**PROGRESS REPORT FOR INFORMATION PRESENTED AT THE 16th SESSION OF REGIONAL ASSOCIATION II (ASIA)**

(unedited)

World Meteorological Organization
REGIONAL ASSOCIATION II (ASIA)
Sixteenth Session
Abu Dhabi, United Arab Emirates
12 to 16 February 2017

RA II-16/INF. 1
Submitted by:
Secretary-General
21.XII.2016

# MATERIAL ARRANGEMENTS FOR THE SESSION

## Venue

At the kind invitation of the Government of the United Arab Emirates, the sixteenth session of Regional Association II (RA II-16) will be held in Abu Dhabi, United Arab Emirates from 12 to 16 February 2017. The opening ceremony will be held at 9.30 am on Sunday, 12 February 2017 at the Dusit Thani Abu Dhabi Hotel (website: http://dusit-thani-abu-dhabi.hotel-rn.com).

The seventh session of the Regional Conference on Management of Meteorological and Hydrological Services (RECO-7) will be held at the same venue from 10 to 11 February 2017.

## Working languages

During the session, simultaneous interpretation in four WMO official languages (Arabic, Chinese, English and Russian) will be provided in the main conference room. Additional meeting rooms without interpretation facilities will also be available.

The RECO-7 will be conducted in English only.

## Documents

Delegations wishing to submit documents before the session are invited to send them to the WMO Secretariat, as soon as possible but not later than 60 days before the opening of the session, in accordance with the provisions of Regulation 173(b) of the WMO General Regulations to allow time for translation. According to Regulation 172 of the WMO General Regulations, session documents should be distributed as soon as possible and preferably not later than 45 days before the opening of the session. Any document presented by a delegation should be submitted in the name of the Member of the Organization and not by an individual person.

## Distribution of documents

Documents will be posted before and during the session on the session website, in line with WMO greening efforts to promote paperless meetings. Therefore, participants are kindly invited to bring Internet-enabled portable computers capable of handling Microsoft Word 2010 and Adobe PDF formats so that they can work on the documents during the session. Pre-session documents for decisions will be posted prior to the session for comments at least 60 days before the opening of the session.

## Provisional abridged report

Approved documents showing amendments will be posted on the RA II-16 website as soon as possible after the session. Approved files of documents discussed during the session will be placed in the folder “Provisional Final Report” that will appear on the same website.

**Registration of participants**

Online pre-registration is required for all participants using the RA II-16 session website (http://meetings.wmo.int/RA-II-16).

A Conference Information and Registration Desk will be set up close to the meeting rooms to facilitate the registration of participants and provision of general information.

Registration for RA II-16 will take place at the Conference Information and Registration Desk at the Dusit Thani Abu Dhabi Hotel on 11 February 2017, from 4.00 p.m. to 6.00 p.m. and will continue throughout the session. Participants will receive identification badges at the time of registration.

Representatives of WMO Members, that are not Members of Region II, who wish to attend as observers must provide official proof of representation, such as a letter from the relevant Member. Representatives of international organizations invited as observers to the session should bring a copy of their authorization by an appropriate authority from their organization.

**Credentials**

Pursuant to Regulation 21 of the General Regulations, prior to a session of a constituent body other than the Executive Council, each Member should, if possible, communicate to the Secretary-General the names of the persons composing the delegation to that body, indicating which of these shall be regarded as its principal delegate. In addition, a letter giving these particulars and signed by, or on behalf of, an appropriate governmental authority of the Member shall be sent to the Secretary-General or handed to his representative at the session. This letter shall be regarded as appropriate credentials for the participation of the individuals named therein in all activities of the constituent body.

**List of participants**

A provisional list of participants will be placed on the website for the session shortly after the beginning of the meeting. This list will be revised as soon as all participants have registered.

**Videoconference facilities**

A videoconference connection will be set up, if necessary, between the main meeting room and WMO headquarters in Geneva.

**Internet facilities**

Wireless Internet connection will be available in the main conference room and at the venue hotel. An Internet corner will be provided for delegates.

**Entry requirements**

Participants requiring an entry visa to the United Arab Emirates should apply directly to the nearest embassy or consulate of the United Arab Emirates. A letter of invitation from the host is provided in Appendix A. Holders of Diplomatic, Service, Official or specified passports from some countries may not require a visa by virtue of bilateral agreements, nonetheless they are encouraged to check with the nearest embassy or consulate of the UAE before departure. Detailed information on immigration is available on the Ministry of Foreign Affairs of the United Arab Emirates webpage:
http://www.mofa.gov.ae/EN/ConsularServices/Pages/ServicesList.aspx

The Local Organizing Committee of the host country can provide participants with individual letters of invitation upon request.

For countries that have no embassy or consulate of the United Arab Emirates, the host can apply for an entry visa on behalf of participants upon the provision of the following: a scanned copy of the information page of a valid passport, a coloured passport-type personal photograph against a white background and a complete Visa Application Form (Appendix B) . Important notes: Applications should be sent at least three weeks before the expected date of arrival in Abu Dhabi. Passports should be valid for at least six months before the expected arrival date. Please send applications to Mr Ibrahim Al Hosani: IAlhosani@ncms.ae with a copy to Ms Kaltham Mangoosh: KMangoosh@ncms.ae

**Hotel reservation**

A block reservation for participants is made at the Dusit Thani Hotel in Abu Dhabi (website: http://dusit-thani-abu-dhabi.hotel-rn.com). The daily rate for single occupancy in a deluxe room is AED 450 net per night inclusive of all city taxes, service charges, buffet breakfast, and Wi-Fi internet connection. To make the hotel reservation, please contact reservations.abudhabi@dusit.com as soon as possible.

A list of other hotels with corporate rates is provided in Appendix C. Participants should make their reservation directly to the provided e-mail addresses and need to use WMO/NCMS meeting as a reference.

Please check-in details with the Local Coordinator for support and follow up with the hotel. This is a peak season in Abu Dhabi, therefore, early hotel booking is highly recommended.

The Hotel Reservation procedure above should also be used to reserve accommodation for those attending the Regional Conference (RECO-7) (10-11 February 2017).

**Transportation and pick-up from airport**

Participants are advised to arrive at the Abu Dhabi International Airport (AUH) (website: http://www.abudhabiairport.ae/english/), where major airlines operate daily flights to this destination. The host will make arrangements to pick up participants from the airport and take them to their hotels. Instructions for airport pick-up upon arrival at Abu Dhabi International Airport are provided in Appendix D.

**Currency**

Currency exchange services are available at Abu Dhabi International Airport as well as in all banks (banks are open from 8 a.m. to 5 p.m. weekdays, while currency exchange services all available every day in shopping centres until 10 p.m.). The local currency is the UAE Dirham (AED). Most businesses, tour operators, airlines and hotels accept major credit cards and American Express traveller's checks. The average exchange rate in AED is as follows:

1 Euro = 4.13 AED
1 US$ = 3.67 AED
1 CHF = 3.77 AED

**Health requirements/medical services**

Up-to-date information on international travel and health requirements is provided by the World Health Organization (WHO) at the following websites: http://www.who.int/ith/en/ and http://www.who.int/countries/are/en/.

It is suggested that you take out personal medical insurance for the duration of the trip.

**Electricity and mobile phone connection**

The meeting room will be equipped with Wi-Fi access. Additionally, an Internet corner will be also provided for participants. Power voltage in the UAE is 220 V, frequency 50 Hz, and type G socket type.

SIM cards for mobile phones are available for sale by local mobile phone operators at the airport and in shopping centers.

**Local climate in February**

Climate data during February in Abu Dhabi are listed below:

| | |
|---|---|
| Mean temperature | 19.6 °C |
| Mean maximum temperature | 25.5 °C |
| Mean minimum temperature | 14.0 °C |
| Mean relative humidity | 67 % |
| Mean precipitation | 0.3 mm |
| Mean number of days with precipitation ≥1 mm | 3 days |
| Mean duration of sunshine | 9.8 h/day |

Updated weather information can be found on the website of the National Centre of Meteorology & Seismology (http://www.ncms.ae/en).

**Information and contact details of the Local Organizing Committee (LOC)**

**WMO Focal Point**

Mr Ryuji Yamada
Programme Manager, Regional Office for Asia and the South-West Pacific
E-mail: ryamada@wmo.int
Telephone: +41 22 730 8309
Fax: +41 22 730 8118

**Local Coordinators**

Mr Ibrahim Al Hosani, Chief International Relation Section, NCMS
E-mail: IAlhosani@ncms.ae
Cell: +971 50 444 8155

Ms Kaltham Mangoosh, International Relation Section, NCMS
E-mail: KMangoosh@ncms.ae
Telephone: +971 2 222 7006
Fax: +971 2 666 1575

Dr Jaser Rabadi, Advisor, International Relation Section, NCMS
E-mail: JRabadi@ncms.ae,
Cell: +971 5 683 66 505

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Appendices: 4 (A and C available in English only)

**APPENDIX A:**
**LETTER OF INVITATION**

المركز الوطني للأرصاد الجوية والزلازل
National Center of Meteorology & Seismology

وزارة شؤون الرئاسة
MINISTRY OF PRESIDENTIAL AFFAIRS

Ref: NCMS/2016/ 706
Date: November / 06 , 2016

**Administrators and Director Generals of National Hydro-meteorological Services in Regional Association II (Asia)**

Dear Colleagues;

I have the honor to invite you to participate in the Seventh Session of the RA II Regional Conference on Management of Meteorological and Hydrological Services (RECO-7), and the Sixteenth Session of the WMO Regional Association II (RA II-16) to be held in Abu Dhabi, United Arab Emirates during the periods 10-11 and 12-16 February 2017, respectively. The meetings will be held in Dusit Thani Abu Dhabi Hotel (http://dusit-thani-abu-dhabi.hotel-rn.com).

I kindly ask you present this invitation to the nearest embassy or consulate of United Arab Emirate when applying for entry visa, if required. Should you need further supporting documents in this regard, please do not hesitate to contact me.

Logistic details and other relevant information will be included in the meeting documents to be distributed by WMO secretariat.

I look forward to welcoming you all in Abu Dhabi

Yours sincerely

**Abdulla Ahmed Al Mandous**
**Director National Centre of Meteorology & Seismology**
**UAE Representative with WMO**

المركز الوطني للأرصاد الجوية والزلازل
National Center of Meteorology & Seismology

United Arab Emirates, Abu Dhabi, P.O. Box: 4815, Tel.: +971 2 222 7777, Fax: +971 2 666 1575

www.ncms.ae

## APPENDIX B:
## VISA APPLICATION FORM

| Personal information for entry visa to UAE<br>Please type and send back as soft copy | | |
|---|---|---|
| 1 | NAME (first, middle, Family) | |
| 2 | (please leave blank) | |
| 3 | NATIONALITY | |
| 4 | OCCUPATION | |
| 5 | GENDER | |
| 6 | DATE OF BIRTH | |
| 7 | COUNTRY OF BIRTH | |
| 8 | PLACE OF BIRTH | |
| 9 | (please leave blank) | |
| 10 | PASSPORT NUMBER | |
| 11 | PASSPORT TYPE | |
| 12 | PASSPORT PLACE OF ISSUANCE | |
| 13 | COUNTRY OF RESIDENCE | |
| 14 | DESCRIPTION OF OCCUPATION | |
| 15 | PASSPORT ISSUANCE DATE | |
| 16 | PASSPORT EXPIRY DATE | |
| 17 | RELIGION | |
| 18 | FAITH | |
| 19 | MARITAL STATUS | |
| 20 | PREVIOUS NATIONALITY (if any) | |
| 21 | QUALIFICATION | |
| 22 | MOTHER'S NAME | |
| 23 | (please leave blank) | |
| 24 | FIRST LANGUAGE | |
| 25 | PERMANENT COUNTRY OF RESIDENCY | |
| 26 | MOBILE NUMBER | |
| 27 | HOME ADDRESS | |
| 28 | E-MAIL ADDRESS | |

Please provide the following:

1. Passport copy (colour) of information page (valid for at least for 6 months before date of entry);
2. Colour photograph with white background;
3. The above Form duly completed.

**Please send applications to Mr Ibrahim Al Hosani: IAlhosani@ncms.ae with a copy to Ms Kaltham Mangoosh: KMangoosh@ncms.ae**

## APPENDIX C:
## LIST OF HOTELS

| Name of the Hotel | Star Rating | Room Type | Rates per night | Distance from Conference Venue | Website and contact information |
|---|---|---|---|---|---|
| Marriott Hotel, Downtown Abu Dhabi | 5 | Deluxe Single | 375 AED | **Approx: 6 km** | Phone: +971 2 304 7777<br><br>Web: marriottdowntownabudhabi.com \| meadowntownabudhabi.com<br><br>E-mail: aymen.khalifa@marriott.com<br><br>Mobile: +971 56 5064006 |
| | | Deluxe Double | 400 AED | | |
| | | Deluxe Single (with breakfast) | 450 AED | | |
| | | Deluxe Double (with breakfast) | 525 AED | | |
| Courtyard Marriott, World Trade Center, Abu Dhabi | 4 | Deluxe Single | 295 AED | **Approx: 6.7 km** | Phone: +971 2 698 2222<br><br>Web: www.marriott.com<br>P.O. Box 107005<br><br>E-mail: ahmed.hamdy@courtyard.com<br><br>Mobile: +971 56 6834563 |
| | | Deluxe Double | 295 AED | | |
| | | Deluxe Single (with breakfast) | 345 AED | | |
| | | Deluxe Double (with breakfast) | 395 AED | | |
| Sheraton AlKhalidiya, Abu Dhabi | 4 | Deluxe Single | 250 AED | **Approx: 7.5 km** | Phone: +971 2 6928622<br><br>Web: www.sheratonalkhalidiya.com<br><br>E-mail: Christine.firmantes@sheratonalkhalidiya.com<br><br>Mobile: +971 56 6695412 |
| | | Deluxe Double | 250 AED | | |
| | | Deluxe Single (with breakfast) | 275 AED | | |
| | | Deluxe Double (with breakfast) | 300 AED | | |
| Kings Gate Hotel, Abu Dhabi | 3 | Deluxe Single | 265 AED | **Approx: 6.1 km** | Phone: +971 2 499 5003<br><br>P.O. Box 48573, Abu Dhabi, United Arab Emirates<br>Regional Website: www.millenniumhotels.ae<br><br>E-mail: reservations.kgad@millenniumhotels.com<br>Mobile: +971 50 233 3186 |
| | | Deluxe Double | 275 AED | | |
| | | Deluxe Single (with breakfast) | 325 AED | | |
| | | Deluxe Double (with breakfast) | 335 AED | | |

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**APPENDIX D:**
**TRANSPORTATION GUIDE**

**Airport Pick-Up Information**
**Abu Dhabi International Airport**

Dear participants,

1. After you clear immigration and customs, please proceed to the exit. You will use a downward moving escalator towards the guarded gate of the arrival hall. This gate leads to a wide reception area.

2. Once you exit this gate, please turn right (along the seating area) towards a currency exchange office called **TRAVELEX**. At this point you are still **inside** the arrival building.

3. Near that TRAVELEX office you will spot a representative of NCMS, holding a WMO sign –see below for illustration- and waiting for you. Introduce yourself and the representative will take you to the hotel (Dusit Thani Abu Dhabi Hotel (website: http://dusit-thani-abu-dhabi.hotel-rn.com). The hotel is located at Mattar Street, Abu Dhabi).

4. If, for one reason or another, you could not meet with the NCMS representative on arrival, the taxi service in Abu Dhabi airport is excellent. Step outside the building from the left exit to the taxi pick-up point. The official airport taxis are brown Mercedes mini buses. The ride to the hotel costs around 80 Dirhams and you can ask the driver for a receipt. There is another limousine taxi service inside the arrival area, which you do not necessarily need to use. We recommend the brown Mercedes mini buses located just outside the arrival building.

In case of emergency regarding pick-up or hotel, please contact **Mr Mohamad Mohsin** @: **+ 971 50 1300 253**


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World Meteorological Organization
REGIONAL ASSOCIATION II (ASIA)
Sixteenth Session
Abu Dhabi, United Arab Emirates
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RA II-16/INF. 3/1
Submitted by:
Secretary-General
8.II.2017

**FINAL REPORT ON THE ACTIVITIES OF RA II WORKING GROUPS AND PILOT PROJECTS (2013–2016)**

Final report of Working Groups and Pilot Projects of RA II on the respective activities is attached herewith.

**EXECUTIVE SUMMARY OF THE ACHIEVEMENTS OF THE RA II WORKING GROUPS DURING THE INTERSESSIONAL PERIOD 2013–2016**

## 1. Working Group on Weather Services (WGWS)

### 1.1 Expert Group on Aeronautical Meteorological Services Delivery (EG-AeM)

Arrangements were being made to share information and best practices for the transition into ISO 9001:2015 which was published in Sep 2015. WMO Secretariat conducted fact finding visiting to those Members to identify the support, including possibility of twinning and/or mentoring, required.

ICAO APAC Regional Office conducted a survey in October 2015 on the implementation status of MET services for ATM. Related seminars were conducted and a capacity building RA II workshop for SIGMET was held in June 2016.

### 1.2 Expert Group on Operational Forecasting (EG-OF)

Regional Subproject Management Team of SWFDP in Southeast Asia decided to start its demonstration phase from January 2016. A new SWFDP – Central Asia is being developed. These activities are supported by Global Centres.

A questionnaire survey for non-registered members has conducted to find out their potential interest in ERA in 2014. A concise guidance for EER was provided to RA II Members in 2014.

A user request survey on the Emergency Response Activities (ERA) was conducted, and the results were reported to the coordinators of EG-OF by the Theme Leader in Emergency Response Activities.

The Regional Specialized Meteorological Centres in the region (RSMCs Beijing, Obninsk, and Tokyo) continued their efforts to maintain contact information for the registered members for the Environmental Emergency Response.

### 1.3 Expert Group on Public Weather Services Delivery (EG-PWS)

The work plan of EG-PWS for 2013-16 was formulated in 2013.

Two training workshops on public weather services were organized under the WMO/CBS Severe Weather Forecast Demonstration Projects (SWFDP). The first one was held in Macao, China from 15 to 19 April 2013 with participants from Cambodia, Lao, Thailand, Viet Nam, India, Maldives, Myanmar, Sri Lanka, Pakistan, Nepal, Bhutan, and others. The second one was held in Manila, Philippines from 9 to 13 June 2014 with participants from Cambodia, Laos, Thailand, Vietnam, and others.

In addition, a Voluntary Cooperation Programme (VCP) training workshop on "Effective Media Communication" was organized in Hong Kong, China in December 2013 for Bhutan, Cambodia, China, Islamic Republic of Iran, Republic of Kazakhstan, Republic of Korea, Thailand and The United Arab Emirates. The workshop covered media communication in different phases of significant weather events, through various channels including the traditional media like TV and radio as well as new media like the social media. There were practical sessions of weather presentation on TV and radio, which offered each participant hands-on experience together with expert feedback.

A meeting of the EG-PWS was held in Doha on 3 December 2014 and teleconferences were held among the Co-coordinators and Theme Leaders of the EG-PWS on 25 March 2015 and 25 June 2015 to discuss the organization of a training workshop for RA II Members in 2015 on the enhancement of public weather service delivery.

With the joint effort of the China Meteorological Administration (CMA) Training Centre, the CMA Public Meteorological Service Centre and the EG-PWS, an International Training Workshop on Public Weather Service was held in Beijing, China from 16 to 20 November 2015. Experts from CMA, Hong Kong Observatory and Korea Meteorological Administration were invited to deliver lectures, which covered such topics as delivery of weather forecast and warning messages, disaster prevention and mitigation strategy, and experience in promoting stakeholder engagement. Nearly 40 participants from 11 countries, including China, Kazakhstan, Maldives and Thailand attended the workshop.

A meeting of the EG-PWS was held in Hong Kong, China on 10 and 11 December 2015. The meeting reviewed the 2013-2016 work plan of the EG-PWS and identified new tasks to be performed in 2016 including public education and outreach; socio-economic studies and evaluations; communication between RA II members and stakeholders; and quality management of service delivery.

Planning ahead, the meeting proposed organizing a workshop on socio-economic benefit study for Members in RA II or subregions in 2016-2019, with the assistance of WMO PWS Programme. Proposals of streamlining the Terms of Reference of EG-PWS and improvement of the structure of EG-PWS were also made for consideration in the next RA II session.

## 2. Working Group on Climate Services (WGCS)

### 2.1 Expert Group on Climate Services (EG-CS)

Currently, three WMO Regional Climate Centers (RCCs) have been operating in RA II such as BCC (China), TCC (Japan) and NEACC (Russian Federation). These RCCs have conducted a variety of RCC-related activities, including the dissemination of climate data/products and the organization of training workshops for capacity development in accordance with RCC mandatory functions.

It is noted that India began a demonstration phase as a candidate RCC in May 2013.Regional Climate Outlook Forums (RCOFs), such as FOCRAII, SASCOF, NEACOF, EASCOF and ASEANCOF, are convened regularly. These RCOFs provide some consensus outlook for next season and some of these RCOFs also provide opportunities to exchange of good practices and the sharing of experiences in the application of climate information among NMHSs and to strengthen user-provider interaction.

It is also noted that a pilot project on Information Sharing on Climate Services (Res.5 (RA II-15)) has been conducted by TCC and it has been operating the dedicated website since March 2014.

### 2.2 Expert Group on Agrometeorology (EG-AgM)

The meeting of RA II Expert Group on Agro-meteorology “Strengthening of agro-meteorological activity in RA II countries” was held in India (Pune) on 9–10 November 2015. The directions of the discussion on the meeting were (1) Weather and Climate Services for Agro-meteorology, (2) Agrometeorological products for Agro-meteorological Services, and (3) Capacity Building & Impact Assessment. International and national delegates participated and gave presentation on the topics.

Activities of EG-AgM are strongly linked with those of CAgM and co-coordinators of EG-AgM make their efforts to catch up with discussions and recommendations by CAgM Implementation Coordination Team (ICT).

In RA II, a variety of issues are reported by the co-coordinators of EG-AgM, such as the progress in Agricultural Meteorology Programme, Nations Drought Management Policies for Asia-Pacific, Capacity development, Farmer Awareness Programme, dissemination of Agromet Advisories to the farmers, seasonal climate forecast and its application in agriculture for farmers at the national as well as district levels.

## 3. Working Group on Hydrological Services (WGHS)

The first session was held in Seoul, Republic of Korea, from 30 September to 2 October 2014, and Individual work programme was developed consisted of actions, activities, outputs, resources, milestones and linkages.

The second session was held in Gyeongju, Republic of Korea, from 14 to 16 April 2015. Progress of the work programme was reported, and the work programme was adjusted.

WGHS members with Dr Pilon (WMO) and Dr Liu (CHy) participated as speakers or panellists in the 7th World Water Forum session titled “Hydrological Services in Asia under Rapidly Changing Conditions”, Gyeongju, Republic of Korea, 15 April 2015 and organized by KICT, MLIT and WMO. Hydrological activities and issues were presented and discussed.

Water resources assessment tool was developed with support of MLIT of Republic of Korea in 2015. The developed tool is a public-domain SW with GUI and GIS interface, and can be used to analyse dynamics of water balance in consideration of climate and land use changes. Pilot test is scheduled in 2016 and the first version can be distributed to Members in 2017.

The third session of WGHS was held in Seoul, Republic of Korea from 25 to 27 October 2016. Participants reported on final progress achieved in this four-year intersessional period, and discussed a shaping of its future work plan for the period 2017–2020 and the decisions stemming from current and possibly future work for consideration of the RA II-16.

## 4. Working Group on WMO Integrated Global Observing System and WMO Information System (WG-WIGOS/WIS)

### 4.1 Expert Group on WIGOS

Regarding implementation of WIGOS, all seven projects have made progress. Most projects have successfully provided useful support to RA II members in implementation of WIGOS, especially Project No. IV - RA II WIGOS Project to Enhance the Availability and Quality Management Support for NMHSs in Surface, Climate and Upper-air Observations and Project No.VI - RA II WIGOS Project to Develop Support for NMHSs in Satellite Data, Products and Training.

The First session of the WMO RA II Expert Group on the WMO Integrated Global Observing System (EG-WIGOS-1) was held from 31 October to 1 November 2016 in Abu Dhabi, United Arab Emirates. EG-WIGOS-1 recommended that the Projects six of seven WIGOS projects should continue during the next intersessional period. A proposal for Regional WIGOS Centers in RA II in pilot mode is submitted to RA II MG meeting for consideration.

The updating structure and new TOR of EG-WIGOS for the next intersessional period is proposed. The term “Theme Leader” is recommended to be changed to “Project Leader”. The name of the Project Leaders is recommended to be identical to those listed in the R-WIP-II

Projects.

Proposal for establishing a Task Team on developing the RBON in RA II by the RA-II-16 is developed, and the TOR with a roadmap for the implementation of RBON in RA II is also drafted and proposed to be submitted to RA II MG for consideration.

An updated R-WIP-II taking into account the Plan for the WIGOS pre-operational phase 2016-2019 is drafted and will be submitted to RA II MG for consideration.

A proposed RBSN/RBCN lists which has considered RBON concept, specifically the key attributes and criteria for the selection of stations/platforms into RBON is prepared and is proposed to be submitted to the 16th session of RA II for approval.

The Joint RA-II/RA-V Workshop on WIGOS for Disaster Risk Reduction was held in Jakarta, Indonesia, 12-14, October 2015, and decided to propose two joint projects, which were "Joint RA-II/RA-V WIGOS Satellite Data Project" and "Joint RA-II/RA-V WIGOS Radar Data Project".

**4.2 Expert Group on WIS (EG-WIS)**

Regarding implementation of WIS, four GISCs became in operation since RA II-15. Now 6 out of 7 GISCs (including Moscow) in RA II are in operational status. Remaining GISC New Delhi is now pre-operational stage. As for the National Centre (NC), 35 out of 37 NCs in RA-II decided their principal GISC in RA-II-15 in 2012. After that remaining two NCs (Turkmenistan and DPRK) decided their principal GISC.

Creation and registration of WIS metadata for GTS bulletins in RA-II is showing a good progress in general. 31 RA-II Members (89%) out of 35 have registered at least one WIS metadata record to the catalogue. The community is waiting for GISC New Delhi to become operational and starting catalogue management for its area of responsibility. As of November 2016, Uzbekistan (its principal GISC is Seoul) has not registered its records to the catalogue yet.

The thirteenth session of RA II (Resolution 5 (2004)) added the GTS link between Thimphu and New Delhi to Regional Meteorological Telecommunication Network (RMTN). After 10-years, the NMC Thimphu (Bhutan) connected to the GTS, started receiving meteorological data through RTH New Delhi in July 2015 and issuing their surface observation data in BUFR format since July 2016. On the other hand, ten circuits in the Regional configuration plan are not in operation. Especially NMCs Baghdad (2 circuits) and Kabul (3 circuits) are still isolated from the GTS. Meanwhile, the NI circuit between Karachi and Tashkent has not been implemented yet, because there are difficulties to deploy telecommunication infrastructure for the area, and both RTHs requested to remove the link from RA II regional circuit plan.

According to the statistics collected every three months from January 2013 to July 2016, (1) notable progress has been seen with the migration of SYNOP data since October 2014, (2) number of BUFR TEMP report increased by about 50 in the first half of 2014, which is attributed to India's BUFR TEMP reports, (3) As of November 2016, Four Members were reporting CLIMAT data in BUFR format, which is a major setback compared to the situation in 2014-2015..

In accordance with the decision of Cg-17, Volume II of WMO No. 386 (Manual on GTS) will be discontinued and replaced by web-based documentation. EG-WIS agreed to organize a Task Team (TT) to proceed and create the web-based document. Theme Leader in Data Communication Technics and Structure will lead the TT with Volunteer Experts of the Theme, and some experts would be invited. The EG-WIS will establish the TT with ToR and plans to submit the draft of web-based document to RA II Management Group.

**LIST OF FINAL REPORTS OF THE RA II WORKING GROUPS AND PILOT PROJECTS OF RA II**

**ANNEX I**

# Report of the RA II Working Group on Weather Services (WGWS)

**B.L. Choy, Hong Kong Observatory**

**Chairperson of the RA II Working Group on Weather Services**

**-----**

**B.L. Choy and Marina Petrova**
**Co-coordinators, Expert Group on Aeronautical Meteorological Services Delivery**

**Yuki Honda and Irina Zaytseva**
**Co-coordinators, Expert Group on Operational Forecasting**

**L.S. Lee, Muhammad Hanif and Evgeniy Vasilyev**
**Co-coordinators, Expert Group on Public Weather Services Delivery**

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**Report of the RA II Working Group on Weather Services (WGWS)**

**1. Introduction**

This report summarizes major activities in association with the expert groups, viz Expert Group on Aeronautical Meteorological Services Delivery (EG-AeM), Expert Group on Operational Forecasting (EG-OF) and Expert Group on Public Weather Services Delivery (EG-PWS), during the period 2013-14.

**2. Working Group Structure**

The Working Group is composed of Expert Group on Aeronautical Meteorological Services Delivery (EG-AeM), Expert Group on Operational Forecasting (EG-OF) and Expert Group on Public Weather Services Delivery (EG-PWS). Each EG consists of two co-coordinators and several theme leaders.

**3. Terms of Reference**

The terms of reference of the Working Group on Weather Services (WGWS) are as follows:

(a) To coordinate and support the work of the expert teams in Aeronautical Meteorology in the Region in cooperation with the Commission for Aeronautical Meteorology;

(b) To coordinate all activities related to the GDPFS, including the Emergency Response Activities, and PWS in the Region in cooperation with the Commission for Basic System;

**4. Membership**

Expert Group on Aeronautical Meteorological Services Delivery (EG-AeM)

| **EG-AeM** | | |
|---|---|---|
| Co-Coordinators | Mr Boon-leung Choy | Hong Kong, China |
| | Ms Marina Petrova | Russian Federation |
| Theme Leader in QMS Implementation and Maintenance | Ms Jie Shao | China |
| Theme Leader in Competency Assessment | Mr Manoj Kumar Bhatnagar | India |
| Theme Leader in Meteorological Support to Air Traffic Management and Provision of SIGMETs | Mr Jun Ryuzaki | Japan |

Expert Group on Operational Forecasting (EG-OF)

| **EG-OF** | | |
|---|---|---|
| Co-Coordinators | Mr Yuki Honda | Japan |
| | Ms Irina Zaytseva | Uzbekistan |
| Theme Leader in Operational Forecasting Process and Support | Ms Sunitha D. Santhamma | India |
| | Mr Vo Van Hoa | Viet Nam |
| Theme Leader in Operational Predictions from sub-seasonal to longer-time scale | Mr Suhee Park | Republic of Korea |
| Theme Leader in Emergency Response Activities | Mr Masami Sakamoto | Japan |

Expert Group on Public Weather Services Delivery (EG-PWS)

| **EG-PWS** | | |
|---|---|---|
| Co-Coordinators | Mr Lap-shun Lee | Hong Kong, China |
| | Dr Muhammad Hanif | Pakistan |
| | Dr Evgeniy Vasilyev | Russian Federation |
| Theme Leader in Socio-economic Benefits of Meteorological and Hydrological Services | Mr Jinjun Pan | China |
| Theme Leader in Delivery of Warning Services | Mr Chuanhai Qian | China |
| Theme Leader in Education and Public Outreach related to PWS | Mr Ikhyun Cho | Republic of Korea |

**4. Expert Group on Aeronautical Meteorological Services Delivery (EG-AeM)**

A meeting of the expert group was held during 10-12 November 2014 in Hong Kong, China. Apart from the Co-coordinators and the Theme Leaders, three additional experts from other Members of RA II were invited to the meeting. Although two of the participants, including the Theme Leader in Competency Assessment (India) and an invited expert (Kazakhstan), were unable to attend the meeting in the end, the meeting still had a reasonable sub-regional representatives of RA II (China; Hong Kong, China; Japan; Kuwait; Russian Federation; Thailand).

Four major areas were discussed during the meeting, they were (i) Review of the outcome of the conjoint ICAO MET Divisional and WMO CAeM meeting in July 2014, (ii) Status of implementation of high priority items in RA II, (iii) Proposal for regional follow up actions and (iv) Coordination of regional aeronautical meteorological services delivery events. Generally speaking, the NMHSs in RA II had great discrepancies in capabilities; while some of them were working on exciting new developments, some of the others were still having deficiencies in the provision of METAR, TAF and SIGMET. This could be one of the reasons why the progress of implementing Quality Management and Competency Assessment Systems, each of these requiring considerable knowledge and skills for sustainable development, was below expectation for the region as a whole when compared with more advanced regions like RA VI. This may also impact the regional ability to face the upcoming challenges in the provision of aeronautical meteorological services for the future global air navigation system. One of the participants had showcased the positive outcome of twinning, arranged through bilateral agreement, in removing deficiencies of NMHS. The possibility of having more twining/mentoring activities in RA II would be further explored.

For more advanced NMHSs in RA II, activities to study and develop new technologies to support the future air navigation system had been started in close co-ordination with relevant Expert Teams of WMO Commissions and ICAO. They had also demonstrated their current abilities to provide new services including space weather and regional hazardous weather advisory services. At the same time, the participants were aware of the evolving requirements of users for the provision of sub-regional aviation meteorological services in a global sense, and the rise of the big data concept which made the value of data and value-added services diverge further. It was recognized that partnership among NMHSs through MOU or bilateral agreements may be able to extend the capabilities of individual NMHS to better serve the global needs of aviation users and worth further exploration.

The work plans of the Theme Leaders for 2013-16 were amended in accordance to the outcome of the meeting. The meeting also considered it essential to review the Terms of Reference of EG-AeM in response to the outcome of the conjoint meeting. However, since a master plan would be discussed at the upcoming meeting of the management group of CAeM in 2015, the meeting agreed to postpone the discussion until the outcome of the CAeM-MG became available.

During RECO-6, the co-coordinators summarized the outcomes of the meeting and would like to propose new points for possible inclusion to the WMO existing challenges and priorities on Meteorological Service for Aviation.

**5. Expert Group on Operational Forecasting (EG-OF)**

See the separate report as given in Annex I.1.

**6. Expert Group on Public Weather Services Delivery (EG-PWS)**

Communication among the Co-coordinators and Theme Leaders of the EG-PWS was mainly made through email exchange in 2013. A meeting of the EG-PWS was held in Doha on 3 December 2014 and a teleconference was held on 25 March 2015. In 2013, the work plan of EG-PWS for 2013-16 was formulated. Some of the proposed tasks were the development of guidelines on assessment of socio-economic benefits and communication with stakeholders. However, it was later found that similar guidelines were being prepared under other WMO programmes. Therefore, the EG-PWS would put more focus on the recommendations given in "The WMO Strategy for Service Delivery and its Implementation Plan" published by WMO in 2014. In this regard, the EG-PWS planned to organize a training workshop/seminar for RA II Members in 2015 on the enhancement of public weather service delivery.

Some of the activities on PWS carried out in this Region during 2013 and 2014 are summarized as follows. Two training workshops on public weather services were organized under the WMO/CBS Severe Weather Forecast Demonstration Projects (SWFDP). The first one was held in Macao, China from 15 to 19 April 2013 with participants from Cambodia, Lao, Thailand, Viet Nam, India, Maldives, Myanmar, Sri Lanka, Pakistan, Nepal, Bhutan, and others. The second one was held in Manila, Philippines from 9 to 13 June 2014 with participants from Cambodia, Laos, Thailand, Vietnam, and others. In addition, a Voluntary Cooperation Programme (VCP) training workshop on "Effective Media Communication" was organized in Hong Kong, China in December 2013 for Bhutan, Cambodia, China, Islamic Republic of Iran, Republic of Kazakhstan, Republic of Korea, Thailand and The United Arab Emirates. The workshop covered media communication in different phases of significant weather events, through various channels including the traditional media like

TV and radio as well as new media like the social media. There were practical sessions of weather presentation on TV and radio, which offered each participant hands-on experience together with expert feedback.

A meeting of the EG-PWS was held in Hong Kong, China on 10 and 11 December 2015. The meeting reviewed the 2013-2016 work plan of the EG-PWS and identified new tasks to be performed in 2016 including public education and outreach; socio-economic studies and evaluations; communication between RA II members and stakeholders; and quality management of service delivery. Planning ahead, the meeting proposed organizing a workshop on socio-economic benefit study for Members in RA II or subregions in 2016-2019, with the assistance of WMO PWS Programme. Proposals of streamlining the Terms of Reference of EG-PWS and improvement of the structure of EG-PWS were also made for consideration in the next RA II session.

**ANNEX I.1**

**Expert Group on Operational Forecasting (EG-OF)**

Y. Honda
Japan Meteorological Agency

**1. Introduction**

This report summarizes major activities in association with Expert Group on Operational Forecasting (EG-OF) during the period 2015-2016.

**2. Expert Group Structure**

The EG-OF is composed of two co-coordinators and three theme leaders.

**3. Terms of Reference**

The terms of reference of the Working Group on Weather Services (WGWS), which the EG-OF belongs to, are as follows:

(a) To coordinate and support the work of the expert teams in Aeronautical Meteorology in the Region in cooperation with the Commission for Aeronautical Meteorology;

(b) To coordinate all activities related to the GDPFS, including the Emergency Response Activities, and PWS in the Region in cooperation with the Commission for Basic System;

**4. Membership**

Expert Group on Operational Forecasting (EG-OF)

| **EG-OF** | | |
|---|---|---|
| Co-Coordinators | Mr Yuki Honda | Japan |
| | Ms Irina Zaytseva | Uzbekistan |
| Theme Leader in Operational Forecasting Process and Support | Ms Sunitha D. Santhamma | India |
| | Mr Vo Van Hoa | Viet Nam |
| Theme Leader in Operational Predictions from sub-seasonal to longer-time scale | Mr Suhee Park | Republic of Korea |
| Theme Leader in Emergency Response Activities | Mr Masami Sakamoto | Japan |

**5. Highlights of EG-OF activities**

- The revised Manual on Global Data-processing and Forecasting System (WMO-No.485) was approved by CBS at its 16th Session (CBS-16) (Guangzhou, China; Nov. 2016).
- There are three regional subprojects of Severe Weather Forecasting Demonstration Project (SWFDP) in RA II. Regional Subproject Management Team of SWFDP in Southeast Asia decided to start its demonstration phase from January 2016. The SWFDP in the Bay of Bengal (South Asia) is moving to the demonstration phase. A new SWFDP in Central Asia is being developed. These activities are supported by Global and Regional Centres.
- A questionnaire survey for non-registered members has conducted to find out their potential interest in ERA in 2014. A concise guidance for EER was provided to RA II Members in 2014. A user request survey on ERA was conducted in 2016 to find needs and queries regarding the activities within the region. User requests and opinions will be conveyed to relevant entities of WMO.

- The 16th ESCAP/WMO Typhoon Committee Attachment Training 2016 course was held at JMA Headquarters from 15 to 26 August 2016. In 2016, two-day lectures on warning coordination were newly introduced.
- Tropical Cyclone Forecaster Training was conducted in 2016. There were 19 participants including 3 from WMO/ESCAP Panel member countries. Regional Training Workshop for capacity development in coastal multi hazard early warning system was also organised in 2016 and trainees from 8 countries from WMO/ESCAP and WMO-Typhoon Committee participated.
- The Commission for Basic Systems approved the designation of China Meteorological Administrator (CMA, Beijing) as RSMC for Atmospheric Sand and Dust storm Forecasts at its 16th Session in 2016.

**6. Expert Group on Operational Forecasting (EG-OF)**

General report on Global Data-processing and Forecasting System

- ✓ In RA II, there are 18 Regional Specialized Meteorological Centres (RSMCs) and 3 Lead Centres as part of WMO Global Data-processing and Forecasting System. In addition to these Centres, the designation of two new RSMCs in RA II was approved by the Commission for Basic Systems at its 16th Session (China, Nov. 2016). One is RSMC Atmospheric Sand and Dust-storm Forecast (ASDF) Beijing, China and the other is Regional Climate Centre (RCC) Pune, India. Their formal designation will be endorsed at the 69th Session of the Executive Council (EC-69) (2017).
- ✓ The revised Manual on GDPFS (WMO-No.485) was also adopted by CBS at its 16th Session (CBS-16) (Guangzhou, China; Nov. 2016). The approved Manual can be found as the approved documents of CBS-16:
  - ➢ http://meetings.wmo.int/CBS-16/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/CBS-16-d03-6(1)-REVISED-MANUAL-GDPFS-approved_en.docx?Web=1
  - ➢ http://meetings.wmo.int/CBS-16/English/2.%20PROVISIONAL%20REPORT%20(Approved%20documents)/CBS-16-d03-6(2)-NEW-TYPE-CENTRES-REVISED-MANUAL-GDPFS-approved-en.docx?Web=1
- ✓ Five Members (China; Hong Kong, China; Japan; Kazakhstan; Thailand) submitted the WMO Technical Progress Report on GDPFS and NWP Research for the year of 2014. Aiming to facilitate the Members' contribution to the Report, the content and reporting method will be reviewed by CBS.
- ✓ The discussion on the future Seamless GDPFS is ongoing under WMO. The vision for the Seamless GDPFS was endorsed at EC-68. The white paper and implementation plan is being developed by the EC Steering Group on the Seamless GDPFS. It is planned to conduct the Members' review next year. To facilitate the implantation plan, Members in RA II will be invited to identify national focal points on GDPFS next year.

Severe Weather Forecasting Demonstration Project

- ✓ SWFDP regional subprojects in Southeast Asia, Bay of Bengal and Central Asia in RA II were started in 2010, 2012 and 2014, respectively. These three subprojects in RA II have shown steady progress during recent years.
- ✓ The SWFDP Southeast Asia (SWFDP-SeA) which involves five countries namely: Cambodia, Lao PDR, Philippines, Thailand and Viet Nam, entered into demonstration phase from 1 January 2016 after decision by its Regional Subproject Management Team (RSMT) which met in Ha Noi, Viet Nam in August 2015. Global NWP centres of ECMWF, CMA, JMA, KMA and DWD are contributing to SWFDP-Southeast Asia, while Viet Nam is providing support as lead

Regional Forecast Support Centre, with support of RSMC Tokyo (for typhoon forecast support) and RSMC New Delhi (for tropical cyclone forecast support).

- ✓ The SWFDP-Bay of Bengal (SWFDP-BB) which initially involved six countries namely: Bangladesh, India, Maldives, Myanmar, Sri Lanka and Thailand, has been expanded in 2016 to benefit Bhutan, Nepal and Pakistan as well to involve all nine countries in South Asia. The SWFDP-Bay of Bengal is ready to start its demonstration phase subject to decision by the first meeting of its Regional Subproject Management Team (RSMT) which is likely to be held in 2017. ECMWF, UKMO and IMD are contributing as global NWP centres for SWFDP-Bay of Bengal with RSMC New Delhi as lead Regional Centre.
- ✓ The SWFDP-Central Asia (SWFDP-CA) involves four countries namely: Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan. The development planning of the subproject was started in 2014. The contributing global NWP centres include Roshydromet, ECMWF, CMA, JMA and KMA. RSMC Tashkent will serve as the lead Regional Centre. The project website which is in Russian language is currently maintained by Roshydromet.
- ✓ Regular specialized training workshops have been conducted for capacity development of participating NMHSsl.
  - Two-week joint SWFDP-SeA and -BB Training Workshop in Macao, China during 8-19 April 2013
  - Two-week SWFDP-SeA Training Workshop in Quezon City, Metro Manila, Philippines during 2-13 June, 2014.
  - One-week SWFDP-Central Asia Workshop on Analysis and Interpretation of Numerical Weather Prediction (NWP) products was held in Moscow, Russian Federation, from 6 to 10 July 2015
  - Two-week joint SWFDP-SeA and -BB Training Workshop in Bangkok, Thailand during 14-25 September 2015.
  - SWFDP-CA Workshop on Forecasting and Public Weather Services (PWS) in Almaty, Kazakhstan, from 22 February to 4 March 2016

<u>Emergency Response Activity</u>

- ✓ A user request survey on the Emergency Response Activities (ERA) in the Regional Association II (RA II) was conducted in 2016, and the results were reported to the coordinators of Expert Group on Operational Forecasting (EG-OF) by Theme Leader in Emergency Response Activities (TL-ERA). The survey questionnaire and the survey report are found in Annexes I.1.1 and I.1.2, respectively.
- ✓ The Regional Specialised Meteorological Centres in the region (RSMCs Beijing, Obninsk, and Tokyo) have continued their efforts to maintain contact information for the registered members for the Environmental Emergency Response (EER).
- ✓ Annual activity report in 2016 submitted by TL-ERA is found in Annex I.1.3.

<u>Training on Tropical Cyclone Forecasting: Report from RSMC Tokyo</u>

- ✓ The 16th ESCAP/WMO Typhoon Committee Attachment Training 2016 course was held at JMA Headquarters from 15 to 26 August 2016. Forecasters from the Panel on Tropical Cyclones (PTC) have also been invited since 2015 to enhance training collaboration between PTC and the Typhoon Committee. The 2016 attendees were Mr. Thatsana Chanvilay from Lao PDR, Ms. Shelly Jo Igpuara Ignacio from the Philippines, Ms. Ton Thi Thao from Vietnam, Mr. Nasser Said Abdullah Al Ismaili from Oman, Mr. Habib Rehmat from Pakistan, and Mr. Ponna Handi Chaminda De Silva from Sri Lanka.

- ✓ The training focused on imparting practical knowledge and skills relating to operational tropical cyclone analysis and forecasting via lectures and exercises using the Satellite Analysis and Viewer Program (SATAID). The course covered a range of subjects including Dvorak analysis, interpretation of microwave data, quantitative precipitation estimation (QPE), quantitative precipitation forecasting (QPF) and storm surge forecasting. All attendees gave presentations to help JMA staff understand the current status of their meteorological and hydrological services. In 2016, two-day lectures on warning coordination were newly introduced. Lectures focused on how to determine warning thresholds using disaster statistics and meteorological datasets through a past tropical cyclone disaster event in Japan. The participants reported that in particular practical exercise using SATAID is effective to obtain operational skills of tropical cyclone analysis/forecasting. However, trainees also stressed their needs for lectures/exercises on analysis/forecast techniques for severe weather phenomena associated with tropical cyclones, such as radar-based heady rainfall estimates and storm surges.
- ✓ Annual report on activities of the RSMC Tokyo – Typhoon Centre can be found in the following website: http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/annualreport.html

<u>Training on Tropical Cyclone Forecasting: Report from RSMC New Delhi</u>

- ✓ Tropical Cyclone Forecaster Training is conducted every year from 2005 onwards. This year this training was conducted during 19-30 September 2016. There were 19 participants including 3 from WMO/ESCAP Panel member countries viz. Bangladesh, Maldives and Pakistan, 11 from Area Cyclone Warning Centres (ACWCs) and Cyclone Warning Centres (CWCs) of IMD and 5 from National Weather Forecasting Centre & RSMC New Delhi.
- ✓ Regional Training Workshop for capacity development in coastal multi hazard early warning system was jointly organised by RSMC, New Delhi & Indian National Centre for Ocean Information Services (INCOIS), Hyderabad and sponsored by UN-ESCAP at Hyderabad during 19-23 September. 8 countries from WMO/ESCAP and WMO-Typhoon Ccommittee participated in the training workshop.
- ✓ In 2015, an advanced training on TC forecasting was conducted by RSMC New Delhi during 03-14 August 2015. There were 16 International participants from WMO/ESCAP Panel and Typhoon Committee member countries. There were 41 national participants from IMD, National Centre for Medium Range Weather Forecasting (NCMRWF), Indian National Centre for Ocean Information Services (INCOIS), Indian Navy (IN) and Indian Air Force (IAF).

<u>Sand and Dust storm Forecasts</u>

- ✓ Cg-XIV endorsed launching of the Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) project with its mission to enhance the ability of WMO Members to deliver timely and quality sand and dust storm forecasts, observations, information and knowledge to users through an international partnership of research and operational communities. SDS-WAS is jointly coordinated by the WMO World Weather Research Programme (WWRP) and the Global Atmosphere Watch (GAW).
- ✓ In view of the demand of many National Meteorological Services and the good results obtained by the SDS-WAS, the WMO Executive Council endorsed to establish a new type of RSMC with activity specialization in Atmospheric Sand and Dust Forecast (RSMC-ASDF) in 2013.
- ✓ The meeting of the Regional Steering Group (RSG) of SDS-WAS Asia Node was organized in September 2016 in Jeju, Korea. The RSG reviewed the technical document and its annex submitted by China Meteorological Administrator. These reports are obtained from the

following links:
http://www.wmo.int/pages/prog/arep/wwrp/new/documents/technique_report_on_asian_RC_final_2015.pdf
http://www.wmo.int/pages/prog/arep/wwrp/new/documents/technique_report_on_asian_RC_final_annex_2015.pdf

✓ The designation of RSMC ASDF Beijing was approved by CBS at its 16th Session (Guangzhou, China; Nov. 2016). Their formal designation will be endorsed at the 69th Session of the Executive Council (EC-69) (2017).

**Annexes**

Annex I.1.1: Survey Questionnaire on Emergency Response Activities
Annex I.1.2: Survey Report on User Request on the Emergency Response Activities (ERA) in Regional Association II (Asia)
Annex I.1.3: Report by the Theme Leader in Emergency Response Activities for 2016

**ANNEX I.1.1**

# Brief Introduction on the WMO ERA

*for the Emergency Response Activities (ERA) in Reginal Association II (Asia)*

*Masami SAKAMOTO*

*(Japan Meteorological Agency,*

*Theme Leader in Emergency Response Activities / Expert Group on Operational Forecasting)*

## 1. Introduction

After the Chernobyl nuclear power plant (NPP) accident in April 1986, the Commission for Basic Systems (CBS) of the World Meteorological Organization (WMO) had a series of discussions and decided to launch an atmospheric transport and dispersion modelling (ATDM) service to meet the broad interest in the atmospheric diffusion of toxic radiological materials. The environmental emergency response (EER) services started in 1989. The 49th session of WMO executive council in 1997 approved three Regional Specialized Meteorological Centres (RSMCs) for EER in Regional Association II (Asia) [see Table 1]. In 2011, the three RSMCs provided ATDM forecasts and joint statements in response to the Fukushima Daiichi NPP accident, and this was the first real operational service since the EER service started. The 16th World Meteorological Congress (Cg-16) in May 2011 noted the contributions by the RSMCs, and a representative of the International Atomic Energy Agency (IAEA) offered an appreciation.

**Table 1.** WMO RSMCs for EER in Regional Association II (Asia)

| | Hosting Organization (Nation / State) |
|---|---|
| RSMC Beijing | China Meteorological Administration (China) |
| RSMC Obninsk | Russian Federal Service for Hydrometeorology and Environmental Monitoring (Russian Federation) |
| RSMC Tokyo | Japan Meteorological Agency (Japan) |

The Emergency Response Activities (ERA) programme is primarily designed to provide ATDM service as part of the World Weather Watch (WWW). The CBS Expert Team on ERA (ET-ERA), which was set up under the CBS Open Programme Area Group on Data-processing and Forecasting Systems (OPAG-DPFS) in 2012, discusses ERA related issues and defines the processes and procedures for the provision of ERA products and services.

## 2. Operational Services and Exercises

The RSMCs provide users with the ATDM charts and a joint statement on weather and ATDM forecasts over the influenced area. Descriptions on the ATDM charts at each centre are found in Annex 4 of WMO technical document 778:
http://www.wmo.int/pages/prog/www/DPS/WMOTDNO778/Annex4.html

WMO and IAEA conduct quarterly regular exercises to prepare the nuclear and radiological emergencies on third Tuesdays in February, May, August, and November. The schedule and target regions for the regular exercises are decided by the beginning of the year. Other than the quarterly exercises, IAEA conducts international exercises named ConvEx, and WMO has been participating in ConvEx-2d and ConvEx-3. [Exercises planned this year (2016) are listed in Table 2.] For all exercises described above, RTH-Offenbach (hosted by the German Weather Service) broadcasts exercise information using the header "WNXX01 IAEA" through the Global Telecommunication System (GTS).

**Table 2.** Planned EER exercises in 2016

| Date | Exercise Type | Target Region |
|---|---|---|
| 18 February | Quarterly Test | RA I (Africa) and RA VI (Europe) |
| 17 May | Quarterly Test | RA II (Asia) |
| 16 August | Quarterly Test | RA III (South America) and RA IV (North and Central America) |
| 5 October | ConvEx-2d | Primary Target: RA VI (Europe) |
| 15 November | Quarterly Test | RA V (Southwest Pacific) |

## 3. Expert Team Activities on ERA

ET-ERA meets once every two years to discuss issues related to ERA. The team consists of experts from RSMCs, RTH-Offenbach, international organizations ( IAEA, ICAO, CTBTO and WHO), and some national weather services.

ET-ERA has been working on the migration from fax service delivery to the service through the Internet (email and web). The implementation of the migration has been a challenge, and the team discussed whether or not the facsimile transmission should be discontinued. The team concluded at the meeting in December 2015 that the facsimile transmission system is still needed to reach some of the NMHSs with limited capabilities and it can also serve as backup to e-mail, in case of Internet failure.

ET-ERA is discussing new types of products to provide to users in the future, and continues experiments to meet user requirements. Experimental products to be provided in the near future are described below.

3 a) Time of Arrival (ToA)

This is the product designed to indicate arrival times of a specific (instantaneous or time-integrated) atmospheric concentration level over geographic areas. ET-ERA conducted ToA product experiments in June and October 2015, and decided to continue effort in further developing of this product. Details of the product are undecided yet, but currently 6 hourly colored hatched arrival time areas are planned to be indicated in 24 hourly forecast charts.

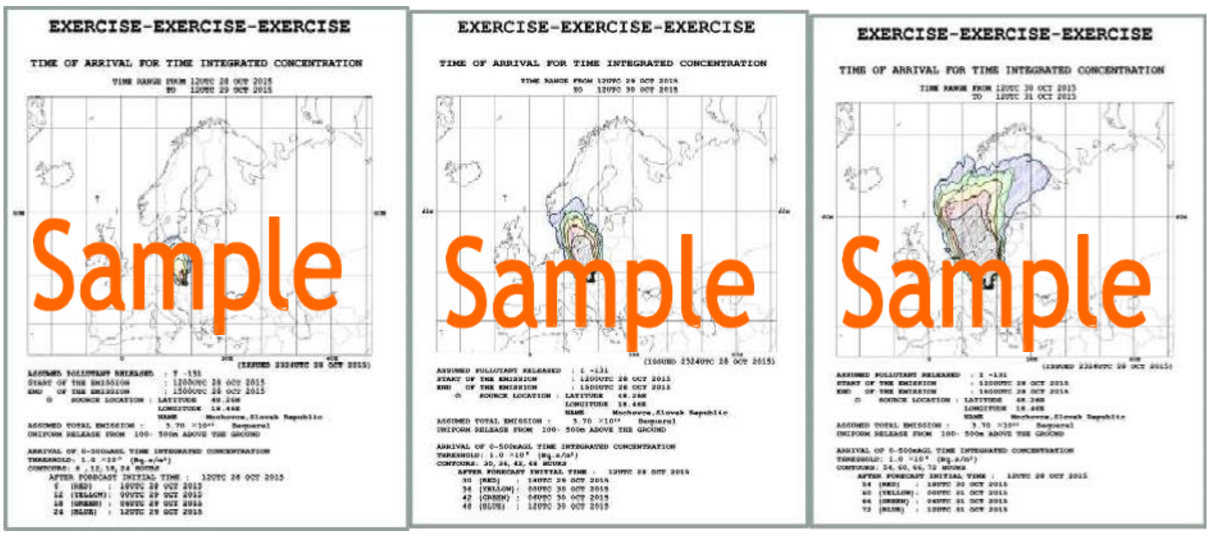



Figure 1. Samples of the time of arrival products (time-integrated concentration).

3 b) Fixed Legends

Currently forecasts for the time-integrated air concentration and total deposition are presented using different legends among three time zones up to 24, 48, and 72 hours after the NWP forecast initial time at each centre [according to the appendix II-7 of WMO No. 485]. A representative of IAEA at ET-ERA meeting in 2015 requested RSMCs to provide fixed legend charts for three time zones. An experiment will be done using the legends specified by IAEA in the near future.

3 c) the Transfer Coefficient Matrix (TCM) technique with the ATDM model ensemble

The 17th World Meteorological Congress (Cg-17) in 2015 noted two types of techniques to be developed for the ATMD services. These were the Transfer Coefficient Matrix (TCM) technique and Ensemble approach to ATDM [see 4.1.47 and 4.1.48 of WMO (2015)].

In most cases of accidental releases of radioactive materials, the release rates are unknown, only time series of radiological monitoring can be available. Unfortunately results of ATDM forecasts and analyses are heavily dependent on the release rates. With the TCM technique, a posterior analysis of toxic material dispersion can be estimated changing and adjusting release rates at a site [see Draxler and Rolph (2012)]. On the other hand, dispersion forecast results are also very dependent on NWP models and ATDMs at forecasting centres. There must be ambiguity stemming from differences of weather and ATDM forecasts. To identify the variations among centres, ET-ERA plans to have a joint experiment for TCM techniques with an ATDM multi-centre model ensemble. The model ensemble comparison is planned using the web application at the Joint Research Centre of the European Commission (JRC-EC).

## 4. Summaries

EER services started in 1989. The activities for the Fukushima Daiichi NPP accident were highly appreciated at Cg-16 in 2011. The CBS ET-ERA is discussing future ATDM services. Opinions and suggestions on the activities from Members will be appreciated.

## References

Draxler R. R., and G. D. Rolph 2012: Evaluation of the Transfer Coefficient Matrix (TCM) approach to model the atmospheric radionuclide air concentrations from Fukushima. *J. Geophy. Res*., **VOL. 117**, D05107, doi:10.1029 / 2011JD017205, 2012.

WMO 2010 (final update in 2015): Manual on the Global Data-processing and Forecasting System Volume I – Global Aspects (WMO-No.485)

WMO 2015: Seventeenth World Meteorological Congress, Geneva, 25 May–12 June 2015, abridged final report with resolutions (WMO-No.1157)

# *SURVEY QUESTIONS*

*Regarding Emergency Response Activities (ERA) in Reginal Association II (Asia)*

## 1. Respondent

Name of County/Territory: ________________________________________________

Name of Organization: ___________________________________________________

Name of Respondent: ____________________________________________________

Title: ____________________________________________________________

Email: ___________________________________________________________

Phone:________________________Facsimile: ___________________________

## 2. User satisfaction

2 a) Does your organization have specific operations using the environmental emergency response (EER) service by RSMCs? (Please check one of below and describe the usage of the EER service in your operations if you have)

1. yes ☐ / 2. no ☐

Your operational usage:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

2 b) What is your overall satisfaction rating with regards to the current ERA service? (Please check one of below and provide us your opinions if you have)

1. excellent ☐ / 2. good ☐ / 3. fair ☐ / 4. not good ☐ / 5. poor ☐

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

2 c) What does your organization think regarding the current exercises on the EER service?
(Please check one of below and provide us your opinions if you have)

1. too many (frequent) ☐ / 2. appropriate ☐ / 3. too few (need more) ☐

## 3. Contents of the Service

3 a) What does your organization think regarding products listed below? (Please refer to sec. 3 of the attached document “Brief Introduction of WMO ERA” and check one option for each)

3.a.i)Time of Arrival products
1. favorable ☐ / 2. no idea (need more explanation) ☐ / 3. unessential ☐

3.a.ii)Fixed legend products
1. favorable ☐ / 2. no idea (need more explanation) ☐ / 3. unessential ☐

3.a.iii)Transfer Matrix Coefficient analysis with the ATDM model ensemble
1. favorable ☐ / 2. no idea (need more explanation) ☐ / 3. unessential ☐

3 b) Does your organization have specific requests on the contents of the EER service? (If you have, please provide us with your opinions)

## 4. Service Provision Measures

4 a) Does your organization have specific purposes to require continuation of the fax service for EER? (Please check one of below and describe your necessity when appropriate)

1. no ☐ / 2. yes ☐

Your necessity for the fax-service continuation:

4 b) What is your overall satisfaction rating with regards to the service through RSMCs' common web pages1? (Please check one of below.)

1. excellent ☐ / 2. good ☐ / 3. fair ☐ / 4. not good ☐ / 5. poor ☐

## 5. Requests (or questions) for the Activities

5) Could you inform us of your request regarding the atmospheric transport and dispersion modelling (ATDM) services within WMO ERA?
(You may ask any questions regarding ERA.)

END

Thank you very much for completing this questionnaire. Please reply the form (this file) to the contact point below by the end of September (Friday, 30 September 2016).

[ Theme Leader in Emergency Response Activities (Mr. Masami SAKAMOTO):
Fax: +81 3 3211 2032, email: masami.sakamot-a@met.kishou.go.jp ]

[1] RSMCs' common webs are maintained to provide users with ATDM forecast results on-line. RSMCs currently send users emails and faxes, in which URLs of the common webs are included with a relevant user ID and a pass word.

Answers by NMHSs (2. User satisfaction 1/2)

| Country/ State | 2 a) | |
|---|---|---|
| China | 1.yes | We provide the government with the support of the nuclear emergency response and provide the public with nuclear accident atmospheric dispersion forecasts. For example, during Japan's Fukushima nuclear accident, we provided decision-making reference to the government and provided explanation to the public. |
| Hong Kong, China | 1.yes | To help assess the potential environmental impact of nuclear accidents. |
| Iran, Islamic Republic of | 1.yes | IN case of Request from users or having the required release information from internal or external sites |
| Japan | 2.no | The Japanese government is not using the EER service, because it has its own atmospheric dispersion models available for the purpose. Therefore the questions below are not applicable. |
| Korea, Republic of | 1.yes | For reference materials |
| Kyrgyzstan | 1.yes | |
| Macao, China | 1.yes | We will request the atmospheric transport and dispersion modelling products from three RSMCs for internal analysis, and also test the internal notification systems. |
| Mongolia | 1.yes | |
| Myanmar | 1.yes | Department of Meteorology and Hydrology (DMH) is operating the usage of the EER service in hydro-meteorological disasters and geological disasters (Earthquake, Land slide, and Tsunami). |
| Pakistan | 1.yes | |
| Russian Federation | 1.yes | Informational support of a national bogies (Ministry of emergency and other) responsible for decision making in case of emergencies lead to environmental contamination |
| Saudi Arabia | 2.no | |
| Thailand | 2.no | |
| Turkmenistan | N/A | |
| United Arab Emirates | 1.yes | |
| Uzbekistan, Republic of | 2.no | Does not guide |
| VIET NAM | 1.yes | We use the website "http://ra2-nwp.kishou.go.jp/cityfc/VietNam/VietNam.html" with an account that RSMCs Tokyo provided. |

Answers by NMHSs (2. User satisfaction 2/2)

| Country/State | 2 b) | | 2 c) | |
|---|---|---|---|---|
| China | 2.good | | 2.appropriate | Exercise and offered sufficient information for analysis and processing. |
| Hong Kong, China | 2.good | | 2.appropriate | |
| Iran, Islamic Republic of | 2.good | It is almost new compared to other WMO activities and in the future will be enhanced with more training and development | 2.appropriate | |
| Japan | N/A | | N/A | |
| Korea, Republic of | 2.good | | 2.appropriate | |
| Kyrgyzstan | 2.good | | 2.appropriate | |
| Macao, China | 2.good | | 2.appropriate | |
| Mongolia | 2.good | | 1.too many | |
| Myanmar | 2.good | | 2.appropriate | |
| Pakistan | 1.excellent | | 2.appropriate | |
| Russian Federation | 2.good | | 2.appropriate | |
| Saudi Arabia | 1.excellent | | 3.too few | We would like to propose to increase EER exercises in RA II at biannual basis. |
| Thailand | N/A | The ATDM service is good but the service from ERA in not covered, especially the products and the right time that meet the requirement of each country for further data use planning. | 2.too many | The current exercises are appropriate but TMD has not yet involved in the exercise. |
| Turkmenistan | N/A | | N/A | |
| United Arab Emirates | 1.excellent | | 2.appropriate | |
| Uzbekistan, Republic of | 2.good | | 3.too few | Exercise and offered sufficient information for analysis and processing. |
| VIET NAM | 2.good | | 2.appropriate | |

Answers by NMHSs (3. Contents of the Service 1/1)

| Country/State | 3 a.i) | 3 a.ii) | 3 a.iii) | 3 b) |
|---|---|---|---|---|
| China | 1.favorable | 3.unfavorable | 1.favorable | It will be better to provide the ensemble ATDM products. RSMC Beijing can provide these products, which have 15 members and are generated from the ensemble T639 and GRAPES_MESO systems. |
| Hong Kong, China | 1.favorable | 1.favorable | 1.favorable | It would be highly desirable to have some tailored products to help assess potential radiological impact to aviation, such as maximum activity concentration / dose rate in air, 3-dimensional grid point values of the model output that can cover flight levels, etc. |
| Iran, Islamic Republic of | 1.favorable | 2.no idea | 1.favorable | Not more than available for the time being and may be in the future. |
| Japan | N/A | N/A | N/A | |
| Korea, Republic of | 1.favorable | 1.favorable | 2.no idea | |
| Kyrgyzstan | 1.favorable | 1.favorable | 1.favorable | No |
| Macao, China | 1.favorable | 1.favorable | 2.no idea | |
| Mongolia | 1.favorable | 2.no idea | 1.favorable | No |
| Myanmar | 1.favorable | 2.no idea | 2.no idea | DMH have specific requests on the Cyclone warning, Tsunami Warning and Landslide warning of the EER service. DMH needs timely warning during the |
| Pakistan | 1.favorable | 1.favorable | 1.favorable | No |
| Russian Federation | N/A | 2.no idea | 2.no idea | |
| Saudi Arabia | 1.favorable | 1.favorable | 2.no idea | No |
| Thailand | 2.no idea | 1.favorable | 1.favorable | TMD requires the atmospheric transport products in various levels ranging from surface to 500hPa or above including particle dispersion. |
| Turkmenistan | N/A | N/A | N/A | |
| United Arab Emirates | 1.favorable | 1.favorable | 1.favorable | None |
| Uzbekistan, Republic of | 1.favorable | 1.favorable | 2.no idea | No |
| VIET NAM | 1.favorable | 1.favorable | 1.favorable | We need to send our people to join in EER training courses, conferences and seminars. |

Answers by NMHSs (4 Service Provision Measures 1/1)

| Country /State | 4a) | | 4b) | |
|---|---|---|---|---|
| China | 2.yes | We hope to continue with the fax service, because the e-mails are sometimes blocked. Meanwhile we also need to receive the important/particular information through fax in some special cases. | 1.excellent / 4. not good | This enables to analyze the situation online and sharing the experiences of other participants. |
| Hong Kong, China | 1.No | While it is not a strict necessity, it would be desirable to maintain the fax service as a backup channel for communication, as well as to receive notifications and products. | 2.good | Based on the experience in the past couple of exercises, the web pages are found to be rather useful for accessing the products. |
| Iran, Islamic Republic of | 1.No | No Necessity | 2.good | |
| Japan | N/A | | N/A | |
| Korea, Republic of | 2.yes | Fax transmission system is necessary as backup to e-mail and it is better to recognize Environmental emergency situation. | 2.good | |
| Kyrgyzstan | 1.No | | 2.good | |
| Macao, China | 2.yes | We recommend that the facsimile transmission system is still needed to be continued, in case of Internet service failure. | 2.good | |
| Mongolia | 1.No | | 2.good | |
| Myanmar | 2.yes | DMH necessitate the fax-service continuation because internet communication system is problem in Myanmar to open the URLs and use the web pages/emails. | 2.good | |
| Pakistan | 1.No | | 2.good | |
| Russian Federation | 1.No | | 2.good | |
| Saudi Arabia | 1.No | | 1.excellent | |
| Thailand | 2.yes | Facsimile transmission system is still necessary for backup system. | N/A | |
| Turkmenistan | N/A | | N/A | |
| United Arab Emirates | 2.yes | We support it as a back up means of delivery of the Service. | 2.good | |
| Uzbekistan, Republic of | 2.yes | Enhance of readiness for emergency situations and to strengthen monitoring of atmospheric air. | 1.excellent | This enables to analyze the situation online and sharing the experiences of other participants. |
| VIETNAM | 1.No | | 2.good | We usually use the seasonal and monthly outlook from these webpages. |

Answers by NMHSs (5 Requests (or questions) for the Activities 1/1)

| Country / State | 5) |
|---|---|
| China | If the new Transfer Matrix Coefficient analysis products are provided in future, could WMO provide the product standards and the TCM coefficient and programs? |
| Hong Kong, China | (a) It would be highly desirable to have 3-dimensional grid point values of the model output that can cover flight levels (e.g. in GRIB or other digital data format) for facilitating further analysis and post-processing of the products.<br>(b) It would be desirable to have more detailed information / procedure regarding request for non-nuclear environmental emergency response ATDM service. |
| Iran, Islamic Republic of | In the future with more exercise and working on the matter as a new task in our met service, we will come across with some technical and scientific issues and we should contact to make better services |
| Japan | |
| Korea, Republic of | |
| Kyrgyzstan | |
| Macao, China | Making the booklets or leaflet to provide a sample to introduce what is the standard procedure for respond the EER warning / exercise. |
| Mongolia | No |
| Myanmar | |
| Pakistan | 1. Why the products are not posted on a special ERA website?<br>2. How local data can be ingested |
| Russian Federation | |
| Saudi Arabia | Support and assist member states in RA II for the provision of products and services, in accordance with their responsibilities, at national level. RSMCs in RA II can play a major role in capacity development of members in RA II. |
| Thailand | 1. To distribute more products to members for utilizing in their works extensively.<br>2.To train members for having understanding of the products appropriately.<br>3.To present the products consistently in both usual and emergency situations.<br>4.ATDM forecast should be longer than 72 hours or above and running the model at least twice a day would be good. |
| Turkmenistan | The National Committee of Hydrometeorology under the Cabinet of Ministers of Turkmenistan does not study and does not monitor the spread of toxic radioactive materials. The function of our Committee include monitoring the weather and weather forecasting.[1] |
| United Arab Emirates | We just would like to thank you and acknowledge your efforts. |
| Uzbekistan, Republic of | Sending information not just through fax and e-mail too. |
| VIET NAM | -Ask the ERA to train our people to get use of the ATDM model<br>-Explore the capacity of setup and running a ATDM model in Viet Nam |

[1] The National Committee of Hydrometeorology under the Cabinet of Ministers of Turkmenistan replied this by an email message, not in the form

**ANNEX I.1.2**

**Survey Report**

**User Request Survey**
**on the Emergency Response Activities (ERA)**
**in Regional Association II (Asia)**

Theme Leader in Emergency Response Activities
/ Expert Group on Operational Forecasting
Under Working Group on Weather Services

## 1. Introduction

Results from the 15th Session of Regional Association II (RA II-15, Doha, 13 – 19 December 2012) included a decision to handle Emergency Response Activities (ERA) as part of work by the Expert Group on Operational Forecasting (EG-OF).

ERA was initiated in 1989 as the Environmental Emergency Response (EER) service launched by the Commission for Basic Systems (CBS) to meet broad interest in the atmospheric dispersion of toxic radiological materials following the Chernobyl Nuclear Power Plant accident in April 1986. The Regional Specialized Meteorological Centres (RSMCs) in Beijing (China), Obninsk (Russian Federation) and Tokyo (Japan) were designated at the 49th session of the WMO executive council in 1997, and began operation on 1 July of the same year. The three RA II RSMCs have committed to their respective contributions in the field.

The first time the International Atomic Energy Agency (IAEA) requested ERA support for an actual event was for the Fukushima Daiichi Nuclear Power Plant accident in March 2011. The three RSMCs in RA II provided Atmospheric Transport, Dispersion, and Deposition Modelling (ATDM) predictions to IAEA and WMO Members within their region of responsibility from March to May 2011. The 16th World Meteorological Congress (Cg-16) in 2011 noted the series of operational services and asked CBS to enhance such products and assistance for National Meteorological and Hydrological Services (NMHSs) [WMO No. 1077; Sixteenth World Meteorological Congress 3.1.3.23].

To enable the provision of better assistance to NMHSs, it is necessary to clarify their needs and how they can apply support from WMO ERA to their domestic services. Against such a background, EG-OF planned a user request survey on ERA in consideration of its usefulness not only to Members within their region but also to those in other Regional Associations, as RA II was only one of the regions that experienced the series of real-time operational services associated with the Fukushima Nuclear Power Plant accident. The 17th World Meteorological Congress (Cg-17) held in May and June 2015 noted the user request survey on ERA in RA II and encouraged Members to actively respond [WMO No.1157; Seventeenth World Meteorological Congress 4.1.46].

Before the user request survey, a concise explanatory material on EER was distributed and a questionnaire survey for non-registered Members was conducted within RA II in October 2014. This work coincided with invitation issuance and checking of contact point information for EER via a letter from the WMO Secretary General sent out on 19 September 2014 [ref. WDS/DPFS-ERA/2014]. One additional member in RA II responded with contact information and joined the

EER service framework. As a result of these consolidation efforts, the number of registered Members for EER in RA II rose to 29 of 35. The user request survey of 2016 incorporated these 29 registered Members.

## 2. Results

### 2.1 Survey results summary

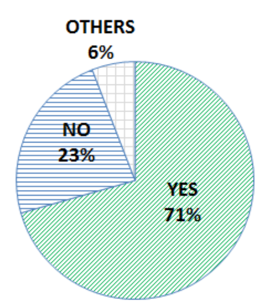
The theme Leader in Emergency Response Activities (TL-ERA; a member of EG-OF) drafted a survey questionnaire and a brief introduction to ERA. The documents were reviewed by experts from the CBS Expert Team on ERA (ET-ERA), those in RA II, EG-OF coordinators, and the chair of the Working Group on Weather Services (WGWS). On 15 June 2016, the Regional Office for Asia and the South-West Pacific (RAP) of the WMO Development and Regional Activities (DRA) department distributed the brief introduction (Appendix I) to all 35 Members of RA II. RAP asked the 29 registered Members to complete the questionnaire (Appendix II) and return it to the designated EG-OF contact point. A total of 17 responses had been received by November 2016 (Appendix III).

The results of each question are summarized in 2.2 below, and brief remarks and comments on the requests along with questions from Members are noted in 2.3.

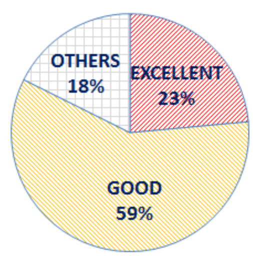
### 2.2 Results

This section presents responses to questionnaire survey. Two Members (Turkmenistan and Japan) did not answer the majority of the questions. When no appropriate answer was given, a response of "Others" was recorded. The item numbers for the questions below (underlined) correspond to those in Appendix II.

2.2.1 User satisfaction




2 a) Does your organization have specific operations using the environmental emergency response (EER) service by RSMCs?



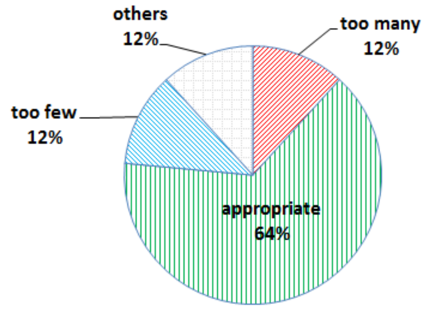

2 b) What is your overall satisfaction rating with regards to the current ERA service?

2 a) Does your organization have specific operations using the environmental emergency response (EER) service by RSMCs?

A total of 12 Members (71%) reported "yes" to this question. Some of such Members planned to use the services in the future, while others indicated specific current usage in their domestic coordination. Four Members (23%) reported not using RSMC products.

2 b) What is your overall satisfaction rating with regards to the current ERA service?

A total of 10 Members (59%) rated the current ERA service as good, and 4 (23%) rated it as excellent. No ratings of fair, not good, or poor were given. Accordingly, the overall level of satisfaction with the current service can be taken as good or higher. It should be noted that negative answers from respondents not specifying any of the options presented are included in *others*.




2 c) What does your organization think regarding the current exercises on the EER service?

2 c) What does your organization think regarding the current exercises on the EER service?

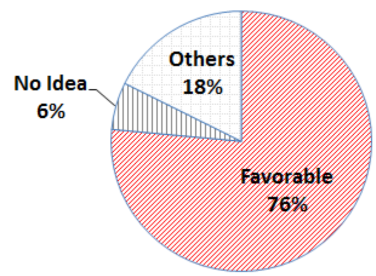
A total of 11 Members (64%) answered that the number was appropriate, 2 (12%) answered that there were too many, and 2 (12%) indicated that there were too few. It should be noted that 3 of the 4 answering too many or too few did not use the EER service in domestic coordination. The data suggest that the majority of current service users believe the current exercise frequency is generally appropriate.

