Summary report on
The 7th International Coordination Group (ICG) Meeting of the GEOSS Asian Water Cycle Initiative (AWCI)
held
at the Institute of Industrial Science, University of Tokyo Komaba Campus, Tokyo, Japan,
5 – 6 October 2010.

The **Seventh GEOSS AWCI ICG meeting** was planned and undertaken to accelerate the GEOSS/AWCI coordination focusing on promotion of regional cooperation on climate change adaptations and implementation of relevant activities proposed at the recent meeting events and more specifically outlined at the Sixth GEOSS AWCI ICG meeting in Bali, Indonesia, March 2010. The meeting included an exhibition of poster presentations of various companies focusing on infrastructure development products and services.

More than 50 participants from 16 countries assembled during the meeting and discussed the topics included on the meeting agenda that followed up on the outcomes and recommendations of the 6th 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://monsoon.t.u-tokyo.ac.jp/AWCI/meetings/Tokyo_Oct2010/presentations.html.

The meeting was co-sponsored by the University of Tokyo, APN, JAXA, ICHARM, and UNU.

1. Executive Summary of Main Issues/Conclusions and Actions

The meeting reviewed the status of the AWCI activities concluding that the demonstration projects were mature in most cases with a good progress in data submission to the DIAS system. Benefits of the AWCI collaborative framework and the integrated data system (DIAS) as well as the GEOSS framework were shown through the outcomes of several demonstration projects. The DIAS system was opened to public on 1 October 2011 providing free access to all the archived data.

The individual working groups, namely flood, drought, water quality, and climate change, have progressed in their activities according to their plans. Several demonstration projects have been completed and stage was set up for transition from research-focused phase to more operational-oriented phase in addressing disasters and water resources management.

Capacity building activities has evolved in a solid program that has been offering a number of training courses and seminars provided by various collaborating organizations including UNU, JAXA, ICHARM, UT, and others. On-line tutorials are being developed for several courses that would facilitate trainees to acquire the necessary knowledge.

Major part of the meeting focused on preparation and implementation planning of the Climate Change Assessment and Adaptation (CCAA) study. Evidence of climate change impact on water resources and water related disasters was provided by country reports that also introduced national efforts to establish adequate policies in coping with these impacts. Related on-going programs and activities and existing methods and tools for climate change assessment have been reviewed and considered in the plan. Complex, end-to-end approaches towards adaptation were also introduced and reflected in the plan. Through an intensive discussion during breakout session, a white paper on the CCAA study has been revised that outlines the implementation strategy and schedule (Attachment 1 below).

The next event will be a training course focused on the rainfall bias correction and hydrological model application in the climate change assessment that will take place in Tokyo, Japan, March 2011. It will be held in conjunction with other related events, namely GTN-H workshop, IGWCO workshop, and the 5th GEOSS AP Symposium that will include a parallel session on Water, which will mainly be dedicated to AWCI.

In addition it was announced that three projects had been accepted under the APN research funding programs that will last for two years (2010/2011 and 2011/2012). These include:

1. River Management System Development in Asia Based on Data Integration and Analysis System (DIAS) under the GEOSS by Prof. Toshio Koike, University of Tokyo.
2. Drought monitoring system development by integrating in-situ data, satellite data and numerical model output by Prof. Ichirow Kaihotsu, Hiroshima University.
3. Climate Change Impact Assessment on the Asia-Pacific Water Resources under GEOSS/AWCI by Prof. Deghyo Bae, Sejong University.

Meeting Agenda

The 7th International Coordination Group (ICG) Meeting GEOSS Asian Water Cycle Initiative (AWCI)
Tokyo, Japan, 5-6, October 2010

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.

Agenda

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)
2.2 Summary Report including Updates of the Demonstration Projects
2.3 Working Group Reports (Flood, Water Quality, Climate Change)

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
3.3 C. Ishida (JAXA): ADB technical assistance projects for Bangladesh, Vietnam, and Philippines
3.4 K. Fukami (ICHARM): ICHARM capacity building activities

12:20 –13:20 LUNCH

13:20 –15:45 4. Flood and Climate Change

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 B. 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

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

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

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)
8.2 Guide Lines : E. Ootsuki (MLIT)
8.3 Handbook : M. Ishiwatari (JICA)
8.4 Re-analysis : K. Takahashi (JMA)
8.5 Satellite Observations : K. Imaoka (JAXA)
8.6 Water Use and Agriculture : D. Yang (TU)

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)
8.8 Hydrological Modeling : D. Bae (SU), L. Wang (UT)

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)
8.10 System Optimization : O. Saavedra (TITECH)

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

2.3 Drought working group report :I. Kaihotsu

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 Report

10.2 Wrap-up: Clearly define the relationship with the WG Activities and the Demonstration Projects

17:30 ADJOURN

2. Full Meeting Report

2.1 Opening

The meeting was opened by Prof. T. Koike, who welcomed the participants and introduced the agenda of the meeting. Welcome talks were given by Mr. Toshihide Fukui of the new, Environmental division of MEXT, and Dr. Makoto Kajii, Associate Executive Director of JAXA.

Mr. Fukui advised the audience that MEXT had recognized the importance of environmental issues and thus had established the environmental division that also addresses issues associated with water cycle. MEXT, as a body representing Japan on GEO and GEOSS, greatly appreciates and endorses AWCI activities that represent implementation of GEOSS principles in the water area on the regional basis and contribute tremendously to the overall GEOSS success. The AWCI achievements have also been well acknowledged and recognized by being nominated as one of the showcase success programs in Asia for the Beijing GEO Ministerial meeting in November 2010. Mr. Fukui congratulated the AWCI participants for these successes and wished the group fruitful meeting and continued momentum in their efforts.

Dr. Kajii also appreciated outstanding achievements of the AWCI group led by Prof. Koike and contribution to the GEOSS agenda. He emphasized that JAXA is pleased to see such meaningful exploitation of their earth observation data. JAXA is currently operating ALOS comprising the most advance earth observation technology and covering the earth globally with global usage of its data. ALOS 2 is under preparation and with a number of other systems focused on climate variables, EOS will provide a unique opportunity to address the climate change issues in the near future. JAXA wishes for continued collaboration with the AWCI community and welcomes its further suggestions in terms of requested observation and associated services.

2.2 AWCI Activity Review

The AWCI activity review session was opened by a **special JAXA report** on the August Pakistan flood detection using ScanSAR imagery that demonstrated high value of the satellite data in detecting and subsequent assessment and management of such large-scale disasters and also showed the effectiveness of the AWCI regional collaborative framework that facilitated an immediate cooperation between JAXA and Pakistan Meteorological Department and Pakistan Agricultural Council under the Sentinel Asia program. The data was also provided to ADB and World Bank for early disaster damage assessment. Dr. Shimada, who presented the report, explained specifics and capabilities of the ScanSAR imagery technique and described several sensors borne on the ALOS satellite. The PALSAR sensor data was used for the Pakistan case, monitoring the evolution of the flood since its occurring in the upper reaches of the Indus river at the beginning of August through its reaching the downstream in September. The same technique was also used for monitoring the oil spill in Gulf of Mexico earlier in 2010 and can also be applied to monitor and evaluate forest changes in Brazil Amazonia.

AWCI Demonstration Project Review

Main themes and outcomes of the 6th AWCI ICG meeting in Bali, March 2010 were reiterated. In particular, 11-year history of the GEOSS Water efforts and almost 5-year history of GEOSS/AWCI were reviewed, pointing out the main events and achievements. The recent AWCI focus on climate change impact assessment and adaptation was emphasized, reiterating the end-to-end approach toward the issues that is only possible through integration of scientific, engineering and socio-economic approaches. Accordingly, socio-economic and policy aspects have been given full attention at the recent AWCI events and respected experts in this arena invited fir further cooperation.

The AWCI demonstration projects in member countries were initiated as early as in 2007 in order to kick off the data collection efforts, carry out a particular study in each nominated basin focused on its specific issues (floods, droughts, water quality…) and demonstrate the benefits of open data sharing policy and advanced data systems like DIAS (Data Integration and Analysis System) for promoting and implementing Integrated Water Resources Management (IWRM) practices. A substantial progress was reported in the data submission and quality control efforts as it is shown in the Figure 1. These data are now freely accessible through the DIAS system available at: http://www.editoria.u-tokyo.ac.jp/dias/link/portal/english_index.html that was opened to public on 1 October 2010. In addition to the data collection progress, a number of valuable findings and conclusions resulted from the demonstration projects that were reported in later sessions of the meeting and contributed to several publications in peer-reviewed journals. These include for example:

- Snowfall-melt-runoff prediction and Climate Change Assessment System in Nepal
- Integrated Drought Monitoring and Climate Change Assessment System in Philippines
- Soil Moisture Observation by PALSAR, Cambodia
- Inundation Prediction System in Hue, Vietnam
- Climate Change Impact Assessment on Water Resources over the AWCI Korean Demonstration Basin
- CMIP3 Climate projection model output analysis in different AWCI river basins

Also a set of capacity building programs were developed for training of practitioners in these techniques.

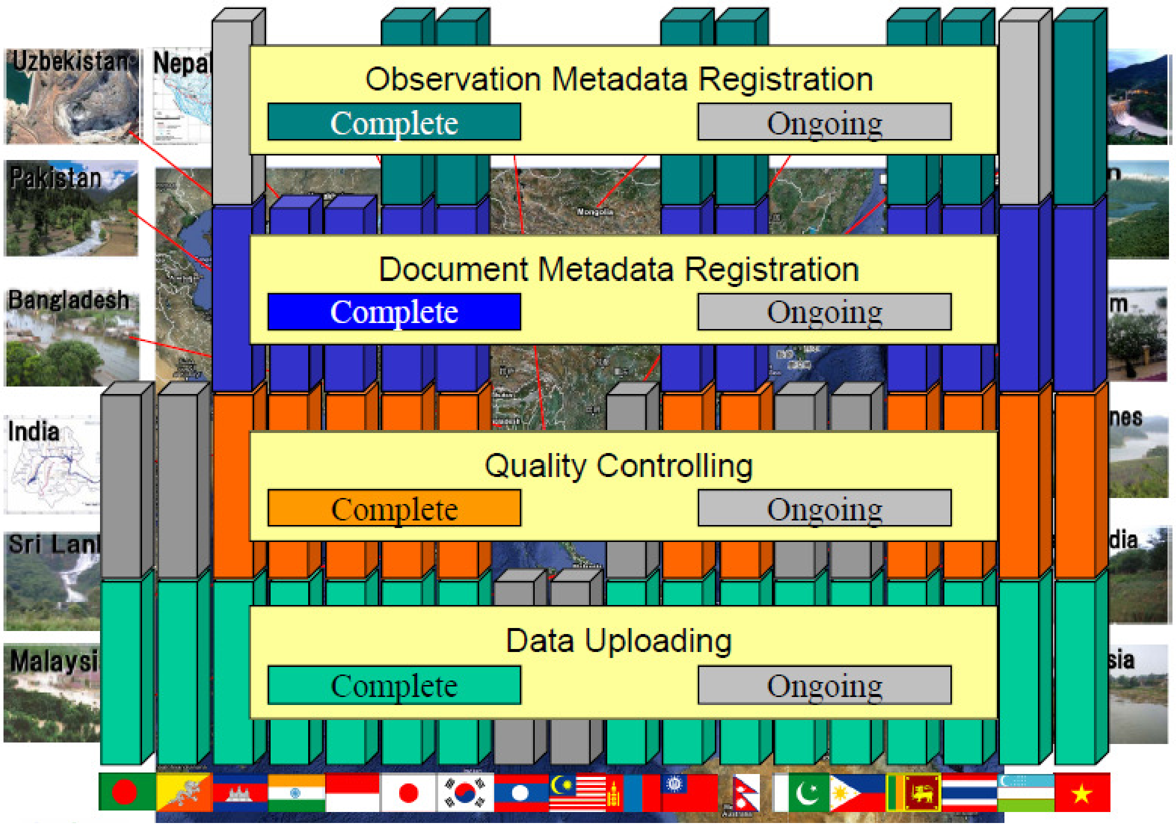


Figure 1: Status of the AWCI demonstration basin data submission and quality control

<u>Flood WG Activity Report</u>

1. The flood WG has completed two-year project funded by APN's ARCP program called "*Flood Risk Management Demonstration Project (Phase 1) under the Asian Water Cycle Initiative for the Global Earth Observation System of Systems*" that was focused on "*building up a scientific basis for sound decision-making and developing policy options for most suitable flood risk management for each country and region in Asia, through the full utilization of new opportunities on global, regional and in-situ dataset under the scheme of AWCI*," and as such covered the first phase of the flood group demonstration project. The main objectives included:

(i) converting observations and data, both through space-borne platforms and data integration initiatives, to usable information for flood reduction
(ii) improving quantitative forecasts for coupled precipitation - flood-forecasting systems
(iii) facilitate risk assessment through the provision of scenarios and data for exposure estimation.

