

**Summary Report on the AWCI Training Workshop on Climate Change Impact Assessment**  
Held in Islamabad, Pakistan, 15 – 17 September 2014

Organized by the Pakistan Meteorological Department (PMD) in cooperation with the University of Tokyo, Japan and supported by the Asia Pacific Network for Global Change Research (APN).

[http://monsoon.t.u-tokyo.ac.jp/AWCI/meetings/IslamabadTraining\\_Sep2014/index.htm](http://monsoon.t.u-tokyo.ac.jp/AWCI/meetings/IslamabadTraining_Sep2014/index.htm)



### **Background**

The Asian Water Cycle Initiative (AWCI) has developed an advanced river management system, which 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. The system has been successfully applied to a set of AWCI demonstration basins showing a high potential for practical applications including assessment of climate change impacts on watershed hydrological regimes and hence water resources availability in future.

While AWCI has always aimed at exploitation of available scientific knowledge and technology advancement for addressing the societal needs in the arena of water resources, such efforts on bridging the science at one side and decision making process and operational use at another side have become even more critical now, when AWCI has entered its second phase. Negative consequences of natural hazards are on the rise despite of scientific and technology advancements in relevant fields and thus it is an imperative to implement activities that facilitates implementation of advanced technology and latest scientific knowledge into praxis. This will contribute to building up a resilient society and achieving sustainable development.

Accordingly, AWCI has been now pursuing operational applications of the developed system and, more generally, the established data integration approaches. This requires capacity building activities to assure the system is understood by a large community of experts and practitioners. The planned Training Workshop is one of these capacity building efforts and it is organized as part of the AWCI related project funded by APN under the CAPaBLE programme, titled: "Impact of Climate Change on Glacier Melting and Water Cycle Variability in Asian River Basins" and led by Dr. Ghulam Rasul, PMD. The Workshop is designed for researchers and practitioners, who are working on assessments of climate change impacts on water resources and also for those with interest in hydrological modeling in snow and glacier basins.

### **Objectives**

The objectives of the Training Workshop included:

- Thematic lectures on Climate-Water-Food-Health Nexus and APN and AWCI related activities in Pakistan.
- Introduction, description and demonstration of capabilities of the Water and Energy Budget Distributed Hydrological Model for Snow and glacier basins (WEB-DHM-S), which is a novel and robust tool for cold region hydrological applications.
- In-depth explanation of the techniques for climate change impact assessment studies on water resources that are built in the Data Integration and Analysis System (DIAS) and available on-line (demonstration version).
- Explanation and Hands-on training on the use of these methods that include:
  - o selection of suitable GCM outputs for the region of interest,
  - o rainfall bias correction of these outputs,
  - o downscaling of the GCM outputs for hydrological modeling at the basin scale
  - o hydrological runs by WEB-DHM (without the advanced snow and glacier component) – informative lecture on WEB-DHM will be provided but not full training of the model due to time constraints,
  - o analyses of the hydrological simulation results to assess possible impacts of climate change with focus on high flows and floods, and
  - o dynamical downscaling lectures.

## **Agenda** (Final version)

### **DAY 1: Monday 15 September 2014**

*09:30 – 09:55 Registration*

#### **10:00 – 11:30 1. Opening and Welcome Remarks** (*Chair: TBD*)

Mr. Hazrat Mir, Director General, *Pakistan Meteorological Department*: Welcome Address (10min)

Dr. Ghulam Rasul, *PMD*: APN Project led by PMD (10min)

Dr. Qamar-uz-Zaman Chaudhry, Special Envoy of WMO Secy Gen for Asia-Pacific (10min)

Dr. Amir Muhammad, APN Representative of Pakistan (10min)

#### **Keynote Speech:**

Prof. Dr. Toshio Koike, *University of Tokyo*, (30 min)

Remarks by the Chief Guest: Iftikhar Ahmed Mir, Senior Joint Secretary (10min)