2.2.2 Contents of the Service

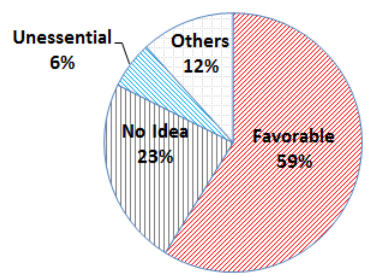
3 a) What does your organization think regarding products listed below?

This question probed interest in and the necessity of products currently evaluated by the ET-ERA. More than half of respondents indicated that such products are useful. The Time of Arrival (ToA) product proved to be the easiest to understand and the most favorable of the three.

More than a third of respondents had no idea on the usage and/or usefulness of Transfer Coefficient Matrix (TCM) analysis with the ATDM model ensemble, which can be attributed to its status as a very new and unfamiliar technique. Some respondents also chose "no idea" for other candidates. Additional information is provided in 2.3.



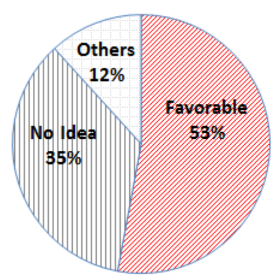

3.a.i) Time of Arrival products




3.a.ii) Fixed legend products

3 b) Does your organization have specific requests on the contents of the EER service?

The question invited specific Member requests regarding the service. Requests and questions from a total of five Members included three-dimensional ATDM results (and various representations thereof) and ensemble ATDM based on ensemble NWP forecasts from individual NWP centres.




3.a.iii) Transfer Coefficient Matrix analysis with the ATDM model ensemble

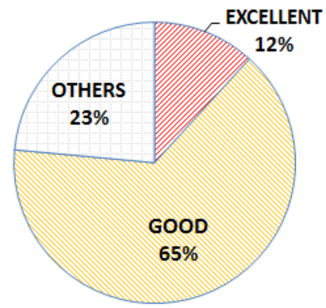
2.2.3 Service Provision Measures

4 a) Does your organization have specific purposes to require continuation of the fax service for EER?

CBS has focused on a gradual migration from facsimile transmission to email and web based services for ATDM prediction. This question probed user preferences regarding service provision measures. A total of 8 Members (47%) reported no longer needing facsimile transmission, while 7 respondents (41%) indicated their necessity of the fax service continuity. The fax service appears to be used as backup for email and web provision. It should be noted that some Members rely exclusively on facsimile transmission based on the results of email and fax transmission tests conducted by the three RSMCs.

4 b) What is your overall satisfaction rating with regards to the service through RSMCs' common web pages?

A total of 11 Members (65%) responded that the service through the common – mirrored web pages is good, with 2 (12%) giving a rating of "excellent." Overall satisfaction with the current web service appeared high. It should be noted that one of the respondents opted for two alternative options, and was included in the *Others* category.



4 b) What is your overall satisfaction rating with regards to the service through RSMCs' common web pages?

2.2.4 Requests/Questions Regarding Activities

This open question inviting requests and queries from Members drew a number of responses as outlined in 2.3 below.

**2.3 Commentary on and Responses to User Questions**

As some respondents chose "no idea (need more explanation)" in response to questions from 3 a i) to 3 a iii), additional information on ToA, fixed legend products, and TCM with the ATDM model ensemble are included. Comments and remarks on the user questions are following.

2.3.1 Time of Arrival (ToA)

Current products for EER consist of (Appendix II-7 of WMO 2010):

1. Three-dimensional trajectories starting at 500, 1500 and 3000 m above the ground, with particle locations at six-hour intervals (main synoptic hours up to the end of the dispersion model forecast);
2. Time-integrated airborne concentrations within the layer 500 m above the ground, in Bq s $m^{-3}$ for each of the three forecast periods;
3. Total deposition (wet + dry) in Bq $m^{-2}$ from the release time to the end of the three forecast periods.

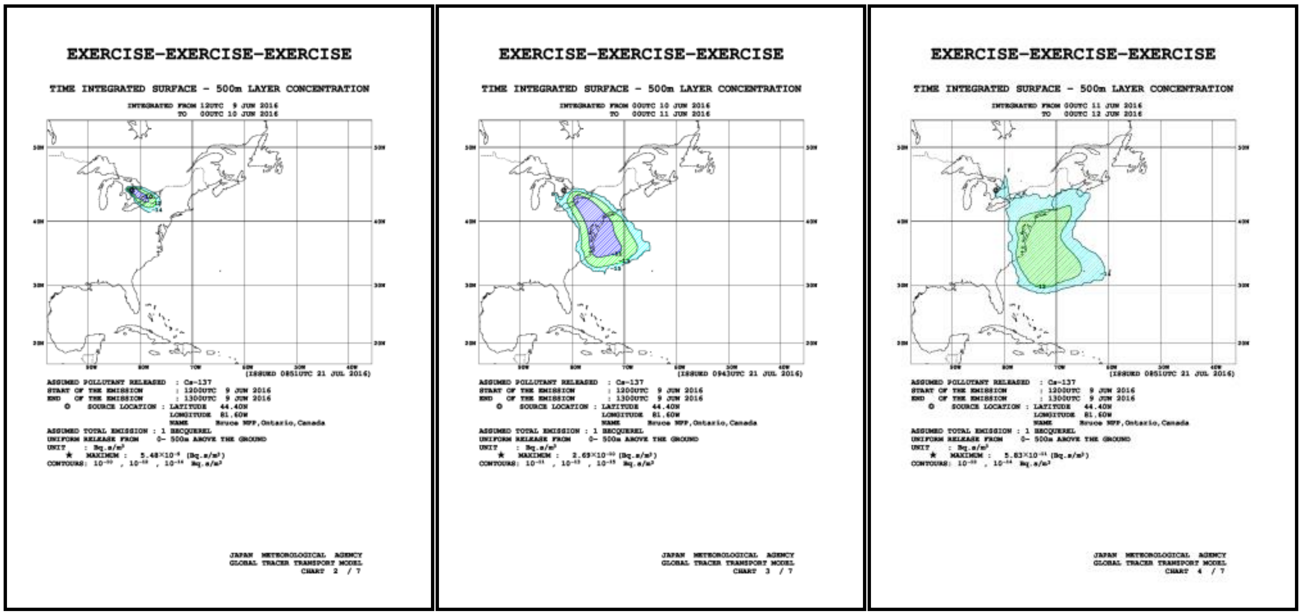
ToA presents a different perspective, and is designed to predict the earliest arrival time of a specific air concentration. Details of the product are as yet undecided (e.g., whether concentration should be instantaneous or time-integrated concentration). Presentation of six-hour colored hatched arrival time areas on 24 hourly charts is currently planned as shown in 3 a) of Appendix I.

2.3.2 Fixed legend products

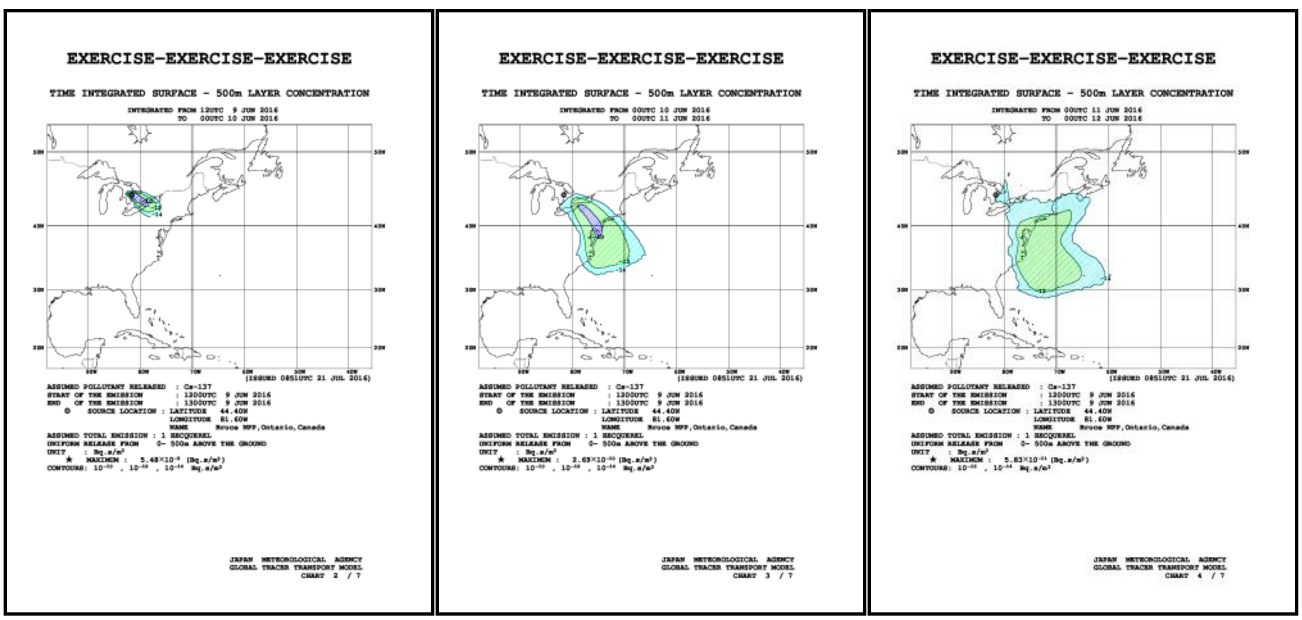
Appendix II-7 of WMO (2010) describes:

"(ii) Contour values may change from chart to chart".

Accordingly, contour values for time-integrated airborne concentrations and total depositions may differ among individual forecast periods (up to 24, 48, and 72 hours from the NWP forecast initial time). By way of example, RSMCs may present airborne concentrations using different contour values from chart to chart (as seen in the upper panels below) in accordance with WMO standards (2010). Users may misinterpret inter-map changes in contouring as sudden spreading of radioactive cloud (as seen in the upper-middle chart) following rapid dilution up to 72 hours from the NWP initial time. The adoption of corresponding contour values facilitates intuitive




Time-integrated airborne concentrations up to 24 hours (left), up to 48 hours (middle), and up to 72 hours (right) after the NWP initial time. The contours indicated are $10^{-10}$, $10^{-12}$, $10^{-14}$ Bq s/m$^3$ for the left and right panels, but $10^{-11}$, $10^{-13}$, and $10^{-15}$ Bq s/m$^3$ for the middle one.




The same figures but the all panels use the same contour values of $10^{-10}$, $10^{-12,}$, and $10^{-14}$ Bq s/m$^3$

understanding of charts, as seen in the lower panels.

2.3.3 Transfer Coefficient Matrix (TCM) analysis with the ATDM model ensemble

In the early stages of accidental toxic material release, exact amount and release time are usually unknown. However, the accuracy of such information has a dominant impact on the results of ATDM forecasts. When the results of related isotope monitoring become available, ATDMs can be useful in the estimation and quantification of data on release at the source. One such technique, known as TCM (transfer coefficient matrix) evaluation, was developed by Draxler and Rolph (2012).

ATDM forecasts are also influenced by NWP forecast quality and modeling techniques in ATDMs. The results of estimation regarding release times and amounts are also significantly dependent on these variables (WMO 2013). Accordingly, evaluation of the impacts and influence of different NWPs and ATDMs on transport and dispersion modeling results is important. ET-ERA plans to conduct an experiment on TCM analysis with an ATDM model ensemble in the near future.

2.3.4 Responses to user requests and questions

"Making the booklets or leaflet to provide a sample to introduce what is the standard procedure for respond the EER warning / exercise." (Macao, China)

Concise examples are presented in a leaflet titled "The Environmental Emergency Response for WMO Members in Regional Association II (Asia)" distributed to RA II Members by RAP in October 2014.

Related information is available in WMO Technical Document 778 (TD778) titled "Documentation on RSMC Support for Environmental Emergency Response" at http://www.wmo.int/pages/prog/www/DPFSERA/td778.html.

"ATDM forecast should be longer than 72 hours or above and running the model at least twice a day would be good." (Thailand)

Longer ATDM forecasts have been discussed by ET-ERA and its predecessors. However, the accuracy of NWPs used for ATDMs decreases with longer forecast times.

As for the frequency of the service, there was a description regarding a 12-hourly update of ATMD forecasts in TD778, but this was withdrawn in March 2011 in line with a suggestion by WMO DPFS.

"If the new Transfer Matrix Coefficient analysis products are provided in future, could WMO provide the product standards and the TCM coefficient and programs?" (China)

The TCM system is being evaluated by ET-ERA (including product standards). An example of how a web-based TCM system may look is provided on the NOAA Air Resource Laboratory (ARL) website at https://ready.arl.noaa.gov/READY_fdnpp.php.

We have no idea regarding if ARL can make available their programs for others.

"How local data can be ingested" (Pakistan)

There is currently no formal procedure for the adoption of local monitoring data. Application to post analysis (as per TCM) may be implemented in the future.

"We would like to propose to increase EER exercises in RA II at biannual basis." (Saudi Arabia)

RA II RSMCs participate in one of the WMO quarterly EER exercises (conducted in February, May, August and November) in each year. As IAEA did not ask the RSMCs to distribute ATDM charts to Members during the exercises (i.e., the quarterly test in May and Convex-2d in October 2016), no ATDM forecast distribution was seen in RA II for this year.

"Support and assist member states in RA II for the provision of products and services, in accordance with their responsibilities, at national level. RSMCs in RA II can play a major role in capacity development of members in RA II." (Saudi Arabia)

This was recognized at the 15th session of CBS [4.4.37, WMO 2012]. The issue was also discussed at the ET-ERA meeting in 2013, resulting in the note, "Face-to-face training workshops require significant human and budgetary resources, and that may not reach a large audience, the meeting agreed that elearning modules and webbased courses may be more appropriate." Web-based materials are currently available as per Technical Document 778 at http://www.wmo.int/pages/prog/www/DPFSERA/td778.html

### 3. Concluding Remarks on the Survey

EG-OF sincerely appreciates the Member responses. This survey was the first attempt, and the results have helped to clarify matters regarding user satisfaction, impressions of service content and opinions on related provision measures as well as associated requests and questions. The positive evaluation provided by the majority of respondents is truly encouraging, and the suggestions/opinions on current and potential future activities are very much appreciated.

The results can be summarized as follows:

- ✓ Most respondents indicated a need for ERA products for their activities, and reported relatively high levels of satisfaction with the current service.
- ✓ User impressions of ET-ERA's candidate products were relatively positive.
- ✓ Nearly half of all respondents requested ongoing fax service. Impressions of the current web service were relatively good.

Opinions and suggestions from Members will be conveyed to the relevant entities of WMO. Such feedback is invited to support the improvement of future WMO ERA activities.

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**ANNEX I.1.3**

**Report by the Theme Leader in Emergency Response Activities for 2016**

Masami SAKAMOTO, Japan Meteorological Agency

**Executive Summary**

A user request survey on the Emergency Response Activities (ERA) in the Regional Association II (RA II) was conducted, and the results were reported to the coordinators of Expert Group on Operational Forecasting (EG-OF) by Theme Leader in Emergency Response Activities (TL-ERA).

The Regional Specialised Meteorological Centres in the region (RSMCs Beijing, Obninsk, and Tokyo) have continued their efforts to maintain contact information for the registered members for the Environmental Emergency Response (EER).

## 1. Background

This report summarizes the activities in 2016 by the Theme Leader in Emergency Response Activities (TL-ERA), who is responsible for the Emergency Response Activities (ERA) in the Regional Association II (RA II: Asia) as a member of the Expert Group on Operational Forecasting (EG-OF). The main objectives of the activities by TL-ERA are;

1) monitoring of the provision of products and services by the designated global data-processing and forecasting system (GDPFS) centres within the framework of ERA,

2) advising on evolving requirements for ERA operational systems and services.

## 2. A User Request Survey on ERA

According to the action plan of EG-OF, TL-ERA drafted a survey questionnaire and a brief introductive material regarding ERA. The documents were reviewed by experts in CBS Expert Team on ERA (ET-ERA) and relevant experts in RA II (Mr. W. M. Ma of Hong Kong Observatory and Dr. S. Kim of NIMR/KMA). The coordinators of EG-OF and the chair of the Working Group on Weather Services (WGWS) also reviewed and gave advices on them.

On 15 June 2016, the Regional Office for Asia and the South-West Pacific (RAP) in the WMO Development and Regional Activities (DRA) department distributed the brief introduction to all 35 Members in RA II. RAP asked 29 registered Members to fill in the questionnaire form, and to send it back to TL-ERA. For Members who did not reply by the initial deadline of the first day of July, TL-ERA asked the contact points of the Members for the Environmental Emergency Response (EER) service to respond to the survey. 17 out of 29 registered Members have responded by November.

The report of the survey was drafted by TL-ERA, and then the documents were reviewed by the exports of ET-ERA and RA II. The report was submitted to the coordinators of EG-OF in November. It should be noted that the seventeenth World Meteorological Congress (Cg-17) in 2015 noted this user request survey in RA II, and encouraged Members to actively respond [WMO No.1157 4.1.46].

## 3. Email / Fax Tests

RSMCs in RA II continue the effort to confirm the email and fax communication for EER service since 2010. As a result of the efforts by RSMCs Beijing, Obninsk, and Tokyo, the reachability to the registered NMHSs in RA-II is 100%, and more than 85% of the registered members specify their operational contact points appropriately. To maintain such a good connectivity, RSMCs are encouraged to continue their efforts.

The current (as of 24 November 2016) statuses of the members are;

i. Registered and reachable members (29 members)

i.a) with the operational contact point information specified (25 members):

Bahrain, Bangladesh, China, Hong Kong, India, Islamic Rep. of Iran, Japan, Kazakhstan, Kyrgyzstan, Macau, Mongolia, Myanmar, Oman, Pakistan, Rep. of Korea, Rep. of Uzbekistan, Rep. of Yemen, Russian Federation, Saudi Arabia, Sri Lanka, State of Kuwait, Tajikistan, Turkmenistan, Thailand, United Arab Emirates,

i.b) without the operational contact point information specified (4 members):

Iraq, State of Qatar, Socialist Rep. of Viet Nam, Democratic People's Rep. of Korea

ii. Registered but not reachable member (zero member):

iii. Non-registered members (6 members):

Afghanistan, Bhutan, Cambodia, Lao, Maldives, Nepal.

## 4. Other Business

A quarterly test of the Environmental Emergency Response (EER) for RA II was conducted on 17 May, but the Incident Emergency Centre (IEC) of the International Atomic Energy Agency (IAEA) made a private request, which asked RSMCs to provide services only to the requestor. The message of the Early Notification of a Nuclear Accident (EMERCON / WNXX01 IAEA) was delivered thought the Global Telecommunication System (GTS) at the exercise.

An international exercise ConvEx-2d was conducted by IAEA on 5 October. IAEA sent no message to WMO, while the manual of IAEA [EPR-IEComm 2012] describes the participation of WMO to the exercise as is shown below,

"This exercise is conducted once every four years on a specified announced date and lasts no more than 8 hours (elapsed time). In advance of this exercise, the IEC invites all Contact Points to participate. This exercise is conducted jointly with the WMO and is expected to involve national meteorological services."

**ANNEX II**

# Report of the RA II Working Group on Climate Services (WGCS)

**Akihiko Shimpo, Japan Meteorological Agency**

**Chairperson of the RA II Working Group on Climate Services**

**-----**

**Ghulam Rasul, Ryuji Yamada and Akihiko Shimpo**
**Co-coordinators, Expert Group on Climate Services**

**Nabansu Chattopadhyay and Alexander Kleschenko**
**Co-coordinators, Expert Group on Agrometeorology**

**-----**

# Report of the RA II Working Group on Climate Services (WGCS)

## 1 Introduction

The WMO RA II Working Group on Climate Services (WGCS) was established considering that the Regional Association II (RA II) should continue to play an important and active role in the implementation of WMO regional activities in the field of climate services including agrometeorological services, with particular attention to matters relevant to implementation of the Global Framework for Climate Services in the Region. WGCS will work on climate and agrometeorological issues laid out in the terms of references in close cooperation with WMO's Technical Commissions, in particular, the Commission for Climatology (CCl) and the Commission for Agrometeorology (CAgM).

## 2 Working Group Structure

The Working Group is composed of Expert Groups for Climate Services (EG-CS) and Expert Group for Agrometeorology (EG-AgM). Both EG-CS and EG-AgM consist of two co-coordinators and five theme leaders. In addition, a number of volunteer experts who are expected to assist the tasks of each Expert Team have also been registered.

## 3 Terms of Reference

(a) To provide assistance and advice to the president of Regional Association II on all matters pertaining to the regional aspects of the relevant components of the World Climate Programme and the Agricultural Meteorology Programme and, in particular, to assist and advise the president of RA II on matters relevant to implementation of the Global Framework for Climate Services in the Region;

(b) To cooperate with the Commission for Climatology and the Commission for Agricultural Meteorology and other WMO bodies on activities related to climate services;

(c) To undertake and to coordinate activities relating to climate services as listed in the EG-CS and EG-AgM, respectively;

(d) To report, through the chair of the WGCS, to the president of RA II on an annual basis on activities relative to the above terms of reference.

## 4 Membership of Working Group

### Expert Group on Climate Services (EG-CS)

| EG-CS | Name | Country |
|---|---|---|
| Co-Coordinators | (~2014) Mr Ryuji Yamada<br>(2015~) Mr Akihiko Shimpo | Japan |
| | Dr Ghulam Rasul | Pakistan |
| Theme Leader in User Liaison and Applications of Climate Information and Products for Climate Risk Management and Adaptation to Climate Change | Dr Ali Karem Kadhum | Iraq |
| Theme Leader in QMS Implementation and Operation of Regional Climate Centres | Mr Peiqun Zhang | China |
| Theme Leader in Operational Regional and National Climate Outlook Forums | Dr A. K. Srivastava | India |
| Theme Leader in Climate Monitoring and Climate Watch | Ms Yuliya Plotnitskaya | Uzbekistan |
| Theme Leader in Climate Research for Development | Ms Yuping Yan | China |

### Expert Group on Agrometeorology (EG-AgM)

| EG-AgM | Name | Country |
|---|---|---|
| Co-Coordinators | Dr N. Chattopadhyay | India |
| | Dr Alexander Kleshchenko | Russian Federation |
| Theme Leader in Agrometeorological Training Needs | Ms Feruza Rakhmanova | Uzbekistan |
| Theme Leader in Soil Moisture Monitoring | Ms Xuefen Zhang | China |
| Theme Leader in Drought Preparedness and Management Strategies | Mr Mir Hazrat | Pakistan |
| Theme Leader in Seasonal Climate Forecast Applications for Agriculture | Mr Liuxi Mao | China |
| Theme Leader in Socio-economic Impact of Agrometeorological Information | Mr Kamalesh Kumar Singh | India |

## 5 Development of Work Plan

A work plan for the WG-CS was developed by co-coordinators of Expert Group on Climate Services and Expert Group on Agrometeorology, with the help of theme leaders and the WMO secretariat. The work plans for the WG-CS were submitted to the WMO Secretariat in December 2013 for 2013-2016 and August 2016 for 2016-2017.

The work plans were developed mainly based on the deliverables outlined in the RA II Strategic Operating Plan, terms of reference of the Expert Groups. The plan consists of: (1) Tasks; (2) Key deliverables; (3) Activities; (4) Timelines and (5) Responsible Theme Leaders/Co-coordinators.

Tasks for EG-CS and EG-AgM were established in the work plans and each task includes several relevant activities. Theme leaders of EG-CS and EG-AgM are expected to take a role in the said activities with the support of, and coordination with, co-coordinators.

## 6 Expert Group on Climate Services

A report of activities on EG-CS is available in ANNEX II.1. Its contents are following.

(i) Implementation and development of Regional Climate Centers (RCCs)

(ii) Progress in the implementation of Regional Climate Outlook Forums (RCOFs)

(iii) User interface for climate services

(iv) Pilot Project on Information Sharing on Climate Services

(v) Capacity development activities for climate services

(vi) Commission for Climatology (CCl) and RA II activity

## 7 Expert Group on Agrometeorology

A report of activities on EG-AgM is available in ANNEX II.2. Its contents are following.

(i) Introduction

(ii) Operational Agromet Advisory Services

(iii) Agromet products under Agromet Services

(iv) Capacity Building Programs

(v) Agrometorology under Global Framework for Climate Services (GFCS)

(vi) Drought Preparedness and Management Strategies

(vii) Economic Impact of Agromet Advisory Services

**ANNEX II.1**

## Report of the RA II Expert Group on Climate Services (EG-CS)

### 1 Implementation and development of Regional Climate Centers (RCCs)

Three WMO Regional Climate Centers (RCCs) have been operating in RA II. The Beijing Climate Center (BCC) of the China Meteorological Administration (CMA) and the Tokyo Climate Center (TCC) of the Japan Meteorological Agency (JMA) were formally designated as WMO RCCs in RA II in 2009, and the North Eurasia Climate Centre (NEACC) coordinated by ROSHYDROMET, Russian Federation was also formally designated as WMO RCC in RA II in 2013. These RCCs have conducted a variety of RCC-related activities, including the dissemination of climate data/products and the organization of training workshops for capacity development in accordance with RCC mandatory functions. A portal site regarding RCCs in RA II is available (http://www.rccra2.org/).

To be a new RCC in RA II, the National Climate Centre of India Meteorological Department (IMD), Pune, began a demonstration phase as a candidate RCC in May 2013. After the success of its demonstration phase, IMD Pune was recommended to the formal designation as a new RCC in RA II, namely RCC Pune, at the sixteenth session of the Commission for Basic Systems (CBS) held in November 2016. Based on this recommendation by CBS, IMD Pune is expected to be formally designated and to start its operational activity as an RCC in 2017. It is noted that the experts of EG-CS reviewed the activities conducted by IMD Pune during its demonstration phase and supported the President of RA II for the designation process of RCC.

It is noted that Iran and Saudi Arabia have expressed interest in hosting WMO RCCs.

### 2 Progress in the implementation of Regional Climate Outlook Forums (RCOFs)

In RA II, Regional Climate Outlook Forums (RCOFs) are convened regularly. These include:

- the Regional Climate Monitoring, Assessment and Prediction for Regional Association II (FOCRA II) coordinated by China since 2005,
- the South Asian Climate Outlook Forum (SASCOF) coordinated by India since 2010,
- the North Eurasian Climate Outlook Forum (NEACOF) coordinated by NEACC since 2011,
- the East Asia winter Climate Outlook Forum (EASCOF) coordinated by Japan, Mongolia and Republic of Korea since 2013, and
- ASEAN Climate Outlook Forum (ASEANCOF; including some RA V Members) since 2013.

RCOFs in RA II held between 2014 and 2016 are listed in Annex II.1.1. RCOF is mainly conducted to produce a consensus statement on seasonal forecast for each targeted region. In addition to this purpose, it is emphasized that RCOF is a good opportunity for experts from RA II Members to communicate each other and exchange their knowledge and experiences for climate services.

### 3 User interface for climate services

There is a recognized need to encourage the exchange of good practices and the sharing of experiences in the application of climate information among NMHSs and to strengthen user-provider interaction. Some RCOFs including FOCRAII and SASCOF have provided such opportunities by inviting experts from user sectors, such as agriculture and health, to the meeting and by listening to their needs for climate information.

## 4 Pilot Project on Information Sharing on Climate Services

For the successful implementation of GFCS, it is important to share good practices and lessons learned, including experienced project management capabilities, to develop projects and improve climate services by NMHSs as well as to avoid duplication and minimize the risk of failure. The WMO RA II's fifteenth session decided to establish a pilot project on information sharing on climate services. The project aims at sharing information on climate services and best practices of climate information among NMHSs in the region for the successful implementation of GFCS. TCC has been designated as Lead for the project to establish and maintain a dedicated website.

TCC has operated the dedicated website launched in March 2014 (http://ds.data.jma.go.jp/tcc/pilot/) and carried out the second questionnaire survey in August 2015, aiming to update on the website and to enhance the information about the concrete examples or good practices of the utilization of climate information. The updated information is available on the website since December 2015.

## 5 Capacity development activities for climate services

A number of capacity development activities, such as training events and expert visits have been conducted in the region organized by WMO Regional Training Centres, RCCs (BCC, NEACC and TCC) and some NMHSs. Such events have also been held in conjunction with RCOFs including FOCRAII, SASCOF and NEACOF. Many of these events have been conducted on a practical basis so that trainees could apply what they learnt to their operational climate services soon after returning to home countries.

Capacity development activities (training events) conducted between 2014 and 2016 are listed in Annex II.1.2.

In addition to the activities listed in Annex II.1.2, it is noted that the Regional Consultation meeting on climate services in the North-Eurasian countries was held in Sochi, Russian Federation on 19-20 October 2015. This regional consultation meeting aimed to integrate efforts of experts from NMHSs in the region with users of climate information from the priority areas of the GFCS for the purpose defining priorities for more effective production and use of global, regional and national climate and forecasting information by all interested parties in climate-sensitive sectors in all North-Eurasian countries. It resulted in: (i) enhanced understanding of the needs for climate services in different user sectors; (ii) clear understanding of capacity development needs to implement the GFCS at regional and national levels; (iii) strategic guidance on institutional arrangements, partnerships and processes required to operationalize the GFCS at the regional and national level.

## 6 Commission for Climatology (CCl) and RA II activity

The Management Group of the WMO Commission for Climatology (CCl-MG) invited the representatives of the working group on climate or climate issues in RAs to the second meeting (October 2015) and the third meeting (September 2016) of the CCl-MG, so that the Chair of WGCS in RA II participated in the meeting. At the meetings, it is recognized that sharing information among CCl and the working groups on climate or climate issues in RAs are important to enhance activities at the regional level.

**ANNEX II.1.1**

## Regional Climate Outlook Forums (RCOFs) in RA II between 2014 and 2016

<2014>

| Name | Dates | Venue | Participants |
|---|---|---|---|
| SASCOF-5 | 22-23 April | Pune, India | Experts of NHMSs from 8 South Asian countries and international experts |
| FOCRAII-10 | 23-25 April | Beijing, China | More than 80 experts from 19 WMO Members including 12 RA II Members (China, DPRK, Hong Kong, Japan, Korea, Macao, Laos, Maldives, Mongolia, Pakistan, Russia, Thailand, Yemen) |
| NEACOF-6 | End of May | (via Internet) | Experts of NHMSs from CIS countries |
| ASEANCOF-2 | 29 May | (via Internet) | Experts of NHMS from ASEAN countries and international experts |
| EASCOF-2 | 29-31 October | Tokyo, Japan | More than 30 experts from China, Japan, Republic of Korea and Mongolia |
| ASEANCOF-3 | 17-19 November | Singapore | Experts of NHMS from ASEAN countries and international experts |

<2015>

| Name | Dates | Venue | Participants |
|---|---|---|---|
| SASCOF-6 | 21-22, April | Dhaka, Bangladesh | Experts of NMHSs from South Asian countries and international experts |
| FOCRAII-11 | 11-13, May | Beijing, China | More than 90 experts from 20 WMO Members including 14 RA II Members (China; DPR of Korea; Hong Kong, China; Japan; Kazakhstan; Lao PDR; Macao China; Maldives; Mauritius; Mongolia; Pakistan; Republic of Korea; Russian Federation; Thailand) |
| ASEANCOF-4 | 21-22, May | Jakarta, Indonesia | Experts of NMHS from ASEAN countries and international experts |
| SASCOF-7 (WinSASCOF) | 14-16, October | Chennai, India | Experts of NMHSs from South Asian countries and international experts |
| EASCOF-3 | 3-5, November | Seoul, Republic of Korea | More than 50 experts from China, Japan, Mongolia and Republic of Korea |
| NEACOF-9 | 10-12, November | Moscow, Russian Federation | 45 experts from 9 NMHSs of CIS countries (Armenia; Azerbaijan; Belarus; Kazakhstan; Kyrgyzstan; Moldova; Russian Federation; Tajikistan; Uzbekistan) |
| ASEANCOF-5 | 18-19, November | Singapore | Experts of NMHS from ASEAN countries and international experts |

<2016>

| Name | Dates | Venue | Participants |
|---|---|---|---|
| FOCRAII-12 | 7-9, April | Guangzhou, China | Experts of NMHS in RA II Members and international experts |
| SASCOF-8 | 25-26, April | Colombo, Sri Lanka | Experts of NMHS from South Asian countries and international experts |
| NEACOF-10 | May | (via internet) | Experts of NMHS from CIS countries |
| ASEANCOF-6 | May | (via internet) | Experts of NMHS from ASEAN countries and |

| | | | |
|---|---|---|---|
| | | | international experts |
| SASCOF-9 | 27-28, September | Nay Pyi Taw, Myanmar. | Experts of NMHS from South Asian countries and international experts |
| EASCOF-4 | 8-9, November | Ulaanbaatar, Mongolia | Experts from China, Japan, Mongolia and Republic of Korea |
| ASEANCOF-7 | 17-18, November | Manila, Philippines | Experts of NMHS from ASEAN countries and international experts |

(Reference)
ASEANCOF: http://asmc.asean.org/asmc_asean_cof_about/
EASCOF: http://ds.data.jma.go.jp/tcc/tcc/library/EASCOF/
FOCRAII: http://bcc.cma.gov.cn/channel.php?channelId=70
NEACOF: http://neacc.meteoinfo.ru/neacc/north-eurasian-climate-outlook-forum/
SASCOF: http://www.imdpune.gov.in/Clim_RCC_LRF/Events.html

**ANNEX II.1.2**

**Capacity development activities (training events) conducted in RA II between 2014 and 2016**

(2014)

| Events/Activities | Dates | Venue | Organ-izer | Participants |
|---|---|---|---|---|
| Capacity Building Training Workshop on Seasonal Prediction (followed by SASCOF-5) | 14-21 April | Pune, India | IMD | Experts of NHMSs from 8 South Asian countries (Afghanistan, Bangladesh, Bhutan, Maldives, Myanmar, Nepal, India and Sri Lanka) and international experts |
| International Training Course on Short-term Climate Prediction Methods (followed by FOCRAII) | 14-25 April | Beijing, China | RTC Beijing | 18 experts of 14 NMHSs including those from 9 Members in RA II (DPRK, Hong Kong, Laos, Maldives, Mongolia, Pakistan, Russia, Thailand and Yemen) |
| Training for Central Asian NMHS specialists in area of Long-range forecasting | 26-30 May | Almaty, Kazakhstan | NEACC | 9 experts from NHMS of Central Asia countries |
| Expert visit on the generation of guidance for seasonal forecasts using the statistical downscaling technique | 24-26 June | Nay Pyi Taw, Myanmar | TCC | 15 experts of the Department of Meteorology and Hydrology |
| Eleventh International Seminar on Climate System and Climate Change | 14-25 July | Beijing, China | BCC | More than 100 experts from 14 WMO Members including 5 RA II Members (Kazakhstan, Pakistan, Myanmar, Mongolia, Hong Kong) |
| International Training Course on Climate Monitoring, Prediction and Application | 20-31 Oct. | Beijing, China | RTC Beijing | 16 experts of 10 WMO Members including 6 RA II Members (Republic of Korea, Hong Kong, Myanmar, DPRK, Oman, Pakistan) |
| Training Seminar for NMHS specialists from Tajikistan | 5-7 Nov. | Moscow, Russia | NEACC | Two experts from NHMS of Tajikistan |

(2015)

| Events/Activities | Dates | Venue | Organ-izer | Participants |
|---|---|---|---|---|
| TCC Training Seminar on Global Warming Projection Information | 26-30, January | Tokyo, Japan | TCC | 13 experts from NMHSs of Asia-Pacific region |
| Expert visit on the generation of global warming prediction information | 25-27, March | Bangkok, Thailand | TCC | 12 experts of the Thai Meteorological Department |
| Capacity Building Training Workshop on | 19-20, April | Dhaka, Bangladesh | IMD | Experts of NHMSs from South Asian countries |

| | | | | |
|---|---|---|---|---|
| Seasonal Prediction (followed by SASCOF-6) | | | | |
| International Training Course on Short-term Climate Prediction Methods (followed by FOCRAII-11) | 14-22, May | Beijing, China | RTC Beijing | 25 experts of 18 NMHSs including those from 9 Members in RA II (DPR of Korea; Hong Kong, China; Lao PDR; Macao, China; Maldives; Mauritius; Mongolia; Pakistan; Thailand) |
| Expert visit on the generation of global warming prediction information | 23-26, June | Sri Lanka, Colombo | TCC | 12 experts of the Department of Meteorology of Sri Lanka |
| Twelfth International Seminar on Climate System and Climate Change | 20-31, July | Lanzhou, China | BCC | More than 100 experts from 10 WMO Members including 5 RA II Members (Kyrgystan; Mauritius; Myanmar; Pakistan; Thailand) |
| TCC Training Seminar on One-month Forecast | 16-20, November | Tokyo, Japan | TCC | 15 experts from NMHSs of Asia-Pacific region |

(2016)

| Events/Activities | Dates | Venue | Organ-izer | Participants |
|---|---|---|---|---|
| Expert visit on One-month Forecast | 5-7, April | Hanoi, Viet Nam | TCC | 18 experts of the National Center for Hydro-Meteorological Forecasting of Viet Nam |
| The Climate service training course | 5-15, April | Beijing, China | BCC | 29 participants from 10 WMO members including 2 RAII members (Thailand and the kingdom of Bhutan) |
| Thirteenth International Seminar on Climate System and Climate Change | 11-22, July | Chengdu, China | BCC | 165 participants from 12 WMO members including 4 RA II members (Pakistan, Thailand, Myanmar, Mauritius) |
| Expert visit on One-month Forecast | 2-4, August | Phnom Penh, Cambodia | TCC | 10 experts of the Department of Meteorology of Cambodia |
| TCC Training Seminar on Primary Modes of Global Climate Variability and Regional Climate | 14-18, November | Tokyo, Japan | TCC | 14 experts from NMHSs of Asia-Pacific region |

**ANNEX II.2**

## Report of the RA II Expert Group on Agrometeorology (EG-AgM)

### TABLE OF CONTENTS

## Introduction

Increased frequency of climate extremes is another face of climate change confronted by humans, resulting in catastrophic losses in agriculture. While climate extremes take place on many scales, impacts are experienced locally and mitigation tools are a function of local conditions. To address this, agrometeorological advisories along with early warning systems must be place and location based, incorporating the climate, crop and land attributes at the appropriate scale. Existing services in RA II region often lack site-specific information on adverse weather and countermeasures relevant to farming activities. Warnings on chronic long term effects of adverse weather or combined effects of two or more weather elements are seldom provided, either. At present in RA-II countries agrometeorological activities are conducted within the Ministry of Agriculture or jointly by the Ministry of Agriculture and the meteorological organizations. The Republic of Kazakhstan is the first country in RA II that initiated agrometeorological operations in 1922. Later on, India, China and Viet Nam joined this area of activity in 1945, 1953 and 1960, respectively. Bangladesh was the last country to begin agrometeorological operations in 1986. The Operational Agrometeorological Services in RA-II region have been divided into different categories like status of issuance of Agromet Bulletins, Agromet Products, Climate Services, Capacity building and Economic Analysis etc. Numbers of on-going and new activities in recent past are summarized below.

## Operational Agromet Advisory Services

Agromet bulletins are prepared in different forms in various countries because of independent observational methods. Out of 34 Member counties in RA II, 14 countries (Bangladesh, Qatar, Japan, Nepal, Viet Nam, South Korea, Uzbekistan, Kazakhstan, Mongolia, India, Thailand, China, Laos, and Iran) informed that they were furnished with an agrometeorological service, which issued agrometeorological bulletins. Such activities in the 11 counties were conducted within their National Meteorological Services (NMSs). In Qatar, agrometeorological activities are conducted within the Ministry of Agriculture. In Japan and Viet Nam, such operations are managed jointly by the Ministry of Agriculture and the Meteorological Organization. In Uzbekistan, Cambodia, weekly bulletins are provided during the cultivating period to identify the best time for crop management. In Nepal, weekly bulletins just represent climate information. In Iran, weekly, monthly and seasonal bulletins include climate as well as soil and canopy information. Ten-day bulletins are regularly prepared in all countries except Qatar, Nepal, Thailand, India and Laos, and include different types of information. In Bangladesh, Srilanka, Thailand, Malaysia, and Japan only climate information is provided, while in the other countries, including Bahrain, Viet Nam, South Russia, Korea, Uzbekistan, Kazakhstan, Iran, China and Mongolia climate, soil and canopy parameters are observed and included in 10-day bulletins. In Mongolia, in addition to the above mentioned types of information, pasture and animal husbandry related matters are also contained in 10-day bulletins.

In Bangladesh, Qatar, Japan, Kazakhstan, Thailand and Laos no monthly bulletins are prepared, while in other countries monthly bulletins with information on soil, climate and canopy are given to users. In addition to weekly, 10-day , fortnightly bulletins and monthly bulletins, other kinds of publications, such as seasonal bulletins are prepared for each product based on observed climate, soil and canopy parameters in Bangladesh, Viet Nam, Uzbekistan Pakistan and Iran. In particular, in Viet Nam special reports are prepared for climate related impacts on vegetation, forest, farming and other agricultural sectors.

The agrometeorological weather forecast is one of the most important items focused on in these bulletins. In this context, short- and long-term forecasts bear particular importance in each bulletin, and users widely apply their information. All the countries in the region have agrometeorological databanks, including phenological observations for different cultivated plants, and data for soil and climate Data quality controls based on standards are regularly accomplished.

In most countries of the region, news and information are broadcasted through the mass media in critical situations, particularly to farmers. In India Hon'ble Union Minister of Agriculture launched the Nowcast-Extreme Weather Alert Services to farmers on 18$^{th}$ June, 2015 for providing localised Extreme Weather Warnings to more than 1 core farmers registered on mKisan portal of Ministry of Agriculture. These Nowcast alerts are based on DWR data and are issued few hours before the event to alert the farming community about the occurrence of the adverse weather.

On the picture 1 data is presented obtained from International Bank of Reconstruction and Development – it shows the distribution of losses due weather among sectors of Russian economy. You see that agriculture is on the first place. Therefore, Russia pays great attention to the agrometeorological service of agriculture at various levels.

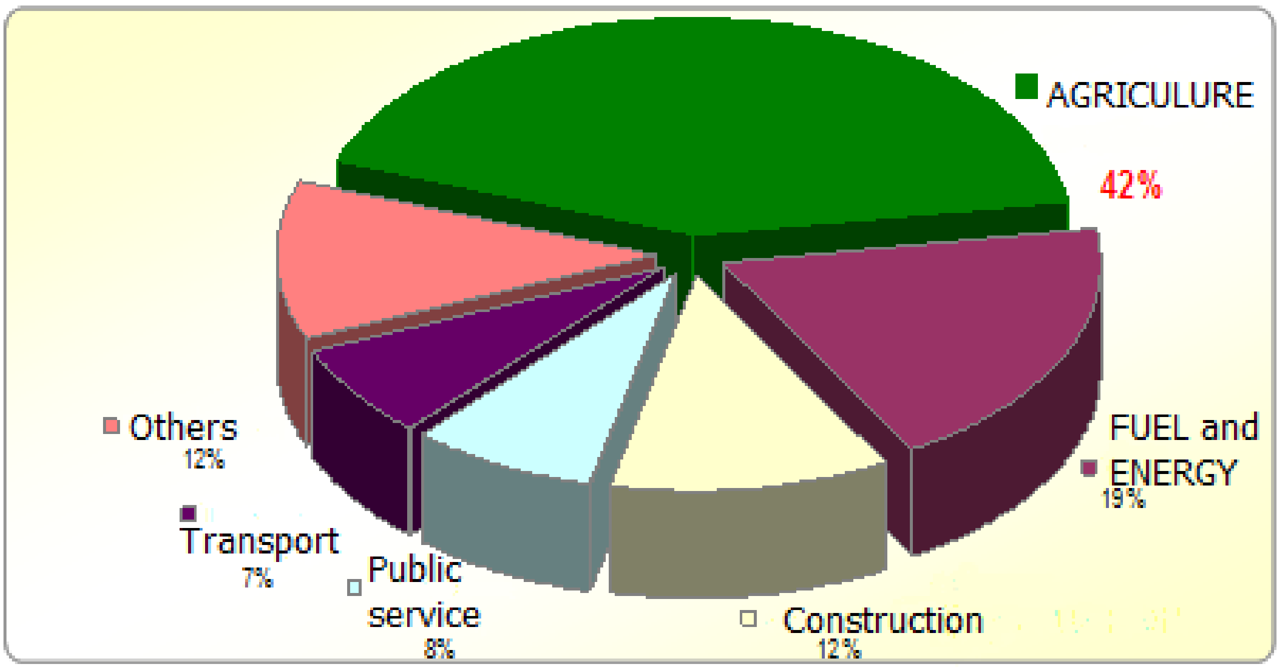


**Figure 1 - Distribution of losses from weather**

On the picture 2 shows the scheme of agro-meteorological support on the federal level of country. The total chain is shown – from receiving information, through processing to submitting results to end users. The output documents could be divided on three groups – bulletins, forecasts and others, such as reviews, analytical reports, etc. The start of the bulletins issued is 1921.

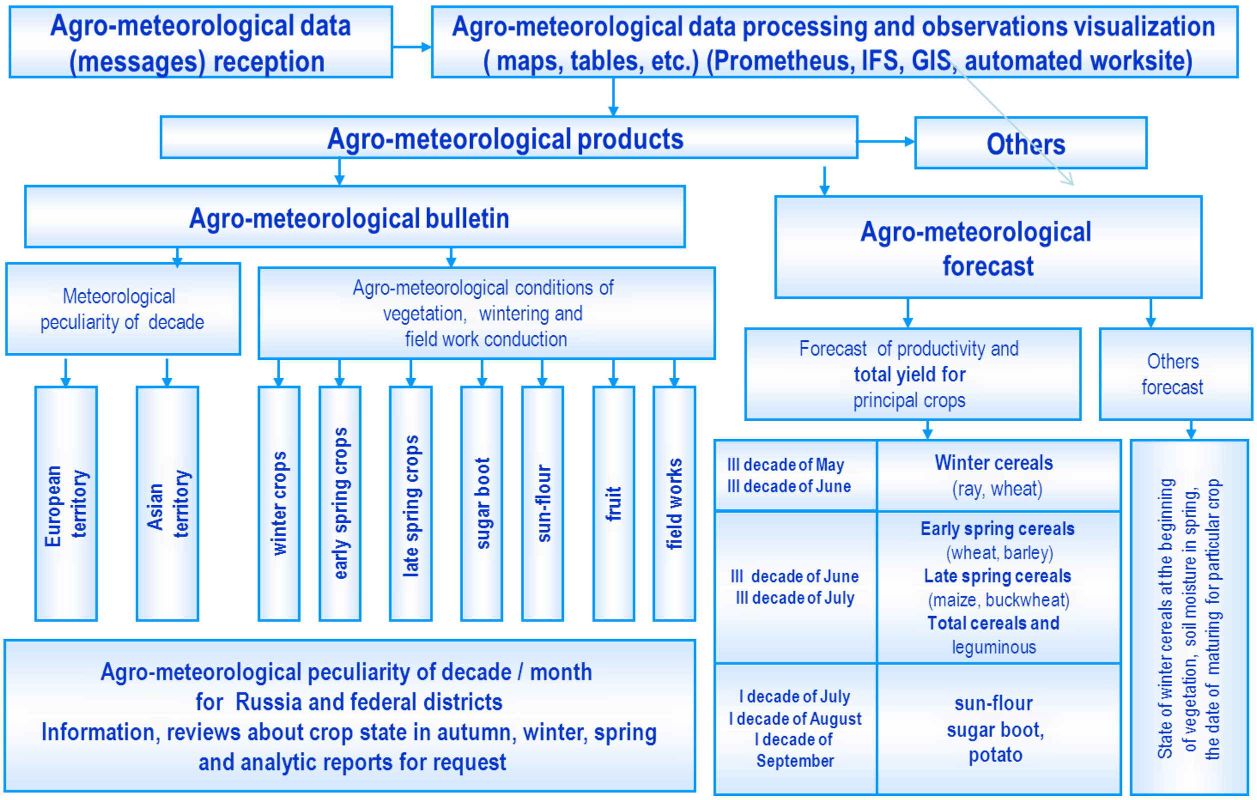


**Figure 2 - Agro-meteorological support of Russian agriculture on federal level**

Bulletin content is::
Weather on the territory in the period (details with real data, especially temperature)
Precipitation (real and norm percent), soil moisture and state
For main cultivated crops (winter and spring cereals, potato, beat, sunflower, etc):
Phases, density, expected productivity, conditions (favorable or bad) for the past and for the future
The most important forecasts are shown there. The regional level characterizes the territory restriction and it conducts by the regional agro-meteorological bodies. At the local level a station provide information to local agricultural enterprise.
The very important aspect is the visualization. The several packages or systems were developed and use at various levels. The one example of corresponding software is shown on the Figure 3.
It is necessary underline that all activities of this system are worked without human interference.
The people need to select crop, period, type of result, etc.

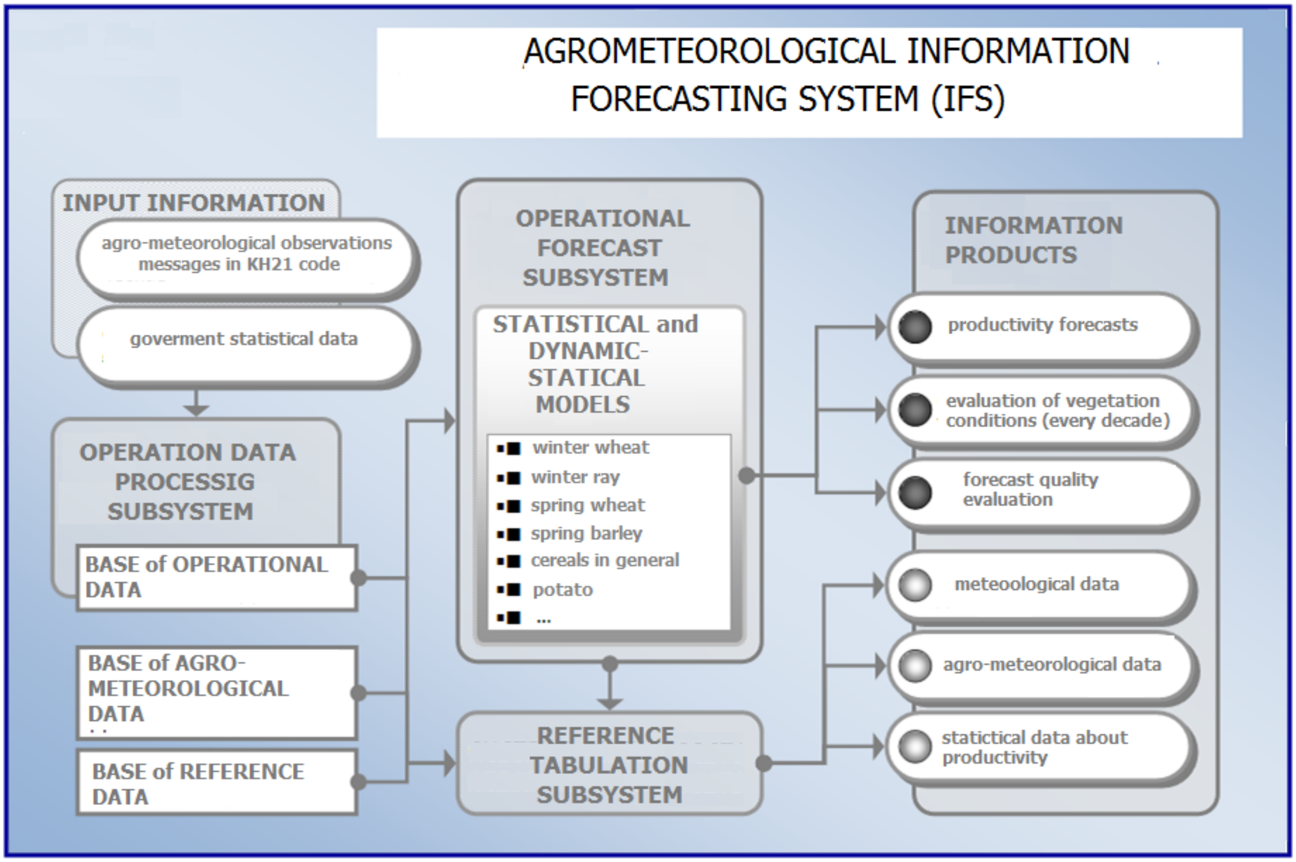


**Figure 3 – Agrometeorological information forecasting system (IFS)**

This Crop Watch bulletin in China presents a global overview of crop stage and condition between April 1 and July 31 2016—in this report referred to as the "April-July" period. It is the 102th bulletin produced by the Crop Watch group at the Institute of Remote Sensing and Digital Earth (RADI) at the Chinese Academy of Sciences, Beijing.
Crop Watch analyses are based mostly on several standard as well as new ground-based and remote sensing indicators, following a hierarchical approach. The analyses cover large global zones; major producing countries of maize, rice, wheat, and soybean; and detailed assessments of Chinese regions. In parallel to an increasing spatial precision of the analyses, indicators become more focused on agriculture as the analyses zoom in to smaller spatial units.
Crop Watch uses two sets of indicators: (i) agroclimatic indicators—RAIN, TEMP, and RADPAR, which describe weather factors; and (ii) agronomic indicators—BIOMSS, VHIn, CALF, and VCIx, describing crop condition and development. The indicators RAIN, TEMP, RADPAR and BIOMSS do not directly describe the weather variables rain, temperature, radiation, or biomass, but rather they are spatial averages over agricultural areas, which are weighted according to the local crop production potential. For more details on the CropWatch indicators and spatial units used for the analysis, please see the quick reference guide online resources and publications posted at www.cropwatch.com.cn.

The network of agro-meteorology stations belonging to the department in Sri Lanka consist of 39 nos. and at these stations, in addition to the general meteorological observations, soil temperature at different depths, minimum observed temperature on grass, evaporation rates and hours of sunshine are measured and the observations are made at these stations twice a day at 08.30 am and 03.30 pm. These data received by the Agro meteorological division at the headquarters , are quality controlled and supplied to interested parties. During the year 2015, a total amount of Rs. 542,000.00 has been collected by supplying agro-meteorological data to outside parties. In the year 2015,it was initiated to issue " a publication of meteorological information" having analyzed and mapped the information obtained and other meteorological data, along with the expecting meteorological changes and agro meteorological information. This is disseminated via internet each week.

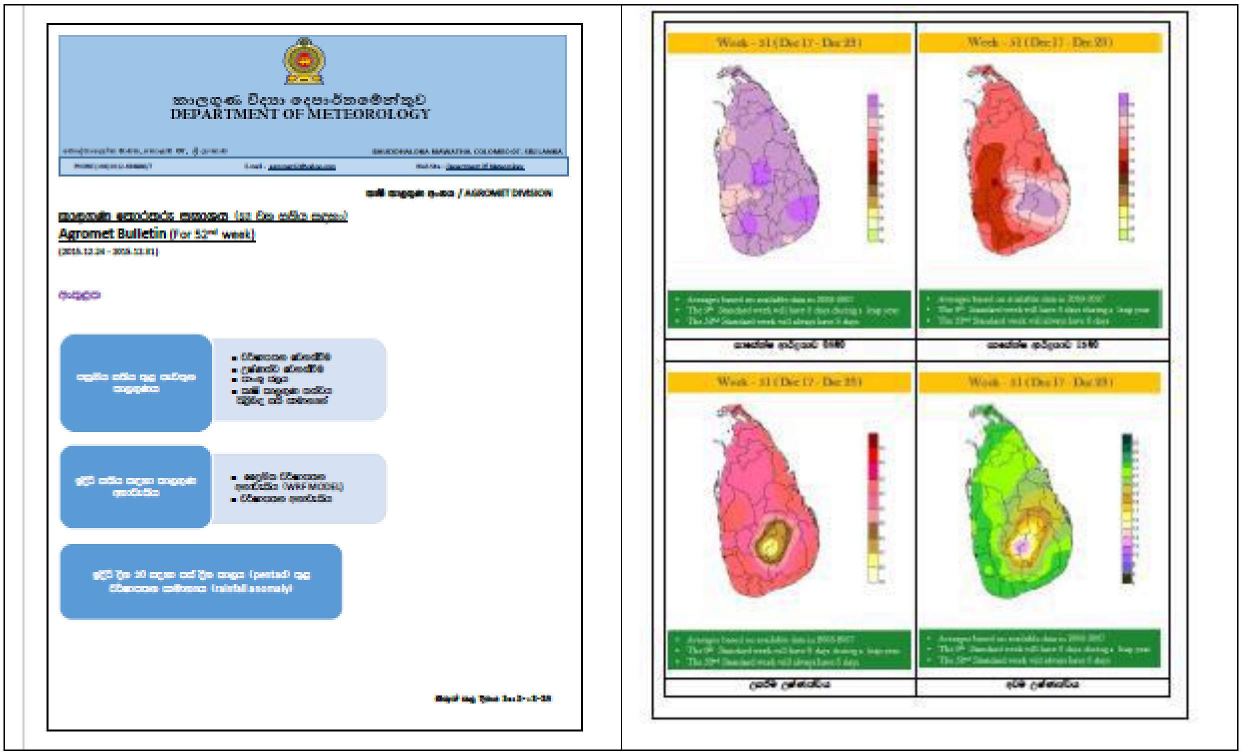


**Figure 4. Agro meteorological information in Sri Lanka**

The following recommendations are made to strengthen operational agrometeorological Services in Regional Association II:

- Developing agrometeorological forecasting centers;
- Developing forest meteorology, predicting yield/biomass before planting;
- Studying sand movement or desertification elements;
- Using AMS for measuring climatic elements and soil moisture;
- Measuring evapotranspiration;
- Establishing the domestic infrastructure of a flux measurement network;
- Developing agrometeorological models for crop growth and development and evaluate agromet environment using agromet advice model "AMBER";
- Integrating agrometeorological information services;
- Collaborating with the World Agrometeorological Information System (WAMIS);
- Cooperating with the International Society of Agricultural Meteorology (INSAM);
- Strengthening agrometeorology networks including station density, fine equipment, and capacity building;
- Providing more detailed agrometeorology information; and,
- Developing the infrastructure of the information network to transfer agrometeorological information to farmers more easily and faster.

## Agromet products under Agromet Services

While climate extremes take place on many scales, impacts are experienced locally and mitigation tools are a function of local conditions. To address this, agrometeorological early warning systems must be place and location based, incorporating the climate, crop and land attributes at the appropriate scale. The 12 parameters, which are among the most important for agriculture are solar radiation, sunshine hours, air temperature, dew point, atmospheric pressure, soil moisture, and rainfall,. The climatic data contribute to determining the exact water requirement of specific crops, helping farmers to irrigate more efficiently and effectively. Different agromet products being generated in the RA II region are listed here.

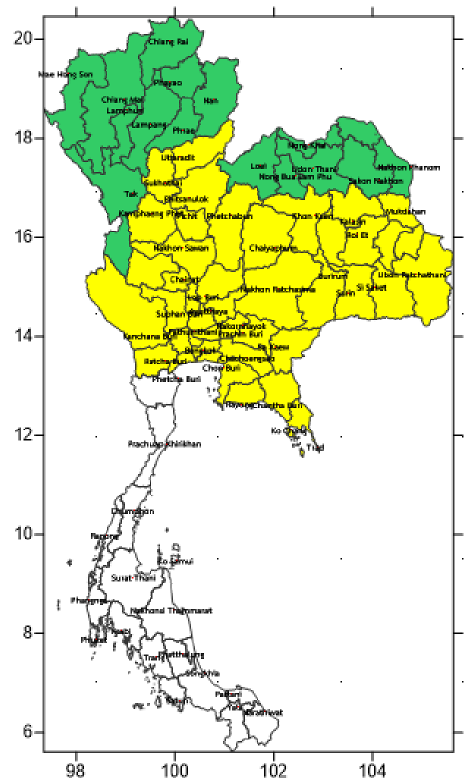


**Figure 5:Map for possible areas for cold air in Thailand In December 2016 – January 2017 (Seasonal Forecast)**


**Figure 6: Crop Weather Calenders**

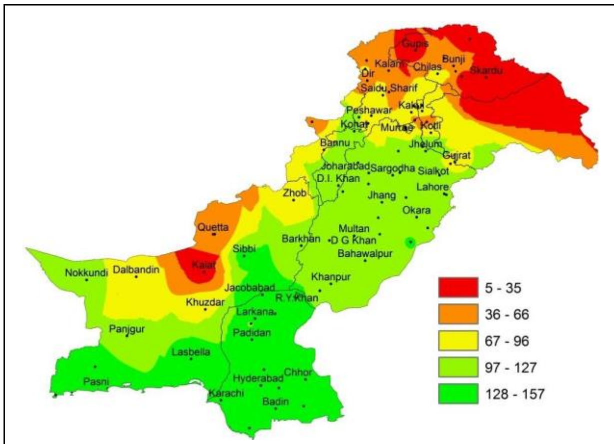


**Figure 7. Total Growing Degree Days accumulated Map Used in Pakistan**

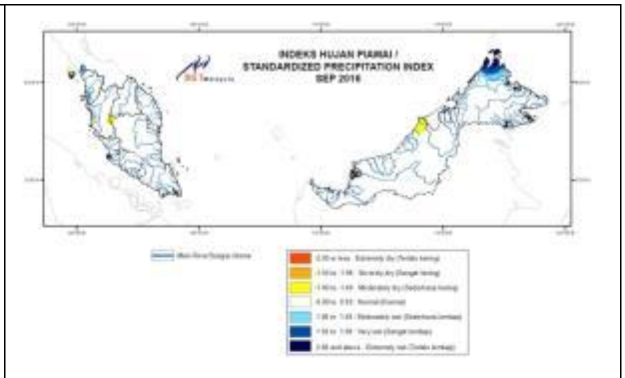


**Figure 8. Standard Precipitation Index used in Malaysia**

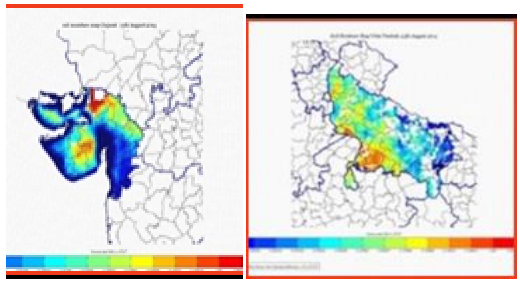

**Figure 9: Satellite based Soil Moisture**

India Meteorological Department (IMD) in collaboration with International Centre for Radio Science (ICRS), Jodhpur has started preparation of soil moisture maps for the States of Gujarat, Madhya Pradesh and Uttar Pradesh. These maps have been generated in near real time using satellite data viz. NDVI and brightness temperature data received from SMOS and MODIS.
For the integrated assessment of climate the National Agro-meteorological Institute (NRIAM) in Russia developed a special indicator - bioclimatic potential (BCP). It represents the total yield of the agro-ecosystem for the warm season.
Remote sensing data could be used for atmospheredrought monitoring as well as ground data territory Russia and some countries of central Asia. Remote sensing data are used in Russia agro-meteorology and agriculture for estimate crop state in different periods on the big territories. The digital data from AVHRR and MODIS as well as NDVI calculated on the base of those data were used. The special software was developed to process remote sensing date to produce such pictures (the country, federal districts, one or several regions). On the picture 4 is presented the cereals state on the territory of Russia. The green points are crops in the good state; yellow means satisfactory, red is for bad state. The other colours correspond to water, forests and not agriculture lands. The ground resolution is quite enough to have the general impression of the phenomenon distribution through the territory. The similar pictures are prepared every 10 days during the vegetation period.

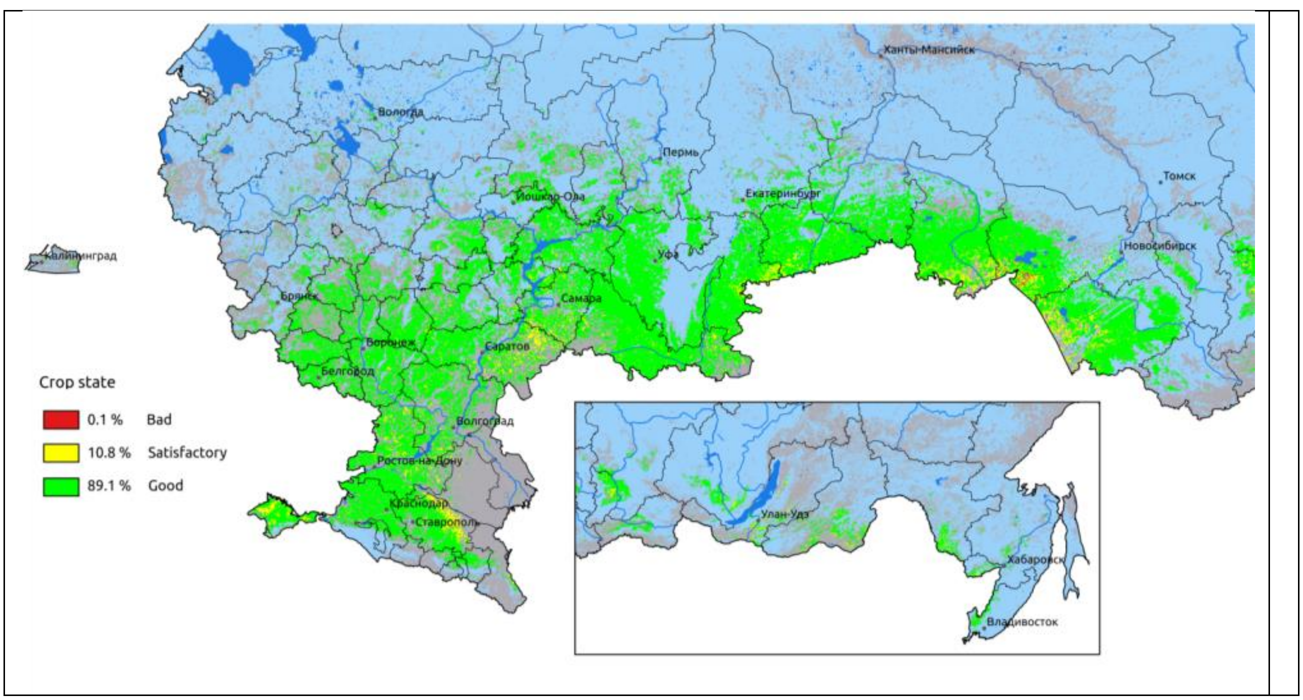


**Figure 10 – Crop state at the mid of June 2016**

On the picture 5 is the same result but only for one region of Russia. Such every 10 days the pictures for every region of Russia and general country would be transferred to the Hydrometeorological center, to the Ministry of Agriculture and regional agricultural organizations at various levels.

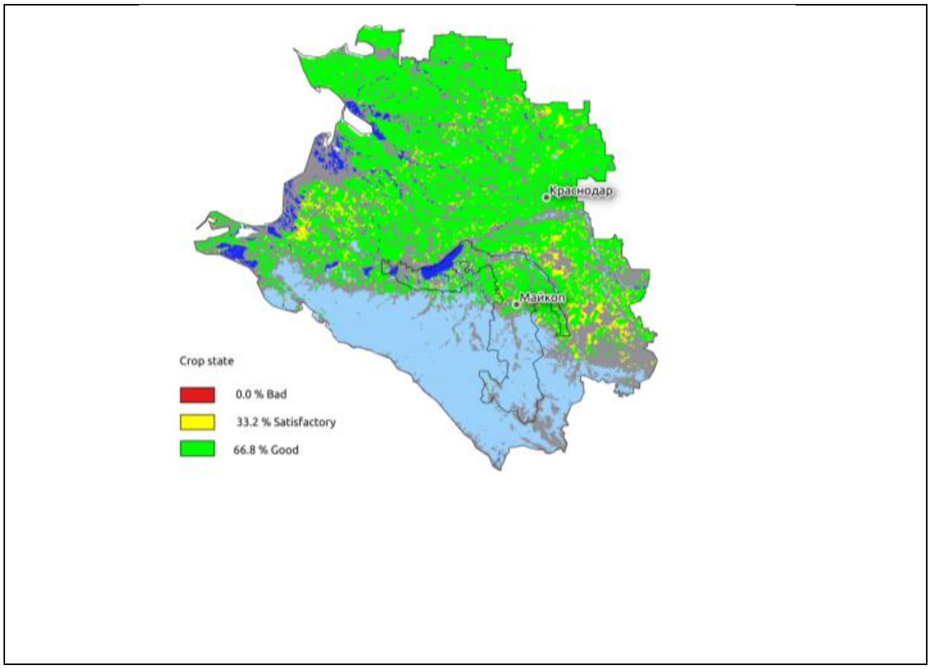


**Figure 11 – Crop state at the beginning of June 2016(Krasnodar Krai)**

In China Crop Watch agroclimatic indicators (CWAIs) are prepared for rainfall (RAIN), temperature (TEMP), and radiation (RADPAR), along with the agronomic indicator for potential biomass (BIOMSS) for sixty-five global Monitoring and Reporting Units (MRU). Rainfall, temperature, and radiation indicators are compared to their average value for the same period over the last fifteen years (called the "average"), while BIOMSS is compared to the indicator's average of the recent five years.

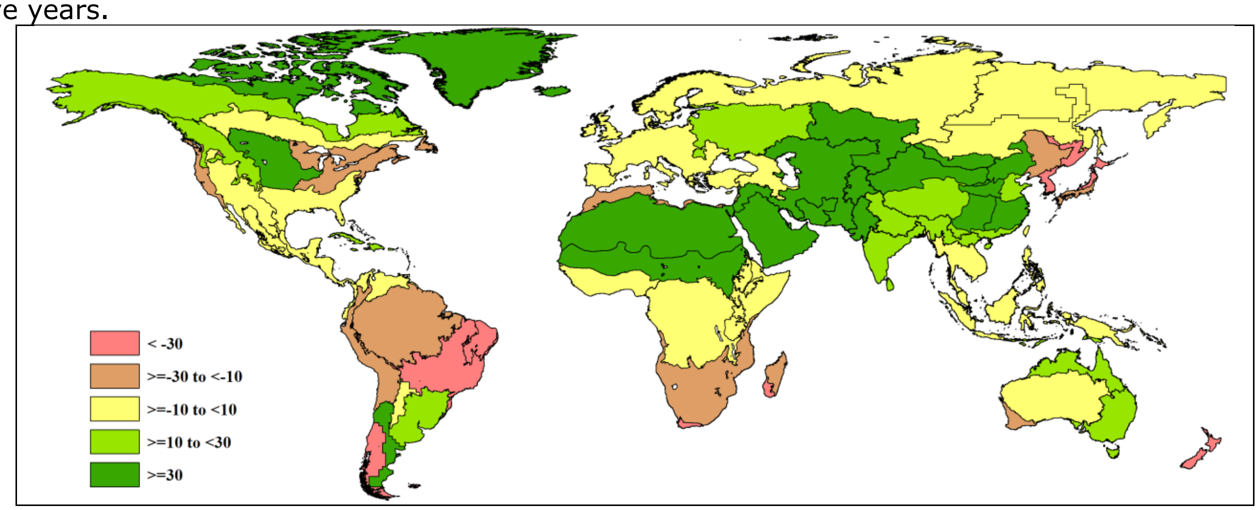


**Figure 12 Global map of April-July 2016 rainfall anomaly (as indicated by the RAIN indicator) by MRU, departure from 15YA (percentage)**

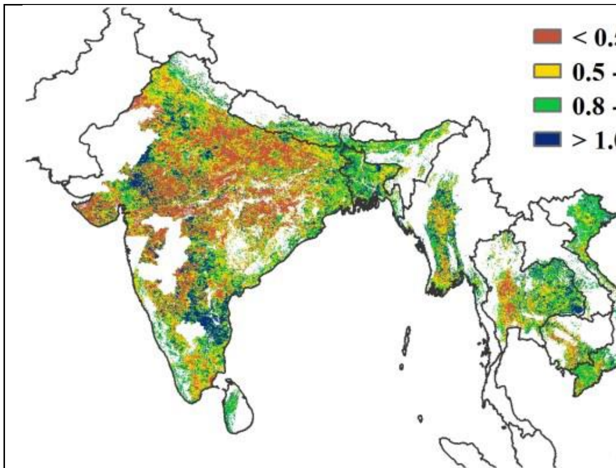


**Figure 13. Spatial distribution of rainfall profiles vegetation condition index**

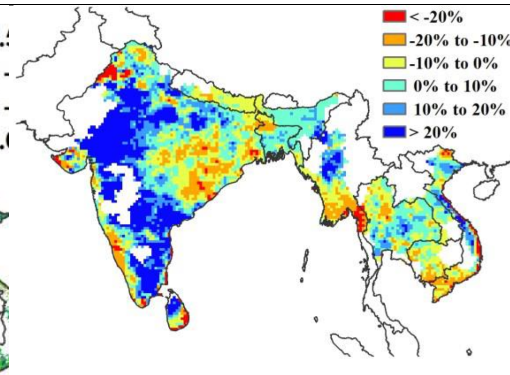


**Figure 14. Biomass accumulation potential departure**

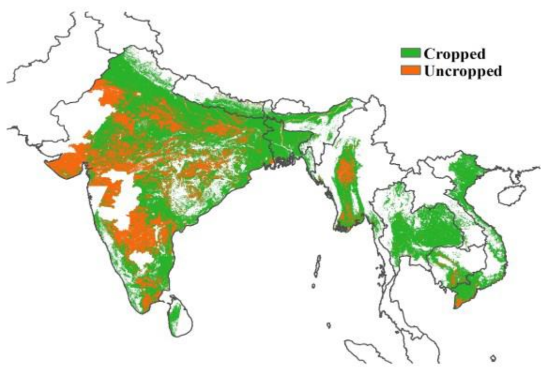


**Figure 15.Cropped arable land**

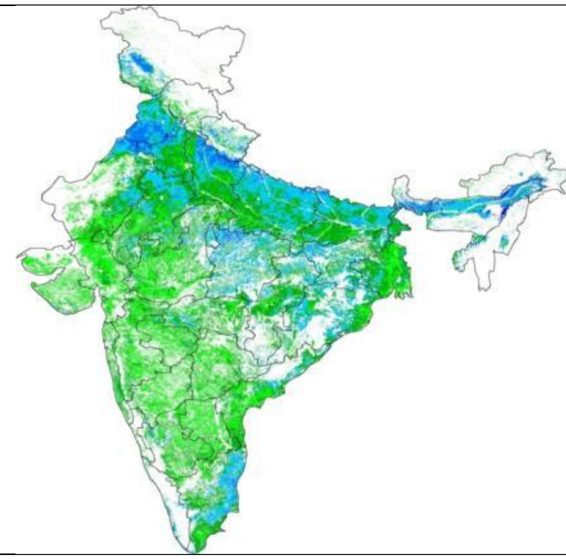

**Figure 16.he operational products of NDVI (Normalised Difference Vegetation Index) at 0700 GMT at 1 km spatial resolution from NOOA/AVHRR used in India**

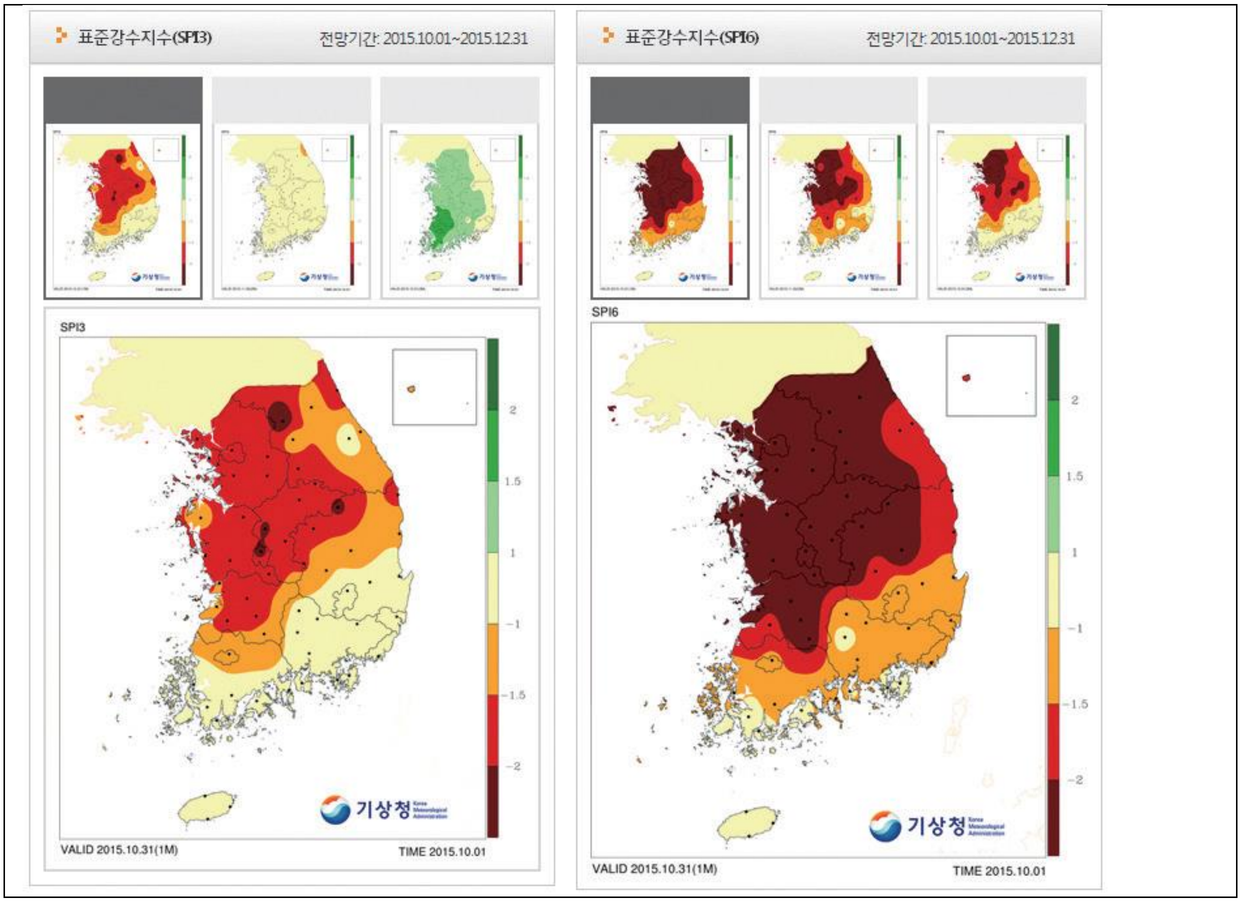


**Figure 17.1-month and 3-month Draught Outlooks of Republic of Korea**

## Capacity Building Programs

Various capacity building programs have been organized in different countries like
1. Short term courses
2. Training Courses at WMO Regional Training Centre
3. Participation in International Seminars, Scientific conferences etc.