The course of activities and results of the project were to be documented in detail in the Final report that was subsequently submitted to APN. The main achievements included promising technologies and practices for the future sustainable flood risk management. Most typical new technologies developed and/or validated through those activities are WEB-DHM, DRESS & FLOWSS of UT, IFAS of ICHARM, RegHCM-PM of NAHRIM, and so forth. Through repetitive meetings, discussions and cooperative activities, advanced technologies and many other innovative practices have been also shared among all the members of Flood WG of GEOSS-AWCI, which will be expected to lead to updating and enhancing a variety of science- & data-based foundations toward sound decision-making and developing policy options for effective flood disaster risk reduction in Asia.

2. Other major activities of the flood group since 2007 were reiterated that included generic template for demonstration projects in GEO on use of satellite information for flood risk management, identification of member countries' needs and resources for capacity building, holding several training courses and workshops focused on application of new technologies for flood forecasting, monitoring, and management like GFAS, IFAS, and others, and presenting and publication of research and activity results at AWCI meetings as well as international conferences (e.g. APHW 2008 in Beijing).

3. Short- and mid- term plans for post-APN project activities were reiterated. Short-term:
(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
(i) (iii)develop capacity building tools for shifting the demonstration systems to operational ones for the next-stage AWCI.

Mid-term:
(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) (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;

<u>Drought WG Activity Report</u>

The four main objectives of the drought WG were reiterated:
(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
(iv) to help developing the early warning system of drought hazard in member countries.

The current status summarized that includes efforts on: (i) building the envisioned data bank, (ii) providing the routine soil moisture data (filling the data gaps), (iii) planning to move forward with practical approach, and (iv) demonstrating the system.

1. Data bank and soil moisture monitoring

The group is building up a drought monitoring and research networks and the data bank of member Asian countries for AWCI. The drought monitoring network includes several ongoing monitoring sites in strong cooperation with CEOP efforts (Mongolia, China, Vietnam, Indonesia, Bangladesh, Pakistan, Tsukuba (Japan), and Thailand) and also plans for future potential sites that, however, need more discussion (Setouchi (Japan), west-Thailand, central Bangladesh). The "Network of Asia Drought Research" is being planned and preparatory initiatives are ongoing to engage related researchers and organization in a coordinated approach toward the drought research in the region.

The data bank consists of soil moisture and soil temperature in-situ observations from a number of participating sites, meteorological data (CEOP reference sites), and satellite data (AMSR-E SM, MODIS data/CEOP satellite data subsets for its reference sites). Except for the CEOP data, which are freely accessible through the internet, the data is available for research/operational use upon request (*Kaihotsu, Rasul*). The participating observation sites include:

- **Mongolia**: CEOP reference sites since 2001 (SM and ST at the 4 depths; multiple stations), NAMHEM SM data (every 5 cm depth from the surface to the 1m depth; more than 30 stations)
- **China**: Shanxi Province, 108 stations, meteorological data and ST data 6-hourly, SM once per 10 days, 3 layers (2006-2007)
- **Pakistan**: Soil moisture data available for 4 stations (10-day SM data at 9 depths in 2002- 2006)
- **Bangladesh**: 9 soil moisture stations (weekly SM data at 5 depths in 2007). Regularly providing the in situ monitoring data of soil moisture will begin in 2011.)
- **Vietnam**, Binh Thuan Province: 3 surface meteorological stations, one of them includes soil temperature observation, no soil moisture.

The in-situ soil moisture data of the bank is also used for validation of AMSR-E soil moisture measurement algorithm (Fig.2).

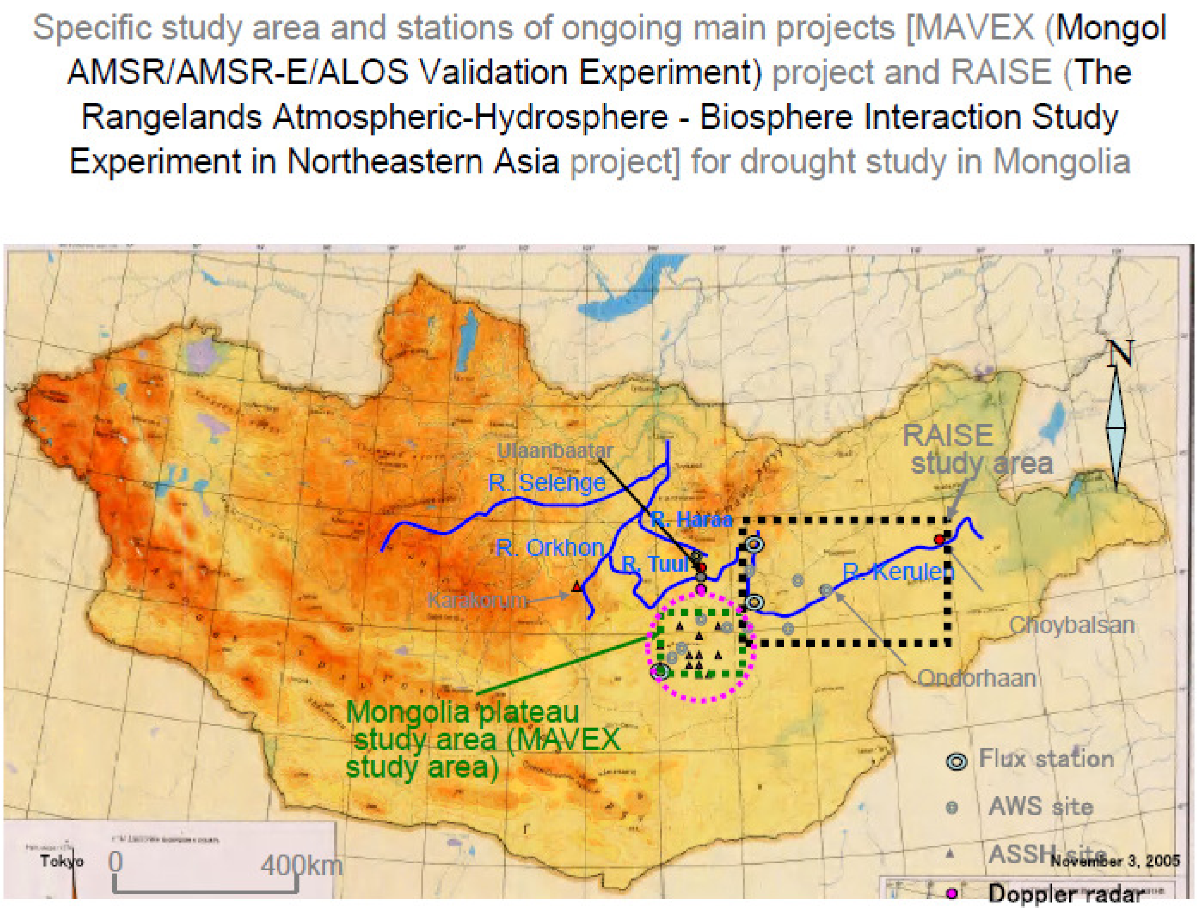


Figure 2: AMSR/AMSR-E validation project area and RAISE project area in Mongolia

2. Practical approach and system demonstration

The group is analyzing the obtained soil moisture and other data from a view point of drought study in climate change and also conducting numerical model studies addressing drought and its prediction. In addition, further study of definitions of drought is being carried out considering practical applications. The group also supports the in situ drought monitoring activities.

Demonstration projects had been initiated to show the benefits of the coordinated approaches pursued by the drought group. As part of the DP in Pakistan, two AWSs and four rain gauges had been installed in the Indus river basin that will contribute the data to the envisioned network. In Mongolia, a number of activities are carried out as part of DP including: water balance studies in the Selbe river basin, NDVI analysis over the whole Mongolia, and soil moisture estimation by AMSR-E and MIRAS (SMOS) in the Mongolian plateau. The DP activities are also being reviewed in relation to climate change and based on the current results, adaptation activities are being considered.

3. APN supported projects
(i) The drought WG has completed two-year project funded by APN's CAPaBLE program named: "*The Capacity Building for Drought Monitoring and Studying in Monsoon Asia under the Framework of Asian Water Cycle Initiative (AWCI)*" that focused mainly on "*setting up a drought monitoring and research working group and the scientific supporting team to provide advices on retrieval of remote sensing data and ground validation as well as on collecting ground observation data related to drought monitoring from participating countries.*" The course of activities and results of the project were to be documented in detail in the Final report that was subsequently submitted to APN.

(ii) In 2010, the group was successful in proposing further two-year project under the APN APN's CAPaBLE program named: "*Drought monitoring system development by integrating in-situ data, satellite data and numerical model output,"* focusing on establishing and development of an integrating system of in-situ data, satellite data and numerical model outputs related to drought in order to facilitate prediction, monitoring, assessment, and management of droughts in the region.

4. Future plans of the drought group include:
- Continuing to collect the data of soil moisture, meteorological elements and numerical model products
- Promoting demonstration projects
- Developing the early warning system for climate change adaptation (results expected be published within 2011)
- Discussion on the investigation of the potential sites and then the installation plan of a new monitoring station of drought in Thailand and Bangladesh
- Scientific supporting team meeting/APN CAPaBLE project meeting (As "Asia Drought WS 2011") in Hiroshima (January 2011)

<u>Water Quality Activity Report</u>

The Water Quality Group reported on ongoing activities that include:
- Demonstration project on sustainable water management in the Huong river basin in Vietnam
- A multi-disciplinary research on quality of water in water related hazards and local responses
- Attempts to explore ways to connect water quality related activities to other AWCI and GEOSS activities

1. Demonstration project in the Hong river basin, Vietnam
The project includes three main components:
(i) *Multi-scale modeling of hydrological situation*: evaluation of effects of river flow/floods in the Hue city using the distributed hydrological model
(ii) *Water quality evaluation during flood/inundation situations*: evaluation of inundation in the urban area of the Hue city using the output of (i) and the urban sewerage system model, considering water pollution phenomena;
(iii) *Health risk evaluation after flood events: estimation of possible risk of spreading of pathogens* due to the polluted water flooding in the city based on the output of 2) and using the risk assessment model

2. The multi-disciplinary research on water quality

The goal is to contribute to the effective incorporation of WQ/environmental and societal issues into flood, droughts, climate change adaptation and other activities by AWC/GEOSS. In particular to conduct research on WQ/environmental/societal issues in floods, droughts and in other events related to climate change in different countries under AWCI. The work has begun in Bangladesh focusing on drought-water quality linkages. First results of the April – May 2010 drought period survey indicated deterioration of water quality determinants that together with the limited water availability contributed to the severe socio-economic drought. The respective water quality and socio-economic drought was more serious in a drought prone region.