#### **11:30 – 11:40 Group Photo**

*11:40 – 11:50 BREAK*

#### **11:50 – 12:00 2. Training Workshop Outline** (Dr. Petra Koudelova, *University of Tokyo*)

#### **12:00 – 12:30 3. Pakistani Contributions to AWCI** (*Chair: Dr. Arshad M. Khan*)

20 minutes presentation and 5 min questions/answers

1. Pakistani activities under AWCI – overview of past, present, and future (Dr. Bashir Ahmad, *PARC*)

*12:30 – 14:00 LUNCH*

#### **14:00 – 14:50 3. Pakistani Contributions to AWCI – continue** (*Chair: Dr. Arshad M. Khan*)

2. Indus project – climate and water nexus (Dr. Ghulam Rasul, *PMD*)

3. Indus project – water and food (agriculture) nexus (Prof. Dr. Ashfaq Chatta, *University of Agriculture, Faisalabad*)

**14:50 – 16:15 4. Hydrological modeling in cold region watersheds** (*Chair: Prof. Dr. Ashfaq Ahmad Chattha*)

20 minutes presentation and 5 min questions/answers

1. UNESCO Flood Project (Mr. Muhammad Riaz, *FFD/PMD*)
2. Distributed hydrologic modeling in cold region and high elevation watersheds in an integrated approach (Dr. Maheswor Shrestha, *UT*)
3. Brief on September 2014 Floods in Pakistan (Mr. Aleem ul Hassan, *National Weather Forecasting Center*)

16:15 – 16:45 *BREAK*

**16:45 – 18:00 5. Data Integration and Analysis System (DIAS) and Data Support Services** (*Chair: Mr. Ahmad Kamal, NDMA*);

20 minutes presentation and 5 min questions/answers

1. Expansion and Linkages of Water Cycle Initiative (Prof. Dr. Toshio Koike)
2. DIAS data upload, quality control and metadata support system (Dr. Petra Koudelova, *UT*)
3. CEOS Water Portal data service (Dr. Petra Koudelova, *UT*)

18:00 *Adjourn*

20:00 Discussion dinner

**DAY 2: Tuesday 16 September 2014**

**Training Workshop on Climate Change Assessment: GCM Bias Correction and Statistical Downscaling, Hydrological Analyses – using a demo case of the Soan Basin, Pakistan**

08:00 – 08:30 *Registration and Arrangements*

**08:30 – 12:00 6. Training Part 1.1: GCM Selection**

08:30 – 08:50 Introductory Lecture (Dr. Petra Koudelova)

08:50 – 10:40 Hands-on: Selection of suitable GCM output for the Soan basin region – using an on-line tool and MS Excel sheet (Dr. Petra Koudelova)

10:40 – 11:00 *BREAK*

11:00 – 12:00 Hands-on: Selection of suitable GCM output for the Soan basin region – using an on-line tool and MS Excel sheet - continue

12:00 – 13:30 *LUNCH*

**13:30 – 15:00 7. Training Part 1.2: GCM Rainfall Bias Correction, Statistical Downscaling**

13:30 – 14:00 Introductory Lecture (Dr. Mohamed Rasmy)

14:00 – 15:00 Hands-on: Correction of the rainfall data of the selected GCMs and downscaling them using an on-line tool; visual inspection and discussion (Dr. Mohamed Rasmy)

15:00 – 15:30 *BREAK*

**15:30 – 17:30 8. Training Part 2: Hydrological Simulation Preparation and Analyses**

15:30 – 16:00 Introductory Lecture (Dr. Asif M. Bhatti)

16:00 – 17:30 Hands-on: Preparing hydrological simulation, WEB-DHM demonstration, Analysis of results including high and low flows, Discussion (Dr. Asif M. Bhatti)

