. Short Training Course 2: "Flood Management"

16:30 –17:30 General Discussion

17:30 Closing

The 7th International Coordination Group (ICG) Meeting GEOSS Asian Water Cycle Initiative (AWCI)

Tokyo, Japan, 5-6, October 2010
(http://monsoon.t.u-tokyo.ac.jp/AWCI/meetings/Tokyo_Oct2010/index.htm)

Objectives

How to promote climate change adaptations by cooperating and coordinating among different societal benefit areas, Climate, Water cycle and Disasters, and to make plans for carrying the ideas into actions and sharing implementation experiences.

Tuesday, 5 October 2010: *Meeting room An301/302, An-building, IIS, The University of Tokyo*

9:00 – 9:30 Registration

9:30 – 9:50 1. Opening
T. Fukui, Ministry Education, Culture, Sports, Science and Technology (MEXT) of Japan
M. Kajii, Japan Aerospace Exploration Agency (JAXA)

Group Photo

9:50 –11:00 2. AWCI Activity Reports
2.1 Special Report on "Flood detection using SAR imagery - A case study in Pakistan."
M. Shimada (JAXA) – 30 min
2.2 Summary Report including Updates of the Demonstration Projects – 10 min
2.3 Working Group Reports (Flood, Water Quality, Climate Change, 10 min each)

11:00 –11:20 Exhibition viewing and BREAK, Seminar room An403/404/405 (4th floor)

11:20 –12:20 3. "Capacity Building" Implementation

3.1 S. Herath (UNU)
3.2 Y. Inomata (JAXA): JAXA's capacity building activities with focus on WRM – 10 min
3.3 C. Ishida (JAXA): ADB technical assistance projects for Bangladesh, Vietnam, and Philippines – 5 min
3.4 K. Fukami (ICHARM): ICHARM capacity building activities – 10 min

12:20 –13:20 LUNCH

13:20 –15:45 4. Flood and Climate Change (12 min each)

4.1 *Thada Sukhapunnaphan:* Thailand country report: "Flood in Upper Northern Basin of Thailand"
4.2 *Surinder Kaur:* "Cloudburst over LEH and flash floods"
4.3 *M. Syahril Badri Kusuma:* "Several Challenges of Flood Control Development in Citarum River Toward MDG 2020"
4.4 *Mohammad Ashfakul Islam:* "Flood in Bangladesh & the Importance of Regional cooperation"
4.5 *Irina Dergacheva*: Uzbekistan country report
4.6 *Mohd Zaki Mat Amin:* "Climate Change Impacts on the hydrological and Hydraulic Performance of Bekok and Labong Dams in Johor"
4.7 *Joesron Loebis:* Indonesia country report: "Flood Management related to Climate Change"
4.8 *Kazuhiko Fukami: "*Preliminary analysis on flash floods in the northwestern Pakistan, 2010, using satellite-based rainfall and global GIS data"
4.9 *Bashir Ahmad:* Pakistan country report, *presented by T. Koike*
4.10 *Tin Aung Tun:* "Water Cycle Initiative and Climate Change Impact in Myanmar"
4.11 *So Im Monichoth:* Cambodia country report – compiling flood and drought issues
4.12 *Toshio Koike:* "Multi-model applications to the assessment of the climate change impacts on floods."

15:45 –16:05 Exhibition viewing and BREAK, Seminar room An403/404/405 (4th floor)

16:05 –17:20 5 Drought and Climate Change (12 min each)

5.1 *Mafizur Rahman:* "Assessment of Spatial and Temporal Drought Pattern in Bangladesh"
5.2 *Dang Ngoc Tinh:* "Drought, water scarcity in Vietnam for last two years"
5.3 *Hansa Vathananukij:* "Satellite analysis on Drought estimation in Thailand"
5.4 *Edna Juanillo:* "The recent El Nino Impact in the Philippine Water resources : Focus on Angat Dam"
5.5 *Davaa Gombo:* Mongolia country report
5.6 *Patricia Ann Jaranilla-Sanchez:* "Drought indices and climate change impact assessment"

17:20 –17:45 6 Water-Quality and Climate Change (12 min each)

6.1 *Bilqis Hoque:* "Impacts of 2010 drought on quality of water: An experience from Bangladesh"
6.2 *Kedar Kumar Shrestha:* "Hydrology and Water Quality Aspect of Bagmati River"

17:45 –18:10 7 Snow-Glacier-GLOF and Climate Change (12 min each)

7.1 *Yukiko Hirabayashi:* "Glacier Modeling"
7.2 *Maheswor Shrestha:* "A new model approach", *presented by T. Koike*

18:30 – ICE BREAKER

Wednesday, 6 October 2010: *Meeting room An301/302, An-building, IIS, The University of Tokyo*

9:00 – 10:30 8 Preparation for Implementation Plan for Climate Change Assessment & Adaptation

8.1 GEOSS & APWF :T. Koike (UT) – 15 min
8.2 Guide Lines : E. Ootsuki (MLIT) – 15 min
8.3 Handbook : M. Ishiwatari (JICA) – 15 min
8.4 Re-analysis : K. Takahashi (JMA) – 15 min

8.5 Satellite Observations : K. Imaoka (JAXA) – 15 min
8.6 Water Use and Agriculture : D. Yang (TU) – 15 min

10:30 – 11:30 Tour to the DIAS Core System and BREAK

11:30 – 12:30 8 Preparation for Implementation Plan for Climate Change Assessment & Adaptation - continue

8.7 Data Integration : E. Ikoma, H. Kinutani (UT) – 30 min
8.8 Hydrological Modeling : D. Bae (SU), L. Wang (UT) – 30 min

12:30 –13:30 LUNCH

13:30 – 14:00 8 Preparation for Implementation Plan for Climate Change Assessment & Adaptation - continue

8.9 Socio-economic Approaches : S. Nasu (KU) – 15 min
8.10 System Optimization : O. Saavedra (TITECH)– 15 min

14:00 – 14:10 2 AWCI Activity Reports – completion

2.3 Drought working group report :I. Kaihotsu – 10 min

14:10 – 15:30 9. Breakout Sessions for Harmonization

9.0 Introduction to White Paper and Points of Breakout Discussion
9.1 Climate Change Assessment & Adaptations – Flood
9.2 Climate Change Assessment & Adaptations – Drought
9.3 Climate Change Assessment & Adaptations – Water Quality
9.4 Climate Change Assessment & Adaptations – Snow-Glacier-GLOF

15:30 – 16:10 Exhibition viewing and BREAK, Seminar room An403/404/405 (4th floor)

16:10 – 17:30 10. Summary Session
10.1 Breakout Session Reports
10.2 Wrap-up
Clearly define the relationship with the WG Activities and the Demonstration Projects

17:30 ADJOURN
18:00 AWCI ICG Special Event (ICG members only)

The lists of participants of the meetings/workshops mentioned above are provided in separate files with this report due to their large scope.

Appendix 3: Summary report on the 4th ICG meeting

Summary report on The 4th International Coordination Group (ICG) Meeting of the GEOSS Asian Water Cycle Initiative (AWCI)

held

at the Kyoto Research Park, Kyoto, Japan, 6 – 7 February 2009.

(final draft: 30 March 2009)

1.1 Background of GEOSS AWCI (http://monsoon.t.u-tokyo.ac.jp/AWCI)

The GEOSS Asian Water Cycle Initiative (AWCI) is a regionally cooperative contribution to the GEO socio-benefit area: "Improving water resource management through better understanding of the water cycle". It has been established based on the regionally common and sharable ideas on the water-related issues in Asia and their natural and socio-economical backgrounds and 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 AWCI that involves 18 participating countries 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:

- 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 unique features include:

- 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.

The **Fourth GEOSS AWCI ICG meeting** was planned and undertaken to accelerate the GEOSS/AWCI coordination, especially on "Data Integration" and "Capacity Building" and to move ahead with implementation of AWCI in accordance with the strategy outlined in the Implementation Plan that was agreed on at the 3rd Asian Water Cycle Symposium in Beppu, Japan, December 2007. The meeting agenda reflected and discussions followed-up on the outcomes of the Third GEOSS AWCI ICG meeting that was held in Beijing, China, November 2008. The outcome of those discussions is summarized in this report. All of the presentation material provided by the participants at the meeting, including abstracts of talks and posters is available on the Internet through the meeting home page at: http://www.editoria.u-tokyo.ac.jp/awci/4th/presentation.html.

1.2 Executive Summary of Main Issues/Conclusions and Actions

The meeting was held in conjunction with the 3rd GEOSS Asian Pacific Symposium that took place at the same venue, 4 – 6 February 2009 and included a special parallel session on "Water Cycle in the

Asia-oceanic region" and a special interdisciplinary session on "Toward Actual Collaboration among Climate, Water Cycle, and Disasters" that were closely related to the AWCI activities.

A brief executive summary of the AWCI ICG meeting and GEOSS AP water-related sessions is given in this section, further details follows in sections 2.1 and 2.2 below.

Expanded collaboration among Water Cycle, Climate, and Disaster SBAs
Through the presentations and discussions of the GEOSS AP Symposium special "water" sessions, a possibility for expanded collaboration among the AWCI current activities focused on water cycle issues and other, closely related socio-benefit areas of GEOSS was sought. Water cycle and Climate related Disasters were identified as a suitable theme for such cooperation that is also common to all of the Asia-Pacific countries and the AWCI participating countries as it was reported at the meeting.

Four target topics and fields were defined based on the outcomes of the country reports on disasters that could be considered as the main areas for cooperation. These include:

1. Typhoon, cyclone, and induced floods
2. Drought
3. Cold surge
4. Snow, glaciers, and GLOF

AWCI progress and issues
The GEO Secretariat, APN and MEXT representatives highlighted that the AWCI organization, approaches, and activities are fully in accord with the GEO and APN principles and with the MEXT mission in terms of water resources and as such has full support of their respective organizations.

The AWCI meeting included several scientific talks that introduced some new findings and advanced tools and methods that could be exploited in the AWCI activities.

A good progress was reported in the AWCI demonstration projects data and metadata submission. Explanation and demonstration of the data and metadata upload system and data quality control tools was provided during the meeting and well acknowledged by the participants.

The AWCI capacity building program has also progressed. The UNU group developed an on-line repository (http://unufms.net:8080/seaside/gcs/AWCI) that will facilitate effective planning of CB activities. Several seminars/workshops took place in 2008 and their outcomes were reported. The AWCI working groups held breakout sessions and proposed concrete activities in the 2009 – 2010 timeframe. A possible water quality study in cooperation with other groups was discussed during a special panel discussion and a framework and basic features of such study were proposed.

Conclusion
The participants concluded that: "Data information, science and technology, cooperation framework, and the members are now ready to expand interdisciplinary cooperation that would bring mutual benefits".

Particular steps were proposed to step forward:

- Countries and organizations will submit proposal on the targeting topic(s)
- A three-day workshop will be held in the September – October 2009 timeframe to discuss:
  1. Sharing Societal Needs, Scientific Ideas, Observation Capability, Modeling Capability, Experiences
  2. Seeking Data Sharing Possibility: Data Policy, Meta Data Generation and Data Infrastructure
  3. Establishing Cooperation Framework under GEO
- Forming a Task Team for drafting an Implementation Plan
- Discussing the draft at the 4th GEOSS AP Symposium in Bali, Indonesia, 2010

2.1 Water Cycle in the Asia-Oceanic Region

Floods are very serious common problems in the Asia-Oceanic region. More than 80% of the loss of human lives by flood in the world occurs in this region. The expansion of urbanization is accelerating the flood economic damages considerably. Since many countries in the Asia-Oceanic region locate in the tectonic zones, landslides and mudflows are also common natural disasters. The Asian summer monsoon usually provides rich water environment. At the same time, its large seasonal and inter-annual variation sometimes leads to severe drought damages in the water consuming societies. The global warming is changing the water cycle. Heavier rainfall events and larger interannual variations are predicted. Global climate change is considered to make considerable impacts on such a vulnerable region, where the percentage of completion of river developments is still critically low in contrast to the high potential water-related hazards.

The objective of this breakout session was to summarize the water-related disasters in the Asia-Oceanic region, and to identify impacts of the climate change on the vulnerable water environment.

The session agenda

09:00-09:10 ***Opening Water Cycle Breakout Session***
09:00-09:10 Data Sharing for a Transverse GEOSS Third Asia-Pacific Symposium Douglas Cripe (*GEO Secretariat*)

09:10-09:40 ***Outlook of the Water Cycle in the Asia-Oceanic region***
09:20-09:50 Water-related Disasters in the Asia-Oceanic Region Kaoru Takara (*KU/DPRI*)

09:40-12:00 ***Short country reports on "Recent Signs of Water-related Disasters"***
GEOSS/AWCI participating countries: Bangladesh, Cambodia, India, Indonesia, Japan, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Uzbekistan, Vietnam

Opening
The session was opened by Dr. Douglas Cripe, GEO Secretariat, who has stressed the importance of Integrated Water Resources Management (IWRM) for coping with water-related disasters and the necessity of data sharing for the IWRM practices. The GEOSS data sharing principles include:
- There will be full and open exchange of data, metadata, and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation.
- All shared data, metadata, and products will be made available with minimum time delay and at minimum cost.
- All shared data, metadata, and products being free of charge or no more than cost of reproduction will be encouraged for research and education.
- All new members of GEO are required to endorse the Plan and therefore these Principles.