3. Linkages with other AWCI activities

Efforts are ongoing that 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.

<u>Climate Change Activity Report</u>

The group reviewed its activities since its establishment in 2008 when the climate change and its impacts on water cycle has been widely recognized by AWCI participating countries as an important issue that was cross-cutting all the AWCI activities and deserved full attention. Through a pilot study on climate change impact assessment and adaptation strategies on Korean water resources including the Korean demonstration basin that proposed a method to reduce the uncertainties of climate change impact assessment, a strategy has been proposed for similar studies over other AWCI basins. The strategy highlights the importance of local hydrological data for global climate change on water resources.

The strategy was further discussed at the 5th and 6th AWCI ICG meetings (Tokyo 2009 and Bali 2010, resp.) focusing on three specific areas of typhoon and induced floods, droughts, and snow and glacier phenomena. This has resulted in the overall AWCI activity plan for so called Climate Change Assessment and Adaptation (CCAA) Study that was introduced at the Bali meeting and further elaborated for discussions during this meeting as mentioned in the second part of this report.

The group also submitted a proposal to the APN's ARCP programme in 2009 for a two-year project named "*Climate change impact assessment on the Asia-Pacific water resources under GEOSS/AWCI*" that was approved for APN funding in 2010. The main objectives include:

- To evaluate the climate change impact assessments on water resources over the Asia-pacific regions joining GEOSS/AWCI
- To promote the capacity building for climate change impact assessment technology

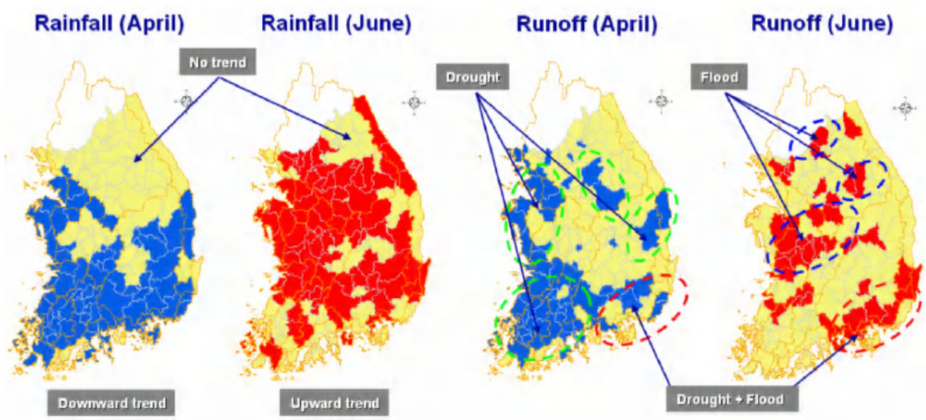
The main scope of activities for Year 1 and Year 2 of the project are described in Figure 3. The expected outcomes include:

- Technical report and scientific paper on the recent trends of hydrologic and climate variables over the Asia-Pacific regions(1st Year)
- Technical report and scientific paper on climate change impact assessment on water resources over the Asia-Pacific regions under GEOSS/AWCI frame work (2nd Year)
- Capacity building for hydrologic impact assessment of climate change (1st & 2nd Years)

In order to implement the planned activities, the project will organize two or three working groups including data collection and quality control, data analysis, hydrologic modeling with downscaling scheme. Scientific advising/supporting team will be necessary. Regarding the data, those stored on Data Integration and Analysis System (DIAS) will be used for each country's demonstration basin. In addition, long-term data, especially long-term (normally more than 20-30 years) daily T, P and Q and hourly data even short periods are necessary. Accordingly, CC working group expects each country will provide their long-term data in the first period from 10-2010 to 02-2011 for the preliminary analysis that includes Mann-Kendall test, linear regression and other analysis to detect the climate change variability before next meeting. Additional data will be provided in the second period from 04-2011 to 06-2011 for the 1st and 2nd year tasks.

Tasks for the First Year (2010-2011)

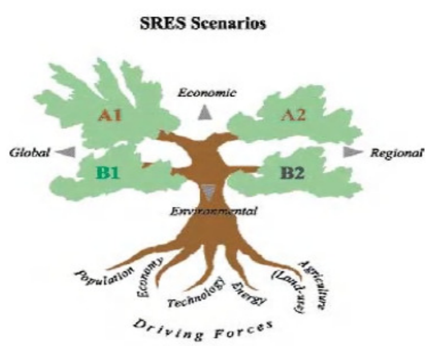
- Analyze the past historical observation data to detect some climate change trends over GEOSS/AWCI
- Use Linear regression method, Mann-Kendall Test, Moran's I Spatial Autocorrelation method

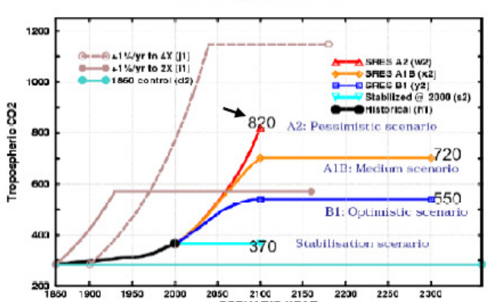


Spatial trend according to Mann-Kendall test for P and Q

Tasks for the Second Year (2010-2012)

- Simulations of climate and water resources under the future greenhouse gas emission scenarios





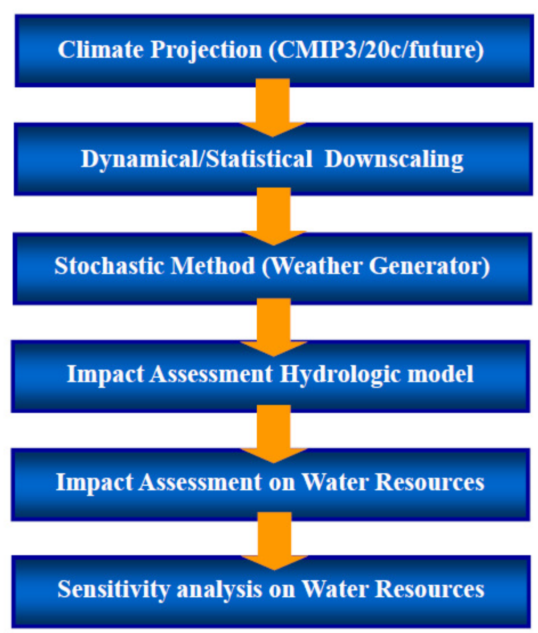


Figure 3: Climate change group APN-funded project activities.

Capacity Building Implementation

A good progress was reported in the capacity building activities. A summary table of main training programs offered by AWCI participating organization was presented and is shown in Figure 4. These programs are provided either on a regular basis or occasionally when needs for such programs are recognized. The full, updated version of the table is available at:
http://cecar.org/groups/awci/wiki/204e3/Resources_Availability_Table.html

ORGANIZATION	NAME OF TRAINING
ICHARM/PWRI	Hydrologic Modeling and Flood Runoff Analysis & Forecasting with IFAS
JAXA	Mini Project
	Sentinel Asia System Operating Training
University of Tokyo EDITORIA	Web-based In-situ Data Loading, Quality Control, Mata data Registration
	Distributed Hydrological Modeling
	Land Data Assimilation System (LDAS)
UNU-ISP	Rainfall Downscaling
	Flood Inundation Modeling
	Flood Loss Estimation

Figure 4 Capacity Building Activity Summary

1. Recent Capacity Development Activity of UNU

Two main activities were reported by UNU-ISP (Institute for Sustainability and Peace): (i) building resilience to climate change and (ii) development of web tutorials.

The UNU-ISP has been involved in the University Network for Climate and Ecosystems Change Adaptation Research (UN-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 activities on development of a common curriculum, joint research, and a needs assessment has been progressing. The curriculum focuses on three themes including (i) science of climate and ecosystems change, (ii) adaptation and mitigation, and (iii) impacts and vulnerabilities, and two detailed courses have already been developed by the consortium of universities by taking modules from 21 syllabi. The courses have been tested by UNU and released for use by member institutions. First full round was organized at UNU from 13 September through 1 October 2010 that included two courses of two credits and in which 33 students of different background from 19 countries participated and successfully completed by an exam and a paper. The details of the program are available through the CECAR home page mentioned above. The course will be provided at UNU in April 2011 again and then will be offered to other CECAR institutions.

Web tutorials to improve and shorten the capacity development training programs as introduced at the Bali meeting have been under construction in two application areas, namely (i) simple GIS applications for water resources assessment – in collaboration with ESRI and (ii) a template for climate change impact assessment and adaptation strategy design that is based on outcomes of current research. Testing of the tutorials will begin in early 2011 and since they are "WIKI" based, they can be improved by participants. In addition to supporting the training programs, the tutorials will also be useful in implementing demonstration projects.

2. Capacity Building at JAXA

JAXA has a long history in capacity building activities in the Asia-Pacific region focusing mainly on use of JAXA's satellite data. The overview of these activities is given in Figure 5.

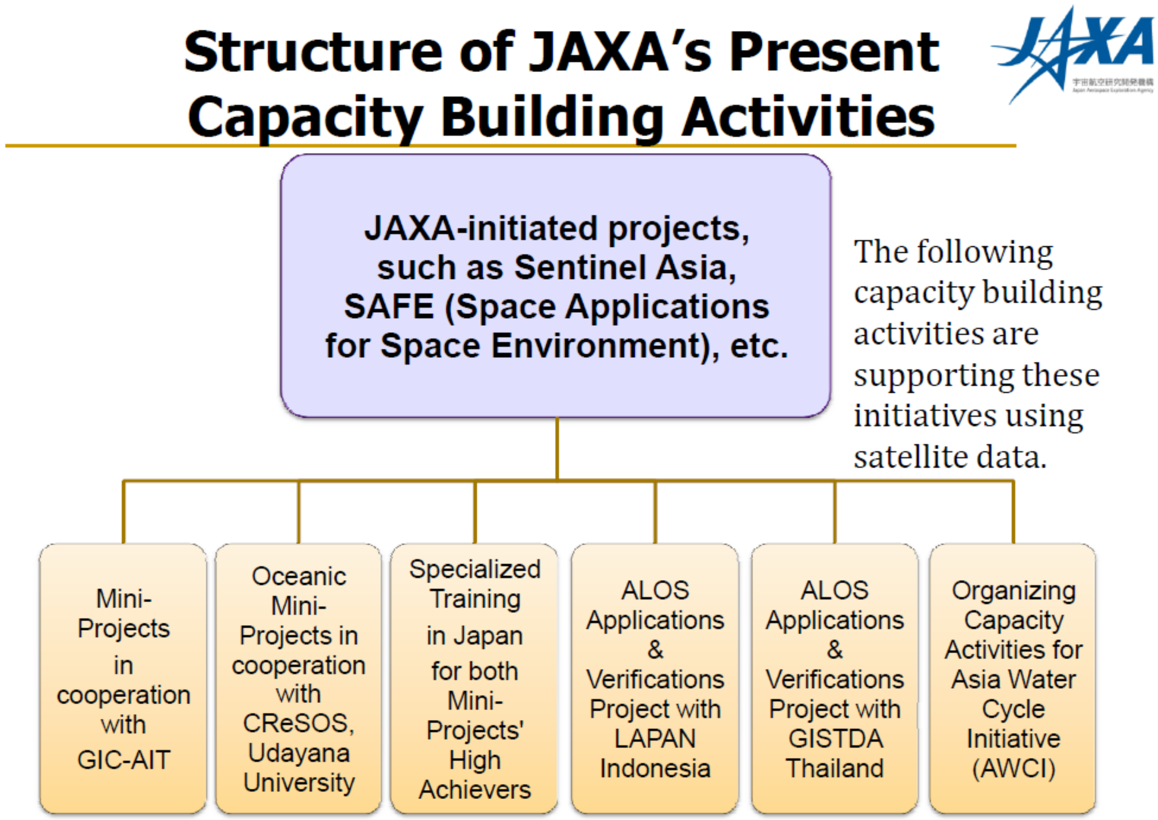


Figure 5: Overview of JAXA's CB activities.