For the first time Russian State Agrarian University – Moscow Timiryazev Agricultural Academy was produced the first graduate of agrometeorologist in Russia in 2016.Training is carried out at Uzbekistan. Tashkent Hydrometeorological Professional College, National University of mid-level for the national Hydrometeorological Service of Uzbekistan Central Asian educational institution for training. Training of highly qualified specialists in the field of hydrometeorology is provided by the National University of Uzbekistan named after MirzoUlugbek, as well as Uzhydromet trough postgraduate specialties

### Agrometeorological training in Uzbekistan

1. **General provisions**

Uzgidromet is a government body, specially authorized to solve problems in the field of hydrometeorology in Uzbekistan. Agrometeorological training intended for the continuous improvement of professional skills of specialists of agrometeorologia.

2. **Training of personnel**

Training is carried out at: Tashkent Hydrometeorological Professional College, National University of Uzbekistan.

Tashkent Hydrometeorological Professional College (TGMPC) is the only Central Asian educational institution for training of mid-level for the national Hydrometeorological Service of Uzbekistan.
Training of highly qualified specialists in the field of hydrometeorology is provided by the National University of Uzbekistan named after Mirzo Ulugbek, as well as Uzhydromet trough postgraduate specialties: 11.00.07. surface hydrology, water resources, hudrochemistry and 11.00.09. meteorology, climatology, agricultural meteorology.

### 3. Improving the skills of workers

The main purpose of training employees is to provide high-potential staff in the field of hydrometeorology by forming and fixing the practice of professional knowledge and skills derived from the theoretical training. The main objectives of training are:
- maintenance and improvement of the professional level of all employees in accordance with modern requirements for hydrometeorological sector;
-update and deepen knowledge in the field of theory and methodology of teaching, management activities on the basis of modern achievements of science, advanced technologies and best practices;
-development of innovative technologies, forms and methods of teaching aids and progressive use at domestic and foreign experience;
-provision of scientific and methodological support for full self-realization of individual creative ideas of employees.

### 4. The basic methodological principles

The basic methodological principles when conducting agrometeorological training to improve the professional level of specialists agrometeorologia:
- constant monitoring of the quality of training and retraining of workers, the degree of integration in the workflow of new technologies;
- regular informing of the employees about the achievements of advanced hydrometeorological science and practice;
- commitment to continuous professional growth;
- expansion of opportunities for training and retraining employees by using personnel resources and technical base of the Tashkent hydrometeorological professional College (TGMC), Scientific-research hydrometeorological Institute (nigmi), National University of Uzbekistan, regional training centres, WMO

### 5. Forms of training

- short courses;
- training and courses at the WMO Regional Training Centres;
- participation in international seminars and scientific conference, competitions of professional skill;
- the organization of individual work on self-education.

A number of training Agromet Advisory Services: programs have to be organized in Nepal for those who are directly and indirectly involved in the agroadvisories and these include:

1. Weather forecast based Agro advisory services to Technical Officers
2. Crop/ P&D models and Decision Support System
3. NWP based local weather forecast techniques
4. Use of Remote Sensing and GIS in agro advisory
5. Outreach Program
6. Provision of adequate training for the end-use

India Meteorological Department (IMD), in collaboration with the World Meteorological Organization (WMO) has organised two weeks training programme from 28th January to 9th February 2013 at National Training Institute, Pashan, Pune on ‚Operational Agrometeorology for serving end users requirement' for capacity building in the agri-culture sector of the Global

Framework for Climate Services (GFCS). The training was specially designed for the professional in East African (Burundi, Ethiopia, Kenya, Rwan-da, Tanzania, Asian participants (Bangladesh, Maldives, Myanmar, Sri Lanka, and Thai-land). those scientists working in operational Agro-Meteorological Advisory Services and those provide climate/ weather information products and services, preferably pro-fessional staff of National Meteorological and Agrometeorological Services and a range of professionals working on farm management and design issues where weather and climate data is relevant

Improvement in District level Weather Forecast organized by IMD for its personnel was organized **on** 28th and 29th September 2015

Use of Remote Sensing and GIS crop for Crop Growth Monitoring and Yeild prediction was organized at Indian Institute of Remote Sensing (IIRS), Dehradun during 31st August 2015 to 20th September 2015 at IIRS, Dehradun which mainly focussed on new approaches of GIS based inputs to Agromet Advisory Services.


Short duration course on “Agrometeorology” for foreign trainees was conducted at Agrimet Division, Pune during 9-20 May 2016, Pune. Mr. UgyenChophel and Mr. SonamRabten from Bhutan attended the training

Pune component of WMO RTC India and Agricultural Meteorology Division, IMD, Pune organised a three weeks training programme from 26th November to 16th December 2013 on “Operational Agrometeorology”, through Agricultural Meteorology Division, India Meteorological Department (IMD), Ministry of Earth Sciences, Government of India. The training is specially designed for professional working in AgrometeorologicalOrganisations/Institutes/Universities in India and other countries. The training would be conducted at Meteorological Training Institute, India Meteorological Department, Dr. HomiBhabha Road, Pashan, Pune, Maharashtra, India. Ideally, the training would draw upon those scientists working in operational Agrometeorological Advisory Services and those, providing climate/ weather information products and services, preferably professional staff of National Meteorological and Agrometeorological Services and a range of professionals

Two-weeks training programme on “Use of Multiple Crop Models and Decision Support System in Agrometeorological Advisory Services” was organized during 7-18 October, 2014 at Agro Climate Research Centre, Agricultural Research Institute, ANGR Agricultural University, Rajendranagar, Hyderabad. Training was imparted to 30 scientists and Senior Research Fellows (SRFs) of IMD on DSSAT, INFOCROP and APSIM crop simulation models for better delivery of weather based Agro advisories and crop yield forecasting at district level in different crops across the country.


Some of the recommendations of the different meetings on agromet products are:
Holding of further training workshops and consideration given to short courses in Agricultural Meteorology.
· Exchange of data and Agricultural Meteorological knowledge between member countries and also the Inter-Regional exchange of these materials.
· Exchanges of experts between member countries as a necessary way to improve the knowledge of Agricultural Meteorology.
· Use of Meteorological forecasts and short- and long-term Agricultural Meteorological recommendations should be included in specialized bulletins for further notice.
· Performance of joint research between member countries to solve common problems considering Agricultural Meteorological affairs.
· Use of GIS and Modeling of Joint Training should be considered

The following four programmes were conducted in Nepal during the year 2015 for the meteorological officers under the Continuous Education and Training (CET) Program

1. Preliminary Course for Statistical meteorological forecasts
2. Analysis of climatic data
3. Training on Meteorological equipment
4. Advanced Course on Agro meteorology

In addition to the meteorological officers , meteorologists and research assistants were made to participate in the higher course on Agro meteorology. Accordingly, the officers trained of these 4 programmes are as follows.

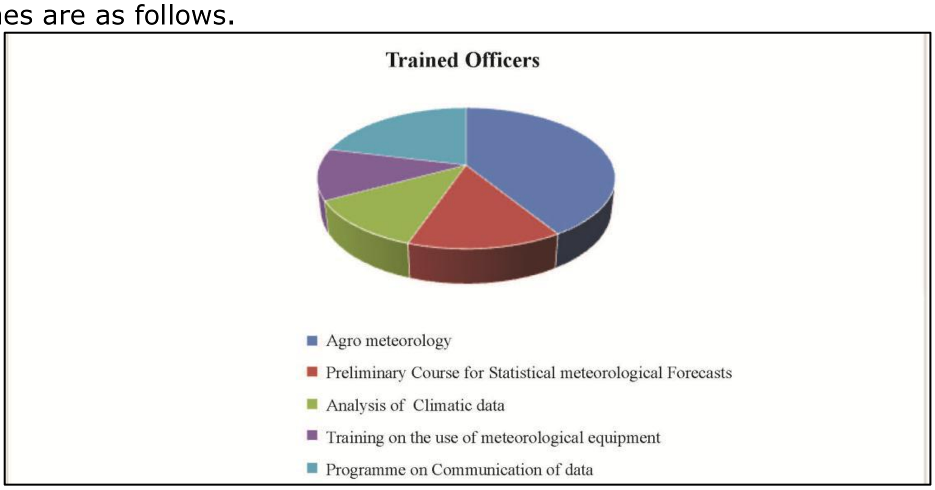


**Figure 18. Status of Trained officers**

## Dissemination

In India IMD (India Meteorological Department) in collaboration with Agromet Field Units (AMFUs) disseminates weather forecast and Agromet Advisories to the farming community in the country in both regional and English languages through Ministry of agriculture portal i.e. farmers' portal (http://farmer.gov.in/advs/login.aspx).Weather forecast and alerts now enable farmers in planning farming operations effectively and taking the best suited action to deal with adverse weather conditions.

Department of Agriculture in Cambodia is issues bulletin based on the climate and seasonal weather forecast of the area or province. They also advice the farmers on the type of crop/variety to plant based on the forecast (drought, floods, delayed/early rainy season, etc.). In case of pests/insects that destroy crops, wind data is important for early preparation.

In order to increase the number of farmers in the data base, a system has been developed by India Meteorological Department and Ministry of Agriculture to provide weather based Agromet advisories to the farming community through free SMS. To avail this service, farmers are requested to register their names and mobile numbers along with the crops. Once registered, the farmers will receive SMS for their specific crops twice in a week on day to day basis as well as during extreme weather events. In Nepal Agro-climatic and weather information is delivered to farmers and farming community via Information and Communication Technology such as web portals and radio, television and mobile phones under early warning system. The agrometeorological extension system in China in most cases a "cascade" system, from Provincial Level to Sub-Provincial Level to County Level and Township Level to Village Level. At the lower levels, extension officers and village technicians must play an important role.

In Mongolia the advices are spread by reports to the government, connections with other departments (Agronomy, Engineering/Machinery etc.) and field meetings at various levels that include extension officers and farmers, in the same "cascade" system already mentioned. Broadcasting of sowing advices is via television programmes received here mostly by cable, rural radio, rural community radio, and SMS messages that are becoming more and more popular. In some places in China, apart from radio and TV as well as SMS messages on mobile phones, there is other dissemination of weather and climate information. This is done through visits, through telephone by using special numbers, through printed leaflets of some of the information or via the internet with separate weather and agricultural sites.

Agromet advisories in India are being communicated to the farmers through multi-channel dissemination system like mobile, Radio, TV, Newspaper including dissemination Kisan Portal (http://farmer.gov.in) launched by the Ministry of Agriculture, other PPP (Public Private Partnership) mode via SMS and IVR (Interactive Voice Response Technology). At present mobile service is restricted to about 19.4 million farmers out of about 94 million farmers' families. Thus, there is a need to reach out each and every farmer in the country. In view of that, there is an urgent need to take up a national initiative in this regard and do it in a grand manner by preparing a road map so that more number of farmers will be benefitted.

Shri NarendraModi, Hon'ble Prime Minister, Govt. of India has launched a dedicated channel for the farmers, viz., DD Kisan. Inputs for ‚Crop Specific Weather based Agromet Advisories' for the country have been prepared on daily basis and sent for telecasting through DD Kisan Channel, New Delhi from the month of May, 2015.
Presently, this channel covers State level and Region wise weather and Agromet Advisories depending upon rainfall situation like dry spell, subdued rainfall, floods etc. and their impact on sowing and selection of crops and cropping on real time in programs like 'Kisan Samachar' and 'Mausam Khabar'. In addition, in some of the States like Maharashtra, regional DD channels (DD Sahyadri) as well as private channels like ETV, telecast weather forecast and Agromet Advisory in Marathi. Other TV channels in Maharashtra have been contacted to telecast weather forecast and Agromet Advisory in Marathi. Similar efforts are undertaken for other States, as well.

From its earliest days, the predecessor of Japan Meteorological Agency (JMA) sought the improvement and expansion of services to meet evolving and diversifying societal needs and requirements and to keep pace with scientific and technical development. The communication and dissemination tools for the public expanded from bulletin board, flag, and newspaper to radio in 1925, and the users of meteorological services were diversified shortly thereafter to include various socio-economic sectors, such as shipping and fishery, aviation, and railway and agriculture.

Under Agrometeorological extension in China and roles for CFSs, first lessons to be learned are (i) the necessity of a strong co-operation of meteorological and agronomical offices to combine trustable data and (ii) the importance of the art of reaching farmers with the information available/needed. One may call the agrometeorological extension system in China in most cases a "cascade" system, from Provincial Level to Sub-Provincial Level to County Level and Township Level to Village Level. At the lower levels, extension officers and village technicians must play an important role.
For example in the current decision making approaches on irrigation from soil moisture forecasting in Henan Province, important agrometeorological information has been successfully delivered to local governments and authorities. They disseminate it down to farming technique facilitation stations at township and village levels. The latter, in turn, show local farmers how to plant and irrigate on a guided basis and how to prevent or get prepared for agricultural hazards. However, some of this information and these services are not directly and quickly accessed by farmers. Farmers are able to get informed of general weather forecasts through some media, including TV and telephone. But too many are unable to receive detailed and practical recommendations on amounts and timing of irrigation. CFSs would be a solution to these problems.

There was a different extension mode in a successful agrometeorological service in Jiangxi Province, of establishing relay intercropping of late rice with lotus. Eight times a kind of Climate Field Classes was organized to demonstrate and popularize the method with the target groups concerned. An office was available for training. A comparison of such an approach with the "cascade" down coming of extension information in China would be a great last phase of the pilot projects started, also comparing class training with field training in CFSs. Even where the information supply line is short, such as in the case on peony flowering to the Luoyang City (Henan) Government and the City Office for Flowers, to benefit organizing the annual Peony Show, these services still cannot be made available to flower growers directly. Simple Field Classes would solve this issue.
In rather some places in China, apart from radio and TV as well as SMS messages on mobile phones, there is other dissemination of weather and climate information. This is done through visits, through telephone by using special numbers, through printed leaflets of some of the information or via the internet with separate weather and agricultural sites. However, Climate Field Schools would reach and stimulate many more farmers much better and would have all the organizational and other advantages that Farmer Field Schools showed to have

## Meeting/ Workshop

Media is a powerful channel for dissemination of sensible weather information and Agromet advisories to the farming community through multimedia including mobile technology. Strong linkages are being established with different Medias in RA II region. Agrimet Division, IMD, Pune organised National Level Media Workshop on "Communication of Agromet Advisories to the User Communities" at Meteorological Training Institute, IMD, Pashan, Pune on 28th March 2014. The basic purpose of this workshop was to make media personnel aware about weather processes and usefulness of weather information for the purpose of agriculture, educate them about various terminologies, concepts and definitions.

India Meteorological Department, Ministry of Earth Sciences & World Meteorological Organization, Geneva organised international workshop on "Capacity building for Agrometeorological Services" on 28th -29th October-2013.The overall objective of the proposed workshop is to review the existing training, capacity building practices, activities for agrometeorological services and to make recommendations on how to improve these activities. Another objective is to start the process of reviewing guidelines on 'Education and Training' in Agricultural Meteorology and make specific recommendations to 16th Session of CAgM in April 2014. The workshop brought together participants from many countries in the world to share their ideas and experiences. The workshop will provide important recommendations to the members of the CAgM and will provide input in the development of the work plan for 16th Session of CAgM. The users will get chance to interact with climate scientists and resource persons to develop user specific products. The participants will include members WMO Commission for Agricultural Meteorology's Implementation / Coordination Team in Agrometeorological Services, representatives from WMO Regional Training Centers (RTCs) and other experts

CAgM Implementation / Coordination Team (ICT) 1.1 meeting was organized from 30th - 31st October 2013 at Pune, India. Terms of reference of the ICT were discussed elaborately and also the discussion was made on the strategies for preparation of working papers for the ensuing meeting of the Commission of Agricultural Meteorology, WMO in April 2014.

In collaboration with Space Application Centre, NRSA, ICAR and other organisations efforts are being made to incorporate satellite based information for monitoring and assessing near real time crop status in as well as development of products for crop and location specific agromet advisories. In line with this initiative, Agrimet Division, IMD, Pune organised workshop on "Applications of satellite information in GraminKrishiMausamSewa" at Meteorological Training Institute, IMD, Pashan, Pune on 27th March 2014. The basic purpose of this workshop was to build mechanism of use of satellite information in operational Agromet Advisory Services not only from the Indian satellites but also the other satellites available from other parts of the world. Different working groups have been formed to implement the concept operationally.

Agrimet Division, India Meteorological Department (IMD), Pune in collaboration with United States Agency for Interna-tional Development (USAID), Washington DC, USA jointly organized international workshop on "Improving Climate Ser-vices for Farmers in Africa and South Asia (ICSFASA)" during 2-3rd February, 2015 at Hotel Ramee Grand, Pune. Around 40 Scientists and farmers from the countries of South Asia and Africa participated in the workshop. The Workshop was the platform to ascertain the farmers' needs in Africa and South Asia about weather and climate information for on farm decision making. The Workshop addressed the type of climate information and communication channels currently available and the constraints faced by farmers in obtaining this information. It also explored in laying the foundation to establish an effective network for farmers in Africa and South Asia to share knowledge and information on climate services and products for on-farm decision making. Review of currently available ICTs for the farmers in Africa and South Asia and enhancing such ICTs for effective dissemination of climate products and services was also addressed in the workshop. Farmers from Nepal, Ethiopia and India shared their valuable knowledge and experience thus enabling the workshop to evolve concrete recommendations.


Sixth Session of Regional Conference on "Management of National Meteorological & Hydrological Services (NMHSs) in Regional Association" was organized in Doha, Qatar during 2_4 December, 2014.

Agrimet Division, IMD, Pune organised a two day workshop on use of "Application of Satellite information in operational Agromet Advisory Services" at Meteorological Training Institute, Pune during 16-17 December, 2014. The objective of this workshop was to prepare road map for the use of satellite data in generation of accurate weather forecasting, Agromet products and ultimately preparation of Agromet Advisories.

## Agrometeorology under Global Framework for Climate Services (GFCS)

It is a well known fact that climate in vast territories of Russia is mostly strongly continental. Thus agriculture in Russia is defined by climate conditions. On the picture 6 is presented data on total grain crops yield in Russia, which varies from 47 mln metric tons in 1998 to 128 in 1978.

| Year | Total yield, mln tons |
|---|---|
| 2014 | 104.0 |
| 2013 | 92.3 |
| 2012 | 70.9 |
| 2011 | 94.2 |
| 2010 | 61.0 |
| 2009 | 97.1 |
| 2008 | 108.2 |
| ... | |
| 1998 | 47.5 |
| ... | |
| 1992 | 116.7 |
| ... | |
| 1978 | 127.4 |
| ... | |
| 1953 | 48.2 |

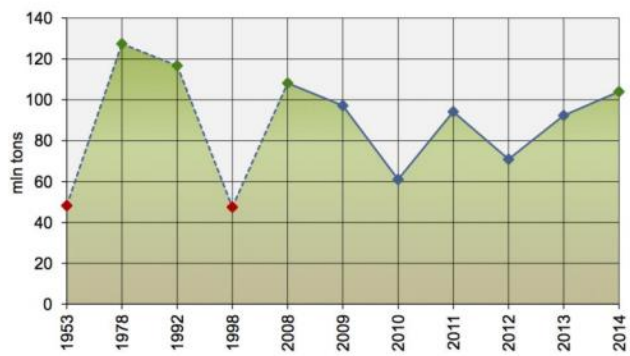


Figure 19 – Total yield of grains and beans in Russia (mln tons)

For the integrated assessment of climate the National Agro-meteorological Institute (NRIAM) developed a special indicator - bioclimatic potential (BCP). It represents the total yield of the agro-ecosystem for the warm season. In the BCP calculation it simulate(with help of Climate-Soil-Yield" imitation system) the growth of grass phytocenosis during the growing period (from the date of temperature transition over 5°C in spring to the date of temperature transition below 5°C in autumn).

BCP indicator has important practical application:

-BCP uses annually to estimate some influence of climate changes on agriculture

-Based on annual estimations of BCP value carried out by NRIAM for different subjects of the Russian Federation, Ministry of Agriculture determines the level of financial support to agricultural sectors of different Russian subjects (regions).

-Some Banks use BCP to evaluate the possibility of region to return credit for agriculture development

## Drought Preparedness and Management Strategies

The drought itself and the consequences of drought result in significant losses in corresponding countries. Droughts attract attention of national bodies and the international community. WMO makes a lot in this area. The commission of the UN on economic and social problems for Asia and Pacific organizes within the Committee on Disasters established the special working group to monitor droughts and to give some early warnings. There were several meetings; a regional mechanism is under development.

The droughts resulted in significant losses in harvest. On the table 1 there are presented the losses in harvest due droughts in some regions of Russia. Those are the historical data.

Table 1 Yield reduction due droughts (as percent of average yield)

| Territory | Year | Yield reduction |
|---|---|---|
| Russia | 1995 | 42 |
| | 1981 | 37 |
| | 1975 | 32 |
| | 1979 | 19 |
| | 1984 | 17 |
| Center of European part of Russia | 1995 | 91 |
| | 1981 | 89 |
| | 1979 | 88 |
| | 1984 | 77 |
| | 1975 | 19 |
| Volga river region | 1975 | 100 |
| | 1995 | 79 |
| | 1984 | 72 |
| | 1981 | 68 |
| | 1972 | 53 |
| | 1979 | 45 |
| Region of Northern Caucasia | 1995 | 33 |
| | 1979 | 36 |
| | 1975 | 30 |

Particularly severe drought was observed in Russia in 2010. The result of this drought was following:

Crop death from drought on the area of 13 200 000 hectares

That figure is equal to:

29% from planted area affected by drought

17% from Russia planted area

30% from planted area occupied by cereals

Drought causes damage Manufacture of agriculture in many of the former Republiks of the former USSR. Therefore by the decision of the Interstate Committee on Hydrometeorology of Commonwealth of Independent States Drought Monitoring Center was established in 2002 for the following countries: Azerbaijan, Armenia, Byelo-russia, Georgia, Kazakhstan, Kyrgyz-stan, Russia, Tajikistan, Uzbekistan. Aims: to develop techniques for drought detecting, evaluating and mitigation, estimation of impact on agriculture.

Remote sensing data could be used for drought monitoring as well as ground data. On the Figure 20 the results of monitoring atmosphere droughts of territory Russia and some countries of central Asian in 2016 year are showed.

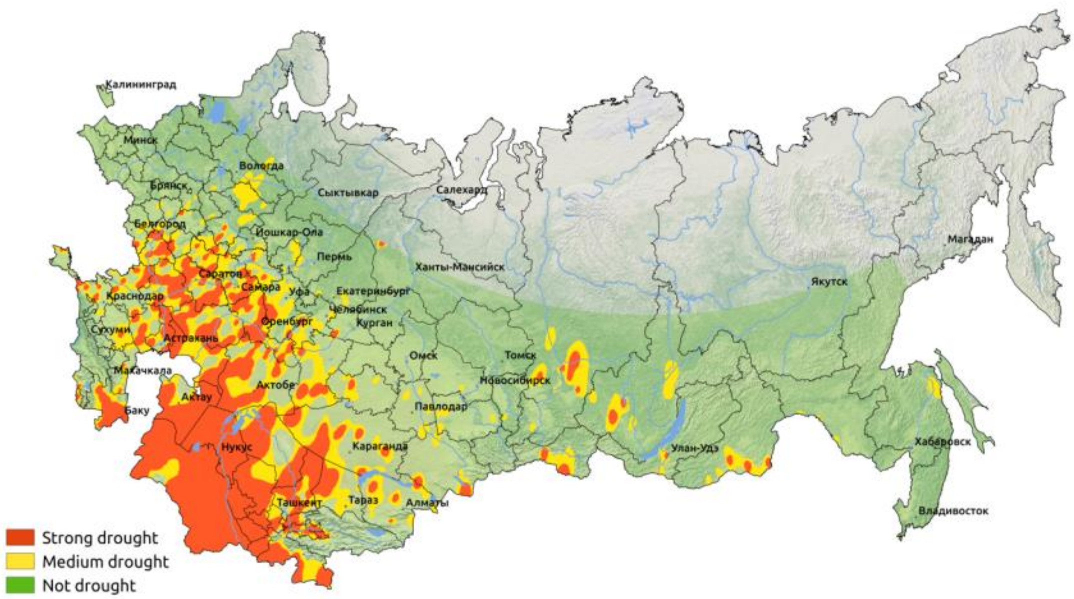


**Figure 20– Atmosphere drought at the mid of July 2016**

## Economic Impact of Agromet Advisory Services

Studies on Economic Impact of Agromet Advisory Services (AAS) in RA II are scanty. However, the same carried out in India indicates that agromet advisory services rendered by India Meteorological Department (IMD) through various channels have resulted in significant increases in farm productivity resulting in increased availability of food and higher income generation. The services helped the farmers not only in increasing their productions but also reducing their losses due to changing weather patterns and others problems. Economic assessment by the National Centre for Agriculture Economics and Policy Research (NCAP) on AAS estimated 10-25% economic benefit obtained by the farmers. The economic benefit of the agromet services runs in crores. The Ministry of Earth Sciences (MoES) had engaged National Council of Applied Economic Research (NCAER) to carry out a comprehensive study on "Impact Assessment and Economic benefits of Weather & Marine Services." This study was carried out during September & October 2010 and restricted to main end users i.e. farmers for Agrometeorological Advisory Services. The field study was carried out in 12 states and 1 Union territory. According to the report only 10 to 15 percent of the farmers are benefitting from the SMS services and about 24% farmers are aware about Agromet Services It was revealed that economic profit estimates can vary between Rs. 50,000 Crore (where 24% farmers receive weather information) to 211,000 Crore (where all farmers receive weather information). This shows that its economic returns depend on the proportion of farmers receiving information.

Studies on Economic Impact of Agro advisory services in Nepal show that farmers could save significant losses of crops and make their farming profitable by using the agro advisory services. It should be planned to extend such studies for more number of years and more number of stations. Agro-meteorological stations across Afghanistan are providing farmers vital information on climatic and soil conditions, enabling them to grow and irrigate their crops more effectively. Five newly installed stations, supported by On-Farm Water Management Project (OFWMP) under the Ministry of Agriculture, Irrigation, and Livestock, are providing more reliable, timely information through an automated system.OFWMP, which works to improve agricultural productivity by enhancing the efficiency of water use, is supported by a $25 million grant from the Afghanistan Reconstruction Trust Fund.

**ANNEX III**

# Report of the RA II Working Group on Hydrological Services (WGHS)

**Sung Kim, Korea Institute of Civil Engineering and Building Technology**

**Chairperson of the RA II Working Group on Hydrological Services**

**-----**

**Muhammad Riaz**

**Vice-chairperson of the RA II Working Group on Hydrological Services**

**Report of the RA II Working Group on Hydrological Services (WGHS)**

## 1. Introduction

At the fifteenth session of the RA II in December 2012, the establishment of the WMO RA II Working Group on Hydrological Services (WGHS) was decided.

## 2. Working Structure

The working group is composed of one Chairperson, one Vice-chairperson, six themes and eight theme leaders.

## 3. Terms of Reference

The terms of reference of the Working Group on Hydrological Services (WGHS) are as follows:

(a) To provide assistance and advice to the president of the Association on all questions pertaining to the regional aspects of the Hydrology and Water Resources Programme;

(b) To engage in and monitor the implementation of water-related activities documented in the RA II Strategic Operating Plan;

(c) To undertake activities relating to the Hydrology and Water Resources Programme as listed below;

- Strengthening the capability of Members to assess their water resources: water resources assessment, its variability and use (surface water including reservoirs and groundwater);
- Improve accuracy and timeliness of forecasting floods of different cause and origin through enhanced cooperation between National Meteorological Services and National Hydrological Services, within the context of the WMO Flood Forecasting Initiative;
- Hydrological aspects of drought, including drought monitoring, and assessment of water scarcity and deficits;
- Hydrological responses to climate variability and change and promotion of the use of climate information by water managers;
- Improved accuracy of hydrometric and sediment observations including space-based technologies;
- Sediment disasters and mass movements (flood and rainfall induced);

(d) To cooperate with the Commission for Hydrology and other WMO bodies on activities and projects related to hydrology and water resources;

(e) To seek cooperation with other regional bodies and organizations on issues related to the Hydrology and Water Resources Programme;

(f) To actively contribute to the Global Framework for Climate Services through dedicated components in the identified theme areas of work during the next intersessional period 2013–2016;

(g) To undertake activities related to the transfer of technology through the Hydrological Operational Multipurpose System and capacity-building in a cross-cutting manner;

**4. Membership**

| | | |
|---|---|---|
| Chairperson WGHS | Dr Sung Kim | Republic of Korea |
| Vice-chairperson WGHS | Mr Muhammad Riaz | Pakistan |
| Theme Leader in Water Resources Assessment | Ms Ge Gao | China |
| | Ms Hwirin Kim | Republic of Korea |
| Theme Leader in Flood Forecasting | Dr Sergey Borshch | Russian Federation |
| 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 Guoqing Wang | China |
| | Dr Thuc Tran | Viet Nam |
| Theme Leader in Improved Accuracy of Hydrometric and Sediment Observations including Space-based Technologies | Mr Youngsin Roh | Republic of Korea |
| Theme Leader in Sediment Disasters and Mass Movements | Dr Tai-Hoon Kim | Republic of Korea |

**5. Working Group meetings**

5.1 The first session

The first 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 with the following agenda.

(a) Opening of the Meeting
(b) Adoption of the agenda and organization of work
(c) Review of activities since previous WG session (including meetings of CHy, Presidents of Technical Commissions and Presidents of Regional Associations)
(d) Modes of operation of the WGHS (including Task Teams)
(e) Consideration of decisions of RA-II-15, CHy-14, Cg-16 and relevant ECs
(f) Work programme
(g) Field trip
(h) Cooperation with other international organizations
(i) Other business
(j) Adoption of the report and closure of the session

The final report of the meeting is available at
http://www.wmo.int/pages/prog/hwrp/RA2/documents/RA-II_WGH_2014_FINAL_REPORT.pdf.

5.2 The second session

The second session of the Working Group on Hydrological Services (WGHS) of the WMO Regional Association II (Asia) was held in Gyeongju, Republic of Korea, from 14 to 16 April 2015 with the following agenda.

(a) Opening of the Meeting
(b) Adoption of the agenda and organization of work
(c) Review and adjustment of work programme
(d) Presentations for WWF7 Regional Session and main messages
(e) Next meeting
(f) Adoption of the report and closure of the meeting

The final report of the meeting is available at
http://www.wmo.int/pages/prog/hwrp/RA2/RAII-WGH-Gyeongju.php

5.3 The third session

The third session of the Working Group on Hydrological Services (WGHS) of the WMO Regional Association II (Asia) was held in Seoul, Republic of Korea, from 25 to 27 October 2016

The draft final report of the meeting is attached to this document.

**WORLD METEOROLOGICAL ORGANIZATION**

# REPORT OF THE THIRD MEETING OF THE REGIONAL ASSOCIATION II (ASIA) WORKING GROUP ON HYDROLOGICAL SERVICES

## Seoul, Republic of Korea
## 25 to 27 October 2016

# FINAL REPORT
**22 November 2016**

**Table of Contents**

# 1. OPENING OF THE MEETING

1.1 At the kind invitation of the Government of the Republic of Korea, the third meeting of the Working Group on Hydrological Services (WGHS) of the WMO Regional Association II (Asia) was held in Seoul, Republic of Korea, from 25 to 27 October 2016.

1.2 The meeting was opened at 09:30 on Tuesday 25 October 2016 at the Han River Flood Control Office, Seoul, Republic of Korea.

1.3 Mr Hajoon Park, Director General, Han River Flood Control Office, welcomed participants to the Republic of Korea and, in particular, to the Han River Flood Control Office. He noted the rising losses in the countries of Regional Association II (Asia) from natural disasters, with flooding being the largest contributor to losses from weather-related natural disasters. He stressed the importance of the Working Group on Hydrological Services (WGHS) efforts pertaining to Water Resources Assessment (WRA), as this allows a Member to track current water availability and its predicted states. As such, this assists disaster managers with knowledge of potential drought and flooding, allowing early actions to be taken to reduce losses. In closing, he wished everyone a pleasant stay in Seoul and for a successful meeting.

1.4 Mr Paul Pilon, WMO Secretariat, thanked the Republic of Korea and the Han River Flood Control Office (HRFCO) for hosting the third meeting of the RA II WGHS, and welcomed everyone to the third meeting on behalf of the Secretary-General WMO, Mr Petteri Taalas. He reiterated the importance of the work of the Regional Association and, in particular, the work of the WGHS, particular with respect to helping build the capabilities of Members to provide services. He concurred with Mr Park's comments on the rising losses attributed in the region to flooding and the growing importance it is playing to the social and economic well-being of Members in the Region. He indicated there were two complementary activities that when undertaken could combine to help manage disaster risk. These activities included integrated flood and drought management as well as the application of early warning systems. He noted that even with the adoption of aggressive flood and drought management measures, constant vigilance through early warning systems was needed to trigger and direct emergency response measures. He concluded by commented that additional efforts were needed to bridge the meteorological and hydrological communities to allow making best use of advances in meteorological science in hydrological forecasting, leading to more effective early warning systems.

1.5 In his welcoming remarks, Senior Research Fellow, KICT, Mr Sung Kim highlighted the importance of this third meeting the RA II WGHS, as it permitted reporting on final progress achieved in this four-year intersessional period, a shaping of its future work plan for the period 2016-2019, and a discussion on decisions stemming from current and possibly future work for consideration of the Sixteenth Session of RA II, to be held 12-16 February 2017 in Abu Dhabi, United Arab Emirates. Mr Kim reviewed the draft agenda noting the opportunity for experts to report on their activities and achievements, the brief Workshop on the morning of Wednesday 26 October for the Dynamic Water resources Assessment Tool (DWAT) that was developed by HRFCO and Korea Institute of Civil Engineering and Building Technology (KICT), and the opportunity to develop follow-up actions for the upcoming Sixteenth Session of RA II in February 2017. He noted that these would be followed by further development of draft work plans consistent with the RA II Operating Plan for 2016-2019 and the development of specific activities for the WGHS for 2016-2019. He noted that in addition, there would be a field trip on Wednesday afternoon to the Kwater pumping station, which was the largest in the world. He recalled that there was a requirement to provide a final report for the WGHS associated with the RA II meeting, and he requested all experts to provide him with a brief summary of their major accomplishments and the revised final work plan for their area of endeavour.

## 2. ADOPTION OF THE AGENDA AND ORGANIZATION OF WORK

2.1 The meeting was attended by 13 participants from 5 countries of the RA II.

2.2 The list of participants is given in **Annex 1** to this report. Mr Paul 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 discussed the agenda and adopted it (**Annex 2**). Mr Kim briefly mentioned that he had reported to the RA II Management Group on the activities of the WGHS during its meeting held 15 June 2016 . He also noted that he had provided the Management Group with the WGHS input to the RA II Operating Plan 2016-2019. It was also noted that all presentations made and material provided during the meeting can be downloaded from the following URL:

http://www.wmo.int/pages/prog/hwrp/RA2/RAII-WGH-III-Seoul.php

2.4 Mr Paul Pilon provided a presentation, which can be found on the URL above, on pertinent outcomes from the 2nd Meeting of the WMO Flood Forecasting Initiative – Advisory Group, which held its meeting in December 2015 in Geneva, and aspects of the Commission for Hydrology (CHy) as a result of the 3rd Meeting of its Advisory Working Group (AWG), which was held in Geneva in February 2016. He also presented on the outcomes directly of relevance to the WGHS stemming from the 68th Session of Executive Council (EC_68) held in June 2016. He noted as well the RA II Operating Plan for 2016-2019 and the upcoming 16th Session of the RA II in February 2017. He indicated that the group should consider what decisions should be placed before the next RA II Session pertaining to its work. This latter aspect would be discussed more fully Wednesday afternoon 26 October) and possibly Thursday morning (27 October).

## 3. REVIEW AND ADJUSTMENT OF WORK PROGRAMME

3.1 The work plans of all members present were reviewed and adjusted during the meeting. The revised work plans appear herein. The next section of this report provides a brief description of the progress made during the intersessional period. The work plans of those members who were absent, namely Messrs Muhammad Riaz, Sergey Borshch, Guoqing Wang, and Tran Thuc were revised by Mr Sung Kim through correspondence with said members following the conclusion of the meeting. This was also undertaken by Mr Sung Kim for Mr Tai-Hoon Kim who had to leave the meeting for an urgent work-related matter. All revisions to their work plans are also contained herein.

### 3.2 WORKPLAN: Chairperson of WGHS — Sung KIM

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| 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 | • Represent WGHS as and when required, (eg at MG and EC)<br>• Attend meetings of chairpersons of Working Groups<br>• Other duties as required of chairpersons WGHS (see General Regulation 168 (b)) | • Hydrology and Water Resources issues remain a key aspect of the work of RAII<br>• NMHSs are assisted in fulfilling their roles and responsibilities.<br>• WGHS is adequately represented within the RAII environment. | • Resources are provided to meet the needs of the theme leaders in doing the work of the Working Group.<br>• Secretariat support | • Meetings and other activities according to the WMO Schedule of meetings.<br>• Report at WGHS meetings<br>• Report at MG Sessions<br>• Report to RAII-16 (2016). | • WGHS<br>• RAII<br>• MG<br>• EC | • Attended RA II Management Group meetings<br>• Attended RA II Chairs Meetings (2014, 2015)<br>• Attended RA II Conference (2014) |
| 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 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 | • Chair theme leaders meetings of the WGHS to develop implementation plan<br>• Report to MG meeting for consultation<br>• Submit report | • WGHS implementation plan | • Resources are provided to meet the needs of the theme leaders in doing the work of the WGHS | • WGHS meeting (Sept. 2014)<br>• WGHS implementation plan (Oct 2014)<br>• Report at MG Sessions for consultation and submit a report to RAII president (2014) | • WGHS<br>• RAII<br>• MG | • Develop WGHS work plan and reported and updated (2013, 2014, 2015, 2016) Develop future WGHS activity plan (2016) |
| 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 | • Attend EC meeting if required<br>• Develop WGHS work plan in consideration of CHy and other regional WGHS activities | • Meeting report<br>• WGHS implementation plan | • Resources are provided to meet the needs of the theme leaders in doing the work of the WGHS | • WGHS meeting (Sept. 2014)<br>• WGHS implementation plan (Oct 2014)<br>• Report at MG Sessions for consultation and submit a report to | • WGHS<br>• RAII<br>• MG | • Attended EC65, EC68<br>• Attend Hydrological Advisors Meeting during EC meeting (2013, 2016)<br>• Report of WGHS and implementation |

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| the Commission for Hydrology and other regional Working Groups on Hydrology | • Organize WGHS meeting | | | RAII president (2014) | | plan |
| 4. To submit to the president of the Association an annual report by 31 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 | • Develop WGHS activity report with input from theme leaders | • WGHS activity report | • Resources are provided to meet the needs of the WGHS theme leaders | • Submit annual report to RAII president and WMO Secretariat (Dec 2014, Dec 2015)<br>• Submit final report to RAII president and WMO Secretariat (2016) | • WGHS<br>• RAII<br>• WMO | • Organize WGHS meetings and submitted report (2013, 2014, 2015, 2016)<br>• Nov 2016 Final Activity Report submitted |

**3.3 WORKPLAN: Vice Chairperson of WGHS (RA II) Muhammad Riaz**

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| 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 | • On-going |
| 2. To review the reports sent by various Theme leaders through the Chairperson | Summary of review | Report | • Chairperson<br>• Theme Leaders<br>• RA II Secretariat<br>• CHy | Not specified | • Chairperson<br>• Theme leaders<br>• RA II Secretariat<br>• CHy | • On-going |
| 3. To review and develop the Hydrological Parts of S.O.P. | Review if required | Review report | • RA II strategic operation Plan<br>• 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 | • Theme Leaders reports in RA II<br>• CHy report | Submission of report by 2016 | RA II<br>WGHS<br>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 | S.O.P<br>WGHS | |

### 3.4 WORKPLAN: Water Resource Assessment

**GAO Ge and Hwirin KIM**

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| 1. Assessment of basin-wide water resources availability, including use of climate predictions (3.3.2) | • 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) | | • RA II | | • RA II<br>• CHy | |
| 2. Assessment of basin-wide water resources availability, including use of climate predictions (3.3.2) | • Set up knowledge base to adapt to changes in water resources availability (trends, outlook) (Priority A) | • Report related to the case studies | • RA II<br>• Research documents<br>• Han River Flood Control Office(HRFCO), Ministry of Land, Transport and Infrastructure(MOLIT), Republic of Korea<br>• Korea Institute of Civil engineering Technology (KICT), Republic of Korea | • Develop new system by Dec 2016<br>• Collection case studies by the end of 2016<br>• Evaluate model performance by Dec 2016<br>• Final case study report on new model in Jan. 2017 | • RA II<br>• AWG | • Case studies being collected<br>• Beta version of Dynamic Water Resources Assessment Tool(DWAT) using hydrologic components of KICT CAT(Catchment hydrologic cycle Assessment Tool) |
| 3. Implementation of Water Resources Assessment (WRA) (3.3.3) | • Provide guidance materials for WRA linking to Climate extended range prediction<br>- Downscaling<br>- monthly and seasonally prediction WRA models<br>- WRA (Priority B) | • Guidance for WRA | • China<br>• Korea | • Provide draft technical report by the end of 2016<br>• Provide draft technical manual of Dynamic Water Resources Assessment Tool by the end of 2016<br>• Provide Final user's Guidance of DWAT system by the end of in Mar.2017 | • RAII<br>• CHy | Technical Report draft has been finished preliminarily. |
| 4. Development of national and regional capacity building programmes and related training activities for hydrological services (3.3.4) | • Provide training material for a training course related to the advances in WRA:<br>- Downscaling methods for extended range prediction<br>- Data collection<br>- WRA methods<br>- WRA Information system (Priority B or C) | • Training Course | • WMO Regional Training Center in Nanjing | • Training Course in 2017 | | |

**3.5 WORKPLAN: Flood Forecasting** **Sergey BORSHCH**

| **Activities** | **Actions** | **Outputs** | **Resources** | **Milestones** | **Linkages** | **Activity report** |
|---|---|---|---|---|---|---|
| 1. Improvement in hydrological warnings capability through enhanced and effective cooperation with other NMHSs (2.1.1) | (a) To prepare recommendations on the use of numerical weather prediction outputs in flood forecasts (Priority A)<br><br>(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)<br><br>(c) Use WMO FFI as platform [for a and b above] (Priority A)<br>(d) Organize training course for Members (Priority C)<br><br>(e) Organize training course for Members (Priority C) | (a) Recommendations on the use of NWP outputs in flood forecasting systems<br><br>(b) Document on the approaches to establishing the deterministic error in NWP outputs and for their use in establishing enhanced accuracy of hydrological forecasts | HMC of Russia | (a) Gathering of background material and documents on the FFI and associated activities - January 2015<br><br>Preparation of Draft Recommendations – June 2015<br><br>(b) Gathering of materials - September 2015<br><br>Preparation of Draft Report on procedures – February 2016 | OPACHE's<br><br>International Flood Initiative - WMO | At the 26/10/2016<br>1. *Recommendations for the development of forecast methods for the spring floods forecasting on the base of meteorological information (the experience of Roshydromet)* – S.Borshch, A. A. Gelfan, Y. Motovilov, Kristoforov, Y. Simonov, V. Belchikov, C. Leontieva and others, - Moscow, 2016, 65 p. (in Russian)<br>2. *Guidelines for verification of hydrological forecasts.* – S.Borshch, A. Khristoforov, C. Lieontieva. – Moscow, 2016, 84 p. (In English<br>3. *Operational Hydrologic Forecast System in Russia (in the book "Flood forecasting: a global perspective". Chapter 7, edited by Thomas E. Adams, III and Thomas C. Pagano),* pp.169-181 (with Y. Simonov), Academic Press, ELSEVIER, 2016 (in English). ISBN 978-0-12-801884-2. In the chapter briefly touches on the hydrologic forecast system of the Roshydromet: hydrological phenomena to forecast; forecasting techniques and models used operationally; the hydrometeorological data network; and automated forecast systems.<br>4. *Recommendations on objective evaluation of observational networks configuration in terms of their density and composition of observations, taking into account the impact on the accuracy of hydrological forecasts.* – S. Borshch, A. Khristoforov, Y. Simonov and others. – Moscow, 2016, 81 p. (in Russian) |
| 2. Issuance of flood, flash and urban warnings and constantly improving upon them (2.2.5) | (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 | (a) Report documenting experiences, including recommendations on approaching implementation of FFGS and its use | (a) Working meeting with hydrologists and meteorologists of the Central Asia countries on use the | (a) Background material and documents on the FFGS and associated activities - April 2015<br><br>Preparation of Draft Document – June 2015 | NMHSs OPACHE's WMO Hydrological Research Center in San Diego (USA) | 1. *Flood forecasting and early warning system for rivers of the Black Sea shore of Caucasian region and the Kuban river basin* (S.V. Borsch, Y.A. Simonov, A.V. Khristoforov). - Proceedings of the Hydro-meteorological Research Center of Russian Federation. Special issue №356. – Moscow, 2015, 247 p. ISSN 0371 – 7089. (in Russian) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (Priority A)<br><br>(b) To investigate the potential use of FFGS in Central Asian countries and facilitate its understanding by operational hydrologists in the region (Priority A)<br><br>(c) To develop recommendations on use of hydrological forecasts (including probabilistic forecasts) in flood management (Priority A)<br><br>(d) Develop user-oriented flood forecasting products (Priority C)<br><br>(e) Conduct mission visit(s) to Members in developing countries or least developed countries (Priority C) | (b) Recommended path forward for advancing the adoption of the FFGS in Central Asia.<br><br>(c) Conduct kick-off meeting of senior meteorologists and hydrologists within Central Asia on the FFGS project<br><br>(d) Report containing recommendations on use of hydrological forecasts (including probabilistic forecasts) in flood management, based on experiences of Roshydromet | FFGS in operative hydrological practice<br><br>(b) Funding for kick-off meeting for Central Asia FFGS | (b) Discussions with potential collaborating NMHSs in Central Asia - March 2015<br><br>Preparation of Draft Recommendations – March 2015<br>Conduct kick-off meeting - May 2015<br>(c) Report prepared by February 2016 | | Main aspects, methodology, principles of setup and operation of the flood forecasting and early warning system are described. Short-range forecast techniques of daily discharge on the hydrological river gauges of the Black Sea shore of the Caucasian region and the Kuban river basin are incorporated into the system. The main objective of the system is to increase quality and robustness of the operative decisions on flood prevention measures and water resources utilization. Developed structure and software of the forecasting system have universal nature and thus can be implemented in different regions of the Russian Federation. The special issue is addressed to specialists in hydrometeorological forecasting, hydrology, water resources, environmental monitoring and ecology. |
| 3. Improvement in capacity for water-related disaster management (hydrological extremes) [with theme on hydrological droughts] (2.1.3) | (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) | (a) Increased capacity for water-related disaster management | (a) Resources to conduct necessary workshop(s) through collaboration with APFM and IDMP | Training session on Integrated Flood Management dealing with development of community capacity - July 2016<br><br>Training session on Integrated Drought Management dealing with development of community capacity – November 2016 | APFM<br>IDMP<br>NMHSs<br>WMO | |

**3.6 WORKPLAN: Hydrological Aspects of Drought** **DERGACHEVA Irina**

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| 1. Monitoring and Warning Systems for Droughts (2.3.1.) | (a) Develop indicators for the determination of the onset of hydrological droughts:<br>• Collection, analysis and systematization of data to identify indicators for the determination of the onset of hydrological droughts<br>• Identify the types of Hydrological drought is characteristic of the Asian region<br>• Study of the conditions of formation of hydrological drought (Priority A) | • Report on the Indicators for the determination of the onset of hydrological droughts | • Centre of Drought Monitoring of Uzbekistan<br>• Uzbekistan experts<br>• Materials for IDMP<br>• Materials for HMNDP | • Preparing of the data and information to develop indicators for the determination of the onset of hydrological droughts - Oct 2015<br>• Draft Report – Dec 2015<br>• Report – November 2016 | • OPACHE's<br>• WGHS<br>• RAII<br>• WMO | • Report prepared on review of potential drought indices leading to selection of Pedya drought index, Standardized Precipitation Index SPI, Drought index for snow storage Sw. It also describes functions and design of an EWS for drought for Central Asian countries.<br>• Uzhydromet established a National Centre for Monitoring of Drought to serve as a coordinating and consultative center for drought preparedness, monitoring, prevention and mitigation of the adverse effects of drought. Potential to expand for all CA countries.<br>• Report also includes an analysis of the conditions leading to low water and drought and an analysis of the frequency of low water and drought for Uzbekistan. Could be used as template for other countries.<br>• This EWS allows the calculation of snow storage, assessments of precipitation and temperature, enabling the analysis of the conditions for river runoff formation in the low water years and the factors for its formation for all drought indices for sub-basins in the runoff formation zone of the Amudarya and Syrdarya rivers (Aral Sea basins). |
| | (b) Prepare guidance for the development of drought monitoring networks :<br>• Gathering information about the status of drought monitoring networks in Asian region | • Guidance materials for the development of drought monitoring networks | • WGHS RAII<br>• OPACHE Uzbekistan experts<br>• Materials for IDMP<br>• Materials for HMNDP | • Information for the development of drought monitoring networks – April 2016<br>• Draft Report – November 2016 | • OPACHE's<br>• WGHS<br>• RAII<br>• WMO | Analysis was performed indicating the need to strengthen / further develop the hydrometeorological monitoring network to improve the early warning of drought. No formal report to be prepared. Analysis is being provided to World Bank project on strengthening |

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
| --- | --- | --- | --- | --- | --- | --- |
| | • Identification of gaps and needs of the national hydrometeorological services to improve the drought monitoring networks (Priority B) | | | | | hydrometeorological services in the region. |

### 3.7 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 | Progress |
|---|---|---|---|---|---|---|
| 1. Improvement in adaptation capacity of water resources systems in a changing climate (2.1.2)<br><br>2. Assessment of basin-wide water resources availability, including use of climate predictions (3.3.2)<br><br>3. Improvement in capacity for water-related disaster management (Hydrological extremes) (2.1.3) | 1) Assessment of changes in climate<br>- Data and method of climate study: Data inventory, climate variables, methods – (Priority A)<br>- Trend of some climate variables: temperature, rainfall and other extremes – (Priority A)<br>- Changes in atmospheric circulation affecting climate extreme: e.g., Monsoon, typhoon and tropical depression, El Nino and Southern Oscillation – (Priority C)<br>- Change in climate affecting natural physical environment: e.g., drought, extreme rainfall, flood, sea water level – (Priority C) | Assessment report on climate change for participating countries | • WGHs<br>• WMO Secretariat<br>• NHRI, China<br>• CMA, China<br>• IMHEN, Vietnam<br>• Other countries | • Report to be submitted (May 2015)<br>• Reports to: AWG-II<br>• Documents as required<br>• Workshop if needed | WGHs<br>RA2<br>WMO Secretariat<br>CHY | 1. Data base establishment. Meteorological data at 758 stations within China and hydrological data recorded at 265 stations on major rivers in China were collected, and database was established.<br><br>2. Scientific report "climate change for major rivers in China", by Guoqing Wang, Jianyun Zhang, Junliang Jin, etc. May, 2015. China (in Chinese with English abstract)<br><br>3. Scientific report "Sea level rise along China's Coast line", by Guoqing Wang, Guowei Chen, etc. Feb, 2016. China (in Chinese with English abstract)<br><br>4. "Viet Nam Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" (in Vietnamese (Nguyen Van Thang et al.) is being translated into English, and the report will be available by Nov 2016<br><br>5. Journal papers are as follows:<br><br>• Meixiu Yu, Xiaolong Liu, Li Wei, Qiongfang Li, Jianyun Zhang and Guoqing Wang. 2016. Drought assessment by a short-/long-term composited drought index in the upper Huaihe River basin, China. Advances in Meteorology. http://dx.doi.org/10.1155/2016/7986568<br><br>• Binquan Li, Zhongmin Liang, Jianyun Zhang, and Guoqing Wang. 2016. A revised drought index based on precipitation and pan evaporation. International Journal of Climatology. DOI: 10.1002/joc.4740<br><br>• Guoqing Wang, Cuishan Liu, Sicheng Wan, Zhenxin Bao and Yanli Liu. 2016. Variability in stream flows of the Xiang River in a changing climate. Int. J. Global Warming. http://www.inderscience.com/info/ingeneral/forthcoming.php?jcode=ijgw<br><br>• G.Q. Wang, J.Y. Zhang. 2015. Variation of water resources in the Huang-huai-hai areas and adaptive strategies to climate change. Quaternary International 380-381 (2015) 180-186. http://dx.doi.org/10.1016/j.quaint.2015.02.005<br><br>Song Xiaomeng, Zhang Jianyun, AghaKouchak Amir, Sen Roy S., Xuan Yunqing, Wang Guoqing, He Ruimin, Wang Xiaojun, Liu Cuishan. Rapid urbanization and changes in spatio-temporal characteristics of precipitation in Beijing metropolitan area. Journal of Geophysical Research: Atmosphere, 2014, 119(19): 11250-11271 |

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| | 2) Conduct climate projections – (Priority A)<br>- Statistical downscaling<br>- Dynamic downscaling | Climate change scenarios for participating countries | | Report to be submitted (May 2015) | | 1. Scientific Report "Analysis and production of Climate Scenarios for Jinsha River basin", by Guoqing Wang, Junliang Jin, and Zhenxin Bao. Jan, 2016. China (in English)<br><br>2. Report of "Climate Chang and Sea level rise for Viet Nam" (in Vietnamese) (Tran Thuc, Nguyen Van Thang, Huynh Thi Lan Huong, Mai Van Khiem, Nguyen Xuan Hien, Doan Ha Phong), is being translated into English, and the report will be sent by Nov 2016 |
| | 3) Assessment of potential hydrological impacts of climate change on water resources of some selected river basins – (Priority A)<br>- Temperature<br>- Rainfall<br>- Evapotranspiration<br>- Flood and inundation<br>- Drought<br>- Water Resources | Report on the impacts of climate extremes and climate change to water resources | | Report to be submitted (Dec 2015) | | 1. Scientific report "Impact of Climate change on water resources of China by using multiple GCMs projections", by Guoqing Wang, Junliang Jin, and Zhenxin Bao. Dec, 2015 (in Chinese), China<br><br>2. Report of "Changes in Climate Extreme and Impact on Water Resources in Viet Nam" (Tran Thuc, Nguyen Xuan Hien, Mai Van Khiem) was submitted on 25 Oct 2016<br><br>3. Report of "Projection of extreme temperature and precipitation and their impacts on water resources in Dong Nai river basin and vicinity – Viet Nam" (in Vietnamese) (Vu Thi Van Anh, Tran Thuc, Vu Hai Son, Truong Thi Thu Hang) is being translated into English, and the report will be sent by Dec 2016<br><br>4. Journal papers are as follows<br><br>● Guoqing Wang, Jianyun Zhang, Ruimin He, Cuishan Liu, Tao Ma, Zhenxin Bao, Yanli Liu. 2016. Runoff sensitivity to climate change for hydro-climatically different catchments in China. Stochastic Environmental Research and Risk Assessment. DOI 10.1007/s00477-016-1218-6<br><br>● Guoqing Wang; Jianyun Zhang; Xuemei Li, Zhenxin Bao; Yanli Liu; Cuishan Liu; Ruimin He; Junsong Luo. 2016. Investigating causes of changes in runoff by using hydrological simulation approach. Applied Water Sciences. DOI: 10.1007/s13201-016-0396-1<br><br>● GuoqingWang, Jianyun Zhang, Thomas C. Pagano, Yueping Xu, Zhenxin Bao, Yanli Liu, Junliang Jin, Cuishan Liu, Xiaomeng Song, Sicheng Wan. 2015. Simulating the hydrological responses to climate change of the Xiang River basin, China. Theor Appl Climatol. DOI 10.1007/s00704-015-1467-1<br><br>Guoqing Wang, Jianyun Zhang, Junliang Jin, Josh Weinberg, Zhenxin |

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
| --- | --- | --- | --- | --- | --- | --- |
| | | | | | | Bao, Cuishan Liu, Yanli Liu, Xiaolin Yan, Xiaomeng Song, Ran Zhai. 2015. Impacts of climate change on water resources in the Yellow River basin and identification of global adaptation strategies. Mitig Adapt Strateg Glob Change. DOI 10.1007/s11027-015-9664-x |
| | 4) Translating climate and climate change information into actions in water resources development and management: – (Priority A)<br>- Case study for a selected | Report of case study | | Report to be submitted (Feb 2016) | | 1. *Recommendation report "Recommendations for China's adaptation strategy in water sector to climate change", submitted to Ministry of Water Resources by RCCC (Research Center for Climate Change, Ministry of Water Resources), drafted by Guoqing Wang and Jianyun Zhang, Dec, 2015. (in Chinese)*<br><br>*Recommendation report "Recommendations on Sponge City Development of Zhenjiang City for better adaptation to climatic extremes", by Guoqing Wang, Cuishan Liu, and Yanli Liu. Feb, 2016 (in Chinese)* |
| 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) | | 1. China's National Scientific Research and Development program "Scientific regulation and benefit sharing role of water resources for transboundary river, a case study of Mekong River basin", Guoqing Wang is the leader of sub-project of "Impact of climate change on eco-hydrology of the Mekong River", the project was approved in 2016<br><br>2. China's National Scientific Research and Development program "Impact of changes in climate and society on global terrestrial water cycle". Guoqing Wang is leading this project. The project was approved in 2016.<br><br>Training workshop on improving environment protection awareness, was held in Nanjing during Apr 12-14, 2016, organizing by Guoqing Wang |
| | 6) Lesson learn and experience sharing – (Priority B) | | | | | Training course for workshop on adaptation to climate change referencing experience from Japan and America, was held in Nanjing during March 12, 2015, organizing by Guoqing Wang. |

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

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| 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) | a) Provide guidance on the use of appropriate instruments and methods of observation in diverse conditions (Priority A)<br>• Collection of existing technical information in IRDMIS<br>➢ Measurement instrumentation (ADVM)<br>➢ Methods of discharge calculation<br>➢ Construction and operation of IRDIMS<br>• Case study on measurement by IRDMIS (52 sites)<br>➢ Measurement of tidal influenced discharge<br>➢ Measurement under backwater conditions caused by weirs, sluice gates, and river junctions<br>➢ Evaluation of measurement results<br>➢ Development of index velocity ratings<br>• Writing Technical report about construction and management by field characteristics | • Technical report of related to IRDIMS With case studies in various conditions<br>- Collection of the existing technical information of IRDIMS<br>- Development for index rating<br>- Installation and operation<br>- Procedure on development of index rating<br>• Development of Software tools to develop index rating | - Republic of Korea(ROK) | • Technical report and guideline with case studies<br><br>DEC 2016<br><br>• Software System (EDpad, MCDpad)<br><br>DEC 2016 | - CHy<br><br>- ROK | Translating Korean technical report into English version<br>• *Technical information of IRDIMS*<br>• *Installation and operation*<br>• *Discharge calculation including development of index rating*<br>• *Software tool for development of index rating*<br>• *Case study on various conditions*<br><br>*1st draft by DEC 2016 Final ver. will be completed by Feb 2017*<br><br>Development of Software tools have been completed, |

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| | | | | | | and its manual will be ready by DEC. 2016 |
| | b) Improve sediment measuring techniques (Priority B)<br>• Collection of existing technical information<br>➢ The status of existing sediment measurement techniques<br>➢ The status of new technologies and their applications<br>➢ The status of analysis methods<br>• Case studies on sediment measurements under various conditions (15 - 20 sites)<br>➢ Analysis of river construction effect on characteristics of sediment load, focused on 4 major river projects in Korea<br>➢ A comparative analysis on sediment load by sequence of rainfall event<br>• Writing Technical report about sediment measurement method and analysis of field characteristics | • Technical report on sediment measurement methods and with case studies in various conditions<br>- Analysis on characteristics of sediment load during rising & falling water level(Loop)<br>- Analysis on river construction effect on characteristic of sediment load, focused on 4major river project in Korea<br>- A comparative analysis on sediment load by sequence of rainfall event. | - Republic of Korea(ROK) | • Provide technical report and guideline with case studies<br><br>DEC 2016 | - CHy<br><br>- ROK | Translating Korean technical report into English version<br>• *Technical information of sediment measurement*<br>• *Case study on sediment measurement various conditions*<br><br>*1st draft by DEC 2016*<br>*Final ver. will be completed by 2017* |
| | 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(Priority B)<br>• Collection of existing technical information<br>➢ On major procedures for rating curve development<br>➢ On tools for rating curve development<br>• Case analysis with various field conditions<br>➢ On development of rating curves when backwater | • Report on methods to develop rating curves<br><br>- *Status of flow measurement the past 3 years*<br>- *Procedure of H-Q rating development*<br>- *Software tools to develop & to* | - Republic of Korea(ROK) | • Provide Technical report and guideline with case studies<br><br>DEC 2016 | - CHy<br><br>- ROK | Translating Korean Technical Report into English version<br>• *Status of flow measurement the past 3 years*<br>• *Procedure of H-Q rating development*<br>• *Software tools* |

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| | conditions exist (weir, junctions)<br>• Writing technical report on rating curve development | *manage of H-Q rating curve*<br>- *Case study on development of H-Q rating curve in various conditions and its guideline (backwater by weir, bed change, vegetation)* | | | | *to develop & manage of H-Q rating curve*<br>• *Case study on development of H-Q rating curve in various conditions and its guideline*<br>• *(backwater by weir, bed change, vegetation)*<br>• *1st draft by DEC 2016*<br>*Final ver. will be completed by 2017* |
| | b)detect trends and variability in selected river basin in the region (Priority C) | | | | | |
| | c) provide guidelines for calculating runoff data accuracy (Priority C) | | | | | |
| 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) | | | | | |

### 3.9 WORKPLAN: SEDIMENT DISASTERS AND MASS MOVEMENTS — TAI-HOON KIM

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| 1. Issuance of landslide/debris flow warnings and consistently improving upon them | • Collect and disseminate materials for assessment of sediment disasters (Priority A)<br>• Investigate warning technologies based on adaptive concepts (Priority B)<br>• Generate sediment disasters risk map (Priority C) | • Actual example for implementation of adaptive sediment disasters risk management tools with identification, reduction and evacuation | • Republic of Korea (ROK)<br>• National Disaster Management Institute (NDMI) | • Case study report for present systems for sediment disasters management - May 2015<br>• Analyzing models for the integrating system - Oct 2015<br>• Report for adaptive sediment risk management tools - Aug 2016 | • SOP 2.2.6<br>• RA II<br>• WMO Secretariat<br>• ROK (MPSS) | • <u>Governmental research reports</u><br>*1. National Disaster Management Institute (2014) A development of regional major disasters response scenarios and standards (I) focusing on urban flooding and drought, NDMI-PR-2014-07-01, 228p.(in Korean)*<br>*2. National Disaster Management Institute (2014) Construction of fundamental technology for disaster risk assessment and response(I), Disaster risk assessment system in Korea, NDMI-PR-2014-07-02-01, 313p.(in Korean)*<br>*3. National Disaster Management Institute (2014) Improvement of design element based on empirical experiments, NDMI-PR-2014-07-09-01, 262p.(in Korean)*<br>*4. National Disaster Management Institute (2015) Enhancement of criteria for disaster mitigation through practical based cause analysis, NDMI-PR-2015-01-02, 130p.(in Korean)*<br>*5. National Disaster Management Institute (2015) The reduction and management plans for risk factors of repeated structural disasters, NDMI-PR-2015-03-02-01, 200p.(in Korean)*<br>*6. National Disaster Management Institute (2015) Establishment of foundation for regional urban flood response system, NDMI-PR-2014-07-02-01, 156p.(in Korean)*<br>• <u>Professional research papers</u><br>*1. Lee, K.S., Jang, C-L., Lee, N.J., and Ahn, S.J. (2014). "Analysis of Flow Characteristics of the Improved-Pneumatic-Movable Weir through the Laboratory Experiments", Journal of Korean Water Resources Association, Vol. 47, No. 11, pp.1007-1015.*<br>*2. Lee, K.S., Ryu, J.K., and Ahn, S.J. (2014). "Change of regime coefficient due to dredging and dam construction.", Journal of Korean Environmental Dredging Society, Vol. 4, No. 1, pp.30-38.*<br>*3. Lee, K.S., and Jang, C-L. (2014). "Estimation of erosion resistance of vegetation mat for protecting bank surface erosion by laboratory experiments.", Journal of Korea National University of Transportation, Vol. 49, No. 1, pp.205-210.*<br>*4. Lee, K.S., and Jang, C-L. (2016). "Numerical investigation of space effects of serial spur dikes on flow and bed changes by using Nays2D.", Journal of Korean Water Resources Association, Vol. 49, No. 3, pp. 241-251.*<br>*5. Lee, K.S., and Jang, C-L., and Lee, N.J. (2016). "Analysis of Submerged Flow Characteristics of the Improved-Pneumatic-Movable weir through the Laboratory Experiments.", Journal of Korean Water Resources Association, Vol. 49, No. 7, pp. 615-623.*<br>*6. Song, Y.K., Kim, Y.U., Kim, K.J., and Lee, K.S. (2016). "Countermeasures on Safety Management of Decrepit Reservoir Based on the Comparative Analysis for Its Collapse Accidents.", Crisisonomy Vol. 12, No. 7, pp. 615-623.* |

| Activities | Actions | Outputs | Resources | Milestones | Linkages | Progress |
|---|---|---|---|---|---|---|
| 2. Improvement in capacity for sediment disaster management (2.1.3 in OP) | • Attend seminars on sediment disasters in order to communicate and cooperate among member countries (Priority A)<br>• Share and bring related technologies to developing countries (Priority B) | • Workshop on the provision of sharing knowledge for sediment disasters (e.g. attend workshop of TC DRR)<br>• ODA projects which transplant knowhow to developing countries | • Republic of Korea (ROK)<br>• National Disaster Manageme nt Institute (NDMI)<br>• WMO/ESCA P Typhoon Committee , Disaster Risk Reduction (TC DRR) | • Report for feasibility survey for ODA projects by April 2016<br>• Attend Workshop of TC DRR on May 2015<br>• Attend International Workshop among Korea, Taiwan, and Japan | • SOP 2.1.3<br>• RA II<br>• WMO Secretariat<br>• TC DRR<br>• ROK (MPSS and KOICA) | • <u>Governmental research reports</u><br>*1. National Disaster Management Institute (2014) Construction of Forecasting and Warning System for Disaster Mitigation in the Philippines-II, NDMI-ODA-2014-1, 150p. (in Korean and English)*<br>*2. National Disaster Management Institute (2014) Regional Peer Learning Forum for Disaster Risk Reduction Capacity Building of Central Asia, NDMI-ODA-2014-02-01, 121p. (in Korean)*<br>*3. National Disaster Management Institute (2014) Development of NDMI's Roadmap for Its International Cooperation Work: Through Promoting international research and ODA project, NDMI-PR-2015-03-02-07, 176p. (in Korean)*<br>*4. National Disaster Management Institute (2015) Technical applicability analysis on disaster risk reduction technology transfer to strategic priority countries (I), Disaster risk assessment system in Korea, NDMI-PR-2014-07-02-01, 313p.(in Korean)*<br>• <u>International cooperation</u><br>*1. Regional forum on space technology applications for drought monitoring and early warning, UN-ESCAP, July 1-2, Colombo, Sri Lanka, 2014.*<br>*2. Expert mission for UNESCAP/WMO Typhoon Committee members, Oct. 21-25, 2014.*<br>*3. MOA bet. NDMI-ESCAP, Oct. 20-24, 2014.*<br>*4. NDMI Regional Peer Learning Forum (PLF) for Central Asia, Nov. 17-22, 2014.*<br>*5. The 47th UNESCAP/WMO Typhoon Committee General Meeting, Thailand, Feb. 9-13, 2015.*<br>*6. Expert mission for automatic rainfall warning system in Philippines Apr. 26-May 1, 2015.*<br>*7. 2015 UNESCAP/WMO Typhoon Committee Working Group on Disaster Risk Reduction meeting, May 19-20, 2015.*<br>*8. Establishment of automatic rainfall warning system in Laos, Sept. 4-6, 2016.*<br>*9. ADRC annual meeting, Thailand, Mar. 25-26, 2016.*<br>*10. The 48th UNESCAP/WMO Typhoon Committee General Meeting, Hawaii, Feb. 22-25, 2016.* |
| 3. Optimization of disseminating sediment disasters related information | • Collect and analyze disseminating methodologies and related policies for sediment disasters information that alarm people not to be involved to the designated areas | • Actual example for sediment disasters information by public broadcasting system and other media (e.g., Facebook, Twitter, etc.) | • Republic of Korea (ROK)<br>• National Disaster Manageme nt Institute (NDMI) | • Summary report for present disseminating codes and regulations by June 2015<br>• Report about the effective disseminating framework by Dec. 2015 | • Above SOP<br>• RA II<br>• WMO Secretariat<br>• TC DRR<br>• ROK (MPSS) | • <u>Governmental research reports</u><br>*1. National Disaster Management Institute (2014) Construction of heat wave risk map based on various heat wave-related information, NDMI-PR-2014-08, 87p. (in Korean)*<br>*2. National Disaster Management Institute (2014) A study on the safe system and resilience circumstances to promote citizen's participation in safety improvement, NDMI-ER-2014-08, 346p. (in Korean)*<br>*3. National Disaster Management Institute (2015) Research on improvement of the evacuation guidance system based on evacuation simulation, NDMI-PR-2015-02-01-01, 105.(in Korean)*<br>• <u>Public services</u><br>*1. App for foreigners, Safety First, released, Nov., 2014.*<br>*2. The second phased service of Safety Map is available, Jan. 26, 2015.* |

## 4. DESCRIPTION OF PROGRESS MADE DURING THE INTERSESSIONAL PERIOD

4.1 Brief descriptions on progress made during the intersessional period are provided herein for the subject-matter topic areas.

4.2 Water Resources Assessment

4.2.1 Many achievements were obtained for the Activities in the Work Plan (see section 3) having the highest priority, specifically Activity 2 (Priority A) and Activity 3 (Priority B). Various case studies and documents on investigations and practices were reviewed. These were primarily on case studies related to climate change adaptation in water resources and its impact on availability. These covered different basins and regions in China during 2015-2016. These were thought to be helpful for providing guidance to users who may be considering studies on water resource assessment as well as adaption analysis. Suggestions are also given on how to present findings to decision makers.

4.2.2 A draft technical report was made available in September 2016 on water resources assessment linked to extended range climate forecasts. In the report, two methods of water resources prediction are introduced, one is hydrological prediction during the flood season based on a statistical method, and the other is a one-way coupling method based on a dynamic extended range climate forecast and hydrological model. Statistical downscaling methods as input to some hydrological models are also included. An introduction to the water resources assessment and prediction tool is made through its application to some basins in China. These applications include examples of major products, which are valuable as reference material. The report also can be used as a source of material for training.

4.2.3 During the meeting, Mr Mikhail Georgievsky provided a presentation informing the WGHS of the efforts being undertaken in the Russian Federation on Water Resources Assessment. His presentation is available on the webpage for the 3rd Meeting of the RA II WGHS.

4.3 Flood Forecasting

4.3.1 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 WMO Flood Forecasting Initiative (FFI). The FFI is the basic implementation framework related to hydrological forecasting and flood management. The main task of FFI is to 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.

4.3.2 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.

4.3.3 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. To assist in this regard, a report has been prepared entitled "Guidelines for verification of hydrological forecasts." It is felt that this report will be useful for professionals involved in operational hydrological forecasting, as well as for professionals involved in the development of forecasting methods.

4.3.4 The Flash Flood Guidance System (FFGS) has been developed by the Hydrologic Research Center in San Diego (USA) under the direction of Mr 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.

4.3.5 Currently there are three projects being implemented in RA II. These are the Mekong River Commission FFGS, the South Asia FFGS and the Central Asia Region 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 Asia and the world; and

(b) investigate the potential use of FFGS in other Asian countries and facilitate its understanding by operational hydrologists in the region.

4.3.6. 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.

4.4 Hydrological Aspects of Drought

4.4.1 Coverage areas and scope of the negative impacts on the population from drought is dominant among other natural disasters in Central Asia. Currently in Central Asia a lot of attention paid to the development of drought early warning systems. Early identification of drought is key to developing a set of measures aimed at mitigating the effects of drought and food security of the countries. In 2008, Uzhydromet established the National Centre for Drought Monitoring. Its purpose is to serve as a coordinating and consultative centre for drought preparedness, monitoring, prevention and mitigation of the adverse effects of drought. This Centre in Uzbekistan uses the infrastructure and scientific knowledge in the country as well as neighbouring ones to study the problem of drought. It also promotes informing stakeholders on various aspects of drought and its prevention. Center specialists developed and implement a drought early warning system.

4.4.2 A Drought Early Warning System is a tool for assessing, monitoring, warning, information sharing and decision making, supported by the necessary information platform and providing dissemination (warning) and exchange of necessary information. The objective of the Drought Early Warning System is to provide decision makers and population with early information about a possibility of drought occurrence with a view to reducing the drought risk as much as possible. Functional capabilities of the Drought Early Warning System are: assessment of water resources; analysis of low water availability and drought formation conditions; assessment of water resources conditions based on climate scenarios; and assessment of low water availability and drought occurrences possibilities based on climate scenarios.

4.4.3 To identify the on-set of drought, the Drought Early Warning System uses three indices: Pedya drought index; Standardized Precipitation Index (SPI); and the Drought index for snow storage (Sw). Using the Pedya drought index has a number of advantages because it gives a degree of deviation of temperature and precipitation from the normal (multi-year) value and allows one to objectively classify all cases according to the degree of aridity or lack of moisture. This index is suitable for any natural area for any length of time (decade, month, season). This indicator does not depend explicitly on the main climatic characteristics: the mean and the variance of temperature and precipitation. The advantage of the SPI is that it can be used over different time intervals (up to several decades) to assess the severity of the drought. It also allows the comparison of moisture conditions at various points in the region. For river basins having snow and snow-glacier regimes, water availability should reflect the accumulation of snow in the mountains in winter. In such cases, it is advisable to use the accumulation of snow in the mountains for a certain period of time as a criterion (index) of the water availability, termed Sw.

4.4.4 These three indices within the EWS allow the calculation of snow storage with assessments of precipitation and temperature, thereby enabling the analysis of the conditions for river runoff formation in the low water years and the factors for its formation for all drought indices for sub-basins in the runoff formation zone. These would be most valuable for assessing the early on-set of drought in the Amudarya and Syrdarya rivers within the Aral Sea basin.

