



WORLD METEOROLOGICAL ORGANIZATION
WORKING GROUP ON HYDROLOGICAL SERVICES
REGIONAL ASSOCIATION II (ASIA)

Report of the WGHS – RA II (Asia)

**Seoul, Republic of Korea
30 September to 2 October 2014**

**FINAL REPORT
4 November 2014**



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1. OPENING OF THE MEETING

1.1 At the kind invitation of the Han River Flood Control Office of the Government of the Republic of Korea, the session of the Working Group on Hydrological Services (WGHS) of the WMO Regional Association II (Asia) was held in Seoul, Republic of Korea, from 30 September to 2 October 2014.

1.2 The session was opened at 09:00 a.m. on Tuesday 30 September 2014 at the WESTERN CO-OP Residence Conference Room at 77-2, Euljiro 5-ga, Jung-gu, Seoul, Korea 100-195.

1.3 In his welcome remarks, Senior Research Fellow, KICT, Mr Sung KIM highlighted the importance of the Regional Working Group on Hydrological Services as an important platform to address hydrological and water management issues that are specific to the region. He noted that the composition of the Working Group also reflects the vast diversity in terms of problems faced in the region and different levels of capacity to cope with these problems. In particular he highlighted the importance of developing and applying new methodologies to improve water resources assessment as an important decision-making tool for improved water management under a changing climate.

1.4 The representative of WMO, Mr Paul Pilon thanked Mr KIM for hosting the meeting of the Working Group. He reiterated the importance of the work of the group, serving as regional platform to address critical issues related to hydrology and water resources in a unique way. He expressed his expectation that the group would fulfill the high expectations of the National Meteorological and Hydrological Services of the region in that satisfactory results could be achieved in the theme areas the Regional Association had endorsed during its session in 2012.

1.5 Mr PARK Hajoon, Director General, Han River Flood Control Office (HRFCO), the Ministry of Land, Infrastructure and Transport (MOLIT), welcomed the members of the WGHS and the representatives of the WMO Secretariat to Seoul, Republic of Korea. He noted that the Asian region is vulnerable to water-related disasters such as floods and droughts every year, and that the needs and efforts to reduce socio-economic damages caused by these disasters are steadily increasing. He commented that the current increases in extreme weather events have resulted in sustainable water use and management rising as the priority issue in Asia, both at the national as well as regional level. He further noted that this has placed an increased importance on the need to develop water resources assessment methodologies, forecast water-related disasters, and to develop adaptive strategies for water resources management in response to climate change and variability. He concluded by wishing everyone a successful meeting and a pleasant stay in Korea.

1.6 Mr Zhiyu LIU, Vice-president CHy, thanked the Government of the Republic of Korea for hosting the meeting. He also welcomed the participants to the meeting and indicated that he was attending as an observer, with the goal of forging stronger links between CHy and the RA II WGHS. Mr LIU provided a brief overview of the activities of CHy, the composition of the CHy Advisory Working Group and its combined mandate. He also introduced the five thematic areas that were adopted by CHy-14 and pointed out

the importance of the Open Panels for CHy Experts (OPACHE) groups as resource pools to assist in the work of the Commission and possibly the RA II WGHS.

2. ADOPTION OF THE AGENDA AND ORGANIZATION OF WORK

2.1 The session was attended by 18 participants from 6 countries of the RA II. Mr Zhiyu LIU attended the meeting in his capacity as Vice-president of the WMO Commission for Hydrology (CHy).

2.2 The list of participants is given in Annex 1 to this report. Mr P. Pilon acted as Secretary for the meeting and Mr Sung KIM, Senior Research Fellow, Korea Institute of Civil Engineering and Building Technology (KICT), chaired the sessions of the WGHS.

2.3 The WGHS adopted its agenda that constitutes the table of contents of this report (Annex 2). Three items were added under "Other Business". One was a presentation and discussion on the 7th World Water Forum and potential participation of the WGHS. Another was a presentation by Mr Jan Muhammad KHAN on the flooding that occurred in Pakistan in September of 2014. The third was a presentation and discussion on the Flash Flood Guidance System. The meeting also indicated that it looked forward to the tour of the Han River Flood Control Office and the field trip to witness first-hand the rehabilitation efforts on the Cheong Gye Cheon River and its Museum, which was established to document this effort. Participants also agreed on the working hours. It was also noted that all presentations made and material provided during the meeting can be downloaded from the following URL:

www.wmo.int/pages/prog/hwrrp/RA2/RAII-WGH-seoul.php

2.4 After an initial discussion, participants agreed that the main deliverables of this meeting were to:

- i. Agree on the deliverables and individual work plans to meet the targets of the Regional Association within the existing work plans;
- ii. Discuss and agree upon the priorities for Working Group on Hydrological Services (WGHS) during this intersessional period of 2012-2016.

3. REVIEW OF ACTIVITIES SINCE PREVIOUS WG SESSION (including meetings of CHy, Presidents of Technical Commissions and Presidents of Regional Associations)

3.1 The representative of WMO, Mr P. Pilon provided a brief overview of activities that had been undertaken since the previous working group session. In his presentation he provided information of programme elements and activities that were relevant for the present and potential future activities of the Working Group.

3.2 In his overview, Mr Pilon first mentioned the activities within the area of Basic Systems in Hydrology, noting Quality Management Framework – Hydrology (QMF-H), the World Hydrological Cycle Observing System (WHYCOS), and water resources assessment. He then presented briefly on Flood Forecasting and Applications in Hydrology, noting the WMO Flood Forecasting Initiative, the Associate Programme on

Flood Management, as well as the area of Water, Climate and Risk Management. He concluded by providing an update on the activities associated with Capacity Building in Hydrology and Water Resources Management.