In addition to specific activities provided directly to AWCI community, the programs related to and supporting AWCI activities include: (i) Mini Projects, (ii) Oceanic Mini-Projects, and (iii) Specialized Training in Japan for Mini-Projects' High Achievers.

The Mini-Project program (http://web-tutorials.tksc.jaxa.jp/gic-ait/index.html) was launched in cooperation with Geo-Informatics Center of the Asian Institute of Technology (GIC-AIT) in Bangkok, Thailand in 1995 and has since involved more than 1300 trainees from 27 countries in the Asia-Pacific region. The mini-projects, focused on application of satellite data and GIS technology, have three phases, two 4-week courses at AIT, Bangkok and a one-week field work in each participating country. In 2010, 9 out of the 23 proposals were accepted that cover a range of issues including flood, drought, landslides, habitat evaluation, impact of urbanization, coastal erosion, and Japanese encephalitis.

From FY 2009, JAXA has entrusted a responsibility to carry out the two Oceanic Mini-Projects to the Center for Remote Sensing & Ocean Sciences (CReSOS) of the Udayana University located on the Indonesian island of Bali. Participating organizations also include the Indonesian National Institute of Aeronautics and Space (LAPAN) and the Ministry for Marine Affairs and Fisheries (DKP). The mini-project themes are (i) study of coral reef and mangrove distribution from satellite data and (ii) study of climate change monitoring using satellite data and data archive system in Indonesia. Further oceanic themes have been made available in 2010 (http://web-tutorials.tksc.jaxa.jp/pdf/Oceanicic%20Mini-Projects.pdf).

From the JFY2008, JAXA started to invite once a year some of the high achievers of the Mini-Projects both in Thailand and Indonesia to Japan in order to let them have another training opportunity in their respective fields in cooperation with some institutes and universities in Japan that include University of Tokyo, Kyoto University, Keio University, Hokkaido University, United Nations University, and ICHARM.

Capacity development activities are also provided by the Sentinel Asia (https://sentinel.tksc.jaxa.jp/sentinel2/topControl.action), which is a voluntary basis initiative led by the APRSAF (Asia-Pacific Regional Space Agency Forum) to support disaster management activity in the Asia-Pacific region by applying the WEB-GIS technology and space based technology, such as earth observation satellites data. In order to convey how to operate Sentinel Asia system and how to utilize earth observation satellite data, JAXA has so far held the Sentinel Asia System Operation Training for six times. In these training sessions, JAXA explains through lectures how to use the new Step-2 system including the activation of Emergency Observation. Lectures and hands-on training for the utilization of earth observation satellite data are made by the lecturers from Data Provider Nodes and Data Analysis Nodes. The principles of the Sentinel Asia program were utilized during the Pakistan flood in August 2010.

Furthermore, JAXA is cooperating with the Asian Development Bank (ADB) to implement various capacity development activities. Recent events/activities included:

- GIS and Satellite Data for Asia" workshop hosted by ADB and CSTP in October 2009
- Field survey in Bangladesh, Vietnam and Phillippines, January – June 2010
- Presidents of ADB and JAXA concluded LOI (Letter of Intent) , at ADB HQ, July 2010 with potential cooperative fields that are consistent with the main AWCI agenda:
    - Disaster management
    - Climate change adaptation
    - Water resources management
    - Forest monitoring
- Cooperation for Pakistan disaster damage assessment (ongoing)
- Technical Assistance project for the flood warning system improvement for the three countries (Bangladesh, the Philippines, and Vietnam) is to start in 2011

3. Capacity Building at ICHARM

ICHARM has been implementing a set of capacity development activities including short training courses, aftercare programs for implementation at trainees local communities, master course program on water-related disaster management with the National Graduate Institute for Policy Studies (GRIPS), as well as a PhD course to foster researchers who can guide and supervise researchers and research projects on water-related disaster risk management (since 2010). The main focus of the ICHARM capacity development activities is to deliver the best available knowledge to local practitioners. With this goal, several training courses on Global Flood Alert System (GFAS) validation and Integrated Flood Analysis System (IFAS) have been organized in Japan and other countries. The GFAS (http://gfas.internationalfloodnetwork.org/gfas-web/) workshops objective is capacity development for local practitioners to validate GFAS rainfall and translate it to GFAS-streamflow (IFAS) in ungaged or poorly gaged basins. IFAS is a toolkit to implement GFAS – Streamflow and provides a basis for flood forecasting/warning system. The most recent event on IFAS training was the IFAS seminar in Myanmar in June 2010, at the Department of Meteorology and Hydrology, Ministry of Transportation. Over the three days, 15 participants were working with the system using demo as well as local data and produced a preliminary runoff analysis at the Hkamti Station in the Chindwin River.

After the CB reports, a small discussion session took place that investigated needs and possibilities for certain training events and or other capacity building requirements in the AWCI countries. Several proposals were made, some of which can be submitted under the existing programs of JAXA, UNU, ICHARM, and UT as specified above. In addition, the need for data quality check, adequate archiving, and integration was reported by Indonesia. The UT can provide software tools to address these issues and a training course for their use can be organized.

2.3 Climate Change Study Focus

Climate change related issues and studies in the AWCI countries

As a background for further development of the AWCI Climate Change Assessment and Adaptation (CCAA) study, a session focusing on climate change related issues and assessment/adaptation activities in the AWCI countries was organized at the meeting. It was divided into four subsections considering main themes of the planned CCAA study, i.e. flood, drought, snow and glaciers, and water quality. Totally, 22 contributions were presented, 12 of which fell into the flood session, 6 into the drought session, and the snow and glaciers, and the water quality sessions had each 2 contributions.

A variety of issues were reported during these presentations and it was indicated that impact of climate change on frequency and magnitude of these issues needed to be properly assessed and possible adaptation plans and mitigation measures investigated. The need for regional collaboration in this endeavor that should be extended from the assessment analyses to the water resources management policies and adaptation plans was stressed out several times, pointing out the large number of transboundary basins in the region. While all country representatives reported evidence of climate change impact on water resources, there is also evidence that the changes and impacts are not explicit but regionally dependent (e.g. glacier melt vs. increase). Impact assessment techniques have already been developed and applied in some countries that will be provided for the planned CCAA study.

1. Flood session

In the flood-focused session, Thailand, Bangladesh, Indonesia, Uzbekistan, and Myanmar reported on the nature of the flood hazard as well as most recent disasters in their countries and introduced country concepts for flood forecasting, flood warning systems and flood disaster management and mitigation approaches. India reported on a unique and very local phenomena of cloud burst that appeared in 2010 in otherwise rather dry area and that was unexpected since such events are not predictable with current skills of NWP systems and actual rain intensities were also unobserved due to lack of raingauges in this rural area. Indonesia also reported on various policies and activities approved and undertaken by the government to reduce the causes of climate change, in particular reducing GHG emissions. Malaysia presented a study to assess impact of climate change on hydraulic and hydrological performance, in which the Regional Hydro-Climate Model of Peninsular Malaysia (RegHCM-PM) developed by the NAHRIM Institute was applied using the Canadian GCM1 output. The first results suggested worsening of both, the flood and drought situations but it was stressed out that:

> *"Climate modeling is not a very precise science and the results therefore cannot be taken as being very accurate but serves to tell us whether climate change has significant consequences to projects and thereafter the authorities concerned can at least be forewarned of possible outcome of the climate change phenomena."*

The issue of the climate projection model output uncertainties was addressed in the presentation by the University of Tokyo team on multi-model applications to the assessment of the climate change impacts on floods that provided analyses of climate change impact assessment using 12 CMIP3 model outputs in Sri Lanka and Japan. Cambodia and Pakistan reported on the flood issues related possibly to climate change and on studies focused on assessment of the climate change impact on water resources. Cambodia is utilizing the water resources assessment and management support system developed in cooperation with University of Tokyo that includes dynamical downscaling of GCM output coupled with hydrological modeling yielding soil moisture estimation. The results are used for addressing farming and water allocation issues. In addition, a case study was presented by ICHARM on analysis of the August 2010 Pakistan flood using combination of satellite-based rainfall and global GIS data with the IFAS system that showed a very high potential to make prompt flood analyses even in poorly-gauged river basins. Nevertheless, it was also highlighted that without any in-situ (ground-truth) data, such integrated information & analysis cannot be assured, verified nor improved and thus it is essential to combine the above method with the in-situ observations.

2. Drought session

Country representatives of Bangladesh, Vietnam, Thailand, Mongolia, and Philippines reported on severe, prolonged and large-scale droughts occurring currently in their countries. While most of these countries are usually battling with floods, flash floods, and landslides, it was felt that drought is a slow, silent disaster, which in the long run will have a more profound impact on peoples' livelihoods, in particular in these agricultural countries. In Vietnam and Philippines, the main reason for drought conditions is a strong El Nino situation and it was noted that better knowledge of relationship between climate change and ENSO phenomena would be essential to improve capability to predict droughts in these countries. A comprehensive study on various drought indices assessment in the Pampanga river basin in Philippines and assessment of climate change impact on drought using the CMIP3 climate projection coupled with distributed hydrological model was presented in which a standardized anomaly index was developed to integrate multiple aspects in the drought quantification. Thailand presented a study in which capabilities of their Hydroinformatic system procedures developed for floods were also tested for analyzing a drought risk. The Normalized Difference Vegetation Index (NDVI) from MODIS Terra was considered through spatial and temporal analysis (layering and weighting method with hydrometeorological factors) on monitoring area and the results showed good agreement with observed situation in the Northern Thailand, where the drought is more severe and probably related to the effects of climate change. A comprehensive assessment of spatial and temporal drought pattern was also carried out in Bangladesh that focused on characterization and quantification of drought severity, drought vulnerability, and damage and prioritization of potential adaptation measures against drought. The results showed moderate to high vulnerability to drought in the country, depending on the region. While hydrological drought is being observed in Mongolia, in particular in steppe and desert steppe zones, with decreasing number of small and extremely small lakes, river runoff is actually increasing in the glacier- and permafrost-fed rivers and simultaneously, total glacier area is decreasing. Mongolia has a government-approved National Water Program that includes intensification of environment monitoring, integrated river basin management, as well as climate change adaptation strategies.

3. Water Quality session

Bangladesh and Nepal reported on pressing water quality issues and connections of water quality to water quantity. In case of Nepal, the main concern is extremely high pollution of the Baghmati river in the Kathmandu valley due to municipal and industrial waste being directly discharged into the rivers. About half of industrial productions operate in the upper Baghmati basin and the relatively dense population along the valley produces large amount of solid waste that is not properly treated and is polluting the valley. The result is chemically and bacteriologically unfit water for any kind of freshwater fauna and flora or irrigation. The water quality improves when discharge considerably increases due to monsoon rains or downstream, when diluted with fresh water of cleaner tributaries. A set of mitigation measures have been suggested. In Bangladesh, a formative research study was conducted to incorporate water quality aspect in assessment of socio-economic drought. A set of water quality parameters were investigated during dry season in rivers as well as ponds in two locations, one of which was drought-prone, the second one drought and flood prone. The results indicated that if the water quality determinants are considered, severe socio-economic drought may occur even though the quantity of water itself is not limiting. The worst situation was in the drought-prone area.