4.5 Assessment of Changes in Climate Extremes, their Impacts on Water Resources, and Translating Climate Information into Action in Water Resources

4.5.1 The activities 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. The participating countries developed their case studies and compiled reports.

4.5.2 In the activities in China, scientific studies of "climate changes for major rivers", "sea level rise along China's Coastal line", and "Impact of climate change on water resources of China by using multiple GCMs projections" were conducted and reported. In addition, recommendation reports for “China’s adaptation strategy in water sector to climate change” (in Chinese) and “Sponge City Development of Zhenjiang City for better adaptation to climatic extremes” (in Chinese) were conducted.

4.5.3 In the activities in Vietnam, scientific studies of “Changes in Climate Extremes and Impacts on the Natural Physical Environment”, “Climate Change and Sea level rise for Viet Nam”, and “Projection of extreme temperature and precipitation and their impacts on water resources in Dong Nai river basin and vicinity – Viet Nam” were conducted and reported in Vietnamese and being translated into English. The report shows that Extreme climatic events in Viet Nam are expected to increase in both frequency and intensity due to climate change.

4.5.4 During the meeting, Mr Nguyen Xuan Hien provided a presentation entitled “Changes in Climate Extreme and Impact on Water Resources in Viet Nam”. As well, he provided the report entitled “Changes in Climate Extreme and Impact on Water Resources in Viet Nam” as a contribution to the efforts within this thematic area. The presentation and the report are available on the webpage for the 3rd Meeting of the RA II WGHS.

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

4.6.1 In order to improve the accuracy of field measurements, it is necessary to review and research relevant techniques. It is also very important to use appropriate instrumentation and analytical techniques for specific flow conditions. The main objective of the activity is to provide a technical report or guideline, based on case studies for various conditions, comprising three parts: hydrological observation techniques; real-time discharge measurements (IRDIMS, Integrated Real-time Discharge Measurement System); and sediment measurement and development of rating curves.

4.6.2 In the activities on hydrometric measurements with quality and accuracy, the first action is to **'Provide guidance on the use of appropriate instruments and methods of observation in diverse conditions’**. In terms of the use of appropriate instruments and methods of observation in diverse conditions, the actions have focused on IRDIMS (Integrated Real-time Discharge Measurement System), which has been used to guide the design and construction and subsequently the operation for difficult sites. This was for measuring discharge under backwater and tidal effects in the Republic of Korea. The main purpose of this action is to provide technical information and guidance on the application of real-time discharge measurements for difficult to monitor sites.

4.6.3 Two sub-actions were conducted in this action plan: (1) Collection of the existing technical information of IRDIMS and (2) Case studies on the measurement of IRDIMS for 52 sites. Technical information related to real-time measurement include measurement instruments, method of discharge calculation, and the construction and operation of IRDIMS. Case studies were used to assess the result of measurements attained using IRDIMS for various specific conditions categorized on characteristics of flow conditions, such as tidal affected areas and backwater affected areas caused by weir, sluice gate, junctions, etc. These case studies also include an evaluation of the results by a comparative analysis using individual measurements and assessment of runoff between upstream and downstream stations. In regards to the development of index ratings, the procedure and software tools (EDpad, MCDpad) have been introduced including analysis of the available measurement range of the ADVM and development of index rating curves, which have been developed using Microsoft Excel. These will be provided to other members to help standardize and facilitate developing index ratings for real-time discharge measurement.

4.6.4 The 2nd action to **'Improve sediment measuring techniques'** is achieved by providing technical information related to sediment measurement and a case study of how to do so reflecting various conditions. Two sub-actions were conducted in this action plan : (1) Collection of the technical information related to measurement and analysis of sediment and (2) Case studies on sediment measurement under various conditions. The collected technical information about sediment measurement included existing and advanced new technologies and their application. Case studies focused on sediment measurement under various conditions, which included an analysis of the characteristic of suspended sediment in rising and falling flow conditions (known as a loop in the concentration-discharge or C-Q rating curve), comparative analysis before and after construction using 4 major river projects, and the characteristic of suspended sediment for successive rainfall event.

4.6.5 In the activity of Calculation of runoff with quality and accuracy, the main action was entitled **'Focus on the development of H-Q rating curve'**. This action aimed to provide a report outlining procedures for developing the optimal H-Q rating curve under various conditions in the Republic of Korea and providing technical information about improved development procedures and introducing a development tool for establishing the H-Q rating curve. Two sub-actions were conducted in this action plan: (1) Collection of the existing technical information and (2) Case studies on development of the H-Q rating curve under various field conditions. For the first sub-activity, the procedure of discharge measurement and its calculation, the evaluation of the measurement and its data quality control (QC), and procedures for the development and evaluation of rating curves were introduced in software tool being used in Hydrological Survey Centre (HSC) of the Republic of Korea. Case studies were used to illustrate the proper development of H-Q rating curves under various fields conditions based on practical experience. The case studies also recommended methodologies and introduced the evaluation using the basin's water balance The case studies focused on developing rating curves for backwater affected areas as caused by weirs and stream junctions. Consideration was also given to the development of H-Q rating curves that reflect changing aquatic vegetation conditions (method and procedure of vegetation monitoring), and the effect of stream-bed changes on H-Q rating curves.

4.7 Sediment Disasters and Mass Movements

4.7.1 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; and (3) optimization of disseminating sediment disasters related information.

4.7.2 In 2016, as the last year of the activity, this theme tried to make all possible results to complete outcomes which the theme leader suggested in the first meeting. Major results of the Activity 1 can be divided into three ingredients: (1) Identify the mechanism of sediment disasters; (2) Establish the analysing system and data base; and (3) Develop various measures for sediment disasters. Our research found that one single landslide would make catastrophic disasters as it moves along the stream, therefore understanding the nature of sediment disasters is top priority. Evaluation of structures such as dam, levee, and so on also needs to be done. Finally, developing guidelines to reduce the sediment disasters and managing data are also required.

4.7.3 The Activity 2 focuses on increasing our ability to manage sediment disasters through collaboration with experts from other countries. This year the thematic area generated three remarkable achievements in this field: (1) International workshop among Korea, Taiwan, and Japan (July 5 to 7, 2016); (2) Korea-Italy bilateral symposium on landslide prediction and warning technology (Mar. 14 to 15, 2016); and (3) Official Development Assistance (ODA ) project in

Vietnam and Laos. From these events, we have learned the importance of cooperation in dealing with sediment disasters and have tried to find a better way to help developing countries based on their needs.

4.7.4 In the Activity 3, the main objective is disseminating information on sediment disasters into communities. Two methods are considered: (1) Early Warning System; and (2) Public dissemination. The thematic area suggests advancing the use of "safety map" (http://www.safemap.go.kr/main/smap.do) of MPSS (Ministry of Public Safety and Security, Republic of Korea) for ordinary people. This map is the world's first portal site on this topic and contains 127 items on safety information from 20 governmental agencies. Sediment disaster is applicable to the category of Disasters in this map.

## 5. WORKSHOP FOR THE DYNAMIC WATER RESOURCES ASSESSMENT TOOL (DWAT)

5.1 The **D**ynamic **W**ater Resources **A**ssessment **T**ool (DWAT) was developed by HRFCO and KICT. Mr Cheol-Hee Jang provided a presentation explaining the concepts and approaches undertaken, including a description of the hydrological process model used within the tool and how various elements within the hydrological cycle are mathematically modelled.

5.2 The presentation resulted in several questions and comments being provided. It was learned that public domain GIS (GDAL) was used within the model, to help reduce the costs associated with implementing it. The tool has been designed to assist long-term planning and policy assessment and development. Its application can allow assess of land-use changes within the basin over time, the impacts on water availability under different consumptive use scenarios, and the impact on availability due to climate change through the application of scenarios.

5.3 Mr Cheol-Hee Jang indicated that the model has been tested on basins ranging in size form 23 km$^2$ to 1,000 km$^2$. It was noted that the computational time step could vary form 1 minute (for smaller basins) to monthly. The Tool was tested to explore its ability to assist in city planning and development. He also indicated that a draft user guide has been prepared.

5.4 The experts also discussed possible future features that could be advantageous to develop. For example, it was noted that the Tool does not consider snow accumulation and ablation, while this would be needed for application in environments where snow is more common and is a significant contribution to the timing and amount of stream discharge and a source for soil moisture and groundwater recharge. As well, the Tool currently only considers in situ climate stations to estimate various elements (e.g., rainfall, temperature, etc) for sub-basins as input to the model. It was noted that this was due to the large observing network that exists, but that consideration should be given to also allowing use of satellite and radar data to derive the best estimates of Quantitative Precipitation Estimates (QPE) for the sub-basins. It was thought that should a Flash Flood Guidance System be operating covering the basin, its merged QPE could be used within the Tool, rather than replicating the computational process. As well, the use of Numerical Weather Prediction outputs was discussed, particularly if the Tool were to be used for shorter-term planning purposed for planning water use restrictions, etc. It was also noted that a module would be needed to downscale climate scenario input to the sub-basin scale for sue in the longer-term planning applications.

5.5 Mr Cheol-Hee Jang noted that the beta version of the Tool will be available by end of 2016. This version would be applied within RA II to further test the system. It was thought that about two years would be required to finalize the beta version of the Tool including making some additional modules available. These would include the ability to easily incorporate climate change scenarios including downscaling, as well as a module to reflect snow modelling. The experts commented that the Tool as illustrated in the workshop was excellent, and they were excited with the possibility of receiving the Tool for testing and use within their countries.

## 6. FUTURE WORK PLAN

6.1 Participants discussed the development of work plans for the next intersessional period and the future structure of the RA II Working Group on Hydrological Services. The future structure agreed upon for the consideration of the 16$^{th}$ Session of RA II was:

**Working Group on Hydrological Services (WGHS)**

**Expert Group on Coordination and Capacity Building (EG-CCB)**

- Theme I Water Related Disaster Management

- Theme II Provision of Hydrological Services

**Expert Group on Measurements, Monitoring and Infosystems (EG-MMI)**

- Theme I Hydrometric Measurements

- Theme II Sediment Disasters and Debris Flows

**Expert Group on Hydrological Applications (EG-HA)**

- Theme I Water Resources Assessment

- Theme II Flood Forecasting

-Theme III Hydrological Aspects of Drought

-Theme IV Hydrological Adaptation to Climate Change

6.2 Participants reviewed the aspects of the RA II Operating Plan 2016-2019 pertaining to the Working Group on Hydrological Services (WGHS). The above working group structure was added to the Operating Plan for the WGHS for ease of future reference.

| DEPT | BRANCH | ER | KEY OUTCOME | KEY PERFORMANCE INDICATOR | DELIVERABLE | PORGAMME | TC | REGION | ACTIVITY | Y2016 | Y2017 | Y2018 | Y2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRA | RAP | 2 | 2.2 | 2.2.1 [EG-HA Theme II] | Improvement in hydrological warnings capability through enhanced and effective cooperation with other NMHSs | WWW, HWRP, DRR | CBS, CHy | RA II | (a) Prepare recommendations on the use of NWP outputs in flood forecasts; (b) Document approaches to ascertain the deterministic error of each ensemble element of NWP products; (c) Use WMO Flood Forecasting Initiative as platform | | x | x | x |
| DRA | RAP | 3 | 3.3 | 3.3.1 [EG-HA Themes 1 & IV] | Improvement in adaptation capacity of water resources systems in a changing climate [using Water Resources Assessment methodologies] | WWW, HWRP, WCP | CBS, CHy, CCl | RA II | (a) Assess changes in climate extremes - Data and method of climate extreme study: data inventory, climate index - Trend of some climate extremes: temperature, rainfall and others (b) Translate climate and climate change information into actions in water resources development and management | x | x | x | x |
| DRA | RAP | 3 | 2.1 | 2.1.1 [EG-CCB Theme I] | Improvement in capacity for water-related disaster management (Hydrological extremes) | WWW, HWRP, DRR | CBS, CHy | RA II | (a) Organize a workshop on the provision of input and support to disaster management (b) Attend seminars on sediment disasters in order to communicate and cooperate among member countries | | x | x | x |
| DRA | RAP | 3 | 3.3 | 3.3.1 [EG-MMI Theme I] | Improvement in hydrometric measurements with quality and accuracy | WWW, HWRP | CBS, CHy, CIMO | RA II | Provide guidance on the use of appropriate instrumentation and methods of observation in diverse conditions | | X | x | X |
| DRA | RAP | 2 | 2.2 | 2.2.1 [EG-HA Theme II] | Issuance of flood, flash and urban flood warnings and constantly improving upon them | WWW, HWRP, DRR | CBS, CHy | RA II | (a) Document experiences in the use of the Central Asia Region Flash Flood Guidance System (FFGS) in participating countries by reviewing its use (b) Facilitate FFGS understanding by operational hydrologists in the Region (c) Develop recommendations on the use of hydrological forecasts in flood management | x | x | x | x |
| DRA | RAP | 2 | 2.1 | 2.1.1 [EG-MMI Theme II] | Issuance of landslide/debris flow warnings and constantly improving on them | WWW, HWRP, DRR | CBS, CHy | RA II | Collect and disseminate guidance materials and manuals on the assessment of rainfall/flood induced mass movement hazards and potential forecast methodologies | | x | x | x |
| DRA | RAP | 3 | 3.3 | 3.3.1 [EG- CCB Theme II] | Development of national and regional capacity building programmes and related training activities for hydrological services | HWRP | CHy | RA II | Synthesize report from individual reports from participating countries in RA II on national and regional capacity development activities in hydrology and make recommendations on their enhancement | | x | x | x |

**RA II Operating Plan for 2016-2019 Working Group on Hydrological Services (WGHS)**

## 7. CONSIDERATION OF INPUT TO CHy-15 AND 16th SESSION OF RA II

7.1 The meeting considered the major accomplishments achieved by the WGHS and developed a short list of those where decisions from either or both the next Session of CHy or the 16th Session of RA II would be desirable. These major accomplishments included:

| Major Accomplishments | Session | Decision |
|---|---|---|
| Dynamic Water Resources Assessment Tool (DWAT) | CHy, RA II | CHy: urges CHy to assess the Tool testing its ability and to provide guidance on its further development for global utility<br>RA II: requests RA II Members to assess the Tool, testing its ability and to provide guidance to the RA II WGHS Chairperson on its further development for the benefit of Members |
| Guidelines for Verification of Hydrological Forecasts | CHy, RA II | CHy: urges CHy to review and assess the global utility of the Guidelines as a potential contribution to the WMO Flood Forecasting Initiative<br>RA II: requests RA II Members to review and apply the verification procedures, reporting their results and views on the procedures to the RA II WGHS Chairperson |
| Software tool for index velocity method | CHy, RA II | CHy: urges CHy to assess the utility and applicability of the software tool and methods therein for measuring discharge under backwater and tidal influence<br>RA II: requests RA II Members to test the Software Tool, reporting their results and views on the procedures to the RA II WGHS Chairperson |

## 8. ADOPTION OF THE REPORT AND CLOSURE OF THE MEETING

8.1 Participants agreed that the final draft report would be circulated to participants allowing a period for Mr Sung Kim to update the work plan with members who were not in attendance and to include their description of progress made during the intersessional period. Once their views have been incorporated, the draft report will be circulated to participants with 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 seeking approval of the President of RA II for its publication.

8.2 The Chairperson, Mr Sung KIM, thanked the participants and the WMO Secretariat for their contributions and professionalism that made the meeting a success. He also thanked experts for their hard work over the last four year period, and he indicated with pleasure that he has seen the experts accomplish many of their tasks in their work plan.

8.3 Mr P. Pilon expressed his gratitude on behalf of WMO to the Government of Korea for their having provided financial assistance, as without this funding the second and third meetings of the RA II WGHS would not have been held. He also thanked Mr Sung Kim, Mr Cheol-hee Jang and all staff in supporting the effective organization of the meeting and for their efforts and assistance. He also thanked Mr Kim specifically for his demonstrated leadership and persistence in directing the work of the working group and in reporting their successes. In closing, he underscored the importance of fulfilling the work plans as outlined prior to the next session of RA II to be held in February 2017, not only for the benefit of National Hydrological Services in RA II, but for all Regions.

8.4 Participants thanked everyone for the excellent, productive meeting at 16:45.

8.5 The meeting closed on the 27th of October 2016.

**ANNEX 1**

**List of Participants - RA II (Asia) Working Group on Hydrological Services (WGHS)**

**(Seoul, Republic of Korea, 25-27 October 2016)**

***<u>Working Group on Hydrological Services (WGHS):</u>***

| | |
|---|---|
| **Chairperson**<br><br><br>**(HOST)** | Dr Sung KIM<br>Senior Research Fellow<br>Korea Institute of Civil Engineering and Building Technology (KICT)<br>283 Goyangdae-ro, Iisanseo-gu,<br>Goyang-si, Gyeonggi-do 10223<br>Republic of Korea<br>Telephone: +82 31 910 0602<br>Telefax: +82 31 910 0251<br>E-Mail: skim@kict.re.kr |
| **Vice-Chairperson WGHS (absent)** | Mr Muhammad RIAZ<br>Pakistan Meteorological Department<br>Flood Forecasting Division<br>46 Jail Road<br>LAHORE<br>Pakistan<br>Phone: +92 42 99 200 208<br>fax: +92 42 99 200 209<br>E-Mail: riaz1962@hotmail.com |
| **Theme Leader in Water Resources Assessment** | Ms Ge GAO<br>National Climate Center<br>China Meteorological Administration<br>No. 46 Zhuang-guan-cun Nan-da-jie<br>Haidian District<br>Beijing 100081<br>China<br>Telephone: +8610 68406915<br>Telefax: +8610 68406975<br>E-Mail: gaoge@cma.gov.cn |
| **Theme Leader in Water Resources Assessment** | Dr Hwirin KIM<br>Han River Flood Control Office<br>Ministry of Land, Infrastructure and Transport<br>328, Dongjakdaero, Seocho-gu<br>Korea 06501<br>Telephone: +82 2 590 9973<br>Fax: +82 2 590 9989<br>Email: hydro@korea.kr |
| **Theme Leader in Hydrological Responses to Climate Variability and Change and Promotion of the** | Dr Guoqing WANG<br>Nanjing Hydraulic Research Institute<br>225 Guangzhou Road |

| | |
|---|---|
| **Use of Climate Information by Water Managers (absent)** | Nanjing 210029<br>China<br>Tel: +8625 85828531<br>Fax +8625 85828555<br>E-Mail: gqwang@nhri.cn<br>E-Mail: guoqing_wang@163.com |
| **Theme Leader in Flood Forecasting (absent)** | Dr Sergey BORSHCH<br>Hydrological Center of Russia<br>Bolshoy Predtechensky Per., 11-13<br>MOSCOW 123242<br>Russian Federation<br>Tel: +7 499 795 21 84<br>Fax: +7 499 252 32 49<br>Mobile +7 916 328 5352<br>E-mail: borsch@mecom.ru<br>E-Mail : borsch56@mail.ru |
| **Theme Leader in Hydrological Aspects of Drought** | Ms Irina DERGACHEVA<br>Research Hydrometeorological Institute of Hydromet<br>Ahmad Yugnaki, 30-40<br>Tashkent 100052<br>Uzbekistan<br>Telephone: +998 71 2359140<br>E-Mail: Dergacheva_iv@mail.ru |
| **Theme Leader in Hydrological Responses to Climate Variability and Change and Promotion of the Use of Climate Information by Water Managers (absent)** | Dr TRAN Thuc<br>Institute of Meteorology Hydrology and Climate Change<br>No. 23 Lane, 62 Nguyen Chi Thanh<br>HANOI 10000<br>Vietnam<br>Telephone: +84 903282894<br>Telefax: +84 38355993<br>E-Mail: thuc@netnam.vn<br>Tranthuc.vkttv@gmail.com |
| **Theme Leader in Sediment Disasters and Mass Movements** | Dr Tai-Hoon KIM<br>Senior Analyst<br>National Disaster Management Research Institute<br>Ministry of Public Safety and Security<br>365, Jongga-ro, Jung-gu<br>Ulsan, 44538<br>Republic of Korea<br>Telephone: +82 52 928 8270<br>Mobile : +82 10 7302 0309<br>Telefax: +82 52 928 8299<br>E-Mail: taihoon@ualberta.ca<br>ddahoon@korea.kr |
| **Theme Leader in Improved Accuracy of Hydrometric and Sediment Observations including Space-based Technologies** | Dr Youngsin ROH<br>Hydrological Survey Center<br>Office building, KINTEX, 407<br>Hallyuworld-ro, Ilsanseo-gu,<br>Goyang-si, Gyeonggi-do<br>Goyang |

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**ANNEX 2**

**World Meteorological Organization**

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

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

SEOUL, REPUBLIC OF KOREA
**25 TO 27 OCTOBER 2016**

Submitted by: Secretariat
Date: 25.10.2016
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**FINAL MEETING AGENDA**

**3rd Meeting for WMO Regional Association II**
**Working Group on Hydrological Services (WGHS)**
**and**
**Workshop on the Dynamic Water resources Assessment Tool**

**Venue: Han River Flood Control Office / Western Coop Residence Hotel**
**Seoul, Republic of Korea**

**25 October to 27 October, 2016**

**<u>Tuesday 25 October</u> (Han River Flood Control Office)**

**3rd WGHS Morning Session (09:00 – 10:00) Session Chairman: Dr. Hwirin Kim**

- Opening of the meeting and welcome by representatives of the hosting organization and WMO (Han River Flood Control Office Director: Mr Hajoon Park)
- Introduction of participants and adoption of the agenda (Sung Kim)
- Report on activities of the Commission for Hydrology (CHy) as a result of the 3rd AWG Meeting, February 2016 (Paul Pilon)
- Report on decisions and recommendations of RA-II, including the RA-II Strategy as a result of the Working Group and Chairs' Meeting in RA-II, December 2015 (Paul Pilon)
- The RA II Operating Plan 2016-2019 as approved by the RA II Management Group on 15 June 2016 (Paul Pilon)

**3rd WGHS Morning Session (10:00 – 12:00)**
**Session Chairman: Dr. Sung Kim**

Report of activities (actions, outputs, milestones and progress) as per the work plans in the following theme areas, focusing on main achievements:

- Water Resources Assessment (Dr. Hwirin Kim, Ms GAO Ge)
- Hydrological Aspect of Drought ( Ms. Irina Dergacheva)

**Lunch break (12:00 – 14:00)** (Lunch will be provided by HRFCO.)

**3rd WGHS Afternoon Session (14:00 – 17:30)**
**Session Chairman: Dr. Sung Kim**

Report of activities (actions, outputs, milestones and progress)as per the work plans in the following theme areas, focusing on main achievements:

- Hydrological Responses to Climate Variability and Change and Promotion of the Use of Climate Information by Water Managers for adaptation of climate change in the context of climate variability in hydrological cycle in each country (Dr. Nguyen Xuan Hien) (Substitute)
- Improved Accuracy of Hydrometric and Sediment Observations including Space-Based Technologies (Mr Youngsin Roh)
- Sediment Disasters and Mass Movements (Dr Tai-Hoon Kim)
- Water Resources Assessment in Russia (Dr Mikhail GEORGIEVSKIY) (observer)

**Welcoming Dinner (18:00 – 20:00)** hosted by the Director of Han River Flood Control Office, Ministry of Land, Infrastructure and Transport (Venue: Korea House 18:00)

**Wednesday 26 October**

**Workshop for the Dynamic Water resources Assessment Tool (DWAT) developed by HRFCO and KICT (09:00 – 10:00): Dr. Cheol-Hee Jang**

- Presentation for the development of the Dynamic Water resources Assessment Tool (DWAT)
- Demonstration of the Dynamic Water resources Assessment Tool (DWAT)
- Discussion on application of the DWAT and identification of possible future improvements

**Discussion on follow-up and future implementation for the upcoming CHy and RA-II sessions (Sung Kim and Paul Pilon)**

- 15th Session of the Commission for Hydrology, Rome, Italy, 7-13 December 2016; and
- 16th Session of RAII, Abu Dhabi, UAE, 12-16 February 2017 and Regional Conference on Management of Meteorological and Hydrological Services (RECO-7) 10-11 February 2017 **(10:00 – 11:00)**

**Lunch break (12:00 – 14:00)** (Lunch will be provided by HRFCO)

**Afternoon session (14:00 – 17:30)**

**FIELD TRIP**

**Welcoming Dinner (18:00 – 20:00)** hosted by the Director of KICT Hydro Science and Engineering

**Thursday 27 October**

**3rd WGHS Morning Session (09:00 – 12:00)**
**(Sung Kim and Paul Pilon)**

- Discussion on the approved RA II Operating Plan 2016-2019 and development of activities for the RA-II WGHS for the following period (2016-2019)

**3rd WGHS Afternoon Session (14:00 – 16:00)**
**(Sung Kim and Paul Pilon)**

- Reviewing and adoption of meeting report
- Closing session

**ANNEX IV**

# Report of the RA II Working Group on WMO Integrated Global Observing System and WMO Information System (WG-WIGOS/WIS)

**Yongqing Chen, China Meteorological Administration**

**Chairperson of the RA II Working Group on WIGOS/WIS**

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**Yongqing Chen and Jaegwang Won**
**Co-coordinators, Expert Group on WIGOS**

**Xiang Li and Kenji Tsunoda**
**Co-coordinators, Expert Group on WIS**

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**Report of the RA II Working Group on WMO Integrated Global Observing System and WMO Information System (WG-WIGOS/WIS)**

## 1. Introduction

In the fifteenth session of Regional Association II which was held in Doha, Qatar, from 13 to 19 December 2012, the Regional Association II Working Group on WMO Integrated Global Observing System and WMO Information System (WG-WIGOS/WIS) was re-established to bear the responsibility of facilitate the accomplishing of missions of WIGOS and WIS.

## 2. Working Group Structure

The Working Group is composed of Expert Group on WIGOS (EG-WIGOS) and Expert Group on WIS (EG-WIS). Both EG- WIGOS and EG- WIS consist of two co-coordinators and several theme leaders. In addition, a number of volunteer experts who are expected to assist the tasks of each Expert Team have also been registered.

## 3. Terms of Reference

(a) To monitor and coordinate the implementation of WIGOS and WIS in the Region; propose measures for improvements, especially for overcoming gaps, deficiencies and inconsistencies in the implementation of these systems; and promote active involvement of the Members of the Region in the implementation of these systems;
(b) To advise on and provide overall technical guidance, assistance and support to the Members of the Region for the implementation of WIGOS and WIS at the regional and national levels;
(c) To promote capacity-development and outreach activities to assist Members in the implementation of WIGOS and WIS;
(d) To liaise with the relevant RA II Working Groups on matters related to WIGOS and WIS implementation;
(e) To advise the president of the Association on matters concerning the implementation of WIGOS and WIS in the Region;
(f) To provide the president of the Association with recommendations for presentation under appropriate agenda items in sessions of technical commissions, joint sessions of the presidents of technical commissions and presidents of regional associations, and the Executive Council;

## 4. Membership

Expert Group on WIGOS (EG-WIGOS)

| **EG-WIGOS** | | |
|---|---|---|
| Co-Coordinators | Mr Yongqing Chen | China |
| | Dr Jaegwang Won | Republic of Korea |
| Theme Leader in Implementation and Updating of R-WIP | Mr Yoshiro Tanaka | Japan |
| Theme Leader in Implementation of EGOS-IP | Mr Yatian Guo | China |
| Theme Leader in Standard and Best Practice | Mr. Namsan Cho<br>Mr. Chulwoon Choi | Republic of Korea |
| Theme Leader in Observational Requirements and Regional Network | Mr D. K. Malik | India |
| | Mr Abdulqaleq Ali Ali | Iraq |

| | | |
|---|---|---|
| Theme Leader in Data Availability and Quality of Observations | Mr Nobuyuki TANAKA | Japan |
| Theme Leader in Surface-based Remote Sensing for Disaster Risk Reduction | Mr Feng Li | China |
| | Dr Oleg Pokrovsky | Russian Federation |
| Theme Leader in Satellite Data, Products and Training | Mr Tomoo Ohno | Japan |
| | Dr Dohyeong Kim | Republic of Korea |

Expert Group on WIS (EG-WIS)

| **EG-WIS** | | |
|---|---|---|
| Co-Coordinators | Ms Xiang Li | China |
| | Mr Kenji Tsunoda | Japan |
| Theme Leader in Data Communication Techniques and Structure | Dr Sunghoi Huh | Republic of Korea |
| Theme Leader in Data Representation and Metadata | Ms Jitsuko Hasegawa | Japan |
| Theme Leader in WIS-GTS operations, including Early Warning | Dr Shyamlal Singh | India |
| | Mr Aleksandr Soloveychik | Uzbekistan |
| Theme Leader in Climate Data Management/Data Rescue | Mr Hongzheng Zhang | China |
| Theme Leader in Integrated Global Data Dissemination System | Ms Wang Chunfang | China |

**5. Completing of membership Working Group on WIGOS and WIS**

In accordance with resolution 11 of RA II-15, there are an Expert Group on WIGOS (EG-WIGOS) and an Expert Group on WIS (EG-WIS) under WG-WIGOS/WIS. Each of these two expert groups consists of two Co-Coordinators and some Theme Leaders and Volunteer Experts. Mr. Yongqing Chen (China) and Dr. Jaegwang Won (Republic of Korea) were approved to be Co-Coordinators of EG-WIGOS in the session, and meanwhile, Ms. Li Xiang (China) and Mr. Kenji Tsunoda (Japan) were approved to be Co-Coordinators of EG-WIS.

Co-coordinators of EG-WIGOS and EG-WIS initially proposed the lists of Theme leaders (areas) of EG-WIGOS and EG-WIS in accordance with Terms of reference (TOR) of EG-WIGOS and EG-WIS, the R-WIP-II approved by XV-RA II, as requested by the WMO secretariat.

The theme areas of EG-WIGOS focus mainly on how to carry out main projects in the R-WIP-II. The list of Theme leaders (areas) of EG-WIGOS is as follows,

(a) Theme leader in Implementation and Updating of R-WIP;
(b) Theme leader in Implementation of EGOS-IP;
(c) Theme leader in Standard and Best Practice;
(e) Theme leader in Observational Requirements and Regional Network;
(f) Theme leader in Data Availability and Quality of Observations;
(g) Theme leader in Surface-based Remote Sensing for Disaster Risk Reduction;
(h) Theme leader in Satellite Data, Products and Training.

The Theme areas of EG-WIGOS focus mainly on coordinating and promoting WIS implementation, operation and services, including GTS and IGDDS, and data management in RA II. The list of Theme leaders (areas) of EG-WIS is as follows,

(a)Theme Leader in Data Communication Techniques and Structure

(b)Theme Leader in Data Representation and Metadata
(c) Theme Leader in WIS-GTS operations, including Early Warning
(d)Theme Leader in Climate Data Management/Data Rescue
(e)Theme Leader in the Integrated Global Data Dissemination System

Then, Theme Leaders of both EG-WIGOS and EG-WIS were nominated by members and finally decided by the management group (MG-7) in May 2013.

The Theme Leaders are expected to lead the activities in their respective theme areas in close coordination with the Members in the Region, monitoring the key performance indicators/targets concerned, and reporting progress of development and implementation to the Expert Group Co-Coordinators concerned.

After that, Volunteer Experts for EG-WIGOS and EG-WIS were also nominated by members finally approved by President of RA II in October 2013.

Therefore, the WG-WIGOS is composed of two co-coordinators, 10 theme leaders and 13 Volunteer Experts, while the WG-WIS is composed of two co-coordinators, 6 theme leaders which and 12 Volunteer Experts.

**6. Drafting the Work Plan of Working Group**

A work plan for the WG-WIGOS/WIS was developed by coordinators of Expert Group on WIGOS and Expert Group on WIS, with the help of theme leaders and WMO secretariat. The work plan for the WG-WIGOS/WIS has been submitted to WMO secretariat by the end of October 2013.

The work plan was developed mainly based on the deliverables outlined in the RA II Strategic Operating Plan, the terms of reference of the Expert Group, and the projects listed in the R-WIP-II, and outlined the main tasks which would be carried out by the Working Group before the next session and key deliverable, activity, expected accomplishing time and responsibility.

Nine tasks for EG-WIGOS were established in the work plan and each task includes several activities which will be accomplished in the expected years. Most of activities would be implemented through the RAII WIGOS projects and RA II members under the initiative of key regional players.  The theme leaders of EG-WIGOS have responsibility to track and promote the execution of these activities and projects. Key deliverables for EG-WIGOS in the work plan are as follows,

(a) A new version of R-WIP-II to be developed
(b) A portal to share progress EGOS IP implementation in RA II to be developed
(c) A portal on standards and best practices to be developed
(d) Collaborative working mechanism toward integrated surface-based remote sensing observations in the East Asia for operational monitoring and forecasting severe weather to be established.
(e) Technical support for instrument maintenance and calibration by experts from RICs to be provided.
(f) ISO/IEC 17025 certification to be obtained.
(g) Report on status on QC/QA procedures and site management in RA II will be available.
(h) Reports on status on meteorological instruments, calibration and training in Regional Association II to be available.
(i) Capacity in use of satellite data/products and facilitation of training datasets and tool boxes to be improved.
(j) The systematic Near Real Time monitoring of sand and dust storm to be carried out in SDS-WAS Asia Node.
(k) RBSN and RBCN to be updated.

Seven tasks for EG-WIS were established in the work plan and each task included several activities which would be accomplished in the expected years. The theme leaders of EG-WIS had responsibility to carry out or promote these activities. Key deliverables for EG-WIS in the work plan are as follows,

(a)RA II- WIS-IP (2013: first version, 2014-2016: review and update)
(b) Status and Plans of RMTN in RA II (2014-2016)
(c) Amendments of Volume II of the manual on the GTS in RA-II (2016)

(d) Status Report of Data Representation and Metadata in RA II (2014-2016)
(e) Status Report of the implementation of WIS service and WIS monitoring in RA II (2014-2016)
(f) Status Report of the Climate Data Management/Data Rescue in RA II (2014-2016)
(g) Status Report on IGDDS in RA II (2014-2016)

Each theme leader in the expert group, supported by volunteer experts if available, would bear responsibility for one or several tasks in the plan which was relevant to his or her theme area and would submit report to co-coordinators of the expert group as required.

**7. Develop and Publish RA II Regional WIS Implementation Plan**

Fifteenth session of RA II reviewed the initial draft of the RA II WIS Implementation Plan which has been developed by local secondments from CMA and KMA and coordinator of WG-IOS/WIS SG-WIS, and the session requested EG-WIS to complete developing the plan as priority items. In accordance with the agreement and user reviews of the initial draft, co-coordinators of EG-WIS established a Task Team on RA II WIS Implementation Plan (TT-R2-WIS-IP) in May 2013 and invited experts from all GISCs and one DCPC and two NCs in RA II to finalize the WIS Implementation Plan.

The final version of RA-II WIS-IP (available at: http://wis.wmo.int/file=653) was completed and approved by the President of RA-II in December, 2013. The RA-II WIS-IP is updated in 2015 and will be submitted to RA II and WMO secretariat by the end of 2016, and it will be available from WMO website. In this time, amendments will be mainly updating WIS Centres Implementation status. In addition, the co-coordinators of EG-WIS will propose a new structure of IP to RA II-16.

To continue identification of WIS requirements of Members, and to better support the implementation and operation of WIS services in RA II, the review and updates of RA-II WIS-IP is ongoing by using the mechanism of local secondment. CMA has nominated Ms. Zhu Ting and Mr. Wang Peng as local secondments. The co-coordinators invite other GISCs and DCPCs in RA II to nominate a few more experts to join this work as local secondments. The nominations are expected to send to WMO secretariat and the co-coordinators by the end of 2016.

**8. The First session of RA II EG-WIGOS** (EG-WIGOS-1)

At the kind invitation of the Government of the United Arab Emirates, the First session of the WMO RA II Expert Group on the WMO Integrated Global Observing System (EG-WIGOS-1) was held from 31 October to 1 November 2016 in Abu Dhabi, United Arab Emirates. H.E. Dr. Abdullah Ahmed Al Mandoos, Director-General of the National Centre for Meteorology & Seismology, Permanent Representative of United Arab Emirates with WMO, opened the meeting and welcomed the participants to Abu Dhabi.

On behalf of the Secretary-General of WMO, Dr. I. Zahumensky, WIGOS Project Office, opened the session and welcomed the participants to Abu Dhabi. Mr. Yongqing Chen, the Co-Coordinator RA II EG-WIGOS, made the opening remarks, in which he reviewed the activities carried out from 2013 to 2016 by the EG-WIGOS.

The Secretariat informed EG-WIGOS-1 about the WIGOS related recommendations from Cg-17 and EC-68, recent progress on the OSCAR/Surface, WIGOS Data Quality Monitoring System, the concepts of the Regional Basic Observing Network (RBON) and Regional WIGOS Centers, respectively, and the protection of radio frequencies.

The progress achieved and the future plans for the seven regional projects defined in RA II WIGOS Implementation Plan (R-WIP-II) were presented by the theme leaders.

The future implementation of WIGOS in RA II, such as establishment of RBON and RWCs in pilot mode, the continuation of the current RBSN/RBCN during the next intersessional period and the future structure of EG-WIGOS were discussed at the meeting.

Several recommendations to the WIGOS Workshop for West Asia (2 to 3 November 2016, Abu Dhabi) were drafted and consequently submitted to the workshop by Dr. Yongqing Chen, chair RA II EG-WIGOS.

The main conclusion of the meeting could be summarized as follows:

Good progress was made in the projects of the R-WIP-II; however, there is the need for future activities to complete them during the following four years. The progress and future actions to be undertaken are detailed in the section 8.

EG-WIGOS-1 recommended that the Projects I, II, III-2, IV, V, and VI should continue during the next intersessional period; they should be updated accordingly, and in line with the Plan for the WIGOS pre-operational phase 2016-2019; new projects should be drafted when appropriately, especially on establishing RWCs in pilot mode. A proposal for Regional WIGOS Centers in RA II is submitted to RA II MG meeting for consideration.

A Task Team on developing the RBON in RA II is proposed to be established by RA-II-16. TOR with a roadmap for the implementation of RBON in RA II is also submitted to RA II MG for consideration. It is proposed that chair of Task Team on RBON should be a member of EG-WIGOS.

EG-WIGOS-1 recommended that the R-WIP-II should be updated taking into account the Plan for the WIGOS pre-operational phase 2016-2019. The updated R-WIP-II is submitted to RA II MG for consideration.

EG-WIGOS-1 further recommended that the current RBSN/RBCN should continue to be operational until the new RBON is formally implemented based on the approval by P-RA/MG or the RA session. The RBSN/RBCN lists should be updated and be submitted to the 16th session of RA II for approval. When the RBSN/RBCN lists are being updated, the RBON concept, specifically the key attributes and criteria for the selection of stations/platforms into RBON should be taken into account.

EG-WIGOS-1 also recommended that the term "Theme Leader" should be changed to "Project Leader". The name of the Project Leaders should be identical to those listed in the R-WIP-II Projects.

**9. The First meeting of RA II EG-WIS (EG-WIS-1)**

At the kind invitation of the Government of Japan, the first meeting of the Expert Group on the WMO Information System (WIS) in Regional Association II (RA II EG-WIS) was held from 25 to 27 November 2015 in Tokyo, Japan.

On behalf of the Secretary-General of WMO, Dr Chung Kyu PARK, the Director of the Regional Office for Asia and the South-West Pacific, presented the results of the fifteenth session of Regional Association II (RA II-15) held in 2012 and the operating plan of EG-WIS. The participants were informed of the WMO Strategic Plan and Priorities for the next fiscal years 2016-2019, which were endorsed by the seventeenth World Meteorological Congress (Cg-17) to meet the global societal needs and to contribute to the Post-2015 Sustainable Development Agenda. Among the WMO Strategic Priorities is to strengthen the global observing systems through the implementation of the WIGOS and WIS.

Mr Peiliang SHI, the Director of WMO Information System Branch, presented the summary of the recommendations from CBS-Ext. (2014) with a link to the associated Cg-17 resolution to allow easy mapping by RA II EG-WIS when considering the progress of WIS implementation in the region, ensuring that the work plans of the group align with the latest technical regulations and guidance that has been agreed since CBS-Ext (2014). He pointed the publishing of the WIS competencies and learning guide essential for Members to be able to ensure that they have staff with the right set of competencies to be able to use and maintain WIS.

The meeting reviewed the regional requirements on WIS, as well as the TLs' reports on Data communication techniques and structure, Data representation and metadata, GTS/WIS operation including Early Warning, and IGDDS. The co-coordinators summarized progress of WIS/GTS in RA II since the RA II-15. 6 GISCs and 4 DCPCs reported the implementation status.

The meeting noted the importance of WIS monitoring for stable operation and continuous improvement of WIS services, and reviewed the pilot dashboards developed by GISCs Beijing and Tokyo, and encouraged all the operational GISCs to consider the implementation of WIS monitoring and start providing JSON files as soon as possible. The meeting also reviewed the progress of Application Pilot Project (PP-App).

The meeting reviewed the current structure of EG-WIS, and the designation procedure of the EG-WIS members after the RA II-15 (2012).

The main recommendations of the meeting could be summarized as follows:

- Amendment of the Manual on WIS. The meeting noted that NC Pyongyang (Democratic People's Republic of Korea (DPRK)) had designated its principal GISC, and requested WMO secretariat to update the information of DPRK in table B.3 (National Centres) of the Manual on the WIS (WMO No.1060).
- Future structure of EG-WIS in RA II. The meeting noted that it's necessary to establish a new group to coordinate WIS Centres (e.g. Implementation and Coordination Group on WIS), and requested the co-coordinators and WMO secretariat to draft a new structure on EG-WIS to consider establishing ICG-WIS in RA II-16 (February 2017).
- Designation procedure for expert group EG-WIS in RA II. The meeting noted that the EG-WIS members including Volunteer Experts were approved in the 8th RA II MG meeting in 2014, and agreed that it must have been approved in a short time. The meeting requested RA II MG to consider designation procedure to be approved within 6 months after RA II session.

**10. Monitoring progress on implementation of WIGOS and WIS**

Theme leaders of EG-WIGOS and EG-WIS are responsible for the monitoring of progress on each project of IP-WIGOS and WIS in close cooperation with the contact person of main players of the Project.

**10.1 Status of implementation of WIGOS**

The implementation of R-WIP-II relies mainly on seven RAII WIGOS projects listed in the R-WIP-II. Seven project contact persons provided progress information to the co-coordinator of EG-WIGOS. The progress for each project is listed as bellow.

**10.1.1 Project No. I- Monitor and review the Implementation of EGOS- IP in RA II**

A portal for sharing the national progress of EGOS-IP implementation was established by CMA Meteorological Observation Centre (MOC). A report template has been prepared by S.T. Chen from Hong Kong, China. The technical scheme of assessing the progress was drafted by CMA MOC. The evaluation indexes were divided into seven aspects: management, integration, observation capacity, products, standardization, data quality and acquisition, cooperation.

**10.1.2 Project No. II- Standard and Best Practice Portal, including Technical Documents with Necessary Details in English from all RA II Members**

As the meteorological data, including NWP, observations, etc, is considered highly valued things in socio-economic sector of Korea, many Korea government agencies, except for KMA, started observation for their own purpose in the 1990s. However, there were not involved regulations and system at that time. KMA enacted the law, that is called "Weather observation and Standardization Act", based on which, KMA has been collaborating with up to 28 agencies and the AWS amounts to over 3,700 at present. A shearing system called "Observation Standard Sharing System (OSS)" was established in 2012. It can collect all data and conduct QC, followed by displaying the data for application. Responding to the challenges on insufficient knowledge and data errors from other agencies, KMA provided e-learning courses for their staff, and built up intermediate server for data flow.

**10.1.3 Project No. III.1 - Observing systems integration for supporting disaster risk reduction - Integration of Surface-based Remote Sensing Data in the East Asia**
***Real-time exchange of radar CAPPI products and automated weather station data between Japan and Korea***

The Japan Meteorological Agency (JMA) and the Korea Meteorological Administration (KMA) mutually agree to exchange radar CAPPI products and automated weather station (AWS) data in near real-time basis to use for operational purpose. In near real-time, KMA obtains radar 2km-height pseudo CAPPI products of JMA's weather radar stations as well as hourly data of JMA's surface observation network, called the Automated Meteorological Data

Acquisition System (AMeDAS). JMA also obtains radar CAPPI products of KMA's weather radar stations as well as most data of KMA's AWSs in near real-time.

JMA succeeded in generating experimentally a two-dimensional grid product of analyzed precipitation over the region of the Republic of Korea using the radar CAPPI data and in-situ precipitation data of AWSs. JMA is now developing a quality control system to remove noise from radar CAPPI products. JMA conducted some experiments for a certain period to investigate the impact of this new analyzed precipitation using JMA's mesoscale NWP system. Although the assimilation of the analyzed precipitation improved precipitation forecasts in some cases, it is also confirmed that the overall precipitation forecast skill degraded. To improve the overall skill, it is inferred that simultaneous assimilation of other humidity observations such as ground-based GNSS data over the Republic of Korea would be essential.

***Non-real-time exchange of raw data of Doppler radar between Japan and Korea***

JMA and KMA also agree to exchange raw data of their Doppler radars in off-line basis to investigate the benefit of operational use of these data in individual NWP system.

In March 2013, JMA obtained a set of raw data for 5 days of July 2012 on the case of heavy rainfall over Kyushu Island from KMA. It was revealed that a quality control was necessary to use such raw data in a meso-scale NWP system.

***Dissemination of ground-based stations of the Global Navigation Satellite Systems on WIS/GTS***

Data of ground-based stations of the Global Navigation Satellite Systems (GNSSs) are disseminated on WIS/GTS in real time so that these data are available for operational use. Table 1 shows a list of such ground-based GNSS stations in China, Korea and Japan. At the Joint Meeting of the 12th Asia Pacific Satellite Data Exchange Meeting (APSDEU) and 24th North America / Europe Data Exchange Meeting (NAEDEX) (22-25 October 2012, Met Office, Exeter, U.K.), CMA, JMA and KMA were requested to provide data of more ground-based GNSS stations on GTS. It is, therefore, expected to increase the data amount in the future. However, any significant progress is not observed yet according to the Members' reports to the Joint meeting of 14th APSDEU and 26th NAEDEX (6-9 October 2015, Montreal, Canada).

KMA have established a new system for ground GNSS data collection and QC in 2015 for the improved meteorological utilization, especially for the NWP model. By the end of November 2015, total 57 stations including 7 IGS around Korean Peninsula are linked to the system, and 39 out of them can be converted into bufr format for the NWP usage after the quality control procedure.

Since the technical method to assimilate zenith tropospheric delay data or total precipitable water vapor data of ground-based GNSS stations is established, the data on WIS/GTS can be used for operational purpose.

Table 1 List of Ground-based GNSS Stations whose data are disseminated on WIS/GTS

| Country | Station Name | Longitude (East) | Latitude (North) |
|---|---|---|---|
| **China** | Wuhan(WUHN-MET) | 114.36 | 30.53 |
| | Lhasa(LHAZ-MET) | 91.10 | 29.66 |
| **Japan** | Usuda(USUD-GOP) | 138.36 | 36.13 |
| **Rep. of Korea** | Daejeon(DAEJ-MET) | 127.37 | 36.40 |

**10.1.4 Project No. III.2 -Observing systems integration for supporting disaster risk reduction - Capacity Building in Radar Techniques in the Southeast Asia**

Thai Meteorological Department (TMD) cooperated with JMA for a regional capacity building project on the maintenance and rainfall estimation and forecast by using weather radar initiated by ASEAN/SCMG (Sub-Committee on Meteorology and Geophysics). With the support of Japan-ASEAN Integration Fund (JAIF), the Regional Training Workshop on Weather Radar Basis and Routine Maintenance and Real-Time Radar Rainfall Estimation and Forecasting was held in Bangkok, from 24 February to 7 March 2014, with 20 participants from 7 ASEAN countries (Indonesia, Lao PDR, Malaysia, Philippines, Singapore, Thailand and Viet Nam), together with three experts from JMA, two experts from Japan Radio Company, and one expert from JICA. The workshop was highly successful.

National reports of many ASEAN members on usage of weather radar was submitted to the 35th and consecutive ASEAN/SCMG annual meetings

TMD-JMA technical meetings on radar issues started in 2011 and followed by every year as activities of the WMO/ESCAP Typhoon Committee.

Experimental international radar data exchange among TMD, MMD and JMA has started in 2016 as an activity of the WMO/ESCAP Typhoon Committee.

MMD-JMA technical meetings on radar issues started in 2014.

BMKG-JMA technical meetings on remote-sensing technology started in 2015.

### 10.1.5 Project No. IV - RA II WIGOS Project to Enhance the Availability and Quality Management Support for NMHSs in Surface, Climate and Upper-air Observations

Based on the mailing list established for the members of coordinating group of RA II Pilot Project to Enhance the Availability and Quality Management Support for NMHSs in Surface, Climate and Upper-air Observations (approved by 14th session of RA II, Tashkent, December 2008), information has been exchanged through the mailing list which was periodically updated.

In 2010, as a pilot project activity, WMO/JMA Survey on Surface, Climate and Upper-air Observations and Quality Management in RA II was implemented to investigate implementing status on meteorological observations by Members. The results of the survey was issued as WMO IOM Report (No. 111) in 2011 and shared by Members. In addition to the Survey, JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia) was held in Japan (July 2010) with 22 participants from 20 Members in the Region.

The survey and workshop revealed that information on calibration of meteorological instruments by Members was required to promote the project, and consequently the WMO/JMA Survey on Meteorological Instruments, Calibration and Training in RA II was implemented in 2011. Following the survey, JMA/WMO Training Workshop on Calibration and Maintenance of Meteorological Instruments in RA II was held in Japan (Feb 2013) with 13 participants from 13 Members in the Region. The survey was reviewed and issued as WMO IOM report (No.122) in 2015.

As one of the activities of the project, quality of land surface observations in RA II Members is regularly monitored by RSMC Tokyo, by analyzing the differences between the surface observations and the corresponding first-guess fields of 6-hour forecasts of JMA's global model. The monitoring results are shared by Members concerned.

To achieve one of the expected key results (provision of technical support for instrument maintenance and calibration by experts from RICs), experts of JMA/RIC Tsukuba visited the Bangladesh Meteorological Department (BMD) and provided practical on-the-job training on meteorological instrument aiming at establishing the operational calibration system using meteorological standards (barometer and thermometer) donated in the framework of JICA technical cooperation project. The same project schemes are ongoing with Fiji, Sri Lanka, Mozambique and the Philippines.

### 10.1.6 Project No. V – Developing a Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) in Asia Node

According to the current GDPFS Manual - Designation and Mandatory Functions of Regional Specialized Meteorological Centres with Activity Specialization in Atmospheric Sand and Dust Storm Forecasts(RSMC-ASDF),SDS-WAS in Asia Node has carried out the following functions:

Has been preparing regional forecast fields by using CUACE/Dust continuously throughout the year on a daily basis. The model consists of a numerical weather prediction model incorporating online parameterizations of all the major phases of the atmospheric dust cycle;

Has been generating forecasts, with an appropriate uncertainty information statement, of the following minimum set of variables:

Dust load (kg•m−2)
Dust concentration at the surface (μg•m−3)
Dust optical depth at 550 nm (-)
3-hour accumulated dry and wet deposition (kg•m−2)

All those forecasts cover the period from the starting time (00 and/or 12 UTC) up to a valid time of 72 hours, with an output frequency of 3 hours. They cover the whole designated area with a horizontal resolution of about 0.5x0.5 degrees. KMA, NCEP and ECMWF have shared its output of SDS model forecast since 2016 in NRT.

The SDS-WAS in Asia Node Web Portal (http://eng.weather.gov.cn/dust/) has been designed to allow users to access to SDS forecast products as well as sources of basic information.

The Non-real-time functions according RSMC-ASDF have been fulfilled by SDS-WAS in Asia Node since 2014 as well. The CUACE/Dust forecasting system has been put into operational run in Asian region node centre(Asian-RC). It shows the forecasting results on the web portal and provides a link with forecasting results from two other SDS forecasting modle systems of JMA and KMA respectively.

### 10.1.7 Project No. VI - RA II WIGOS Project to Develop Support for NMHSs in Satellite Data, Products and Training

***Issuance of newsletters to RA II Members.***

Quarterly newsletters have been issued to share recent satellite-related information on topics such as imagery data, products and training. The newsletters listed below contained brief reports on relevant meetings, product development report, news on successful launch of new satellites and information on preparations for the Himawari-8/9 satellite series of JMA and Geo-KOMPSAT-2A of KMA. For example, in the vol.5/No.4, JMA introduced the first images captured by Himawari-8 new-generation geostationary meteorological satellite, which was launched on 7 October 2014.

Vol. 4/No. 1, April 2013
Vol. 4/No. 2, June 2013
Vol. 4/No. 3, November 2013
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All the newsletters in the past are available at the following RAII WIGOS Project webpage: http://www.jma.go.jp/jma/jma-eng/satellite/ra2wigosproject/ra2wigosproject-intro_en_jma.html

*6th Asia/Oceania Meteorological Satellite Users' Conference and training event*

The sixth AOMSUC was held in Tokyo, Japan from 9 to 13 November 2015. The conference was hosted and sponsored by JMA and was co-sponsored by CMA, KMA, ROSHYDROMET, AuBOM, WMO and GEO. The two day training event was also held with participants from Region II and V.

In addition, the Third Meeting of the Coordinating Group of the WMO Regional

Association II (Asia) WIGOS Project to Develop Support for National Meteorological and Hydrological Services (NMHSs) in Satellite Data, Products and Training was held at the JMA headquarters in Tokyo, Japan, on 14 November 2015, following the AOMSUC-6. The progress of the WIGOS Project was reviewed and the work plan 2015-2016 was discussed in the meeting by the participants of RA II Members and observers of RA V Members.

*7th Asia/Oceania Meteorological Satellite Users' Conference and training event*

The seventh AOMSUC was held in Songdo, Korea from 24 to 27 October 2016. The conference was hosted and sponsored by JMA and was co-sponsored by CMA, KMA, ROSHYDROMET, AuBOM, WMO and GEO. The two day training event (21-22 October 2016, Jincheon, Korea) was also held with participants from Region II and V before the Conference.

In addition, the Fourth Meeting of the Coordinating Group of the WMO Regional Association II (Asia) WIGOS Project to Develop Support for National Meteorological and Hydrological Services (NMHSs) in Satellite Data, Products and Training was held at Songdo, Korea, on 28 October 2016, following the AOMSUC-7. The progress of the WIGOS Project was reviewed and the work plan 2017-2020 was discussed in the meeting by the participants of RA II Members and observers of RA V Members.

### 10.1.8 Collaboration of RA-II and RA-V for future regional WIGOS projects

The Joint RA-II/RA-V Workshop on WIGOS for Disaster Risk Reduction was held in Jakarta, Indonesia, 12-14, October 2015, to seek synergies for the increase of data availability, geographic coverage, timeliness and quality of observations in the region, primarily those relevant for weather watch and nowcasting activities. The participants in the Workshop decided to propose two joint projects as follows.

a) A "Joint RA-II/RA-V WIGOS Satellite Data Project" aiming at
   - (i) strengthening the capabilities of all Members to use geostationary satellite images and derived products in support of Disaster Risk Reduction,
   - (ii) developing a protocol for the NMHSs in the project countries to request event-driven rapid-scan imagery for their respective national areas of interest

b) A "Joint RA-II/RA-V WIGOS Radar Data Project" aiming at
   - (i) improvement of data quality of existing radars,
   - (ii) development and expansion of national radar networks,
   - (iii) near real time international exchange of radar data, and
   - (iv) development of «sub-regional» radar data centre(s);

## 10.2 Status of implementation of WIS

With the framework of WMO Information System, WIS centres (GISC, DCPC, and NC) have been established by WMO members complying with the WIS technical requirements. As of November 2015, there are 7 GISCs[1] (6 are operational: 86%), 29 DCPCs (26 are endorsed: 90%) with 37 NCs in Regional Association II (RA II). 35 out of 37 NCs in RA-II decided their principal GISC in 2012, after that remaining two NCs decided their principal GISC. To facilitate the implementation and operation of WIS in RA II, there are various capacity building activities provided by the GISCs, which includes 6 on-site trainings and WIS workshops run by GISC Beijing, 1 workshop organized by GISC Jeddah, 2 workshops organized by GISC Seoul, 1 workshop organized by GISC Teheran, and 4 workshops organized by GISC Tokyo, in the course of 2014-2015.

10.2.2 WIS components

As the WIS core network, RMDNC-NG managed by ECMWF has been completed on its migration at the last May, 2014. GISC Beijing, Jeddah, Moscow, New Delhi, Seoul, Tokyo have completed their RMDCN-NG migration or connection to RMDCN-NG, but GISC Tehran has not been connected yet due to the license issue from supplier.

An annual survey for the status and plans of RMTN in RA II has completed. As of October 2016, the RA II RMTN consists of 108 links. One NI (Not Implementation) circuit between Bhutan and RTH New Delhi was established in 2015, and then, Bhutan started issuing their surface observation data in BUFR format since July 2016. On the other hand, ten circuits in the Regional configuration plan are not in operation. Especially NMCs Baghdad (ought to have 2 regional circuits), Kabul (3) is isolated from the GTS. Meanwhile, the NI circuit between Karachi and Tashkent has not been implemented yet, because there are difficulties to deploy telecommunication infrastructure for the area, and both RTHs requested to remove the link from RA II regional circuit plan. EG-WIS recognized the situation and accepted their requirement.

The operational links (90) in RMTN are operated on three types of communication infrastructure, dedicated leased line (30), MPLS/VPLS (28) and the internet (31). Before 1999, all the GTS circuits in RA-II were operated on dedicated leased line, but these days, communication links tend to migrate to the internet. Internet is a cost-effective, but centres need to consider and understand the characteristics of internet, in particular the internet security and best-effort serves. Satellite broadcasting systems, including CMACast, Meteoinform, INSAT-DMDD, EUMETCast and etc., are being used for complements to the GTS, backup sources and cost-effective alternatives to HF radio broadcasts.

The IGDDS is for the efficient circulation of space-based observation data and products meeting the needs of WMO programmes and regional requirements. It is noted that CMACast began operation in June 2012 and has established data exchange and re-dissemination service with EUMETCast, JMA started to distribute Himawari-8/9 data via Internet cloud and DVB-S2 based HimawariCast in July 2015. KMA is planning for the follow-on geostationary meteorological satellite GEOKOMPSAT-2A which will be launched in May, 2018. With the advent of advanced sounding instruments like METOP/IASI and SNPP/CrIS, and with successful launches of Chinese FY-3 series satellites, the scope of Regional ATOVS Retransmission Service (RARS) has been extended as DBNet (Direct Broadcast Network for Near Real-Time Relay of Low Earth Orbit Satellite Data). The DBNet Coordination Group has been established in 2015 and has drafted “A Guide to DBNet” to record the DBNet specifications, define standards, best practices and coordination mechanisms. The draft Guide has been discussed at APSDEU-NAEDEX (now GODEX-NWP), ITSC-20, WMO IPETSUP-2 and CGMS-44 and will be submitted to WMO CBS-16 (November 2016)for formal endorsement as a WIS guide. In the future, it is necessary to collaborate with DBNet expert team and activities to improve the data availability, user awareness, data access and technological training in RA II.

10.2.3 Data management

[1] *GISC Moscow is geographically located in RA VI, but GISC Moscow provides services to DCPCs/NCs in RA II. In this document, GISC Moscow is counted as an RA II GISC.*

The main activities related to the theme of Data Representation and Metadata include technical consultation and support for Members working on code form migration, monitoring, analysis and questionnaires on the status of migration to Table Driven Code Forms (TDCF) and implementation of WIS discovery metadata. To determine the level of Members' understanding on the migration to TDCFs and WIS metadata management and status of implementation, and to assess training requirements on these areas, a questionnaire was sent to RA II Members in November 2015 and received responded by 18 Members.

According to the statistics collected every three months from January 2013 to July 2016, (1) notable progress has been seen with the migration of SYNOP data since October 2014, (2) number of BUFR TEMP report increased by about 50 in the first half of 2014, which is attributed to India's BUFR TEMP reports, (3) As of November 2016, Four Members were reporting CLIMAT data in BUFR format, which is a major setback compared to the situation in 2014-2015.

Creation and registration of WIS metadata for GTS bulletins in RA-II is showing a good progress in general. GISCs Moscow, Seoul, Teheran and Jeddah started operation during 2013-2015 and 31 RA-II Members (89%) out of 35 have registered at least one WIS metadata record to the catalogue. The community is waiting for GISC New Delhi to become operational and starting catalogue management for its area of responsibility. As of November 2016, Uzbekistan (its principal GISC is Seoul) has not registered its records to the catalogue yet.

The questionnaire survey results indicated the requirements for improving communication between Global Information system Centres (GISCs) and National Centres (NCs) and for training on WIS metadata management.

10.2.4 Discontinuing Volume II of the Manual on GTS

In accordance with the decision of Cg-17, Volume II of WMO No. 386 (Manual on GTS) will be discontinued and replaced by web-based documentation. EG-WIS agreed to organize a Task Team (TT) to proceed and create the web-based document. Theme Leader in Data Communication Technics and Structure will lead the TT with Volunteer Experts of the Theme, and some experts would be invited. The EG-WIS will establish the TT with ToR and plans to submit the draft of web-based document to RAII Management Group.

10.2.5 WIS related projects

WIS monitoring is aimed at monitor availability of WIS centre functions and services in order to ensure stable operation, and the pilot project has been conducted by CBS/ET-WISC and leaded by two project managers. Currently four GISCs in RA II (Beijing, Moscow, Seoul and Tokyo) are providing actual operation status and GISC Beijing and Tokyo are providing prototype service to be available by web browser.

- GISC Beijing: http://wisportal.cma.gov.cn/wis/
- GISC Tokyo: http://www.wis-jma.go.jp/cms/about-wis/

GISCs Jeddah, New Delhi and Teheran have a plan to join the project.

**APPENDIX**

## 1. Proposed RA II Expert Group on WIGOS (EG-WIGOS)

(draft)

**Terms of Reference**

(a) To coordinate the planning and implementation of WIGOS in the Region in accordance with the Regional WIGOS Implementation Plan (R-WIP-II), in accordance with decisions and guidance from Cg-17, the follow-up EC sessions, RA II Management Group, and the RA II Strategic and Operating Plan;

(b) To provide support and assistance to RA II Members in accordance with the R-WIP-II and in a response to their requests (subject to availability of resources/funds);

(c) To assist RA II Members to develop their National WIGOS Implementation Plans (N-WIPs);

(d) To monitor the progress in the implementation and operations of WIGOS in the Region; advise on possible improvements and priorities for appropriate actions and the need for external support, where required, according to the technical guidance from the technical commissions, specified in the GFCS-IP, EGOS-IP, GCOS-IP and other observing system implementation plans in order to evolve and implement WIGOS in the Region;

(e) To support the implementation and improvement of OSCAR/Surface in the Region;

(f) To collaborate with related bodies on the implementation of WDQMS in the Region;

(g) To collaborate with the RWC candidates, RA II management group and WIGOS-PO on the establishment of the Regional WIGOS Centres in the Region;

(h) To coordinate relevant activities with the regional groupings involved in observations to ensure consistency of approach and synergy;

(i) To advise the president of the Regional Association and the chair of the WIGOS relevant Working Group on the proposed composition and changes to the Regional Basic Synoptic Network and Regional Basic Climatological Network;

(j) To collaborate with TT-RBON on the implementation of the Regional Basic Observing Network in the Region.

(k) To advise RA-II/MG on WIGOS implementation in the Region.

**Membership**

RA II Expert Group on WIGOS (EG-WIGOS)

| **Title** | **NAME** | **Country** |
|---|---|---|
| Co-Coordinators | | |
| | | |
| Project Leader in Monitoring and Reviewing the Implementation of EGOS IP in RA II | | |
| Project Leader in The web-interface for sharing status of standardization and experience and monitoring synoptic observations in RA II | | |
| Project Leader in Capacity Building in Radar Techniques in the Southeast Asia | | |
| Project Leader in Enhancing the Availability and Quality Management Support for NMHSs in Surface, Climate and Upper-air Observations | | |
| Project Leader in Developing a Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) in Asia Node | | |
| Project Leader in Developing Support for NMHSs in Satellite Data, Products and Training | | |
| Chair of Task Team on RBON | | |

## 2. RA II Task Team on the Regional Basic Observing Network (TT-RBON)

## 3.

**Terms of Reference**

1. Develop the proposal for the Regional Basic Observing Network in RA II:
   a. Prioritize the WMO application areas relevant to the Region;
   b. Define the RA II specific criteria for the selection of stations/platforms into RBON of RA II;
   c. Select the RBON stations/platforms in accordance with the RBON concept and RA II specific criteria;
   d. Identify gaps and develop a draft action plan to deal with them;
   e. Develop the Roadmap for, and coordinate the activities on the implementation of the RBON in RA II;
2. Work with RA II EG-WIGOS and WIGOS-PO on the further elaboration of the RBON concept.

**Roadmap for the implementation of the RBON in RA II:**

February 2017, establishment of TT-RBON;

April 2017, RA II specific criteria for the selection of stations/platforms into RBON;

June 2017, a draft pilot RBON;

July 2017 to June 2018, the pilot RBON testing;

September 2018, evaluation for the pilot RBON

December 2018, the draft RBON

January 2019, submission of the draft RBON to president of RA II

# 1. Proposed RA II Expert Group on WIS (EG-WIS)

(draft)

**Terms of Reference**

(a) To monitor the progress made in the implementation and operation of WIS in the Region and advise on possible improvements and priorities for appropriate actions to be carried out under the respective WMO Programmes and cosponsored Programmes;

(b) To keep abreast of new developments in WIS, promote the relevant WIS support to all WMO Programmes, and make recommendations, in compliance with relevant WMO Technical Regulations, for WIS implementation in the Region as regards communication techniques, communication structure, data management, data and metadata representation and relevant monitoring activities;

(c) To keep under constant review the Regional Meteorological Telecommunication Network and its implementation, as the WIS component for time-critical and operation-critical exchange, identify shortcomings and recommend appropriate measures for remedial action in the Region;

(d) To provide guidance to the Members of the Region in capacity-building for information and outreach relevant to improving WIS;

(e) To communicate with WIS 2.0 strategy and plan on the regional requirements.

**Membership**

RA II Expert Group on WIS (EG-WIS)

| **Title** | **NAME** | **Country** |
|---|---|---|
| Co-Coordinators | | |
| | | |
| Theme Leader on WIS Infrastructure and Implementation (TL-II) | | |
| Theme Leader on Data representation and Metadata (TL-DM) | | |
| Theme Leader on Capacity Development (TL-CD) | | |
| Theme Leader on Information Management and Emerging Data Issues (TL-IM) | | |

**Terms of Reference of the Co-Coordinators and Theme Leaders of EG-WIS**

## 1. Terms of reference of the co-coordinators of the Expert-Group on WIS

(a) To coordinate activities of the regional theme leaders;

(b) To advise and report to the president of the Regional Association on issues and all matters concerning the regional aspects of the WMO Information System (WIS) implementation, operation and services, including the Global Telecommunication System (GTS) and the Integrated Global Data Dissemination System (IGDDS), and data management in the Region;

(c) To advise members of the Working Group on issues and all matters related to the regional aspects of the WIS;

(d) To promote regional contributions to implementation of the WMO Information System;

(e) To represent the Region at relevant sessions of the Commission for Basic Systems (CBS) Open Programme Area Group on Information Systems and Services.

## 2. Terms of reference of the theme leader on WIS Infrastructure and Implementation

(a) To keep under review the organizational, technical, procedural aspects of the WIS data communication structure, and especially of the Global Telecommunication System in the Region;

(b) To keep under review the status of implementation and operation of the Regional Meteorological Telecommunication Network (RMTN), including in particular routing arrangements for the exchange of operation-critical observational data and processed information within the Region and with other Regions, with special attention to arrangements for the distribution of early warnings and related information;

(c) To keep under review and assist in the definition of regional requirements for data exchange, management and access of WMO programmes and other relevant international programmes, and their impact on WIS implementation, services and plans;

(d) To formulate recommendations for the further development and upgrading of the RMTN and of the regional data communication structure of WIS, including implementation of telecommunication facilities and techniques, and updating the Volume II of the Manual on the GTS (WMO-No 386);

(e) To support to multi hazard early warning systems, WIS centre nominations and compliance and evolution of WIS to 2.0.

## 3. Terms of reference of the theme leader on Data Representation and Metadata

(a) To keep under review inter-programme data representation matters, including migration to Table Driven Code Forms (TDCF) and regional codes, and make recommendations;

(b) To keep under review the status of implementation of the WIS DAR metadata catalogue and migration from WMO Catalogue of Meteorological Bulletins (Volume C1) to DAR metadata;

(c) To review procedures for the reception of operation-critical data and products, especially for the World Weather Watch (WWW), in case of major outages at key facilities;

(d) To keep under review WIS monitoring developing activities and implementation in the Region, including the real-time and non real-time WWW monitoring activities pertaining to the GTS in the Region, and make recommendations on how to benefit from it regionally.

**4. Terms of reference of the theme leader on Capacity Development**

(a) To keep under review the regional requirements on capacity development related to WIS;

(b) To assist RA II WIS centres in developing the training plan on the implementation and operation of WIS.

(c) To communicate with RA II GISCs and RTCs to collect their training plan related to WIS, and keep under review and update the training plan in R2-WIS-IP.

**5. Terms of reference of the theme leader on Information Management and Emerging Data Issues**

(a) To keep under review and report on available information management practices, and plan on the regional requirements;

(b) To communicate with CBS Task Team on Information Management (TT-IM) and ensure the regional requirements taken into consideration by the TT, and develop the regional plan on Information Management;

(c) To communicate with the other TLs of ET-WIS on the plan and practices on information management.