4. MODES OF OPERATION OF THE WGHS (including Task Teams)

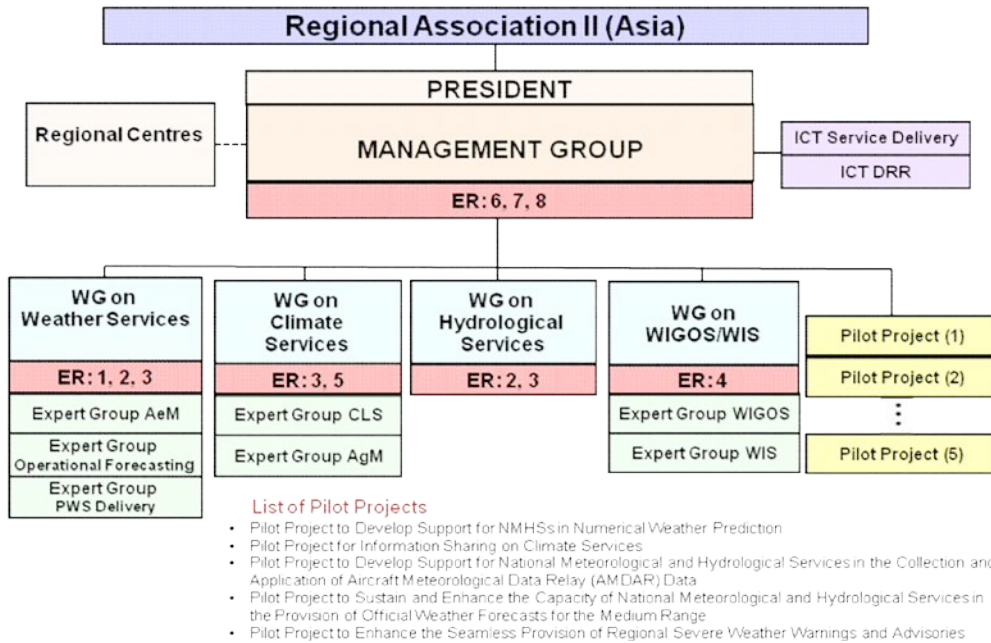
4.1 Mr Sung KIM provided a brief overview of the RA II Working Structure, depicted in the below figure. He noted that there were four working groups, the WGHS being one, and that the three other groups had two or three Expert Groups formed to assist them in their activities. The group took note of the relationship of the WGHS in the context of other working groups that had been established by WMO RA-II (Asia) during its XV session in 2012.

4.2 Mr KIM also provided a brief summary of the structure and membership on the WGHS (Annex III). He recalled the process that resulted in the current membership of the working group, where applicants for themes 1, 2, 3 and 4 were reviewed and leaders were selected by the RA II Management Group 7th Session (MG7) (May 2013). He noted that no nominations had been received for the theme areas 5 and 6. After unsuccessful efforts to obtain nominations for these two areas, Mr KIM, as WGHS Chair, while attending the Working Group, Implementation and Coordination Team and Task Team Chairs Meeting on Implementation and Development of Strategic Operating Plan in Regional Association II (Asia), nominated two experts from the Republic of Korea as theme leaders. These nominations were approved by the president.

4.3 Two aspects were noted with concern regarding nominations and timing of appointments. One was that two years had transpired before membership was firmed-up on the WGHS and the initiation of the work planning process. Second was that Members had not put forth nominations for two topic areas deemed of importance by the previous Working Group. This was thought to be possibly due to a disconnect between those experts wishing to participate in the work of the group and those that are officially put forward by the Members, resulting in a lack of continuity in membership as well as having some areas receiving no nominations whatsoever.

4.4 Members of the group also noted with concern the generally low level of representation of experts in hydrology and water resources in WMO's regional meetings where a more adequate representation of hydrologists was needed given the importance of hydrology and water resources in many programmes of WMO.

RA II Working Structure (2012-2015)



5. CONSIDERATION OF DECISIONS OF RA-II-15, CHy-14, Cg-16 and relevant ECs

5.1 The group reviewed the work programme and structures that had been adopted by the Commission for Hydrology at its 14th session in 2012. This included a thorough review of the five theme areas that fall under the mandate of WMO:

1. Quality Management Framework – Hydrology (QMF–Hydrology);
2. Data Operations and Management;
3. Water Resources Assessment;
4. Hydrological Forecasting and Prediction;
5. Water, Climate and Risk Management.

5.2 Attention was also given to the list of activities and the expected results for each thematic area. The work plans for each member of the Advisory Working Group were also mentioned and would be of assistance when developing the work plans for the RA II WGHS.

6. WORK PROGRAMME

6.01 Two different styles for the Working Group work plan were presented to participants and were discussed at length. It was decided that the best approach would be to adopt the work plan used by the current CHy Advisory Working Group members, with slight modifications agreed to by participants.

6.02 Mr KIM also presented on the RA II Operating Plan for 2012-2015. He stressed the importance of considering the deliverables indicated therein related to hydrology and water resources and that the WGHS work plans should be supportive of achieving them.

6.1 Chairperson

6.1.1 The Terms of Reference of the WGHS is provided in Resolution 10 (RA II-15). The objective of the WGHS is to contribute to the implementation of the WMO Strategic Plan and the RA-II Strategic Operating Plan 2012-2015. The focus will be on producing the Expected Results associated with three of the five Strategic Thrusts, namely: Improving service quality and service delivery; Advancing scientific research and application, as well as development and implementation of technology; and Strengthening capacity building.

6.1.2 As per the Terms of Reference of the WGHS as established by Resolution 10 (RA II-15), the WGHS will develop its implementation plan in consultation with the president and the Management Group of the Association, with reference to the key performance indicators/targets and action plans under the respective expected results of the RA II Strategic Operating Plan. The WGHS will undertake work on the various theme areas under the charge of the Working Group.

6.1.3 According to the Terms of Reference of the WGHS Chairperson provided in Resolution 10 (RA II-15), the work plan is developed to accomplish the responsibilities as follows.

WORKPLAN: Chairperson of WGHS

Sung KIM

Activities	Actions	Outputs	Resources	Milestones	Linkages
<p>1. In his capacity as Hydrological Adviser, to assist the president of RA II in accordance with the duties stipulated in Regulation 168 (b) of the WMO General Regulations</p>	<ul style="list-style-type: none"> • Represent WGHS as and when required, (eg at MG and EC) • Attend meetings of chairpersons of Working Groups • Other duties as required of chairpersons WGHS (see General Regulation 168 (b)) 	<ul style="list-style-type: none"> • Hydrology and Water Resources issues remain a key aspect of the work of RAIL • NMHSs are assisted in fulfilling their roles and responsibilities. • WGHS is adequately represented within the RAIL environment. 	<ul style="list-style-type: none"> • Resources are provided to meet the needs of the theme leaders in doing the work of the Working Group. • Secretariat support 	<ul style="list-style-type: none"> • Meetings and other activities according to the WMO Schedule of meetings. • Report at WGHS meetings • Report at MG Sessions • Report to RAIL-16 (2016). 	<ul style="list-style-type: none"> • WGHS • RAIL • MG • EC
<p>2. To develop a Working Group implementation plan in consultation with the president and the Management Group of the Association, with reference to the key performance</p>	<ul style="list-style-type: none"> • Chair theme leaders meetings of the WGHS to develop implementation plan • Report to MG meeting for consultation 	<ul style="list-style-type: none"> • WGHS implementation plan 	<ul style="list-style-type: none"> • Resources are provided to meet the needs of the theme leaders in doing the work of the WGHS 	<ul style="list-style-type: none"> • WGHS meeting (Sept. 2014) • WGHS implementation plan (Oct 2014) • Report at MG Sessions for consultation and submit a report to RAIL president 	<ul style="list-style-type: none"> • WGHS • RAIL • MG