4. Snow and Glacier session

During this session, modeling activities focusing on snow and glacier phenomena were introduced. A global glacier “Hyoga” model operating with 0.5 degree spatial resolution, 50 m vertical resolution of snowpack and glaciers, and a daily time step was developed at the University of Tokyo. The empirical degree-day factor is used to calculate snowpack and glacier melt but more accurate energy balance method is under development. The model was calibrated against climatology of measured mass balance and applied to estimate global glacier mass changed over the past 60 years. The model can be applied for future glacier change estimation using the climate model projections, however, there are several limitations that need to be considered, i.e. uncertainty of current total glacier volume due to lack of precise observation, simple mass balance method, and limited validation possibilities. Nevertheless, the model has a great potential for the AWCI climate change study in the snow and glacier areas. In addition, a new snowfall-snowmelt-runoff model is under development based on the energy balance scheme. Preliminary assessments of the model showed good performance in snowcover simulation against satellite observation. The model has a potential of coupling with the abovementioned glacier model and as such would be applicable in the snow and glacier regions.

Preparation for Implementation Plan

In this session, a number of programs, frameworks, projects, activities, as well as tools, methods and technologies were introduced that are related to the AWCI climate change focus and should be considered in the CCAA study implementation planning.

Firstly, the key role of GEO and GEOSS – the global, coordinated, comprehensive, and sustained system of observing systems – and its data and information principles were emphasized. It provides a nice framework not only for the AWCI activities and those AWCI countries, which had not joined GEO yet, were asked to consider such a step. The Governing Council of another relevant framework, the Asia-Pacific Water Forum, established a Steering Group on Water and Climate Change in June 2009 that is tasked with (i) advising leaders on policies and practices, (ii) guiding knowledge networking in the region, and (iii) reporting progress annually to the leaders in the Asia-Pacific region with recommendations for action. The steering group operates with five principles:

1. Scientists and practitioners working together must prioritize the development of knowledge that supports effective actions and increases public awareness.
2. We must identify and implement approaches that improve water security over a wide range of potential conditions, including current climate variability.
3. We must build the capacity of society to demonstrate resilience in the face of changing climate.
4. We must adopt optimal combinations of measures.
5. Substantial increases in dedicated financing are required.

These principles translate into specific recommended actions that are described in the Framework Document at: http://www.apwf.org/weblog/public_html/weblog/information/archives/201011/000034.php.

The River Bureau of the Ministry of Land, Infrastructure and Transportation, Japan introduced Practical Guidelines on Strategic Climate Change Adaptation Planning for Flood Disasters that are based on the common background in the Asia-Pacific region including seasonal distribution of rain, dense urban development in low-lying flood-prone areas, frequent typhoons and cyclones, etc. The guidelines, issued also as a booklet, aim to describe a framework for procedures to develop adaptation measures against the increases in the intensity and frequency of floods caused by climate change and to support the decision making to secure the sustainable development in the Asia-Pacific Region in overcoming the flood risks. The concept follows a flexible approach to optimize the combination of adaptation measures considering future uncertainties and need for regular feedback, i.e. “climbing-a-spiral” approach (Fig. 6),

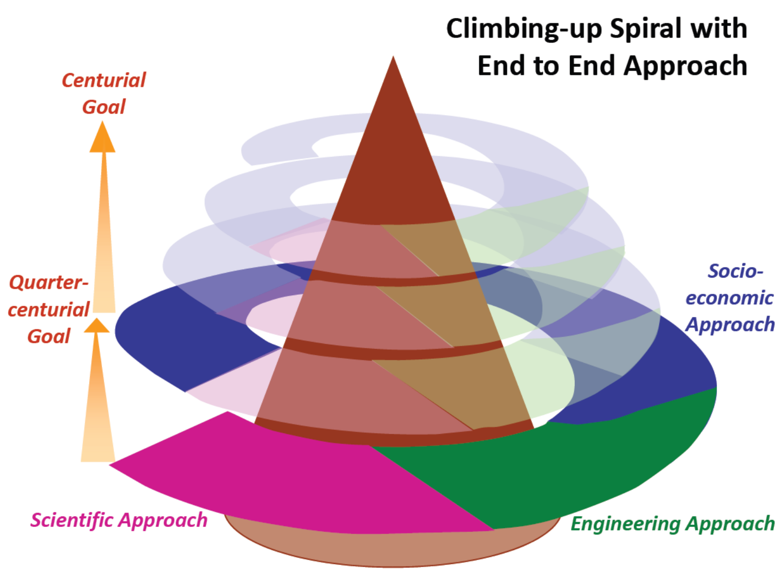


Figure 6: Scheme of climbing-up spiral approach.

targeting 100-year period. The IPCC projections of future rainfall intensities are reflected in the adaptation procedures consisting of combination of structural and non-structural, i.e. management measures. The booklet is available at:
http://www.mlit.go.jp/river/basic_info/english/pdf/Practical_Guideline_on_Strategic_Climate_Change_Adaptation_Planning_E.pdf

Similar approach towards climate change adaptation (CCA) was adopted by Japan International Cooperation Agency (JICA) in their Handbook of Climate Change Adaptation in Water Sector. Their proposed method is schematically shown in Figure 7. The method considers that the stationarity in the hydrological cycle is no more valid due to changing climate and is developed along five basics concepts:

1. Human security: focusing on individuals, particularly the most vulnerable
2. Engagement with the society: engaging with the society as a whole, including policymakers and decision makers
3. Building a sustainable adaptive society: resiliently cope with a changing climate whose prediction entails uncertainty
4. Disaster risk management: with the focus on the society's vulnerabilities, especially associated with urbanization, and adaptive capacity
5. “Zero victim” goal of flood control: (i) protecting critical areas using structures, (ii) no settlement in disaster hazard areas, and (iii) coping with unavoidable inundation with CBDM.

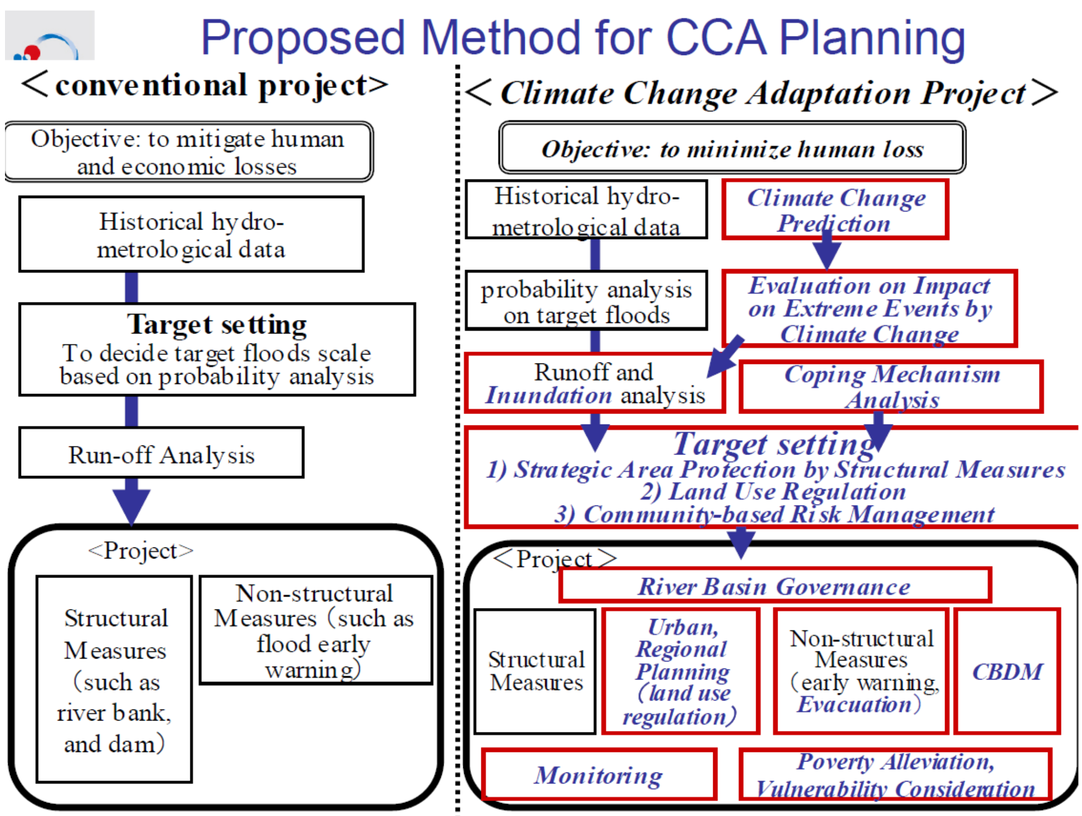


Figure 7: JICA’s climate change adaptation planning scheme

The method was applied at two cases in Philippines that resulted in revised plans for flood protections putting more focus on non-structural measures, in particular on land use management and community-based risk management. The experience showed that various local solutions are required for adaptation.

Japan Meteorological Agency (JMA) introduced the system, purposes and potential application of re-analyses in CCAA studies as well as the status of the latest JMA re-analysis (JRA-25, and JRA-55). The re-analysis process is schematically shown in Figure 8. Since the re-analyses provide homogeneous data of the earth climate system, they are very useful in multiple applications including climate monitoring, worldwide extreme events monitoring, seasonal forecasts, analysis of energy and water cycle, providing forcing for ocean models and regional and meso-scale atmospheric models, etc. It can also be used for in re-examination of past extreme events that are important for assessment of climate change and its impacts.

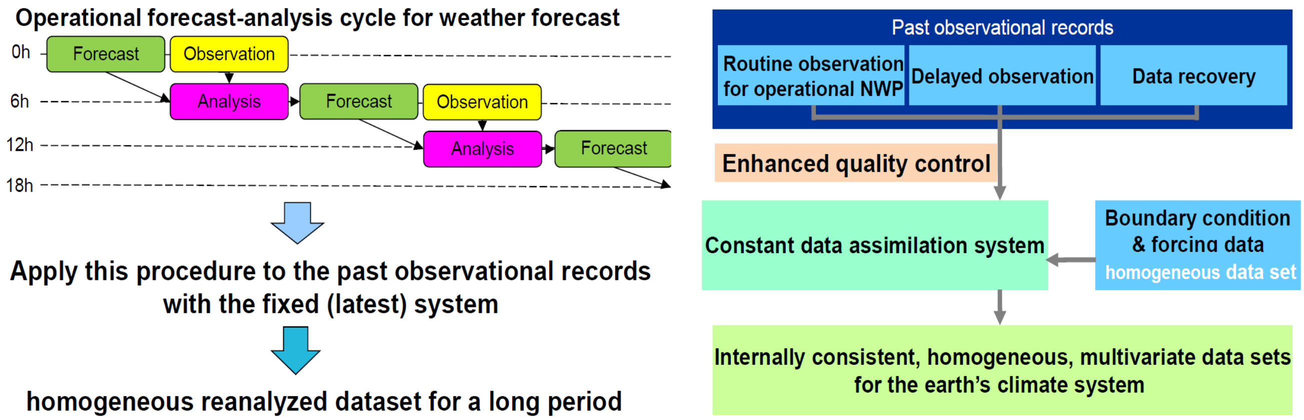


Figure 8: Scheme of the re-analysis production process.