**ANNEX IV.1**

## Current RA II WIGOS IMPLEMENTATION PROJECTS

### Project No. I

| | |
|---|---|
| **Project Title** | **RA II WIGOS Project to Monitor and Review the Implementation of EGOS-IP in RA II** |
| **Type** | Regional Implementation Project (RA II) |
| **Status** | Draft Design |
| **Overview** | A vision for the Global Observing Systems in 2025 which provides high-level goals to guide the evolution of the global observing systems during the coming decades has been approved by EC-LXI in 2009. Accordingly, CBS-15 adopted a recommendation for the Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP) to complement and respond to this Vision. The Implementation Plan outlined the key activities to be implemented during the period 2012 to 2025 aiming at maintaining and developing all WMO component observing systems. Thus, a project can be established to monitor the progress of RA II Members on the implementation of EGOS-IP, analyze gaps in the regional observing network, and therefore, prioritize actions listed in EGOS-IP. The concerned information should be shared by RA II Members and all users by establishing a portal. This project will:<br>● Encourage RA II Members to appoint National Focal Points and submit EGOS National Reports annually,<br>● Identify gaps and prioritize actions listed in EGOS-IP through reviewing the progress of EGOS-IP in RA II,<br>● Develop a Portal to share the progress of EGOS-IP Implementation of RA II Members. |
| **Aim(s)** | ● To identify gaps and prioritize actions listed in the EGOS-IP through reviewing the progress of the Evolution of Global Observing Systems (EGOS),<br>● The progress and experiences are shared by RA II members when implementing the EGOS-IP. |
| **Benefits** | The Portal will provide Members and users with a platform for sharing updated progress of EGOS-IP implementation in RA II |
| **Key Regional Players** | China and Hong Kong, China |
| **Capacity development requirements** | ● Technical assistance by CBS,<br>● Workshop(s) on gaps analysis and actions prioritizing listed in EGOS-IP. |
| **Partners/Participants** | All RA II Members |
| **Funding Source(s)** | This project will rely on existing budget allocations at the national level. Additional funding will be needed to facilitate some elements such as the cost for developing the portal software. |
| **Overall Costs** | (TBD) |

| | |
|---|---|
| **Timescale** | 2013–2016 |
| **Expected Key Deliverables/Key responsible body** | • A list of RA II EGOS National Focal Points,<br>• Prioritized actions listed in the EGOS-IP,<br>• Portal to share progress EGOS IP implementation in RA II. |
| **Main risk(s)** | Lack of resources (funds/expertise), lack of cooperation and missing or mistaken information from Members |
| **Website** | Not available |
| **Summary** | This project will develop a Portal that will provide updated progress on EGOS-IP in RA II, identify gaps and prioritize actions listed in EGOS-IP identify regional prioritized actions to be taken. |
| **Date of the update** | 21 November 2012 |
| **Contact Person 1** | Ms GUO Jianxia<br>Meteorological Observation Center,<br>China Meteorological Administration (CMA)<br>China<br>Tel: +86 10 68407934<br>Fax: +86 10 68400936<br>E-mail: gjxaoc@cma.gov.cn |
| **Contact Person 2** | Mr LEE Lap Shun<br>Hong Kong Observatory<br>Hong Kong, China<br>Tel.: +852-2926-8416<br>Fax: +852-2311-9448<br>E-mail: lslee@hko.gov.hk |

**Project No. II**

| | |
|---|---|
| **Title** | **RA II WIGOS Project for Standard and Best Practice Portal, including Technical Documents with Necessary Details in English from all RA II Members** |
| **Type** | Regional Implementation Project (RA II) |
| **Status** | Draft Design |
| **Overview** | This project will develop a Standard and Best Practise Portal including mechanism and procedures needed for a regular updating process. |
| **Aim(s)** | ● To develop a Standard and Best Practise Portal,<br>● To establish regional standard and best practices documentation (regional practices database) for enhanced observational data/products utilization, including data/metadata management,<br>● To specify mechanisms, procedures for regular monitoring and updating of the portal. |
| **Benefits** | The standard and best practices portal will enhance and improve quality and utilization of data/products. |
| **Key Regional Player** | Republic of Korea |
| **Capacity development requirements** | Technical assistance by CBS and CIMO |
| **Partners/Participants** | RA II Members |
| **Relationship with existing project(s)** | KMA WIGOS demonstration project |
| **Funding Source(s)** | This project will rely on existing budget allocations at the national level |
| **Overall Costs** | (TBD) |
| **Timescale** | 2013–2016 |
| **Expected Key Deliverables / Key responsible body** | Portal on standards and best practices with mechanisms and procedures for regular monitoring and keeping the portal up-to-dated. |
| **Main risk(s)** | Lack of resources (funds/expertise), lack of cooperation and missing or mistaken information from Members. |
| **Website** | Not available |
| **Summary** | This subproject will establish a RA II Portal of standards and best practices for enhanced observational data/products utilization. |
| **Date of the update** | 21 November 2012 |
| **Contact Person 1** | Dr WON Jaegwang<br>Korea Meteorological Administration (KMA)<br>Republic of Korea<br>Tel.: +82-2-2181-0694<br>Fax: +82-2-2181-0709<br>E-mail: wonjg@kma.go.kr, ecotus37@korea.kr |
| **Contact Person 2** | Dr PARK Seongchan<br>Korea Meteorological Administration (KMA)<br>Republic of Korea<br>Tel. +82-2-2181-0696<br>Fax: +82-2-2181-0709<br>E-mail: scpark@korea.com |

**Project No. III.1**

| | |
|---|---|
| **Project Title** | **RA II WIGOS Project for Observing Systems Integration for Supporting Disaster Risk Reduction** |
| **Subproject Title** | **Integration of Surface-based Remote Sensing Data in the East Asia** |
| **Type** | Regional Implementation Project (RA II) |
| **Status** | Draft Design |
| **Overview** | In order to enhance observing capabilities in severe weather monitoring and forecasting, specifically in East Asia, surface-based remote sensing datasets/ products, such as radar and GPS data, should be integrated for their better utilization.<br>This project, as a first step, aims at developing a feasible and optimal draft design of integrated surface-based remote sensing observations toward future operational assimilation in meso-scale NWP system at the sub-regional level, as well as real-time quality-assured radar composite maps. The project will be Observing System Experiments (OSE) driven and proceed as follows:<br>1. Offline Exchange of surface-based remote sensing datasets/products including radar echo intensity, Doppler velocity, AWS data, and, if available, GPS precipitable water vapour, together with supplementary information (e.g. data format, details on observations, and data quality) among participating organs.<br>2. Examination of impacts of assimilation of exchanged remote sensing observation on its NWP performance. Also, sub-regional radar composite maps meeting their own operational requirements will be developed. Results and identified technical issues (e.g. data format, data policies, telecommunication for real-time data exchange, and quality of data) will be shared with and worked out cooperatively by the participating organs. Thus, requirements of data exchange for operational phase will be specified.<br>3. A feasible and optimal draft design of integration of surface-based remote sensing observations will be developed based on the results of the project.<br>To proceed with this project, existing frameworks such as CMA-JMA-KMA NWP meeting will be expanded to include this project into its agenda. |
| **Aim(s)** | The aim of this project is to develop a feasible and optimal draft design of integrated surface-based remote sensing observations toward operational assimilation of those data in meso-scale NWP model of the participating organs at the sub-regional level, as well as real-time quality-assured radar composite maps. |
| **Benefits** | Members in East Asia will benefit from this project through enhancement of their capabilities in observations for better early monitoring/warning/nowcasting/very short-range forecasting.<br>All the other RA II Members, particularly ones in Southeast Asia which might plan a similar project in the future, will benefit from shared outcomes of this project, namely: (1) solutions to identified issues for integration of surface-based remote sensing observations at sub-regional level; as well as (2) results of impact analysis on capacities in severe weather monitoring and forecasting. |
| **Key Regional Player** | China, Japan and Republic of Korea |
| **Capacity development** | Workshop(s) on better utilization (decision making & assimilation) |

| | |
|---|---|
| **requirements** | |
| **Partners/Participants** | CMA, JMA, KMA |
| **Relationship with existing project(s)** | 1. WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction.<br>2. CMA-JMA-KMA joint workshop on NWP (The 1st CMA-JMA-KMA joint workshop on NWP was held in September 2011).<br>3. WMO/CIMO Radar Quality Control and Quantitative Precipitation Estimation Intercomparison (RQQI). |
| **Funding Source(s)** | This project will rely on existing budget allocations at the national level. The project will build on existing national observational networks and information management infrastructures. Additional funding might be needed to regularly hold technical meetings among CMA, JMA, and KMA to proceed with this project. |
| **Overall Costs** | (TBD) |
| **Timescale** | 2013 – 2016 |
| **Expected Key Deliverables / Key responsible body** | 1. Establishment of collaborative working mechanism toward integrated surface-based remote sensing observations in the East Asia for operational monitoring and forecasting severe weather.<br>2. Solutions to identify issues to be solved for integration of surface-based remote sensing observations at sub-regional level and their solutions.<br>3. Impacts on capacities of NMHSs in severe weather monitoring and forecasting through utilization of surface-based remote sensing observations. |
| **Main risk(s)** | 1. Limited exchange of observational data, for instance, due to data policies of providers.<br>2. Lack of sharing relevant technical documentation on exchanged data. |
| **Website** | Not to be established |
| **Summary** | This project will develop a feasible and optimal draft design of integrated surface-based remote sensing observations toward the sub-regional utilization in East Asia. |
| **Date of the update** | 21 November 2012 |
| **Contact Person 1** | Mr Yuki HONDA<br>Office of International Affairs<br>Japan Meteorological Agency (JMA)<br>Japan<br>Tel.: +81-3-3211-4966<br>Fax: +81-3-3211-2032<br>E-mail: iao-jma@met.kishou.go.jp, |
| **Contact Person 2** | Dr Jaegwang WON<br>Korea Meteorological Administration (KMA)<br>Republic of Korea<br>Tel.: +82-2-2181-0694<br>Fax: +82-2-2181-0709<br>E-mail: wonjg@kma.go.kr, ecotus37@korea.kr |
| **Contact Person 3** | Mr LI Feng<br>Meteorological Observation Center<br>China Meteorological Administration (CMA)<br>China<br>Tel.: +86 10 68409293<br>Fax: +86 10 68400936<br>E-mail: liflif04@cma.gov.cn |

**Project No. III.2**

| | |
|---|---|
| **Project Title** | **RA II WIGOS Project for Observing Systems Integration for Supporting Disaster Risk Reduction** |
| **Subproject Title** | **Capacity Building in Radar Techniques in the Southeast Asia** |
| **Type** | Cross-regional Implementation Project (RAs II and V) |
| **Status** | Draft Design |
| **Overview** | Developing countries in Southeast Asia share common challenges for severe weather monitoring and forecasting. In spite of many radars having been installed in the region, they are not fully utilized due to lack of their expertises in weather radar techniques. Thus, capacity building in weather radar techniques is crucial concern for the countries.<br>Although their levels of operational usage of radar vary, they are often facing common technical challenges. In this regard, sharing their technical issues and lessons learnt among countries in the Region and developing the regional strategy on development of the radar network in the Region will enable them to tackle those challenges collaboratively with help from the WMO community in an effective and efficient manner.<br>This project, initiated by Thailand and Malaysia, within the framework of the ASEAN Sub-Committee on Meteorology and Geophysics (SCMG), aims at establishing a collaborative mechanism within SCMG through the following steps:<br>1) Thailand and Malaysia, as leaders of this project, will develop their national reports toward operational rainfall estimation/forecasting based on radar data. In order to share their experiences and lessons learnt among the participating organs, and to identify technical problems to be solved and necessary technical supports for, the reports should include the following items in a well-structured format:<br>(a) overview of the current radar systems,<br>(b) organization (department, division, staff, and budget),<br>(c) specification of radar systems,<br>(d) maintenance of equipment,<br>(e) data processing (QC, calibration, and composite technique),<br>(f) radar products,<br>(g) details of current technical problems associated with (a) to (f),<br>(h) lessons learnt from the past experiences,<br>(i) recent progress,<br>(j) future development plans.<br>The reports will be submitted to the 35$^{th}$ SCMG meeting (2013).<br>2) The other ASEAN member countries will also develop their national reports in the same format as that of <u>Thailand and Malaysia</u>, and submit their reports to 36$^{th}$ SCMG meeting. Based on the submitted report, the meeting will develop a regional strategic plan on radar which identifies common technical issues and necessary actions to be taken.<br>3) During the period of the project, all the above Members will be requested to update their national reports and submit the latest version to a SCMG meeting every year. Thailand and Malaysia are requested to encourage the other Members to develop and keep their national reports up-to-date. The regional strategic plan is also to be updated at every SCMG meeting.<br>*Each Member will consult with the WMO or advanced RA II Members about appropriate technical missions focused on identified technical issues in the reports such as dispatch of radar experts to recipient countries, with the VCP or other funds. On completion of such a mission, the recipient Member is requested to update its national report by including details of the outcomes of the mission. |

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| | *SCMG set up a new agenda item for discussion on the progress of this project. |
| **Aim(s)** | This project aims to develop effective early warning systems building on radar data in Southeast Asia. |
| **Benefits** | Capacity in monitoring and forecasting of the severe weather using radar data will be enhanced by shared experiences and lessons among the participating organs and technical missions focused on technical issues identified in national reports and the regional strategic plan. |
| **Key Regional Player** | ASEAN-SCMG: Thailand, Malaysia |
| **Partners/ Participants** | All the ASEAN Member countries (Cambodia, Brunei Darussalam, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam) |
| **Relationship with existing project(s)** | - Radar composite map in Southeast Asia, one of the on-going projects under the Meteorological Working Group of the WMO/ESCAP Typhoon Committee,<br>- Severe Weather Forecasting Demonstration Project (SWFDP) for Southeast Asia,<br>- ASEAN Sub-Committee on Meteorology and Geophysics(SCMG). |
| **Funding Source(s)** | This project will rely on existing budget allocations at the national level. The project will build on existing national observational networks and information management infrastructures. Additional funding will be needed for technical cooperation for those countries by dispatching appropriate experts and/or providing training workshops. |
| **Overall Costs** | (TBD) |
| **Timescale** | 2013–2016 |
| **Expected Key Deliverables / Key responsible body** | - National reports in the Southeast Asia toward operational rainfall estimation/forecasting based on radar data,<br>- Regional strategic plan on development of the radar network. |
| **Main risk(s)** | 1) Failure of development of national reports by participating organs.<br>2) Lack of available experts.<br>3) Lack of funds available. |
| **Website** | Not to be established |
| **Date of the update** | 21 November 2012 |
| **Contact Person 1** | Dr.Somchai Baimoung<br>Deputy Director-General/Acting Director-General<br>Thai Meteorological Department<br>Thailand<br>Tel.: +66 81 989 9025<br>Email: somchaib@tmd.go.th |
| **Contact Person 2** | Mr A. Kamiluddin Hj Ibrahim<br>Director, Radar Meteorology Division<br>Malaysian Meteorological Department<br>Malaysia<br>Tel.: +603 7967 8154<br>Fax: +603 7955 0964<br>E-mail: kamiluddin@met.gov.my |

**Project No. IV**

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| **Project Title** | **RA II WIGOS Project to Enhance the Availability and Quality Management Support for NMHSs in Surface, Climate and Upper-air Observations** |
| **Type** | Regional Implementation Project (RA II) |
| **Status** | Draft Design |
| **Overview** | The Japan Meteorological Agency (JMA)/World Meteorological Organization (WMO) Workshop on Quality Management in Surface, Climate and Upper-air Observations, held at Tokyo in July 2010 as part of activities of the Pilot Project to Enhance the Availability and Quality Management Support for NMHSs in Surface, Climate and Upper-air Observations (hereafter, Pilot Project), found out that primary factors adversely affecting data quality in RA II are calibration and maintenance of instruments mainly due to lack of traceability of measurements to international standards and calibration facilities. This project will build on outcomes of the workshop. It consists of the following two activities: (i) improvements of data quality of RBCN/RBSN stations; and (ii) enhancement of capabilities of RIC-Tsukuba and RIC-Beijing. All the outcomes of this project will be shared at a Portal to be established by the Coordinator.<br>1. Improvements of data quality at RBCN/RBSN stations<br>(a) Monitoring Data Quality<br>The Coordinator checks data quality of RA II stations and identifies and requests RA II Members to identify technical issues, based on the following results:<br>• Questionnaire on the Surface, Climate, and Upper-air Observations and Quality Management in Regional Association II (Asia) (conducted in July 2010),<br>• Questionnaire on meteorological instruments, calibration and training in Regional Association II (Asia) (conducted in January 2012),<br>• 6-monthly monitoring reports by the Lead Centre for monitoring the quality of land surface observations in Region II.<br>(b) Survey on status on QA/QC procedures and site managements for the network of RBCN/RBSN stations, and report the results.<br>Based on requests from the Coordinator, the following Members will consider the possibility of technical support if funds are available, and share the summary of the technical missions with RA II Members:<br>- CMA, HKO, JMA, and KMA for Southeast Asia,<br>- IMD for South Asia,<br>- Roshydromet for Central Asia,<br>- Kuwait for Middle East.<br>2. Enhancement of RIC's Services<br>RICs plan to implement the following action items for further enhancement of their services in capacity building and calibration during the project:<br>(a) Organization of a training workshop to improve understanding of calibration and maintenance of |

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| | meteorological instruments according to needs of RA II Members to be identified by the "Questionnaire on Meteorological Instruments, Calibration and Training in Regional Association II (Asia)",<br>(b) Development of training materials on calibration and maintenance of instruments (to be prepared for publication as an Instruments and Methods of Observation Programme (IMOP) technical document),<br>(c) Obtaining the International Standard ISO/IEC 17025 – General requirements for the competence of testing and calibration laboratories – certification for air pressure, temperature, and humidity,<br>(d) Development of RIC's Websites,<br>(e) Intercomparison between RIC-Tsukuba and RIC-Beijing,<br>(f) Reports on status on calibration instruments for surface-based observations in RA II (to be prepared for publication as an Instruments and Methods of Observation Programme (IMOP) technical document). |
| **Aim(s)** | This project aims at improvement of data quality at RBCN/RBSN stations and enhancement of services of RA II RICs. |
| **Benefits** | RA II Members, especially those with technical issues on data quality of observations, will potentially benefit from this project. |
| **Role/Involvement of WMO Regional Centres in RA II** | Regional Instrument Centres (RICs)<br>Lead Centre for monitoring the quality of land surface observations |
| **Key Regional Player** | JMA (Coordinator), and Members of Coordination Group<br><br>Technical Mission:<br>- CMA, HKO, JMA, and KMA for Southeast Asia,<br>- IMD for South Asia,<br>- Roshydromet for Central Asia,<br>- Kuwait for Middle East. |
| **Capacity development requirements** | 1. Workshop on maintenance, field inspection, etc. (basic level),<br>2. Workshop on traceability, measurement uncertainty, etc. (advanced level). |
| **Partners/Participants** | RA II Members |
| **Funding Source(s)** | This project will rely on existing budget allocations at the national level. Additional funding will be needed to dispatch experts to NMHSs in developing countries and/or invite their observational staff to RICs for trainings and calibrations of national standards. |
| **Overall Costs** | (TBD) |
| **Timescale** | 2013–2016 |
| **Expected Key Deliverables / Key responsible body** | 1. Provision of technical support for instrument maintenance and calibration by experts from RICs.<br>2. Holding a RIC's training workshop for RA II Members.<br>3. Development of training materials (to be prepared for publication as an IMOP technical document).<br>4. Obtaining ISO/IEC 17025 certification.<br>5. Portal Website to share outcomes of this project.<br>6. Report on status on QC/QA procedures and site management in RA II. |

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| | 7. Reports on status on meteorological instruments, calibration and training in Regional Association II. |
| **Main risk(s)** | • Lack of funding for technical missions by RICs,<br>• Insufficient communication between the Coordinator, RICs, and RA II Members on their status on maintenance and calibration of instruments to specify needs of technical supports,<br>• Lack of responses from RA II Members. |
| **Website** | RIC's Website/Portal on QC/QA |
| **Summary** | Improvement of data quality of RA II Members through enhancement of RIC's services and capacity |
| **Date of the update** | 21 November 2012 |
| **Contact Person 1** | Mr Yoshihisa NAKAMOTO<br>Senior Coordinator for Observation Planning<br>Administration Division, Observations Department<br>Japan Meteorological Agency (JMA)<br>Japan<br>Tel.: +81 3 3211 6018<br>Fax: +81 3 3211 7084<br>Email: nakamoto@met.kishou.go.jp |
| **Contact Person 2** | Mr He Xiaolei<br>Meteorological Observation Center<br>China Meteorological Administration (CMA)<br>China<br>Tel: +86 10 68409767<br>Fax: +86 10 68400936<br>E-mail: hxlaoc@cma.gov.cn |

**Project No. V**

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| **Project Title** | **RA II WIGOS Project to Develop a Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) in Asia Node** |
| **Type** | Regional Implementation Project (RA II) |
| **Status** | Draft Design |
| **Overview** | SDS-WAS was established in 2007 to achieve comprehensive, coordinated and sustained observations and modelling capabilities of sand and dust storms in order to improve the monitoring of sand and dust storms to increase the understanding of the dust processes and to enhance dust prediction capabilities for mitigation of risks in many affected area (aviation, health impacts, etc.).<br><br>The WMO SDS-WAS Region for Asia third meeting of Regional Steering Group (RSG) was held at Tsukuba, Japan in March 2012. At the meeting, it was confirmed that observation data exchange schemes should be implemented promptly in order to enhance systematic near-real-time (NRT) monitoring of sand and dust events in each country, and the following near-term implementation plan was agreed within the SDS-WAS Asia Node activity:<br><br>• Each country will confirm their data policy on observation data delivery, to reach an agreement on the provision of observation data to be shared within the Node in NRT,<br><br>• Regional Centre (RC: China) will provide a portal website with a function for sharing the observation data and announce it to the Node members,<br><br>• At the beginning, experimental observation data sharing will be conducted in off-line basis (not NRT) for the sand/dust storms (SDS) seasons,<br><br>• For the data exchange, the ad-hoc working group will propose appropriate data format and parameters,<br><br>• In SDS season in the spring (from February to June) 2013, the NRT (with a goal of approximately 1-day delay) data exchange will be conducted regularly,<br><br>• NRT data will be used for intercomparison of sand and dust storm forecast model to improve forecast accuracy as well as for monitoring of sand and dust storms. |
| **Aim(s)** | This project aims at mitigation of risks in many affected areas in the Asia Node countries through enhancement of systematic NRT monitoring of sand and dust storm. |
| **Benefits** | The systematic NRT monitoring of sand and dust storm will provide the Asia Node countries with useful information for sand and dust storm risk mitigation. |
| **Role/Involvement of** | Regional Specialized Meteorological Centre with activity |

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| **WMO Regional Centres in RA II** | specialization on Atmospheric Sand and Dust Forecast (RSMC-ASDF) (TBD) |
| **Key Regional Player** | China, Japan, Republic of Korea |
| **Partners/Participants** | Countries in SDS-WAS Asia Node (China, Japan, Kazakhstan, Republic of Korea and Mongolia) |
| **Funding Source(s)** | This project will rely on existing budget allocations at the national level. |
| **Overall Costs** | (TBD) |
| **Timescale** | 2013–2015 |
| **Expected Key Deliverables / Key responsible body** | The systematic NRT monitoring of sand and dust storm in SDS-WAS Asia Node |
| **Main risk(s)** | Lack of resources (funds/expertise) |
| **Website** | SDS-WAS Asia Node portal |
| **Summary** | Improvement of sand and dust storms monitoring in the SDS-WAS Asia Node |
| **Date of the update** | 12 November 2012 |
| **Contact Person 1** | Mr. ZHOU Qingliang<br>National Meteorological Center<br>China Meteorological Administration (CMA)<br>China<br>Tel.: +86 10 68406184<br>Fax: +86 10 68408454<br>E-mail: zhouql@cma.gov.cn |
| **Contact Person 1** | Mr Hiroshi Koide<br>Senior Coordinator for Global Atmosphere Watch<br>Atmospheric Environment Division<br>Global Environment and Marine Department<br>Japan Meteorological Agency (JMA)<br>Japan<br>Tel.: +81-3-3287-3439<br>Fax: +81-3-3211-4640<br>E-mail: hkoide@met.kishou.go.jp |
| **Contact Person 1** | Dr Youngsin Chin<br>Korea Meteorological Administration (KMA)<br>Republic of Korea<br>Tel.: +82 70 7850 6752<br>Fax: +82 2 831 4930<br>E-mail: hwangsa@korea.kr |

**Project No. VI**

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| **Project Title** | **RA II WIGOS Project to Develop Support for NMHSs in Satellite Data, Products and Training** |
| **Type** | Regional Implementation Project (RA II) |
| **Status** | Draft Design |
| **Overview** | At its fourteenth session (December 2008), Regional Association II adopted a resolution to establish a pilot project for the development of support for National Meteorological and Hydrological Services (NMHSs) in the areas of satellite data, products and training. The Coordinating Group of the Pilot Project is composed of Japan (Co-coordinator); Republic of Korea (Co-coordinator); Bahrain; China; Hong Kong, China; India; Kyrgyzstan; Maldives; Oman; Pakistan; Russian Federation; Uzbekistan; Viet Nam and EUMETSAT (observer).<br>The object of this project is to encourage NMHSs in RA II to make a kind of self-help effort to improve the flow of satellite-derived information by:<br>● Identifying the requirements of NMHSs of developing countries, regarding satellite imagery, data and products, use the results to update the RRR user requirements database and to fine tune the EGOS-IP,<br>● Facilitating the timely provision of satellite-related information by satellite operators themselves to users via the project web page, newsletters, etc., and<br>● Aligning with VLab activities to optimize assistance to NMHSs in RA II and coordinating training activities on use of satellite data/products). |
| **Aim(s)** | ● To encourage NMHSs in RA II to make a kind of self-help effort to improve the flow of satellite-derived information,<br>● To improve the knowledge and techniques to use satellite data and products. |
| **Benefits** | NMHSs in RA II have benefited from this project to find means to access satellite data, products and training they want, and to improve the usage of satellite-derived information. This is expected to improve NMHSs' activities from nowcasting to climate and environment monitoring. |
| **Key Regional Player** | Japan, Republic of Korea and other satellite operators in RA II |
| **Capacity development requirements** | ● Assistance (or support) of WMO VLab activities and other regional training activities,<br>● Assistance of satellite operators,<br>● Liaison with EGOS-IP. |
| **Partners/Participants** | Members of the Coordination Group members: Japan (Co-coordinator); Republic of Korea (Co-coordinator); Bahrain; China; Hong Kong, China; India; Kyrgyzstan; Maldives; Oman; Pakistan; Russian Federation; Uzbekistan; Viet Nam, RA V (observer) and |

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| | EUMETSAT (observer)<br>All other RA II Members can be nominated as the Group members. |
| **Relationship with existing project(s)** | (TBD) |
| **Funding Source(s)** | Regular activities of this project rely on existing budget allocations at the national level. Additional funding will be needed to hold the Coordination Group meetings and training events regularly. |
| **Overall Costs** | (TBD) |
| **Timescale** | 2012–2016 |
| **Expected Key Deliverables / Key responsible body** | • Reports on requirements of NMHSs regarding satellite imagery, data and products,<br>• Improvement on access to information on satellite data/products,<br>• Improvement on capacity in use of satellite data/products and facilitation of training datasets and toolboxes. |
| **Main risk(s)** | Lack of resources (funds/expertise) and lack of cooperation from Members |
| **Website** | The portal site of the project is operated on JMA's web server.<br>http://www.jma.go.jp/jma/indexe.html |
| **Summary** | The project will encourage NMHSs in RA II to make a kind of self-help effort to improve the flow of satellite-érelated information. |
| **Date of the update** | 30 November 2015 |
| **Contact Person 1** | Mr Takeshi Otomo<br>Senior Coordinator for Satellite Systems<br>Satellite Program Division, Observation Department<br>Japan Meteorological Agency (JMA)<br>Japan<br>Tel: +81-3201-8677<br>Fax: +81-3217-1036<br>E-mail: ootomo@met.kishou.go.jp |
| **Contact Person 2** | Dr Dohyeong KIM<br>Senior Scientist<br>National Meteorological Satellite Center<br>Korea Meteorological Administration<br>Republic of Korea<br>Tel: +82-70-7850-5705<br>Fax: +82-43-717-0210<br>E-mail: dkim@kma.go.kr |

**ANNEX IV.2**

## Outcomes of EG-WIS-1

The first meeting of the Expert Group on the WMO Information System (WIS) in Regional Association II (RA II EG-WIS) was held from 25 to 27 November 2015 in Tokyo, Japan. The outcomes are summarized as follows.

(1) The meeting noted that the NMC Thimphu, Bhutan Department of Hydro-Meteorological Service (DHMS) connected to the GTS in July 2015 with support from RTH New Delhi, RTH Bangkok and JICA, and Thimphu has started receiving data/products from the GTS. Their observation data are being collected through EUMETSAT Data Collection Platform (DCP) and plan to distribute it over the GTS in BUFR format. The meeting agreed that the link RTH Bangkok and NMC Thimphu should be added in RMTN as a supplement regional circuit.

(2) Pakistan Meteorological Department (PMD) requested EG-WIS to remove the regional circuit between Karachi and Tashkent from RA II point-to-point Regional Meteorological Telecommunication Network. The current status of the link is NI (Not Implementation). The meeting recognized difficulties to deploy telecommunication infrastructure for the area and requested the Theme Leader on DCTS to confirm the intention of Tashkent about removing the circuit from RMTN.

(3) The meeting noted that EG-WIS organizes the RMTN status survey annually. The result of the survey is very helpful for understanding the status and progress of RA II RMTN. The meeting suggested that EG-WIS include the MSS/FSS status in the survey.

(4) The meeting reviewed implementation status from six GISCs and four DCPCs and identified things RA II need to do next. The meeting drafted a table to make the status visible.

(5) The meeting noted that Myanmar changed the location of NMC/NC from Yangon to Nay Pyi Taw. NMC Nay Pyi Taw connected to RTHs Bangkok and New Delhi and started GTS operation in 2013. The change has been reflected in the annual RMTN survey produced by EG-WIS and in the latest RMTN diagram. The meeting requested NMC/NC Nay Pyi Taw to confirm its "CCCC" used for WIS/GTS and report the change to WMO secretariat in proper procedures with the support of its RTH and principal GISC.

(6) The meeting reviewed implementation status of the TDCF migration in RA II and confirmed a progress since 15th RA-II (2012). The meeting confirmed the fact that we were still in the process of migration and encouraged Members to complete the migration. The meeting also reviewed the problems on upper-air BUFR converted from TAC (e.g. TEMP/PILOT series) and recognized the letter from the CBS president. The meeting agreed that RA II members should continue parallel distribution until the problem has been resolved. http://www.wmo.int/pages/prog/www/WIS/wiswiki/tiki-view_blog_post.php?postId=171

(7) The meeting recognized that RA II-15 requested to promote the recovery and digitization of old climate records which remain critical for climate change assessment and the development of climate services in the context of climate change adaptation and the GFCS as a matter of high priority. The meeting noted it is necessary to collaborate with RA II WG on Climate Services. The meeting asked the TL in Climate Data Management/Data Rescue to take actions on keeping under review and report CDMS and DARE project in the region.

(8) The meeting noted some Theme Leaders have been keeping a good communication with Volunteer Experts in their theme, and it built teamwork and stimulated the regional activities. The meeting encouraged all Theme Leaders to consider making collaboration and sharing the workload with Volunteer Experts.

(9) The meeting discussed utilizing communication tools among EG-WIS members. Normally, this face-to-face meeting is held once four years, and it's not easy to have more frequently. The meeting noted that WMO provides communication service (don't need any additional cost)

and CBS expert teams are using WebEx, WIS WIKI, Google group and so on. The meeting agreed to use these services to keep good communications and share the information.

(10) The meeting noted the RA II RMTN is operated by three major types of communication infrastructure: MPLS/VPLS, The Internet and leased circuit. The meeting noted that if the centers operate GTS over the Internet, centres have to carefully consider and understand the characteristics of Internet, in particular, the Internet security and best-effort service (actual link speed: bandwidth).

(11) The meeting reviewed RA II WIS Implementation Plan (R2-WIS-IP) Version 1.00 issued in December 2013. The meeting noted the Plan should be updated including progress since the first version has been issued. The meeting noted the IP has status and plan but status already reported in TL's annual report and needs to be restructured to avoid duplication. The co-coordinators of EG will propose a new structure of IP to the next RA II session

(12) The meeting recognized that WIS should support all Working Groups in RA II and related projects. The meeting agreed that the GISCs should support requirements of data exchange/sharing not only for WIGOS but also for other activities in RA II. The meeting requested particularly GISCs to support activities in its AMDCN in cooperation with other WGs.

(13) The meeting noted the importance of WIS monitoring for stable operation and continuous improvement of WIS services. The meeting noted that GISCs Beijing, Seoul and Tokyo have participated in the WIS monitoring pilot project which is organized by TT-GISC, and reviewed the pilot dashboards developed by GISCs Beijing and Tokyo. The meeting encouraged all the operational GISCs to consider the implementation of WIS monitoring and start providing JSON files as soon as possible.

(14) The meeting reviewed the progress of Application Pilot Project (PP-App). The coordinator of PP-App proposed adding WIS monitoring as a new item for the PP-App. The meeting agreed to continuously support the project and proposal continuing support the PP-App. The meeting noted that issuing newsletters (since 2013, twice a year) is a good way to stimulate the project, but all the newsletters were published by only JMA so far. The meeting proposed all participants of the project to contribute issuing newsletters.

(15) The meeting noted that continuing participation in of the Expert Group would be efficient and effective to achieve deliverables. The meeting invited TLs to be nominated as a member of the group in the next period of RA II (2016-2019).

**ANNEX IV.3**

# WORLD METEOROLOGICAL ORGANIZATION

# REGIONAL ASSOCIATION II (ASIA)

# WIS Implementation Plan

# DRAFT

(Version 1.10 1st December 2015)

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**Appendices:**

Appendix I: WIS Implementation Plan for NMHS with RMTN Connection in RA II (NC)
Appendix II: WIS Implementation Plan for DCPC in RA II
Appendix III: Sample letters
Appendix IV: WIS Test Cases for NCs
Appendix V: List of acronyms

# 1. EXECUTIVE SUMMARY

The XV Session of RA II (Doha, 2012) was pleased with the progress of WIS Implementation in the Region noting that GISCs Beijing and Tokyo have been operational since August 2011. It noted that GISC Seoul had also been successfully audited by CBS and that it will become operational in early 2013. GISCs Jeddah, Moscow, and Tehran are preparing for their audits with an aim to beginning operations in 2013. Seven GISCs are expected to be directly supporting RA II by the end of 2013. The Association expressed its appreciation to GISCs Beijing and Tokyo for providing WMO Interim Metadata Management Services (WIMMS[2,3]) to support those WIS centres that do not yet have access to an operational GISC. It further noted that GISC Seoul will be able to provide WIMMS starting from early 2013. The Association noted the important role of GISCs in ensuring effective exchange of information between Members, and encouraged Members to work with GISCs on network and data management issues and to participate in the WIS Application Pilot Project in Regions II and V (former WIS VPN Pilot Project) focusing on pragmatic applications providing benefits from GISC services via internet.

Since the beginning of the year 2012, the RA II WIS Implementation Plan has been developed and discussed in meetings with the relevant bodies in RA II. In addition, the WMO Secretariat was involved in many aspects of the evolving plan.

The plan is based on WMO regulatory material, in particular the WMO Technical Regulation, Volume I, Section A3 (WMO No. 49[4]), the Manual on the WIS (WMO No. 1060[5]) and the Guide to the WIS (WMO No. 1061[6]). The plan focuses on the Members of RA II to set up National Centres (NC) connected to one of the seven designated Global Information System Centres (GISC) in the Region. Plans of RA II Members to establish Data Collection or Production Centres (DCPC) are presented briefly. Their implementation is not covered in detail by this document, because implementation procedures for DCPCs are covered by the Manual on WIS and WIS Demonstration Process "Procedures and Guidelines,"[7]

After describing the features of WIS and highlighting the benefits for Members to be connected to WIS, the current status of WIS in RA II and the telecommunication network used for meteorological data and products are delineated. The role of WIS core network, which is implemented via RA-VI RMDCN (Regional Meteorological Data Communications Network[8] ), is highlighted, in particular in view of its ability to support WIS structures by allowing any-to-any connectivity. The list of countries in RA II together with their principal GISC (arranged in 15th session of RA-II, Qatar Doha, December 2012) provides an overview of the structure of WIS after its regional implementation. The steps an NMHS has to take to become a WIS NC are described in detail. The initial steps to establish a DCPC are mentioned as well, in particular, for the existing RTHs, which as components of the GTS still have crucial roles to play, including providing GTS connectivity to centres not on the RMDCN. Sample step-by-step implementation approaches for these two cases are provided in the Appendices.

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[2] GISC Beijing WIMMS http://wisportal.cma.gov.cn/wis/jsp/UserGuide/downloadFile.jsp?file=WIMMS_Service_in_GISC_Beijing.pdf

[3] GISC Tokyo WIMMS http://www.wis-jma.go.jp/cms/help-desk/user-guide/guide-to-maintenance-of-gts-metadata-at-giscwimms-tokyo/

[4] WMO-No. 49 Volume 1 - http://library.wmo.int/opac/index.php?lvl=notice_display&id=14073

[5] WMO-No. 1060 Manual on the WIS - http://library.wmo.int/opac/index.php?lvl=notice_display&id=9254

[6] WMO-No. 1061 Guide to the WIS - http://library.wmo.int/opac/index.php?lvl=notice_display&id=6856

[7] WIS Demonstration Process Guidelines - http://www-db.wmo.int/WIS/centres/guidance.doc

[8] Regional Meteorological Data Communications Network - http://www.ecmwf.int/en/computing/our-facilities/rmdcn

Furthermore, risks for the success of the plan are assessed together with possible remedies. The future activities to implement the plan are listed with the goal that most of the RA II Members will be WIS enabled by the end of 2013 to 2014.

Finally, the responsibilities of the GISCs and DCPCs in the WIS implementation monitoring are described with their importance for the successful implementation of the plan. The participation and cooperation of the national WIS Focal Points is stressed.

## 2. INTRODUCTION

The Fourteenth World Meteorological Congress (Cg-14) in 2003 noted that the current WMO information systems had been developed to meet a diverse set of requirements. The principal system was the GTS along with the related data management functions that had been developed to serve the WWW for the exchange of real-time high priority data. Other information systems had been developed to meet the needs of other programmes and commissions. Congress recognized that the multiplicity of systems operated for different programmes had, however, resulted in incompatibilities, inefficiencies, duplication of effort and higher overall costs for members. A further uncoordinated development would exacerbate those problems and would isolate the WMO programmes from the wider environmental community.

Congress supported the views and conclusions of CBS that an overarching approach was required a single coordinated global infrastructure. The solution was called Future WMO information system (FWIS) with the following features:

- FWIS would be used for the collection and sharing of information for all WMO and related international programmes.
- The information and communication responsibilities of existing WWW and other WMO Programme Centres could be mapped into the corresponding functions within the FWIS.
- FWIS would provide a flexible and extensible structure that would allow the participating centres to enhance their capabilities as their national and international responsibilities grew.
- The implementation of FWIS should build upon the most successful components of existing WMO information systems in an evolutionary process.
- FWIS should pay special attention to a smooth and coordinated transition.
- FWIS would build upon the GTS with respect to the requirements for highly reliable delivery of time-critical data and products, taking into account that information systems technology was evolving rapidly, and strengthening further the current trend of the current GTS development.
- FWIS should utilize international industry standards for protocols, hardware and software to allow exploitation of the wide range of modern data communication services, including the ubiquitous Internet and Web services.

The Fifteenth World Meteorological Congress (Cg-15) in 2007 recalled the Fourteenth Congress decision to establish an overarching WMO Information System (WIS) that would be used for the collection and sharing of information for all WMO and related international programmes. The name, Future WMO information system (FWIS), was transformed to WMO information system (WIS). Congress recognized the good progress that has been made in demonstrating the technological solutions for WIS through pilots and prototypes projects, but noted that much work remained to be done before an operational version of WIS could be realized.

Congress agreed that the WMO Information System should provide three fundamental types of services to meet the different requirements, as follows:

(a) Routine collection and dissemination service for time-critical and operation-critical data and products: The service was based on real-time “push” mechanism including multicast and broadcast; it would be implemented essentially through dedicated telecommunication means providing a guaranteed quality of service.

(b) Data discovery, access and retrieval service: The service was based on request/reply “pull” mechanism with relevant data management functions; it would be implemented essentially through the Internet.

(c) Timely delivery service for data and products: The service was based on delayed mode “push” mechanism; it would be implemented through a combination of dedicated telecommunication means and of public data-communication networks, especially the Internet.

Congress emphasized that the WIS implementation should build upon existing WMO information systems in a smooth and evolutionary process. It agreed that the WIS implementation plan had two parts that would be developed in parallel:

(a) Part A: the continued consolidation and further improvements of the GTS for time critical and operation-critical data, including its extension to meet operational requirements of WMO Programmes in addition to the World Weather Watch (including improved management of services);

(b) Part B: an extension of the information services through flexible data discovery, access and retrieval services to authorized users, as well as flexible timely delivery services.

The Sixteenth World Meteorological Congress (Cg-16) in 2011 noted with appreciation that the regional WIS training workshops successfully hosted by Japan and China provided practical information on the new information system to many Asian countries. Congress stressed the necessity of more capacity development projects for WIS National Centres in developing countries, and the promotion of the use of WIS, together with WIGOS. Congress felt that the area of responsibility of each RA II GISC should be officially agreed upon at the next session of RA II in 2012. However, to allow the Members of RA II to benefit from the new system before this, Congress encouraged RA II to initiate the coordination and consultations as a tentative solution so that each National Centre should be linked to a principal GISC and to a secondary GISC, taking into account the efficiency of options, the cost effectiveness for both NCs and GISCs, data distribution capacity of the GISCs, and the current structure of the GTS.

Congress noted that WIS has moved from a development stage into an operational stage and WIS activities in 2012–2015 should be:

(1) Complete WIS implementation across all WMO Centres.

Congress noted and supported the following major activities and implementation target dates, and urged all Members and the Secretary-General to identify the necessary resources for reaching the objectives:

(a) Improving the knowledge and capabilities of Members to benefit from WIS functionality, in particular least developed countries, developing countries and small island states through regional workshops and information sessions: 2012–2013.

(b) Implementation of WIS at all NMHS national centres (NCs): 2012–2015.

(c) Implementation of remaining candidate GISCs: 2012–2013.

(d) Implementation of more DCPCs, i.e. WIS interfaces at WMO Programmes' centres: 2012–2015.

(e) Amendments to the Manual on WIS for enhanced operational arrangements of WIS centres, especially GISCs: 2014.

Congress noted that the structure of GTS is evolving to a two-level network architecture, invited the regional associations to coordinate the definition of area of responsibility for each GISC, in particular their Area Meteorological Data Communication Network (AMDCN), taking advantage of the improved performance of data exchange enabled by new technologies. Regional associations should consult with CBS when reviewing AMDCNs, being mindful of potential cost impacts on the remainder of WIS.

(2) Capacity-building to ensure support of all WMO Members.

(3) Leverage WIS advantages for all WMO Programmes.

(4) Take advantage of WIS in all WMO Data Management.

The Fifteenth Session of Regional Association II (RA II: Asia) in December 2012 recalled that Cg-16 stated that WIS has moved from a development stage into an operational stage and that WIS activities in 2012–2015 should be. The Association noted that capacity-building has been given an effective start through the contributions of China, Japan and the Republic of Korea by running international workshops on WIS, and through the successful incorporation of WIS into telecommunication-related training workshops undertaken by

Regional Training Centres in the Islamic Republic of Iran and Turkey. The Association noted that a training workshop on the BUFR and WIS matters was held (26–30 November 2012, Moscow) for Russian speaking countries. It emphasized that all Regional Training Centres should consider ways to incorporate WIS, to improve current training programmes, improve the trainers' understanding of WIS, and to ensure that the principles of WIS data management are taken up in other WMO Programme activities. The Association noted the initiatives of CBS for developing training strategies and encouraged Members to monitor this activity and to take advantage of CBS guidance and initiatives on capacity-building.

The Association recognized substantial improvement in upgrading GTS links and progress on WIS implementation through operational services of GISCs Beijing and Tokyo and trial operations at four conditionally-designated GISCs in Seoul, New Delhi, Tehran and Jeddah, as well as the development of a WIS Implementation Plan for RA II by the Coordinator of the Sub Group on WIS from Japan and two dedicated (Local Secondment) experts from China and Republic of Korea.

The Association reviewed the draft RA II Regional WIS Implementation Plan and expressed its appreciation to China, Japan and the Republic of Korea for their contributions to development of the plan. It agreed that fully implementing WIS in the Region was an essential step toward the efficient implementation of WIGOS, GFCS and other priority areas. The Association noted the effectiveness of having a virtual WIS Implementation Project Office, utilizing local secondments in Beijing and Seoul. It encouraged other centres, especially GISCs, to provide similar resources towards completing the implementation of WIS in all centres in the Region. The Association noted the draft plan and agreed that the virtual WIS Implementation Project Office should continue to refine the plan and assist the RA II Management Group to guide Members through the implementation process. It agreed that the aim was to have WIS implemented in all RA II Members' centres by the Seventeenth World Meteorological Congress (Cg-17) in 2015 and that it was important to regularly review the progress of WIS implementation, with a major review in mid-2014 with an aim to accelerating WIS implementation for those centres which are not likely to meet the 2015 target.

In accordance with the agreement and user reviews of initial draft, a new Task Team on developing RA-II WIS Implementation Plan (R2-WIS-IP) was established. The members of Task Team were nominated by the WIS focal points from each GISC/GISC candidate and some DCPCs/NCs in RA II. Coordinating by the RA-II co-coordinators of Expert Group on WIS, the Task Team is comprised of eleven nominations from GISC/GISC candidate Beijing, Jeddah, New Delhi, Seoul, Tehran, Tokyo and DCPC/NC Bangkok, Doha and Karachi.

In addition to capacity-building activities in RA-II, this RA-II WIS Implementation Plan (R2-WIS-IP) incorporating with Manual on WIS and WIS Demonstration Guidelines is a set of reference documents for RA II members at national and regional level to follow in order to achieve all objectives and requirements of WMO information system (WIS).

## 3. SCOPE AND PURPOSE OF THE RA II WIS IMPLEMENTATION PLAN

For the effective and efficient WIS system, the WIS implementation has three layers/criteria of scope: global, regional, national. The global WIS Project and Implementation Plan have been developed by WMO secretariat and provided task area or activities in global aspect. This plan is available online (WIS Project and Implementation Plan v1.2.1, August 2010[9] . The national plans will be focused on the identification and registration of relevant centres by each Member and partner international organizations, as well as on the capacity development for meeting the WIS requirements, defined in the related WMO technical regulations, and for making the full use of the WIS functionalities.

The regional plan ensures a harmonized and synchronous implementation by all regional members as well as inter-regional project. The RA II WIS implementation plan is based on guidelines, requirements and tasks. In particular, this plan includes:

- Functional Architecture;
- Status of WIS in RA II;
- Technical compliance Specification of the GISC, DCPC and NC;
- Governance Procedures for implement of WIS centres;
- Execution and timelines.

The purpose of the RII WIS Implementation Plan is to provide:

a) RA II members with overall technical guidance, assistance and support for the implementation of the WIS, which would coordinate the implementation of WIS including further improvement of GTS and optimize and achieve maximum compliance. In view of the foregoing, the RA II WIS Implementation Plan is aimed at assisting RA II Members to implement WIS functionality in their identified centres and become effective WIS users in a timely and harmonized manner. Therefore, it concentrates on the access to WIS by NMHSs as National Centres (NC). The requirements and procedures for other types of centres, like Global Information System Centres (GISC) or Data Production or Collection Centres (DCPC), are described in detail in the Manual on WIS (Manual on the WMO Information System [WMO-No. 1060]) and WIS Demonstration Guidelines, and therefore only briefly mentioned in this paper. However, in implementing and supporting WIS in RA II and monitoring its performance, GISCs will have to take on certain responsibilities described below. Information about the implementation of GISCs and DCPCs by RA II Members and international organizations is included in the Plan monitoring process in order to provide "one stop shop" with regard to the overall WIS implementation in Region II (Asia).

b) Strategic approaches to effective and efficient capacity building highlight some key issues on technical implementation and designation requirement for WIS centres. The Plan also provides practical guidance and a step-by-step approach towards the WIS implementation by Members in their National Centres. A primary task for the NMHSs is ensuring compliance with the WIS requirements established by the WMO regulatory material WMO Technical Regulations, Volume I (WNO-No. 49) and its Annex VII, Manual on the WMO Information System (WMO-No. 1060). In order to facilitate the implementation process, the GISCs should establish close contacts with the NCs in their areas of responsibility and act as "help desks" when assistance is needed. In particular, GISCs should plan for providing assistance to build the capacity of the NCs to handle the required discovery metadata.

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[9] WIS Project and Implementation Plan (2010) - http://www.wmo.int/pages/prog/www/WIS/documents/WIS-ProjectPlan-v1-2-1.doc

## 4. DESCRIPTION OF WIS

WIS (WMO Information System) is the global infrastructure for data management and making it available to access weather, water and climate information. WIS provides an integrated approach to meet the requirements for routine collection and automated dissemination of observed data and products, as well as data discovery, access and retrieval services for all weather, climate, water and related data produced by centres and member countries in the framework of any WMO programme.

### 4.1 WIS Services

Since the WMO was founded, timely data exchange has been crucial. Like early telegraph and telephone systems, operators would route data messages over dedicated lines using systems dedicated to WMO. This is the WMO Global Telecommunication System (GTS). Now WMO is taking a step beyond managing data messages. WIS builds on and extends the GTS, and it is also a new approach to data discovery and data provision in the meteorological community. WIS goes far beyond providing telecommunication services, and offers new and modern data management services to its users. These are essentially the possibility to discover all data and products of the wider WMO community, as well as the means and information on how to obtain the data. For this purpose, all information within WIS is described by discovery metadata in accordance to the WMO Metadata Core Profile as described in Part V of the Manual on the WIS and its associated Appendix C. It is assumed that WIS by including the GTS and the Internet will have sufficient bandwidth/link capacity available to fulfil future user needs. To this end, in 2007, the WMO Congress stated that WIS is to provide three types of services:

- Routine collection and dissemination service: for time-critical and operation-critical data and products based on real-time "push" via dedicated telecommunication
- Data Discovery, Access and Retrieval service: based on request/reply "pull" via Internet
- Timely delivery service for data and products: based on delayed mode "push" via combination of dedicated and public networks

### 4.2 The structure of WIS

WMO Member countries will implement and operate WIS, using existing centres with some additional or modified capabilities. In operational terms, WIS encompasses three types of centres as well as the WIS data communication network.

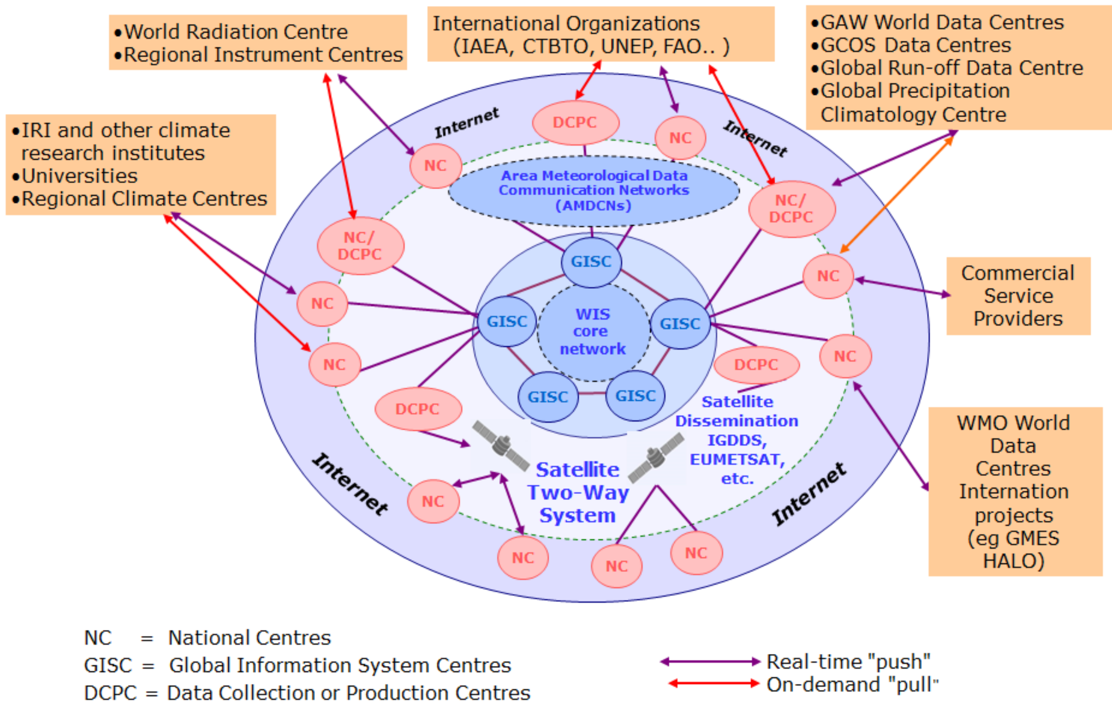
- Global Information System Centres (GISCs),
- Data Collection or Production Centres (DCPCs) and
- National Centre (NCs)
- Data networks

### 4.3 WIS Centres

**GISCs** collect and distribute information for routine global dissemination, such as GTS data. **GISCs** hold and distribute copies of at least 24 hours of WMO data and products intended for global distribution. They serve as collection and distribution centres in their areas of responsibility and they provide access points for any request for data held within the WIS. A WIS user accessing the web portal of any GISC will be able to browse any data catalogue of information available in WIS.

**DCPCs** collect, disseminate, add value to, and archive regional or programme-specific data and products. DCPCs maintain catalogues of their holdings and services, and appropriate parts of these catalogues update a comprehensive catalogue of WIS holdings, hosted by the GISCs.

**NCs** collect and distribute data on a national basis and coordinate or authorize the use of the WIS by national users, normally under a policy established by the respective Permanent Representative with WMO.

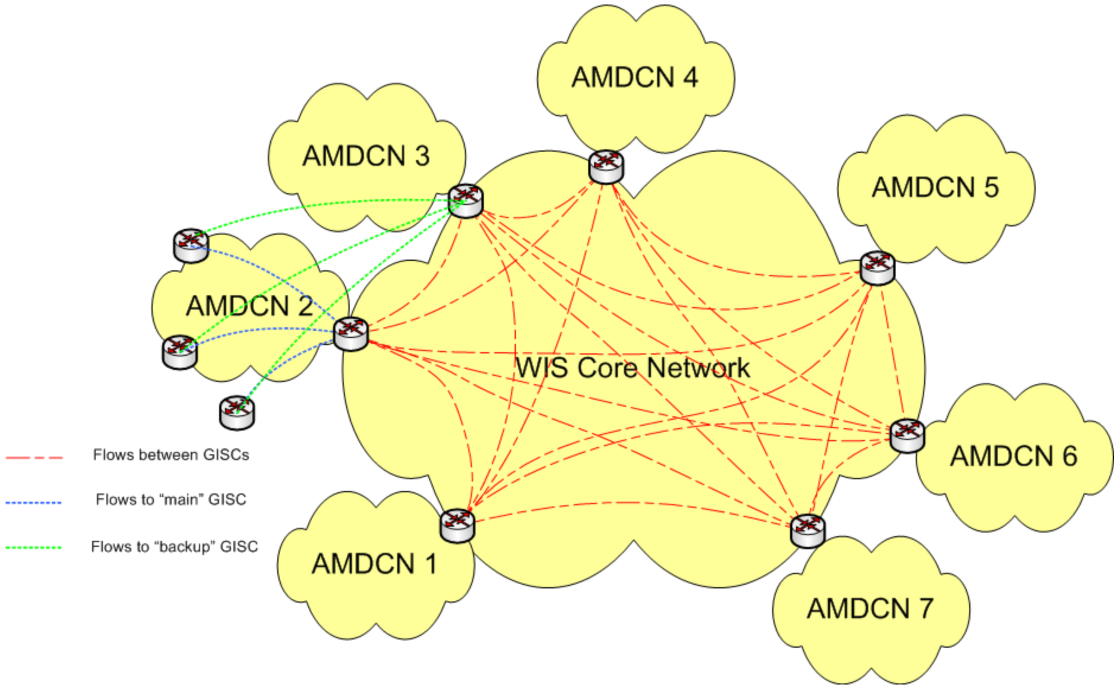



## 4.4 WIS data networks

The WIS network structure consists of a WIS Core Network connecting all GISCs to each other. The WIS real-time network would be composed of a number of Area Meteorological Data Communication Networks (AMDCNs) and a WIS core network interconnecting the GISCs and AMDCNs together. An NC or DCPC may be in multiple AMDCNs. The AMDCNs incorporate GTS infrastructure and may involve single, partial or multiple regional meteorological telecommunication networks.

The data communication networks that can be used in WIS include:

- The GTS Main Telecommunications Network (MTN) was significantly modified by the Improved MTN (IMTN) project that started at ET-IMTN meeting in Sep/Oct 1999. Its implementation has progressed in technical evolution process as the configuration of two clouds (i.e. Network I & Network II) until Sep 2009. By the end of 2009, all links via Network I have migrated to via Network II. CBS noted the completion of the IMTN Project at its 2010 Extraordinary Session in Namibia with the MTN operating on a single coordinated MPLS cloud based on the RMDCN.
- GISCs are also connected by the Internet, which presently is being used for discovery metadata synchronization.
- The GTS (MTN and RMTN) provides the dedicated network component of the AMDCNs, especially for meeting real-time exchange requirements and the all hazards network. Note that the GTS includes extensive use of Internet through Virtual Private Networks (VPN) in many areas where no alternatives exist.
- Satellite distribution and collection systems such as those described by the Integrated Global Data Dissemination Service (IGDDS) form an essential part of the GTS and therefore the WIS, especially for the support of remote areas where terrestrial communication systems do not effectively meet the need. This includes data collection systems for remote platforms as well as for distribution of data and products related to the WMO Space Programme.
- Terrestrial links or managed data network services.
- The Internet, either open or utilizing VPN, which will be used in the AMDCNs to increase bandwidth capacity to many centres as well as providing connectivity for non-GTS centres and for individual users accessing WIS.




**4.5 Benefits of WIS:**

As an integral part of WIS from the World Weather Watch Programme (WWW), the aim of the GTS is to ensure delivery of time-critical and operation-critical data, products and services for all WMO Programmes, including warnings to and from NMHSs. GTS realizes this through the "Routine collection and dissemination service for time-critical and operation-critical data and products".

Some benefits of WIS are as follows:

- WIS enhances the collection of critical data needed to monitor and predict aspects of the environment, including hazards;
- WIS catalogs the full range of data and products, simplifying search and assuring equitable access per WMO policies;
- WIS enhances the availability of time-critical data and products at centres in all nations, ensuring the effective provision of services to their populations and economies;
- WIS opens up WMO's private network (the GTS) to other types of environmental data so that all programmes have stronger infrastructure support; and

WIS exploits opportunities as they become available with technology innovation.

Existing centres within WMO Member States that comply with the required WIS functions and technical specifications will be designated as one of the three types of WIS centre. While Members can chose to apply for a type of centre matching their level of responsibilities and commitment, the expected mapping of current WWW centres into WIS centres remains to be:

| **WWW Centre** | **WIS Centre** |
|---|---|
| NMC | NC |
| RSMC | DCPC |
| WMC | DCPC and/or GISC |
| RTH | DCPC |
| RTH on MTN | DCPC and/or GISC |
| Others | NC and/or DCPC |

**4.6 WMO information sources and regulations on WIS**

Information on all aspects of WIS is available on the WMO website at: http://www.wmo.int/wis.

The implementation of the WIS is coordinated through a Global Project and Implementation Plan available at: http://www.wmo.int/pages/prog/www/WIS/documents/WIS-ProjectPlan-v1-2-1.doc.

The technical regulations related to WIS are published in the WMO Technical Regulations (WMO-No.49), Volume 1, General Meteorological Standards and Recommended Practices, Part A3, and in Annex VII, Manual on WIS (WMO-No.1060). Practical guidance on the implementation of the technical regulations is provided in the Guide to WIS (WMO-No. 1061).

# 5. WIS IN REGION II (ASIA)

## 5.1 Current status of RA II telecommunication

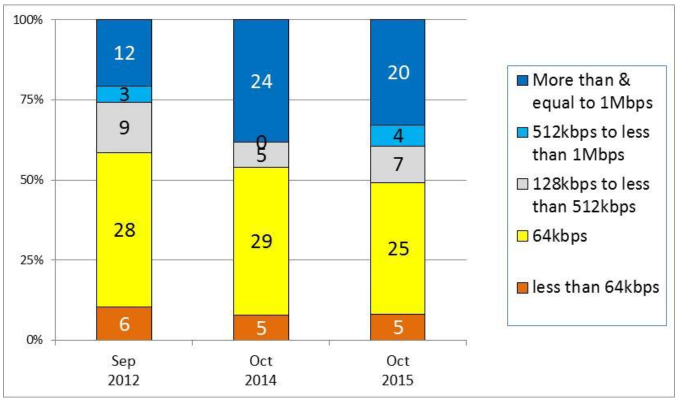
The Regional Meteorological Telecommunication Network (RMTN) is the communications and data management component that operates through the collection and distribution of the information critical to NMHSs operations. RMTN is also accompanied by very developed data management practices. These facilitate the orderly and efficient overall management of meteorological data and products of the World Weather Watch programme.

In the operation of WIS, the communication links enable the routine collection and dissemination of time-critical and operation-critical data and products. These, and the timely delivery of all other data and products, are the lifeblood of WMO activities. Communications links of WIS will be a core network connecting GISCs, (the GTS Main Telecommunication Network (MTN)) plus a number of communication networks connecting the various GISCs to DCPCs and NCs within each GISC's area of responsibility. This Area Meteorological Data Networks (AMDCN) will include technologies such as the GTS, Internet and satellite broadcast systems.

An overview of RMTN is given below.

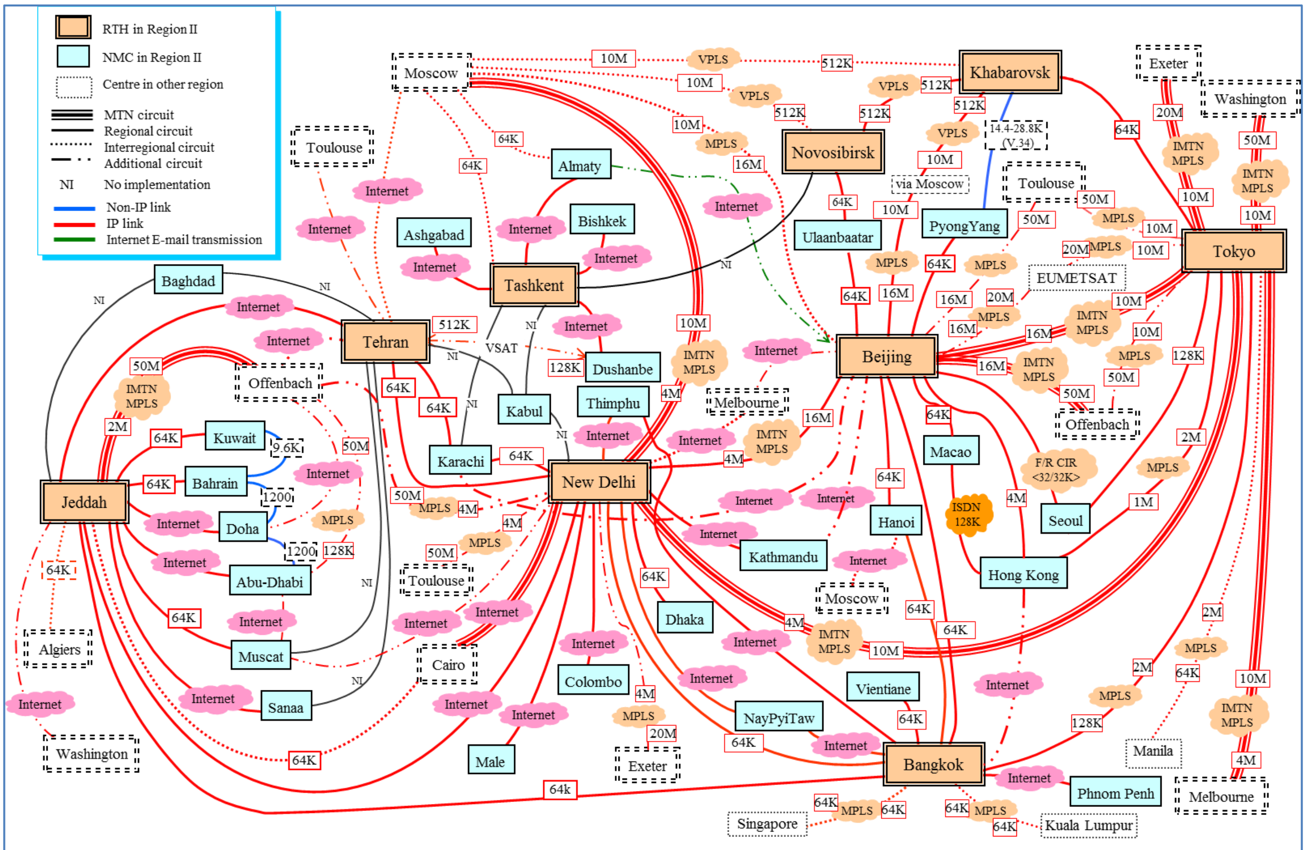
| | | Aug 2007 | Oct 2008 | Sep 2009 | Aug 2010 | Nov 2011 | Sep 2012 | Oct 2014 | Oct 2015 |
|---|---|---|---|---|---|---|---|---|---|
| The number of the circuits in operation | MTN circuits | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 |
| | Regional circuits | 47 | 45 | 46 | 46 | 46 | 46 | 46 | 48 |
| | Interregional circuits | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 |
| | Additional circuits | 10 | 10 | 11 | 12 | 12 | 13 | 20 | 20 |
| | Total | 77 | 75 | 78 | 80 | 80 | 81 | 88 | 90 |
| The number of the circuits not in operation | MTN circuits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Regional circuits | 8 | 10 | 9 | 9 | 9 | 9 | 9 | 8 |
| | Interregional circuits | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Additional circuits | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | Total | 11 | 13 | 11 | 11 | 11 | 11 | 11 | 10 |
| The number of circuits via the Internet | MTN circuits | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | Regional circuits | 6 | 8 | 12 | 12 | 12 | 12 | 12 | 17 |
| | Interregional circuits | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |
| | Additional circuits | 7 | 7 | 7 | 7 | 7 | 8 | 10 | 10 |
| | Total | 14 | 16 | 22 | 22 | 22 | 23 | 25 | 31 |
| The number of IP-VPN circuits (MPLS VPLS) | MTN circuits | 5 | 5 | 5 | 8 | 8 | 8 | 8 | 8 |
| | Regional circuits | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 5 |
| | Interregional circuits | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 6 |
| | Additional circuits | 2 | 2 | 3 | 4 | 4 | 4 | 9 | 9 |
| | Total | 10 | 10 | 16 | 20 | 20 | 20 | 25 | 28 |
| The number of circuits at each speed (exclude internet) | less than 64kbps | | | | | | 6 | 5 | 5 |
| | 64kbps | | | | | | 28 | 29 | 25 |
| | 128kbps - 511kbps | | | | | | 9 | 5 | 7 |
| | 512kbps - 999kbps | | | | | | 3 | 0 | 4 |
| | 1Mbps =< | | | | | | 12 | 24 | 20 |
| | Total | | | | | | 58 | 63 | 61 |
| Network type operation + non-operation | Internet | 14 | 16 | 22 | 22 | 22 | 23 | 25 | 31 |
| | Frame Relay | 9 | 9 | 3 | 1 | 1 | 1 | 1 | 1 |
| | MPLS, VPLS | 10 | 10 | 16 | 20 | 20 | 20 | 25 | 28 |
| | Leased Line, VSAT tec. | 44 | 40 | 37 | 37 | 37 | 37 | 37 | 30 |
| | Not in Operation | 11 | 13 | 11 | 11 | 11 | 11 | 11 | 10 |
| | Total | 88 | 88 | 89 | 91 | 91 | 92 | 99 | 100 |

Analysis of implementation status of RMTN depicts that




More than 90% circuits (bandwidth guarantee: total 60 links in 2015) are running at speed ≥ 64 kbps. For effective implementation of WIS, it was recommended in the Meeting of WMO RA II Working Group on WMO Integrated Observing System and WMO Information System (WG-IOS/WIS), Seoul, Republic of Korea, 30 November - 7 December 2011 that the circuits may be upgraded to 512 kbps because new sets of data like satellite and NWP products have significant contribution for operation critical activities and 512 kbps would help timely delivery of various sets of data to end users in minimal time.

However, at present only 40% of total circuits (bandwidth guarantee: total 60 links in 2015) operate at speed ≥ 512 kbps. Therefore there is a need to push NMHSs for upgrade of circuits. The number of circuits at each speed as of Oct 2015 (Revised categories since 2011)




**Regional Meteorological Telecommunication Network for Region II (Asia)**
Current status as of 28 October 2015 (Based on the annual survey produced by RA-II EG-WIS)

Moreover, certain RMTN circuits like Karachi - Tashkent and Kabul -Tashkent are not logical networks and there is no chance of their revival in coming time. It would be appropriate to remind concerned NMHSs to either revive the linkages, implement Internet links or opt for their deletion from the network list. Pictorial representation of RMTN for RA II is appended above.

**5.2 WIS centres in RA II**

The procedures for the designation of the GISC, DCPC and NC of WIS centres are provided in the Manual on WIS (WMO No. 1060), Part II. After successful completion of the designation procedure, the centre is included in Appendix B to the Manual, Approved WMO Information System Centres.

Note: Information on the current status of the designation of centres by Members is available on: http://www.wmo.int/pages/prog/www/WIS/centres/index_en.php.

At present, there are the three GISCs (Beijing, Tokyo, Seoul) in RA-II which are endorsed and are operational. The other three GISCs in RA II have been successfully audited by CBS are New Delhi, Tehran and Jeddah. GISC Moscow also services RA II. All are expected to become fully operational in near future.

| Member | Centre type | GTS Function | Principal GISC | Const. Body | Endorsement CBS | Congress/EC |
|---|---|---|---|---|---|---|
| China | GISC | RTH | Beijing | CBS | Endorsed by CBS | 2011/6/1 |
| India | GISC | RTH | New Delhi | CBS | Endorsed by CBS | 2011/6/1 |
| Iran, Islamic Republic of | GISC | RTH | Tehran | CBS | Endorsed by CBS | 2011/6/1 |
| Japan | GISC | RTH | Tokyo | CBS | Endorsed by CBS | 2011/6/1 |
| Republic of Korea | GISC | NMC | Seoul | CBS | Endorsed by CBS | 2011/6/1 |
| Saudi Arabia | GISC | RTH | Jeddah | CBS | Endorsed by CBS | 2011/6/1 |
| Russian Federation | GISC | WMC | Moscow | CBS | Endorsed by CBS | 2011/6/1 |

A list of links to the GISCs in RA II as follows:

- GISC Beijing : http://wisportal.cma.gov.cn/wis/
- GISC Tokyo : http://www.wis-jma.go.jp/
- GISC Seoul : http://gisc.kma.go.kr/
- GISC New Delhi : http://wis.imd.gov.in/MessirWIS/
- GISC Tehran : http://gisc.irimo.ir/
- GISC Jeddah : http://84.235.53.3:8080/MessirWIS
- GISC Moscow : http://portal.gisc-msk.wis.mecom.ru/

**5.2.2 DCPCs**

The table below provides information on the DCPCs that have been designated by the RA II Members with their planned functions.

| Member | Centre type | GTS Function | Principal GISC | WIMMS | Const. Body | Endorsement CBS | Congress /EC |
|---|---|---|---|---|---|---|---|
| China | DCPC | RTH | Beijing | | CBS | Endorsed by CBS | 2011/6/1 |
| China | DCPC | RSMC-Geographical (NMC) | Beijing | | CBS | Endorsed by CBS | 2011/6/1 |
| China | DCPC | RSMC-Activity-ATM (NMC) | Beijing | | CBS | Endorsed by CBS | 2011/6/1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| China | DCPC | RCC (Beijing NCC, - RA II) | Beijing | | CCl | Endorsed by CBS | 2011/6/1 |
| China | DCPC | NSMC | Beijing | | CBS | Endorsed by CBS | 2011/6/1 |
| Hong Kong, China | DCPC | WWIS | Beijing | Beijin g | CBS | Endorsed by CBS | 2011/6/1 |
| India | DCPC | RTH | New Delhi | Tokyo | CBS | Under review by ET-GDDP | 2011/6/1 |
| India | DCPC | RSMC-Activity-TC | New Delhi | Tokyo | CBS | Under review by ET-GDDP | 2011/6/1 |
| Iran, Islamic Republic of | DCPC | RTH | Tehran | | CBS | Under review by ET-GDDP | 2011/6/1 |
| Japan | DCPC | WDC-GHG | Tokyo | | CAS | Endorsed by CBS | 2011/6/1 |
| Japan | DCPC | Satellite Centre | Tokyo | | CBS | Endorsed by CBS | 2011/6/1 |
| Japan | DCPC | RTH | Tokyo | | CBS | Endorsed by CBS | 2011/6/1 |
| Japan | DCPC | RSMC-Geographical | Tokyo | | CBS | Endorsed by CBS | 2011/6/1 |
| Japan | DCPC | RSMC-Activity-TC | Tokyo | | CBS | Endorsed by CBS | 2011/6/1 |
| Japan | DCPC | RSMC-Activity-ATM | Tokyo | | CBS | Endorsed by CBS | 2011/6/1 |
| Japan | DCPC | RCC (Tokyo NCC, RA II) | Tokyo | | CCl | Endorsed by CBS | 2011/6/1 |
| Japan | DCPC | GPC/LRF | Tokyo | | CBS | Endorsed by CBS | 2011/6/1 |
| Japan | DCPC | NICT (Space Weather) | Tokyo | | ICT-SW, (CAeM, CBS) | Endorsed by CBS | 2015/6/3 |
| Qatar | DCPC | Marine Meteorologic al Centre (MMC) | Jeddah | Tokyo | JCOMM | Endorsed by CBS | 2015/6/3 |
| Republic of Korea | DCPC | WAMIS | Seoul | | CAgM | Endorsed by CBS | 2011/6/1 |
| Republic of Korea | DCPC | NMSC | Seoul | | CBS | Endorsed by CBS | 2011/6/1 |
| Republic of Korea | DCPC | GPC / LC-LRFMME | Seoul | | CBS | Endorsed by CBS | 2011/6/1 |
| Russian Federation | DCPC | RTH/RSMC-Geographical (Novosibirsk) | Moscow | | CBS | Not submitted to ET-GDDP | 2011/6/1 |
| Russian Federation | DCPC | RTH/RSMC-Geographical (Khabarovsk) | Moscow | | CBS | Not submitted to ET-GDDP | 2011/6/1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Saudi Arabia | DCPC | RTH | Jeddah | | CBS | Under review by ET-GDDP | 2011/6/1 |
| Saudi Arabia | DCPC | RSMC-Geographical (Jeddah) | Jeddah | | CBS | Not submitted to ET-GDDP | |
| Saudi Arabia | DCPC | RDMEC (Drought) | Jeddah | | CHy | Not submitted to ET-GDDP | |
| Thailand | DCPC | RTH | Tokyo | | CBS | Endorsed by CBS | 2015/6/3 |
| Uzbekistan | DCPC | RTH | Seoul | | CBS | Not submitted to ET-GDDP | |

**5.2.3 NCs**

In accordance with the Manual on WIS (WMO No. 1060), each WMO Member shall notify WMO of the name and location of its centre(s) that are to be designated as NC(s). It is therefore expected that each Member will have at least one NC in WIS (and for most of the Members, it is likely that one NC would be sufficient),

In February 2012, WMO circulated a letter to all Members inquiring information from the Permanent Representatives regarding: 1) nomination of a principle GISC which will be associated with the WIS centre(s) of the Member; and, 2) nomination of a focal point for WIS/GTS related matters).

The table below presents the current status of the designation of NCs in RA II with their principal GISC, WIMMS and Focal Point.