Activities	Actions	Outputs	Resources	Milestones	Linkages
indicators/targets and action plans under the respective expected results of the RA II Strategic Operating Plan, to undertake work on the various theme areas under the charge of the Working Group	<ul style="list-style-type: none"> • Submit report 			(2014)	
3. To participate in Executive Council sessions, when invited, representing the regional interests in relation to hydrology and water resources and to coordinate the WGHS activities with the Commission for Hydrology and other regional Working Groups on Hydrology	<ul style="list-style-type: none"> • Attend EC meeting if required • Develop WGHS work plan in consideration of CHy and other regional WGHS activities • Organize WGHS meeting 	<ul style="list-style-type: none"> • Meeting report • WGHS implementation plan 	<ul style="list-style-type: none"> • Resources are provided to meet the needs of the theme leaders in doing the work of the WGHS 	<ul style="list-style-type: none"> • WGHS meeting (Sept. 2014) • WGHS implementation plan (Oct 2014) • Report at MG Sessions for consultation and submit a report to RAI president (2014) 	<ul style="list-style-type: none"> • WGHS • RAI • MG
4. To submit to the president of the Association an annual report by 31	<ul style="list-style-type: none"> • Develop WGHS activity report with input from theme leaders 	<ul style="list-style-type: none"> • WGHS activity report 	<ul style="list-style-type: none"> • Resources are provided to meet the needs of the WGHS theme 	<ul style="list-style-type: none"> • Submit annual report to RAI president and WMO Secretariat (Dec 	<ul style="list-style-type: none"> • WGHS • RAI • WMO

Activities	Actions	Outputs	Resources	Milestones	Linkages
<p>December every year and a final report in time for presentation to the sixteenth session of the Association, both copied to the WMO Secretariat, with inputs from theme leaders under the Working Group</p>			<p>leaders</p>	<p>2014, Dec 2015)</p> <ul style="list-style-type: none"> • Submit final report to RAI president and WMO Secretariat (2016) 	

6.2 Vice-Chairperson

The work plan of the Vice-Chairperson includes his roles and activities that will be conducted during the intersessional period. The work plan was developed by Mr Jan Muhammad KHAN in close collaboration with the Chairperson Mr Sung KIM.

WORKPLAN: Vice Chairperson of WGHS (RA II)

Muhammad Riaz

Activities	Actions	Outputs	Resources	Milestones	Linkages
1. To assist the chairperson WGHS in accomplishing his work related to the group activities	As delegated by the chairperson	Not Specified	As appropriate	As appropriate	Chairperson
2. To review the reports sent by various Theme leaders through the Chairperson	Summary of review	Report	<ul style="list-style-type: none"> • Chairperson • Theme Leaders • RA II Secretariat CHy 	Not specified	<ul style="list-style-type: none"> • Chairperson • Theme leaders • RA II Secretariate • CHy
3. To review and develop the Hydrological Parts of S.O.P.	Review if required	Review report	<ul style="list-style-type: none"> • RA II strategic operation Plan • RA II MG 	Not specified	Chairperson
4. To put up suggestions and collaboration in strengthening of Flood Forecasting & Warning System amongst Member States	Review related reports	Suggestions	<ul style="list-style-type: none"> • Theme Leaders reports in RA II • CHy report 	Submission of report by 2016	<ul style="list-style-type: none"> • RA II • WGHS • CHy
5. To assist the Chairperson on matters related in combating marine pollution	Review S.O.P. and some suggestions	Suggestions	S.O.P	Suggestions by the end of 2014	<ul style="list-style-type: none"> • S.O.P • WGHS

6.3 Water Resources Assessment

6.3.1 The overall objective of work on water resources assessment is to provide useful and accurate information to facilitate decision making by a variety of users. Improvements on capabilities to assess water resources will focus on two aspects. First is regarding the technological aspects of assessing the availability of basin-wide water resources, including climate predictions. The second is to assist in furthering the implementation of water resources assessment.

6.3.2 The main task of the work plan is to improve approaches and models of water resources assessment. These will be used to analyse basin-wide water resource surpluses and deficits in real time and to consider climate prediction and climate change scenarios of potential future states. Tools (test version) to undertake dynamic water resources assessment will be applied to a demonstration basin and will be expanded to member countries. The information system, such as database and metadata catalogues of water availability, will be built to facilitate the provision of the related information to users. Based on results from pilot tests, guidance will be developed in the fields of data collection, models and methods of water resource assessment, and knowledge based on adaption to the changes in water availability. Training courses and workshops will be conducted for capacity improvement of the members of RA II.

6.3.3 To expand the abilities of the water resources assessment approaches and their application, it is desirable for the WGHS members to apply the tools in their countries and provide feedback to the theme leader.