JAXA introduced their satellites and sensors relevant for the energy and water cycle that include TRMM PR, Aqua AMSR-E, DAICHI (ALOS), and IBUKI (GOSAT) from those in operation and several others to be launched in a few next years. Examples of observation products by these sensors were presented that indicated a wide range of applications in the water cycle field. Aside from standard GCOS products like precipitation, soil moisture, snow cover, land cover, cloud properties and others, more complex products and services were introduced including the Global Rainfall Map in near-real time (4-hours delay) using TRMM, AMSR-E and other satellite data, and the JAXA Satellite Monitoring for Environment Study (JASMES) (Fig. 9). The way how to obtain the JAXA earth observation data using the Earth Observation

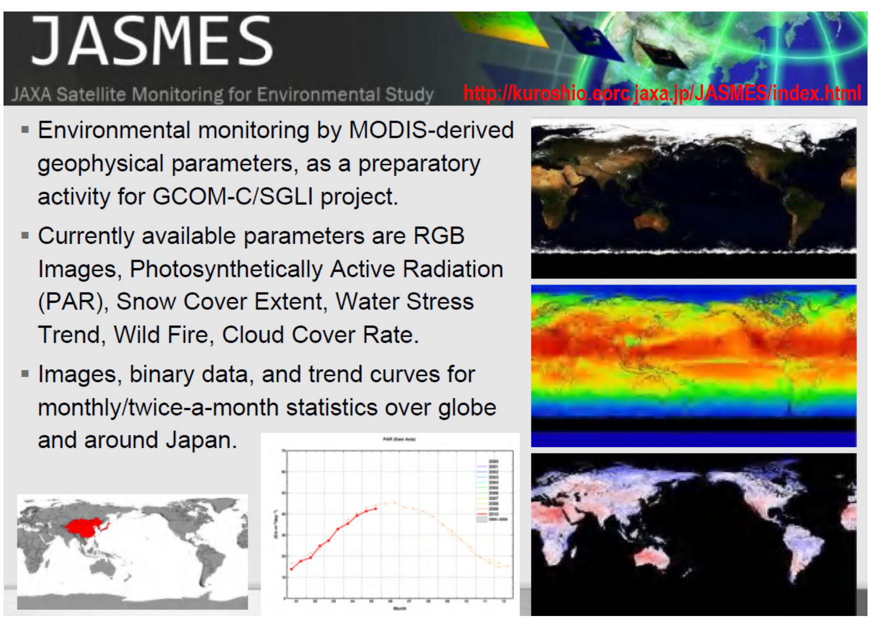


Figure 9: JAXA Satellite Monitoring for Environmental Study

Research Center (EORC) website was explained (http://www.eorc.jaxa.jp/). In particular, individual categories of JAXA products can be found at following sites:

- Standard Product: http://www.eorc.jaxa.jp/about/distribution/index.html (All products, except ALOS and GOSAT, can be used by registration)
- Research Product (not limited to below), Browse Images:
    - AMSR-E (http://sharaku.eorc.jaxa.jp/AMSR/index.html)
    - GSMaP (http://sharaku.eorc.jaxa.jp/GSMaP/index_j.htm)
    - JASMES (http://kuroshio.eorc.jaxa.jp/JASMES/index.html)
- CEOP Satellite Data Gateway (http://www.ceop.net)

The following presentation provided some suggestions for the CCAA study implementation plan that should focus on narrowing the gap between scientific capacities and society needs (large uncertainties of projections vs. need of accurate predictions). This was illustrated by climate change impacts analyses on water and agriculture in China. Analysis of past observations showed increasing trend in drought frequency and a pilot study of future climate change impacts was conducted using 17 GCM projections. The results indicated more severe droughts in certain basins while opposite trend in other basins. The changes in rainfed crop yields were also calculated. As also mentioned by other presenters, due to uncertainties in climate model projections, the results are not conclusive but only indicative and this need to be addressed in CCAA efforts. Accordingly, the following was suggested for the AWCI CCAA implementation planning:

- development of assessment models/tools for water management policy-making (need to predict mean and extreme, trend and variability; and to quantify uncertainties)
- long-term forecast of flood and drought for natural disaster prevention (GCM/RCM outputs not reliable for this purpose at this stage)
- better infrastructure operation considering prediction uncertainty (optimization schemes including input uncertainties)
- prediction of the agricultural water use (simulation of water-CO_2-nitrogen cycle is necessary)

An infrastructure (dam) operation optimization scheme that considers uncertainty of predicted rainfall values was developed through cooperative efforts of UT and Tokyo Institute of Technology (TITECH) and introduced at the meeting. This Dam Release Support System (DRESS) aims to support decisions on dam releases during flood with the two-fold goal: (i) reduction of flood peak, and (ii) storing water for later use. It employs the WEB-DHM hydrological model that is forced with quantitative precipitation forecast (QPF) data. The forecast error is assessed for past forecasts against available observation and introduced through current forecast perturbations making thus ensemble of QPF. The system was tested in the Upper Tone river basin in Japan during several heavy rainfall events. The suggested operations resulted in reduced flood peaks as well as maximized water storage in reservoirs for a later use. Similar approach for prediction error assessment and consideration is used in another scheme targeted for timely flood warning (Flood Warning Support System – FLOWSS). It uses real-time rain gauge data, quasi-real-time satellite precipitation data, and regional forecast data to force the WEBH-DHM in the lead time, giving thus prediction of river flows. This scheme was successfully tested in the Huong river basin.

The concept, structure and use of the Water and Energy Budget Distributed Hydrological Model (WEB-DHM) was also introduced, focusing on applications for improved integrated water resources management. The model was developed as a combination of the advanced land surface scheme SiB2 and a robust distributed hydrological model with some substantial improvements in the soil scheme. Over a few past years, the WEB-DHM has been improved in several ways including frozen soil parameterization and snow physics and has also been used in a number of water resources assessment studies focusing on floods and droughts, as well as combined with the abovementioned DRESS and FLOWSS schemes for flood warning and dam release decision support. It has already been used for the climate change impact assessment in some of the AWCI countries, e.g. Philippines in case of drought (as presented in the *Drought session* above.

The role of hydrological modeling in the climate change impact assessment was explained and recommendations from this viewpoint for the AWCI CCAA implementation plan given. The general process of the climate change impact assessment and adaptation studies is schematically shown in Figure 10. There are a number of hydrological models available in the world that have been applied in climate change studies and that employ various approaches towards individual hydrological processes like evapotranspiration, soil water, and river routing. Several models have been tested on Korean basins and it was concluded that in some cases (like a winter season), uncertainties from a hydrological model itself may be even higher than those from input data from GCM projections. Nevertheless, it was emphasized that uncertainties exists in the whole CCA process, the GCM output being usually the main source, except specific cases as shown in the Korean study, and downscaling procedures being another source. Therefore multi-model ensemble analyses (Fig. 11) are indispensable in the CCA studies. Also a

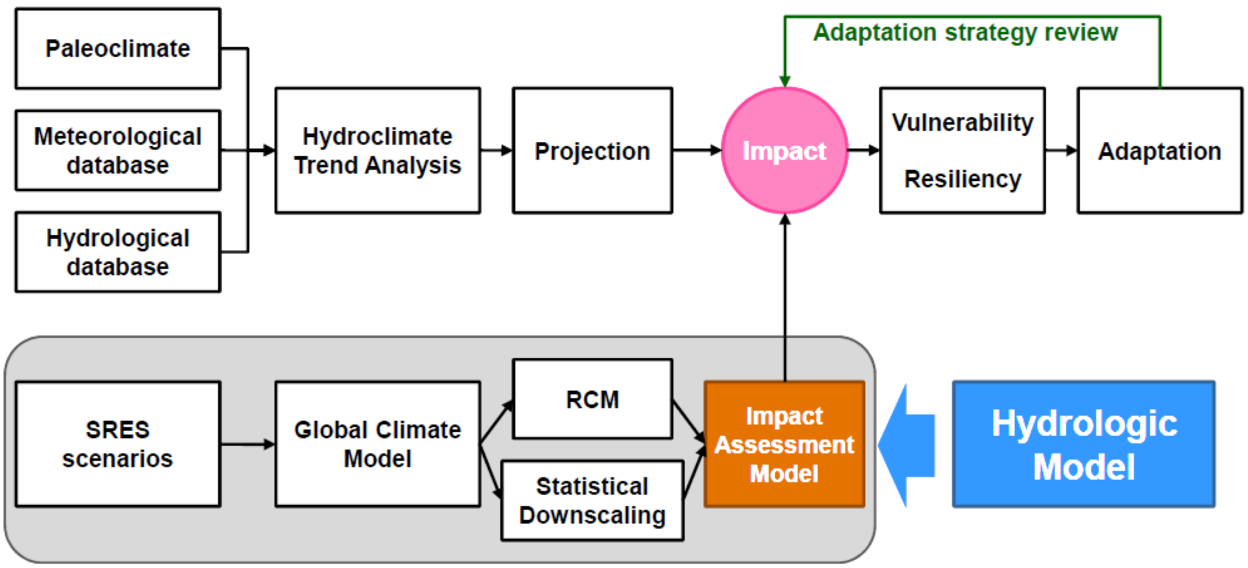


Figure 10: General process of the climate change impact, vulnerability and adaptation studies on water resources

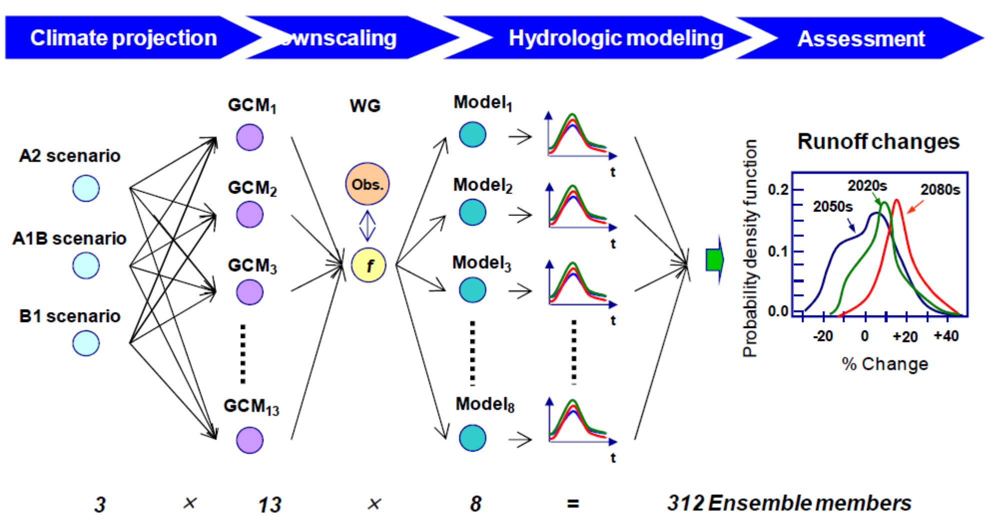


Figure 11: A schematic diagram of a multi-model ensemble analysis

regionalization method for hydrological model parameter estimation in ungauged basins was introduced that may be useful for some basins of the AWCI CCAA study. The major expected outcomes of the impact assessment part of the CCAA study would be annual variations of water cycle components under A2 climate change scenario, changes in seasonal runoff and variations of extreme events. The individual implementation steps are shown in Figure 12.