17:30 *Adjourn and Dinner*

## **DAY 3: Wednesday 17 September 2014**

### **Training Workshop on Climate Change Assessment: WEB-DHM-S, Dynamical Downscaling**

*08:00 – 08:30 Registration and Arrangements*

**08:30 – 09:30 9. Hydrological Modeling in Cold Regions: WEB-DHM-S model – physical and technical details, applicability discussion** (Dr. Maheswor Shrestha)

**09:30 – 12:00 10. Dynamical Downscaling** (Dr. Mohamed Rasmy)

09:30 – 10:30 Methodology Introduction Lecture (Dr. Mohamed Rasmy)

*10:30 – 10:50 BREAK*

10:50 – 12:00 Case studies presentation, Discussion (Dr. Mohamed Rasmy)

**12:00 – 12:30 11. Certificate Ceremony**

**12:30 – 13:00 12. Closing Remarks**

*13:00 – 14:00 LUNCH*

**14:00 – 17:00 EXCURSION**

*17:00 Adjourn*

### **Workshop Report**

The workshop has been planned and carried out to fulfill the objectives stated above. It included a plenary lecture session on the Day 1, which was attended by a larger audience of more than 100 persons consisting of experts from various sectors. The Day 2 and Day 3 were dedicated to a practical training of smaller group of experts and researchers from the AWCI countries and PMD. The training took place at the PMD computer lab, providing access to one PC to each of the participants.

This report provides summary of the given presentations and undertaken activities. The presentation files, reference documents and photos of the event are available through the workshop website at: [http://monsoon.t.u-tokyo.ac.jp/AWCI/meetings/IslamabadTraining\\_Sep2014/index.htm](http://monsoon.t.u-tokyo.ac.jp/AWCI/meetings/IslamabadTraining_Sep2014/index.htm)

### **Plenary Lecture Sessions on Day 1**

#### **Inaugural Session**

The whole event was opened by Director General PMD, Mr. Hazrat Mir. In his welcome address, Mr. Mir highlighted the importance of the workshop for expanding skills of invited researchers and experts from Pakistan and other AWCI countries as well as raising awareness of the subject issues and targeted techniques among broader community participating in the Plenary Sessions on Day 1. Mr. Mir also mentioned the vulnerability of Pakistan to climate change impacts that are aggravated by other factors like population growth and further aspects of global change. Extreme floods and droughts have been affecting large number of people and causing enormous losses and thus the efforts like this workshop to utilize scientific and technological advancement to reduce such risks are highly valued. The APN project funding that made possible to organize this event was acknowledged.

The PMD project under the APN CAPaBLE program entitled “Impact of Climate Change on Glacier Melting and Water Cycle Variability in Asian River Basins” was briefly introduced in the opening talk of Dr. Ghulam Rasul, Chief Meteorologist PMD. The project has been planned and carried out under the AWCI framework and included most of the AWCI participating countries. The project focused mainly on the cold regions but also on drought phenomena and how these may be affected by climatic changes. The snow

and glacier region of Himalayas-Karakorum-Hindukush plays a key role in the Pakistan water resources and thus changes in this region affect the whole country. It is therefore very much needed to properly assess the possible regime shifts in the snow and glacier processes in the region. The WEB-DHM-S hydrological model is an advance tool that enables such assessment and thus its comprehensive introduction was included into this workshop together with the training on climate model output bias correction methods. In such arrangements, the training is valuable not only for the researchers from Pakistan but also for all other AWCI countries dealing with the need to properly assess the impacts of climate change on water resources. The participation of the colleagues from other AWCI countries was acknowledged and appreciated.

The third speaker of the inaugural session was Dr. Qamar-uz-Zaman Chaudhry, Special Envoy of WMO Secy Gen for Asia-Pacific, who appreciated the good timing of such training event. The climate related disasters have been coming into attention of policy makers, who have been now calling for more attention to it and for increasing efforts to find adaptation solutions. Dr. Chaudhry mentioned that Pakistan has already developed a comprehensive national policy framework for addressing the climate change related issues but it is a high time for implementation of the adaptation measures and the current training workshop is contributing to this implementation process. Dr. Chaudhry also emphasized the urgent need for enhancing the regional collaboration relationships in terms of real-time, seamless hydrological data sharing without which the efforts on establishing advanced and robust early warning system cannot be fully successful.