WORKPLAN: Water Resource Assessment

GAO Ge and Hwirin KIM

Activities	Actions	Outputs	Resources	Milestones	Linkages
1. Assessment of basin-wide water resources availability, including use of climate predictions (3.3.2)	<ul style="list-style-type: none"> • Prepare assessment and outlook of basin-wide availability water surplus and deficits on a national level in a regional context including the use of climate scenarios. (Priority C) 		RAII		RAII ;CHy
2. Assessment of basin-wide water resources availability, including use of climate predictions (3.3.2)	<ul style="list-style-type: none"> • Set up knowledge base to adapt to changes in water resources availability. (trends, outlook) (Priority A) 	Report related to the case studies	RA II Research Documents	- collection case studies in Feb.2015 -summary the achievements in Jun. 2015 -Final report in Dec. 2015	RAII, AWG
3. Implementation of Water Resources Assessment (WRA) (3.3.3)	<ul style="list-style-type: none"> • Provide guidance materials for WRA linking to Climate prediction <ul style="list-style-type: none"> - downscaling - monthly and seasonally prediction WRA models <ul style="list-style-type: none"> - WRA (Priority B) 	Guidance for WRA.	China Korea	- Provided manual in Dec.2016	RAII CHy
4. Development of national and regional capacity building programmes and related training activities for hydrological services (3.3.4)	<ul style="list-style-type: none"> • Organize a training course related to the advancements of WRA : <ul style="list-style-type: none"> -Downscaling methods; -Data collection; -WRA methods; -WRA Information system (Priority B or C) 	Training Course	WMO Regional Training Center in Nanjing	Training Course in Jun. 2016	

6.4 Flood Forecasting

6.4.1 The basic direction of RA-II activities in the area of flood forecasting during the last intersessional period has been connected to the realization of the Flood Forecasting Initiative (FFI). The WMO Flood Forecasting Initiative is the basic implementation framework related to hydrological forecasting and flood management. The main task of FFI is improve the capacity of meteorological and hydrological services to jointly deliver timely and more accurate products and services required in flood forecasting and warning and to further collaboration with disaster managers, active in flood emergency preparedness and response. The goal of this task is to improve interaction and understanding of meteorologists and hydrologists in the effective use of numerical weather forecasts in hydrological modelling for flood forecasting.

6.4.2 In a number of National Meteorological and Hydrological Services there is valuable experience in creating Flood Forecasting Systems based on sharing of meteorological and hydrological data and model outputs. Hydrologists and meteorologists take part in the development of these systems in common. However many flood forecasting systems have separate meteorological and hydrological modelling systems. In such cases, numerical weather forecasts are used as input to the hydrological modelling systems. When approached in this manner, it is necessary to develop requirements for the meteorological forecasts to mesh with the spatial and time resolution requirements of hydrological models, resulting in hydrological forecasts. Hence, it would be helpful to have general recommendations on the requirements of numerical weather forecasts for use in flood forecasting.

6.4.3 Now there are many meteorological models at the global, meso-, and regional scales which are used in flood forecasting systems. Some hydrological modelling systems are making use of ensemble meteorological forecasts. This leads to the development of ensemble hydrological forecasts. Sometimes, such hydrological forecasts have high variance, reflective of the uncertainty in the meteorological forecasts. In addition, analyses can be conducted to ascertain the deterministic error of each ensemble element, for example over the previous thirty day period, using this deterministic signal to provide a weighting on the confidence of the forecasted ensemble elements. This results in improvements in the accuracy of hydrological forecasts.

6.4.4 The Flash Flood Guidance System (FFGS) has been developed by the Hydrologic Research Center in San Diego (USA) under the direction of Dr K. Georgakakos. The Flash Flood Guidance System (FFGS) project with global coverage was endorsed by Resolution 21 (Cg-XV) as a Flood Forecasting Initiative component that had been developed by the WMO Commission for Hydrology (CHy) jointly with the WMO Commission for Basic Systems (CBS) and in collaboration with the US National Weather Service, and the Hydrologic Research Center in San Diego. This system provides a very useful tool for establishing guidance on the possibility of threats of flash floods occurring on small basins. The Flash Flood Guidance System is being implemented with the assistance of the USAID/OFDA, and it is now being used in several countries.

6.4.5 Currently there are two projects being implemented in RA II. These are the Mekong River FFGS and the South Asia FFGS. It would be beneficial to further expand the number of countries in RA II (Asia) being covered by the Flash Flood Guidance System. To assist in this regard, it would be advantageous to:

- (a) disseminate broadly the experiences and benefits obtained through the use of the FFGS in various countries throughout the world; and
- (b) investigate the potential use of FFGS in Central Asian countries and facilitate its understanding by operational hydrologists in the region.

6.4.6. Flood management effectiveness depends not only on quality and timeliness of the hydrological forecast, but also on the ability of users to understand and use the various forecast products. Over the last decade, advances have been made in the use of probabilistic hydrological forecasts. The utility of such forecasts is highly related to the training of experts in their use, and such forecasts have greatly enhanced the utility of flood forecasting in the area of flood management. To further advance the use of probabilistic forecasts and their utility in flood management, it is recommended that effort be undertaken to prepare guidance and training material on the use of hydrological forecasts (including probabilistic forecasts) in flood management.

WORKPLAN: Flood Forecasting

Sergey BORSHCH

Activities	Actions	Outputs	Resources	Milestones	Linkages
<p>1. Improvement in hydrological warnings capability through enhanced and effective cooperation with other NMHSs (2.1.1)</p>	<p>(a) To prepare recommendations on the use of numerical weather prediction outputs in flood forecasts (Priority A)</p> <p>(b) Document approaches to ascertain the deterministic error of each ensemble element of a NWP output, for example over the previous thirty day period, using this deterministic signal to provide a weighting on the confidence of the forecasted ensemble elements (Priority A)</p> <p>(c) Use WMO FFI as platform [for a and b above] (Priority A)</p>	<p>(a) Recommendations on the use of NWP outputs in flood forecasting systems</p> <p>(b) Document on the approaches to establishing the deterministic error in NWP outputs and for their use in establishing enhanced accuracy of hydrological forecasts</p>	<p>HMC of Russia</p>	<p>(a) Gathering of background material and documents on the FFI and associated activities - January 2015</p> <p>Preparation of Draft Recommendations – June 2015</p> <p>(b) Gathering of materials - September 2015</p> <p>Preparation of Draft Report on procedures – February 2016</p>	<p>OPACHE's International Flood Initiative - WMO</p>