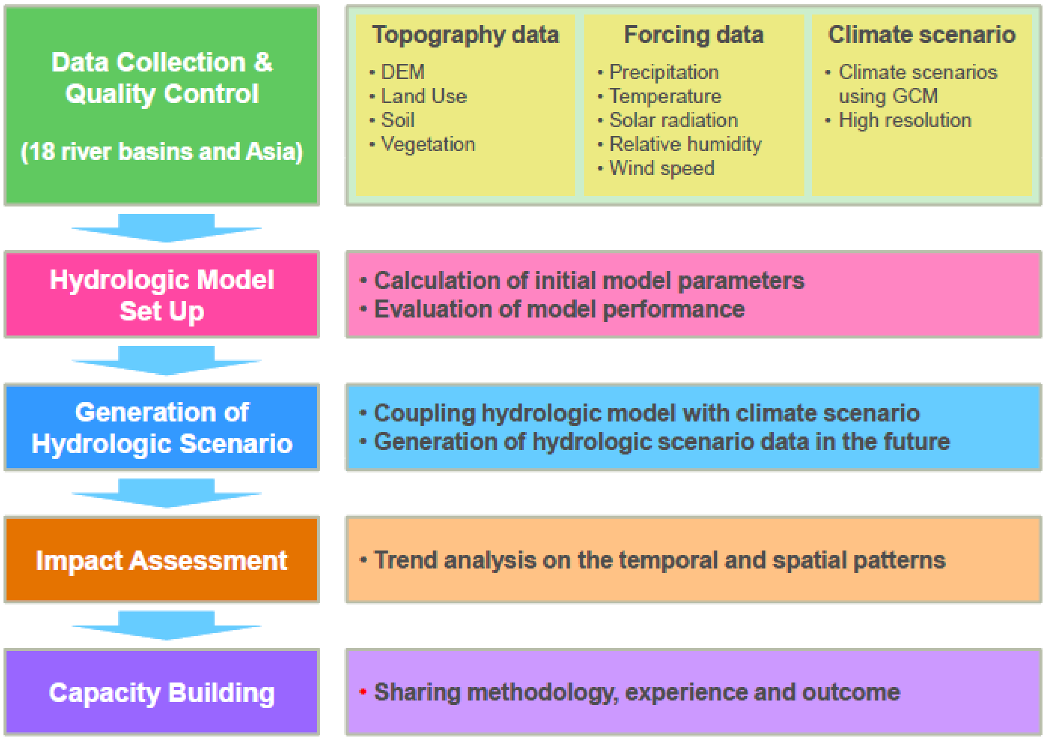


Figure 12: A schematic diagram CCAA implementation steps

The data integration tools including raw data uploading system, data quality control system, and metadata registration system and their use were introduced with highlighting improvements from previous versions and a good progress in the AWCI data submission, quality check and metadata provision was reported. It was emphasized that with opening the DIAS system to public on 1 October (http://www.editoria.u-tokyo.ac.jp/dias/link/portal/english_index.html), all the AWCI data submitted under the AWCI data sharing policy was now freely available for download. At the same time, users have access to numerous other datasets from various sources. The DIAS system and how it access and download data was explained in detail and participants were encouraged to use the system and report their comments to the data integration team. DIAS also includes an interoperability portal that provides data/metadata search, technical term search and visualization of relations among dataset to very large-scale and wide variety of earth observation data registered in the DIAS core system. This is a powerful tool that, however, requires duly registration of metadata by data providers for its full functionality. The DIAS system structure and data catalog interface are shown in figures 13 and 14, respectively.

Development of climate change adaptation strategies require appropriate methodology for integrating socio-economic aspect into the impact assessment scheme, i.e. solving the following issues:

- Impact evaluation" of the climate change
    - Quantification of the impacts on agricultural, industrial, lifestyle and environment from converting precipitation patterns calculated by climate change to river discharge, volume and quality of the water resource
    - Evaluation of the impacts on drought, water disaster and water contamination in regional and river basin scale due to climate change

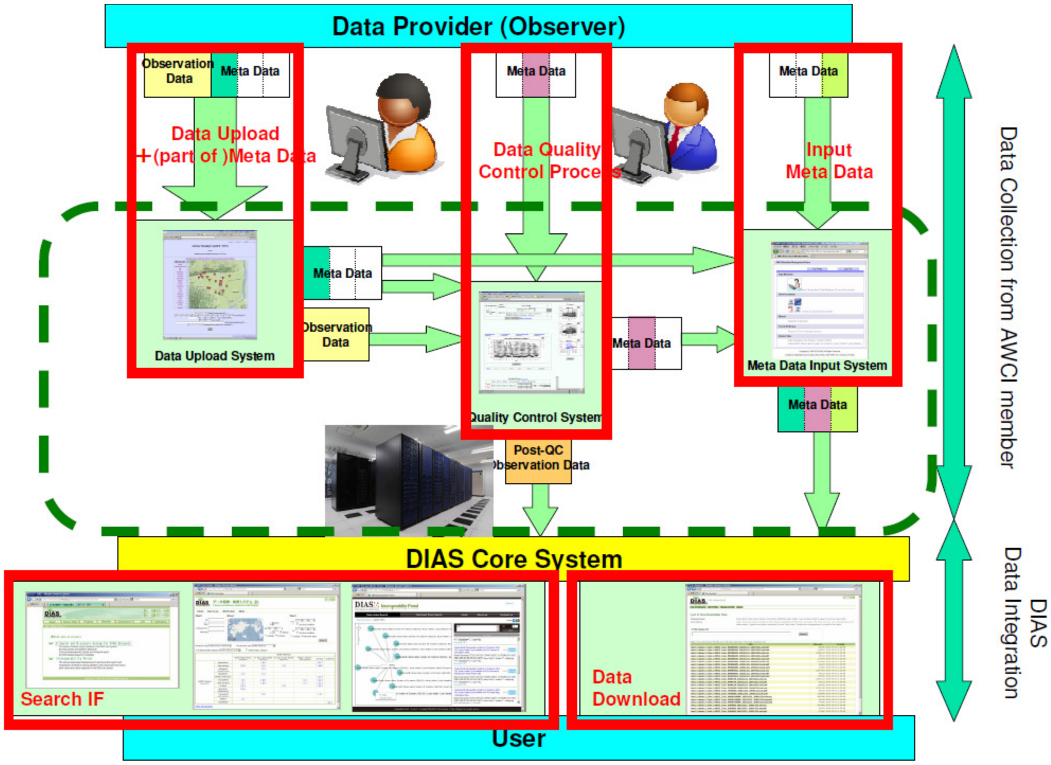


Figure 13: Structure of the DIAS system.

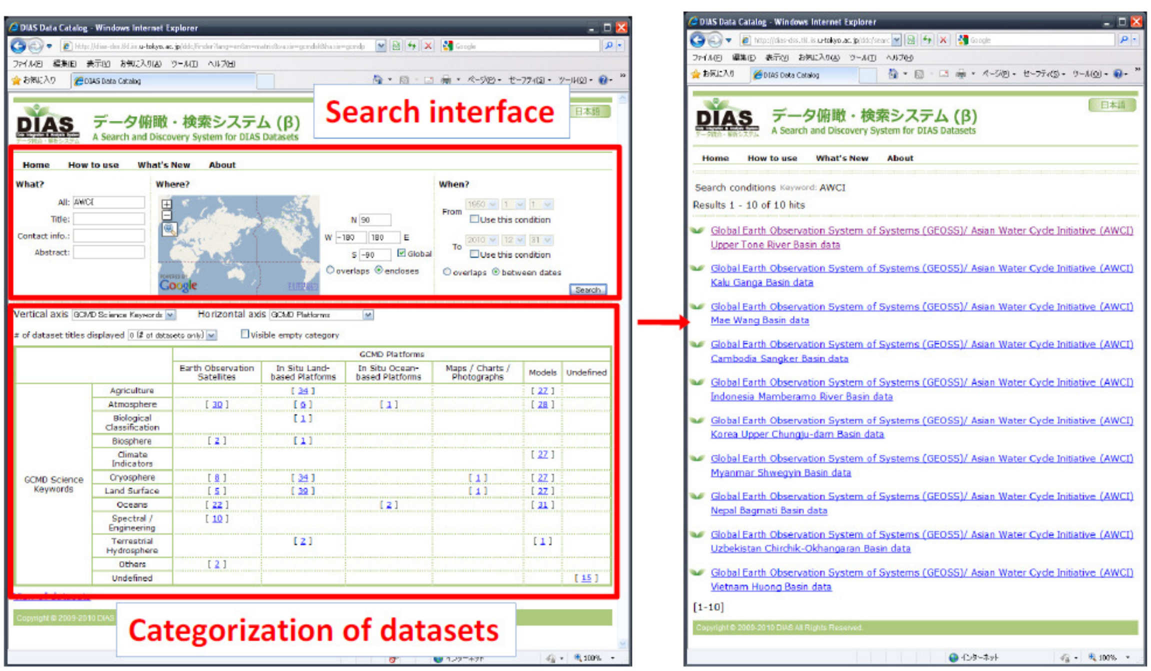


Figure 14: DIAS data catalog interface.

- "Establishment" of a policy decision making to the climate change
    - Development of a policy decision making system by considering the uncertainty of climate change and cost expectation in the future. Evaluation of benefit of economic activities and satisfaction of people in this area.
    - Development of option selection system in order to maximize the social profit while considering the uncertainty in the future
- Policy implementation
    - From the above problem solving procedures, it is necessary to form the management system that can monitor, verify, evaluate and correct the processes in the "Regional management system" by combining the functions of agreement formation and benefit sharing in the region
    - Propose the regional management system for the adaptation policy implementation on the climate change

Such a methodology was proposed by the Kochi University team that was designed for river basin management and tested in Shikoku and Thailand. The methodology includes a logical model of citizens' mindset regarding water issues that is based on survey among local citizens and transformed into numerical form. Using such awareness structured logical modeling, total benefits of individual proposed policies can be evaluated and a set of options of adaptation policies suggested to the public management. The whole process is depicted in Figure 15.