Note: The current status is based on the Resolution 5 of the Fifteenth session of Regional Association II (ASIA), Qatar Doha, December 2012.

| Member | NC | GTS Function | Principal GISC | WIMMS | Focal Point |
|---|---|---|---|---|---|
| Afghanistan | Kabul | NMC | Tehran | | Mr Mohammad Nasim Muradi<br>Afghan Meteorological Authority<br>Khwaga Rawash P.O. Box 425<br>KABUL<br>the Interim Administration of Afghanistan<br>Tel: 0093 (0) 700180705<br>Email: raket_nasim@yahoo.com |
| Bahrain | Manama | NMC | Jeddah | Beijing | Mr Nader Ahmed Abdulla<br>Bahrain Meteorological Service P.O. Box 586<br>BAHRAIN<br>Bahrain<br>Tel: +973 17321163<br>Fax: +973 17320630<br>Email: nader@caa.gov.bh |

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|---|---|---|---|---|---|
| Bangladesh | Dhaka | NMC | New Delhi | Tokyo | Mr Abdul Matin<br>Bangladesh Meteorological Department<br>Meteorological Complex Abhawa Bhaban<br>Agargaon 1207<br>DHAKA<br>Bangladesh<br>Tel: +880-2-8116634<br>Fax: +880-2-9103908<br>Email: info@bmd.gov.bd ;<br>amatin2004@yahoo.com |
| Bhutan | Thimphu | NMC | New Delhi | | Mr Chimi Wangda<br>Council for Renewable Natural Resources Research, Ministry of Economic Affairs, Thimphu<br>Bhutan<br>Tel: 02 323703<br>Fax: 02 324 999<br>Email: chimwangs10@gmail.com |
| Cambodia | Phnom Penh | NMC | Tokyo | Tokyo | Ms Peou Phalla<br>Department of Meteorology<br>364, Preah Monivong Blvd, Chamkarmon<br>PHNOM PENH<br>Cambodia<br>Tel: +855-16-616-927<br>Fax: +855-23-213-490<br>Email: phallapeou1@gmail.com |
| China | Beijing | NMC | Beijing | | Ms Xiang Li<br>China Meteorological Administration<br>46 Zhongguancun Nandajie<br>BEIJING 100081<br>China<br>Tel: +86 10 6840 6275<br>Fax: +86 10 6218 6241<br>Email: lixiang@cma.gov.cn |
| Democratic People's Republic of Korea | Pyŏngyang | NMC | Beijing | | State Hydrometeorological Administration |
| Hong Kong, China | Hong Kong | NMC | Beijing | Beijing | Mr Lee Lap Shun<br>Hong Kong Observatory<br>134A Nathan Road<br>KOWLOON<br>Hong Kong, China<br>Tel: +852 2926 8416<br>Fax: +852 2311 9448<br>Email: lslee@hko.gov.hk |
| India | New Delhi | NMC | New Delhi | Tokyo | Dr L. R. Meena<br>India Meteorological Department<br>Mausam Bhavan Lodi Road<br>NEW DELHI 110003<br>India<br>Tel: 011 -2461 6051<br>Fax: 011- 2469 9216<br>Mobile: 91 - 98105 56531<br>Email: lr.meena@imd.gov.in;<br>lrmeena@gmail.com |

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|---|---|---|---|---|---|
| Iran, Islamic Republic of | Tehran | NMC | Tehran | Tokyo | Ms Farah Mohammadi<br>Islamic Republic of Iran Meteorological Organization<br>P.O. Box 13185-461<br>TEHRAN<br>the Islamic Republic of Iran<br>Tel: +989123842058<br>Fax: +982166070077<br>Mobile: +989123842058<br>Email: farahmohamadi@yahoo.com |
| Iraq | Baghdad | NMC | Tehran | | Mr Sallam S. Nadhim<br>Iraqi Meteorological Organization<br>Almansoor P.O. Box 6078<br>BAGHDAD<br>Iraq<br>Tel: +964 7702766948<br>Email: sallam_omery@yahoo.com |
| Japan | Tokyo | NMC | Tokyo | | Mr Kenji Tsunoda<br>Japan Meteorological Agency<br>Otemachi 1-3-4, Chiyoda-ku<br>TOKYO 100-8122<br>Japan<br>Tel: +81-3 3212 8341<br>Fax: +81-3 3211 8404<br>Email: tsunoda@met.kishou.go.jp |
| Kazakhstan | Almaty | NMC | Moscow | | B. S RAPIKOV<br>Kazhydromet<br>ul. Orynbor 11/1<br>010000 Astana<br>Kazakhstan<br>Tel: +8-7172-798399<br>Email: rapikov_b@kazhydromet.kz; rapikov@gmail.com |
| Kuwait | Kuwait City | NMC | Jeddah | Tokyo | Mr Fahad Alnajadah<br>Department of Meteorology<br>P.O. Box 17<br>SAFAT 13001<br>Kuwait<br>Tel: +965 66808266<br>Fax: +965 24727326<br>Email: f.alnajadah@met.gov.kw |
| Kyrgyzstan | Bishkek | NMC | Moscow | | Dr Tatiana KOZHEVNIKOVA (Ms)<br>Main Hydrometeorological Administration<br>1, Karasuiskaya Street<br>GSP 720017 BISHKEK<br>Kyrgyz Republic<br>Tel: +(996 312) 314 605<br>Fax: +(996 312) 314 663<br>Email: usi@meteo.ktnet.kg |

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|---|---|---|---|---|---|
| Lao People's Democratic Republic | Vientiane | NMC | Tokyo | Tokyo | Mr Singthong Pathoummady<br>Department of Meteorology and Hydrology<br>P.O. Box 811<br>VIENTIANE<br>Lao People's Democratic Republic<br>Tel: (+856) 21 21 5010<br>Fax: +856 21 223446<br>Mobile: (+856) 20 538 9651<br>Email: singthong_dmh@etllao.com; p.singthong@yahoo.com |
| Macao, China | Macau | WSO | Beijing | | Mr Ian Vai Kei, Brian<br>Meteorological and Geophysical Bureau<br>Rampa do Observatório Taipa Grande<br>Caixa postal No.93<br>MACAU<br>Macao, China<br>Tel: +853 88986260<br>Fax: +853 28850557<br>Email: brianian@smg.gov.mo |
| Maldives | Malé | NMC | New Delhi | Tokyo | Mr Ali Shareef<br>Department of Meteorology<br>Orchid Building Orchid Magu<br>MALE 20-05<br>Maldives<br>Tel: +960 332 6200<br>Fax: +960 3320021<br>Mobile: +960 7771828<br>Email: admin@meteorology.gov.mv |
| Mongolia | Ulaanbaatar | NMC | Beijing | | Ms Davaasuren Tungalag<br>National Agency for Meteorology, Hydrology and Environment Monitoring<br>Khudaldaany Gudamj-5<br>ULAANBAATAR 46<br>Mongolia<br>Tel: +976-11-328 035<br>Fax: +976 11 329968<br>Email: tungalag@icc.mn/ tungalag@yahoo.com |
| Myanmar | Yangon | NMC | Tokyo | | Dr Hrin Nei Thiam<br>Department of Meteorology and Hydrology<br>Mayangon P.O. 11061<br>YANGON<br>Myanmar<br>Tel: 00 95 67 411031<br>Fax: 00 95 67 411449<br>Email: dg.dmh@mptmail.net.mm |

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|---|---|---|---|---|---|
| Nepal | Kathmandu | NMC | Beijing | | Mr Kamal Prakash Budhathori<br>Department of Hydrology and Meteorology<br>G.P.O. Box 406 Babar Mahal<br>KATHMANDU<br>Nepal<br>Tel: +977 1 4255920<br>Fax: +977 1 4262348/ +977 1 4254890<br>Email: kp_budhathoki@yahoo.com |
| Oman | Muscat | NMC | Jeddah | Tokyo | Mr Ahmed H. Al Harthy<br>Department of Meteorology<br>P.O. Box 1, Code: 111 & P.O. Box 204, Code: 113<br>Muscat<br>Oman<br>Tel: +968-24-519360<br>Fax: +968-24-518360<br>Email: a.alharthy@met.gov.om |
| Pakistan | Karachi | NMC | Beijing | Beijing | Mr Azmat Hayat Khan<br>Pakistan Meteorological Department<br>Sector: H-8/2 P.O. Box 1214<br>ISLAMABAD<br>Pakistan<br>Tel: +92-51-9250598<br>Fax: +92-51-9250368<br>Email: dirndmc@gmail.com; pakmet_islamabad@yahoo.com; director@pmd.gov.pk |
| Qatar | Doha | NMC | Jeddah | Tokyo | Mr R. Monikumar<br>Qatar Meteorology Department<br>PostBoxNo.3000,<br>Doha,Qatar<br>Tel: 0097466812409<br>moni.kumar@caa.gov.qa<br>monikumar.r@gmail.com |
| Qatar | Doha | Aviation Centre | Jeddah | Tokyo | Mr R. Monikumar<br>Qatar Meteorology Department<br>PostBoxNo.3000,<br>Doha,Qatar<br>Tel: 0097466812409<br>moni.kumar@caa.gov.qa<br>monikumar.r@gmail.com |
| Republic of Korea | Seoul | NMC | Seoul | | Mr Sunghoi Huh<br>Korea Meteorological Administration<br>460-18, Shindaebang-dong Dongjak-gu<br>SEOUL 156-720<br>Republic of Korea<br>Tel: +82 2 2181 0416<br>Fax: +82 2 2181 0449<br>Mobile: +82-10-4559-7256<br>Email: shhuh@korea.kr |

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|---|---|---|---|---|---|
| Russian Federation | Novosibirsk | WSO (Novosibirsk) | Moscow | | Mr Alexander Karpenko<br>Russian Federal Service for Hydrometeorology and Environmental Monitoring (Novosibirsk)<br>Novosibirsk,Sovetskayastr,30,Russia<br>Tel:+73832224388<br>Fax:+73832222555<br>karp@meteo-nso.ru aspd@meteo-nso.ru |
| Russian Federation | Khabarovsk | WSO (Khabarovsk) | Moscow | | Mr Anatoly Nagorsky<br>Russian Federal Service for Hydrometeorology and Environmental Monitoring (Khabarovsk)<br>Khabarovsk,Leninstr,18Russia<br>Tel:+74212233064<br>Fax:+74212214248<br>aspd@hbrv.mecom.ru |
| Saudi Arabia | Jeddah | NMC | Jeddah | | Dr Saad Almajnooni<br>Presidency of Meteorology and Environment<br>P.O. Box 1358<br>JEDDAH 21431<br>Saudi Arabia<br>Tel: +966 546467695<br>Fax: +966 26572931<br>Email: saad_J2001@hotmail.com |
| Sri Lanka | Colombo | NMC | New Delhi | | Mr S. R. Jayasekara<br>Department of Meteorology<br>383,BauddhalokaMawatha,Colombo07<br>Tel:+94112691443<br>Fax:+94112698311<br>siriranjith@gmail.com |
| Tajikistan | Dushanbe | NMC | Moscow | | Mr Suhrob Olimov<br>Main Administration of Hydrometeorology and Monitoring of the Environment<br>DUSHANBE 734025<br>Tajikistan<br>Tel: +99244625848<br>Mobile: +992918297570<br>Email: olimovsa@gmail.com |
| Thailand | Bangkok | NMC | Tokyo | | Dr Wanchalearm Petsuwan<br>Thai Meteorological Department<br>4353 Sukhumvit, Bangna<br>10260<br>BANGKOK<br>Thailand<br>Tel: +662 399-4596<br>Fax: +662 398-9861<br>Email: wpetsuwan@hotmail.com;<br>gtsbkk@metnet.tmd.go.th |
| Turkmenistan | Ashgabat | NMC | Moscow | Seoul | Mr Hallyyev Batyr Jumamuradovich<br>Administration of Hydrometeorology<br>28, Azadi Avenue<br>ASHGABAT 744000<br>Turkmenistan<br>Tel: +993 12 93 81 58<br>Fax: +993 12 93 56 86<br>Email: meteo@online.tm |

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|---|---|---|---|---|---|
| United Arab Emirates | Abu Dhabi | NMC | Jeddah | | Mr Jassim Almarzouqi<br>National Center of Meteorology and Seismology<br>P.O. Box 4815<br>ABU DHABI<br>United Arab Emirates<br>Tel: +971 2222 7771<br>Fax: +971 26661575<br>Email: jalmarzouqi@ncms.ae |
| Uzbekistan | Tashkent | NMC | Seoul | | Mr Bakhtier Makhmudov<br>Uzhydromet<br>72, 1st Bodomzor yuli str.<br>TASHKENT 100052<br>Uzbekistan<br>Tel: +998 711 508 635, 237 35 11<br>Fax: +998 712332025<br>Email: uzhymet@meteo.uz, mtb@meteo.uz |
| Viet Nam | Hanoi | NMC | Tokyo | | Mr Nguyen Nam Thanh<br>Hydrometeorological Service<br>No. 4, Dang Thai Than Str. Hoan Kiem<br>HANOI<br>the Socialist Republic of Viet Nam<br>Tel: +844 3 824 4120, +844 3 824 4187<br>Fax: +844 3 826 0779, +844 3 825 7740<br>Email: hoahtqt@gmail.com, daikhanh@kttv.gov.vn |
| Yemen | Sana'a | NMC | Jeddah | | Mr Tareg S. Alhamady<br>Yemen Meteorological Service<br>Haddah Post Office P.O. Box 7145<br>SANA'A<br>Republic of Yemen<br>Tel: + 967 1 419774 ext 215<br>Fax: +967 1 419771<br>Email: fore@yms.gov.ye |

## 6. WIS PLANNING AND IMPLEMENTATION BY RA II MEMBERS

EC-65 confirmed all NMHS's National Meteorological Centres under the World Weather Watch as National Centres. See Resolution 13 (EC-65). In planning the WIS implementation at national level, Members should strive to comply with the relevant WMO technical regulations, that include procedures, specifications and functional requirements, provided in the WMO Technical Regulations (WMO-No. 49[10]), Volume I, Part A3, and the Manual on WIS, (WMO-No. 1060[11]). The Guide to WIS (WMO-No. 1061[12]) complements the technical regulations with additional description and explanation of the WIS, which would assist Members in their implementation actions.

### 6.1 Pre-requisites for use of WIS by an NMHS

Each WMO RA II Member must implement at least one NC; NMHS shall bring about an internal decision to join WIS in RA II. For an NMHS, there are several requirements to be met by a current GTS centre before it can start using WIS and thus become a compliant NC. They are mostly concerned with administrative issues and less with technical matters.

#### 6.1.1 WIS Focal Points

When a centre plans to use WIS, the PR of the country should nominate a "WIS Focal Point". The WIS Focal Point should be a member of staff who is familiar with the service, in particular the current GTS support. The person will receive all WIS related information with regard to the country on one hand, but is expected on the other hand to inform WMO and its relevant bodies about any progress or problems encountered when using WIS. He/she will attend training courses organized by WMO or WIS centres and serve as the national distributor of WIS knowledge, in particular metadata concepts. It is envisaged that the WIS Focal Point will provide the necessary monitoring information.

Since the structure of WIS assumes that an NC is connected to a GISC for its WIS functions and thus participates in the AMDCN organized by that GISC, it is necessary to set up the required administrative links with the GISC. In principle, an NC may belong to the users of any GISC, unless the network connectivity only allows one choice. In any case, an agreement should be reached between the NC and the GISC about their relationship, including identifying their "Principal GISC" for the purposes of managing discovery metadata, of which the WMO should be notified together with the nomination of the WIS Focal Point (see Appendix III).

#### 6.1.2 Principle GISC

Records of the list of NCs and their Principal GISC are maintained in Annex B Table 3 of the Manual on the WIS (WMO No 1060). The principal GISC will ensure within its AMDCN that all connected centres will receive all the data meant for them, be it globally distributed, additional or addressed data. It will also receive the data sent by them and distribute it in accordance with the distribution lists in either GTS or other formats, using the WIS data transfer options. It will maintain the WIS comprehensive metadata catalogue and provide means for its AMDCN centres to update those parts of the discovery metadata catalogue describing their data and products, possibly via Internet access.

The principal GISC is the organization to be contacted first by any of its connected centres about any issue related to WIS. It will organize regular meetings with the WIS Focal Points of the centres belonging to its AMDCN and provide training material and courses as required. It will support the metadata activities in its area of responsibility in a suitable manner and provide data for the regional WIS monitoring.

Besides the principal, associated backup GISC is required for operational continuity in case the principal GISC is not available for some reason. Each GISC shall identify a back up

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[10] WMO No. 49 Volume 1 - http://library.wmo.int/opac/index.php?lvl=notice_display&id=14073

[11] WMO No 1060 Manual on the WIS - http://library.wmo.int/opac/index.php?lvl=notice_display&id=9254

[12] WMO No 1061 Guide to the WIS - http://library.wmo.int/opac/index.php?lvl=notice_display&id=6856

GISC for supporting centres in its AMDCN. The GISC will maintain business continuity plans and handover arrangements to ensure continued service to centres, especially for the collection and distribution of data and products.

**6.1.3 Backup and Associated GISCs**

To guarantee at least the dissemination and collection of the globally distributed GTS data set, a communication connection has to be established with back-up GISC(s),. It should be chosen in collaboration with the principal GISC. Agreement needs to be reached on the network specific details. Regular tests should be carried out to ensure the availability of the back-up when suddenly required. Details of further back-up arrangements to be provided still need further work by the relevant CBS WIS expert teams. The choice of the principal, backup and associated GISC(s) may be influenced by the network "connectivity".

Although a centre can have only one GISC (and its backup) for the purposes of metadata management, any centre can have multiple associations with other GISCs for access to their services. Records of associated GISCs are maintained by the secretariat and available online at http://www.wmo.int/pages/prog/www/WIS/centres/index_en.php.

**6.1.4 Connectivity**

All the operational GISCs should establish their AMDCN (Area Meteorological Data Communication Networks) using the current RMTN connections as soon as they can. Taking into account the current structure of the RMTN, all the GISCs in RA-II should support at least four communication infrastructures, which are "dedicated leased line", "MPLS VPN", "satellite broadcast systems" and "Internet". This will be a fast way to establish an AMDCN and accelerate WIS implementation. In RA II, NMHS should set up a communication link to the principle GISC via AMDCN. Most NMHSs are connected to the Internet and can use this medium for less critical interactive access and file transfers. Although the Manual on WIS allows any country to any GISC regardless of Region, for RA II, if a country belongs to the RMDCN cloud, it may choose any RA II GISC or Moscow as its principal GISC, because all the GISCs in RA II would be connected to the RMDCN and this network allows any-to-any connectivity. If, however, only a dedicated link to an adjacent centre exists, a GTS RTH scenario, then the principal GISCs of these two centres should be the same to avoid unnecessary complications in traffic routing. The RTH in this context will act as a gateway between the principal GISC and the NC. Similarly, an NC or DCPC in a Member that is not the NMHS and not connected to the RMTN, can use its NMHS NC as the connection to the RMTN, or use the Internet to connect to the GISC.

**6.1.5 Bandwidth**

In contrast to the GTS where the dedicated network bandwidth between adjacent centres was limited and thus the traffic between any two centres had to be prioritized in advance, the WIS approach allows for the use of the Internet and allows for the combined the bandwidth of the Internet, satellite broadcast systems and dedicated network to be sufficient to support the intended data exchange between the GISC and the NC. As long as the data to be transmitted consists of only the globally distributed and additional data sets, a dedicated bandwidth of 64 kbps seems to be the minimum for RA II. If, however, specialized data sets like satellite or radar data are being considered, bandwidths in excess of 128 Kbps may have to be implemented. Depending on the local situation, it may be necessary to continue using GTS type dissemination until the network bandwidth, either RMDCN or Internet if appropriate, is sufficient for the intended use.

The major difference in the GTS before and after WIS is the need for discovery metadata records held by the GISCs for each data item being exchanged on the GTS. This is because WIS is an information based system and not only a communication system.

**6.1.6 DAR Metadata**

Whereas the GTS data is defined by its header or file name which is recorded in the relevant volumes, held by WMO, the data in WIS is described by a discovery metadata record in accordance to the WMO Metadata Core Profile and is stored in a metadata catalogue for each GISC and shared amongst all GISCs at regular intervals. It is the responsibility of the data owner to generate the corresponding discovery metadata record and to maintain it. However, in order to facilitate the initial deployment of WIS, Météo France generated metadata records for all data currently exchanged via the GTS. In the longer term though, these initial records have to be taken over by the relevant data owners and updated as required. In addition, if any new data is being considered for exchange, a corresponding discovery metadata record has to be generated and sent to the principal GISC in advance of the data. If the data is to circulate on the GTS, relevant WMO publications (WMO No 9, Volume C1) also need to be updated by the receiving RTH or principal GISC if not coming through an RTH.

Each NC, therefore, requires personnel with metadata knowledge and responsibility. To train the staff of NCs in discovery metadata handling, their principal GISC will offer regular training courses in addition to WMO sponsored training events like the WMO WIS Centre Jump-Start Offer (WIS Jump Start [http://www.wmo.int/pages/prog/www/WIS/documents/JumpStartFlyer.doc]). Each NC should make sure that at least two staff are knowledgeable about the WMO Metadata Core Profile and are able to update its metadata records. RTH staff also need to be trained in metadata requirements and management.

### 6.1.7 Access to metadata editor

Each NC should decide whether the metadata editor should be supported locally or remotely by the GISC (WIMMS at the early stage). In view of this decision, the necessary software environment should be set up: either by installing the editor on a local server or by setting up an Internet connection to the GISC for the editing. Each NC should make registration and apply for the metadata management authorization to its principal GISC. Verify the metadata information from the URLs and update then appropriate in cooperation with its principal GISC. If an NC is willing to maintain its own metadata, it could have its own system installed for metadata functions. If the metadata is maintained in the GISC or DCPC (RTH), this can be arranged by creating a user registration at the GISC or DCPC and by maintaining the NCs metadata there.

### 6.1.8 Designation of National Centres

Each RA II member shall notify WMO of the current name and location of each of its centres that is to be designated as a National Centre in WIS. The NCs designated by members will then be registered in the WIS section of the WMO Country Profile Data Base (see 8.5). Compliance with WIS will be demonstrated by the successful completion of the test cases provided in Attachment IV of this document.

### 6.2 Pre-requisites for use of WIS by other centres

There may be other WIS centres besides the NC of an NMHS within a country. For example, the NMHS might also operate one or more DCPCs for specialized data or there may be multiple NCs run by different organizations like hydrology and oceanographic centres.

### 6.2.1 DCPC

As stated earlier, a DCPC provides Programme-specific data for WIS, e.g. GTS data as an RTH. Therefore, it has to be sponsored by a WMO Programme and connected to a GISC in the region with sufficient bandwidth. In addition, special software to support the planned operation of a DCPC has to be installed at the centre. Once this has been achieved, the relevant PR or Director of the Organization may submit a proposal to WMO for the DCPC to be accepted, nominating a staff member responsible and stating the commitment to operate the DCPC after its validation.

In accordance with the Manual on WIS, a number of certifications and tests will subsequently be carried out by WMO and, in particular, the CBS expert team designated for this role. When all operational and administrative requirements have been met successfully, CBS will propose to the EC that the DCPC becomes part of WIS. Of course, the staff of the DCPC will in the meantime have gained sufficient knowledge of the special software and the WMO Metadata Core Profile to support the activities of the centre’s new WIS functionality.

**6.2.2 NC**

Any NC additional to that of the NMHS will have to adhere to the same procedures as stated above. Its WIS centre Focal point should work closely with the national WIS Focal point of the NMHS who will be the main WIS interface of the country or area.

# 7. RISKS ASSOCIATED WITH WIS IMPLEMENTATION

## 7.1 General WIS acceptance

The main objectives of WIS are:

- To enhance GTS services by making it available to wide range of users through public domain (internet),
- To add new products and make them available to users through the public domain. According to these objectives WIS is expected to be used by three different groups of users:
- WMO related programs' users ;
- Operational data users ; and
- Other users (researchers & industry)

A wide range of acceptance is necessary to achieve above objectives. All RA II GISCs should consider all kinds of users, encouraging them to make use of WIS effectively. Users of WMO related programs should also be encouraged to use WIS as their basic source of information. Each operational GISC should train WIS staff of their area of responsibility and urge them to participate in relevant WMO-sponsored courses. Operational GISCs should announce their available products and services to users. A need exists to frequently update regional researchers and industry users on data/products of their interest and encouraging them to use WIS as search engine for weather related products. A need exists to urge Data Collection or Production Centres (DCPCs) to generate user-tailored products for WIS.

## 7.2 Lack of staff resources for operational WIS centre

The implementation of WIS puts stress on established consultation and information processes. The success of the projects and tasks are expected to be at risk without the availability of WIS focal points or metadata knowledge. Lack of Members` understanding about WIS may also impacts on resources allocation or the giving of priority to WIS activities.

In general, staff knowledge and background criteria would differ between WIS Centres (GISC, DCPC, NC). GISC and DCPC staff should be educated enough about metadata, DAR and WIS related software. NC's staff could manage WIS related activities. RA II GISCs and GISC candidates should enhance their staff training as well as the staff of their area of responsibility. They should ensure the availability of adequate communication systems and give the necessary consultation and cooperation with all Members, to improve their functions, including the establishment of routine RA II WIS long/short-term training programs capable of giving effective communications links.

## 7.3 Lack of DAR Metadata knowledge

Lack of DAR metadata knowledge poses a real risk to WIS success, in particular, at the beginning of its evolution. RA II should take proper measures to face DAR metadata knowledge risks on the basis of WMO requirements and plan to solve this problem through training at three different levels:

At Level 1: Each GISC should take responsibility of training its staff and staff of area of responsibility on regular basis.

At Level 2: RA II should arrange DAR metadata training courses for the region staff.

At Level 3: WMO should have a leading role in tackling this risk by customizing training courses that addresses all WIS knowledge, especially DAR metadata issue.

Each WIS centre (GISC, DCPC, NC) should establish its own training plan and encourage its staff members to actively participate in different WIS related courses.

## 7.4 Insufficient bandwidth of communication links

Telecommunication links bandwidth of RA II region could pose a curb on WIS efficiency. In general, 80% of RA II links work at less than 1Mb/s (September 2012 status). To overcome this risk, all GISCs in RA II should be invited to analyze their telecommunication links with their area of responsibility (AMDCN) in term of data volume exchange (currently and in the future) and compare it with the available bandwidth, making technical and financial plans to smooth the migration from current GTS status to WIS permanent .

The plan should address communication links redundancy as well, in order to avoid any service interruption.

# 8. RA II WIS IMPLEMENTATION PLAN - EXECUTION AND TIMELINE

## 8.1 Regional coordination and monitoring

The regional coordination of the WIS implementation by the RA II Members was initiated at the workshop on WIS implementation in Tokyo, Japan (22-24 October 2012), reviewed the analysis of traffic volume of a 64 Kbps GTS circuit and the results of the survey over the current status at each centre. To meet the growing demand of data and product volume, including satellite products, the workshop recommended updating the minimum requirement for GTS links to be 128 Kbps. The workshop also reviewed the progress on management of discovery metadata in WIS. It noted that WIS metadata management has started in some DCPCs operated by JMA associated to GISC Tokyo. Participants noted with satisfaction that an Excel-based WIS metadata creation tool developed by JMA is proving to be a useful solution for collecting information needed for populating WIS discovery metadata. The workshop supported further refinement of this tool and requested that the development should be part of WIS Application Pilot Project. All comments and suggestions have been incorporated. CBS teams supported the use of the tool noting that it is important that such usage does not lose any modifications to existing metadata records that would have to be re-entered by the Member.

The workshop discussed a draft regional implementation plan that should allow all RA II Members to join WIS in a synchronous and harmonized manner. This includes different forms of assistance to those Members that will need to build their capacity for becoming WIS users. An important aspect of the regional approach is the monitoring of the implementation actions that would allow quick identification and response to observed problems and deficiencies. Without monitoring, there is a high risk that the implementation of WIS in some parts of Region II would be delayed. The monitoring procedures will be defined to include regular information flow between RA II WIS Focal Points and the Secretariat. GISCs and DCPCs will play an important role in the GISC performance monitoring as described in 8.8 below.

## 8.2 RA II WIS Implementation Focal Point

To assist in monitoring the WIS implementation a major component of the RA II WIS Implementation by the RA II Members will be to ensure training for all RA II Members in the use of WIS, with a priority being the use and management of DAR Metadata. GISCs Tokyo, Beijing and Seoul have already held International Workshops for RA II Members in 2010, 2011 and 2012 respectively demonstrating the important role of GISCs in capacity building activities. GISC Tehran utilized the Regional Training Centre Iran in collaboration with the WIS Jump Start offer to develop a training course on WIS in 2011 and will be working with other Regional Training Centres to share their experience. Regional Training Centre Turkey, which supports some RA II Members, incorporated training on WIS to its 2010 and 2012 International Workshops on Meteorological Telecommunications and METCAP Software. GISC New Delhi had also planned a workshop for 2012 but this had to be postponed until 2013. The CBS Expert Team on WIS Centres is developing a training strategy that will also be usable by Regional Associations (See Report[13] on ET-WISC 5$^{th}$ session, paragraphs 4.4 and 4.5 and Document 4.3 of ET-WISC[14]). Training and implementation of WIS has included many WIS Jump Starts being provided by the Secretariat. Experts from WIS centres are encouraged to participate in the WIS Jump Start initiative supporting other centres in their Region.

## 8.3 National implementation plans

Members are expected to develop their own national WIS Implementation Plans by end of 2013. The national WIS Focal point should communicate to the Secretariat and to the RA II WIS Implementation Focal Point (see paragraph 8.3) the target dates for the planned WIS centres to become operational (this information will be registered in the WIS section of the WMO Country Profile Data Base to allow measuring of progress). The national plans should

[13] http://www.wmo.int/pages/prog/www/ISS/Meetings/ET-WISC_Melbourne2012/FReport-ET-WISC2012.doc

[14] https://wiswiki.wmo.int/tiki-download_wiki_attachment.php?attId=869

be coordinated with the principal GISC and should be in agreement with the RA II WIS Implementation Timeline.

**8.4 RA II WIS member database**

The principal source of information on the WIS implementation by Members should be the WMO Country Profile Data Base (CPDB[15]), maintained by the WMO Secretariat. The CPDB WIS section should contain (as a minimum) the following WIS-related information from Members:

- Contact information (national WIS Focal point(s))
- Network connection details and traffic patterns
- Local implementation plan details and results
- Specification of problem areas and failures

The data to be stored in the database is needed to monitor the proper implementation of the plan and to allow appropriate interventions and assistance to be provided to Members, as required. The WIS Focal points of the countries and the DCPCs will play crucial role in keeping the information up-to-date and to highlight any specific problems.

*Note: Procedures for interacting with the CPDB, including login and inserting information by the WIS FPs will be provided in due course.*

**8.5 Capacity building – training courses and WIS users' meeting**

Starting at the latest in the 4th quarter of 2013, the GISCs in RA II should hold regular users' meetings and organize metadata training courses for the members of their AMDCN. The frequency of these meetings should be agreed with the likely participants and be in accordance with the RA II Implementation timeline.

**8.6 Goals and timeline**

After laying the foundations for a successful implementation of the plan in 2013-2014, the main implementation effort should be carried out throughout 2013. The RA II Management Group meetings should review the progress. It will be essential to monitor for and identify Members that are falling behind the implementation schedule and to arrange suitable assistance from other Members as required.

**8.7 Performance Monitoring**

When looking at the monitoring of WIS, one has to distinguish between the network and the users. CBS-15 requested OPAG-ISS to prepare an effective plan for monitoring the WIS by October 2013, and to invite designated GISCs and DCPCs to participate in pre-operational implementation to test its effectiveness, and to report progress to CBS-Ext.(14).

It is highly recommended that the GISCs in RA II hold regular meetings, at least annually, to coordinate their work and to share experiences. These meetings could be held in conjunction with the global GISC meetings planned by CBS, including TT-GISC meeting.

[15] WMO Country Profile Database - http://www.wmo.int/cpdb

## APPENDIX I

## WIS Implementation Plan for NMHS with RMTN Connection in RA II (NC)

1. Bring about an internal decision to join WIS in RA II.
2. Choose a staff member to be nominated as the WIS Focal Point. The person should be knowledgeable about the current GTS transmissions.
3. Check the communication network connectivity, in particular the bandwidth to the current RTH and the Internet access.
4. Check the traffic pattern for the GTS data and ensure that the bandwidth is sufficient to send and receive all data without undue delays. If this is not the case, either plan an increase in bandwidth or stay with GTS data transmissions and have additional data via other means such as via the Internet.
5. Determine which GISC should become the principal GISC and communicate with the chosen GISC to gain its approval.
6. Inform WMO by letter from the PR about the decision to become an NC, the choice of the principal GISC and the nomination of the WIS Focal point.
7. Develop a national implementation plan in agreement with the principal GISC and report it to the Secretariat and RA II WIS Implementation Focal Point for inclusion in the WMO Country Profile Data Base.
8. Set up a communication link to the principal GISC via RMTN and create an user account at the GISC for administrative matters.
9. Decide whether the metadata editor should be supported locally or remotely by the GISC. In view of this decision, set up the necessary software environment: either by installing the editor on a local server or by setting-up a connection to the GISC for the editing.
10. Train a staff member and a back-up in the WMO metadata Core Profile by sending them to training courses organized by WMO or the GISC. It is also possible to ask for local support via the WMO Jumpstart Offer.
11. Take over responsibility for the metadata records describing the data submitted by the NMHS and modify if necessary the initial metadata records provided by GISC Tokyo JMA/ GISC Beijing CMA.
12. Start using the WIS functionality for sending and receiving data with their appropriate metadata descriptions.
13. Join the user group of the GISC by attending meetings and other organised events.
14. Support the monitoring of the regional WIS by regularly updating the member’s records in the WMO Country Profile Data Base including availability of service, traffic figures, errors and other comments.

## APPENDIX II

## WIS Implementation Plan for DCPC in RA II

1. Bring about an internal decision of the organization to join WIS in RA II as a DCPC.
2. Choose a staff member to become the WIS Focal point. The person should be knowledgeable about communications protocols and the WMO Metadata Core Profile.
3. Gain the support of a WMO Programme for the special data to be made available as a DCPC. In case of a current RTH who wishes to become a DCPC, the NCs to be connected to the new DCPC for data collection and distribution services should be contacted for support, expressed by the relevant PR's.
4. Determine which GISC in the region should become the principal GISC and communicate with the chosen GISC to gain its approval.
5. Check the communication network connectivity, in particular the bandwidth to the chosen GISC and the interactive access.
6. Check the planned traffic pattern for the data and the interactive load, assuming full DCPC operations. Ensure that the bandwidth is sufficient to send and receive all data without undue delays. If this were not the case, make sure that an upgrade of the communication network is planned prior to starting operations as a DCPC.
7. In accordance with the mandatory services to be provided by a DCPC as described in the Manual on WIS, select the necessary special software and install it locally. Make sure that it passes all the tests for DCPCs which have been published by WMO.
8. Inform WMO, in particular CBS, by letter from the Director of the Organization about the wish to become a DCPC, the supporting WMO Programme, the choice of the principal GISC and the nomination of the WIS Focal point.
9. In accordance with the Manual on WIS, collaborate with the relevant CBS ET's to pass all the necessary tests for a DCPC.
10. Once the tests have been passed successfully and the centre has been endorsed by WMO Congress / EC, set up operations as a DCPC.
11. Join the user group of the GISC by attending meetings and other organised events.
12. Support the monitoring of the regional WIS by regularly updating the organization's records in the WMO Country Profile Data Base including availability of service, traffic figures, errors and other comments.

**APPENDIX III**

**Sample Letter**

To: the Secretary-General

Subject: Proposal for designation of National Centre

Dear Secretary-General

According to the Manual on the WMO Information System (WMO-No. 1060) I have the pleasure in requesting that the NC [city] is designated as a part of the WIS centre of [name of NMHS]. I believe that NC [city] will be continuously complied with WIS requirements and harmonized with WIS implementation. I would like to inform you that the principal Global Information System Centre (GISC) associated to NC [city] should be [GISC name] and secondary GISC be [GISC name]. For coordinating WIS activities, I hereby nominate Mr/Ms [name, position, email, address] as the national WIS Focal Point.

Yours sincerely,

Permanent Representative of [NMHS]

**APPENDIX IV**

**WIS Test Cases for NCs**

<table>
<tr><th colspan="2">Test Case Name: NC Demonstration Test Case 1</th></tr>
<tr><td colspan="2">Uploading of Discovery Metadata for Data and Products into DAR catalogue</td></tr>
<tr><td>Test Case ID</td><td>NC-TC1</td></tr>
<tr><td>Component</td><td>Metadata Management</td></tr>
<tr><td colspan="2">Purpose of test</td></tr>
<tr><td colspan="2">Validate the function of adding, updating and deleting metadata records from NC to the Principal GISC.<br><br>All metadata records must be checked against the relevant schemas. (e.g. The record should be rejected if not fitting the schema)<br><br>Note 1: The term “upload” refers to the movement of metadata records between a National Centre that provides the metadata and the Principal GISC that manages the DAR catalogue. It can actually be implemented as a “pull” initiated from the DAR catalogue site, or as a “push” initiated by the metadata provider.<br><br>Note 2: this functionalities can be implemented as:<br>• A web interface allowing registered users to manage their metadata interactively<br>• A machine-to-machine interface allowing automated batch processing of metadata.<br><br>All GISCs support both methods (GISC Beijing, Tokyo and Seoul provide WIMMS). The NC may choose one or both methods.</td></tr>
<tr><td colspan="2">Relevant technical specifications</td></tr>
<tr><td colspan="2">• Tech specs 1 (Uploading of metadata)<br>• Tech specs 8 (DAR Catalogue Search and Retrieval)</td></tr>
<tr><td colspan="2">Precondition</td></tr>
<tr><td colspan="2">1. Have network connection (dedicated and/or public connection) exists between the NC and Principal GISC<br>2. The Principal GISC has a file upload facility for collecting metadata from NCs<br>3. The Principal GISC has a fully functional DAR catalogue<br>4. The Principal GISC has a registered user/process that is authorized to manage metadata of a given NC<br>5. The Principal GISC has a web interface to the DAR catalogue that allow searches (see WIS-TC6 -> http://www-db.wmo.int/WIS/centres/guidance.doc)</td></tr>
<tr><th colspan="2">Test Steps</th></tr>
</table>

| | Description | Expected Results | Actual Results |
|---|---|---|---|
| **1** | A user/process adds a new valid metadata record to the DAR catalogue | The metadata record must be found when browsing/searching the DAR catalogue | |
| **2** | A user/process modifies an existed record from the DAR catalogue, | The modification should be immediately visible when browsing/searching the DAR catalogue | |
| **3** | A user/process deletes an existed record from the DAR catalogue, | The deleted record should not be found when browsing/searching the DAR catalogue | |
| **…** | An authorized user/process attempts to upload an invalid metadata record | The user/process must be notified of the fact that the metadata record is invalid. The addition/update operation is aborted. The DAR catalogue is unchanged. | |
| **…** | An authorized user/process attempts to upload a record with a unique identifier that is already in the DAR catalogue | The DAR catalogue should not contain record with duplicate identifiers. Either:<br>1. The new metadata record replaces the old metadata record. The old metadata record should not be present in the catalogue. The new metadata record must be found when browsing/searching the catalogue<br>2. The user/process must be notified of the fact that the record is a duplicate. The addition/update operation is aborted. The DAR catalogue is unchanged.<br>Note: it is essential to ensure an update is an edit and not an accidental duplication | |
| **…** | Access control - No unauthorized addition 1 | A non-authorized user/process should not be able to add a metadata record to the DAR catalogue | |
| **…** | Access control - No unauthorized addition 2 | A user/process should not be able to add a metadata record to the DAR catalogue representing data from another WIS centre | |
| **…** | Access control - No unauthorized modification 1 | A non-authorized user/process should not be able to modify a metadata record from the DAR catalogue | |
| **…** | Access control - No unauthorized modification 2 | A user/process should not be able to modify a metadata record from the DAR catalogue that belongs to another WIS centre | |
| **…** | Access control - No unauthorized deletion 1 | A non-authorized user/process should not be able to delete a metadata record to the DAR catalogue | |
| **…** | Access control - No unauthorized deletion 2 | A user/process should not be able to delete a metadata record from the DAR catalogue that belongs to another WIS centre | |

| **Centre** | | **Organization** | | **Country** | |
|---|---|---|---|---|---|
| **Test Date** | | | | | |

| **Test Case Name: NC Demonstration Test Case 2** | | | | | |
|---|---|---|---|---|---|
| Uploading and downloading of data between NC and other WIS Centres | | | | | |
| **Test Case ID** | NC-TC2 | | | | |
| **Component** | | | | | |
| **Purpose of test** | | | | | |
| Validate the upload and download of data and products and association with metadata | | | | | |
| **Requirements Covered** | | | | | |
| • Tech specs 2 (Uploading of data and products)<br>• Tech specs 10 (Downloading file via dedicated network)<br>• Tech specs 11 (Downloading file via non-dedicated network)<br>• Tech specs 12 (Downloading file via other methods) | | | | | |
| **Precondition** | | | | | |
| 1. Have network connection (dedicated and/or public connection) between the NC and other WIS centre (Principal GISC) (includes via RTH where relevant)<br>2. Have file upload and download facilities (FTP/SMTP/HTTP client…)<br>3. Have data available for upload or download<br>**4.** Have DAR facilities available at GISC. | | | | | |
| **Test Steps** | | | | | |

| | Description | Expected Results | Actual Results |
|---|---|---|---|
| **1** | a. upload a file which is associated with a metadata record in the DAR catalogue of the NC to a GISC centre<br>b. use DAR facilities to search the metadata then retrieve the file, using any download facilities | a. The uploaded file has been delivered to the GISC and match with the corresponding metadata<br>b. The file can be downloaded | |

| **Centre** | | **Organization** | | **Country** | |
|---|---|---|---|---|---|
| **Test Date** | | | | | |

| Test Case Name: NC Demonstration Test Case 3 | |
|---|---|
| Maintenance of users, roles, authorization and authentication | |
| **Test Case ID** | NC-TC3 |
| **Component** | Management of users and access |
| **Purpose of test** | |
| Create and exercise a variety of user types<br>Note: A centre may utilize GISC user control interface | |
| **Relevant Technical Specifications** | |
| • Tech specs 4 (Maintenance of User Identification and Role Information)<br>• Tech specs 6 (Authentication of a User)<br>• Tech specs 7 (Authorization of a User Role)<br>• Tech specs 13 (Maintenance of Dissemination Metadata) | |
| **Precondition** | |
| 1. The Centre has authority to provide access to user (ie PR approval from users country)<br>2. A process is in place between the NC and the Principal GISC to authorize its users to use the GISC with appropriate access levels.<br>3. The user interface is via the internet (i.e. web page) | |
| **Test Steps** | |

| | Description | Expected Results | Actual Results |
|---|---|---|---|
| **1** | Provide access for an external user to search metadata | Temporary user can search metadata, but not access data from the GISC or cache, or subscribe to data. | |
| | a) User goes to search web page<br>b) User makes metadata search<br>c) Tries to access data | a) User has access to search page<br>b) User finds metadata<br>c) User tries to access data and is referred to authorization page at data source. Cannot access data without validating in an authorized user role | |
| **2** | Create accounts with access to WIS metadata and data for a WMO centre authorized user | Two users are created. One with access to metadata only, the other with the ability to access the Centre subscription service or ad hoc request from the cache | |
| | a) User goes to registered user web page<br>b) User is required to login or create account<br>c) User registers account and selects role of valid WMO member with authority to access WIS data (eg is from WMO NC)<br>d) User enters login details<br>e) User makes metadata search<br>f) Tries to access WMO globally available data from the centre | a) User has access to login page<br>b) New user, so has to create an account<br>c) User account is validated as a WMO NC member and account is created. The user receives a user login (eg code via email or encrypted symbol)<br>d) User is logged in. As user us validated as WMO NC member, he is allocated access to search and access to download data from cache and to subscription services<br>e) User finds metadata<br>f) User successfully accesses data from centre | |

| | | | |
|---|---|---|---|
| | g) User tries to access additional data at centre that he is not authorized to access<br>h) Tries to access data or product at another site<br>i) User subscribes to data for future delivery from centre<br>j) User returns on another session and reuses login to search or subscribe<br>k) User edits subscription details<br>l) User cancels a subscription<br>m) User logs out or leaves centre's site and tries to return to a bookmarked page at a later date and access data | g) User receives advice that he is not authorized to access this data and referred to access page where he can request change in user role or re-login as another user<br>h) User is referred to authorization page at other site.<br>i) User receives scheduled data via agreed method at agreed time<br>j) User maintains successful access with same access rights<br>k) Users subscription details are updated and reflected in subsequent deliveries<br>l) Users subscription details are updated and receives no further deliveries<br>m) Attempting to use a bookmarked page from earlier session to access data, directs the user to the registered user login page. | |
| **3** | User checks status of account and subscriptions | User can view his account and subscription details, including historic and future transactions, and the status of current transactions | |
| **...** | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Centre** | | **Organization** | | **Country** | |
| **Test Date** | | | | | |

# APPENDIX V
## List of acronyms

| | |
|---|---|
| AMDCN | Area Meteorological Data Communication Network |
| CBS | Commission for Basic Systems |
| DAR | Discovery, Access and Retrieval |
| DCPC | Data Collection or Production centre; Part of the WIS |
| GISC | Global Information System Centre; Part of the WIS |
| GTS | Global Telecommunication System |
| IMTN | Improved Main Telecommunication Network |
| MG | Management Group of RA II |
| MPLS | Multiprotocol Label Switching |
| MTN | Main Telecommunication Network (of the GTS) |
| NC | National Centre; Part of the WIS |
| NMC | National Meteorological Centre |
| NMHS | National Meteorological and Hydrological Service |
| R2-WIS-IP | Regional Association II WIS Implementation Plan |
| RMTN | Regional Main Telecommunication Network |
| RSMC | Regional Specialized Meteorological Centres |
| RTH | Regional Telecommunication Hub |
| TCP/IP | Transmission Control Protocol / Internet Protocol |
| VPN | Virtual Private Network |
| WIMMS | WIS Interim Metadata Management Services |
| WIS | WMO Information System |
| WMC | World Meteorological Centre |
| WMO | World Meteorological Organization |
| WWW | World Weather Watch |

**ANNEX V**

# Report on the RA II Pilot Projects

**RA II Pilot Project (1)**

| | |
|---|---|
| **Project Name:** | **Pilot Project to Develop Support for National Meteorological and Hydrological Services in Numerical Weather Prediction** |
| **Acronym:** | RAII-PP-NWP |
| **Project Type:** | Pilot |
| **Project Status:** | The Pilot Project has completed Phase 2, and will move to Phase 3 of implementation. |
| **Project Overview:** | This Project is established in accordance to Resolution 6 of RA II-14 and taken forward to Phase 2 under Resolution 14 of RA II-15 to develop support for NMHSs in numerical weather prediction (NWP). It is proposed to move into Phase 3 to setup resource and support on the techniques for post-processing EPS products. The web-based portal "Asian Consortium for NWP Forecasts (ACNF)" has become operational, and will be continuously enhanced. |
| **Project Aims:** | Short-term:<br>(1) To promote sharing of experience and expertise in post-processing of NWP products, modelling and data assimilation;<br>(2) To assist recipient Members in accessing and using NWP products<br>Long-term:<br>(1) To assist NMHSs in Region II in development and operation of NWP model and data assimilation systems;<br>(2) To promote exchange of knowledge and best practices between Members in different areas of NWP including data assimilation, modelling, post-processing and computational aspects |
| **Partners/Participants:** | Korea Meteorological Administration (KMA) (Co-coordinator)<br>Hong Kong Observatory (HKO) (Co-coordinator) |
| **Project Cost:** | Not applicable. |
| **Funding Source(s):** | This project will make optimum use of the expertise of members from the Coordinating Group. Financial support will be provided through voluntary contributions. |
| **Project Timescale:** | The project is expected to continue during the period 2016-19. |

| | |
|---|---|
| **Deliverables:** | (1) Survey result on users' feedback on the usefulness of the ACNF website in NWP development and applications, possible enhancement of the website, and the future training needs<br>(2) Training workshops for RA II members (under the framework of WMO Voluntary Cooperation Programme) on more advanced NWP techniques in support of disaster risk reduction (DRR) *e.g.* targeted observation and data assimilation for tropical cyclones, post-processing of ensemble prediction systems output for probabilistic and extreme weather event forecast.<br>(3) Enhancement of ACNF to include resources and support on post-processing of NWP and ensemble prediction system |
| **Project Links:** | http://acnf.weather.gov.hk |
| **Project Summary:** | Completion of the project is expected to foster closer collaboration and technical exchange between NHMSs in Region II on NWP, contribute to enhancing weather services delivery, disaster risk reduction and capacity development efforts. |
| **Date of Last Update:** | 6 December 2016 |
| **Contact Person 1:**<br>**Name:**<br>**Organization:**<br>**Address:**<br><br>**Telephone:**<br>**Fax:**<br>**E-mail:** | <br>Mr. Chan, Pak-wai<br>Hong Kong Observatory<br>134A Nathan Road, Tsim Sha Tsui, Kowloon, Hong Kong, China<br>+852 2926 8435<br>+852 2375 2645<br>pwchan@hko.gov.hk |
| **Contact Person 2:**<br>**Name:**<br>**Organization:**<br>**Address:**<br>**Telephone:**<br>**Fax:**<br>**E-mail:** | Mr. SHIN Hyun Cheol<br>Korea Meteorological Administration<br>61 Yeoeuidaebang-ro 16-gil, Dongjak-gu Seoul 156-720, Korea<br>+82-2-2181-0544<br>+82-2-2181-0908<br>sinhyo@korea.kr |

**RA II Pilot Project (2)**

| | |
|---|---|
| **Project Name:** | **Pilot Project on Information Sharing on Climate Services** |
| **Acronym:** | RAII-PP-ISCS |
| **Project Type:** | Pilot |
| **Project Status:** | Implemented (the dedicated website for this PP was launched in March 2014 and is kept updated.) |
| **Project Overview:** | This Project is established in accordance with Resolution 15 (RA II-15) for collecting and sharing information on climate services provided by NMHSs as well as activities related to the Global Framework for Climate Services (GFCS). |
| **Project Aims:** | Short-term:<br>(1) To share climate services by NMHSs and information on good practices in the application of climate information in various fields, such as agriculture, health and water management.<br><br>Long-term:<br>(1) To contribute to the successful implementation of GFCS by sharing information mentioned above;<br>(2) To support the consideration of future work to facilitate the utilization of climate information. |
| **Partners/Participants:** | Tokyo Climate Center (TCC) of the Japan Meteorological Agency (JMA) (Lead) |
| **Project Cost:** | Not applicable |
| **Funding Source(s):** | This project is based on the kind cooperation of RA II Members by providing information via questionnaires and keeping updated. The dedicated website is maintained by TCC. |
| **Project Timescale:** | The dedicated website for this PP has already been launched in March 2014 and will be kept updated. |
| **Deliverables:** | (1) Quick reference and access to climate services by NMHSs and information on good practices in the applications of climate information in various fields, such as agriculture, health and water management. http://ds.data.jma.go.jp/tcc/pilot/ |
| **Project Links:** | http://ds.data.jma.go.jp/tcc/pilot/ |

| | |
|---|---|
| **Project Summary:** | TCC plays a leading role in the implementation of the Project, and started collecting information from NMHSs via an email-based questionnaire in 2013. Based on the data received, TCC has developed a new dedicated website to support the sharing of information on climate services provided by NMHSs and on their Framework-related activities. The website was officially launched on 31 March 2014, and TCC keeps it updated by collecting pertinent information from NMHSs to be shared with Members. Furthermore, TCC has done the second questionnaire survey in summer 2015 in order to renew information and to add more information about the utilization of climate information, aiming to contribute to the activities of GFCS. The updated information is available on the website since December 2015. |
| **Date of Last Update:** | 18 December 2015 |
| **Contact Person :**<br>**Name:**<br>**Organization:**<br><br><br><br>**Address:**<br>**Telephone:**<br>**Fax:**<br>**E-mail:** | <br>Mr. Kiyotoshi Takahashi<br>Head, Tokyo Climate Center<br>Climate Prediction Division<br>Global Environment and Marine Department<br>Japan Meteorological Agency (JMA)<br>1-3-4 Otemachi, Chiyoda-ku, Tokyo 100-8122, Japan<br>+81 3 3211 8406<br>+81 3 3211 2032<br>tcc@met.kishou.go.jp |

**RA II Pilot Project (3)**

| | |
|---|---|
| **Project Name:** | **Pilot Project to Develop Support for National Meteorological and Hydrological Services in the Collection and Application of Aircraft Meteorological Data Relay Data** |
| **Acronym:** | RAII-PP-AMDAR |
| **Project Type:** | Pilot |
| **Project Status:** | The Project has completed Phase 1 of implementation. |
| **Project Overview:** | This Project is established in accordance to Resolution 16 (RA II-15) to develop support for NMHSs in the collection and application of AMDAR data. |
| **Project Aims:** | Short-term:<br>(1) To share experience among NMHSs in setting up and operating AMDAR programme;<br>(2) To conduct best practice workshop(s) on the setting up of AMDAR programme;<br>(3) To share experience among NMHSs on the application of AMDAR data, including in aerodrome forecast and in forecast for the Terminal Area;<br>(4) To assist NMHSs in Region II, especially developing country Members, in establishing their own AMDAR programme;<br>(5) To assist NMHSs in Region II in decoding, processing and visualization of AMDAR data;<br>Long-term:<br>(1) To promote sharing of AMDAR data from different AMDAR programmes;<br>(2) To promote the application of AMDAR data in Terminal Area Forecast and Service<br>(3) To assist NMHSs in Region II in the assimilation of AMDAR data in NWP models, development of new products/applications from AMDAR data to enhance the provision of weather forecasting and warning services;<br>(4) To identify and explore means to optimize the collection of AMDAR data; |
| **Partners/Participants:** | China Meteorological Administration (CMA) (Co-coordinator)<br>Civil Aviation Administration of China(CAAC) (Co-coordinator)<br>Hong Kong Observatory (HKO) (Co-coordinator) |
| **Project Cost:** | Around EUR 20,000. |
| **Funding Source(s):** | This project will make optimum use of the expertise available from the CBS Expert Team on Aircraft-based Observing Systems (ET-ABO). Financial support will be provided through voluntary contributions by CMA, CAAC and HKO. |
| **Project Timescale:** | Will be completed by December 2016 |

| | |
|---|---|
| **Deliverables:** | (4) Survey report on RA II Members' readiness to collect and apply AMDAR data<br>(5) RA II Workshop(s) on the establishment of a national AMDAR programme and application of AMDAR data to enhance weather forecasting and warning services<br>(6) Establishment of an on-line discussion forum to facilitate the sharing of experience in the collection and application of AMDAR data of RA II Members and an Internet webpage to showcase the benefit of AMDAR data in weather forecasting and warning service |
| **Project Links:** | To be announced. |
| **Project Summary:** | Best practice workshop(s) and on-line support will be provided to Members of RA II to assist them in setting up its own national AMDAR programmes and in the application of AMDAR data in weather forecasting and warning service. |
| **Date of Last Update:** | 7 December 2016 |
| **Contact Person 1:**<br>**Name:**<br>**Organization:**<br>**Address:**<br><br>**Telephone:**<br>**Fax:**<br>**E-mail:**<br><br>**Contact Person2:**<br>**Name:**<br>**Organization:**<br>**Address:**<br>**Telephone:**<br>**Fax:**<br>**E-mail:**<br><br>**Contact Person3:**<br>**Name:**<br>**Organization:**<br>**Address:**<br>**Telephone:**<br>**Fax:**<br>**E-mail:** | <br>Mr. Xu Jiangliang<br>Civil Aviation Administration of China<br>Deyuanjiuhe Plaza , Hongyan Road , Chaoyang District, Beijing,China<br>8610-87922183<br>8610-87922084<br>xujl@atmb.net.cn<br><br><br>Mr. Zhang Qiang[16]<br>China Meteorological Administration, CMA<br>46 Zhongguancun Nandajie, Haidian District, Beijing, China<br>+86 10 68407032<br>+86 10 62173225<br>zhangq@cma.gov.cn<br><br>Mr. Choy Boon-leung<br>Hong Kong Observatory<br>134A Nathan Road, Tsim Sha Tsui, Kowloon, Hong Kong, China<br>+852 2926 8350<br>+852 2375 2645<br>blchoy@hko.gov.hk |

[16] There may be a change of co-coordinator from CMA. Details to be confirmed.

**RA II Pilot Project (4)**

| | |
|---|---|
| **Project Name:** | **Pilot Project to Sustain and Enhance the Capacity of National Meteorological and Hydrological Services (NMHSs) in the Provision of Official Weather Forecasts for Medium Range** |
| **Acronym:** | RAII-PP-MWF |
| **Project Type:** | Pilot |
| **Project Status:** | Phase 1 of implementation is completed. |
| **Project Overview:** | This Project is established in accordance to Resolution 17 (RA II-15) to develop support for NMHSs in provision of official weather forecasts for medium range. |
| **Project Aims:** | Short-term:<br>(1) To identify the current capacity and limitations in NMHSs in providing medium range weather forecasts;<br>(2) To identify reliable sources of NWP products to support NMHSs in providing medium range weather forecasts;<br>(3) To explore and identify means on post-processing of NWP products to better support NMHSs in providing medium range weather forecasts;<br><br>Long-term:<br>(1) To assist NMHSs in applying NWP products and post-processing methods to generate medium range forecast, in compliance with the needs of NMHSs to be supported;<br>(2) To identify methods and assist NMHSs in verification and validation of NWP-based weather forecasts;<br>(3) To promote sharing of experience in NWP product application, post-processing techniques among RA II Members especially developing country Members;<br>(4) To synergize with other related RA II Project such as “Project on the Provision of City-Specific NWP Products to Developing Countries” in supporting this pilot project. |
| **Partners/Participants:** | Hong Kong Observatory (HKO) (Co-coordinator)<br>Korea Meteorological Administration (KMA) (Co-coordinator) |
| **Project Cost:** | Not applicable |
| **Funding Source(s):** | This project will make optimum use of the expertise on NWP model applications in Members of RA II. Funding support on the Project development will be through voluntary contributions. |
| **Project Timescale:** | Project implementation to continue in 2016-2019. |

| | |
|---|---|
| **Deliverables:** | (1) Survey report on RA II Members' readiness to apply NWP products and post-processing methods in providing medium range weather forecasts;<br>(2) Where possible, training workshop on the application of NWP models and post-processing methods for medium range weather forecasts;<br>(3) On-line forum or knowledge-based portal to facilitate sharing of experience on NWP application and post-processing. |
| **Project Links:** | To be implemented. |
| **Project Summary:** | A survey was successfully conducted to collect the current status and requirements from the participating Members of RA II in using NWP model products for medium range weather forecasts. The survey results would be used to implement appropriate NWP forecast outputs and post-processed products.<br><br>A couple of training courses on NWP model and post-processing techniques were organized; provision of NWP products for Tajikistan was also implemented by KMA in 2016 such that a total of 302 cities of 21 Asian countries are being supported.<br><br>With the support from the Project, Members of RA II will enhance their knowledge and capacity in using NWP products and post-processing techniques for provision of medium range weather forecasts. The NWP-based forecast products will be disseminated to the public as official products on Internet such as through the World Weather Information Service (WWIS) website. |
| **Date of Last Update:** | 19 November 2016 |
| **Contact Person 1:**<br>**Name:**<br>**Organization:**<br>**Address:**<br>**Telephone:**<br>**Fax:**<br>**E-mail:**<br><br>**Contact Person 2:**<br>**Name:**<br>**Organization:**<br>**Address:**<br>**Telephone:**<br>**Fax:**<br>**E-mail:** | Mr. WONG Wai Kin<br>Hong Kong Observatory<br>134A Nathan Road, Tsim Sha Tsui, Kowloon, Hong Kong, China<br>+852 2926 8416<br>+852 2375 2645<br>wkwong@hko.gov.hk<br><br>Mr. SHIN Hyun Cheol<br>Korea Meteorological Administration<br>61 Yeoeuidaebang-ro 16-gil, Dongjak-gu Seoul 156-720, Korea<br>+82-2-2181-0544<br>+82-2-2181-0908<br>sinhyo@korea.kr |

**RA II Pilot Project (5)**

| | |
|---|---|
| **Project Name:** | **Pilot Project to Enhance the Seamless Provision of Regional Severe Weather Warnings and Advisories** |
| **Acronym:** | RAII-PP-WARNING |
| **Project Type:** | Pilot |
| **Project Status:** | The Pilot Project is currently under Phase 1 of implementation. |
| **Project Overview:** | This Project is established in accordance with Resolution 18 (RA II-15) to enhance the seamless provision of regional severe weather warnings and advisories. |
| **Project Aims:** | First phase:<br>(1) To share experiences in data formats for tropical cyclone warnings/advisories among RA II Members;<br>(2) To identify challenges to be solved for converting tropical cyclones warnings/advisories of RA II Members into a common data format;<br>(3) To seek potential benefits from using a common data format for tropical cyclone warnings/advisories;<br>Second phase after completing first phase:<br>(1) To access the feasibility of developing a common data format for severe weather warnings/advisories by RA II Members;<br>(2) To give the Coordinators of SWIC advice on its development of a consolidated and seamless provision of severe weather warnings/advisories through SWIC; |
| **Partners/Participants:** | Hong Kong Observatory (HKO) (Co-coordinator) |
| **Project Cost:** | Not applicable. |
| **Funding Source(s):** | This project will make optimum use of the expertise available from RA II members. Financial support will be provided through voluntary contributions by HKO. |
| **Project Timescale:** | Will be completed by December 2016 |
| **Deliverables:** | (1) Survey report on data format of tropical cyclone warnings/advisories currently in use by RA II Members<br>(2) Report on feasibility of converting RA II Members' tropical cyclone warnings/advisories into common data format |
| **Project Links:** | To be announced. |
| **Project Summary:** | With the completion of the Project, a common data format could be recommended for use by RA II Members for exchange and seamless provision of tropical cyclone warnings and advisories |
| **Date of Last Update:** | 4 November 2016 |

| | |
|---|---|
| **Contact Person:** | |
| **Name:** | Mr. Cheng Yuen-chung Armstrong |
| **Organization:** | Hong Kong Observatory |
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| **Fax:** | +852 2311 9448 |
| **E-mail:** | yccheng@hko.gov.hk |

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Submitted by:
President of RA II

8.II.2017

# SURVEY REPORT ON THE INSTITUTIONAL ARRANGEMENTS, CHALLENGES AND PRIORITIES IN REGIONAL ASSOCIATION II (ASIA)

# Survey Report

# Institutional Arrangements, Challenges and Priorities in Regional Association II (Asia)

**World Meteorological Organization**

**December 2014**

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# Executive Summary

The Members of WMO Regional Association II (RA II) have been surveyed in order to gather information on the institutional arrangements for the national provision of hydrometeorological services and to identify the most important challenges and priorities of Members and of the regional association as a whole. The survey was prepared by the RA II Task Team on Strategic and Operating Planning (TT-SOP) which reports to the RA II Management Group with the assistance of the WMO Secretariat. The data obtained from the survey will help the RA II Management Group and the WMO Secretariat to prepare baseline information and background material, including the identification of regional priorities, in order to inform and support evidence-based strategic planning discussions at the forthcoming sixth session of Regional Conference, which is scheduled to be held from 2 to 4 December 2014.

The survey was conducted on-line using the Survey Monkey platform during the period from July to October 2014. Thirty-three responses out of possible 35 Members were received.

**Institutional Arrangements**

All National Meteorological and Hydrological Services (NMHSs) in RA II are the government entities, work under a variety of different parent organizations, including ministry, council of ministers and state council, with different degrees of autonomy. Four fifths of Members are functioning under one or more legislative acts or orders of decree; and one fifth of Members are functioning without legal meteorological authorities or on an ad hoc basis.

**Management and Organization**

Most NMHSs in RA II are government or state-owned agencies operating within national government policies and frameworks with, in most cases, little scope for commercial activities. All NMHSs have development/strategic plans in place covering the next 3-5 years. Enhancing the monitoring infrastructure, improving operational forecast and warning services, strengthened IT capability and enhanced climate services (implementation of the GFCS); and training, education and capacity-building of staff are the most commonly identified priorities of these plans.

**Operations and Services**

NMHSs in RA II deliver a broad range of services across many sectors: public weather forecasts and warning services are provided by all Members; climate, agrometeorological and aviation services are provided by most of the Members; marine services and hydrological services are also commonly provided by the Members; and only a small number of NMHSs provided air/water quality and earthquake/seismological services, tailored services to specific users, tsunami and volcano services. Since this survey only focused on hydrological services provided by NMHSs, it might not represent the overall status of hydrometeorological services at the national level.

The primary challenges in delivering the above services are insufficiency of staffing resources and shortcomings in the underpinning climate services and Numerical Weather Prediction (NWP) modelling.

**Challenges and Priorities**

The challenges in the Region identified by the survey include lack of qualified personnel, NWP modelling capacity, and the adequacy of climate services and early warning services for disaster risk reduction (DRR), and improved visibility towards the decision-makers.

| **Serious** | **Moderate to Serious** |
|---|---|
| • Adequacy of qualified personnel in some areas<br>• Adequacy of NWP modelling capacity<br>• Budget - anticipated cuts | • Adequacy of climate services<br>• Improved visibility towards the decision-makers<br>• Adequacy of EWS and services for DRR |
| **Moderate** | **Slight** |
| • Anticipated staff cuts<br>• Data policies<br>• Relationship with private sector | • Introduction/maintenance of QMS<br>• Adequacy of telecommunication facilities and capacity<br>• Adequacy of the existing observing systems |

The survey identified six regional priority areas for continued attention:

1. Implementation WIGOS - WIS including GISC
2. Capacity development
3. Strengthening of Climate Services including GFCS
4. Enhancement of Services – PWS, hydrology and Aviation
5. Disaster Risk Reduction/Early Warning System (DRR/EWS)
6. Improvement of Quality Management System (QMS)

**Suggestions for RA II Activities**

Financial and staffing constraints are one of the main challenges that limit the ability of many Members to participate in regional activities and working bodies. Language problems also exist in some Member countries.

Members look to support from other Members in the form of joint/twinning projects, capacity-building, technical support on QMS and developing and/or strengthening regulation and SOP, and infrastructure support. Members also look to the WMO Secretariat for coordination support for participation in regional events, and sharing information on regional activities and facilitating support in coordination of Voluntary Contribution Programme (VCP) mobilization for Least Developed Countries (LDCs).

# 1 Introduction

The Members of WMO Regional Association II (Asia) have been surveyed in order to gather information on the institutional arrangements for the national provision of hydrometeorological services and to identify the most important challenges and priorities of Members and of Regional Association II (RA II) as a whole. The survey was prepared by the RA II Task Team on Strategic and Operating Planning (TT-SOP) which reports to the RA II Management Group with the assistance of the WMO Secretariat. The data obtained from the survey will help the RA II Management Group and the WMO Secretariat to prepare baseline information and background material, including the identification of regional priorities, in order to inform and support evidence-based strategic planning discussions at the forthcoming sixth session of Regional Conference in RA II.

The survey was conducted on-line using the Survey Monkey platform during the period from July to October 2014. Thirty-three responses out of a possible 35 Members were received[1]. Analysis result presented in this report was based on the responses obtained in this survey.

## 1.1 Composition of RA II

RA II is composed of 35 Member countries and territories in Asia. Based on geographic location, the Members of RA II can be assigned to five sub-regions: Central Asia (6 Members), East Asia (7 Members), South-East (SE) Asia (5 Members), South Asia (8 Members), and West Asia (9 Members). According to the WMO Membership record, Bhutan is the most recent Member country in RA II to take WMO membership. Details are given in Figure 1.1 and Table 1.1.

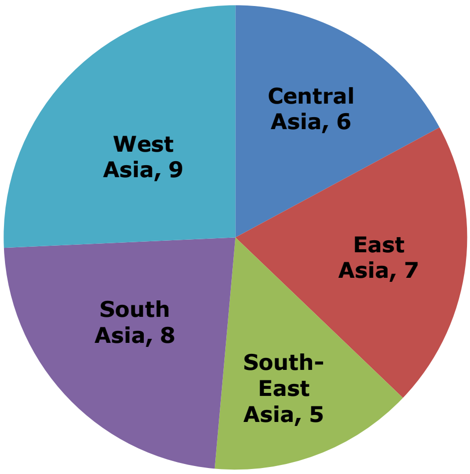



**Figure 1.1: Sub-regional group of Members**

[1] The following Members responded to the Survey: Afghanistan; Bahrain; Bangladesh; Cambodia; China; DPR Korea; Hong Kong, China; India; Iran, Islamic Republic of; Iraq; Japan; Kazakhstan; Kuwait; Kyrgyz Republic; Lao PDR; Macao, China; Maldives; Mongolia; Myanmar; Nepal; Oman; Pakistan; Qatar; Republic of Korea; Russian Federation; Saudi Arabia; Sri Lanka; Tajikistan; Thailand; United Arab Emirates; Uzbekistan; Viet Nam; and Yemen

**Table 1.1: Regional Members by sub-region and WMO accession date**

| Sub-region | Member | WMO Accession Date *(Source: WMO, 2014)* |
|---|---|---|
| Central Asia | Kazakhstan | 5-May-1993 |
| | Kyrgyz Republic | 20-Jul-1994 |
| | Russian Federation | 2-Apr-1948 |
| | Tajikistan | 10-Aug-1993 |
| | Turkmenistan | 4-Dec-1992 |
| | Uzbekistan | 23-Dec-1992 |
| East Asia | China | *** |
| | Democratic People's Republic of Korea | 27-May-1975 |
| | Hong Kong, China | 14-Dec-1948 |
| | Japan | 11-Aug-1953 |
| | Macao, China | 24-Jan-1996 |
| | Mongolia | 4-Apr-1963 |
| | Republic of Korea | 15-Feb-1956 |
| South-East Asia | Cambodia | 8-Nov-1955 |
| | Lao People's Democratic Republic | 1-Jun-1955 |
| | Myanmar | 19-Aug-1949 |
| | Thailand | 11-Jul-1949 |
| | Viet Nam | 8-Jul-1975 |
| South Asia | Afghanistan | 11-Sep-1956 |
| | Bangladesh | 24-Aug-1973 |
| | Bhutan | 11-Feb-2003 |
| | India | 27-Apr-1949 |
| | Maldives | 1-Jun-1978 |
| | Nepal | 12-Aug-1966 |
| | Pakistan | 11-Apr-1950 |
| | Sri Lanka | 23-May-1951 |
| West Asia | Bahrain | 21-Apr-1980 |
| | Iran, Islamic Republic of | 30-Sep-1959 |
| | Iraq | 21-Feb-1950 |
| | Kuwait | 1-Dec-1962 |
| | Oman | 3-Jan-1975 |
| | Qatar | 4-Apr-1975 |
| | Saudi Arabia | 26-Feb-1959 |
| | United Arab Emirates | 17-Dec-1986 |
| | Yemen | 8-July-1971 |

*** for China: The following statement is given at the request of the Government of the People's Republic of China: “On 11 October 1947, the representative of the Chinese Government signed the Convention of the World Meteorological Organization. After the founding of the People's Republic of China, her rightful seat in WMO was usurped by the Chiang Kai-shek clique, whose `ratification' of the Convention of the World Meteorological Organization on 2 March 1951 was illegal and null and void. The rightful seat of the People's Republic of China was restored to her on 25 February 1972.”

### 1.2 Organization of Survey Questionnaire

The survey questionnaire was designed to collect information from RA II Members under five broad headings: (1) Institutional Arrangements; (2) Management and Organization; (3) Operations and Services; (4) Challenges and Priorities; and (5) Suggestions for the RA II Activities. For ease and consistency of response, the majority of questions were 'closed', with respondents choosing from one or more defined answers. However, in instances where more subjective or narrative information was required, the questions were left 'open'. The survey structure and questions were strongly based on a similar survey conducted by Regional Association V (South-West Pacific) and Regional Association VI (Europe) to allow for some comparisons between regional associations.

The survey questionnaire is available at WMO, RAP website: http://www.wmo.int/pages/prog/dra/rap.php

## 2 Institutional Arrangements

The institutional set-up of NMHSs is governed by legislative frameworks, mandates and scope. The enactment of legislation and government priorities define the functional responsibilities of the NMHS and its position within the Government. The purpose of this section is to present basic information about the NMHSs of RA II Members, including the position of the NMHS within Government, as well as the role and mandate of the NMHS in the provision of services.

### 2.1 Title and Parent Organization

In RA II, NMHSs operate under various titles and functional definitions, as described in Table 2.1 below.

**Table 2.1: Formal title of NMHSs in local languages and English**

| Sub-region | Member | Title of NMHSs in local languages and English |
|---|---|---|
| Central Asia | Kazakhstan | Қазақстан гидрометқызметінің<br>National Hydrometeorological Service |
| | Kyrgyz Republic | Agency on hydrometeorology |
| | Russian Federation | Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) |
| | Tajikistan | ГосударственноеУчреждениепогидрометеорологииРеспубликиТаджикистан<br>State Administration for Hydrometeorology of the Republic of Tajikistan |
| | Uzbekistan | Centre of Hydrometeorological Service of the Republic of Uzbekistan (Uzhydromet) |
| East Asia | China | 中国气象局<br>China Meteorological Administration |
| | DPR Korea | 기상수문국<br>State Hydrometeorological Administration(SHMA) |
| | Hong Kong, China | 香港天文台<br>Hong Kong Observatory |
| | Japan | 気象庁<br>Japan Meteorological Agency |

| Sub-region | Member | Title of NMHSs in local languages and English |
|---|---|---|
| | Macao, China | Direcção dos ServiçosMeteorológicos e Geofísicos (SMG)<br>Macao Meteorological and Geophysical Bureau (SMG) |
| | Mongolia | National Agency for Meteorology and Environment Monitoring of Mongolia |
| | Republic of Korea | 기상청<br>Korea Meteorological Administration |
| South-East Asia | Cambodia | Department of Meteorology |
| | Lao PDR | ກົມອຸຕຸນິຍົມແລະອຸທົກກະສາດ<br>Department of Meteorology and Hydrology (DMH), Lao PDR |
| | Myanmar | Department of Meteorology and Hydrology |
| | Thailand | กรมอุตุนิยมวิทยา<br>Thai Meteorological Department |
| | Viet Nam | TrungtâmKhítượngThủyvănquốcgia<br>National Hydro-Meteorological Service of Viet Nam |
| South Asia | Afghanistan | Afghanistan Meteorological Authority (AMA) |
| | Bangladesh | Bangladesh Meteorological Department |
| | India | भारतमौसमविज्ञानविभाग<br>India Meteorological Department |
| | Maldives | Maldives Meteorological Service |
| | Nepal | जलतथामौसमबिज्ञानविभाग<br>Department of Hydrology and Meteorology |
| | Pakistan | MahkmaMosmiat<br>Pakistan Meteorological Department |
| | Sri Lanka | KaalagunaVidyaDeparthamenthuva.<br>Department of Meteorology |
| West Asia | Bahrain | Bahrain Meteorological Services |
| | Iran | سازمان هواشناسی جمهوری اسلامی ایران<br>Islamic Republic of Iran Meteorological Organization (IRIMO) |
| | Iraq | الهيئة العامة للأنواء الجوية و الرصد الزلزالي<br>Iraqi Meteorological Organization and Seismology |
| | Kuwait | إدارةالأرصادالجوية<br>Meteorological Department |
| | Oman | المديريةالعامةللأرصادالجوية<br>Director General of Meteorology |
| | Qatar | Qatar Meteorology Department |
| | Saudi Arabia | الرئاسة العامة للأرصاد وحماية البيئة<br>Presidency of Meteorology and Environment |
| | UAE | المركز الوطني للأرصاد الجوية والزلازل<br>National Center of Meteorology and Seismology |
| | Yemen | الهيئهالعامه للطيران المدني والارصاد - قطاع الارصاد الجويه<br>Civil Aviation&Meteorology Authority |

Table 2.2 presents the parent organization and its legal status under which NMHS is currently operating. It is revealed from the survey that almost all NMHSs in RA II are functioning as government entities with legal status of either specialized government department or state enterprise/agency. NMHSs in RA II are running under different ministries whilst in Uzbekistan and Saudi Arabia they are under the council of ministers and in China under state council.

**Table 2.2: Parent organization and legal status of NMHS**

| Sub-region | Member | Title of the Parent Organization | Legal Status of the NMHS |
|---|---|---|---|
| Central Asia | Kazakhstan | Ministry of Energy of the Republic of Kazakhstan | State owned Enterprise |
| | Kyrgyz Republic | Ministry of emergency situations of the Kyrgyz Republic | Agency |
| | Russian Federation | Ministry Of Natural Resources | National Federal Service |
| | Tajikistan | Committee on Environmental Protection under the Government of the Republic of Tajikistan | State owned enterprise |
| | Uzbekistan | Cabinet of Ministers | State owned enterprise |
| East Asia | China | State Council | Agency |
| | DPR Korea | State Hydrometeorological Administration | Ministry |
| | Hong Kong, China | Commerce and Economic Development Bureau | Department |
| | Japan | Ministry | Agency |
| | Macao, China | Secretaria para os Transportes e Obras Públicas | Department |
| | Mongolia | National Agency for Meteorology and Environment Monitoring of Mongolia | Agency |
| | Republic of Korea | Ministry of Environment | Administration |
| South-East Asia | Cambodia | Ministry of Water Resources and Meteorology | Department |
| | Lao PDR | Ministry of Natural Resources and Environment | Department |
| | Myanmar | Ministry of Transport | Department |
| | Thailand | Ministry of Information and Communication Technology | Department |
| | Viet Nam | Ministry of Natural Resources and Environment | Agency |
| South Asia | Afghanistan | Ministry of Transport and Civil Aviation | Authority |
| | Bangladesh | Ministry of Defense | Department |
| | India | Ministry of Earth Sciences | Department |
| | Maldives | Ministry of Environment and Energy | Department |
| | Nepal | Ministry of Science, Technology and Environment | Department |
| | Pakistan | Aviation Division | Department |
| | Sri Lanka | Ministry of Disaster Management | Department |
| West Asia | Bahrain | Ministry of Transportation | State owned enterprise |
| | Iran | Ministry of Roads &Urban Development | State owned organization |
| | Iraq | Ministry of Transportation | State owned enterprise |
| | Kuwait | - | Department |
| | Oman | Public Authority for Civil Aviation | Department |
| | Qatar | Civil Aviation Authority | Department |
| | Saudi Arabia | Council of Ministers | Presidency |
| | UAE | Ministry of Presidential affairs | State Owned Enterprise |
| | Yemen | Ministry of transportation | Sector (State Owned Enterprise) |

## 2.2 Functional Scope

NMHSs possess a range of functions and often provide services across a number of areas in addition to meteorology, including hydrology, oceanography and seismology. Responsibility for operational hydrology lies with agencies other than the NMHS in 17 of the 33 Members that responded to the survey, and NMHSs in 16 Members have responsibility for operational hydrology. Figure 2.1 presents the sub-regional distribution of operational hydrological responsibility. All five Members of Central Asia are responsible for operational hydrological services whilst all nine Members of West Asia are not.

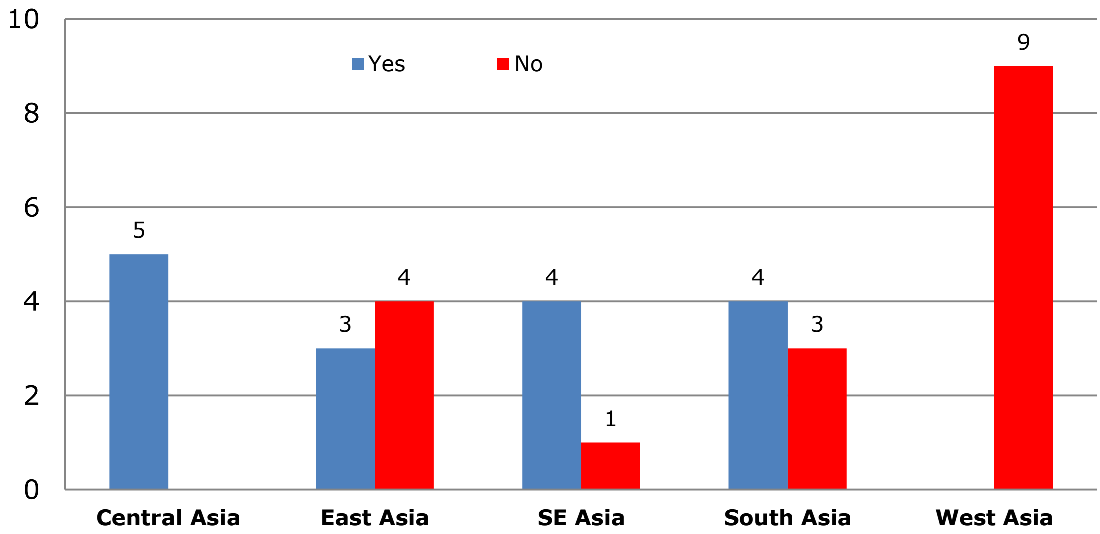



**Figure 2.1: NMHS responsible for hydrological services**

Institutional arrangements for the provision of hydrological services are summarized in Table 2.3. Thailand and Pakistan share a responsibility of operational hydrological services among other government agencies or bureau, and Bahrain does not have any agency responsible for operational hydrology.

**Table 2.3: Institutions responsible for hydrological services**

| Sub-region | Member | Organization Responsible for Hydrology |
|---|---|---|
| Central Asia | Kazakhstan | Ministry of Environment and Water Resources |
| | Kyrgyz Republic | Agency on hydrometeorology |
| | Russian Federation | Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) |
| | Tajikistan | State Administration for Hydrometeorology |
| | Uzbekistan | Centre of Hydrometeorological Service |
| East Asia | China | Ministry of Water Resources |
| | DPR Korea | State Hydrometeorological Administration(SHMA) |
| | Hong Kong, China | Hong Kong Observatory |
| | Japan | Water and Disaster Management Bureau, Ministry of Land, Infrastructure, Transport and Tourism (MLIT) |
| | Macao, China | Marine and Water Bureau |
| | Mongolia | National Agency for Meteorology and Environment Monitoring of |

| Sub-region | Member | Organization Responsible for Hydrology |
|---|---|---|
| | | Mongolia |
| | Republic of Korea | Ministry of Land, Infrastructure and Transport |
| South-East Asia | Cambodia | Department of Hydrology and River Works |
| | Lao PDR | Department of Meteorology and Hydrology (DMH), Lao PDR |
| | Myanmar | Department of Meteorology and Hydrology |
| | Thailand | Thailand has some of governmental agencies responsible on operational hydrology, water resources management and assessment activities, i.e. Thai Meteorological Department (TMD), Royal Irrigation Department (RID), Department of Water resources (DWR), Electricity Generating Authority of Thailand (EGAT), etc. Hydrological Adviser to PR of Thailand is from the Thai Meteorological Department |
| | Viet Nam | National Hydro-Meteorological Service of Viet Nam |
| South Asia | Afghanistan | Afghanistan Meteorological Authority (AMA) |
| | Bangladesh | Bangladesh Water Development Board |
| | India | Central Water Commission |
| | Maldives | Maldives Meteorological Service |
| | Nepal | Department of Hydrology and Meteorology |
| | Pakistan | Hydrological Adviser is designated from Federal Flood Commission (FFC) |
| | Sri Lanka | Department of Irrigation |
| West Asia | Bahrain | does not exist |
| | Iran | Ministry of energy in water affair |
| | Iraq | Ministry of water resources |
| | Kuwait | Ministry of Electricity & Water |
| | Oman | Ministry of Regional Municipalities & Water Resources |
| | Qatar | Shared among other Ministries |
| | Saudi Arabia | Saudi Geological Survey SGS |
| | UAE | - |
| | Yemen | National Water Resource Authority (NWRA) |

With respect to aeronautical meteorological services, the survey sought information on each NMHS's role as the Meteorological Authority and Meteorological Service Provider and their compliance with ICAO Annex 3 protocols.