The next opening talk was given by Dr. Amir Muhammad, APN Representative of Pakistan, who expressed his appreciation of the APN project led by PMD, Dr. Rasul, and voiced that such training workshops are very important and improved modeling skills in water resources fields are a high priority in this region at these times. Pakistan's economy highly depends on agriculture and meteorological and hydrological extremes are causing large damages to the agriculture production and thus significant economic losses of the country. Accordingly, the hydrometeorology background as well as advanced techniques for climate change impact assessment and early warning systems for floods and droughts should not only be taught occasionally at specific events but should be introduced into the syllabus of agriculture university programs.

The opening session also included a keynote lecture provided by Prof. Toshio Koike, University of Tokyo. The lecture focused on the overarching theme of sustainable development and explained the key role of water cycle for this goal. Also, the importance of inter-disciplinary and trans-disciplinary approaches was highlighted and Prof. Koike acknowledged participation of experts from various sectors in the event. He emphasized the absolutely essential need of proper data and data archiving, managing, and sharing capabilities that have been pursued and addressed by Global Earth Observation System of Systems (GEOSS) of the GEO framework. The regional initiative AWCI, which has also been involved in the current PMD project, has been contributing to GEOSS since the AWCI inception in 2007. The AWCI activities and accomplishments were demonstrated in a short movie that Prof. Koike included in his lecture. Subsequently, Prof. Koike showed a number of examples on how the integration of various data (satellite, model output, in-situ observations) by using advanced modeling and visualization techniques, had been used to resolve concrete issues under the AWCI framework. These examples are shown in his presentation file available through the meeting website. It also includes the recent work on combining the flood or drought simulation/prediction models with socio-economy data and economy growth simulation model that can assess impact of the disasters and at the same time impact of potential disaster prevention investment on future economy growth. Such tools are a great help in the process of building resilience to global changes in our efforts aiming at sustainable development.

The last inaugural talk was provided by Mr. Iftikhar Ahmed Mir, Sr. Joint Secretary, Ministry of Defense, Pakistan Government. Mr. Mir underlined the utmost importance of coordinated efforts in water resources management under the effects of global changes and the urgent need of more effective and efficient utilization of advanced scientific knowledge and technologies for practical solution at local level. In this context, Mr. Mir acknowledged the current training activity that as a commendable contribution to this desirable process that would lead to reduced risks of disasters associated with extreme situations of floods and droughts.

### Session on Pakistani Contributions to AWC/

After the brief outline of the training workshop, three presentations on Pakistani involvement in AWC/ activities were given. In the first one, Dr. Bashir Ahmad, Pakistan Agriculture Research Center (PARC), provided an overview of the long-term participation of Pakistan in the AWC/ program that included provision of a number of datasets to the publicly open DIAS archive, development of hydrological models in the upper Indus basin and the Soan river basin, climate change impact assessment, participation in several training sessions and initiation of a broader project in the whole Indus basin. The most significant contribution was proposing and realization of the current APN funded project under the leadership of PMD. This presentation was followed by Dr. Ghulam Rasul, who introduced the water and climate nexus perspectives of Pakistan, highlighting the need to implement effective adaptation measures that also include continued efforts on society awareness raising, promotion of climate smart technologies (irrigation, change in cropping pattern, etc.), pursuing further comprehensive research into climate change and variability impact on food security, and also understanding the roles and responsibilities of individual sectors.