	(d) Organize training course for Members (Priority C)				
2. Issuance of flood, flash ad urban warnings and constantly improving upon them (2.2.5)	<p>(a) To document experiences in the use of the Flash Flood Guidance System (FFGS) in various countries by reviewing use of the Flash Flood Guidance System (FFGS) in the various countries (Priority A)</p> <p>(b) To investigate the potential use of FFGS in Central Asian countries and facilitate its understanding by operational hydrologists in the region (Priority A)</p> <p>(c) To develop recommendations on use of hydrological forecasts (including probabilistic forecasts) in flood management (Priority A)</p>	<p>(a) Report documenting experiences, including recommendations on approaching implementation of FFGS and its use</p> <p>(b) Recommended path forward for advancing the adoption of the FFGS in Central Asia.</p> <p>(c) Conduct kick-off meeting of senior meteorologists and hydrologists within Central Asia on the FFGS project</p> <p>(d) Report containing recommendations on use of hydrological forecasts (including probabilistic forecasts) in flood management, based on experiences of Roshydromet</p>	<p>(a) Working meeting with hydrologists and meteorologists of the Central Asia countries on use the FFGS in operative hydrological practice</p> <p>(b) Funding for kick-off meeting for Central Asia FFGS</p>	<p>(a) Background material and documents on the FFGS and associated activities - April 2015</p> <p>Preparation of Draft Document – June 2015</p> <p>(b) Discussions with potential collaborating NMHSs in Central Asia - March 2015</p> <p>Preparation of Draft Recommendations – March 2015</p> <p>Conduct kick-off meeting - May 2015</p> <p>(c) Report prepared by February 2016</p>	NMHSs OPACHE's WMO Hydrological Research Center in San Diego (USA)

	<p>(d) Develop user-oriented flood forecasting products (Priority C)</p> <p>(e) Conduct mission visit(s) to Members in developing countries or least developed countries (Priority C)</p>				
<p>3. Improvement in capacity for water-related disaster management (hydrological extremes) [with theme on hydrological droughts] (2.1.3)</p>	<p>(a) Organize a workshop [or two workshops] on the provision of input and support to disaster management [on community-based flood and drought management including participation of NMHSs, emergency services and disaster management groups] (Priority B)</p>	<p>(a) Increased capacity for water-related disaster management</p>	<p>(a) Resources to conduct necessary workshop(s) through collaboration with APFM and IDMP</p>	<p>Training session on Integrated Flood Management dealing with development of community capacity - July 2016</p> <p>Training session on Integrated Drought Management dealing with development of community capacity – November 2016</p>	<p>APFM IDMP NMHSs WMO</p>

6.5 Hydrological Aspects of Drought

6.5.1 There have been recent developments in the establishment of an Integrated Drought Management Programme (IDMP) in association with the Global Water Partnership and WMO, based on and inspired by the development and success of the Associate Programme on Flood Management (APFM). Measures, such as establishing comprehensive early warning systems, improving seasonal forecasts and increasing the awareness of the public, can contribute to enhancing societal resilience and in supporting more robust planning and investment decisions, including the reduction of the consequences from droughts. In accordance with Operating Plan for the Enhancement of National Meteorological and Hydrological Services (NMHSs) in Regional Association II (ASIA) 2012-2015, there are deliverables to be achieved for the theme area of hydrological aspects of drought. Efforts will focus on: improving monitoring and early warning of hydrological drought; enhancing preparedness to predict and manage hydrological droughts; and provision of knowledge to assist decision making.

6.5.2 With respect to monitoring and warning systems for drought, it is understood that monitoring and analysis of situations leading to hydrological drought is the methodological basis for the development of early warning system for drought. Within this, the difficulty lies in determining the onset of drought. In the context of timely response and the development of preventive measures, indicators for the determination of the onset of hydrological droughts are critical and urgently needed. In addition, assessing the sufficiency of the existing hydrometeorological monitoring system is also an important factor.

6.5.3 Major activities addressed in the work plan include:

(a) Development of indicators for the determination of the onset of hydrological drought.

- Collection, analysis and systematization of data to identify indicators for the determination of the onset of hydrological droughts;
- Identify the types of hydrological drought that are typical for the Asian region
- Study of the conditions of formation of hydrological drought

(b) Preparation of guidance material for the development of drought monitoring networks.

- Gathering information about the status of drought monitoring networks in Asian region
- Identification of gaps and needs of the National Meteorological and Hydrological Services to improve the drought monitoring networks.

6.5.4 Enhancing preparedness is, in part, dependent on improving prediction capabilities. This, in turn, will help manage hydrological droughts and provide increased knowledge for decision making. This Theme Leader will review and synthesise national guidance materials to assist in managing droughts.

WORKPLAN: Hydrological Aspects of Drought
Table 1

DERGACHEVA Irina

Activities	Actions	Outputs	Resources	Milestones	Linkages
1. Monitoring and Warning Systems for Droughts (2.3.1.)	(a) Develop indicators for the determination of the onset of hydrological droughts. <ul style="list-style-type: none"> • Collection, analysis and systematization of data to identify indicators for the determination of the onset of hydrological droughts; • Identify the types of Hydrological drought is characteristic of the Asian region • Study of the conditions of formation of hydrological drought (Priority A) 	Report on the Indicators for the determination of the onset of hydrological droughts.	WGHS RAI OPACHE Uzbekistan experts Materials for IDMP Materials for HMNDP	Preparing of the data and information to develop indicators for the determination of the onset of hydrological droughts - October 2015 Draft Report December 2015	<ul style="list-style-type: none"> • OPACHE's • WGHS • RAI • WMO
	(b) Prepare guidance for the development of drought monitoring networks. <ul style="list-style-type: none"> • Gathering information about the status of drought monitoring networks in Asian region • Identification of gaps and needs of the national hydrometeorological services to improve the drought monitoring networks (Priority B) 	Guidance materials for the development of drought monitoring networks	WGHS RAI OPACHE Uzbekistan experts Materials for IDMP Materials for HMNDP	Information for the development of drought monitoring networks – April 2016 Draft Report May 2016	<ul style="list-style-type: none"> • OPACHE's • WGHS • RAI • WMO

<p>2. Enhanced preparedness to predict and manage hydrological droughts and knowledge for decision making (3.4.1.)</p>	<p>(a) Document national guidance materials to manage droughts.</p> <ul style="list-style-type: none"> • survey on current status • analysis • identify good practice (Priority C) 	<p>Guidance materials to manage droughts.</p>	<p>WGHS RAI OPACHE Uzbekistan experts Materials for IDMP Materials for HMNDP</p>	<p>Draft Report July 2016 Report September 2016</p>	<ul style="list-style-type: none"> • OPACHE's • WGHS • RAI • WMO
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6.6 Hydrological Responses to Climate Variability and Change and Promotion of the Use of Climate Information by Water Managers

6.6.1 In the context of climate change, climate-related disasters, including storms, floods, inundations, flash floods, and droughts, are likely to increase in intensity and frequency. As well, it is possible that such events might become more difficult to forecast. At the same time, the demand for information about climate and climate change is increasing, as is the need for adaptive measures. There is an urgent and growing need to translate climate and climate change information into actions appropriate for sectors/locations, especially for water resources management.