Dr. Cripe further reiterated that GEOSS is about:
- Ensuring Access for All
- Making Basic Data Sets Available
- Developing End-to-end Services
- Coordinating and Sustaining Observing Systems

Outlook of the Water Cycle in the Asia-Oceanic region
Prof. Kaoru Takara, Kyoto University, Disaster Prevention Research Institute, gave an overview of the major types of water-related disasters in Asia-Oceanic region that include: Floods, Landslides, Extended droughts, Tropical Cyclones, Typhoons. Floods are major disaster in the world and in Japan and humid areas in Asia the level of floods has been increasing in past 2 decades. Prof. Takara pointed out that though many mechanisms causing the disasters have been clarified, there is still plenty of remaining issues that require further geoscience research. He also emphasized that IWRM practices and public awareness are critical for preventing water-related disasters and resulting damages.

Short country reports

In this session, the AWCI country representatives introduced the major water-related risks in their countries and provided overview of the recent disasters and possible trends in their occurrence. In total, 15 reports were given including following countries: Bangladesh, Cambodia, India, Indonesia, Japan, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Uzbekistan, and Vietnam. Floods were identified as the most severe and most common disasters that all countries are suffering from. Also common features of floods in different regions were identified. The representatives also introduced methods and systems used for floods and other disasters predictions, risk management, and impact mitigation. While in some countries, advanced integrated systems are being made operational, other countries still have high needs for capacity building in this area.

The main presentation and discussion points of the Water Cycle in the Asia-Oceanic Region session were summarized in the Table 1 below. The common issues and available/needed capacities suggested possible areas for closer collaboration including the effective framework established through the GEOSS AWCI. The strategy of such expanded collaboration was discussed at the following interdisciplinary session "Toward Actual Collaboration among Climate, Water Cycle, and Disasters".

Table 1: The session summary table. Yellow color indicates items highlighted by individual country representatives

			BD	BT	CB	IN	ID	JP	MY	MM	MN	NP	PK	PH	SL	TH	UZ	VT
	Flood	13																
	Typhoon/Cyclone	5																
	Localized torrential rainfall	3																
	GLOF	1																
	Snowmelt Flood	1																
	Avalanche	1																
	Glacier	3																
	Landslide/Mudflow	6																
	Bank Erosion	2																
	Tsunami	3																
	Drought	5																
	Water Logging	1																
	Cold Wave	1																
	Climate Change	8																
	Meteorological Observation	3																
	Hydrological Observation	2																
	Data and Information System	4																
	Weather Forecast	1																
	Flood Forecast	1																
	Land Use	1																
	Hazard & Risk Mapping	3																
	Counter Measure/Mitigation	5																
	Decision Making Support	1																

2.2 Toward Actual Collaboration among Climate, Water Cycle, and Disasters SBAs

Climate observation and prediction systems provide data and information that is broadly useful to the Water Cycle area. The Water Cycle SBA/projects then combine then own data with outputs from Climate systems/projects, producing integrated data sets and other derived products, which can in turn be passed on to other societal benefit areas, for example, Disasters SBA. In this way, a comprehensive understanding of issues in the Disasters area can be gained through interoperable use of data and information from the other areas. As the managers of Climate systems react to this broader market for their outputs, they become more attuned to making products that are responsive to these broader user requirements.

GEOSS will be able to provide opportunities for such interconnection between various societal benefit areas. To accelerate to share implementation experiences, as well as their data product availability and requirements of contributing systems, it was discussed how to cooperate and coordinate among different societal benefit areas, Climate, Water cycle and Disasters, and to make plans for carrying the ideas into actions.

The session agenda

13:00-13:10 ***Opening "Climate-Water Cycle-Disasters" Joint Session***
13:00-13:10 Breakout Session Design *E. Nakakita*

13:10-15:00 ***Short reports on "What is on-going and/or planned?"*** *(10min each)*
- Climate Projection *A. Kitoh (MRI)*
- Applications of Climate Models to Water-related Disaster *E.Nakakita (KU/DPRI)*
- GEOSS-WCRP collaboration in MAHASRI and HARIMAU *M. Yamanaka, J. Matsumoto (JAMSTEC)*
- Recent change in global sea surface layer salinity detected by Argo float array - Footprint of enhanced hydrological cycle *S.Hosoda (JAMSTEC)*
- Abnormal hydrological condition and disaster due to Arctic *T.Ohata (JAMSTEC)*
- Water Productivity Mapping using Remote Sensing to solve Global Food Crisis *P. Thenkabail (USGS)*
- Global Mapping Project *Y.Fukushima (MLIT/GSI)*
- Sentinel Asia and SAFE *T.Moriyama (JAXA)*
- ICHARM Commitments to enhance regional cooperation in Asia and Pacific *K. Fukami (ICHARM)*
- Water for the World *T. Wiener (IEEE)*
- WCRP/GEWEX/CEOP *S.Williams (NCAR/EOL)*

15:00-15:20 ***Break***

15:20-17:30 ***Direction of Alliance's Efforts***
14:50-15:20 Data and Information Sharing Approach *R. Shibasaki*
15:20-17:30 Discussion for Implementation *All*
  - Target Topics and Fields:
    Typhoon and Cyclone/Drought/Cold Surge/Snow and Glacier
  - Regional Coordination Framework
  - Linkage to Global Coordination Framework
  - Building capacity
  - Planning Strategy

17:30-18:00 ***Closing "Climate-Water Cycle-Disaster" Joint Session***
17:30-17:50 Session Summary *T. Koike*
17:50-18:00 Concluding Remarks *GEO Secretariat*

Opening
The session was opened by Prof. Eiiji Nakakita, Kyoto University, Disaster Prevention Research Institute, who explained the purposes for organizing this interdisciplinary session among different societal benefit areas and its design and objectives. He has emphasized that all the GEO SBAs are naturally related but in particular in case of Climate, Water Cycle and Disasters, the mutual connections are substantial and the interdisciplinary approach towards addressing the pressing issues would be beneficial for all groups.

Short reports on on-going/planned activities related to the Climate, Water Cycle and Disasters SBAs

A total of 11 talks were given in this session as listed in the session agenda that introduced various on-going and planned activities that either were truly interdisciplinary dealing jointly with the Climate, Water Cycle and Disasters SBA issues or could be exploited in more collaborative way to address other SBA issues than originally designed for. The introduced activities included projects focusing on climate projection methods and climate scenarios impacts assessment; projects on further research into the climate changes and their impacts on regional and global level; projects on advanced mapping technologies and their capabilities; integrated observation and data integration systems projects; and projects focusing on capacity building and enhancing cooperation in the region.

Direction of Alliance's Efforts

This session was opened by Prof. Ryosuke Shibasaki, University of Tokyo, who emphasized the importance of proper metadata without which data sharing would be very difficult. He explained the basic principles for making data and data products interoperable and mentioned the example of the metadata structure definition based on ISO-19115 that is being used for DIAS, CEOP, and AWCI projects. He also highlighted the need to develop metadata registries offering tools that enable data providers to generate metadata on their data in an effective manner. It was pointed out that GEO Architecture and Data Committee has inputted a task in their Task plan on metadata registry and ontology to support data providers as well as metadata design development.

The session further continued through the planning strategy discussion for cooperation/coordination that resulted in identification of next step activities. Four target topics and fields were defined based on the outcomes of the country reports on disasters that could be considered as the main areas for cooperation. These include:

1. Typhoon, cyclone, and induced floods
2. Drought
3. Cold surge
4. Snow, glaciers, GLOF

The discussion on each of the above target topics included the four items: (i) regional coordination framework; (ii) linkage to global coordination framework; (iii) building capacity; and (iv) planning strategy, considering the on-going and planned activities introduced in the previous session. The enthusiastic and productive discussion brought plenty of ideas and suggestions for enhanced cooperation.

In case of Typhoon and cyclone theme, the focus should be on integrated data systems that would enable data and information sharing on a real- or near real-time basis that is critical for early warning and disaster management. Also the need to advance the research into the mechanisms of the typhoon and cyclone phenomena within the context of larger scale situation was mentioned. Oceanographic data are of high importance and thus closer collaboration is needed with oceanography groups.

The importance of a regional approach to the drought issues was emphasized as droughts are usually affecting larger areas. Collaboration with agriculture experts is desirable.

The basic mechanism of Cold Surge was explained and its role in heavy rain events in some areas emphasized. The effect of local processes in connection with large-scale circulation is crucial in case of Cold Surge and needs to be further studied. A collaborative study between science communities and operational sectors maybe needed.

Regarding the Snow, glaciers, and GLOF theme, it was reported that certain databases exist in the Himalayan area and further cryospheric observation network and database for the Asian region is being developed through joint research projects. What is needed to be developed are prediction models of snow and ice mass changes and early warning systems for disasters associated with GLOF and other cryosphere-related events.

In general, it was concluded that good and relatively comprehensive datasets would be available for:

1. Integrated Water Resources Management focus in each country
2. Regional activities focused on the four target topics for which regional coordination framework is very important.

In addition, it was emphasized that it would be mutually beneficial to share ideas and policies on adaptation and disaster management on common issues. A matrix was developed showing possible cooperation linkages that is shown in Table 2.

Conclusion of the two Water-related sessions

The "Water Cycle in the Asia-Oceanic Region" and "Toward Actual Collaboration among Climate, Water Cycle, and Disasters" sessions were concluded with the message that: "Data information, science and technology, cooperation framework, and the members are now ready to expand interdisciplinary cooperation that would bring mutual benefits".

The group has proposed planning strategy with a particular steps that will be undertaken before the next, 4th GEOSS AP Symposium:

- Countries and organizations will submit proposal on the targeting topic(s)
- A three-day workshop will be held to discuss:
    1. Sharing Societal Needs, Scientific Ideas, Observation Capability, Modeling Capability, Experiences
    2. Seeking Data Sharing Possibility: Data Policy, Meta Data Generation and Data Infrastructure
    3. Establishing Cooperation Framework under GEO
- Forming a Task Team for drafting an Implementation Plan
- Discussing the draft at the 4th GEOSS AP Symposium

Table 2: Cooperation Linkages

		IWRM	Typhoon/Cyclone Adaptation	Drought	Cold Surge	Snow/Glacier/GLOF
Hydro. Obs.	AWCI Demo Basin	X	X	X	X	X
Basin Meta	AWCI Demo Basin	X	X	X	X	X
Integrated Obs.						
Land-Atmos.	JAMSTEC, CEOP	X	X	X	X	X
Ocean	JAMSTEC	X	X		X	
Model Weather	NWPCs, CEOP	X	X	X	X	X
Model Climate	KAKUSHIN, CMIP3/5	X	X	X	X	X
	DIAS	X	X	X	X	X
Satellite	Sentinel Asia	X	X	X	X	X
	SAFE	X	X	X	X	X
	CEOS	X	X	X	X	X
	CEOP	X	X	X	X	X
	WCRP CliC					X
Climate Obs.	Nations, GCOS	X	X	X	X	X
Geographic Data	GMP, Global DEM	X	X	X	X	X
Irrigation/Rain fed Productivity	GIAM, GMRCA (IWMI, USGS)	X		X		
Scientific Knowledge	Intl. Sci. Communities					
	KAKUSHIN	X	X	X		X
	CEOP	X	X	X	X	X
Capacity Building	AWCI/CB	X	X	X	X	X
Regional Coordination	APN	X		X		
	ICHARM	X	X	X		X
	Typhoon Committee		X			
	ICIMOD					X
	UNU, ADB,					
Case Study	IEEE	X				
	Member countries					
Counter Measures	Member countries					

2.3 The 4th International Coordination Group Meeting of the GEOSS AWCI ICG

To accelerate the GEOSS/AWCI coordination, especially on “Data Integration” and “Capacity Building”, by reviewing and sharing the updated status of the GEOSS, the AWCI demonstration projects, and the related sciences.