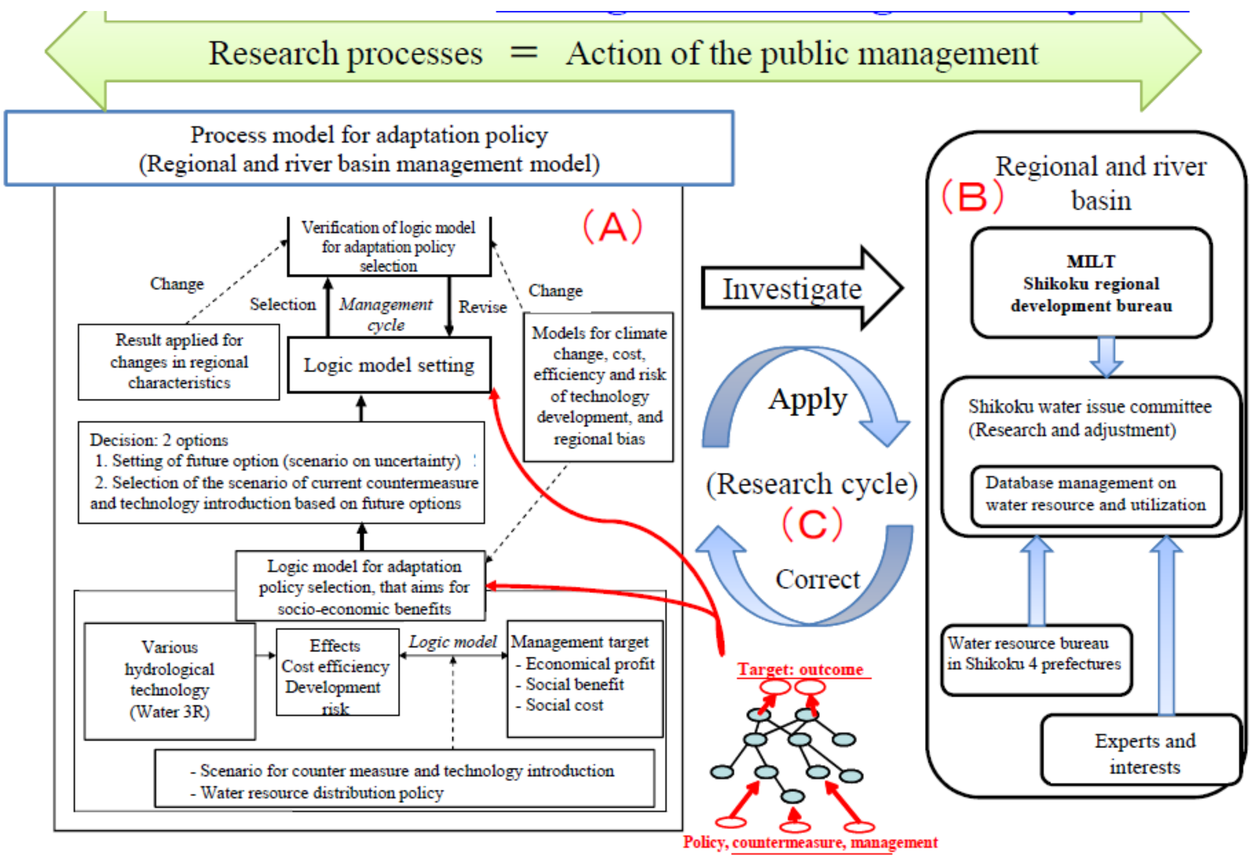


Figure 15: Scheme of the process of implementation of adaptation policies

Breakout group session for CCAA implementation planning

After the introduction of available programs, frameworks, projects, activities, as well as tools, methods, and technologies relevant for the AWCI CCAA study, breakout group session was held to discuss implementation plan for respective focus areas including flood, drought and water quality. Due to absence of key representatives from the snow, glacier and GLOF focus, this group discussed the CCAA implementation subsequently at a dedicated conference call.

A first-draft version of a white paper on AWCI CCAA was distributed to the participants prior to the meeting and several points/questions were handed out before the session that the groups should focus on:
- What is the key mission of the CCAA study
- Methodology for two steps: (i) climate and bio-physical drivers and (ii) socio-economic drivers
- Implementation strategy, plan, and schedule

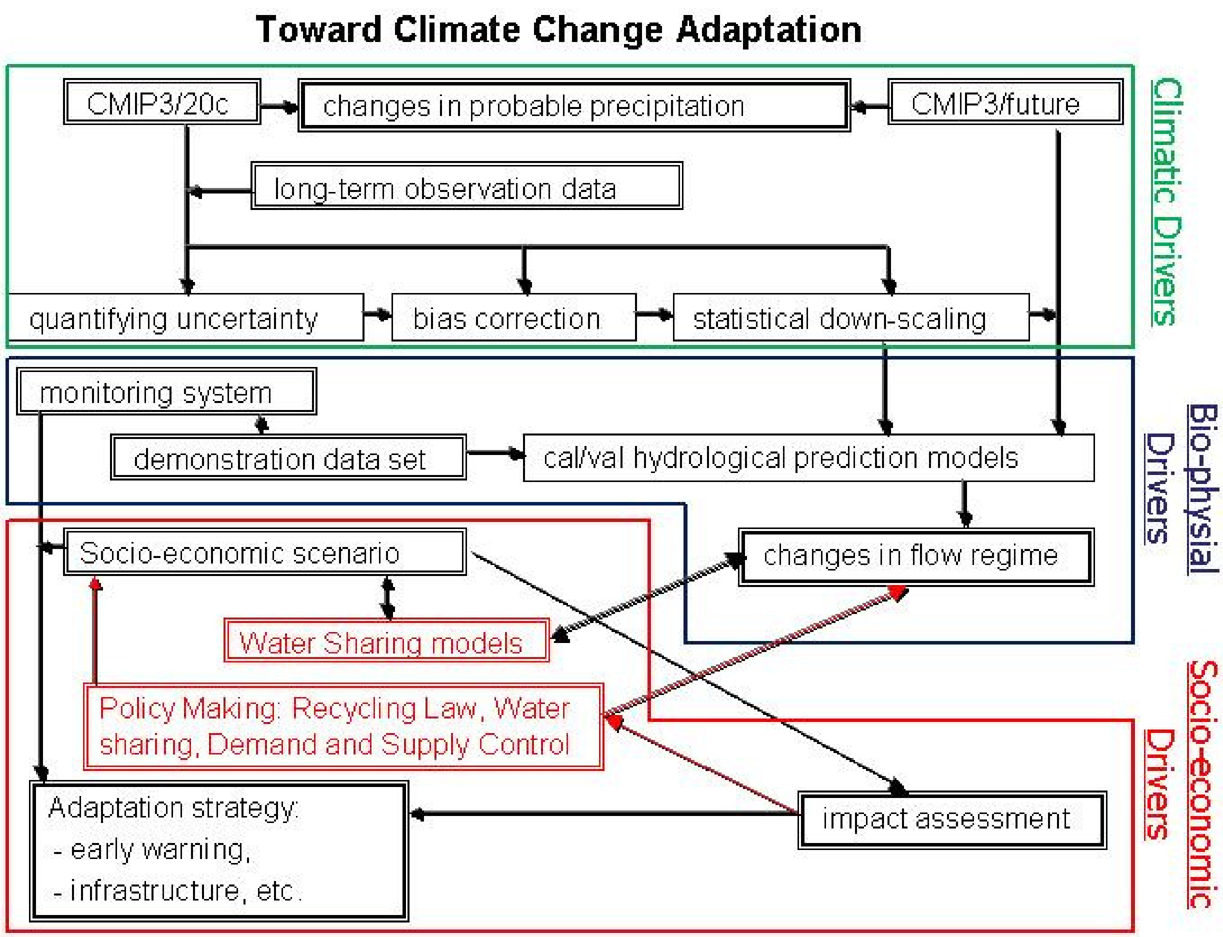


Figure 16: Flowchart of an implementation plan toward assessing impacts of climate change and preparing adaptation strategy – resulting version from breakout group discussions.

The flowchart of an implementation plan toward assessing impacts of climate change and preparing adaptation strategy that resulted from the Bali meeting discussions (Fig. 16) was also presented before the breakout group session.

The participants in the flood, drought and water quality groups discussed the above points and came out with certain recommendations that were incorporated into the white paper draft. The final version of the draft is attached in Appendix 1 below this report. Also outcomes of the snow, glacier and GLOF focused conference call that was held later in October, were incorporated in the updated version of the white paper draft.

Summary session

The outcomes of the two-day event were summarized, highlighting the continued progress in the demonstration project data submission that had enabled various studies be carried out as presented during the meeting. High awareness of the climate change related issues at the governmental level of AWCI countries that was evident from country reports was acknowledged and expected be helpful in pursuing the AWCI CCAA study. In addition, a wide range of on-going projects and activities focusing on climate change and including capacity building programs are available offering multiple opportunities for collaboration.

With the data submission protocol established, benefits of the AWCI framework shown and recognized through the outcomes of several demonstration projects, the need for climate change assessment and adaptation understood, and various methods, tools, and climate projection data available, the group felt ready to move on to implementation of CCAA study. With regards to the presented contributions, the implementation plan of the CCAA study was discussed and subsequently summarized in the white paper (Appendix 1), which also includes the implementation schedule.

As planned, the next AWCI event will be a training session focused on the rainfall bias correction and hydrological model application in the climate change assessment that will take place in Tokyo, Japan, March 2011. It will be held in conjunction with other related events, namely GTN-H workshop, IGWCO workshop, and the 5th GEOSS AP Symposium that will include a parallel session on Water, which will mainly be dedicated to AWCI.

All the participants were acknowledged for their active participation in the meeting and contributing their valuable knowledge and ideas to the discussions. The successful meeting was closed by thanking the organizers and all the supporting staff that assured smooth course of the meeting.

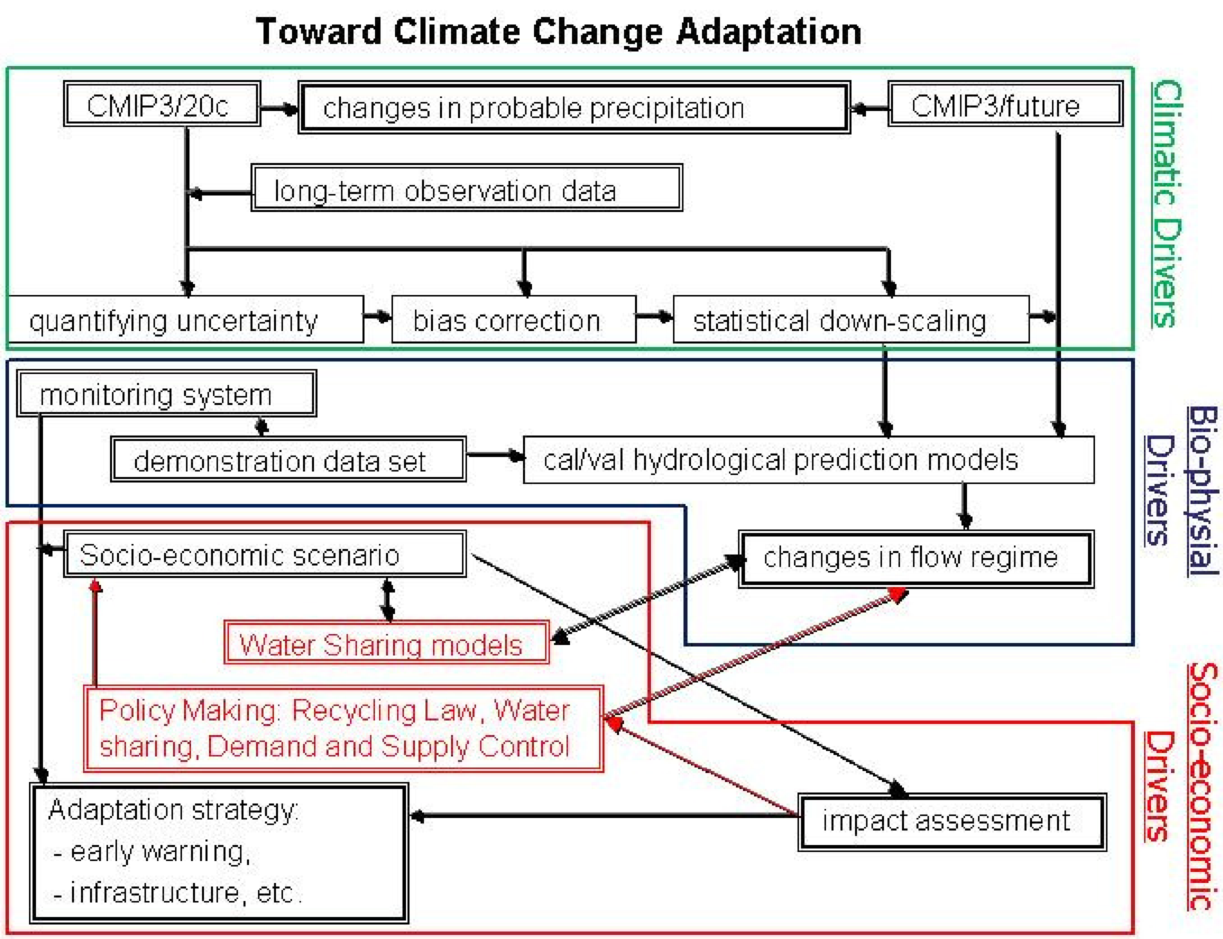
Appendix 1

Whitepaper on the GEOSS/AWCI Climate Change Impact Assessment Activity

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.

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.



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

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

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.

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.

<u>3. Governance</u>
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