6.6.2 The activities of Theme 4 include: (1) Assessment of change in climate extremes; (2) Climate projections; (3) Assessment of potential impacts of climate extremes and climate change on water resources of selected river basins; (4) Translating climate and climate change information into actions in water resources development and management for selected river basins; (5) Compilation of reports; and (6) Experience sharing and lesson learned. It is anticipated that participating countries will work independently to develop its case study, following the activities of the work plan. The Theme Leaders will compile reports from participating countries to prepare an overall synthesis report.

6.6.3 The work plan has been developed not just for a single country but rather for all countries within RA II (Asia). It is strongly recommended that member countries participate and contribute to the study. Theme Leaders will work with each participating country so that efforts follow a common template.

WORKPLAN: Assessment of Changes in Climate Extremes, Their Impacts on Water Resources, and Translating Climate Information into Action in Water Resources Management
WANG Guoqing and TRAN Thuc

Activities	Actions	Outputs	Resources	Milestones	Linkages
<p>1. Improvement in adaptation capacity of water resources systems in a changing climate (2.1.2)</p> <p>2. Assessment of basin-wide water resources availability, including use of climate predictions (3.3.2)</p>	<p>1) Assessment of changes in climate extremes</p> <ul style="list-style-type: none"> - Data and method of climate extreme study: Data inventory, Climate index, Method – (Priority A) - Trend of some climate extremes: Temperature Extreme, Rainfall extreme, other extremes – (Priority A) - Changes in atmospheric circulation affecting climate extreme: Monsoon, typhoon and tropical depression, El Nino and Southern Oscillation – (Priority C) - Change in climate extreme affecting natural physical environment: Heat wave, cold wave, drought, extreme rainfall, flood, hoarfrost, extreme sea water level – (Priority C) 	<p>Assessment report on climate extremes for participating countries</p>	<ul style="list-style-type: none"> • WGHs • WMO Secretariat • NHRI, China • CMA, China • IMHEN, Vietnam • Other countries 	<ul style="list-style-type: none"> • Report to be submitted (May 2015) • Reports to: AWG-II • Documents as required • Workshop if needed 	<p>WGHs RA2 WMO Secretariat CHY</p>
<p>3. Improvement in capacity for water-related disaster management (Hydrological extremes) (2.1.3)</p>	<p>2) Conduct climate projections – (Priority A)</p> <ul style="list-style-type: none"> - Statistical downscaling - Dynamic downscaling 	<p>Climate change scenarios for participating countries</p>		<p>Report to be submitted (May 2015)</p>	
	<p>3) Assessment of potential impacts of climate extremes and climate change on selected river basin water resources – (Priority A)</p> <ul style="list-style-type: none"> - Temperature - Rainfall - Evapotranspiration - Flood and inundation - Drought 	<p>Report on the impacts of climate extremes and climate change to water resources</p>		<p>Report to be submitted (Dec 2015)</p>	

Activities	Actions	Outputs	Resources	Milestones	Linkages
	<ul style="list-style-type: none"> - Water Resources 4) Translating climate and climate change information into actions in water resources development and management: – (Priority A) - Case study for a selected 	Report of case study		Report to be submitted (Feb 2016)	
4. Development of national and regional capacity building programmes and related training activities for hydrological service (3.3.4)	5) Synthesize report from individual reports from participating countries in the RA II – (Priority A)			Report to be submitted (May 2016)	
	6) Lesson learn and experience sharing – (Priority B)				

6.7 Improved Accuracy of Hydrometric and Sediment Observations including Space-based Technologies

6.7.1 HSC is a specialized hydrological survey organization funded by the Government of Korea. The main mission of HSC is to provide hydrological data for the Republic of Korea. Mr Roh, as theme leader, will provide a technical report or manual about real-time discharge measurement, sediment measurement and development of rating curves using HSC's technical Know-How. Several case studies will be provided.

6.7.2 The first activity is to document the Integrated Real-time Discharge Measurement System (IRDIMS). This will include its design, construction, operating system software, and quality control (QC) system. IRDIMS produces real-time discharge for hydrometric sites at over 50 sites throughout Korea using an automated production system. The second activity is to prepare a technical report documenting the approaches taken for sediment. The final activity is to provide a report outlining procedures for developing the optimal rating curve taking into consideration the various conditions (weir, backwater, vegetation and tidal etc.) that can occur in the field.

WORKPLAN: Improved Accuracy of Hydrometric and Sediment Observations including Space-based Technologies
Youngsin ROH

Activities	Actions	Outputs	Resources	Milestones	Linkages
1. Reliability of quality control procedure applied on data collected from hydrological stations (2.2.1)	a) assess the performance of hydrometric instruments and techniques of observations (Priority C)				
	b) Prepare documentation for the intercomparison of instruments and methods of observation (Priority C)				
2. Hydrometric measurements with quality and accuracy (2.2.2)	<p>a) Provide guidance on the use of appropriate instruments and methods of observation in diverse conditions (Priority A)</p> <ul style="list-style-type: none"> - Collection of the existing technical information of IRDIMS - Collection of construction, measurement cases and management of IRDIMS (More 52 sites) - Writing Technical report about construction and management by field characteristics 	<ul style="list-style-type: none"> - Provide Technical report and guideline to design, install and operate of facilities of Integrated Real-time Discharge measurement system (IRDIMS) - Software System and manual for data QC and evaluation of IRDIMS 	- Republic of Korea (ROK)	<ul style="list-style-type: none"> - Provide Technical report and guideline with case studies by Dec 2016 - Collection of the existing technical information of IRDIMS by June 2015 - Collection of construction, measurement cases and management of IRDIMS (More 52 	<ul style="list-style-type: none"> - CHy - ROK

Activities	Actions	Outputs	Resources	Milestones	Linkages
				sites) by Dec 2015 -Writing Technical report about construction and management by field characteristics by Dec 2016	
	b)Improve sediment measuring techniques (Priority B) - Collection of the existing technical information -Collection of measurement case(20-50 sites) -Writing Technical report about sediment measurement method and analysis of field characteristics	- Technical report for sediment measurement	- Republic of Korea(ROK)	-Provide Technical report and guideline with case studies by Dec 2016	- CHy - ROK