The session agenda

Friday, 6 February 2009:

13:30 – 14:00 1. Opening by Guest Speakers
1.1 Hirota Tani, MEXT
1.2 Linda Anne Stevenson, APN
1.3 Douglas Cripe, GEO Secretariat

14:00 – 14:20 2. GEOSS/AWCI Overview and Meeting Objectives *T. Koike*

14:20 – 15:00 3. Science Interaction Session – Land Use
3.1 Paddy Field Monitoring by Satellite *W. Takeuchi*
3.2 Global Irrigated Area Map (GIAM) and Global Map of Rainfed Cropland Areas (GMRCA) *P. S. Thenkabail*

15:00 – 15:20 ***Break***

15:20 – 17:30 4. “Capacity Building” Implementation Plan Development
4.1 Plenary session; Objectives and guidance *S. Herath and C. Ishida*

4.2 Breakout sessions

All

- Floods WG
- Drought WG
- Water quality WG
- Climate Change WG

4.3 Plenary session; WG reports and coordination

17:30 ADJOURN

Saturday, 7 February 2009:

9:00 – 9:40 5. Scientific Reports

5.1 Land-Lake-Atmosphere Interaction and its Effects on Local Water Use	*K. Tsujimoto*
5.2 WEB-DHM and IWRM	*L. Wang*

9:40 – 10:30 6. Data Management (1)

6.1 GEOSS/AWCI data archiving update	*K. Tamagawa*
6.2 Data loading and quality check	*E. Ikoma*

10:30 – 10:50 *Break*

10:50 – 12:00 6. Data Management (2)

6.3 Thailand Hydroinformatics System	*S. Malaikrisanachalee*
6.4 Data Infrastructure – present situation and future prospects	*M. Kitsuregawa*
6.5 Meta-data Registry	*H. Kinutani*

12:00 – 13:00 *Lunch*

13:00 – 14:30 7. Special Panel Session on "Promotion of Water Quality Study"
H. Furumai, and Flood/Drought/Climate Change WG Chairs

14:30 – 15:00 8. Summary and Way Forward *T. Koike*

Opening

The meeting was opened by representatives of Ministry of Education, Culture, Sports, Science, and Technology, Japan (MEXT), Asia-Pacific Network for Global Change Research (APN), and GEO Secretariat. **Mr. Hirota Tani, MEXT,** emphasized the Ministry's recognition of the importance of water resources issues and expressed Ministry's support of the data integration and analysis efforts and capacity building activities that are being undertaken by GEO and GEOSS AWCI. **Dr. Linda A. Stevenson, APN,** mentioned that APN strongly supports activities of GEOSS AWCI that was initiated with a significant contribution of an APN funded project. Currently, three projects under AWCI are financially supported by APN through ARCP and CAPaBLE. Dr. Stevenson advised the participants that APN's budget would be increased and APN planned to allocate the additional funds to enhance activities in climate change theme, in particularly training sessions on downscaling the global information for local use. **Dr. Douglas Cripe, GEO Secretariat**, highlighted the principles for GEO capacity building that include: (i) focus on user needs; (ii) building on existing efforts and best practices; (iii) fostering collaboration and partnership; (iv) enhancing the sustainability of earth observations; and (v) holistic approach: consider all the SBAs at the global, regional, and local levels.

GEOSS/AWCI Overview and Meeting Objectives

The opening talks were followed by introduction of the meeting objectives and the GEOSS AWCI overview given by the AWCI leader, **Prof. Toshio Koike, University of Tokyo**. Prof. Koike summarized the outcomes of the **3rd GEOSS AWCI ICG meeting** that was held in Beijing, 6 November 2008 and was connected to the 4th Conference of the Asia Pacific Association of Hydrology and Water Resources (APHW). At this occasion, a special AWCI session was held as a part of the APHW conference that introduced scientific work related to the AWCI activities. The 3rd AWCI ICG meeting sessions included demonstration project update reports, AWCI activity reports (GEOSS

current status, undertaken capacity building activities, and working group reports), establishing a new working group on "Climate Change Impacts and Adaptation", metadata and data archiving and data quality check demonstration, and capacity building implementation strategy discussion. The 3rd AWCI ICG meeting outcomes included:

1. New AWCI working group on climate change impacts and adaptation was established, the Co-Chairs are Prof. Deg-Hyo Bae, Korea, and Prof. Mafizur Rahman, Bangladesh.
2. The metadata and data upload system is ready the actual data and metadata provision by countries has begun but it is desirable to expedite this process in accordance with the demonstration projects implementation plan. Progress would be reported at the 4th AWCI ICG meeting in Kyoto, February 2009.
3. Capacity building strategy focuses on the identified 3 target groups: (i) researchers/scientists, (ii) professional/practitioners, and (iii) administrative/local government officers; and follows 3 approaches towards the capacity building pilot projects (PP) proposed and agreed earlier: (i) country based PP; (ii) training module based PP; and (iii) country data plus training module based PP. The ICG members are expected to introduce concrete proposals by the Kyoto meeting, where actual plans will be discussed.

In addition, Prof. Koike gave an overview of the "water" breakout sessions that took place as a part of the GEOSS AP Symposium on Thursday 5 February and introduced the outcomes of these sessions and implication for further AWCI development.

Scientific sessions

The meeting included two scientific sessions. The first one focused on land use issues and introduced the methodology for paddy field monitoring using satellite data and the global maps of irrigated and rainfed croplands. The outcomes of these efforts might be very useful in various AWCI projects. The second scientific session scheduled a talk on land-lake-atmosphere interaction at a local scale and a talk on applicability of an advanced distributed hydrological model for the IWRM purposes. These talks were also very inspiring for the AWCI project planning.

"Capacity Building" Implementation Plan Development

The session was opened by **Mr. Chu Ishida** who summarized the past developments of the AWCI integrated capacity building strategy that was formulated based on the outcomes of capacity needs and available resources surveys. The objective is to show the applicability of available data, information, models, algorithms, and systems at AWCI demonstration basins in order to overcome water issues.

Modules available from resource organizations include:

- Data Integration System, quality control (CEOP)
- Global flood alert system, hazard mapping (ICHARM)
- Satellite Data, Mini-projects, Sentinel Asia (JAXA)
- Flood hazard mapping, emergency manage (MRC)
- Floods inundation modeling, rainfall downscaling (UNU)
- Radar rainfall, real-time forecast (Sejong University)
- Flood simulation, dam operation (University of Tokyo)

The location of the training modules is schematically shown in Figure 1.

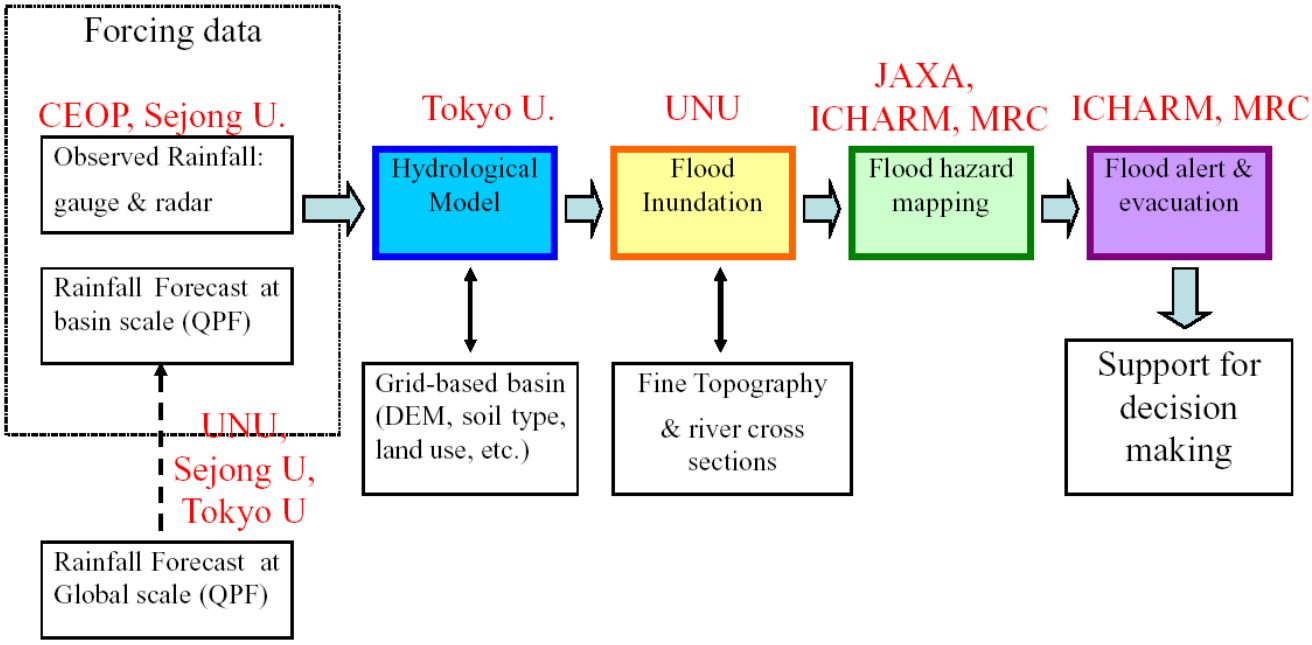


Figure 1: Location of capacity building training modules

In addition, Mr. Ishida introduced present JAXA's Capacity Building Activities for the Asia-Pacific Region that include number of Mini-projects in cooperation with Geo-Informatics Center, Asian Institute of Technology (GIC-AIT).
The next talk, given by **Prof. Srikantha Herath, UNU**, reiterated the guiding principles of capacity development and emphasized that the capacity development program is based on the local needs. The AWCI capacity building activities are closely related to the AWCI demonstration projects and are pursued through the framework of four working groups (Flood, Drought, Water Quality, and Climate Change). Prof. Herath further reported on the UNU capacity building activities, especially training seminars and workshops for scientists and researchers using country data. In support of the AWCI CB program, the UNU group has constructed an on-line repository that contains information on AWCI CB activities including available training modules and is editable by all members. It provides a module information template for organizations to provide information on available training modules. The site is available at: http://unufms.net:8080/seaside/gcs/AWCI and countries were invited to propose hosting of workshop or seminar in their country.

Breakout group sessions
After the two introductory talks, the breakout sessions on Flood, Drought, Water Quality, and Climate Change took place. The groups were asked to discuss and formulate a concrete proposal for training modules:

Flood WG proposed a workshop to be held at AIT, Thailand, in FY2009 that would last 2 days at least, include GFAS and IFAS, and consider 10 – 20 participants. In addition training on rainfall downscaling with WRF model was proposed for country representatives to be followed by local roving seminar.

Drought WG reported the need to continue the scientific discussion to finalize the details of the proposed drought monitoring study, ecpecially to identify common drought indices. Accordingly, the group proposed a scientific workshop on drought research to be held in the September-October 2009 timeframe that will be followed by a drought monitoring training workshop.

Water Quality WG reiterated its past activities and reported the need of recognition of the water quality issues at "effective level" because without considering water quality, IWRM cannot be implemented. Also empahsized was the need of capacity building at the scientific level and improve water quality monitoring. The group proposed following items for AWCI CB program: (i) identify hydrological models that could be coupled with water quality models, (ii) satellite data for watershed management

monitoring, and (iii) an on-going training initiative utilized to help water quality experts to use satellite data.

Climate Change WG was formed at the Beijing meeting in November 2008 and thus outlined its plans that include (i) historical observation data analysis for finding the evidence of climate change and (ii) future projections by GCM outputs from specific greenhouse gas emission scenarios, downscaling and hydrological model applications. The focus will be on assessment of the impact on food security and water cycle. The near future action plan includes work with the flood working group regarding capacity building for the data downscaling; preparation and submission of a project proposal; and workshop on the developed methodology for the climate change and impact assessment.

Data Management

This session reviewed the status of the AWCI demonstration project metadata and data submission and also provided a comprehensive guidelines for utilizing the tools designed for metadata and data upload and data quality control that were developed by the University of Tokyo in cooperation with the DIAS project. A good progress has been reported in terms of the demonstration project metadata and data submissions. The current status is summarized in the Table 3 below.

In addition to the AWCI data system detailed introduction and its use demonstration, Dr. S. Malaikrisanachalee presented the Thailand Hydroinformatics System and its development and capabilities. Furthermore, Prof. M. Kitsuregawa gave an overview of the present situation and future prospects of data infrastructure. He introduced “cloud computing” and “elastic services” – newly emerging terms in the IT community and emphasized the importance of data and care of data that has been recognized by scientists and experts in all the fields but still need to be fully appreciated by policy and decision makers.

Special Panel Session on “Promotion of Water Quality Study”

This session was planned in order to promote the water quality study within the context of other AWCI activities and was opened by a summary of **Dr. Bilqis Hoque’s** presentation from the previous day emphasizing the idea to carry out an integrated study of flood and water quality. After that, **Prof. Hiroaki Furumai** introduced their recent study on Water quality monitoring under dry and wet weather conditions in the downtown of Hanoi city that could be expanded into the proposed integrated study of flood and water quality.