Twenty-nine respondents identified the NMHS as both the Meteorological Authority and the Service Provider for the aviation sector. Two respondents (Kazakhstan and China) identified the NMHS as not being the Meteorological Authority but partially involved in the Met Services for aviation. One respondent (Tajikistan) identified the NMHS as Met service provider for aviation but not the Meteorological Authority, and one respondent from South-East Asia (Viet Nam) identified the NMHS services as being neither the Meteorological Authority nor the service provider for the aviation sector (see Figure 2.2).

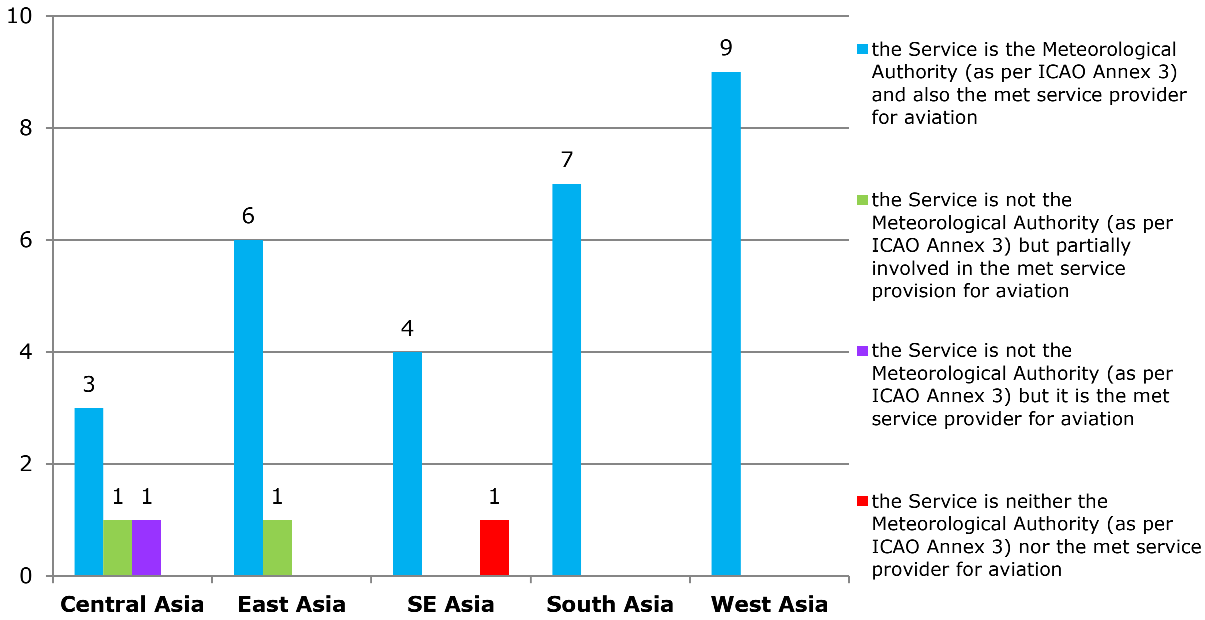



**Figure 2.2: Provision of aeronautical meteorological services**

## 2.3 Legislative Arrangements

Legal instruments for the establishment and function of the NMHS exist in 27 Members. The type of legislative instruments varies, and includes Acts of Parliament, laws, statutory instruments and decrees. Twelve Members operate under a Government Act, and 15 under a decree (see Figure 2.3). Seven Members operate without either. Two Members (Lao PDR and Yemen) reported that specific legislation relevant to the NMHS is under formulation and expected to be enacted by government soon. Where legislation does not exist, the need for assistance in developing such legislation should be assessed. The majority of existing legislation focuses on the meteorological and hydrological duties and responsibilities of the NMHS.

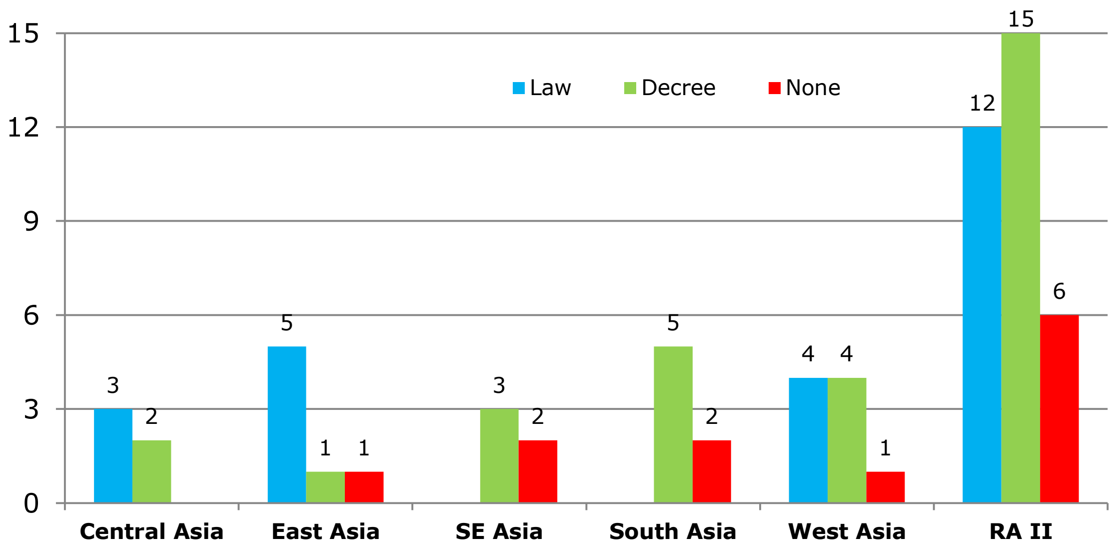



**Figure 2.3: Legal instrument for meteorology**

Specific details about each Member's legislative arrangements are described in Table 2.4. Six NMHSs are working under direct meteorological Acts/Laws, five under hydrometeorology, four under royal or minister's decrees, two under civil aviation Acts, and two under disaster management Acts. Two NMHSs (Nepal and Yemen) do not operate under such legislative instruments and three respondents (Hong Kong, China; Cambodia and India) did not mention any. The existing primary legislative Act that determines the function of NMHS services in RA II Member countries and territories is given in Table 2.4 below.

**Table 2.4: Primary legislation that determines the functions of NMHS**

| Sub-region | Member | Primary Legislative Act |
|---|---|---|
| Central Asia | Kazakhstan | RSE Kazhydromet according st.145-2 the Environmental Code of Kazakhstan performs the functions of the National Hydrometeorological Service of the Republic of Kazakhstan |
| | Kyrgyz Republic | - |
| | Russian Federation | RF Government Resolution of 23 July 2004 № 372 |
| | Tajikistan | Law of the Republic of Tajikistan on «Hydrometeorological activities». № 86, 02/12/2002. |
| | Uzbekistan | "On improvement hydrometeorological service of RUz" No. 183 from 14.04.2004 |
| East Asia | China | Meteorological Law |
| | DPR Korea | The State Meteorological Law |
| | Hong Kong, China | - |
| | Japan | Meteorological Service Act |
| | Macao, China | Aprova a lei orgânica da Direcção dos ServiçosMeteorológicos e Geofísicos. |
| | Mongolia | Law on Hydrometeorology and Environment Monitoring |
| | Republic of Korea | Weather Act |
| South-East Asia | Cambodia | - |
| | Lao PDR | Minister's Resolutions and Mandates of DMH |
| | Myanmar | Government Civil Service Regulation, National Disaster Management standing Order, Government Rules and Regulations |
| | Thailand | 2009 Ministry Regulations |
| | Viet Nam | Prime Minister |
| South Asia | Afghanistan | Afghanistan Civil Aviation Law |
| | Bangladesh | Disaster Management Act, 2012. |
| | India | - |
| | Maldives | Act No.3/68 (11 Nov 1968) |
| | Nepal | - |
| | Pakistan | National Disaster Management Act |
| | Sri Lanka | Gazette |
| West Asia | Bahrain | Civil Aviation Law |
| | Iran | - |
| | Iraq | Act No. 7 for 1994- Ministry of transportation |
| | Kuwait | Ministerial Decree |
| | Oman | Royal Decree No.43/2013 dated 16 September 2013 |
| | Qatar | EMIRI Decree No 47 of 2009 |
| | Saudi Arabia | Royal Decrees |

| Sub-region | Member | Primary Legislative Act |
|---|---|---|
| | UAE | - |
| | Yemen | - |

## 2.4 Other Regulatory Frameworks

In addition to primary acts and legal frameworks for meteorology, many Members have other regulatory frameworks or mutual agreements/arrangements with users for meteorological and other services. The most common such frameworks are: (a) government decrees and orders other than meteorology; (b) service level agreements with national civil aviation administrations; (c) Letters of Agreement (LoA) or Memoranda of Understanding (MoU) with disaster response agencies; and (d) MoU with other Members for data sharing, etc.

Each Member has its own regulatory framework for services delivery. Some have several stakeholder agreements and some have none. The details of some of the more important existing regulatory frameworks are given in Table 2.5.

**Table 2.5: Additional regulatory frameworks of NMHSs**

| Sub-region | Member | Regulatory framework |
|---|---|---|
| Central Asia | Kazakhstan | • № 524 Decree of the Republic of Kazakhstan from 26th April 2012 on Approval of the Regulations on the stationary observation stations and others |
| | Kyrgyz Republic | • MoU with Finish Meteorological Institute |
| | Russian Federation | - |
| | Tajikistan | • Decrees and orders of the President of the Republic of Tajikistan<br>• Decrees and orders of the Government of the Republic of Tajikistan, normative legal acts of the Committee for Environmental Protection under the Government of the Republic of Tajikistan<br>• Other regulatory and legal acts, including : Convention of the World Meteorological Organization, 1992 |
| | Uzbekistan | - |
| East Asia | China | • Regulations on Protection of Meteorological Facilities and Observation Environment |
| | DPR Korea | - |
| | Hong Kong, China | • Designated meteorological authority under ICAO<br>• Contingency Plan for Natural Disasters |
| | Japan | - |
| | Macao, China | - |
| | Mongolia | • Agency functions under the Ministry of Environment and Green Development |
| | Republic of Korea | - |
| South-East Asia | Cambodia | - |
| | Lao PDR | • MoU with Dept. of Civil Aviation<br>• LoA with National Airport Authority on the service providing for aviation |
| | Myanmar | • The rules and regulations of the Government, Ministry of Transport,<br>• National Disaster Management Standing Order<br>• WMO Guidelines, etc. |

| Sub-region | Member | Regulatory framework |
|---|---|---|
| | Thailand | - |
| | Viet Nam | • Decision promulgating functions, responsibilities and structure of NHMS Viet Nam<br>• Law on Natural Disaster Prevention and Control<br>• Decision promulgating Regulation and Broadcasting Tropical Depression, Typhoon and Flood Information |
| South Asia | Afghanistan | • Agromet Project |
| | Bangladesh | • The organization responsible for disaster management is DDM (Directorate of Disaster Management). No LoA or MoU is needed with DDM<br>• LoA with Civil Aviation Authority of Bangladesh<br>• MoUs with Norwegian Meteorological Institute, ADPC at RIMES at Thailand, CPP (cyclone preparedness programme) |
| | India | • Allocation of Business, Government of India |
| | Maldives | • Civil Service Employment Act and mandated by the government |
| | Nepal | • Cabinet decision published in the national gadget |
| | Pakistan | • National Disaster Management Act defines the role of the NMHS for early warnings and PMD as the nodal agency for early warning of hydrometeorological hazards |
| | Sri Lanka | - |
| West Asia | Bahrain | • Agreement with protection agency |
| | Iran | • MOUs with environmental protection organization for warning information<br>• MOUs with national risk &hazard management for warning information<br>• MOUs with aviation sector for providing aviation products<br>• MOUs with national TV to present Weather forecast to public<br>• MOUs with national entities such as marine transportation and road transportation to provide tailored forecasts |
| | Iraq | - |
| | Kuwait | • Ministries, other National Sectors  Regional GCCC, Arab League WMO, ICAO |
| | Oman | • Agreement with Directorate General of Air Navigation |
| | Qatar | - |
| | Saudi Arabia | - |
| | UAE | - |
| | Yemen | - |

## 3 Management and Organization

This section summarizes the status of management and organizational capacities of RA II NMHSs in terms of human and financial resources, scope of services, and business model.

### 3.1 Human Resources

There is a vast range in the staffing level of NMHSs in RA II, from 45(Cambodia) to 54,426 (China). The total number of NMHS's employees in 33 responding Members of RA II is 114,258, with China contributing almost half this number. Staffing levels, including gender composition (36% women), are illustrated in Figures 3.1a and 3.1b (Note that gender information for Russian Federation, Japan, Kyrgyz Republic and Saudi Arabia are not available).

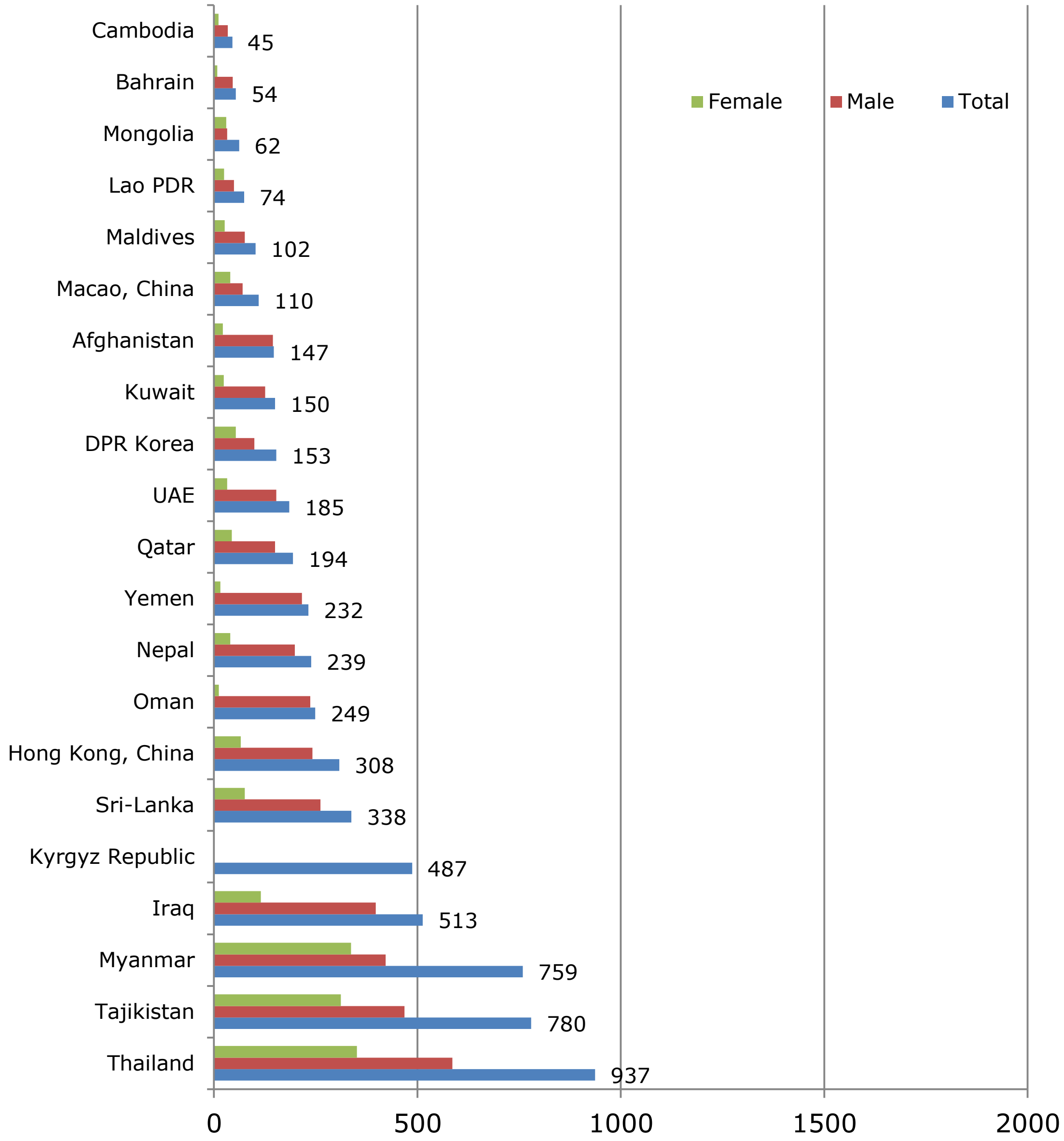



**Figure 3.1a: Number of staff in NMHSs with <1000 staff**

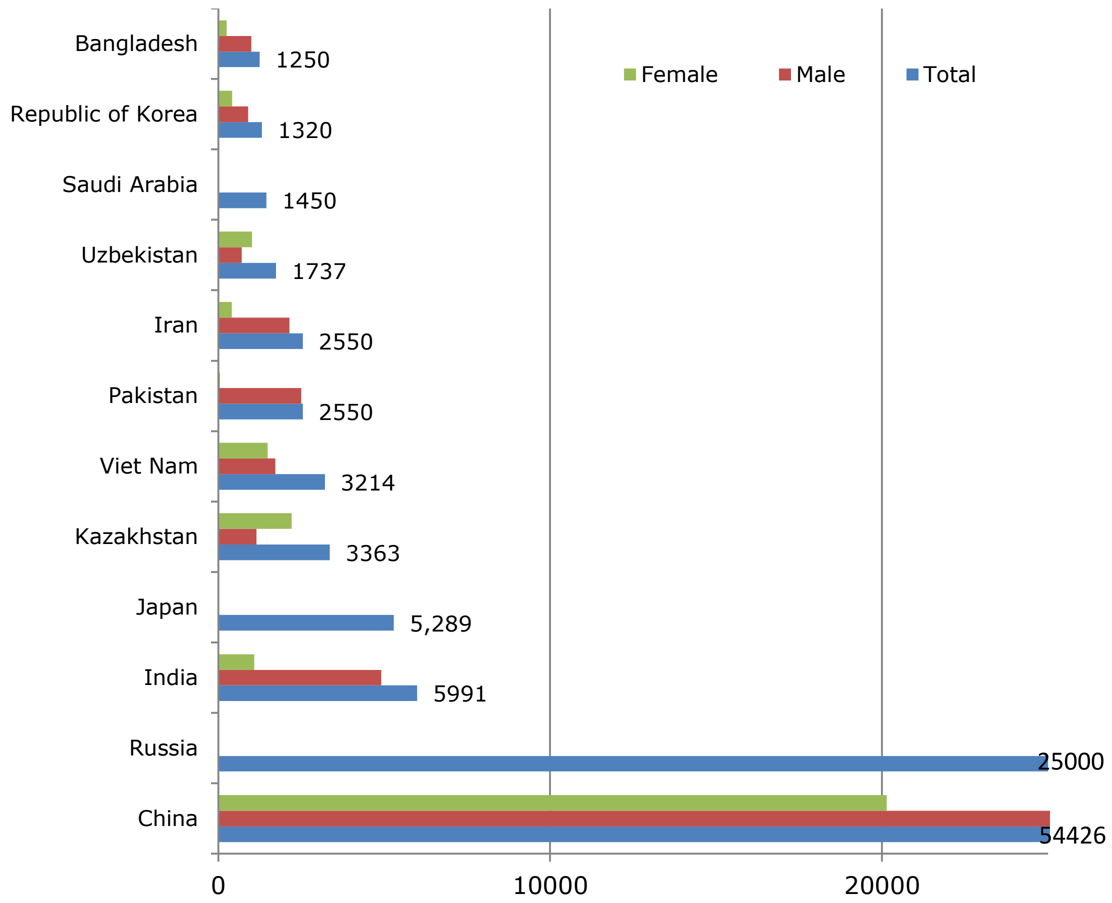



**Figure 3.1b: Number of staff in NMHSs with >1000 staff**

The level of qualifications and work experience of staff and their strength in number indicate the overall capacity of the institution. The survey reveals that overall in RA II; over 62% of NMHS staff members possess education qualifications at the university degree level or higher. China and Republic of Korea have more than 80% of staff members with university degrees, whilst Maldives has less than 10% staff members holding a university degree.

The average age of the staff of RA II NMHSs varies between 30 and 45 years old, with an average value of 39.10. The level of educational qualifications and average age of NMHS staff in RA II are shown in Table 3.1.

**Table 3.1: Education and average age of staffing**

| Sub-region | Member | Total staff | Staff with higher degree (#, %) | Average age of Staff (year) |
|---|---|---|---|---|
| Central Asia | Kazakhstan | 3363 | 1155 (34%) | 40 |
| | Kyrgyz Republic | 487 | 154 (32%) | 45 |
| | Russian Federation | 25000 | 12000 (48%) | 45 |
| | Tajikistan | 780 | 468 (60%) | 37 |
| | Uzbekistan | 1737 | 352 (20%) | 35 |
| East Asia | China | 54426 | 47489 (87%) | - |
| | DPR Korea | 153 | 95 (62%) | 45 |
| | Hong Kong, China | 308 | 177 (57%) | 44.4 |
| | Japan | 5,289 | - | - |

| | | | | |
|---|---|---|---|---|
| | Macao, China | 110 | 35 (32%) | 40 |
| | Mongolia | 62 | 12 (19%) | 40 |
| | Republic of Korea | 1320 | 1057 (80%) | 42.7 |
| South-East Asia | Cambodia | 45 | 13 (29%) | 37 |
| | Lao PDR | 74 | 26 (35%) | 35 |
| | Myanmar | 759 | 504 (66%) | - |
| | Thailand | 937 | 555 (59%) | 42 |
| | Viet Nam | 3214 | 1732 (54%) | 38.61 |
| South Asia | Afghanistan | 147 | 20 (14%) | 40 |
| | Bangladesh | 1250 | 350 (28%) | - |
| | India | 5991 | 2921 (49%) | 45 |
| | Maldives | 102 | 6 (6%) | 30 |
| | Nepal | 239 | 35 (15%) | 35 |
| | Pakistan | 2550 | 1000 (39%) | 42 |
| | Sri Lanka | 338 | 48 (14%) | 40 |
| West Asia | Bahrain | 54 | 16 (30%) | 37 |
| | Iran | 2550 | 1530 (60%) | 40 |
| | Iraq | 513 | 217 (42%) | 45 |
| | Kuwait | 150 | 48 (32%) | 35 |
| | Oman | 249 | 86 (35%) | 30 |
| | Qatar | 194 | 110 (57%) | 35 |
| | Saudi Arabia | 1450 | 600 (41%) | - |
| | UAE | 185 | 112 (61%) | 40 |
| | Yemen | 232 | 48 (21%) | 35 |

The trend of staffing in NMHSs in RA II during the past 3-5 years was reported to be more or less stable to expanding, with 14 Members reporting no significant change, whilst another 12 Members report an increase in numbers and six Members (Japan, India, Maldives, Bahrain, Iran and Kuwait) reporting a decrease. The breakdown of staffing trends by sub-region is illustrated in Figure 3.2.

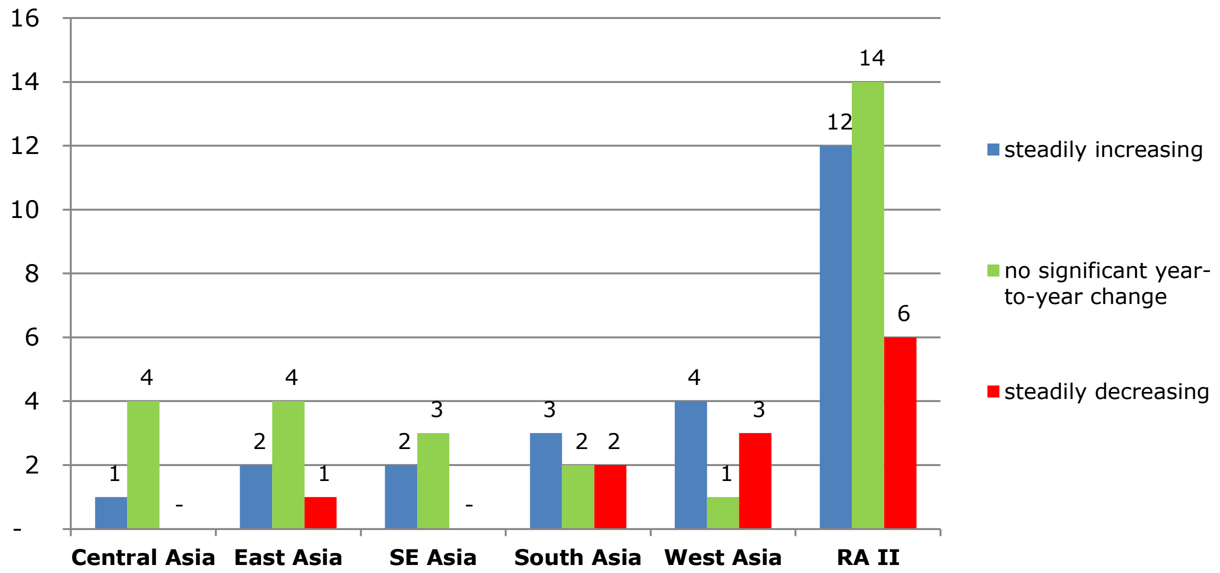



**Figure 3.2: Trends of staff numbers in recent 3-5 years**

### 3.2 Budgetary Provision in Year 2013-2014

The total annual budgets of NMHSs across RA II vary considerably, with reported budgets ranging between USD 607 million in Japan and USD 0.3 million in Afghanistan. Qatar reported there is no specific limitation in budget for the NMHS. The budget of individual Member NMHSs in their most recent fiscal years, in US dollars, is summarized in Table 3.2.

**Table 3.2: Budget of NMHS for recent fiscal year**

| Sub-region | Member | Budget 2013-14 (US dollars) |
|---|---|---|
| Central Asia | Kazakhstan | 48,463,723.82 |
| | Kyrgyz Republic | 1,213,300.18 |
| | Russian Federation | - |
| | Tajikistan | 792,079.21 |
| | Uzbekistan | 15,609,437.16 |
| East Asia | China | - |
| | DPR Korea | - |
| | Hong Kong, China | 33,479,268.61 |
| | Japan | 607,008,875.47 |
| | Macao, China | 4,375,546.94 |
| | Mongolia | 10,928,961.75 |
| | Republic of Korea | 317,685,446.44 |
| South-East Asia | Cambodia | 10,037,855.36 |
| | Lao PDR | 530,502.99 |
| | Myanmar | 2,242,914.98 |
| | Thailand | 32,726,150.05 |
| | Viet Nam | 36,047,497.88 |
| South Asia | Afghanistan | 300,000.00 |
| | Bangladesh | - |
| | India | 81,261,173.41 |
| | Maldives | 1,522,776.93 |
| | Nepal | 2,060,793.41 |
| | Pakistan | - |
| | Sri Lanka | 2,077,742.85 |
| West Asia | Bahrain | 3,183,023.87 |
| | Iran | 18,500,000.00 |
| | Iraq | 7,692,307.69 |
| | Kuwait | 7,067,137.81 |
| | Oman | - |
| | Qatar | No specific limitations |
| | Saudi Arabia | - |
| | UAE | - |
| | Yemen | 1,761,122.20 |

National Government is the main source of budget for NMHSs in RA II (see Table 3.3). Three Members (Kazakhstan, Uzbekistan and Viet Nam) also receive budget under commercial arrangements. Similarly, four Members (DPR Korea, Republic of Korea, Uzbekistan and Iran) reported that there is a provision of cost-recovery in aviation services.

Only Kazakhstan and Kyrgyzstan reported the small amount of budget - 7.4% and 1-3% - coming from non-government sources respectively. Nepal reported that they have a running World Bank managed Pilot Project for Climate Resilience (PPCR) (about US$ 25 million for 5 years). Once the project is phased out, the regular budget will be reduced significantly.

**Table 3.3: Budget Sources of NMHS for recent fiscal year**

| Budget Sources | Sub-region | | | | | RA II (33) |
|---|---|---|---|---|---|---|
| | Central Asia (5) | East Asia (7) | SE Asia (5) | South Asia (7) | West Asia (9) | |
| Government | 5 | 7 | 5 | 7 | 9 | 33 |
| Commercial activities | 2 | - | 1 | - | - | 3 |
| Cost recovery | 1 | 2 | - | - | 4 | 4 |

In addition to regular government budget, many NMHSs received additional budget extra funds in the form of projects funded by international agencies, national agencies and research projects (see Table 3.4). The survey revealed that 15 Members received project funds from international agencies whereas 10 Members received project funds from national agencies. Eleven Members reported that they have research projects. Funding from international agencies is relatively higher in central, South-East and South Asia. Four out of five Members in Central Asia said that they currently have research project funds.

**Table 3.4: Funding Sources of NMHS Budget**

| Budget Fund Sources | Sub-region | | | | | RA II (33) |
|---|---|---|---|---|---|---|
| | Central Asia (5) | East Asia (7) | SE Asia (5) | South Asia (7) | West Asia (9) | |
| Projects funded by international agencies | 4 | 1 | 4 | 5 | 1 | 15 |
| Research projects | 4 | 2 | 1 | 2 | 2 | 11 |
| Projects funded by national agencies | 2 | 2 | 2 | 2 | 2 | 10 |

## 3.3 Scope of Services

Meteorology, including observations, data-processing and forecasting and warning services is the common operational responsibility of NMHSs in RA II. All but one respondent (Oman) also reported the provision of climate services as an operational responsibility too. Table 3.5 summarizes the range of operational services provided by each NMHS in RA II. Some Members specified the specific services e.g. radiological monitoring by Hong Kong, China; Volcanology by Japan; agrometeorology by Myanmar, Thailand, and India; and glaciology and Glacial Lake Outburst Flood (GLOF) by Nepal.

**Table 3.5: Scope of services provided by NMHS**

| RA II Members | Meteo-rology | Hydro-logy | Climate | Air/ Water quality | Tsuna-mi | DRR/ DRM | Seismol-ogy | Ocean-ography | Others |
|---|---|---|---|---|---|---|---|---|---|
| Central Asia | | | | | | | | | |
| Kazakhstan | X | X | X | X | | | | | |
| Kyrgyz Republic | X | X | X | X | | | | | |
| Russian Federation | X | X | X | X | X | X | | X | |
| Tajikistan | X | X | X | X | | X | | | emergency situations |
| Uzbekistan | X | X | X | X | | X | | | |
| East Asia | | | | | | | | | |
| China | X | | X | X | | X | | | |
| DPR Korea | X | X | X | X | X | | | X | |
| Hong Kong, China | X | X | X | | X | X | X | X | Radiological monitoring and assessment |
| Japan | X | | X | | X | | X | X | Volcanology |
| Macao, China | X | | X | X | X | | X | | |
| Mongolia | X | X | X | X | | | | | |
| Republic of Korea | X | X | X | | X | X | X | X | |
| South-East Asia | | | | | | | | | |
| Cambodia | X | | X | | | | | X | |
| Lao PDR | X | X | X | | | | X | | |
| Myanmar | X | X | X | | X | | X | | Agro-meteorology |
| Thailand | X | X | X | | X | | X | X | Agro meteorology |
| Viet Nam | X | X | X | X | | X | | | |
| South Asia | | | | | | | | | |
| Afghanistan | X | X | X | X | | X | | | |
| Bangladesh | X | | X | | X | | X | | |
| India | X | X | X | X | X | X | X | X | Agro-meteorology& Aviation |
| Maldives | X | X | X | | X | | X | | |
| Nepal | X | X | X | X | | X | | | Glaciology, GLOF mitigation, |
| Pakistan | X | X | X | X | X | X | X | X | |
| Sri Lanka | X | | X | | X | | | | |
| West Asia | | | | | | | | | |
| Bahrain | X | | X | | | | X | | |
| Iran | X | | X | | | X | | X | |
| Iraq | X | X | X | | | | X | | |
| Kuwait | X | | X | | | | | | |

| RA II Members | Meteo-rology | Hydro-logy | Climate | Air/ Water quality | Tsuna-mi | DRR/ DRM | Seismol-ogy | Ocean-ography | Others |
|---|---|---|---|---|---|---|---|---|---|
| Oman | X | | | | X | | | | |
| Qatar | X | | X | | | | X | | |
| Saudi Arabia | X | | X | X | | X | | | |
| UAE | X | | X | X | X | X | X | | |
| Yemen | X | | X | | X | | | | |

### 3.4 Business Model

The survey examined the business model under which each NMHS operates. Most NMHSs in RA II are Government/State owned enterprises providing public weather services without commercial activities. Four RA II Members (Tajikistan, Uzbekistan, Viet Nam and Oman) reported that their NMHSs also engage in commercial activities (see Figure 3.3). Only one Member UAE reported that it is operated under private company modality.

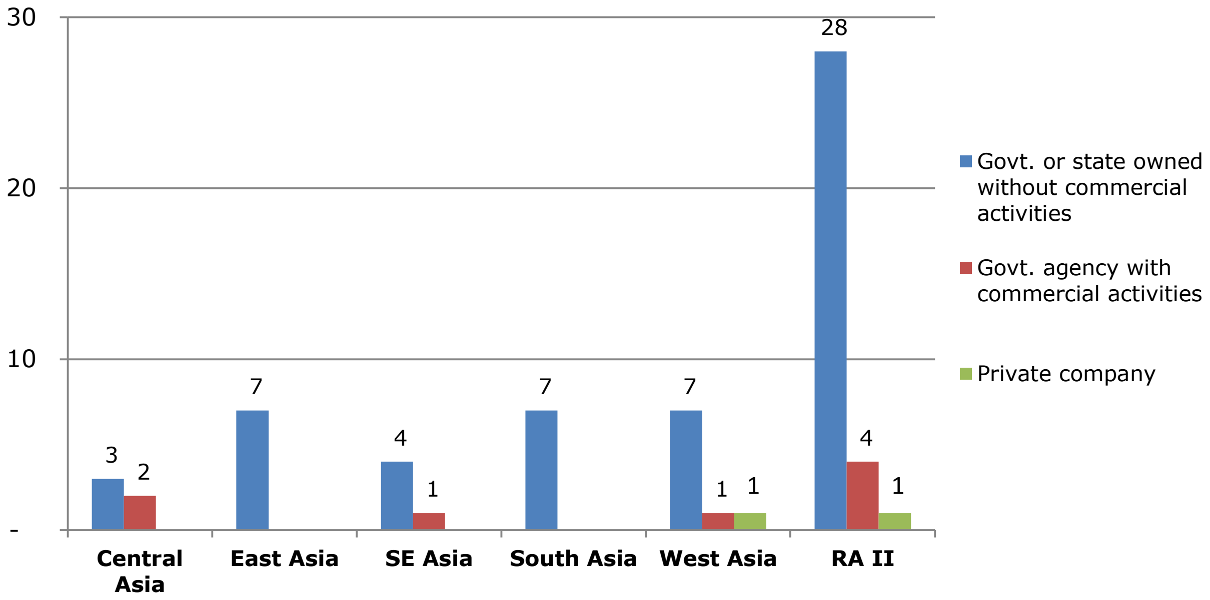



**Figure 3.3: Business model of NMHSs**

### 3.5 NMHS Quality Management Programme

The context for this survey question was implementation of ICAO Annex 3 – Meteorological Service for International Air Navigation and the mandatory need for Quality Management Systems (QMSs) from 15 November 2012 in all contracting States.

The majority of Members responded that their NMHS has some kind of Quality Management programme. Twelve Members (Kyrgyz Republic, Russian Federation, Tajikistan, China, DPR Korea, Republic of Korea, Cambodia, Afghanistan, Bahrain, Iraq, Kuwait and Qatar) have implemented QMS across their whole NMHS, including for aviation, whilst thirteen (Uzbekistan; Hong Kong, China; Japan; Macao, China; Myanmar; Thailand; Bangladesh; India; Nepal; Pakistan; Iran and Saudi Arabia) have implemented QMS for aviation services and seven Members (Kazakhstan, Lao PDR, Viet Nam, Maldives, Sri Lanka, Oman and Yemen) reported an absence of QMS frameworks. One Member UAE remained silent in this question. Sub-region wise QMS implementation status in RA II is shown in Figure 3.4.

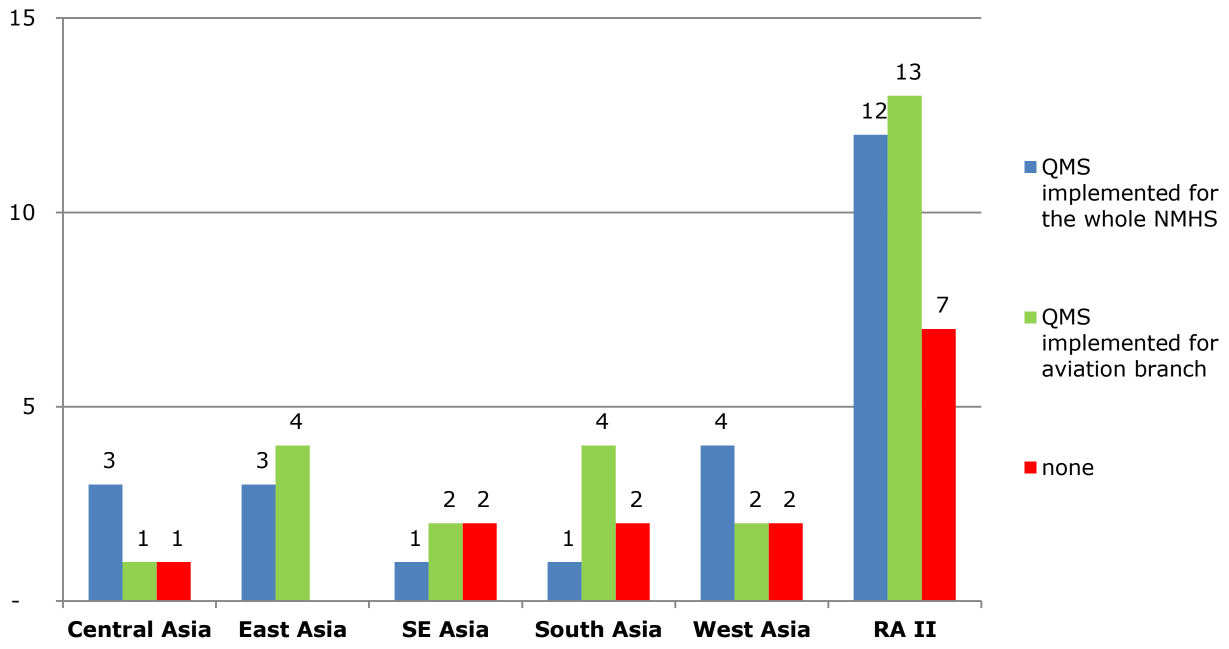



**Figure 3.4: QMS implementation status**

### 3.6 Development/Strategic Plan for Next 3- 5 Years

The survey examined the extent to which RA II Members had strategic plans or national development in place that identify the priorities of the NMHSs over the next few years. All Members reported having such plans in place.

The most frequently cited strategic priority areas identified in these plans were enhancing the monitoring infrastructure, and improving operational forecast and warning services, which were reported by 31 Members and closely followed by strengthened IT capability with 29 responses, and enhanced climate services (implementation of the GFCS); and training, education and capacity-building of staff with 28 responses each. However, the top three priorities of West Asia are improved IT, enhanced climate services; and training, education and capacity-building. Table 3.6 provides a summary of the responses, ordered according to the most commonly reported priority areas with sub-region disaggregation.

**Table 3.6: Priority areas of Development/Strategic Plan**

| Priority Area | Sub-region | | | | | RA II |
|---|---|---|---|---|---|---|
| | Central Asia | East Asia | SE Asia | South Asia | West Asia | |
| Enhancing the monitoring infrastructure | 5 | 7 | 5 | 7 | 7 | 31 |
| Improving operational forecasts including the warning products | 5 | 7 | 5 | 7 | 7 | 31 |
| Improved IT (including better use of web services and social media) | 4 | 6 | 5 | 6 | 8 | 29 |
| Enhanced climate services (implementation of the GFCS) | 2 | 6 | 5 | 7 | 8 | 28 |
| Training, education and capacity building of staff | 4 | 5 | 4 | 7 | 8 | 28 |
| Automation of the observing networks | 5 | 5 | 5 | 6 | 6 | 27 |
| Implementation of WIS | 4 | 6 | 4 | 6 | 5 | 25 |
| Research & development | 3 | 6 | 3 | 7 | 6 | 25 |
| Extending services to new user sectors | 3 | 6 | 4 | 6 | 5 | 24 |
| Improving the management and institutional arrangements | 4 | 5 | 5 | 4 | 3 | 21 |
| Implementation of WIGOS | 3 | 6 | 1 | 4 | 4 | 18 |
| Development and implementation of new commercial services/products | 2 | 3 | 2 | 3 | 4 | 14 |

## 4 Operations and Services

This section provides a summary of the scope of services delivered by Member NMHSs and the areas in need of attention in terms of coverage, timeliness and meeting the needs of users.

### 4.1 Types of Service Provisions

Table 4.1 summarizes the different types of services provided by RA II NMHSs. Public weather forecasts and warning services are provided by all and most also provide climate, agrometeorological and aviation services. Marine services and hydrological services are also commonly provided by the Members. It is found that only a small numbers of NMHSs provided air/water quality services, earthquake/seismological services, tailored services to specific users, tsunami and volcano services.

**Table 4.1: Type of services provisions**

| Type of Services | Sub-region | | | | | RA II |
|---|---|---|---|---|---|---|
| | Central Asia | East Asia | SE Asia | South Asia | West Asia | |
| Public Weather Services (PWS) | 5 | 7 | 5 | 7 | 9 | 33 |
| Warning services | 5 | 7 | 5 | 7 | 9 | 33 |
| Climate services | 4 | 7 | 5 | 7 | 7 | 30 |
| Agro-meteorological services | 5 | 6 | 5 | 7 | 5 | 28 |
| Aviation services | 2 | 6 | 4 | 7 | 9 | 28 |
| Marine Services | 1 | 4 | 4 | 5 | 8 | 22 |
| Hydrological services | 5 | 3 | 5 | 5 | 2 | 20 |
| Air/water quality | 5 | 3 | 1 | 2 | 3 | 14 |
| Earthquake/Seismological Services | - | 4 | 3 | 4 | 3 | 14 |
| Tailored services to specific economic sectors | 3 | 3 | 2 | 3 | 2 | 13 |
| Tsunami Services | 1 | 4 | 2 | 5 | 1 | 13 |
| Volcano Services | - | 3 | - | - | 1 | 4 |

## 4.2 Current Level of Service Provisions

An assessment of the current adequacy of service provision was provided by respondents and is summarized in Figure 4.1. The majority of respondents rated their NMHS service level as satisfactorily meeting most requirements. Public weather, warnings, and aviation services, were most consistently rated as meeting most or exceeding requirements. Climate, earthquake/volcano, hydrological services, as well as tsunami and marine services were also rated as satisfactory or better by a majority of Members who provide these services. Tailored services to specific economic sectors and agrometeorological services were identified by many respondents as only partly meeting requirements and were perhaps the service most in need of development. Air/Water quality service is not applicable to as many as one third of the Members in RA II.

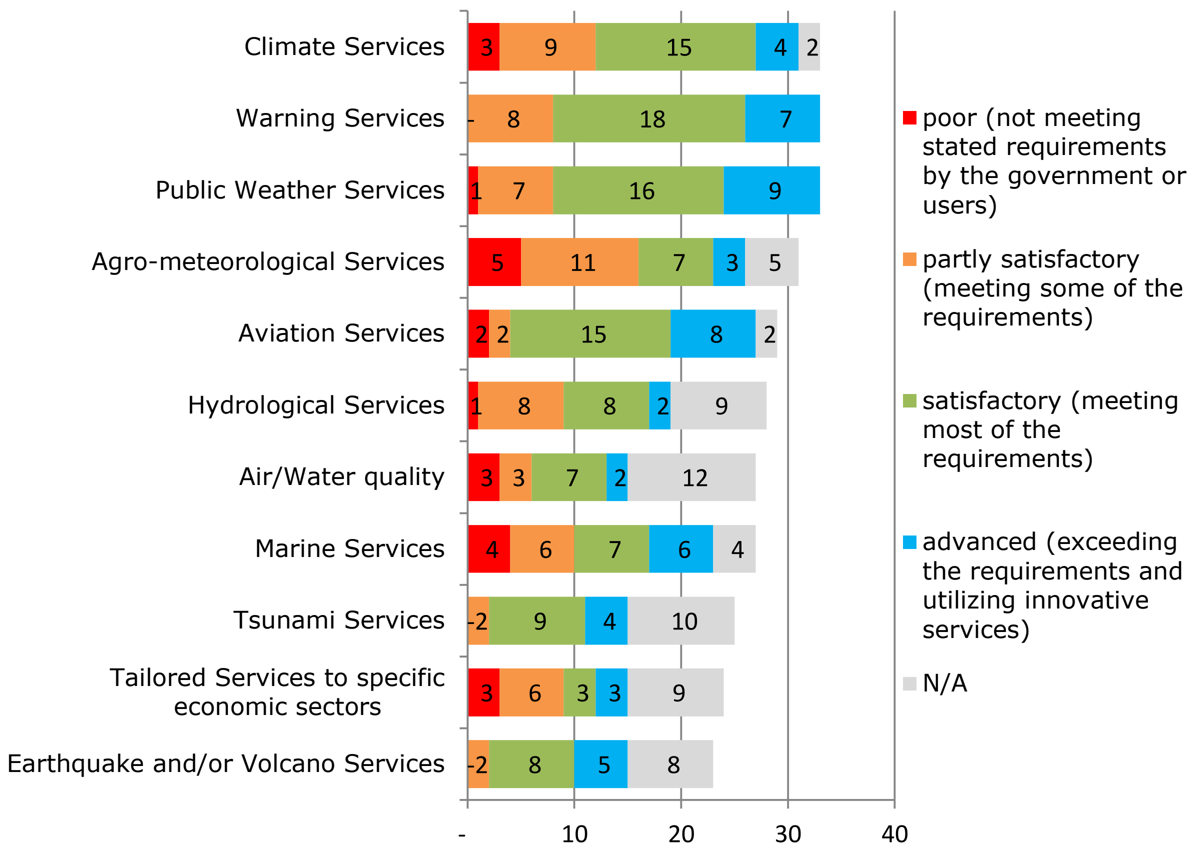



**Figure 4.1: Current level of service provisions**

Respondents were also asked to rate the adequacy of national research capability to support service delivery. Research in support of early warning systems, marine and aviation services were seen as the advanced level that meets or exceed users' requirement, although in all instances, there were significant numbers of Members who rated the underpinning research as being satisfactory or only partly satisfactory. Similarly, considerable numbers of Members also rated the research capabilities as poor not meeting stated requirement by government or users. Details are given in Figure 4.2 below.

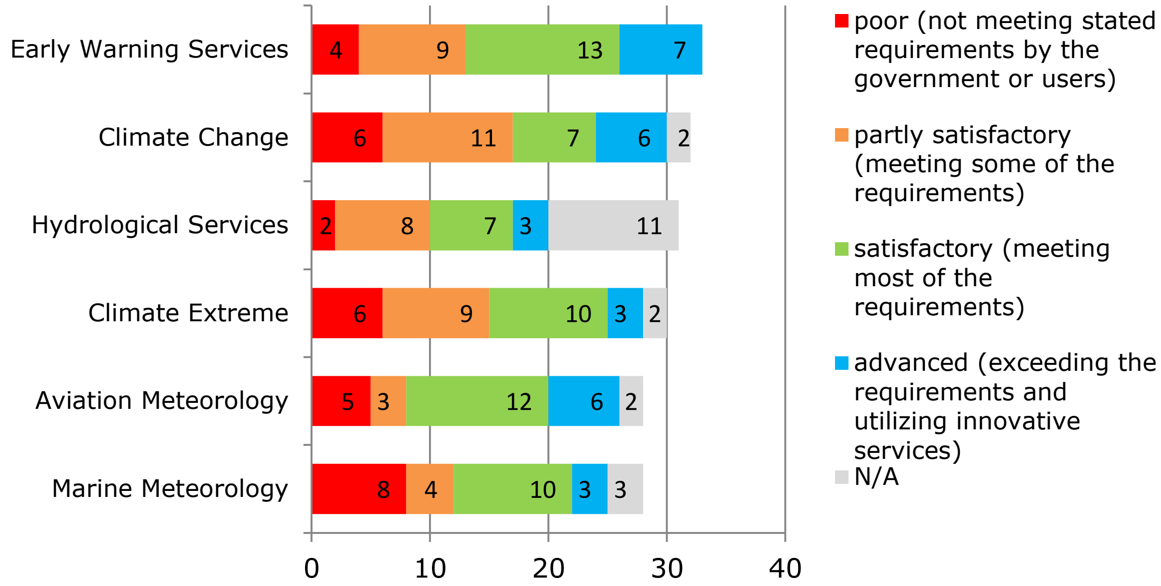



**Figure 4.2: Level of research capabilities and development areas**

### 4.3 Adequacy of Monitoring Infrastructure

Members were asked to rate the inadequacy of monitoring infrastructure (observations and IT). Most commonly reported concerns related to upper-air observations, automation of the observing networks and weather radar observations. Concerns about the IT and telecommunication (national) facilities, and surface observation were also widely reported. These results are summarized in Figure 4.3 below.

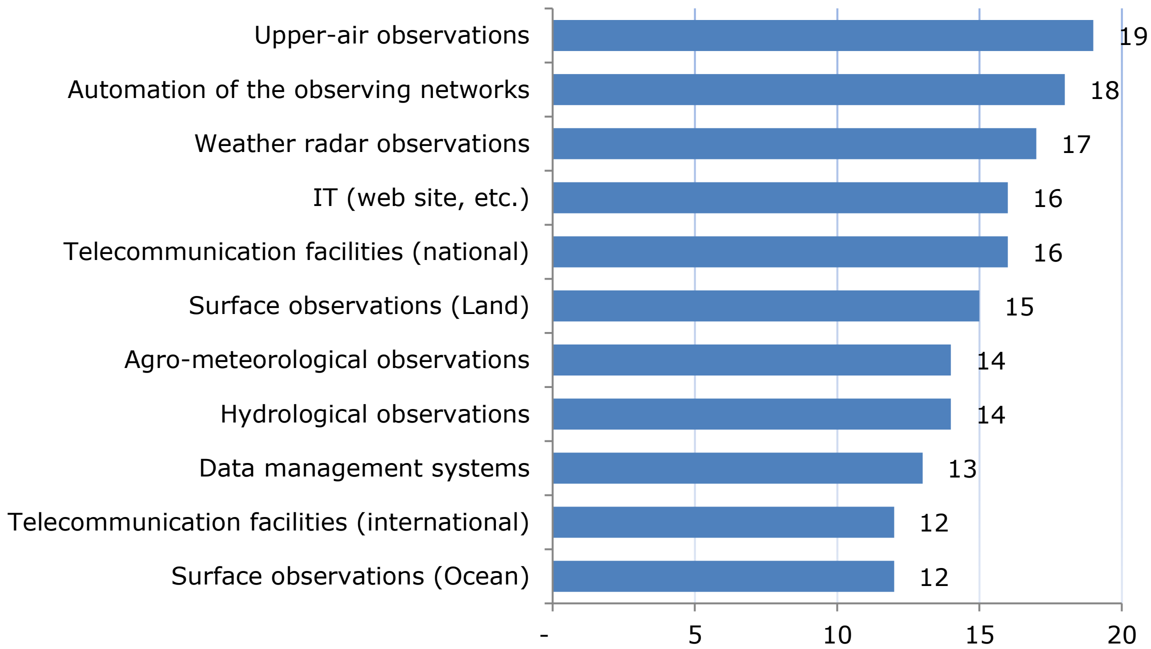



**Figure 4.3: Inadequacy of equipment and infrastructure**

These results by sub-region are presented in Table 4.2. The most common concerns shared by South-East, South and West Asian Members is upper-air observations. Automation of the observing networks and weather radar observation are common concerned of Central, South-

East and South Asian Members. Similarly, a national telecommunication facility is major concerned among the Central, East and South-East Asian Members.

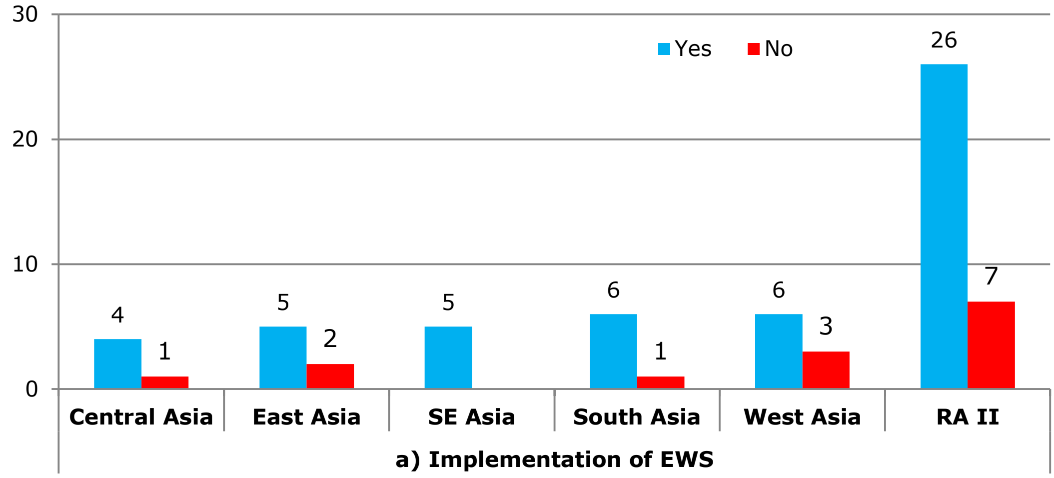
**Table 4.2: Areas of equipment and infrastructure inadequacy**

| Areas of Inadequacy | Sub-Region | | | | | RA II |
|---|---|---|---|---|---|---|
| | Central Asia | East Asia | SE Asia | South Asia | West Asia | |
| Upper-air observations | 3 | 2 | 4 | 5 | 5 | 19 |
| Automation of the observing networks | 3 | 3 | 4 | 5 | 3 | 18 |
| Weather radar observations | 4 | 3 | 4 | 4 | 2 | 17 |
| IT (web site, etc.) | 4 | 3 | 4 | 3 | 2 | 16 |
| Telecommunication facilities (national) | 4 | 3 | 3 | 3 | 3 | 16 |
| Surface observations (Land) | 4 | 2 | 4 | 3 | 2 | 15 |
| Agro-meteorological observations | 3 | 1 | 3 | 4 | 3 | 14 |
| Hydrological observations | 3 | 1 | 3 | 3 | 4 | 14 |
| Data management systems | 3 | 1 | 4 | 3 | 2 | 13 |
| Surface observations (Ocean) | - | 2 | 3 | 3 | 4 | 12 |
| Telecommunication facilities (international) | 4 | 2 | 3 | 1 | 2 | 12 |

## 4.4 Forecasting Capacity and Early Warning System

The survey concluded its section on operations and services with an assessment of the adequacy of staffing levels to deliver 24 hr-7days operational services and also whether the NMHS has early warning systems in place. A significant number of Members (7 from 33 respondents) reported that they did not have sufficient staff to maintain around-the-clock operations.

On the other hand, all but seven respondents (Kazakhstan, DPR Korea, Mongolia, Afghanistan, Bahrain, Iraq and Yemen) reported that they had early warning systems implemented. These two aspects of NMHS capability are summarized in Figure 4.4.



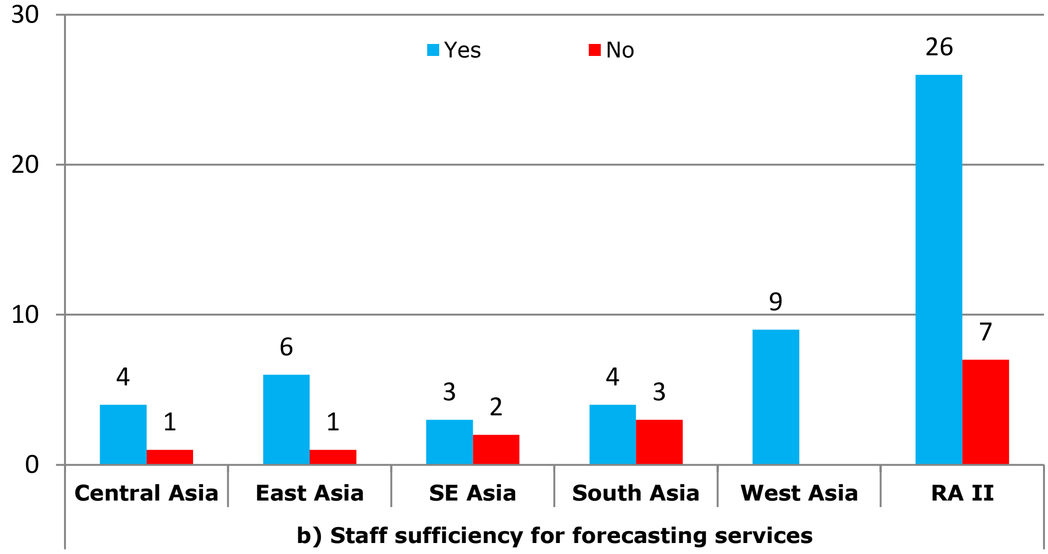




**Figure 4.4: Forecasting capacity of NMHSs**

## 5 Challenges and Priorities for RA II

This section examines the major NMHS challenges and gaps that Members identified and the priority actions for the next 3-5 years.

### 5.1 Challenges

Members were asked to identify the most pressing challenges from a list of 12 predefined categories by rating the extent of the challenge on a 5-point scale (1 = no challenge; 2 = slight challenge; 3 = moderate challenge; 4 = moderate/serious challenge; 5 = serious challenge). The scores were then tallied and averaged to produce a list that illustrates the most significant challenges facing NMHSs in order of significance (see Figure 5.1 below).

The most significant/widespread challenges identified were: adequacy of qualified personnel, adequacy of climate services, and NWP modelling capacity. Other challenges such as improved visibility and adequacy of EWS services for DRR, relationship with private sector, introduction and maintenance of QMS, anticipated budget and staff cuts, data policies, and adequacy of the existing observing system were also rated relatively higher than average value of 2,500. Only adequacy of telecommunication facilities and capacity is rated as below average value of 2,500.

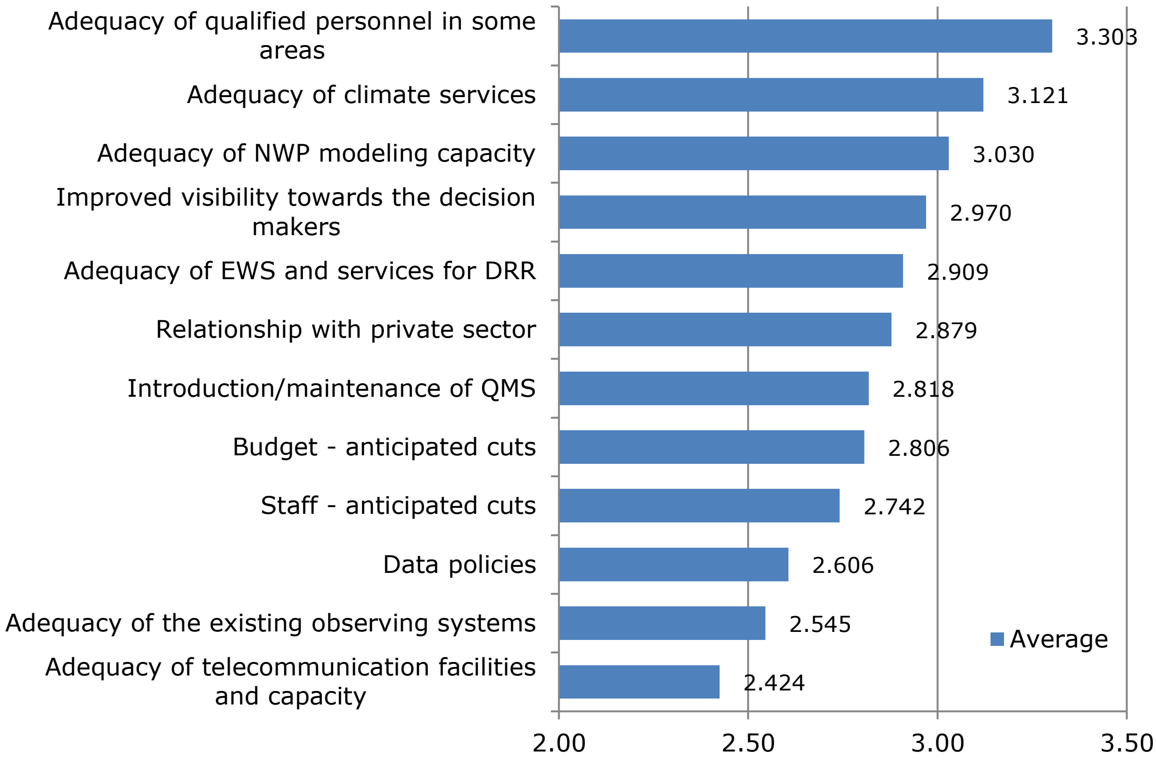



**Figure 5.1: Challenges of NMHSs**

An alternative analysis was also undertaken that identified the three most commonly identified challenges under each of the four categories slight, moderate, moderate/serious and serious. These are summarized in Table 5.1 below.

**Table 5.1: Challenges at different levels**

| **Serious** | **Moderate to Serious** |
|---|---|
| • Adequacy of qualified personnel in some areas<br>• Adequacy of NWP modelling capacity<br>• Budget - anticipated cuts | • Adequacy of climate services<br>• Improved visibility towards the decision-makers<br>• Adequacy of EWS and services for DRR |
| **Moderate** | **Slight** |
| • Anticipated staff cuts<br>• Data policies<br>• Relationship with private sector | • Introduction/maintenance of QMS<br>• Adequacy of telecommunication facilities and capacity<br>• Adequacy of the existing observing systems |

Apart from these challenges, continuous skill development and retention of qualified personnel, increasing operational cost, and potential competition from overseas commercial service providers are some of other challenges in some of RA II Members for long-term sustainability.

Figure 5.2 illustrates challenges of NMHSs by sub-region. The order of listed challenges varies significantly among the sub-regions in RA II. Top challenges are: anticipated budget in Central Asia; adequacy of climate services and relationship with private sectors in East Asia; adequacy of qualified personnel and improved visibility towards the decision-makers in South-East Asia; adequacy of qualified personnel and introduction/maintenance of QMS in South Asia; and adequacy of climate services and adequacy of qualified personnel in West Asia. It is found that the adequacy of qualified personnel is one of the serious challenges in all sub-regions, and the challenges are relatively less serious in East Asia as indicated by lower average values.

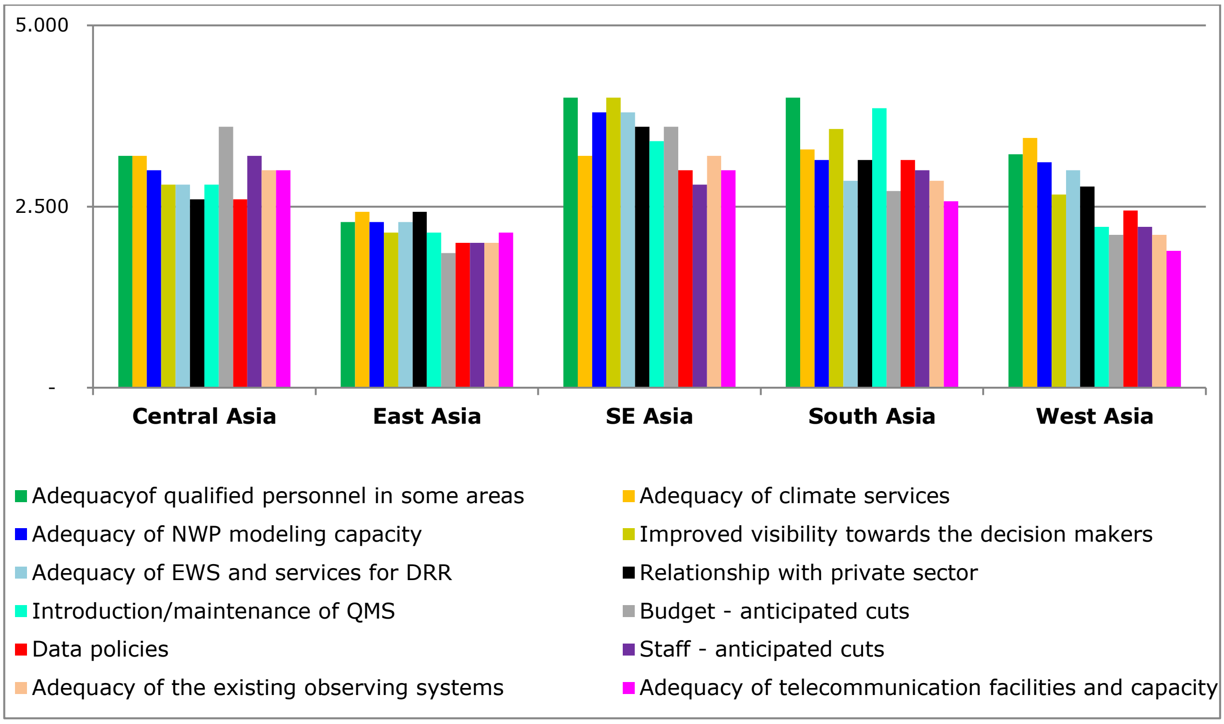



**Figure 5.2: Challenges of NMHSs by sub-region**

## 5.2 Future Priorities

Respondents were asked to identify up to six priority areas for future work to help address the challenges identified above. Free text was used for responses and a degree of interpretation was used to summarize this information and map it to the following 9 priority areas. Table 5.2 provides the comparative priority areas based on weighted value weighing top priority as highest value of 6 and decreasing subsequently.

**Table 5.2: Weighted priority areas**

| S. N. | Priority Areas | Priority | | | | | | Response Frequency | Weighted Value |
|---|---|---|---|---|---|---|---|---|---|
| | | *1* | *2* | *3* | *4* | *5* | *6* | | |
| 1 | WIGOS - WIS including GISC | 6 | 10 | 2 | 3 | 3 | 7 | 31 | 116 |
| 2 | Capacity development | 8 | 6 | 5 | 2 | 1 | 2 | 24 | 108 |
| 3 | Strengthening of Climate Services including GFCS | 2 | 4 | 7 | 10 | 5 | - | 28 | 100 |
| 4 | Enhancement of services delivery | 3 | 3 | 6 | 5 | 2 | 3 | 22 | 79 |
| 5 | Disaster Risk Reduction/Early Warning System DRR/EWS | 3 | 4 | 3 | 6 | 3 | 1 | 20 | 75 |
| 6 | Improvement of QMS | 3 | 1 | 3 | 2 | 7 | 3 | 19 | 58 |
| 7 | Scientific research | 3 | 1 | - | 3 | 5 | 5 | 17 | 47 |
| 8 | International partnerships | - | - | 4 | - | 2 | 1 | 7 | 21 |
| 9 | Strengthening good governance | 1 | - | - | - | 1 | 3 | 5 | 11 |

**Priority 1: Implementation of WIGOS and WIS including GISC:** expressed in terms of the need to maintain and improve observing systems, the quality of observations, improve communication and information sharing, telecommunication and IT infrastructures and database management, and regional and national implementation of WIGOS.

**Priority 2: Capacity-building**: identified by Members in terms of budget and staffing resource deficiencies, education and training needs, exchange of experts and modelling capacity such as NWP.

**Priority 3: Strengthening of climate services including GFCS:** expressed in terms of the need for improved climate services including climate change, variability and prediction services; and the implementation of GFCS at national and regional levels.

**Priority 4: Enhancement of services – PWS, hydrology and aviation:** expressed in terms of developing the capacity for adequate services in support of public weather services, aviation, and hydrology, including medium- and long-range forecast services;

**Priority 5: Disaster Risk Reduction/Early Warning System (DRR/EWS):** expressed in terms of reliable observation system, capacity enhancement of both human resources and observation system to issue early warning and emergency services.

**Priority 6: Improvement of Quality Management System (QMS):** expressed in terms of observer and forecaster training in support of QMS implementation; application in specific sectors commonly identified in aviation sector.

**Priority 7: Scientific research:** expressed in terms of joint research on surface and upper-air observations, climate change, and regional data acquisition and sharing.

**Priority 8: Cooperation and partnerships:** expressed in terms of improving outreach to the community, encouraging engagement with local government, raising the effectiveness and efficiency of regional activities, building common positions on issues like data policy, commercialization and public/private sector relationships.

**Priority 9: Strengthening good governance:** expressed in terms of improving legal and technical regulation, developing and/or strengthening SOP.

Sub-regional priority areas are shown in Figure 5.3 below. The top priority areas are: WIGOS-WIS including GISC in Central Asia; Disaster Risk Reduction and Early Warning System, and WIGOS-WIS including GISC and Strengthening of Climate Services including GFCS in East Asia; Disaster Risk Reduction and Early Warning Systems, and Capacity Development in South Asia; and Capacity Development and WIGOS-WIS including GISC in South-East Asia and West Asia. Priority areas of sub-regions may represent the specific needs of the sub-region. WIGOS-WIS including GISC, capacity-building and strengthening of climate services including GFCS are priority areas in most of the sub-regions. Enhancement of services delivery-PWS, hydrology and aviation is still a priority area in West Asia and Central Asia. Improvement of QMS is also one of the high priorities in South Asia.

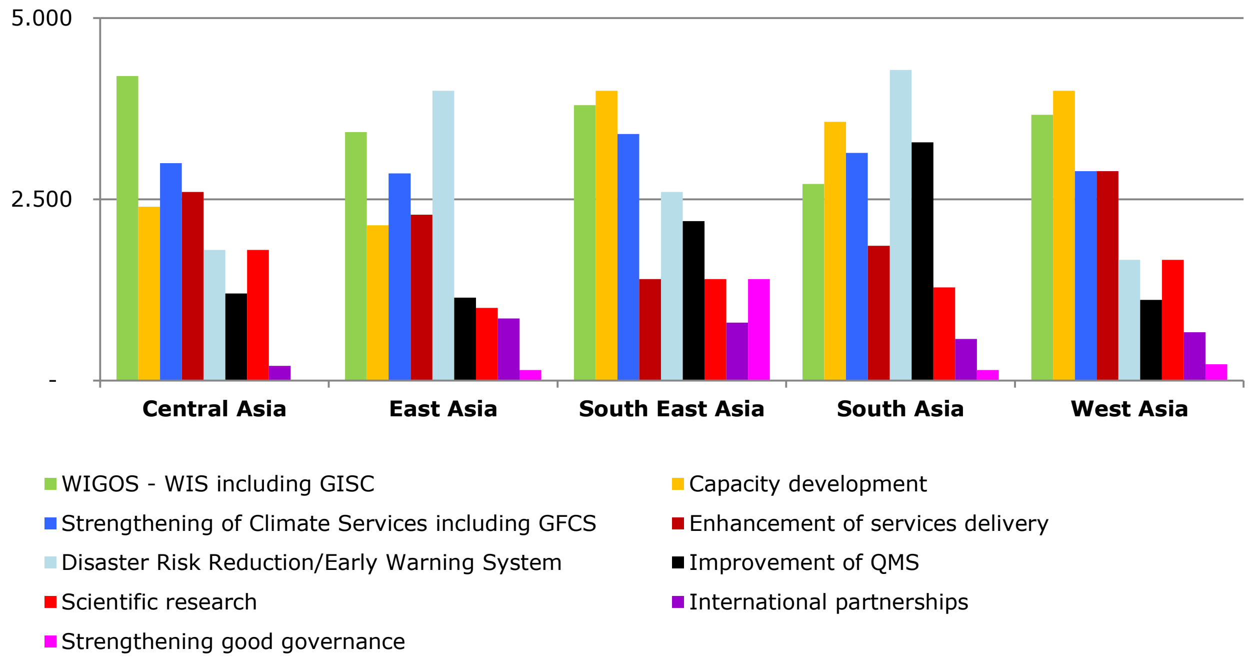



**Figure 5.3: Weighted priority areas by sub-region**

In addition to this group of five priority areas, Members expressed other priorities namely improvement of quality management system (QMS); scientific research; cooperation and partnerships; and strengthening good governance. Apart from these listed priorities, some Members also have their own specific priorities such as commercialization of services, strengthening the institutional regulatory framework of NMHSs, development of Numeric Weather Prediction (NWP), and seasonal climate prediction.

## 6 Suggestions for the RA II Activities

This section summarizes expectations and suggestions of Members in terms of participation in subsidiary bodies, partnership with other Members and support from the Secretariat for improvement of RA II activities.

### 6.1 Participation in Subsidiary Bodies

Members were surveyed to determine their ability to participate in the working mechanisms (Working Groups, Task Teams, etc.) of RA II. The majority of responses (19) indicate that participation in this work is only possible with financial support from WMO. Seven Members (three from East Asia, one each from other sub-regions) indicated that they are able to allocate their own resources to support participation in meetings of subsidiary bodies. Eight Members expressed an ability to participate through electronic means only (e.g., web forum, email, WebEx conferences etc.). Three Members (two from South Asia and one from West Asia) mentioned that there is no possibility to allocate staff to support regional activities. The responses are shown in Figure 6.1 below.

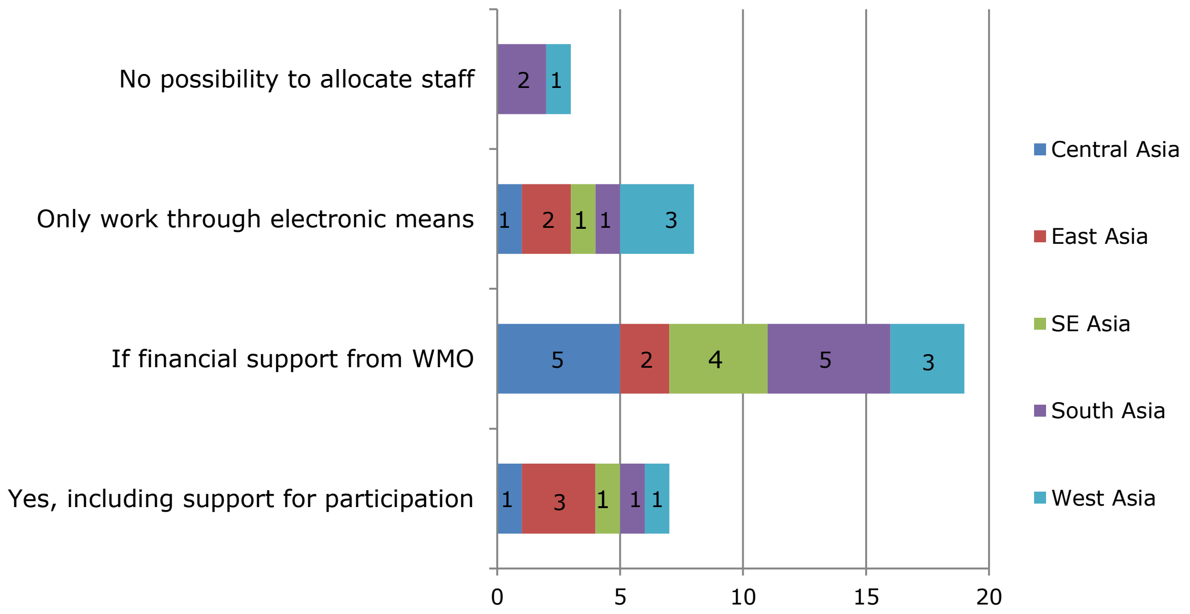



**Figure 6.1: Support to subsidiary bodies**

Budget constraint and insufficient staff in NMHSs are the main hindrance to support the activities of RA II subsidiary bodies. Insufficient staff resources is major problem in West Asia whilst budget constraints is the major problem in South-East Asia. Five Members also reported that language was a problem among them, two in Central Asia and one each in East Asia, South Asia and West Asia. The main constraints on participation in RA II subsidiary bodies are summarized in Figure 6.2 below.