Activities	Actions	Outputs	Resources	Milestones	Linkages
	c) assess the accuracy and use of space-based observation (Priority C)				
3. Calculation of runoff with quality and accuracy (2.2.3)	a) Focus on the development of rating curve - Collection of the existing technical information (Priority B) -Arrangement of theory for development rating curve -Case analysis with field condition (weir, tidal, backwater, vegetation etc.) - Writing Technical of characteristics	-Report on methods to develop rating curves	- Republic of Korea(ROK)	-Provide Technical report and guideline with case studies by Dec 2016	- CHy - ROK
	b) detect trends and variability in selected river basin in the region (Priority C)				
	c) provide guidelines for calculating runoff data accuracy (Priority C)				

Activities	Actions	Outputs	Resources	Milestones	Linkages
4. Establishment of Quality Management Frameworks for Hydrology using current guidance materials for hydrology and water resource management (3.3.3)	Encourage and facilitate exchange and training on relevant know-how (Priority C)				
5. Development of national and regional capacity building programmes and related training activities for hydrological services (3.3.4)	Encourage and facilitate exchange and training on relevant know-how (Priority C)				

6.8 Sediment Disasters and Mass Movements

6.8.1 The main goal of the Sediment Disasters and Mass Movements theme is to develop the Integrated Management Platform that consists of systems, policies and international cooperation. It has three different perspectives on sediment disasters. These include: (1) issuance of landslide/debris flow warning and consistently improving upon them; (2) improvement in capacity for water-related disaster management; (3) optimization of disseminating sediment disasters related information.

6.8.2 The warning for landslide/debris flow is an essential part of this project, and it has three substantial activities which have ascending priority. These are: (1) collection of information, review and development of materials for assessment of sediment disasters, and their dissemination; (2) investigate warning technologies based on adaptive concepts; and (3) generate sediment disasters risk maps. Increasing capability for water-related disaster management will result from close collaboration of countries within RA II (Asia). Activities to further dissemination and cooperation are, as follows, with ascending order of importance: (1) attending seminars on sediment disasters in order to communicate and further cooperation among member countries and related organizations; (2) sharing and bringing related technologies to developing and least developed countries. And finally, this project would try to effectively and efficiently distribute sediment disaster-related information to communities, governments and people living in hazardous areas. Such information will include methodologies and related policies that can greatly assist reduction of risk for those most affected.

6.8.3 The key objective of this project is to generate a platform which is applicable to not only developed but also developing and least developed countries. This process recognizes the important gaps in understanding scientific processes and in the level of technological capacities that can exist at the country and community level. The effort will strive to overcome these differences in capabilities.

WORKPLAN: Sediment Disasters and Mass Movements

Tai-Hoon KIM

Activities	Actions	Outputs	Resources	Milestones	Linkages
<p>1. Issuance of landslide/debris flow warnings and consistently improving upon them</p>	<ul style="list-style-type: none"> - Collect and disseminate materials for assessment of sediment disasters (Priority A) - Investigate warning technologies based on adaptive concepts (Priority B) - Generate sediment disasters risk map (Priority C) 	<ul style="list-style-type: none"> - Guidance materials for implementation of adaptive sediment disasters risk management tools with identification, reduction, and evacuation 	<ul style="list-style-type: none"> - Republic of Korea (ROK) - National Disaster Management Institute (NDMI) 	<ul style="list-style-type: none"> - Case study report for present systems for sediment disasters management by May 2015 - Analyzing models for the integrating system by Oct. 2015 - Report for adaptive sediment risk management tools by AUG. 2016 	<ul style="list-style-type: none"> - SOP 2.2.6 - RA2 - WMO Secretariat - ROK (MOSPA and NEMA, etc.)

Activities	Actions	Outputs	Resources	Milestones	Linkages
2. Improvement in capacity for sediment disaster management (2.1.3 in OP)	<ul style="list-style-type: none"> - Attend seminars on sediment disasters in order to communicate and cooperate among member countries (Priority A) - Share and bring related technologies to developing countries (Priority B) 	<ul style="list-style-type: none"> - Workshop on the provision of sharing knowledge for sediment disasters (e.g. Joint Workshop with TC DRR) - ODA projects which transplant knowhow to developing countries 	<ul style="list-style-type: none"> - Republic of Korea (ROK) - National Disaster Management Institute (NDMI) - WMO/ESCAP Typhoon Committee, Disaster Risk Reduction (TC DRR) 	<ul style="list-style-type: none"> - Report for feasibility survey for ODA projects by April 2016 - Joint Workshop with TC DRR on May 2015 - Strategy plan for distributing adaptive sediment risk management tools by Oct. 2016 - Submission Draft to MG for review (TBA) 	<ul style="list-style-type: none"> - SOP 2.1.3 - RA2 - WMO Secretariat - TC DRR - ROK (MOSPA, NEMA, and KOICA, etc.)
3. Optimization of disseminating sediment disasters related information	<ul style="list-style-type: none"> - Collect and analyse disseminating methodologies and related policies for sediment disasters information that alarm people not to be involved to the designated areas 	<ul style="list-style-type: none"> - Standard Operation Plans for sediment disasters information by public broadcasting system and other media (e.g., Facebook, Twitter, etc.) 	<ul style="list-style-type: none"> - Republic of Korea (ROK) - National Disaster Management Institute (NDMI) 	<ul style="list-style-type: none"> - Summary report for present disseminating codes and regulations by June 2015 - Report about the effective disseminating framework by Dec. 2015 	<ul style="list-style-type: none"> - Above SOP - RA2 - WMO Secretariat - TC DRR - ROK (MOSPA and NEMA, etc.)

7. FIELD TRIP

7.1 Participants toured the Cheon Gye Cheon (River) Restoration Project and the Cheon Gye Museum. Participants were extremely impressed with the environmentally friendly efforts undertaken and the dramatic changes to the landscape, the river and its aquatic environment that had occurred due to the financial investments made by the community.

7.2 Participants were also invited by Mr PARK Hajoong to visit the Han River Flood Control Office, wherein a presentation was provided by Ms Ji Youn SUNG. She provided an overview of the responsibilities of the Office including hydrological surveys, flood forecasting operations and approaches, water management activities, information system capabilities and activities on international cooperation. Participants asked several questions due to the high interest taken by them on the activities of the Office.