Table 3: Status of the AWCI demonstration project metadata and data submisstion

After the introductory talks, the panel discussion took place that focused on the following items:

- Idea on the integrated study of flood and water quality – case study is needed
- Candidate basins

	Country	Basin Name	Basic Info.	Raw DataUpload		Quality Control		Metadata Initial Registration		Metadata Update	Remarks
			Complete	Ready	Complete	Ready	Complete	Ready	Complete	Complete	
1	Bangladesh	Meghna	09/01/20	09/01/20							
2	Bhutan	Punatsangchhu	09/01/20	09/01/22	09/02/03	09/02/05	△	09/02/05			
3	Cambodia	Sangker	08/10/30	09/02/06	△			08/11/04			
4	India	Seonath	08/07/22	08/08/22	○						
5	Indonesia	Mamberamo	09/01/20	09/01/20	○						
6	Japan	Tone	08/10/30	08/12/26	08/12/26	09/01/18	△	08/12/26			
7	Korea	Upper Chungju-dam	08/08/05	08/08/05	08/10/02	08/11/02		08/11/04			
8	Lao PDR	Sebangfai									
9	Malaysia	Langat	09/02/06	09/02/06							
10	Mongolia	Selbe	08/07/22	08/08/22							
11	Myanmar	Shwegyin	09/01/22	09/01/22	○						
12	Nepal	Bagmati	08/11/10	08/11/12	09/01/17						
13	Pakistan	Swat	08/07/22	08/08/22	△						
14	Philippines	Pampanga	08/08/05	08/08/22	○						
15	Sri Lanka	Kalu Ganga	08/08/05	08/08/22	09/01/20						
16	Thailand	Mae Wang	08/08/05	08/09/01	09/01/31						
17	Uzbekistan	Chirchik-Okhangaran	08/08/05	08/09/01	○						
18	Vietnam	Huong	08/07/22	08/09/04	○						

YY/MM/DD : Handling Date — Completely Finished

○ : Full Data provided by offline

△ : Partial Data provided by offline — Partially Finished

The proposed ideas for the water quality study included:

1. ICHARM has been carrying study on water quality degradation in diminishing water resources that involves distributed hydrological model coupled with a module introducing pollution sources. This model can be used for the AWCI water quality pilot study.
2. WEB DHM developed at the University of Tokyo can also be coupled with a water quality module or the model introduced by Prof. Furumai. A study is already being planned in the Hue river basin in Vietnam.
3. The study should be carried out in the context of water quantity, i.e. flood/normal conditions/drought.
4. Exploration of possibilities to use remote sensing data for water quality issues through enhanced discussion with experts in this field. Remote sensing for inundation mapping.
5. Need to involve more water quality experts from AWCI participating countries to activate the water quality study.

The candidate basin should fulfill the following criteria:

- Longer data record in basin (climatology analysis desirable)
- Reasonable size including urban area (pollution source)
- Flood and drought conditions occurring in the basin
- Hydrological model calibrated for the basin

It was concluded that possible candidate is the Hue river basin in Vietnam including Hue city urban area. It has a reasonable size, hydrological and water quality studies have been carried out and

hydrological model has been developed there. The issue may be with the water quality data, additional sampling in the upstream of the Hue city is necessary.

Closing of the 4th AWCI ICG meeting

Prof. Toshio Koike, UT, summarized the meeting including the message from the GEOSS AP Symposium "water" sessions. He emphasized good potential for expanded collaboration between AWCI current activities and Disasters and Climate Change SBAs of GEOSS.

The scientific talks introduced some new findings and advanced tools and methods that could be exploited in the AWCI activities and great interest of participants in these methods/tools was shown in ensuing discussions.

A good progress was reported in the AWCI demonstration projects data and metadata submission and the AWCI representatives expressed their intention to continue in this effort at the same level. They acknowledged the provided explanation and demonstration of the data and metadata upload system and data quality control tools.

The AWCI capacity building program has been developing well and concrete training seminars are being proposed. The on-line repository developed by UNU was found very useful and will facilitate effective planning of CB activities. Several seminars/workshops took place in 2008 and their outcomes were reported. The AWCI working groups are at different level of development and thus have different needs for capacity building programs. These needs were discussed and concrete activities proposed. A possible water quality study in cooperation with other groups was discussed during a special panel discussion and a framework and basic features of such study were proposed.

In his closing remark, **Dr. Douglas Cripe**, GEO Secretariat, acknowledged the progress of the AWCI and its openness to expand collaboration across other GEOSS SBAs. He highlighted that the AWCI organization, approaches, and activities are fully in accord with the GEO principles and as such has full support of the GEO Secretariat.

In conclusion, particular steps were proposed to step forward that include:

- Countries and organizations will submit proposal on the targeting topic(s)
- A three-day workshop will be held to discuss:
    4. Sharing Societal Needs, Scientific Ideas, Observation Capability, Modeling Capability, Experiences
    5. Seeking Data Sharing Possibility: Data Policy, Meta Data Generation and Data Infrastructure
    6. Establishing Cooperation Framework under GEO
- Forming a Task Team for drafting an Implementation Plan
- Discussing the draft at the 4th GEOSS AP Symposium

Appendix 4: Summary report on the 6th ICG meeting

SUMMARY REPORT ON

The 6th International Coordination Group (ICG) Meeting of the GEOSS Asian Water Cycle Initiative (AWCI)

held

at the Sanur Paradise Plaza Hotel, Bali, Indonesia, 13 March 2010.

(Final draft: 2 June 2010)

The **Sixth GEOSS AWCI ICG meeting** was planned and undertaken to accelerate the GEOSS/AWCI coordination focusing on promotion of regional cooperation on climate change adaptations that was recognized as one of the main challenges of AWCI at the Fifth GEOSS AWCI ICG meeting held in Tokyo, Japan, December 2009. About 40 participants from 16 countries assembled during the meeting and discussed the topics included on the meeting agenda that reflected the outcomes of the 5th AWCI ICG meeting. The result of those discussions is summarized in this report. All of the presentation material provided by the participants at the meeting is available on the Internet through the meeting home page at: http://www.editoria.u-tokyo.ac.jp/awci/6th/presentation.html.

1. Executive Summary of Main Issues/Conclusions and Actions

The meeting was held in conjunction with the 4th GEOSS Asian Pacific Symposium that took place at the same venue, 10 – 12 March 2010 and included a special parallel session on "Hydrometeorological-Related Disaster and Water Resources Management" to which AWCI participating countries and working groups significantly contributed.

A brief executive summary of the AWCI ICG meeting and GEOSS AP water-related session is given in this section, further details follows in sections 2.1 and 2.2 below.

1.1 Hydrometeorological-Related Disaster and Water Resources Management Session

The GEOSS Asian Water Cycle Initiative (AWCI), including its four working groups on floods, droughts, water quality and climate change, has been building a regionally cooperative framework by involving experts from 20 countries. The focus is on sharing data, models, experiences and knowledge and on implementing capacity-development programs. Participants considered further convergence and harmonization of observational activities, analytical and down-scaling techniques, interoperability arrangements, and effective and comprehensive data management as the most fundamental elements for mobilizing the efforts by AWCI to create societal benefits.

The participants in the session on Hydrometeorological-Related Disaster and Water Resources Management requests the Beijing Ministerial Summit to recognize the direction and achievements of AWCI as one of the most effective regional approaches for climate change adaptation and to endorse its activities at the national and regional levels for improving the efficiency of operational water resources management.

1.2 The 6th GEOSS/AWCI International Coordination Group Meeting

The meeting reviewed accomplished and on-going activities and recognized good progress in all four working groups – flood, drought, water quality, and climate change. In particular, demonstration project data submissions, data quality control, and also metadata registration has progressed significantly since the last reporting period. The demonstration project activities in individual basins have been launched and have advanced in concert with the GEOSS/AWCI implementation plan. Also implementation planning in the three focus areas – (i) typhoon, cyclone, and induced floods; (ii) drought; and (iii) snow, glacier, and GLOF – has progressed and concrete activities are proposed aimed toward climate change impact assessment and adaptation strategies. Owing to the well populated DIAS archive including the demonstration basin data, global datasets and in particular climate projection model outputs, opportunities have arisen for climate change impact assessment and adaptation studies. Implementation chart for such studies was proposed and agreed by the participants (Fig. 8 on page 15 below).

The GEOSS/AWCI capacity building program continues in successful implementation of a number of training modules that are based on identified needs in the region as well as individual countries. The web-based interactive repository of available modules and proposed seminars that was developed by UNU is a very supportive tool that facilitates better coordination in planning the events. Also newly suggested web tutorials of individual training modules will be available through this website. The proposed further direction of the CB program is toward integration of research, capacity development and applications including capacity development programs for training a large number of competent persons and higher education research.

Two short training courses were held on the DIAS data quality check and metadata registration tools and the ICHARM flood management system IFAS, respectively. Metadata registration was accomplished for several basins during the practical exercise of the DIAS tool course.

The 4th Asian Water Cycle Symposium was proposed be held before the GEO Ministerial Summit in November 2010, most probably in October in Tokyo, Japan, in conjunction with a related ministerial-level meeting organized by MLIT, Japan. Confirmation and further details will be announced in due course.

Concluding messages were formulated:

Although climate change adaptation requires socially and economically efficient and sustainable management of the world's limited supplies of freshwater, this precious resource cannot be managed unless we know where the water is, its quantity and quality, and how its variability will change in the future.

This knowledge base relies upon our ability to measure and monitor precipitation, water quantity and quality and our continued efforts to improve our physical, chemical, biological, and ecological understanding of the water cycle.

Based on the reports and discussions at the GEOSS-AP symposium and the ICG meeting, the participants recognized the commonality and regionality of water-related issues and socio-economic impacts caused by water-related problems associated with the climate change in the Asia-Pacific region.

It was agreed that well-coordinated scientific research initiatives along with a combination of global Earth observations and integrated data provided by GEOSS are essential to adequately address these issues.

Message to the GEO ministerial summit:

The Summit is requested to recognize the direction and achievements by GEOSS/AWCI as one of the most effective regional approaches for climate change adaptations and to endorse its

activities in each country and the Asia-Pacific region in improving the efficiency of operational water resources management.

2.1 Hydrometeorological-Related Disaster and Water Resources Management – full report

Floods, droughts and water pollution are commonly severe problems in Asia-Pacific region. In addition to the rapid population growth and urban expansion, climate change is changing the water cycle. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) projected more frequent heavy precipitation events, an increase in the area affected by drought, and more intense tropical cyclones (typhoons and hurricanes) associated with global warming (IPCC, 2007). Changes in water resources, from melting glaciers to increased floods, droughts, and sea level rise, amongst others, will impact significantly on socio-economic development and the environment in unprecedented ways. GEOSS is strongly expected to provide usable information for sound decision making on climate change adaptations in the field of water resources management.

The objective of this parallel session was to review various plans and on-going actions in the Asia-Pacific regions and discuss how to cooperate and coordinate regionally and globally in order to accelerate sharing of implementation experiences, as well as data product availability and requirements of contributing systems within GEOSS.

The session agenda

Morning session: Co-Chairs: **Rick Lawford & Leonarda B. Ibnu Said**

09:00-09:10 ***Opening Water Session***

09:00-09:05 Welcome and introduction to session Objectives — Session Co-Chairs

09:05-09:15 Introduction to Hydrometeorological-Related Disaster and Water Resources Management — Toshio Koike (University of Tokyo (UT))

09:15-09:50 ***Report form the 5th GEOSS/AWCI International Coordination Group Meeting***

Drought	Rasul Ghulam (PMD)
Typhoon and Cyclone	Kazuhiko Fukami (ICHARM)
Snow, Glacier, and GLOF	Toshio Koike (UT)
Climate Change Adaptation	Mafizur Rahman (BUET)

10:00-12:00 ***Short country reports on "Climate Change Impact Assessment and Adaptation"***

GEOSS/AWCI participating countries: Australia, Bangladesh, Bhutan, Cambodia, China, Indonesia, Japan, Malaysia, Mongolia, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand, Uzbekistan, Vietnam

Afternoon session: Co-Chairs: **Toshio Koike and Eddy Hermawan**

13:00 – 14:00 ***Short reports on "What is on-going and/or planned"***

Geo-Water	Rick Lawford (Canada)
Global Mapping	Shuhei Kojima (Japan)
Water Management	Hidayat Pawitan (MHI, Indonesia)
Indonesian Climate Model	Didi Satiadi (LAPAN, Indonesia)

14:00 – 15:40 ***Socio-Economic and Political Approach***

APWF Water and Climate Change Steering Group	Toshio Koike (Japan)
Policy-Science-Engineering Collaboration	Wu Xun, Gopi Rethinaraj, Priyanka Anand (NUS)
Water quality: an inseparable perspective of Disaster and Water Resources Management	Bilqis A. Hoque (Bangladesh)
Discussion for Implementation	Moderators: Wu Xun, Gopi Rethinaraj (NUS)

15:40 – 16:00 ***Closing Session***

Session summary — Co-Chairs

Closing remarks Co-Chairs

Opening

The session was opened by session Co-Chairs Rick Lawford (GEO Water: IGWCO) and Leonarda B. Ibnu Said (Ministry of Public Work of Indonesia) who provided welcome remarks and stressed out the importance of regional collaboration for pursuing assessments of climate change impacts on water resources and hydrometeorological-related hazards as well as for development and implementation of adaptation plans.

Prof. Toshio Koike then introduced evolution of the Hydrometeorological-Related Disaster and Water Resources Management theme since the 3rd GEOSS Asian Pacific Symposium that was held in Kyoto, Japan, February 2009. At that Symposium, participants discussed on how to cooperate and coordinate among different societal benefit areas, Climate, Water cycle and Disasters, and to make plans for carrying the ideas into actions. Four main focus areas were identified for collaboration including: (i) Typhoon, cyclone, and induced floods, (ii) Drought, (iii) Cold surge, and (iv) Snow, glaciers, and GLOF. Nevertheless from the ensuing survey was concluded that the interest of GEOSS/AWCI participating countries in the Cold surge is not as significant as in other three areas and thus the Cold surge theme has not been considered for further discussion. On the other hand, the Climate Change adaptation issue has been brought up as an overarching, key focus of the GEOSS/AWCI activities.