The third lecture in this session was provided by Prof. Ahmad Ashfaq Chattha, University of Agriculture, Faisalabad, and focused on Water and Food/Agriculture nexus. The main constraint for crop production in Pakistan is the water availability and thus the adaptation efforts in agriculture sector include research into a possibility to increase production without increasing water consumption. This encompasses development of a set of agronomic and other practices to improve crop water productivity, replacing traditional crops with alternate, less water-demanding and more resilient varieties and introducing new species suitable for the changed climate conditions. Intensive research is being carried out at the Faisalabad University with promising results. What is needed is effective promotion of the new practices among farmers and Prof. Chattha introduced several recent and ongoing projects addressing this issue.

### Session on Hydrological modeling in cold region watersheds

The session was opened by the presentation on the UNESCO Flood Project that developed operational flood forecast system, flood hazard maps, and platforms for sharing hydrometeorological observations. The flood forecast system was based on the IFAS model, provided by the International Centre for Water Hazard and Risk Management under the auspices of UNESCO (ICHRM), and series of training sessions were undertaken to assure the local professionals at PMD-FFD in Lahore can operate the system smoothly. At the time of the workshop, the test simulations were underway.

As the second contribution to the session, Dr. Maheswor Shrestha, University of Tokyo, gave a comprehensive lecture on distributed hydrological modeling in cold regions covering the physics of natural phenomena associated with snowing, snowmelt and glacier dynamics as well as main features and structure of the WEB-DHM-S hydrological model. At the end of his lecture, Dr. Shrestha showed results of pilot applications of the model demonstrating its good performance. It was emphasized that the good results can only be achieved if satisfactory input data is available, which is a key issue in cold regions that are usually very remote and sparsely monitored. Therefore advance techniques for input data bias correction (snowfall) were also developed and introduced during the lecture.

The last presentation of the session was provided by Dr. Aleem ul Hassan, National Weather Forecasting Center, who informed the audience of the actual flood situation in Pakistan and relevant forecasts issues by the Center preceding the flood situation. This presentation was an alternate contribution instead of originally scheduled talk on Disaster Management Plan of Pakistan, because Mr. Kamal, who was supposed to provide this talk was preoccupied with the actual flood management operations. The outlook on the seasonal and short term rainfall forecasts was very informative and showed rather high accuracy of the forecasts that were provided with sufficient time advance. This indicated that a severe flood could be expected and if more efficient flood warning and disaster management systems were in place, the disaster impact could be reduced. This conclusion only confirmed the urgent need for improving such skills.

### Session on Data Integration and Analysis System (DIAS) and Data Support Services

This session included three contributions focusing on the data archiving and data management systems that are an indispensable basis for any advanced modeling and assessment tools. In the first talk, Prof. Toshio Koike, University of Tokyo, introduced the so called Water Cycle Integrator (WCI) approach towards solutions for climate change adaptations, integrated water resources management, agriculture support, and river basin management. The WCI approach is based on a fact, that water is a key bridging factor between climate processes and societal benefits and it is necessary to consider and integrate large volume of disparate water-related data from various sources as well as information from other disciplines including socio-economy sector. Such task requires a robust data archive with numerous built-in functions and tools for data processing and a system of models and techniques to address various water cycle phenomena and their interactions with other areas. The Data Integration and Analysis System (DIAS) of Japan had been designed to fulfill these functions and its development had progressed to the beginning of operational phase. AWCI activities are closely linked with DIAS and Prof. Koike introduced AWCI case studies that had been solved by utilizing DIAS capabilities and adopting the WCI approach.

The second presentation given by Dr. Petra Koudelova introduced the DIAS data upload, quality control and metadata support system, which is a dedicated tool for in-situ data providers to maximally simplify and facilitate the data submission procedure to the DIAS archive and subsequent data quality check and metadata registration steps. The importance of such data procedures for their easy accessibility and reliable usability was emphasized. Potential data providers interested in the system were encouraged to contact the DIAS team.