8. COOPERATION WITH OTHER INTERNATIONAL ORGANIZATIONS

Mr Sung KIM indicated that an invitation was extended to the Typhoon Committee to participate in this session of the WGHS. Unfortunately, the Committee had scheduled meetings during the same week and could not therefore attend this session of the WGHS. The meeting agreed that the final report of this session should be provided to the Secretary of the Typhoon Committee by Mr Sung KIM as Chairperson, WGHS, requesting that it review the report and provide suggestions for areas of cooperation between the two groups. Participants noted the important historical role and liaison work of the two groups and underlined the importance of continuing the good cooperation between both groups.

9. OTHER BUSINESS

9.1 Mr Sung KIM provided a brief presentation on the 7th World Water Forum to be held in Daegu EXCO and Gyeongju HICO, Republic of Korea from 12-17 April, 2014. Participants discussed a proposal to hold one Science and Technology session on "Hydrological Services in Hydrology" at this major world event. Participants thought it was an excellent opportunity to illustrate to a broad audience the activities of National Hydrological Services in RA II (Asia) and to showcase the work of the RA II WGHS. Mr KIM also noted that it also provided an opportunity for the WGHS to meet and review progress and adjust individual work plans. It is anticipated that a meeting of the Working Group would be held for a three-day period including the session, which is be of 100 minute duration. Mr KIM noted that some funding might be made available from the Government of Korea to assist in holding the second meeting of the Work Group. He also noted that he would submit the application for the session by October 17, 2014 on behalf of the Working Group.

9.2 Mr Jan Muhammad KHAN provided a presentation on the recent flooding that occurred in areas of Pakistan in September 2014. He indicated the sequence of forecasts leading to the flooding and noted the overall high accuracy that had been attained.

9.3 Mr Paul Pilon provided a brief presentation on the Flash Flood Guidance System (FFGS) with global coverage. The presentation provided a brief description of the objectives and approaches taken to provide guidance and threats on flash floods. He also provided a summary of the status of the implementation on the FFGS in various regions throughout the world.

10. ADOPTION OF THE REPORT AND CLOSURE OF THE MEETING

10.1 The group adopted the conclusions, recommendations and work plans as elaborated during the session of the Working Group. Participants agreed that the final draft report would be circulated to participants allowing a two week period for provision of revisions. It was agreed that the final endorsement of the report should be sought from the Chair of the Working Group before finalizing it and broadly disseminating it.

10.2 The Chairperson, Mr Sung KIM, thanked the participants and the WMO Secretariat for their contributions and professionalism that made the meeting a success. Mr KIM thanked the representative of CHy for providing a close link between the work of the Commission and the RA II WGH. He noted with appreciation the links established between the WMO RA II WGHS and the Commission for Hydrology that was made possible through the contributions provided by Mr Z. LIU, Vice-president of CHy. He also thanked Mr Pilon for the effective conduct of the meeting.

10.3 The Vice-president of the Commission for Hydrology, Mr Z. LIU, thanked the Sustainable Water Resources Research Centre for providing all necessary technical and professional inputs that helped making the meeting a success. He expressed his satisfaction to see a really active Working Group that he would expect to deliver its final expected outputs. He further congratulated the participants on the results of the meeting and reiterated the need for continuing an enhanced cooperation between CHy and the RA II WGHS.

10.4 Mr P. Pilon expressed his gratitude to KICT and in particular Mr S. KIM, Mr Cheolhee JANG and all staff in supporting the effective organization of the meeting. He further thanked the participants for their commitment to the tasks of the Working Group and their constructive contributions towards the success of the meeting. He expressed the expectation that the work plans would be fulfilled to the benefit of the NMHSs and the region at large.

10.5 The meeting closed on 2 October 2014 at 15:00.

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**List of Experts Meeting of RA II (Asia) Working Group on Hydrological Services
(WGHS)
(Seoul, Republic of Korea, 30 September - 2 October 2014)**

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World Meteorological Organization

**ANNEX 2
RA-II WGHS/Doc. 1**

**REGIONAL ASSOCIATION II WORKING GROUP
ON HYDROLOGICAL SERVICES**

Submitted by: Secretariat

Date: 30.09.2014

Original Language: English

SEOUL, REPUBLIC OF KOREA
30 SEPTEMBER TO 2 OCTOBER 2014

Status: **DRAFT 2**

PROVISIONAL AGENDA

- 1. OPENING OF THE MEETING**
- 2. ADOPTION OF THE AGENDA AND ORGANIZATION OF WORK**
- 3. REVIEW OF ACTIVITIES SINCE PREVIOUS WG SESSION (including meetings of CHy, Presidents of Technical Commissions and Presidents of Regional Associations)**
- 4. MODES OF OPERATION OF THE WGHS (including Task Teams)**
- 5. CONSIDERATION OF DECISIONS OF RA-II-15, CHy-14, Cg-16 and relevant ECs**
- 6. WORK PROGRAMME**
 - 6.1 Chairperson
 - 6.2 Vice-Chairperson
 - 6.3 Water Resources Assessment
 - 6.4 Flood Forecasting
 - 6.5 Hydrological Aspects of Drought
 - 6.6 Hydrological Responses to Climate Variability and Change and Promotion of the Use of Climate Information by Water Managers
 - 6.7 Improved Accuracy of Hydrometric and Sediment Observations including Space-based Technologies
 - 6.8 Sediment Disasters and Mass Movements
- 7. FIELD TRIP**
- 8. COOPERATION WITH OTHER INTERNATIONAL ORGANIZATIONS**
- 9. OTHER BUSINESS**
- 10. ADOPTION OF THE REPORT AND CLOSURE OF THE SESSION**

Membership -- Working Group on Hydrological Services (WGHS)

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Chairperson WGHS	Dr Sung KIM	Republic of Korea
Vice-chairperson WGHS	Mr Muhammad RIAZ	Pakistan
Theme Leader in Water Resources Assessment	Ms GAO Ge	China
	Ms Hwirin KIM	ROK
Theme Leader in Flood Forecasting	Dr Sergey BORSHCH	Russia
Theme Leader in Hydrological Aspects of Drought	Ms Irina DERGACHEVA	Uzbekistan
Theme Leader in Hydrological Responses to Climate Variability and Change and Promotion of the Use of Climate Information by Water Managers	Mr WANG GUOQING	China
	Dr Thuc TRAN	Viet Nam
Theme Leader in Improved Accuracy of Hydrometric and Sediment Observations including Space-based	Dr Yeongsin ROH	Republic of Korea
Theme Leader in Sediment Disasters and Mass Movements	Dr Tai-Hoon KIM	Republic of Korea