In general for all the proposed focus areas, key actions were proposed that included: (i) Activating modeling activity and accumulating knowledge, (ii) Promoting collaboration among data integration centers, and (iii) Considering the characteristic meteorological environment in the Equatorial region. Particular steps to implement the proposed activities were outlined:

- Countries and organizations would submit proposal on the targeting topic(s)
- A three-day workshop would be held in fall 2009 to discuss:
  7. Sharing Societal Needs, Scientific Ideas, Observation Capability, Modeling Capability, Experiences
  8. Seeking Data Sharing Possibility: Data Policy, Meta Data Generation and Data Infrastructure
  9. Establishing Cooperation Framework under GEO
- Implementation Plan discussion
- Reporting to the 4th GEOSS AP Symposium in Bali, Indonesia, 2010

Per the proposed schedule, a four day meeting event was held in Tokyo, 15 – 18 December 2009 that included the 5th GEOSS/AWCI ICG meeting, a part of which was the IWRA-GEOSS/AWCI Joint Symposium, and the Joint Training Workshop on the Application of Remote Sensing Products on Drought Monitoring in Asia. The meeting was directed “Toward regional and interdisciplinary collaboration for addressing our common water-related issues in Asia by making maximum use of GEOSS” and the discussion focused on collaboration with on-going AWCI Demonstration Projects and with the Water Quality group, and on data and capacity building needs for promoting the activities. The discussions were led in the context of Climate Change Adaptations and it was concluded that “End to End approach” (Fig. 1) was necessary for successful implementation of the envisioned activities.

Further, Prof. Koike provided updated status of the GEOSS/AWCI Demonstration basins data submissions to the DIAS data system as well as the Demonstration Project implementation progress. More than 70% of expected demonstration basin data has been submitted and quality-checked and multiple studies have been carried out at these basins as part of Demonstration Projects. In addition, plenty of further data including in-situ and satellite observation data and model outputs is now available at DIAS and can be exploited for implementing the GEOSS/AWCI activities.

Report from the 5th GEOSS/AWCI ICG Meeting

Outcomes of the discussions per individual focus areas at the 5th GEOSS/AWCI ICG Meeting were presented during this session.

The **Drought theme** was represented by Dr. Ghulam Rasul who introduced its four main objectives that include: (i) to build up a drought monitoring and researching network of member Asian countries, (ii) to share and improve the drought monitoring data/capability in various Asian countries, (iii) to make a collaboration with the demonstration projects studying climate change, and (iv) to help

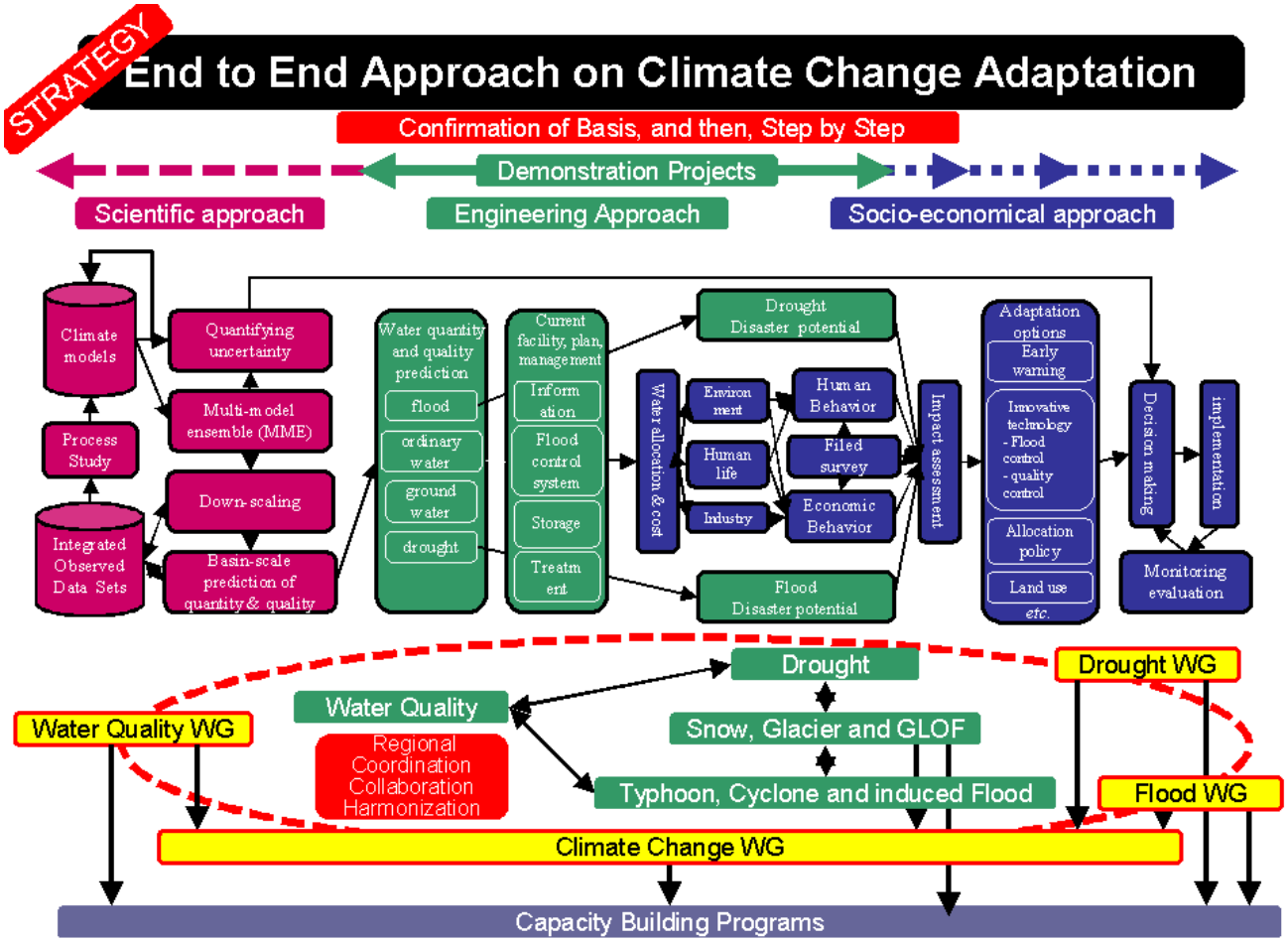


Figure 1: Scheme of the End to End Approach on Climate Change Adaptation

developing the early warning system of drought hazard in member countries. Objectives (i) and (ii) are now being implemented using number of soil moisture observation stations in participating countries (Bangladesh, China, Mongolia, Pakistan, Vietnam) as well as satellite observation data (AMSR-E, MODIS), while the latter ones will begin to be implemented in 2010. Closer collaboration with GEOSS/AWCI demonstration projects in participating countries is being sought and also linkages with the water quality themes have been identified.

Dr. Kazuhiko Fukami presented the outcomes of the **Typhoon and Cyclone theme** discussions. The targets and activities include: (i) to promote sharing state-of-the-art knowledge and capacity building so as to reduce and mitigate flood disasters caused by typhoons/cyclones, through Flood WG activities of GEOSS/AWCI, (ii) to promote climate change impact analysis on flood disasters / water resources and policy-making for climate change adaptation strategy, (iii) to enhance integrated flood/water resources management based on combined use of a state-of-the-art model with GEOSS data and in-situ data, and (iv) to share long-term historical meteorological and hydrological databases to enhance climate change impact analyses and adaptation studies through GEOSS. A flowchart of an Assessment of the climate change impact on flood disaster risk and its reduction measures over the globe and specific vulnerable areas was introduced that involves number of models from an atmospheric one to inundation and risk assessment models. To promote its activities the Typhoon and Cyclone theme seek for: (i) long-term historical extreme data (flood and low flow), (ii) most accurate DEM data (ASTER DEM), (iii) high quality in-situ hydrological data, and (iv) technical standards to determine a design flow (and/or rainfall) for planning river works.

The **Snow, Glacier and GLOF theme** outcomes were presented by Prof. Toshio Koike who reported the need of scoping discussion among the involved members (Pakistan, Mongolia, Nepal and possibly Bhutan, India, Uzbekistan), related projects (CEOP-HE, CEOP Cold regions, ICIMOD), and experts in this field. To activate the theme efforts, a model intercomparison project in various cold

regions was proposed that would include appropriate GEOSS/AWCI Demonstration projects or even dedicated cold region demonstration basins in participating countries. Existing tools/models will be investigated and employed. The needed data include: (i) high special resolution without cloud for glacier – for shorter period: ALOS; SPOT, Aster30, (ii) Longer-term Landsat data (by GEO), (iii) long term in-situ data: temperature, precipitation; mountain reg. Data, (iv) DEM – from global data SRTM30 + more precise local data. Capacity building is desirable in the field of (i) glacier physics and modeling, (ii) spatial distribution of snow model, and (iii) satellite remote sensing application to glacier and mountainous regions.

Overview of the **Climate Change Adaptation** focus was given by Prof. Mafizur Rahman who emphasized the relevance of the IPCC climate change projection scenarios for climate change impact assessment. Climate change impact assessment studies are proposed as part of the GEOSS/AWCI activities. In addition, Prof. Rahman introduced a complex climate change adaptation strategy of Bangladesh, very vulnerable country to the climate change impacts.

Short country reports on "Climate Change Impact Assessment and Adaptation

Representatives of GEOSS/AWCI participating countries, namely *Australia, Bangladesh, Bhutan, Cambodia, China, Indonesia, Japan, Malaysia, Mongolia, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand, Uzbekistan, Vietnam*, introduced their country activities focused on Climate change impact assessment and adaptation. A wide range of water-related risks associated with climate change was reported. All countries also reported that climate change impacts and need of adaptation measures were understood by their governments and dedicated national climate change adaptation plans and strategies have been proposed and their implementation set off.

Short reports on "What is on-going and/or planned"

Four presentations were provided in this session that introduced on-going and planned activities focusing on further convergence and harmonization of observations, analytical and down-scaling techniques, improvement of modeling capabilities, interoperability arrangements, and effective and comprehensive data management. These included GEO Water by Dr. Rick Lawford, Global Mapping by Dr. Shuhei Kojima, Water Management by Dr. Hidayat Pawitan, and Indonesian Climate Model by Dr. Didi Satiadi. It was stated that the IGWCO activity had provided a framework for developing and advancing GEO Water and that the progress had been satisfactory, although uneven in some areas. Importance of the role AWCI plays in GEO Water and IGWCO was mentioned. Capabilities provided by Global Map (www.iscgm.org) were found very usable for sound decision making on GEOSS SBAs. In addition, further encouraging of collaborative research and information exchange among scientists as well as water resources professionals in Asian-Pacific region is highly desirable. Certain specifics of continent-maritime region climate were introduced that are posing special requirements for climate models, including need of high-resolution observation, dynamical modeling and improved representation of convection in the models.

Socio-Economic and Political Approach

This session initiated discussion on strategies on how to bridge policy, science, and engineering arenas for effective collaboration that is essential for improving the efficiency of operational water resources management and for climate change adaptation plans preparation and implementation.

The session was opened by Prof. Toshio Koike, who introduced the Asian Pacific Water Forum (APWF) framework and its mission and goals and mentioned upcoming Asia-Pacific Water Ministers' Forum that will take place in Singapore, on 28 June 2010. He further explained the roles of the APWF Water and Climate Change Steering Group that include advising leaders, guiding knowledge networking, and progress reporting. The steering group's composition of about 15 members including: (i) experts in water and climate change projections, impact assessments, technical and socio-economic aspects of adaptation, and capacity development; (ii) leaders from government and civil society, from two large and two small countries; and (iii) representatives from international and bilateral funding agencies, will assure good collaboration among the science, engineering, and policy arenas as well as funding agencies.

A team of experts from the Institute of Water Policy, National University of Singapore including Drs. Priyanka Anand, Gopi Rethinaraj, and Wu Xun, delivered a very informative talk focusing on (i) relationship between climate change and urbanization and implications for city planning strategies; (ii)

relevance of science and technology inputs for policy making; and (iii) Integrated Policy-Making for Sustainable Development – a process by which governments translate the objectives of sustainable development into policy actions in a given policy environment. At the end of this session, the team moderated the "discussion for implementation" to discuss next steps for developing better communication methods for more informed and effective policy making for the future.

Dr. Bilqis A. Hoque introduced Water quality aspect as an inseparable perspective of Disaster and Water Resources Management and emphasized conjunction of water quantity and water quality issues especially in the context of climate change impacts on water resources. Dr. Hoque presented examples of studies focusing on flood/drought events considering both water quantity and water quality aspects.

Closing session

The meeting presentations and discussions were summarized and overall message proposed and agreed:

GEOSS Asian Water Cycle Initiative (AWCI), including four working groups, flood, drought, water quality and climate change, has been building a **regionally cooperative framework** by involving experts from 20 countries in sharing data, models, experiences and knowledge and implementing capacity development programs.