The last contribution introduced the Water Portal system developed by the JAXA RESTEC team and was provided by Dr. Koudelova on behalf of them. This so called distributed system provides access to data archived in remote data centers and complements it with various services. The JAXA RESTEC team had prepared very informative overview of the system capabilities that were briefly demonstrated at the session and the participants were encouraged to browse and try to use the system.

### **Practical Training Sessions on Day 2 and 3**

The practical training sessions were held at the PMD computing lab, where each participant was provided a PC and focused on the methods and techniques utilized for assessing the impact of climate change on hydrological regimes of a basin and thus on possible changes in water resources availability. The overall methodology of climate change impact assessment on hydrological regime was reiterated, that is using the climate projection model output for past and future periods as forcing data for a hydrological model to elucidate changes in the basin flows and soil moisture budgets. As the GCM output cannot be used directly to force basin scale hydrological models, several steps must be undertaken with the GCM output to prepare a suitable input for the hydrological simulations. All these steps were explained using the said techniques and these techniques were demonstrated on the Soan basin of Pakistan and all the participants focused on this basin in their individual work. The training included following sessions focused on climate change impact assessment on water resources:

1. Selection of appropriate climate projection outputs by GCMs (CMIP3 datasets) for desired assessment
2. GCM rainfall bias correction and statistical downscaling
3. Hydrological simulation preparation and analyses
4. Hydrological modeling in cold regions
5. Dynamical downscaling

The first session was led by Dr. Petra Koudelova and included a demonstration lecture with hands-on practices. The DIAS based on-line tool for accessing, analyzing and downloading the CMIP3 datasets was introduced, each participant followed the procedure individually. The step-by-step outline presented at the session is available through the workshop website. Participants mastered the use of this on-line tool for the purpose of selecting appropriate GCM output for a given region and completed the demonstration task.

The second session, led by Dr. Mohamed Rasmy, explained the need of correcting the GCM precipitation output for hydrological analyses at the local scale (basin scale) and introduced the dedicated function of

the said DIAS tool for statistical bias correction and downscaling of the GCM precipitation output. Participants followed the procedure and mastered the use of this function.

The results of the previous steps were bias corrected precipitation datasets for the past (current climate) and future (future climate) periods. In the third session, led by Dr. Asif Mumtaz Bhatti, the preparation for a hydrological analysis by using the WEB-DHM hydrological model and the obtained corrected precipitation data as forcing input was explained. More details of the WEB-DHM basis and physics were provided and the procedure of a basin's setting up and data preparation for simulation was explained. The case of WEB-DHM application in the climate change impact assessment study in the Soan basin was presented.

The fourth session was dedicated to the details of the WEB-DHM-S model, a hydrological model for cold and high altitude regions that is based on the WEB-DHM model and adds sophisticated snow and glacier process simulation components. The session was designed by Dr. Maheswor Shrestha, the developer of WEB-DHM-S and provided an insightful lecture on the physics of the snow and glacier processes, possibilities of their simulations and details of the snow and glacier components in WEB-DHM-S. Examples of WEB-DHM-S applications were introduced including the upper Indus basin simulations.

At the last session, Dr. Mohamed Rasmy gave a comprehensive lecture on dynamical downscaling of the GCM outputs for regional and local scales. Details of the methodologies were introduced for the case of weather forecasts and for the case of climate projections. The weather forecast downscaling part included explanation of model calibration, downscaling/nesting technique using the mesoscale WRF model, initial conditions and boundary conditions and their improvement, and data assimilation technique. In the climate projection part, the so called Pseudo Global Warming Downscaling (PGW-DS) experiments were introduced.

The training workshop was summarized by Dr. Koudelova and an assignment for the participants was introduced that targeted the feedback from the audience on the provided training and their views of its usefulness for their future work. The event was closed by the ceremonial awarding of participants with the Certificates of Accomplishment, handed out by Dr. Arif Mahmood, former Director General, PMD, Mr. Hazrat Mir, Director General, PMD, and Dr. Ghulam Rasul, Chief Meteorologist, PMD.