The participants considered further **convergence and harmonization of observational activities, analytical and down-scaling techniques, interoperability arrangements, and effective and comprehensive data management** as the most fundamental elements that can mobilize the efforts by GEOSS/AWCI to create societal benefits.

2.2 The 6th International Coordination Group Meeting of the GEOSS AWCI ICG – full report

To accelerate the GEOSS/AWCI coordination, it was discussed how to promote regional cooperation and coordination on climate change adaptations.

The meeting agenda

09:00 – 9:20 **Opening**
Hirota Tani, Director, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan
Koki Iwao, GEO Representative

09:20 –10:00 **AWCI Activity Reports**
Summary Report including Updates of the Demonstration Projects
Working Group Reports (Flood, Drought, Water Quality, Climate Change)

10:10 –10:25 **Welcome a new member**
Australia Dr Stuart Minchin

10:40 – 11:40 **"Capacity Building" Implementation Plan Development**
Srikantha Herath (UNU), Chu Ishida (JAXA)

11:40 – 12:00 **Breakout Sessions for Implementation**
1. Climate Change Adaptations – Drought
2. Climate Change Adaptations – Snow, Glacier and GLOF
3. Climate Change Adaptations – Typhoon, Cyclone, and Induced Floods
- Basic Strategy
- Technical Approaches
- Political Approach

13:00 – 14:00 **Breakout Sessions for Implementation – continued**

14:00 – 14:45 Short Plenary for Breakout Session Reports

15:00 – 16:00 Short Training Course 1: "Data quality check and meta data registration"

16:00 – 16:30 Short Training Course 2: "Flood Management"
1
16:30 –17:30 General Discussion

Station Name	Basic Info.	Data Upload	Quality Control Status	%
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Bhutan	Complete	Complete		1
Cambodia	Complete	Complete		100
India	Complete	Complete		88
Indonesia	Complete	Complete		38
Japan	Complete	Complete		100
Korea	Complete	Complete		100
Lao	Ongoing			0
Malaysia	Complete	Ongoing		0
Mongolia	Complete	Complete		0
Myanmar	Complete	Complete		100
Nepal	Complete	Complete		100
Pakistan	Complete	Complete		0
Philippines	Complete	Complete		0
Sri Lanka	Complete	Complete		100
Thailand	Complete	Complete		100
Uzbekistan	Complete	Complete		100
Vietnam	Complete	Complete		100

Figure 2: Status of the AWCI demonstration project data submissions and quality control

17:30 Closing

Opening

The meeting was opened by Dr. Hirota Tani, Director, MEXT, Japan, and Dr. Koki Iwao, GEO Secretariat.

Dr. Tani acknowledged the progress of the AWCI activities and emphasized the importance of regional collaboration as well as collaboration between GEOSS, AWCI, and DIAS that has already resulted in development of approaches for addressing water-related issues associated with climate change. He also regarded the transferability of these approaches that is demonstrated by the developing African Water Cycle Coordination Initiative.

Dr. Iwao mentioned the GEO ministerial summit in Beijing, November 2010 and introduced potential GEO success stories to be presented at the summit. One candidate is the Asian regional showcase that includes GEOSS/AWCI. This high evaluation of AWCI activities is true acknowledgment of great efforts contributed by participating countries and collaborating organizations and initiatives.

#	Country	Basin Name	Status		
			Partners	Topics	Fundings
1	Bangladesh	Meghna	MD/BMD, BUET, JAXA, ADB	Flood/Storm Alarming by Mobile Phone	To be expected from ADB
2	Bhutan	Punatsangchhu	Hydro-met Services, UT	Supporting to GLOF Prediction	to be expected
3	Cambodia	Sangker	MOWRAM/DHRW, UT, JAXA	Water management and Local Water Circulation	APRSAF/SAFE by JAXA
4	India	Seonath			
5	Indonesia	Mamberamo			
		Citarum, Solo, Brantas	MPW, UT, ADB	Climate Change Adaptation	To be expected from ADB
6	Japan	Tone	MLIT, UT	Optimization al the dam operation for flood control and water use	DIAS
7	Korea	Upper Chungju-dam	National Project	Climate Change Adaptation	
8	Lao PDR	Sebangfai			
9	Malaysia	Langat	National Project	Climate Change Adaptation	
10	Mongolia	Selbe	Institute of Meteorology and hydrology, Mongolia, National Geo information center, IHP-Japan	Water balance monitoring, Use of Remote senising for land cover changes	Sciense and technology foundation, Mongolia,
11	Myanmar	Shwegyin			
12	Nepal	Bagmati	considering snow, glaciar, GLOF		
13	Pakistan	Gilgit	TMD, UT	Monitoring and prediction capability of snow, glacier and soil moisture	APRSAF/SAFE by JAXA
		Indus	FFC, WAPDA, KUT	Water resources management for climate change adaptation	to be expected from JICA
14	Philippines	Pampanga	PAGASA, UT	Optimization al the dam operation for flood control and water use	to be expected
15	Sri Lanka	Kalu Ganga	University of Peradeniya, United Nations University, Irrigation Dept, Meteorology Dept	Adaptation to extereme floods caused by climate change, Weather Modelling and downscaling by GCM	Reseach facilities by University of Peradeniya, Scholarships to researchers by UNU, Data from Irrigation and Meteorology Departments
16	Thailand	Mae Wang	GAME-T	Flood Early Warning System	JEPP by MEXT
17	Uzbekistan	Chirchik-Okhangaran			
18	Vietnam	Huong	NHMS, MAHASRI	forecasting, warning capability for Central Region	3.7 M USD (2008-2013)
			NHMS, UT/GCOE	Flood-Water Quality- Health Public Awareness	to be expected

Figure 3: Status of the AWCI Demonstration Projects

AWCI Activity Reports

Prof.Toshio Koike provided an overview of the 11 years GEOSS Water and the 5 years of AWCI history pointing out the main achievements of these initiatives. In case of AWCI, it included a very important agreement on data policy, adopting the demonstration project (DP) approach and initiating their implementation in 18 river basins in participating countries, data collection activity in cooperation with DIAS (UT), and the capacity building program with its number of accomplished as well as on-going and planned activities. In particular, he mentioned that more than 50% of the data commitments for the DPs had been submitted and quality checked through the DIAS tools and reported on the status of DPs (Fig. 2 and 3). In addition, opportunities for climate change impact assessment studies in the AWCI participating countries were introduced that have arisen due to the DIAS stored data, especially climate projection models outputs.

Flood group: Dr. Kazuhiko Fukami reported on the major activities of the AWCI flood group that included generic template for demonstration projects in GEO on use of satellite information for flood risk management, flood-focused demonstration projects update, identification of member countries' needs and resources for capacity building, and the 2-year APN funded project under the ARCP program that aims "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". Specifically, the project addressed the following objectives: (i) converting observations and data, both through space-borne platforms and data integration initiatives, to usable information for flood reduction; (ii) improvement of quantitative forecasts for coupled precipitation - flood-forecasting systems; and (iii) facilitate risk assessment through the provision of scenarios and

data for exposure estimation. Enhancement and utilization of regional cooperation using the resources and knowledge available at various specialized institutions was pointed out. Training programs on the use of tools and data formed the basis for capacity development activities. These included IFAS and GFAS training workshops in 2008 and 2009.

In a **short-term** perspective, the group plans to: (i) continue in-situ observations to get enough validation data; (ii) improve the demonstration systems/scenarios and to make final validations of them with the archived & analyzed data; and (iii) develop capacity building tools for shifting the demonstration systems to operational ones for the next-stage AWCI. In addition **mid-term** plans were outlined as to: (i) promote each demonstration project of each member country according to its own specific objectives and the dissemination of its achievements through papers/presentations; (ii) identify and share any problems to promote demonstration projects, and to support how to cope with them through our mutual cooperation, so that we will figure out what the next action should be, toward their operational uses; and (iii) ask each AWCI member to give us any materials, including the information of presentations & submissions of papers, to summarize final achievements for two-year activities related to flood issues for the APN-ARCP project around December 2010 (TBD). The importance of intense communication between the AWCI meetings was emphasized.

Drought group: Dr. Ghulam Rasul reiterated the objectives of the AWCI Drought working group (see Section 2.1 above) and explained linkages of drought group activities with demonstration projects that primarily address hydrological drought phenomenon, i.e. lesser flow in streams than long-term average, yet other drought phenomena including meteorological, agricultural, and socio-economic droughts are closely related and can/will be covered by the drought-oriented DPs. The group had several opportunities to meet and discuss the achievements and plans at several meeting events in 2009 including: the 4th AWCI ICG meeting in Feb 2009 in Kyoto, the Drought group scientific meeting in Bangkok on 15-16 May 2009, the Drought group scientific meeting in Chiang Mai on 1-2 Oct 2009, the 5th AWCI ICG meeting in Tokyo, on 15-17 Dec 2009, and the Joint drought training workshop in Tokyo, on 17-18 Dec 2009.

The group is currently working on a data bank including soil moisture, temperature and meteorological observation data from selected stations in Bangladesh, Mongolia, Pakistan, China, and Vietnam. In addition, supplementary data, in particular soil properties, is being collected where available. Further, the group is working on soil moisture retrieval and drought indices determination using remote sensing data, especially MODIS and AMSR-E data. Certain water quality issues associated with drought conditions have been identified and are the group plans to address some of these in collaboration with water quality group. An APN CAPaBLE program proposal was submitted in 2009 for the drought-oriented project “Drought monitoring system development by integrating in-situ data, satellite data and numerical output“, led by Prof. Ichirow Kaihotsu, and has been approved for funding.

Plans for 2010 and 2011 were introduced that include, among others: (i) continuing in building up the drought monitoring and researching network for AWCI and providing and sharing the soil moisture and other metrological data of the ground-based and satellite monitoring including development of a mechanism to share the data (data bank); (ii) building a closer collaboration with other AWCI groups and reviewing demonstration projects to step in their adaptation activities; (iii) call for contributions for the drought working group report; (iv) improving standard of drought monitoring and assessment; (v) organize workshops in member countries to develop capacity and exchanging the experience and expertise; and (vi) providing the trial early warning system for drought hazard in related countries.

Water Quality group: Dr. Petra Koudelova presented updates of the Water quality working group on behalf of Dr. Hoque and Prof. Furumai. It was emphasized that a demonstration project in the Huong river basin in Vietnam had been initiated under the leadership of Prof. Furumai. The project focuses on sustainable water management in the basin and in particular in the Hue city including water quality issues under the flood conditions. In addition, a study on associations between drought and water quality in a rural coastal area in Bangladesh is being prepared in cooperation with Environment and Population Research Centre (EPRC), Bangladesh, and may be expanded to include climate change adaptation, health impacts, and other aspects if funds are available.

The group’s activities further include: (i) identification of hydrological models that can be coupled with water quality models, (ii) exploring possibilities to use remote sensing data for water quality issues and an access to such data for watershed management monitoring, and (iii) utilizing on-going capacity building initiatives to help water quality experts to use satellite data/explore

collaboration with other Groups. It was also noted that communication through conference calls was found very useful for advancing the group activities.

Welcome New Member

A new member, Australia, has joined the AWCI community and Dr. Stuart Minchin introduced the Australian approach to a deepening problem of water scarcity in the country that arises mainly due to 8 factors including: warming and drying climate due to global climate change, environmental flows imperative, growing urban demand, over-allocation to irrigation, uncapped groundwater extraction, expanding plantations, expanding farm dams, and bushfire recovery impacts. Dr. Minchin pointed out that in Australia, major part of precipitation - the only water supply of the country - evaporated and dam reservoirs were essential components of the water resources system. Water has become a property right and the ability to adequately measure it is essential for its management. The Australian Bureau of Meteorology has devised and implements an ambitious plan of water data integration that poses a great data interoperability challenge since the data are provided by more than 600 agencies. A system for water resources management has been developed through fusion of in-situ observation, satellite observation, and biophysical models. With this system, for example, the Murray-Darling Basin Sustainable Yield Project is examining security of water supply for every demand node in the river basin under 16 future scenarios over 150 years. The Bureau of Meteorology is responsible for data integration as well as operational delivery of the information. An advanced visualization tools involving Google Earth maps and Google earth interactive interfaces have been developed to present the water resources related information to decision makers and public.

		Bangladesh					Bhutan	Cambodia	China	Indonesia	Lao PDR	Mongolia			Myanmar	Phillipines					Sri Lanka	Thailand				Vietnam		
	Legend: 3: being applied 2: applicable 1: potentially applicable 0: not applicable	RS data	On-site monitoring	Software	Training	Information dissemination sys	Flood forecasting and EWS	Flood forecasting and warning	Flood and drought forecasting	Flood and drought risk map	Flood	Flood and drought forecasting	Remote sensing application	Drought	Flash flood forecast	radar and sat data use training	Access to GCM output	in-situ and sat data integration	Flood hazard map	Climate change scenario	Capacity building	Data assimilation	Climate model for long range forecast	Radar interpretation	Meteorological EWS	Flood forecasting	Water quality	Drought forecasting
CEOP	data integration service	2	2	0	0	0	2	2	2	2	2	2	2	2	2	0	2	2	0	0	0	2	0	0	0	2	1	1
	QC service	2	2	0	0	0	2	2	2	2	2	2	2	2	2	0	2	2	0	0	0	2	0	0	0	2	1	1
GWSP	Global DB(Digital Atlas, Dam)	1	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	0
	training &research workshop	0	0	0	1	0	1	1	1	1	1	1	0	1	1	0	0	1	1	0	1	0	1	0	0	1	1	1
	University curricula	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	Web-based teaching package	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	2	0	0	0
UNU	flood inundation modelling	0	0	1	1	0	2	2	3	3	2	2	0	1	2	0	0	0	3	0	3	0	2	0	2	3	0	1
	loss estimation	0	0	0	1	0	1	1	3	3	1	1	0	1	1	0	0	0	3	0	3	0	0	0	1	3	0	1
	rainfall downscaling and forecast	0	0	0	1	0	2	2	3	3	2	2	0	1	2	0	0	0	3	0	3	2	2	2	1	3	0	1
ICHARM	Global Flood Alert System	2	0	0	0	0	2	2	2	2	2	2	2	0	2	0	0	0	2	0	0	0	0	0	1	2	0	0
	flood hazard map training	0	0	0	2	0	1	1	1	1	1	1	0	0	1	0	0	0	1	0	2	0	0	1	2	1	0	0
	river and dam engineering training	0	0	0	2	0	1	1	1	1	1	1	0	0	1	0	0	0	1	0	2	0	0	0	0	1	0	0
	Master course on flood mitigation	0	0	0	2	0	1	1	1	1	1	1	0	0	1	0	0	0	1	0	2	0	0	0	1	1	0	0
MRC	river basin management training	0	0	0	2	0	1	1	1	1	1	1	0	0	1	0	0	0	1	0	2	0	0	0	1	1	1	0
	water quality analysis training	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0
	flood hazard mapping training	0	0	0	2	0	2	2	2	2	2	2	0	0	2	0	0	0	2	0	2	0	0	1	2	2	0	0
	flood emergency management training	0	0	0	2	0	2	2	2	2	2	2	0	0	2	0	0	0	2	0	2	0	0	0	0	2	0	0
	mathematical modelling training	0	0	0	2	0	1	1	1	1	1	1	0	0	1	0	0	0	1	0	2	0	2	0	0	1	0	1
	satellite rain estimation training	0	0	0	2	0	1	1	1	1	1	1	0	0	1	0	0	0	1	0	2	0	2	0	2	1	0	1
China	flood and drought management system	0	0	0	0	1	1	1	2	1	1	1	0	1	1	0	0	0	1	0	0	0	0	0	2	1	0	1
	training	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	1	0	0	0
	Data & product access	1	1	0	2	2	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2	2	1	0	2	0	0	0
PUB	WGs and projects	0	0	0	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	0	1	1	1	0	0	1	0	0
JAXA/AIT	Mini-projects	3	2	1	3	0	2	3	2	2	3	2	3	3	2	0	0	2	2	0	3	0	0	1	2	3	0	0
	Sentinel Asia (Operational training)	1	0	0	3	3	2	2	2	2	3	2	1	0	2	0	0	2	2	0	3	0	0	0	0	2	0	0
MAIRS	Enhanced observation	1	1	0	1	1	1	1	2	1	1	2	1	1	1	0	0	1	1	0	1	0	2	2	2	1	0	0
	regional model development	0	0	0	1	1	0	0	3	0	0	2	0	3	0	0	0	0	0	0	0	2	2	1	1	0	0	1
*EPRC	Monitoring WQ in normal and disasters (in-situ) 3	0	0	0	3	0	0	0	0	0	0	0	0	0													3	
	Monitoring water related health and social impacts	0	0	0	3	0	0	0	0	0	0																3	
	Management of safe drinking water in floods, cyclones	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
	Development of environmental health (including WQ, sanitation) training materials for TOT of teachers, local govt., NGOs, communities, etc. by itself/in collaboration with others	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
	Community based hazard/risk mapping	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	

*EPRC does those in Bangladesh and can do for other country

Figure 4: GEOSS/AWCI Capacity Building Needs vs. Resources Matrix

Capacity Building Implementation Plan Development

This session was organized by Prof. Srikantha Herath and by Mr. Chu Ishida, who firstly reiterated the history of development of the Capacity Building (CB) program under the framework of GEOSS/AWCI and highlighted the matrixes on CB resources in the Asia Pacific region. The updated version of the CB matrix – needs versus resources – is provided in Fig. 4. He also reiterated that the goal of the capacity development program of the GEOSS/AWCI was 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 the GEOSS framework. The capacity development activities are designed and carried out concurrently in support of applications in 18 Asian basins being studied within the GEOSS/AWCI for clarification of basin water cycle and the development of appropriate water management practices. Specific objectives of the CB program include: (i) downscaling regional and global information to basin scale and improving accuracy required by operational water management applications through a combination of numerical forecasting and fusion of local observations; (ii) identifying 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; and (iii) conversion of information to water resources management applications, both for operational use and scenario based assessments for planning purposes.

Prof. Herath clarified respective roles of and linkages among GEOSS/AWCI demonstration projects, working group activities, and capacity development component, as illustrated in Fig. 5. The effective strategy includes: (i) setting **objectives** of a demonstration project, (ii) proposing

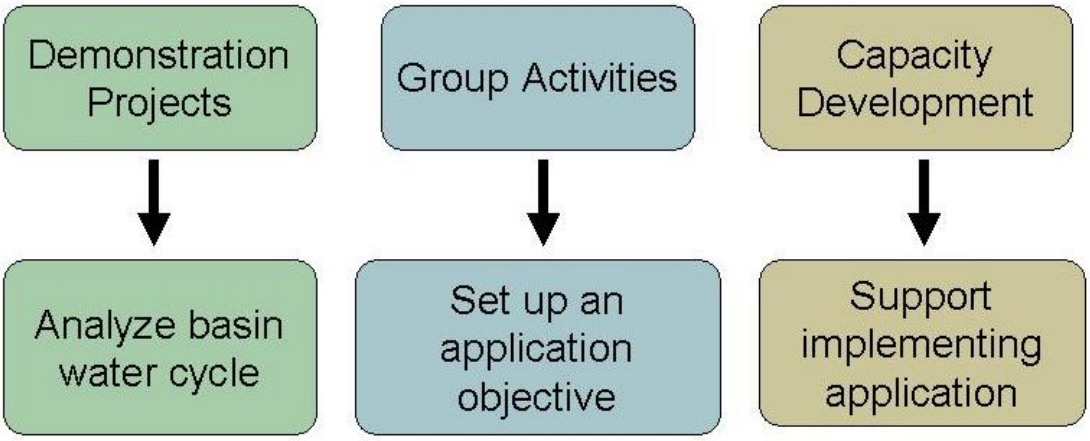

Figure 5: Linkages among GEOSS/AWCI demonstration projects, working group activities and capacity development.

methodology for achieving the objectives, (iii) identifying **development needs** for achieving the objectives, and (iv) identifying and exploiting **available resources** for supporting capacity development. An example of a flood demonstration project was introduced with its priority areas: National Database, Rainfall, Downscaling, Radar use, Satellite based data, Inundation modeling, Flood forecasting, Flash flood forecasting, Risk assessment, Use of Space observation for analysis data preparation, Use of Space Observation for post disaster response, and Land classification for risk assessment. Based on these, requested training modules can be identified and a capacity building plan for that specific project outlined.

In addition, Prof. Herath reiterated that an on-line repository of available training modules had been devised by the UNU team and could be accessed and edited by all AWCI members (http://unufms.net:8080/seaside/gcs/AWCI). It includes a module information template for organizations to provide information on available training modules. Any proposed training module should include the following items:

11. Title
12. The component of the flood problem the module would solve
13. Suggested duration
14. Expected number of participants and the maximum number allowed
15. Data to be prepared by participants in advance
16. Type of facilities (please list OS and min. ram for PC machines)
17. Any background training the participants are expected to have
18. Resources to be prepared in country by hosting agencies to carry out training seminar
19. Any other materials providing detailed descriptions of the modules
20. Availability (tentative and if possible) schedule for 2009-2010 (2011)

Four basic types of training modules were recognized including:

- *Type A:* **Multi-country teams**, use local data sets, long duration, generally a two-phase program.
- *Type B:* Demonstration data set. Short duration and participants are **multi-country teams.**
- *Type C*: **Site (local) data** for training and application. **Participants are all from the host country.**
- *Type D*: Training using a demonstration data set in a country. Program is of short duration and **participants are all from the host country.**

The overview of the accomplished training courses was presented that showed a wide range of activities provided by various organizations (Fig. 6). In addition other proposal for organizing so called Roving Seminars (type D) by several countries including Indonesia, Lao PDR, and Philippines were presented.

Further, Prof. Herath stressed out the need to integrate Research, Capacity Development and Applications including capacity development programs for training a large number of competent persons and higher education research. Demonstration projects provide opportunities for such integration as shown in Fig. 7. Another opportunity for collaboration especially in the higher education field is The University Network for Climate and Ecosystems Change Adaptation Research (UN-

ORGANIZATION	COURSE	Bangladesh	Bhutan	Cambodia	China	India	Indonesia	Japan	Korea	Lao PDR	Malaysia	Mongolia	Myanmar	Nepal	Paskitan	Phillipines	Sri Lanka	Thailand	Uzbekistan	Vietnam
ICHARM/PWRI	GEOSS-AWCI Seminar						D: 2008/7/2-3													
	JICA Seminar						C: 2009/2/2-3													
	WMO/IFNet/ICHARM							A: 2008/10/3-8												
	ICHARM/IFNet/ APN							A: 2009/8/3-7												
	ICHARM Seminar													D: 2009/8/26-27						
JAXA	Mini Project 2008	A		A						A										A
	Mini Project 2007	A								A			A	A			A			
	Mini Project 2006	A		A						A				A						
	1st Training	B		B		B	B		B	B		B	B	B		B	B	B		B
	2nd Training	B	B				B			B	B	B		B		B	B	B		B
	3rd Training	B		B		B	B		B	B		B	B	B		B	B	B		B
	4th Training	B	B				B			B		B	B	B		B	B	B		B
University of Tokyo EDITORIA	JICA 2008				C															
	UT-Winter 2009							C												
	UT-Summer 2009							C												
	JICA 2009				D															
	AWCI/SAFE 2008																			
	UT-Summer 2009						D													D
	AWCI, 2008							C												
	JICA 2008				C, D															
UNU-ISP	2007-2009				A									A, D		A	A, D	A		A, D
	2007-2009				A									A, D		A	A, D	A		A, D
	2007-2009				A									A, D		A	A, D	A		A, D

Figure 6: Table of the accomplished training activities relevant to the GEOSS/AWCI.

Figure 7: Scheme of integration of research, capacity development, and application activities along DP.

CECAR; http://cecar.unu.edu) that was established in 2009 by leading universities in the Asia Pacific region to strengthen the higher education sector to respond effectively to climate and ecosystems change. UN-CECAR has been working on a common curriculum, joint research, and a needs assessment.

Finally, the plans for 2010 and 2011 were introduced that include:

2010: (i) Development of **web tutorials** for the existing modules including **theory, tutorial** (data, models), and **an example** to be followed by a participant (providing results for comparison).
(ii) Engagement of task groups in each working group to support the activity.

2011: (i) Conduct several **roving seminars** for application **in selected demonstration basins**. Basic background will be covered through web tutorials and a number of resources organizations will arrange with local proposals.
(ii) Selection of demonstration basin clusters (based on country and focus - 3 or 4) should be done in 2010

This session was followed by a lively discussion that yielded several proposals for additional training modules. In particular multiple countries (e.g. Philippines, Bangladesh, Indonesia, Pakistan, Myanmar) reported the need of training in **rainfall estimation and downscaling** as well as setting and running **hydrological models**. It was agreed that the country representatives provide description of proposed modules in accordance with the list of 10 necessary information items listed above and then potential contributors to these modules will be identified and tutorials prepared. It was also suggested that in case of hydrological modeling a certain sample dataset from the demonstration project database be prepared for a tutorial example. The data in the tutorial should have the same policy as the GEOSS/AWCI database. In this context, Dr. Minchin voiced that the Monash University provided a Hydrological toolkit including 50 different models and related material for hydrological modeling. Though developed for Australia, the toolkit should be applicable in the whole Asia Pacific region.

The need of better **rainfall forecast skills**, in particular forecasting extreme events, was also pointed out but the current GEOSS/AWCI network does not involve adequate experts in the weather forecasting field. Nevertheless, Dr. Iwao mentioned that the **GEO Weather group** was focusing on this issue and would be willing to collaborate with the AWCI community.

Policy Making Tool for Water Management

Prof. Seigo Nasu, Kochi University of Technology, Japan, presented their research devoted to the **water resources demand management** and policy making. He introduced development of a tool designed for policy making for water management that is based on **equilibrium analysis and evaluation**. The tool consists of a set of models including an End-to-End model of natural and social phenomena, an application model to utilize the End-to-End model, and an implementation procedure model and regional management model. The End-to-End model encompasses number of components including water demand model considering public awareness, water supply model, hydrological model, social welfare logic model, and equilibrium analysis model that considers multiple water demand control measures such as infrastructure, pricing policy, laws and regulations, etc.

Prof. Nasu provided examples of practical application of their tool including equilibrium an analysis of water demand and supply in future and an analysis and prediction of water demand in Pakistan. In addition, he introduced their work on developing a water quality model using satellite data that has a great potential for monitoring surface water quality.

At the end of his presentation, Prof. Nasu outlined a way forward for water resources demand management that includes three aspects:

1. Policy: Effective water pricing policy. A plan for safe, adequate, equitable, sustainable, and affordable water services.
2. Legislation: The extraction of groundwater should be regulated and more efficiently monitored. Development of water quality and quantity standards.
3. Programme: Actions at regional, local and users levels. Building new social framework including community participation. Capacity Building of institutions/NGOs & community.

Breakout Sessions for Implementation

Three breakout groups were organized to discuss and propose strategy for implementation of activities focusing on climate change adaptations. These groups, namely (i) Drought, (ii) Snow, Glacier, and GLOF; and (iii) Typhoon, Cyclone, and Induced Floods, were provided with a flowchart displaying a possible approach toward assessing impacts of climate change using the CMIP3/20 and CMIP3/future climate projection scenarios and were asked to consider following questions:

- What should be added, removed and modified in the provided chart?
- What are bottlenecks for implementation, e.g. data, models, capacity and/or funding?
- How to coordinate, especially with socio-economic partners in each country and in the region as a whole?
- Schedule?

Drought group report

The Drought group proposed that water sharing models based on policy rules are incorporated in the assessment part of the scheme in order to clarify impact on individual water users and determining socio-economic response. Changes in hydrograph itself do not reveal the real impact. Also, the group felt that employing a range of scenarios instead of a single one would provide more reliable outputs through a range of possible responses. A watershed scale and water sharing models were considered main bottlenecks in the flowchart. Coordination of implementation may be enhanced

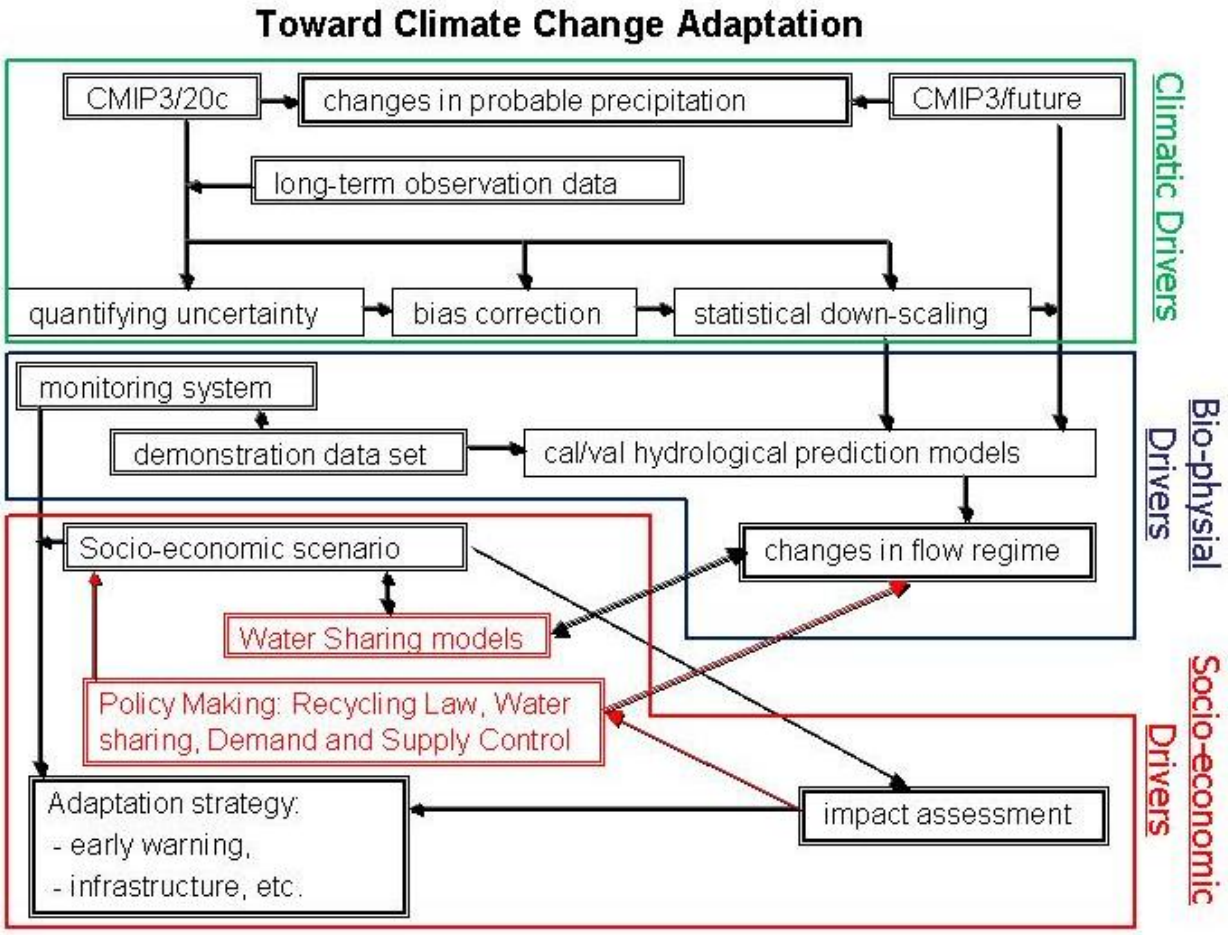

Figure 8: Flowchart of an implementation plan toward assessing impacts of climate change and preparing adaptation strategy – resulting version from breakout group discussions.

by an awareness campaign supported by policy. As for the schedule, the group recommended systematic training as well as intensive work on the model during the first year. The suggested changes were incorporated into the final flowchart (Fig. 8).

Snow, Glacier, and GLOF group report

The Snow, Glacier, and GLOF group agreed with the overall structure of the flowchart but recognized several bottlenecks for a study focused on the cold region features including insufficient long-term monitoring system, in particular glacier and GLOF, and hydrological prediction models suitable for snow and glacier phenomena. Limited funding was also mentioned as a constraining issue. Since quantifying uncertainty and bias correction is difficult without long-term observation data, the group proposed to use satellite data for glacier change monitoring, namely Landsat data and the high resolution ASTER GDEM. Also collaboration with activities focusing on special dataset generation in the mountain region (e.g. CEOP-High Elevation group or Dr. Yatagai's group) was recommended. A **strategy** for the model output quantification was suggested as: To generate a **statistical value** of a **snow covered area** from the output of climate projection model combined with hydrological model and compare with Landsat data to evaluate climate prediction model. It is important to encourage communication between observers and modelers with focus on data interoperability.

The participants further concluded that the main socio-economic partners would be **national committees or institutions** appointed to deal with the climate change related issues including adaptation plans and policies. In addition, a need to communicate the issues on the **regional level** was stressed out because in many areas the issues are of **transboundary** character and negotiation among involved countries is essential. A rough schedule of the proposed activities was also outlined up to March 2012:

6. -> *September 2010*: **Hydrological model** development for mountain regions (ongoing, by UT group).

7. -> *December 2010*: Collection of satellite (MODIS, Landsat, ALOS) data used for the Altai mountain **glaciers monitoring and assessmen**t of their change (ongoing, under the framework of DIAS).
8. -> *March 2011*: Archive satellite data targeting 2 – 3 areas and develop monitoring system for these areas based on satellite data coupled with recently established in-situ station in Mongolia; Uzbekistan and other countries – possibly study in DP basin.
9. *September 2010 – September 2011*: **Coupling** climate projection model with the developed hydrological model.
10. *September 2011 – March 2012*: Generate the **statistical value** of a snow covered area and compare with Landsat data –> climate projection **model evaluation.**

Typhoon, Cyclone, and Induced Floods group report

The group suggested several modifications to the provided flowchart that were incorporated into the final version (Fig. 8). It was pointed out that an alternate approach to statistical downscaling should be adopted if long-term observation data are not available. Such approach include (i) criteria for sufficiency as long-term observation, (ii) methodology for supplementing/reconstructing/restoring long-term observation data, and (iii) use of dynamical downscaling approach if the existing data does not satisfy the criteria. Lack of data, manpower, and funding for capacity building and infrastructure were felt as the main bottlenecks for the typhoon, cyclone and induced floods study.

As for coordination, raising awareness was emphasized for policy makers, the public, private sectors, etc., about the importance of integrated flood management with climate change adaptation strategy not only for disaster mitigation itself but also for nationwide economic/welfare development. A two-year schedule was proposed considering capacity building for data arrangement, downscaling, modeling, etc. for the first year and first case studies in the demonstration project basins in the second year.

Short training courses

Two short training courses were provided in the afternoon that included: (i) the **Data quality check and metadata registration** course and (ii) the **Flood Management** course.

During the first one, Drs. Ikoma and Kinutani provided guidelines on how to perform data quality check and metadata registration using the on-line tools provided by the University of Tokyo in cooperation with DIAS that were designed taking into account the needs of the AWCI data providers. The attendees actively participated in the course running the system on their own PCs connected to a server that was brought and installed by Drs. Ikoma and Kinutani especially for this purpose. During the course, several demonstration basins' metadata were successfully registered.

In the Flood Management course, a demonstration of the Integrated Flood Analysis System (IFAS) developed at ICHARM was provided by Dr. Fukami for a real catchment in the Kyushu island of Japan. The system enables to use available global dataset for both catchment settings and forcing data and thus can also be used for basins with very limited observations. The system is available for download free of charge at the ICHARM website:
(http://www.icharm.pwri.go.jp/research/ifas/index.html).

Closing session

At the end of the day, Prof. Koike summarized the outcomes of the GEOSS/AWCI ICG Meeting as well as the preceding GEOSS Symposium. He acknowledged significant progress that was recognized during the meeting events, in particular great progress in data submission. He summarized the evolution of the GEOSS/AWCI framework and activities reiterating that four target groups had been established (flood, drought, water quality and climate change), objectives set up, data policy agreed, 18 demonstration river basins selected, data from the basins archived, and metadata registered. CEOP integrated datasets and DIAS archive including climate model projection outputs are available, capacity needs have been identified and based on these a capacity building program has been designed and needed activities launched. In addition, climate change adaptation activities in countries have been identified, socio-economic aspects included, and linkages with policy-making experts established.

The meeting reviewed what has been done and is being done and a general implementation chart toward climate change impact assessment and adaptation strategy (Fig.8) was proposed with certain specifics for three focus areas, namely Drought; Snow, glacier and GLOF; and Typhoon, cyclone and induced floods. Further convergence and harmonization of observational activities, analytical and down-scaling techniques, interoperability arrangements, and effective and comprehensive data management were considered as the most fundamental elements that can mobilize the efforts by GEOSS/AWCI to create societal benefits.

The list of past meeting events related to the GEOSS/AWCI was presented and the next event was proposed be The 4th Asian Water Cycle Symposium was proposed held before the GEO Ministerial Summit in November 2010, most probably in October in Tokyo, Japan, in conjunction with a related ministerial-level meeting organized by MLIT, Japan. Confirmation and further details will be announced in due course.

Concluding messages were formulated:

Although climate change adaptation requires socially and economically efficient and sustainable management of the world's limited supplies of freshwater, this precious resource cannot be managed unless we know where the water is, its quantity and quality, and how its variability will change in the future.

This knowledge base relies upon our ability to measure and monitor precipitation, water quantity and quality and our continued efforts to improve our physical, chemical, biological, and ecological understanding of the water cycle.

Based on the reports and discussions at the GEOSS-AP symposium and the ICG meeting, the participants recognized the commonality and regionality of water-related issues and socio-economic impacts caused by water-related problems associated with the climate change in the Asia-Pacific region.

It was agreed that well-coordinated scientific research initiatives along with a combination of global Earth observations and integrated data provided by GEOSS are essential to adequately address these issues.

Message to the GEO ministerial summit:

The Summit is requested to recognize the direction and achievements by GEOSS/AWCI as one of the most effective regional approaches for climate change adaptations and to endorse its activities in each country and the Asia-Pacific region in improving the efficiency of operational water resources management.

Appendix 5: Funding sources outside the APN

Ministry of Education, Culture, Sports, Science, and Technology (MEXT), Japan: financial support
University of Tokyo (UT), Japan: financial and in-kind support
Japan Aerospace and Exploration Agency (JAXA), Japan: financial and in-kind support
United Nations University (UNU), Japan: in-kind support
Asian Institute of Technology (AIT), Thailand: in-kind support

Appendix 6: Glossary of Terms

AIT	Asian Institute of Technology
AWCS	Asian Water Cycle Symposium
AWCI	Asian Water Cycle Initiative
CB	Capacity Building
CCAA	Climate Change Assessment and Adaptation
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
ICG	International Coordination Group
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
SAFE	Space Applications for Environment
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