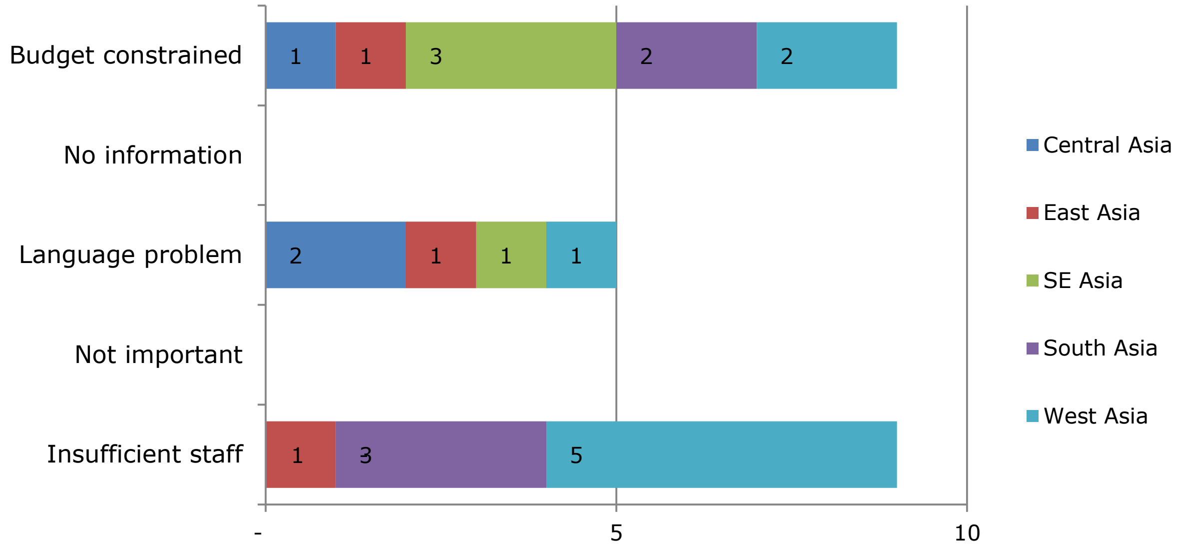



**Figure 6.2: Reason for not supporting subsidiary bodies**

Members were also asked to identify the main outcomes they seek from the work of the RA II subsidiary bodies, using a 3-point scale (1 = not useful; 2 = useful; 3 = very useful). A clear preference was expressed for three types of activities: regional implementation plans (WIS, WIGOS, GFCS etc.); regional capacity development events such as forum, seminar/ conference/workshops, cooperation and partnership; and assisting in setting up implementation projects and providing guidance material on the implementation of priority programmes and projects. See Figure 6.3 below for a summary of the average usefulness rating across RA II.

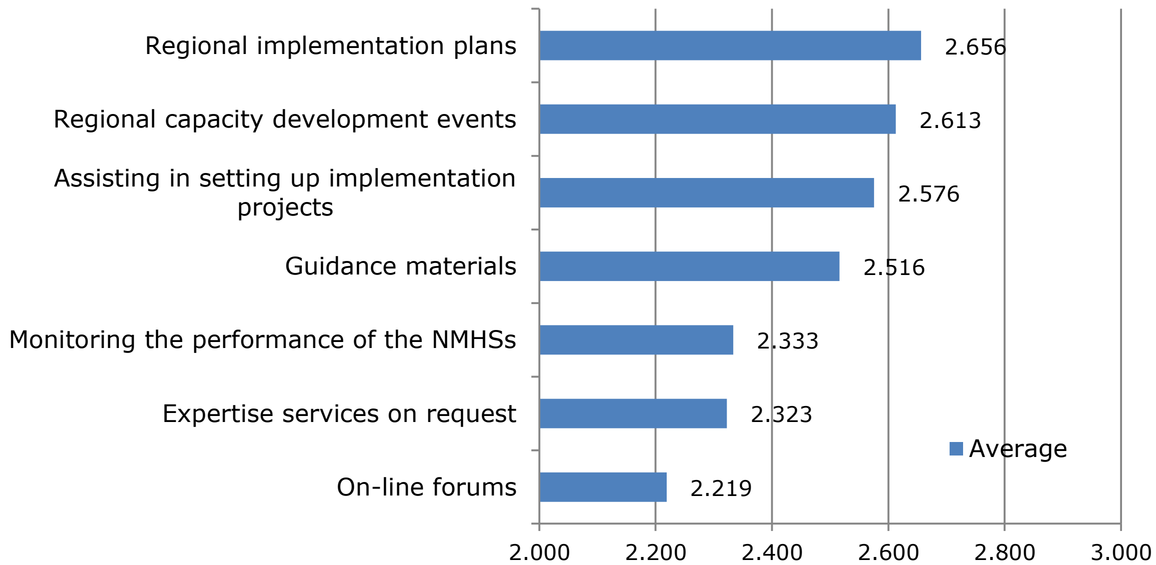



**Figure 6.3: Useful activities of subsidiary bodies**

Table 6.1 presents a numerical breakdown of level of usefulness of regional activities under each category with sub-region representations. It is revealed that the majority of Members rated listed regional activities as either useful or very useful. Three Members, one each from South-East, South and West Asia, rated monitoring the performance of the NMHSs, one

Member from South-East rated guidance material and one Member from East Asia rated on-line forums as not useful.

**Table 6.1: Number of respondents by outcome and level of usefulness**

| Useful Outcomes | Sub-Region | | | | | | | | | | | | | | | RA II | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Central Asia | | | East Asia | | | SE Asia | | | South Asia | | | West Asia | | | | | |
| | *1* | *2* | *3* | *1* | *2* | *3* | *1* | *2* | *3* | *1* | *2* | *3* | *1* | *2* | *3* | *1* | *2* | *3* |
| Regional implementation plans | - | 2 | 2 | - | 2 | 5 | - | 1 | 4 | - | 2 | 5 | - | 4 | 5 | - | 11 | 21 |
| Regional capacity development events | - | 1 | 3 | - | 4 | 3 | - | 2 | 2 | - | - | 7 | - | 5 | 4 | - | 12 | 19 |
| Assisting in setting up implementation projects | - | 3 | 2 | - | 2 | 5 | - | 2 | 3 | - | 3 | 4 | - | 4 | 5 | - | 14 | 19 |
| Guidance materials | - | 2 | 2 | - | 4 | 3 | 1 | 1 | 2 | - | 3 | 4 | - | 3 | 6 | 1 | 13 | 17 |
| Monitoring the performance of the NMHSs | - | 4 | 1 | - | 4 | 3 | 1 | 1 | 3 | 1 | 2 | 4 | 1 | 5 | 3 | 3 | 16 | 14 |
| Expertise services on request | - | 2 | 1 | - | 7 | - | - | 3 | 2 | - | 4 | 3 | - | 5 | 4 | - | 21 | 10 |
| On-line forums | - | 2 | 2 | 1 | 6 | - | - | 3 | 2 | - | 5 | 2 | - | 7 | 2 | 1 | 23 | 8 |

*Note: 1 = not useful, 2 = useful and 3 = very useful*

### 6.2 Supports from Members and Secretariat

The final part of this section examined the kind and level of support sought by RA II Members from the WMO Secretariat and from other Members.

With regard to support from Members, although there was a wide range of responses, the strongest emphasis was on training, joint/twinning capacity development projects (NWP, GFCS, climate change, hydrology, glaciology), exchanges of expertise, technical support (e.g., for implementation of QMS, strengthening automatic and upper-air observation networks), sharing and production of data, developing joint research activities/projects and assistance in developing and/or strengthening regulation and SOP.

Similarly, respondents identified financial and coordination support as a key expectation from the WMO Secretariat. The responses provided a number of suggestions for improving this, including financial assistance for participation in regional events that promote the visibility and mandate of NMHSs. Most of the responses indicate that the Secretariat should review its working mechanisms and adopt a more practical approach to foster regional and sub-regional cooperation to tackle challenges and increase its efficiency and effectiveness in coordinating activities and assisting Members. Some Members pointed out the Secretariat's role in coordination and facilitation of VCP activities.

Specific suggestions focused on enhancement of regional data exchange network, continued assistance with information sharing on regional activities, involvement of experts in international or/and regional researches, mobilization of regional/international resources in support of humanity/DRR initiatives, support and guidance in developing the projects and technology transfer, practical guides for implementation of WIS/GISC, GFCS, QMS.

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World Meteorological Organization
REGIONAL ASSOCIATION II (ASIA)
Sixteenth Session
Abu Dhabi, United Arab Emirates
12 to 16 February 2017

RA II-16/INF. 3(3)
Submitted by:
President of RA II
1.II.2017

# CHALLENGES AND FUTURE PRIORITIES OF RA II FOR 2016–2019 IDENTIFIED BY THE SIXTH REGIONAL CONFERENCE ON MANAGEMENT OF NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES IN REGIONAL ASSOCIATION II

The challenges and future priorities for RA II Members were identified by the regional survey and further discussed during the sixth Regional Conference on Management of National Meteorological and Hydrological Services in RA II (RECO-6; Doha, Qatar, December 2014). The highest priority challenges identified in these discussions include:

(a) Inadequacies of climate services, extended forecast (sub-seasonal to seasonal) at high resolution;

(b) The lack of qualified personnel and needs for capacity-building;

(c) Need for ongoing competency assessments and implementation of a quality management system, particularly in the field of aeronautical meteorology;

(d) Need to improve development, access and usage of numerical weather prediction (NWP) guidance material as underlying support to prepare skilful, location-specific weather forecast for improving service delivery;

(e) Inadequate capabilities (meteorological, hydrological observing systems, data communication systems and effective dissemination systems) to deliver end-to-end multi hazard early warning systems to support DRR.

The future priorities include:

(a) **Improvement of Early Warning System (EWS) for Disaster Risk Reduction (DRR)** to meet the increasing demands for effective and more accurate location- and time-specific forecasts for stakeholders to issue early warning and render emergency services;

(b) **Implementation of WIGOS and WIS including GISC** to maintain and improve real-time observing systems including metadata, the quality and quantity of observations (particularly in mountains, deserts and oceans), improve communication and information sharing, telecommunication and IT infrastructures and database management, regional and national implementation of WIGOS;

(c) **Enhancement of Hydrological, Aviation and Public Weather Services** for the development of the capacity for adequate services in support of Public Weather Services, aviation, and hydrology, including nowcast, short- and medium-range forecast services;

(d) **Strengthening of Climate Services including GFCS** for improved climate services including climate change, variability and prediction services; and the implementation of the GFCS at national and regional levels;

(e) **Capacity Development** in terms of budget and staffing resource deficiencies, education and training needs, twinning of experts and modeling such as NWP;

(f) **Improvement of Quality Management System (QMS)** in terms of training and education in support of implementation of personnel qualification, competency and QMS to leverage cost-recovery systems to improve aviation services.

**OTHER CHALLENGES AND FUTURE PRIORITIES OF RA II**

**I. CHALLENGES**

(a) Competition with private sector and impact of social media;

(b) Anticipated budget and staff cuts;

(c) Inadequacies in regional observing and telecommunications systems for monitoring, forecasting, and dissemination of products for weather, water and climate;

(d) Requirement for improved partnership for better visibility and communication with users and stakeholders for effective delivery of user-focused services;

(e) Enhancement of scientific research and transfer of results to operational services of NMHSs;

(f) Need to improve real-time meteorological and hydrological data sharing and the application of open data policies at all timescales.

**II. FUTURE PRIORITIES**

(a) **Enhancement of Scientific Research** including joint research in meteorological observing system, satellite meteorology, radar meteorology, data assimilation, atmospheric and oceanic processes, modelling and climate change;

(b) **Enhancing Cooperation and Partnerships** to improve the provision of meteorological services, outreach to the community, encouraging engagement with local/national/regional governments, raising the effectiveness and efficiency of meteorological activities, building consensus on issues like data policy, commercialization and public/private sector relationships, etc.;

(c) **Strengthening good governance** including legal and technical regulations, developing and/or strengthening standard operating procedures (SOP).

**ADDITIONAL COMMENTS FROM THE SUB-REGIONS ON THE CHALLENGES AND FUTURE PRIORITIES**

**I. CHALLENGES**

**East Asia**

(a) Lack of qualified personnel and infrastructure: Need to improve the capacity of NMHSs in the development and application of technologies including NWP model, nowcasting tool, meteorological satellite, and observational instruments through twinning/ mentoring programmes, institutional development at the regional/sub-regional level, as well as introduction and maintenance of QMS;

(b) Need to improve visibility and communication with the public, special users, stakeholders, decision-makers and commercial weather service providers, such as outreach programmes for better delivery of user-focused services and for more effective DRR activities; and the demonstration of socioeconomic benefits of weather and climate services;

(c) Need to enhance research by NMHSs and partnership with research institutions on various scientific fields such as NWP and climate prediction, and transfer the research results to operational NMHSs services.

**Southeast Asia**

(a) Inadequacy of qualified personnel towards the implementation of WIGOS, WIS and GFCS;

(b) Inadequacy of Modernized Multi-hazard EWS network components, lack of capacity in accurate impact forecast/warning modelling and "Single Voice" dissemination mechanism;

(c) Improved visibility towards government leaders, decision-makers relating to national budget constraint in supporting to raise the capability and profile of NMHSs, including partnership and inter-institutional collaboration.

**South Asia**

(a) Lack of hydrometeorological observations in mountains (Himalayas/ Hindu-Kush regions) and Indian Ocean (Bay of Bengal and Arabian Sea);

(b) Seasonal forecast at high resolution for all seasons;

(c) Capacity-building;

(d) Early warning system for high impact weather (TS, heavy rain, etc.).

**Central Asia**

(a) Lack of harmonization of air navigation and aeronautical meteorological systems;

(b) Insufficient support from the Secretariat in resource mobilization (through donor organizations) to initiate vital sub-regional projects (e.g. Aral HYCOS);

(c) Lack of required technical and technological facilities for enhanced hydrometeorological services to meet changing user needs.

## II. FUTURE PRIORITIES

**East Asia**

(a) Enhancement of service delivery: development of adequate services of PWS, hydrology, aeronautical meteorology, agricultural meteorology, and climate services including GFCS, and enhancing cooperation and partnerships with relevant sectors to facilitate the provision of those services, and capacity-building to support those activities;

(b) Improvement of Early Warning System for Disaster Risk Management and Reduction, establishing early warning systems based upon impact-based forecast and risk-based warning, especially for sectors vulnerable to weather and climate change;

(c) Enhancement of scientific research, including joint research with relevant institutions, on surface- and upper-air observations, satellite meteorological techniques, global to regional NWP and sub-seasonal to seasonal climate prediction, climate change, and regional data acquisition and sharing.

**Southeast Asia**

(a) Enhancement of services and improvement of PWS, EWS and implementation of QMS including personnel competency for Aeronautical Meteorological Services and Meteorological Services in the Terminal Area (MSTA) at sub-regional and national levels;

(b) Implementation of WIGOS at sub-regional and national levels, improvement of WIS operational at sub-regional (RTH) level and national (NC) level, including sub-regional radar data/products composite;

(c) Enhancement of the operational status of sub-regional SWFDP-SeA, emphasis on continuing capacity-building by support to global and regional centres, and improve routine utilization/applications at national level.

**South Asia**

(a) To set up hydrometeorological observation system (surface, upper-air, radar, air quality, ocean buoys, tide gauges) with real-time data dissemination;

(b) Develop numerical coupled forecasting system with regional data assimilation to generate seasonal and monthly forecasts at meteorological sub-divisional scale;

(c) Training on observing system (surface, upper-air, radar, satellite, etc.), telecommunication, data assimilation, NWP modelling and post processing;

(d) Medium-range high resolution precipitation prediction model coupling with rainfall runoff model.

**Central Asia**

(a) Continuous technical and technological modernization in NMHSs;

(b) Life-long personnel education and training;

(c) Scientific and methodological support for hydrometeorological activities.

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World Meteorological Organization
REGIONAL ASSOCIATION II (ASIA)
Sixteenth Session
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Submitted by:
President of RA II
7.II.2017

**SURVEY REPORT ON THE BASIC CAPABILITY OF NMHSS IN REGIONAL ASSOCIATION II (ASIA)**

# SURVEY REPORT

## THE BASIC CAPABILITY OF NMHSs IN RA II (ASIA)

**WORLD METEOROLOGICAL ORGANIZATION**

**JANUARY 2017**

## EXECUTIVE SUMMARY

The Members of WMO Regional Association II (RA II) have been surveyed in order to gather information on the basic capability of National Meteorological and Hydrological Services (NMHSs) in the Region. The Survey was conducted online using the SurveyMonkey platform during the period from October to November 2016. Thirty-three responses out of 35 Members were received.

The results of 2016 survey indicated steady improvement of weather, climate and water services by Members in RA II, but also showed the gaps among the Members.

Most of the Members maintained highly qualified staff with specialized training and had a structured training plan for professional, technical and supporting staff, but 18 per cent of Members had the difficulty in maintaining such staff members. Meanwhile, as many as 70 per cent of Members acquired professional certification in respect of WMO's latest personnel classification scheme.

The number of Members operating ground stations to receive high-resolution geostationary satellite images has increased significantly. More Members used the service of Regional Instrument Centres (RICs) to ensure the accuracy of the instruments.

In general, operational observation networks in the Region have been well maintained or enhanced. However there is also a serious concern that observational infrastructure, such as weather radar, wind profiler and lightning detection networks to detect severe weather phenomena, was far from sufficient in some Members to produce and provide reliable and timely forecast and warning services.

While there are still two Members which did not have connection with Regional Telecommunication Hubs, 72 per cent of Members benefited from WIS in terms of data exchange, in part due to the enhancement in the capability of WIS implementation.

Most Members operated NWP systems and utilized NWP products from major centres in the forecasting process, but some Members need to improve development, access and usage of NWP guidance material as underlying support to prepare skillful, location-specific weather forecast for improving service delivery. The use of a nowcasting system for high-impact weather warning should be enhanced urgently with the highest priority.

The number of Members implementing training and assessment procedures for personnel in order that they meet the competency requirements for the provision of aeronautical meteorological services has increased from 55 to 84 per cent.

There has been a significant increase in the number of Members explicitly providing monthly and/or seasonal climate predictions. Sixty-six per cent of Members provided agrometeorological information, forecasts and agrometeorological services to the user community by promoting practical applications of technological advances. It is required to strengthen climate services including climate change, variability and prediction.

It was also found that many LDCs could not afford to have qualified technicians for the maintenance of observation instruments and communication infrastructure required for real-time delivery of observations. Overall however, there has been an improvement in aeronautical meteorological services in LDCs.

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## 1. Background

1.1 At its fifteenth session held in Doha, Qatar, in December 2012, the WMO Regional Association II (RA II) adopted the Strategic Operating Plan for the Enhancement of National Meteorological and Hydrological Services (NMHSs) in RA II (2012–2015), which was developed based on the survey results on the basic capabilities of NMHSs in RA II during 2010–2011. The report is available at: https://www.wmo.int/pages/prog/dra/documents/RAIISurveyReport2010-2011.pdf.

1.2 To identify the progresses of RA II Members during the intersessional period in the implementation of the Strategic Operating Plan 2012–2015, the Association carried out a revised survey on the basic capability of NMHSs in the Region in 2016. The survey questionnaire consisted of 12 main topics including management, observing systems, telecommunications, data-processing and forecasting systems, natural disaster prevention and mitigation, climate services, agricultural, aeronautical and marine meteorological services, hydrological services, public weather services, and partnership.

1.3 The survey was conducted online using the SurveyMonkey platform during the period of October to November 2016. Thirty-three out of 35 Members responded to the survey (response rate: 33/35 = 94%). A list of participating Members is given in Annex I. Key findings of the survey are summarized below. It should be noted that the analysis of the survey is based on 33 Members' returns and therefore the interpretation of the results has some limitations. The survey form is given in Annex II, with the analyzed result inserted, for reference.

1.4 The Members' responses to the survey questionnaires are attached to this report as Annex III for reference.

## 2. Highlights of survey results

### *2.1 Management*

(1) Eighty-two per cent of Members responded that they had legal basis for the provision of meteorological services, but yet 52 per cent of Members did not implement cost-recovery for the services.

(2) Eighty-two per cent of Members maintained highly-qualified staff with specialized training but compared with the last survey, the percentage has decreased by more than 10 per cent. This is considered due to the difficulty of some Members to put emphasis on capacity development of human resources, and more effort should be put in to assist the remaining NMHSs to maintain high-quality staff. Meanwhile, 73 per cent of Members had access to and use e-learning materials, which might be good education materials.

(3) The percentage of Members which responded that their staff acquired the professional certification in respect of WMO's latest personnel classification scheme has significantly increased from 53 per cent to 70 per cent. This is considered due to Members' efforts to apply WMO's latest classification scheme.

(4) Eighty-five per cent of Members responded that they engaged in continuous education programmes.

(5) Close cooperation with academia and media was very well kept at 91 per cent and 97 per cent, respectively. It is noted that close cooperation with private sector was also high at 88 per cent.

### *2.2 WMO Integrated Global Observing System (WIGOS)*

(1) The percentage of Members which answered 'Yes' to the questions regarding the observation systems in this and the last surveys are summarized in Table 1.

(2) The percentage of Members which implemented reliability measures on quality management routines and procedures of weather observations has remained high at 88 per cent.

(3) Members which delivered the measured observations at remote stations in real-time and those which worked towards enhancement of temporal and spatial coverage of their weather measurements have also remained high at 91 per cent and 88 per cent, respectively. On the other hand, Members carrying out regular maintenance and calibration of observation instruments have decreased from 90 per cent to 84 per cent and the rate of employing qualified maintenance technicians has also decreased from 83 per cent to 75 per cent. It is deemed that regular maintenance of the equipment and employing qualified human resources are one of the challenges for some Members.

(4) While there has been a significant increase of Members which operate weather radars, six Members (Afghanistan, Bhutan, Kyrgyzstan, Nepal, Sri Lanka and Yemen) still do not operate any weather radars, which is an essential observational tool for detecting detailed structure of severe storms and therefore a critical component of the nowcasting system.

(5) There has also been an increase of Members which operated ground stations to receive high-resolution geostationary satellite images (from 77 per cent to 88 per cent), which is considered as a result of the support by satellite operating Members to install such systems. Meanwhile, the number of Members which operated the polar-orbiting satellite receiving systems was still low.

(6) It was shown that the percentage of Members which operated lightning detection networks has stayed low at 25 per cent. Considering that lightning is often related to severe storms and hence to the possibility of disasters, the enhancement of the lightning detection network of the Members would be one of the demanding issues.

(7) The percentage of Members using the service of Regional Instrument Centres (RICs) to ensure the accuracy of the instruments has increased from 47 per cent to 63 per cent. This is considered as a result of active contribution of RICs to the Members in the Region.

***Table 1.*** *Percentage of Members answering 'yes' to the questions regarding maintenance of observation systems*

| Questions | 2011 (%) | 2016 (%) |
|---|---|---|
| II-1. Carries out regular maintenance and calibration of observation instruments | 90 | 84 |
| II-2. Implements reliability measures on quality management routines and procedures of weather observations | 90 | 88 |
| II-3. Implements real-time delivery of measured observations at remote stations | 87 | 91 |
| II-4. Enhances the temporal and spatial coverage of weather measurements | 87 | 88 |
| II-5. Has qualified maintenance technicians | 83 | 75 |

### *2.3 WMO Information System (WIS)*

(1) The speed of GTS connection to the Regional Telecommunication Hub (RTH) was analyzed with three categories: Category I with speed less than 9.6 kbps; Category II between 9.6 and 64 kbps; and Category III over 64 kbps. While 86 per cent

of Members belonged to Category III, two Members (Afghanistan and Iraq) responded that there was no GTS connection with Regional Telecommunication Hubs (RTHs).

(2) Almost all Members were connected to the Internet but two (Kuwait and Kyrgyzstan) responded no operational Internet connection by broadband. Five Members were still running radiofacsimile broadcast of meteorological and oceanographic information.

(3) Seventy-two per cent of Members reported that they benefited from WIS in terms of data exchange, which has been a significant increase of 20 per cent since the last survey. This is considered due to the enhancement in the capability of WIS implementation.

### *2.4 Data-processing and Forecasting System (DPFS) and Disaster Prevention*

(1) Seventy-eight per cent of Members answered that they implemented automatic data reception and archival. In view of the fact that automatic data processing is an essential component of efficient and effective early warning for disaster risk management, further improvement of capability of automatic data processing should be one of priority areas in the Region.

(2) Eighty-four per cent of Members were operating NWP systems and 94 per cent of Members used and interpreted NWP products. The use of a nowcasting system for high-impact weather warning has not yet been applied in more than half the Members (53 per cent).

(3) Members using ensemble prediction system and consensus technique for tropical cyclone forecasting increased from 40 per cent to 53 per cent due to collaboration among Members and in support of WMO/ESCAP Panel on Tropical Cyclones and ESCAP/WMO Typhoon Committee (Table 2).

***Table 2.*** *Percentage of Members answered 'yes' to the questions regarding data-processing and forecasting systems*

| Questions | 2011 (%) | 2016 (%) |
|---|---|---|
| IV-4. Automatic data-processing | 77 | 78 |
| IV-5. Runs NWP model(s) operationally | 67 | 84 |
| IV-6. Has access to NWP products from major centres operationally | 93 | 94 |
| IV-8. Operates a nowcasting system for high impact weather warning | 57 | 47 |
| IV-10. Extends the use of EPS and consensus technique for tropical cyclone forecasting | 40 | 53 |

(4) Ninety-four per cent of Members had links with national disaster managers. Given that 66 per cent of Members had a public education programme for disaster prevention and mitigation, more efforts have to be made for better communication with the public.

### *2.5 Climate and Agricultural Meteorological Services*

(1) Fifty-nine per cent of Members have increased the number of climatological stations and the number of climate variables measured and processed.

(2) Eighty-eight per cent of Members explicitly provided monthly and/or seasonal climate predictions, which has been a significant increase by 22 per cent since the last survey due to the active contribution of Regional Climate Centres (RCCs) and Regional Climate Outlook Forum (RCOF).

(3) Almost all Members responded that they rescued and digitized climate records (Table 3).

(4) Sixty-six per cent of Members provided agrometeorological information, forecasts and agrometeorological services to the user community by promoting practical applications of technological advances. Fifty-nine per cent of Members had monitoring and warning systems for drought (Table 3).

***Table 3.*** *Percentage of Members answered 'yes' to the questions regarding: (a) climate; and (b) agricultural meteorological services*

*(a)*

| Questions | 2011 (%) | 2016 (%) |
|---|---|---|
| VI-1. Increases the number of climatological stations and the number of climate variables measured and processed | 47 | 59 |
| VI-2. Increases the issuance of climatological statistics and indices and make them easily available and delivered to users | 87 | 81 |
| VI-4. Provides monthly/seasonal climate prediction | 66 | 88 |
| VI-11. Rescues and digitizes climate records | 90 | 97 |

*(b)*

| Questions | 2011 (%) | 2016 (%) |
|---|---|---|
| VII-1. Provides agrometeorological information and forecasts to users | 77 | 66 |
| VII-2. Provides agrometeorological services to the user community by promoting practical applications of technological advances | 57 | 66 |
| VII-3. Has monitoring and warning systems for drought | 49 | 59 |

## *2.6 Aeronautical and Marine Meteorological Services*

(1) Ninety-one per cent of Members were designated as the meteorological authority for aviation services and provided flight documentation to airlines with 88 per cent.

(2) The number of Members implementing cost-recovery of services increased from 38 per cent to 44 per cent. Sixty-nine per cent of Members implemented quality management systems meeting ICAO and WMO standards.

(3) The number of Members implementing requirements for personnel by meeting competency increased from 55 per cent to 84 per cent and the number of Members implementing requirements for meeting education and training increased from 52 per cent to 63 per cent. This is considered as a result of cooperation between WMO and ICAO, and Members' efforts to achieve compliance with the ICAO and WMO standards on Quality Management and competency for aeronautical meteorological personnel (Table 4).

***Table 4.*** *Percentage of Members answered 'yes' to the questions regarding aeronautical meteorological services*

| Questions | 2011 (%) | 2016 (%) |
|---|---|---|
| VIII-2. Meteorological authority designated | 88 | 91 |
| VIII-8. Provides flight documentation to airlines | 88 | 88 |
| VIII-9. Cost-recovery of aeronautical meteorological services implemented | 38 | 44 |
| VIII-10. Has in place a quality management system meeting international standards | 41 | 69 |
| VIII-11. Implements WMO-No. 258 requirements for aeronautical meteorological personnel by meeting competency requirements (current deadline is late 2013) | 55 | Fully:50 Partially: 34 |
| VIII-12. Implements WMO-No. 258 requirements for aeronautical meteorological personnel by meeting education and training requirements (current deadline is late 2016) | 52 | 63 |

(4) Seventy-five per cent of Members issued marine forecasts/warnings for coastal waters including sea state and wave/swell. On the other hand, 59 per cent of Members issued marine forecasts/warnings for high seas and 63 per cent of Members issued storm surge warnings.

## *2.7 Hydrological forecasts and assessments*

(1) Some of the questionnaires on this topic are incomplete since the hydrological forecast services are not provided by the national meteorological services in several Members. In this regard, the interpretation of the results is limited. The percentage provided in Annex II (X) is based on the total number of responses received for individual questionnaires, not the total number of 33.

(2) Seventy-six per cent of Members expanded the spatial and temporal coverage of hydrological observation networks and 88 per cent of Members provided services on flood and flash flood warnings. 79 per cent of NMHSs made the efforts for the improvements of adaptation capacity of water resources system in a changing climate.

(3) Eighty-seven per cent of Members improved the capacity for water-related disaster management.

## *2.8 Public Weather Services and Partnership*

(1) Ninety-one per cent of Members operated a website for real-time weather forecasts and warnings, which is quite similar compared with 90 per cent in the previous survey in 2011.

(2) The percentage of Members operating automatic telephone answering systems has increased from 65 per cent to 75 per cent. However, the percentage of Members operating a TV weather forecast programme remained low at 38 per cent. Cooperation with other service providers in the provision of specific weather services or advice may need to be improved.

(3) Thirteen per cent of Members collected and distributed automated meteorological observations from aircraft.

(4) Fifty-nine per cent participated in and used the products of RA II pilot project "Develop Support for NMHSs in Numerical Weather Prediction". Meanwhile, 34 per cent of Members joined the RA II pilot project "Develop Support for NMHSs in the Collection and Application of Aircraft Meteorological Data Relay Data."

## 3. Issues in LDCs in the Region

3.1 As of May 2016, a total of eight Members in the Region were categorized as Least Developed Countries (LDCs) as given in Annex I. All LDCs in the Region responded to the survey questionnaires. The responses from LDCs were analyzed to identify capacities, gaps and needs of LDCs.

3.2 The remarkable gaps in the Region were found in the observational infrastructure of the LDCs as presented in Table 6. Five out of eight LDCs in the Region did not have qualified maintenance technicians. Six out of eight LDCs did not have operational RBSN upper-air stations.

3.3 Four out of eight also had no weather radars. Furthermore no LDCs had operational lighting location network, and only three of them had interaction with Regional Instrument Centres (RICs).

***Table 5.*** *Observational infrastructure for LDCs*

| Questions | AFG | BGD | BTN | KHM | LAO | MYA | NPL | YMD |
|---|---|---|---|---|---|---|---|---|
| II-3. Implement a real-time delivery of measured observations | yes | yes | yes | yes | yes | no | yes | yes |
| II-5. Qualified maintenance technicians | no | yes | no | no | yes | no | no | yes |
| II-9. Operational RBSN upper-air stations | 0 | 15 | 0 | 0 | 0 | 1 | 0 | 0 |
| II-13. Weather radars | 0 | 5 | 0 | 1 | 1 | 2 | 0 | 0 |
| II-17. Operational lighting location network | no | no | no | no | no | no | no | no |
| II-19. Interaction with Regional Instrument Centres (RICs) | no | yes | no | no | yes | no | no | yes |

3.4 Although four out of eight LDCs had systems for automatic data-processing and NWP, seven of them had an access to NWP products from major centres and mostly used and interpreted the NWP products in their forecasting operations as given in Table 7. Training opportunities to develop their capacity on the use of NWP products are, therefore, necessary.

3.5 Two LDCs operated nowcasting systems for high impact weather warning. This showed an improvement since 2011 when no LDCs operated nowcasting systems. Seven out of eight LDCs had strong links with national disaster managers.

***Table 6.*** *Data-processing and forecasting systems for LDCs*

| Questions | AFG | BGD | BTN | KHM | LAO | MYA | NPL | YMD |
|---|---|---|---|---|---|---|---|---|
| IV-4. Systems for automatic data-processing and NWP | no | no | no | yes | yes | no | yes | yes |
| IV-6. Access to NWP products from major centres | no | yes | yes | yes | yes | yes | yes | yes |
| IV-7. Interpret the NWP products in their forecasting operations | no | yes | yes | yes | yes | yes | no | yes |
| IV-8. Operates nowcasting system for high impact weather warning | no | yes | no | yes | no | no | no | no |
| V-1. Strong link with national disaster managers | yes | yes | yes | yes | yes | yes | yes | no |

3.6 Six out of eight LDCs who responded to the survey were designated as the meteorological authority for aviation services, but only two of them implemented cost-recovery services as given in Table 8.

3.7 The number of Members implementing quality management systems meeting ICAO and WMO standards has increased from zero to four. This shows an improvement of quality management systems among LDCs through training and twinning programmes.

***Table 7.*** *Aeronautical meteorological services for LDCs*

| Questions | AFG | BGD | BTN | KHM | LAO | MYA | NPL | YMD |
|---|---|---|---|---|---|---|---|---|
| VIII-2. Designated as the meteorological authority for aviation services | no | yes | yes | no | yes | yes | yes | yes |
| VIII-9. Cost-recovery of aeronautical meteorological services implemented | no | no | no | no | yes | yes | no | no |
| VIII-10. Has in place a quality management system meeting ICAO and WMO standards | yes | yes | no | no | yes | yes | no | no |

## 4. Consideration of regional needs and priorities

4.1 The results of the 2016 survey indicate steady improvement of weather, climate and water services by Members in RA II, but also show the gaps among Members.

4.2 In general, operational observation networks in the Region have been well maintained or enhanced. However there is also a serious concern that the observational infrastructure, such as weather radar, wind profiler and lightning detection networks to detect severe weather phenomena, is far from sufficient in some Members to produce and provide reliable and timely forecast and warning services.

4.3 Most Members operate NWP systems and utilize NWP products from major centres in the forecasting process and implement automatic data reception, archival and data-processing. The number of Members using ensemble prediction systems and consensus techniques for tropical cyclone forecasting has increased significantly but some Members need to improve development, access and usage of NWP guidance material as underlying support to prepare skillful, location-specific weather forecasts for improving service delivery.

4.4 The use of a nowcasting system for high impact weather warning has not yet been applied in many Members. The use of a nowcasting system for high impact weather warning should be urgently enhanced and given the highest priority, while further improvement of capability of automatic data processing should be one of priority areas in the Region.

4.5 There has been a significant increase in the number of Members explicitly providing monthly and/or seasonal climate predictions. It is necessary to strengthen climate services for improved services including climate change, variability and prediction.

4.6 It was also found in many LDCs that they cannot afford to have qualified maintenance technicians for observation instruments and communication infrastructure for real-time delivery of observations. Overall however, there has been an improvement in aeronautical meteorological services in LDCs. The number of Members implementing cost-recovery of services and quality management systems has grown due to improvement of quality management system through training and twinning programmes.

__________

## Annex I: Participating Members in the Survey

| No. | Member | 2016 |
|---|---|---|
| 1 | Afghanistan* | |
| 2 | Bahrain | |
| 3 | Bangladesh* | |
| 4 | Bhutan* | |
| 5 | Cambodia* | |
| 6 | China | |
| 7 | Democratic People’s Republic of Korea | X |
| 8 | Hong Kong, China | |
| 9 | India | |
| 10 | Iran, Islamic Republic of | |
| 11 | Iraq | |
| 12 | Japan | |
| 13 | Kazakhstan | |
| 14 | Kyrgyzstan | |
| 15 | Kuwait | |
| 16 | Lao People's Democratic Republic* | |
| 17 | Macao, China | |
| 18 | Maldives | |
| 19 | Mongolia | |
| 20 | Myanmar* | |
| 21 | Nepal* | |
| 22 | Oman | |
| 23 | Pakistan | |
| 24 | Qatar | |
| 25 | Republic of Korea | |
| 26 | Russian Federation | |
| 27 | Saudi Arabia | |
| 28 | Sri Lanka | |
| 29 | Tajikistan | |
| 30 | Thailand | |
| 31 | Turkmenistan | X |
| 32 | United Arab Emirates | |
| 33 | Uzbekistan | |
| 34 | Vietnam | |
| 35 | Yemen* | |

* Least Developed Countries
X No response

## Annex II: Survey Questionnaire and Results

| **I. Management** | **(%)** |
|---|---|
| 1. Legal basis for provision of meteorological services (Yes/No) | 82 |
| 2. Cost-recovery for services implemented (Yes/No) | 48 |
| 3. Has access to the outline to formulate capacity assessment and development plan (as part of a national strategic plan for the enhanced provision of weather, climate and water services) (Yes/No) | 82 |
| 4. Maintains highly-qualified staff with specialized training (Yes/No) | 82 |
| 5. Has a structured training plan for professional, technical and supporting staff (Yes/No) | 85 |
| 6. Has access to and uses e-learning materials (Yes/No) | 73 |
| 7. Staff acquire professional certification in respect of WMO's latest personnel classification scheme (Yes/No) | 70 |
| 8. Engages in continuous education programmes and refresher courses for staff as well as management training for mid- and high-level personnel (Yes/No) | 85 |
| 9. Cooperates with academia (Yes/No) | 91 |
| 10. Cooperates with media (Yes/No) | 97 |
| 11. Cooperates with private sector (Yes/No) | 88 |

| **II. Observing systems** | **(%)** |
|---|---|
| 1. Carries out regular maintenance and calibration of observation instruments (Yes/No) | 84 |
| 2. Implements reliability measures on quality management routines and procedures of weather observations (Yes/No) | 88 |
| 3. Implements real-time delivery of measured observations at remote stations (Yes/No) | 91 |
| 4. Enhances the temporal and spatial coverage of weather measurements (Yes/No) | 88 |
| 5. Has qualified maintenance technicians (Yes/No) | 75 |
| 6. Number of operational Regional Basic Synoptic Network (RBSN) surface stations* | 2024 |
| 7. Number of automatic weather stations (AWSs)* | 62031 |
| 8. Number of rainfall stations* | 24990 |
| 9. Number of operational RBSN upper-air stations* | 322 |
| 10. Number of operational Regional Basic Climatological Network (RBCN) stations* | 1229 |
| 11. Number of operational GCOS surface stations* | 818 |
| 12. Number of operational GCOS upper-air stations* | 85 |
| 13. Number of operational weather radar stations* | 378 |
| 14. Operates ground station(s) to receive high-resolution images from geostationary meteorological satellites (Yes/No) | 88 |
| 15. Operates ground station(s) to receive high-resolution images from polar-orbiting meteorological satellites (Yes/No) | 53 |
| 16. Number of operational wind profiler stations* | 176 |
| 17. Operates a lightning location network (Yes/No) | 25 |

| | |
|---|---|
| 18. Number of Global Atmospheric Watch (GAW) stations* | 87 |
| 19. Ensures the accuracy of the instruments by using the service of Regional Instrument Centre (RIC) (Yes/No) | 63 |
| 20. Ensures the accuracy of the instruments by using the service of national standards laboratory/institution (Yes/No) | 66 |
| 21. Number of AWSs on green technology for sustainable development* | 59016 |

| **III. Telecommunications** | **(%)** |
|---|---|
| 1. Speed of GTS connection to Regional Telecommunication Hub(s) (Specify the highest speed among all circuits, in bps; No for no connection) | - |
| 2. Connected to Internet by broadband (Yes/No) | 94 |
| 3. Connected to Internet by telephone dial-up (Yes/No) | 16 |
| 4. Still runs radiofacsimile broadcast of meteorological and oceanographic information, i.e., not shifted to more economical modern communication means (Yes/No) | 16 |
| 5. Implements WMO Information System (WIS) (Yes/No) | 78 |
| 6. Benefits from WIS in terms of data and products exchange (Yes/No) | 72 |

| **IV. Data-processing and forecasting systems** | **(%)** |
|---|---|
| 1. Speed of the fastest computer system (GFLOPS) | - |
| 2. Automatic data reception and archival (Yes/No) | 81 |
| 3. Automatic data plotting (Yes/No) | 75 |
| 4. Automatic data-processing (Yes/No) | 78 |
| 5. Runs NWP model(s) operationally (Yes/No) | 84 |
| 6. Has access to NWP products from major centres operationally (Yes/No) | 94 |
| 7. Uses and interprets comprehensive NWP products in forecasting operations (Yes/No) | 94 |
| 8. Operates a nowcasting system for high impact weather warning (Yes/No) | 47 |
| 9. Increases the accuracy, timeliness and usefulness of tropical cyclone forecasts and warnings (Yes/No) | 63 |
| 10. Extends the use of EPS and consensus technique for tropical cyclone forecasting (Yes/No) | 53 |
| 11. Put in practice the principle of free and unrestricted international exchange of data and products among Members (Yes/No) | 75 |

| **V. Natural disaster prevention and mitigation** | **(%)** |
|---|---|
| 1. Links with national disaster managers (Yes/No) | 94 |
| 2. Has a public education programme (Yes/No) | 63 |

| **VI. Climate, climate change and climate variability** | **(%)** |
|---|---|
| 1. Increases the number of climatological stations and the number of climate variables measured and processed (Yes/No) | 59 |
| 2. Increases the issuance of climatological statistics and indices and make them easily available and delivered to users (Yes/No) | 81 |
| 3. Increases the number of users receiving climatological products periodically (Yes/No) | 75 |
| 4. Provides monthly/seasonal climate prediction (Yes/No) | 88 |
| 5. Makes observations to monitor climate change and climate variability (Yes/No) | 72 |
| 6. Provides meteorological and climatological information for the sustainable use and conservation of natural resources (Yes/No) | 88 |
| 7. Makes marine observations and provides data to support global and regional climate studies (Yes/No) | 44 |
| 8. Maintains metadata records for observation stations (Yes/No) | 81 |
| 9. Adopts innovative agrometeorological adaptation strategies in face of climate variability and climate change (Yes/No) | 47 |
| 10. Participates in regional or sub-regional climate research (Yes/No) | 75 |
| 11. Rescues and digitizes climate records (Yes/No) | 97 |

| **VII. Agricultural meteorological services** | **(%)** |
|---|---|
| 1. Provides agrometeorological information and forecasts to users (Yes/No) | 66 |
| 2. Provides agrometeorological services to the user community by promoting practical applications of technological advances (Yes/No) | 66 |
| 3. Has monitoring and warning systems for drought (Yes/No) | 59 |
| 4. Operates early warning system for frost formation (Yes/No) | 59 |
| 5. Operates early warning system for heat waves (Yes/No) | 63 |

| **VIII. Aeronautical meteorological services** | **(%)** |
|---|---|
| 1. Be aeronautical meteorological service provider (AEMSP) (Yes/No) | 81 |
| 2. Meteorological authority designated (Yes/No) | 91 |
| 3. Fully equipped to make and transmit aerodrome meteorological observations (Yes/No) | 75 |
| 4. Issues TAF operationally (Yes/No) | 84 |
| 5. Issues SIGMET operationally (Yes/No) | 75 |
| 6. Receives OPMET data operationally (Yes/No) | 81 |
| 7. Receives WAFS products operationally through other channels (Yes/No) | 81 |
| 8. Provides flight documentation to airlines (Yes/No) | 88 |
| 9. Cost-recovery of aeronautical meteorological services implemented (Yes/No) | 44 |
| 10. Has in place a quality management system meeting international standards (Yes/No) | 69 |
| 11. Implements WMO-No. 258 requirements for aeronautical meteorological personnel by meeting competency requirements (current deadline is late 2013) (Fully/Partially/No) | Fully:50<br>Partially:<br>34 |

| | |
|---|---|
| 12. Implements WMO-No. 258 requirements for aeronautical meteorological personnel by meeting education and training requirements (current deadline is late 2016) (Yes/No) | 63 |
| 13. Verifies aviation forecasts (including TAF) and warnings using a WMO-approved set of methods (Yes/No) | 59 |
| 14. Obtains feedback from aviation users through opinion surveys, user groups, etc. (Yes/No) | 66 |

| **IX. Marine meteorological services and oceanography** | **(%)** |
|---|---|
| 1. Number of operational tide gauges* | 619 |
| 2. Number of operational drifting and moored buoys* | 257 |
| 3. Number of voluntary observing ships (VOS) for meteorological, oceanographic and/or upper-air observations* | 981 |
| 4. Issues marine forecasts/warnings for coastal waters including sea state and wave/swell (Yes/No) | 75 |
| 5. Issues marine forecasts/warnings for high seas (Yes/No) | 59 |
| 6. Issues storm surge warnings (Yes/No) | 63 |
| 7. Runs storm surge model(s) operationally (Yes/No) | 38 |
| 8. Provides support for combating marine pollution (Yes/No) | 50 |
| 9. Provides support for search and rescue (Yes/No) | 66 |
| 10. Number of systems implemented for real-time monitoring of storm surge or tsunami* | 48 |
| 11. Obtains feedback from marine users through opinion surveys, user groups, etc. (Yes/No) | 41 |

| **X. Hydrological forecasts and assessments** | **(%)** |
|---|---|
| 1. Expands the spatial and temporal coverage of hydrological observation networks (Yes/No/Not applicable) | 76 |
| 2. Implements reliability measures for maintenance procedures for measurement and equipment in hydrological stations and for quality control procedures applied on data collected from hydrological stations (Yes/No/Not applicable) | 77 |
| 3. Calculates runoff with quality and accuracy (Yes/No/Not applicable) | 68 |
| 4. Measures changes in river flow in snow/glacier-fed rivers (Yes/No/Not applicable) | 55 |
| 5. Issues flood and flash flood warnings and constantly improves upon them (Yes/No/Not applicable) | 88 |
| 6. Issues landslide/debris flow warnings and constantly improves upon them (Yes/No/Not applicable) | 57 |
| 7. Improves hydrological warnings capability through enhanced and effective cooperation with other NMHSs (Yes/No/Not applicable) | 67 |
| 8. Enhances the preparedness to predict and manage hydrological droughts and the knowledge for decision-making (Yes/No/Not applicable) | 68 |
| 9. Improves the adaptation capacity of water resources systems in a changing climate (Yes/No/Not applicable) | 79 |
| 10. Improves the capacity for water-related disaster management (Yes/No/Not applicable) | 87 |

| **XI. Public weather services** | **(%)** |
|---|---|
| 1. Provides nowcasting of high impact weather (0-6 hours ahead) (Yes/No) | 78 |
| 2. Issues short-range weather forecasts/warnings (6-24 hours ahead) (Yes/No) | 100 |
| 3. Issues medium-range weather forecasts/warnings (1 day–2 weeks ahead) (Yes/No) | 84 |
| 4. Range of public weather forecasts (Days) | - |
| 5. Operates a website for real-time weather information, forecasts and warnings (Yes/No) | 91 |
| 6. Operates and updates a website for the delivery and display of services and products (Yes/No) | 91 |
| 7. Operates an automatic telephone answering system for weather information, forecasts and warnings (Yes/No) | 75 |
| 8. Operates a TV weather programme (Yes/No) | 38 |
| 9. Verifies public forecasts accuracy (Yes/No) | 72 |
| 10. Obtains feedback from users through opinion surveys, user groups, etc. (Yes/No) | 66 |

| **XII. Partnership** | **(%)** |
|---|---|
| 1. Collects and distributes automated meteorological observations from aircraft (Yes/No) | 13 |
| 2. Number of automated meteorological observations from aircraft generated per year* | 11303280 |
| 3. Engages in health-related studies in association with partner organizations (Yes/No) | 56 |
| 4. Engages in socioeconomic studies demonstrating the benefits of meteorological, climatological and hydrological infrastructure, information, products and services (Yes/No) | 63 |
| 5. Contributes operational weather information to WMO's on-line World Weather Information Service (WWIS) (Yes/No) | 75 |
| 6. Number of cities for which weather forecasts are on WWIS* | 482 |
| 7. Supports the exchange of official warnings of severe weather by contributing to WMO's on-line Severe Weather Information Centre (SWIC) (Yes/No) | 44 |
| 8. Joins the RA II Pilot Project to Develop Support for NMHSs in Numerical Weather Prediction (Yes/No) | 59 |
| 9. Joins the RA II Pilot Project on Information Sharing on Climate Services (Yes/No) | 50 |
| 10. Joins the RA II Pilot Project to Develop Support for NMHSs in the Collection and Application of Aircraft Meteorological Data Relay Data (Yes/No) | 34 |
| 11. Joins the RA II Pilot Project to Sustain and Enhance the Capacity of NMHSs in the Provision of Official Weather Forecasts for Medium Range (Yes/No) | 56 |
| 12. Joins the RA II Pilot Project to Enhance the Seamless Provision of Regional Severe Weather Warnings and Advisories (Yes/No) | 50 |

* Total number

## Annex III: Survey Responses

### I. MANAGEMENT (YES/NO)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **AFG** | O | X | O | O | O | X | X | O | O | O | O |
| **BHR** | O | O | O | O | O | O | O | O | O | O | O |
| **BGD** | X | X | X | X | O | O | X | X | O | O | X |
| **BTN** | O | X | O | X | X | X | X | X | X | O | X |
| **KHM** | O | X | O | O | O | X | O | O | O | O | O |
| **CHN** | O | O | O | O | O | O | O | O | O | O | O |
| **HKG** | X | O | O | O | O | O | O | O | O | O | O |
| **IND** | O | X | O | O | O | O | O | O | O | O | O |
| **IRN** | O | X | O | O | O | O | O | O | O | O | O |
| **IRQ** | O | X | O | O | O | X | O | O | O | O | O |
| **JPN** | O | X | O | O | O | X | X | O | O | O | O |
| **KAZ** | O | O | O | O | O | X | X | O | O | O | O |
| **KWT** | X | O | X | O | O | O | O | O | O | O | O |
| **KGZ** | O | O | O | O | O | O | O | O | O | O | O |
| **LAO** | O | O | O | O | O | O | O | O | O | O | O |
| **MAC** | O | X | O | O | O | O | O | X | O | X | X |
| **MDV** | X | X | O | X | X | O | X | X | X | O | O |
| **MNG** | O | O | O | O | O | O | O | O | O | O | O |
| **MYA** | O | X | O | X | O | X | O | O | O | O | O |
| **NPL** | X | X | X | X | X | O | X | O | O | O | X |
| **OMN** | O | O | O | O | O | O | O | O | O | O | O |
| **PAK** | O | O | O | O | O | O | O | O | O | O | O |
| **QAT** | O | O | O | O | O | O | O | O | O | O | O |
| **KOR** | O | X | O | O | O | O | O | O | O | O | O |
| **RUS** | O | O | O | O | O | O | X | O | O | O | O |
| **SAU** | O | X | O | X | O | X | O | O | O | O | O |
| **LKA** | O | X | X | O | X | O | O | O | X | O | O |
| **TJK** | O | O | O | O | X | O | X | O | O | O | O |
| **THA** | O | X | O | O | O | O | O | O | O | O | O |
| **UAE** | O | O | O | O | O | X | O | X | O | O | O |
| **UZB** | O | O | X | O | O | O | O | O | O | O | O |
| **VNM** | O | O | O | O | O | O | O | O | O | O | O |
| **YMD** | X | X | X | O | O | O | X | O | O | O | O |

**QUESTIONS**
1. Legal basis for provision of meteorological services (Yes/No)
2. Cost-recovery for services implemented (Yes/No)
3. Has access to the outline to formulate capacity assessment and development plan (as part of a national strategic plan for the enhanced provision of weather, climate and water services) (Yes/No)
4. Maintains highly-qualified staff with specialized training (Yes/No)
5. Has a structured training plan for professional, technical and supporting staff (Yes/No)
6. Has access to and uses e-learning materials (Yes/No)
7. Staff acquire professional certification in respect of WMO's latest personnel classification scheme (Yes/No)
8. Engages in continuous education programmes and refresher courses for staff as well as management training for mid- and high-level personnel (Yes/No)
9. Cooperates with academia (Yes/No)
10. Cooperates with media (Yes/No)
11. Cooperates with private sector (Yes/No)

YES = O
NO = X

## II. (a) OBSERVING SYSTEMS (YES/NO)

| | 1 | 2 | 3 | 4 | 5 | 14 | 15 | 17 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| **AFG** | X | O | O | X | X | X | X | X | X | X |
| **BHR** | O | O | O | O | O | O | X | X | O | X |
| **BGD** | O | O | O | X | O | O | X | X | O | O |
| **BTN** | O | X | O | O | X | O | X | X | X | X |
| **KHM** | O | X | O | O | X | O | X | X | X | X |
| **CHN** | O | O | O | O | O | O | O | O | O | O |
| **HKG** | O | O | O | O | O | O | O | O | O | O |
| **IND** | O | O | X | O | O | O | O | X | O | O |
| **IRN** | O | O | O | O | O | O | O | X | O | O |
| **IRQ** | O | O | O | O | O | X | O | X | O | O |
| **JPN** | O | O | O | O | O | O | O | O | O | O |
| **KAZ** | O | O | O | O | O | X | X | X | X | O |
| **KWT** | O | O | O | O | O | O | O | X | X | X |
| **KGZ** | X | O | O | O | O | O | O | X | X | O |
| **LAO** | O | O | O | O | O | O | X | X | O | O |
| **MAC** | O | O | O | O | X | O | X | O | X | X |
| **MDV** | X | O | O | O | X | O | X | X | X | X |
| **MNG** | O | O | O | O | O | O | O | X | O | O |
| **MYA** | X | O | X | X | X | O | X | X | X | O |
| **NPL** | X | X | O | O | X | X | X | X | X | X |
| **OMN** | O | O | O | O | O | O | O | O | O | O |
| **PAK** | O | O | O | O | O | O | X | X | X | X |
| **QAT** | O | O | O | O | O | O | O | X | O | O |
| **KOR** | O | O | O | O | O | O | O | O | O | O |
| **RUS** | O | O | O | O | O | O | O | O | O | O |
| **SAU** | O | O | O | O | O | O | O | X | O | X |
| **LKA** | O | O | O | O | O | O | X | X | O | X |
| **TJK** | | | | | | | | | | |
| **THA** | O | O | O | O | O | O | O | O | O | O |
| **UAE** | O | O | O | O | O | O | O | X | O | O |
| **UZB** | O | X | O | O | O | O | O | X | X | O |
| **VNM** | O | O | X | O | X | O | X | X | O | O |
| **YMD** | O | O | O | X | O | O | X | X | O | O |

**QUESTIONS**
1. Carries out regular maintenance and calibration of observation instruments (Yes/No)
2. Implements reliability measures on quality management routines and procedures of weather observations (Yes/No)
3. Implements real-time delivery of measured observations at remote stations (Yes/No)
4. Enhances the temporal and spatial coverage of weather measurements (Yes/No)
5. Has qualified maintenance technicians (Yes/No)
14. Operates ground station(s) to receive high-resolution images from geostationary meteorological satellites (Yes/No)
15. Operates ground station(s) to receive high-resolution images from polar-orbiting meteorological satellites (Yes/No)
17. Operates a lightning location network (Yes/No)
19. Ensures the accuracy of the instruments by using the service of Regional Instrument Centre (RIC) (Yes/No)
20. Ensures the accuracy of the instruments by using the service of national standards laboratory/institution (Yes/No)

---

YES = O
NO = X

## II. (b) OBSERVING SYSTEMS (NUMBERS)

| | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 16 | 18 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AFG | 21 | 5 | 26 | 0 | 26 | 0 | 0 | 0 | 26 | 0 | 0 |
| BHR | 1 | 4 | 5 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |
| BGD | 42 | 32 | 58 | 15 | 10 | 10 | 4 | 5 | 0 | 0 | 0 |
| BTN | 1 | 22 | 80 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| KHM | 0 | 35 | 105 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CHN | 220 | 57427 | 15658 | 88 | 81 | 32 | 7 | 190 | 31 | 4 | 57427 |
| HKG | 1 | 120 | 180 | 1 | 1 | 0 | 1 | 5 | 4 | 2 | 50 |
| IND | 89 | 679 | 1350 | 44 | 66 | 21 | 6 | 24 | 0 | 10 | 679 |
| IRN | 77 | 325 | 2450 | 10 | 13 | 7 | 1 | 9 | 1 | 1 | 445 |
| IRQ | 49 | 8 | 15 | 2 | 1 | 0 | 0 | 2 | 0 | 0 | 3 |
| JPN | 52 | 931 | 373 | 16 | 52 | 13 | 6 | 20 | 33 | 6 | 0 |
| KAZ | 66 | 132 | 328 | 9 | 44 | 13 | 9 | 1 | 0 | 0 | 21 |
| KWT | 8 | 28 | 22 | 1 | 28 | 28 | 28 | 1 | 28 | 0 | 0 |
| KGZ | 28 | 24 | 28 | 1 | 28 | 28 | 1 | 0 | 28 | 1 | 24 |
| LAO | 22 | 44 | 119 | 0 | 27 | 0 | 0 | 1 | 0 | 0 | 44 |
| MAC | 1 | 15 | 15 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 0 |
| MDV | 5 | 18 | 7 | 1 | 5 | 5 | 1 | 1 | 0 | 5 | 0 |
| MNG | 135 | 140 | 316 | 4 | 316 | 316 | 4 | 1 | 0 | 1 | 10 |
| MYA | 51 | 47 | 120 | 1 | 5 | 4 | 0 | 2 | 0 | 0 | 47 |
| NPL | 15 | 20 | 400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OMN | 70 | 70 | 70 | 2 | 70 | 70 | 2 | 4 | 2 | 0 | 0 |
| PAK | 36 | 50 | 400 | 15 | 100 | 56 | 0 | 5 | 1 | 1 | 50 |
| QAT | 1 | 19 | 44 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 40 |
| KOR | 44 | 585 | 585 | 5 | 11 | 3 | 1 | 10 | 9 | 6 | 0 |
| RUS | 579 | 300 | - | 78 | 183 | 109 | 10 | 38 | 0 | 48 | 150 |
| SAU | 28 | 155 | 375 | 8 | 34 | 6 | 1 | 12 | 1 | 0 | 16 |
| LKA | 23 | 38 | 450 | 4 | 17 | 5 | 0 | 0 | 0 | 0 | 0 |
| TJK | | | | | | | | | | | |
| THA | 87 | 91 | 979 | 11 | 13 | 6 | 2 | 26 | 1 | 2 | 0 |
| UAE | 6 | 50 | 30 | 1 | 3 | 2 | 0 | 5 | 0 | 0 | 4 |
| UZB | 66 | 11 | 81 | 0 | 21 | 81 | 0 | 3 | 0 | 0 | 0 |
| VNM | 180 | 600 | 300 | 4 | 51 | 0 | 0 | 8 | 7 | 0 | 0 |
| YMD | 20 | 6 | 21 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 6 |

**QUESTIONS**

6. Number of operational Regional Basic Synoptic Network (RBSN) surface stations
7. Number of automatic weather stations (AWSs)
8. Number of rainfall stations
9. Number of operational RBSN upper-air stations*
10. Number of operational Regional Basic Climatological Network (RBCN) stations
11. Number of operational GCOS surface stations
12. Number of operational GCOS upper-air stations
13. Number of operational weather radar stations
16. Number of operational wind profiler stations
18. Number of Global Atmospheric Watch (GAW) stations
21. Number of AWSs on green technology for sustainable development

### III. (a) TELECOMMUNICATION (YES/NO)

| | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| **AFG** | O | X | O | O | X |
| **BHR** | O | X | X | O | X |
| **BGD** | O | X | X | X | X |
| **BTN** | O | X | O | O | O |
| **KHM** | O | X | X | O | X |
| **CHN** | O | X | X | O | O |
| **HKG** | O | X | X | O | O |
| **IND** | O | X | X | O | O |
| **IRN** | O | X | X | O | O |
| **IRQ** | O | X | X | X | X |
| **JPN** | O | X | O | O | O |
| **KAZ** | O | O | O | X | X |
| **KWT** | X | X | X | O | O |
| **KGZ** | X | X | X | X | O |
| **LAO** | O | X | X | O | O |
| **MAC** | O | X | X | O | O |
| **MDV** | O | X | X | O | O |
| **MNG** | O | O | X | X | X |
| **MYA** | O | X | X | O | O |
| **NPL** | O | O | X | X | X |
| **OMN** | O | X | X | O | X |
| **PAK** | O | O | X | O | O |
| **QAT** | O | X | X | O | O |
| **KOR** | O | X | X | O | O |
| **RUS** | O | X | X | O | O |
| **SAU** | O | X | X | O | O |
| **LKA** | O | X | X | X | O |
| **TJK** | | | | | |
| **THA** | O | X | O | O | O |
| **UAE** | O | X | X | O | O |
| **UZB** | O | X | X | O | O |
| **VNM** | O | X | X | O | O |
| **YMD** | O | O | X | O | O |

**QUESTIONS**
2. Connected to Internet by broadband (Yes/No)
3. Connected to Internet by telephone dial-up (Yes/No)
4. Still runs radiofacsimile broadcast of meteorological and oceanographic information, i.e., not shifted to more economical modern communication means (Yes/No)
5. Implements WMO Information System (WIS) (Yes/No)
6. Benefits from WIS in terms of data and products exchange (Yes/No)

### III. (b) TELECOMMUNICATION (NUMBERS)

| | 1 |
|---|---|
| **AFG** | No |
| **BHR** | 9600 |
| **BGD** | 64K |
| **BTN** | 1M |
| **KHM** | 2M |
| **CHN** | 16M |
| **HKG** | 4M |
| **IND** | 1G |
| **IRN** | 50M |
| **IRQ** | No |
| **JPN** | 10M |
| **KAZ** | 64K |
| **KWT** | 64K |
| **KGZ** | 5M |
| **LAO** | 128K |
| **MAC** | 2M |
| **MDV** | 10M |
| **MNG** | 64K |
| **MYA** | 2M |
| **NPL** | 3M |
| **OMN** | 64K |
| **PAK** | 128K |
| **QAT** | 16K |
| **KOR** | 4M |
| **RUS** | ---- |
| **SAU** | 2M |
| **LKA** | 256K |
| **TJK** | |
| **THA** | 128K |
| **UAE** | 32M |
| **UZB** | 64K |
| **VNM** | 64K |
| **YMD** | 256K |

**QUESTION**
1. Speed of GTS connection to Regional Telecommunication Hub(s) (Specify the highest speed among all circuits, in bps; No for no connection)

YES = O
NO = X

## IV. (a) DATA-PROCESSING AND FORECASTING SYSTEMS (YES/NO)

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **AFG** | X | X | X | X | X | X | X | X | X | X |
| **BHR** | O | O | O | O | O | O | O | O | O | O |
| **BGD** | X | O | X | O | O | O | O | O | O | X |
| **BTN** | X | X | X | O | O | O | X | X | O | O |
| **KHM** | O | X | O | X | O | O | O | O | X | X |
| **CHN** | O | O | O | O | O | O | O | O | O | O |
| **HKG** | O | O | O | O | O | O | O | O | O | O |
| **IND** | O | O | O | O | O | O | O | O | O | O |
| **IRN** | O | O | O | O | O | O | O | X | X | O |
| **IRQ** | O | O | X | X | X | O | X | X | X | X |
| **JPN** | O | O | O | O | O | O | O | O | O | O |
| **KAZ** | O | O | O | O | O | O | X | X | X | X |
| **KWT** | O | O | O | O | O | O | X | X | X | O |
| **KGZ** | O | O | O | O | O | O | X | X | X | O |
| **LAO** | O | X | O | X | O | O | X | O | O | O |
| **MAC** | O | O | O | O | O | O | X | O | O | X |
| **MDV** | X | O | X | O | O | O | X | X | X | O |
| **MNG** | O | O | O | O | O | O | O | X | X | O |
| **MYA** | X | X | X | O | O | O | X | O | O | X |
| **NPL** | O | X | O | O | O | X | X | X | X | O |
| **OMN** | O | O | O | O | O | O | X | O | O | O |
| **PAK** | O | O | O | O | O | O | O | O | O | O |
| **QAT** | O | O | O | O | O | O | O | X | X | O |
| **KOR** | O | X | O | O | O | O | O | O | O | O |
| **RUS** | O | O | O | O | O | O | O | O | X | O |
| **SAU** | O | O | O | O | O | O | O | X | X | O |
| **LKA** | X | O | O | O | O | O | X | O | O | X |
| **TJK** | | | | | | | | | | |
| **THA** | O | X | O | O | O | O | X | O | O | O |
| **UAE** | O | O | O | O | O | O | O | O | O | O |
| **UZB** | O | O | X | O | O | O | X | O | X | O |
| **VNM** | O | O | O | O | O | O | X | O | O | O |
| **YMD** | O | O | O | X | O | O | X | O | X | O |

**QUESTIONS**
2. Automatic data reception and archival (Yes/No)
3. Automatic data plotting (Yes/No)
4. Automatic data-processing (Yes/No)
5. Runs NWP model(s) operationally (Yes/No)
6. Has access to NWP products from major centres operationally (Yes/No)
7. Uses and interprets comprehensive NWP products in forecasting operations (Yes/No)
8. Operates a nowcasting system for high impact weather warning (Yes/No)
9. Increases the accuracy, timeliness and usefulness of tropical cyclone forecasts and warnings (Yes/No)
10. Extends the use of EPS and consensus technique for tropical cyclone forecasting (Yes/No)
11. Put in practice the principle of free and unrestricted international exchange of data and products among Members (Yes/No)

______________________________

YES = O
NO = X

## IV. (b) DATA-PROCESSING AND FORECASTING SYSTEMS (NUMBERS)

| | 1 |
|---|---|
| **AFG** | Core i3, 2gb ram but in near future we will have access to last generation of computers which is a part of WMO on-going project |
| **BHR** | 8.809 GFLOPS |
| **BGD** | 3.5 TFLOPS |
| **BTN** | |
| **KHM** | 13 GFLOPS |
| **CHN** | 1054000 GFLOPS |
| **HKG** | 18700 GFLOPS |
| **IND** | 1.2 PFLOPS |
| **IRN** | 14 TFLOPS |
| **IRQ** | |
| **JPN** | 847000 GFLOPS |
| **KAZ** | 0.5 TFLOPS |
| **KWT** | |
| **KGZ** | |
| **LAO** | 6 GFLOPS |
| **MAC** | 500 GFLOPS |
| **MDV** | 2.4 GFLOPS |
| **MNG** | 6.5 GFLOPS |
| **MYA** | |
| **NPL** | |
| **OMN** | 4600 GFLOPS |
| **PAK** | 3.6 TFLOPS |
| **QAT** | 64 GFLOPS |
| **KOR** | 2,900,000 GFLOPS |
| **RUS** | 35000 GFLOPS |
| **SAU** | 2060 GFLOPS |
| **LKA** | |
| **TJK** | |
| **THA** | 7.488 GFLOPS |
| **UAE** | 30GFLOPS |
| **UZB** | 411 GFLOPS |
| **VNM** | 2 TFLOPS -> 70 TFLOPS(2017-2018) |
| **YMD** | |

**QUESTION**
1. Speed of the fastest computer system

## V. NATURAL DISASTER PREVENTION AND MITIGATION (YES/NO)

| | 1 | 2 |
|---|---|---|
| **AFG** | O | X |
| **BHR** | O | O |
| **BGD** | O | O |
| **BTN** | O | O |
| **KHM** | O | X |
| **CHN** | O | O |
| **HKG** | O | O |
| **IND** | O | O |
| **IRN** | O | O |
| **IRQ** | O | O |
| **JPN** | O | O |
| **KAZ** | O | X |
| **KWT** | X | X |
| **KGZ** | O | O |
| **LAO** | O | X |
| **MAC** | O | O |
| **MDV** | O | O |
| **MNG** | O | X |
| **MYA** | O | O |
| **NPL** | O | X |
| **OMN** | O | O |
| **PAK** | O | O |
| **QAT** | O | O |
| **KOR** | O | O |
| **RUS** | O | X |
| **SAU** | O | X |
| **LKA** | O | O |
| **TJK** | | |
| **THA** | O | O |
| **UAE** | O | X |
| **UZB** | O | O |
| **VNM** | O | X |
| **YMD** | X | X |

**QUESTIONS**
1. Links with national disaster managers (Yes/No)
2. Has a public education programme (Yes/No)

---
YES = O
NO = X

**VI. CLIMATE, CLIMATE CHANGE AND CLIMATE VARIABILITY** (YES/NO)

| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **AFG** | X | O | X | O | X | O | X | O | X | O | O |
| **BHR** | X | O | O | O | O | O | X | O | X | O | O |
| **BGD** | O | O | O | O | X | O | X | O | X | O | O |
| **BTN** | O | O | X | O | X | O | X | X | X | X | O |
| **KHM** | X | X | X | O | X | O | X | O | X | X | O |
| **CHN** | O | O | O | O | O | O | O | O | O | O | O |
| **HKG** | O | O | O | O | O | O | O | O | O | O | O |
| **IND** | O | O | O | O | O | O | O | O | O | O | O |
| **IRN** | O | O | O | O | O | O | O | O | O | O | O |
| **IRQ** | O | X | O | O | O | O | X | O | X | X | O |
| **JPN** | X | O | O | O | O | O | O | O | X | O | O |
| **KAZ** | X | X | O | O | O | X | O | O | X | O | O |
| **KWT** | O | O | O | O | O | O | O | O | O | O | O |
| **KGZ** | O | X | X | X | O | O | X | X | X | O | O |
| **LAO** | O | O | O | O | X | O | X | O | O | X | O |
| **MAC** | X | X | X | O | O | X | X | O | X | O | O |
| **MDV** | X | O | O | O | O | O | X | O | X | X | O |
| **MNG** | X | X | X | O | O | X | X | O | O | O | O |
| **MYA** | O | O | O | O | O | O | X | O | O | O | O |
| **NPL** | O | O | O | O | O | O | X | X | X | O | O |
| **OMN** | O | O | O | X | X | O | O | O | X | X | O |
| **PAK** | O | O | O | O | O | O | O | O | O | O | O |
| **QAT** | O | O | O | O | O | O | O | O | X | O | O |
| **KOR** | X | O | O | O | O | X | O | O | O | O | O |
| **RUS** | X | O | O | O | O | O | O | O | O | O | O |
| **SAU** | X | O | X | O | X | O | X | X | X | O | O |
| **LKA** | O | O | O | O | O | O | X | O | O | O | O |
| **TJK** | | | | | | | | | | | |
| **THA** | X | O | O | O | O | O | O | O | O | O | O |
| **UAE** | O | O | O | X | X | O | O | X | X | X | O |
| **UZB** | X | O | O | O | O | O | X | X | O | O | O |
| **VNM** | O | O | O | O | O | O | X | O | O | O | X |
| **YMD** | O | O | X | X | X | O | X | O | X | X | O |

**QUESTIONS**
1. Increases the number of climatological stations and the number of climate variables measured and processed (Yes/No)
2. Increases the issuance of climatological statistics and indices and make them easily available and delivered to users (Yes/No)
3. Increases the number of users receiving climatological products periodically (Yes/No)
4. Provides monthly/seasonal climate prediction (Yes/No)
5. Makes observations to monitor climate change and climate variability (Yes/No)
6. Provides meteorological and climatological information for the sustainable use and conservation of natural resources (Yes/No)
7. Makes marine observations and provides data to support global and regional climate studies (Yes/No)
8. Maintains metadata records for observation stations (Yes/No)
9. Adopts innovative agrometeorological adaptation strategies in face of climate variability and climate change (Yes/No)
10. Participates in regional or sub-regional climate research (Yes/No)
11. Rescues and digitizes climate records (Yes/No)

---

YES = O
NO = X

### VII. AGRICULTURAL METEOROLOGICAL SERVICES (YES/NO)

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **AFG** | X | X | X | X | O |
| **BHR** | X | X | X | X | X |
| **BGD** | O | O | O | X | O |
| **BTN** | X | X | X | X | X |
| **KHM** | X | X | O | X | O |
| **CHN** | O | O | O | O | O |
| **HKG** | O | O | O | O | O |
| **IND** | O | O | O | O | O |
| **IRN** | O | O | O | O | O |
| **IRQ** | O | O | X | X | X |
| **JPN** | O | O | O | O | O |
| **KAZ** | O | O | O | O | O |
| **KWT** | O | X | O | O | O |
| **KGZ** | O | O | X | O | X |
| **LAO** | O | O | O | O | O |
| **MAC** | X | X | X | X | X |
| **MDV** | X | X | X | X | X |
| **MNG** | O | O | O | O | O |
| **MYA** | O | O | O | X | X |
| **NPL** | X | O | X | O | O |
| **OMN** | X | X | X | X | X |
| **PAK** | O | O | O | O | O |
| **QAT** | O | O | X | X | O |
| **KOR** | O | O | O | O | O |
| **RUS** | O | O | O | O | O |
| **SAU** | X | X | O | X | O |
| **LKA** | O | O | O | O | X |
| **TJK** | | | | | |
| **THA** | O | O | O | O | X |
| **UAE** | X | X | X | X | X |
| **UZB** | O | O | X | O | X |
| **VNM** | O | O | O | O | O |
| **YMD** | X | X | X | O | O |

**QUESTIONS**
1. Provides agrometeorological information and forecasts to users (Yes/No)
2. Provides agrometeorological services to the user community by promoting practical applications of technological advances (Yes/No)
3. Has monitoring and warning systems for drought (Yes/No)
4. Operates early warning system for frost formation (Yes/No)
5. Operates early warning system for heat waves (Yes/No)

YES = O
NO = X

## VIII. AERONAUTICAL METEROLOGICAL SERVICES (YES/NO)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AFG** | X | O | X | X | X | X | X | O | X | O | Partially | X | O | X |
| **BHR** | O | O | O | O | O | O | O | O | O | O | Fully | O | O | O |
| **BGD** | O | O | O | O | O | O | O | O | X | O | Partially | X | O | O |
| **BTN** | O | O | X | X | X | X | X | O | X | X | X | X | X | X |
| **KHM** | X | X | X | X | X | O | O | X | X | X | X | X | X | X |
| **CHN** | O | O | O | O | O | O | O | O | O | O | Fully | O | O | O |
| **HKG** | O | O | O | O | O | O | O | O | O | O | Fully | O | O | O |
| **IND** | O | O | O | O | O | O | O | O | O | O | Fully | O | O | O |
| **IRN** | O | O | O | O | O | O | O | O | X | O | Partially | O | O | O |
| **IRQ** | X | O | O | O | O | O | X | O | X | X | X | O | O | X |
| **JPN** | O | O | O | O | O | O | O | O | O | O | Fully | O | X | O |
| **KAZ** | X | X | X | O | X | X | X | X | X | X | X | X | X | X |
| **KWT** | O | O | O | O | O | O | O | O | O | O | Fully | O | O | X |
| **KGZ** | X | O | X | X | X | X | X | X | X | X | X | X | X | X |
| **LAO** | O | O | X | O | O | O | O | O | O | O | Fully | X | X | O |
| **MAC** | O | O | O | O | X | O | O | O | X | O | Fully | O | X | O |
| **MDV** | O | O | O | O | O | O | O | O | X | X | Partially | X | X | O |
| **MNG** | O | O | O | O | O | O | O | O | X | O | Fully | O | O | O |
| **MYA** | O | O | X | O | O | O | O | O | O | O | Partially | O | O | O |
| **NPL** | O | O | O | O | O | X | O | O | X | X | Partially | X | X | O |
| **OMN** | O | O | O | O | O | O | O | O | O | X | Partially | O | X | O |
| **PAK** | O | O | O | O | O | O | O | O | O | O | Fully | O | X | X |
| **QAT** | O | O | O | O | X | O | O | O | X | O | Partially | O | O | O |
| **KOR** | O | O | O | O | O | O | O | O | O | O | Fully | O | O | O |
| **RUS** | O | O | O | O | O | O | O | O | O | O | Fully | O | O | O |
| **SAU** | O | O | O | O | O | O | O | O | X | O | Partially | O | O | O |
| **LKA** | O | O | O | O | O | O | O | O | X | X | Fully | O | X | X |
| **TJK** | | | | | | | | | | | | | | |
| **THA** | O | O | O | O | O | O | O | O | X | O | Partially | X | O | O |
| **UAE** | O | O | O | O | O | O | O | O | O | O | Fully | O | O | O |
| **UZB** | O | O | O | O | O | O | O | O | O | O | Fully | O | O | O |
| **VNM** | X | X | X | X | X | X | X | X | X | O | Fully | X | X | X |
| **YMD** | O | O | O | O | O | O | O | O | X | X | Partially | X | O | X |

**QUESTIONS**
1. Be aeronautical meteorological service provider (AEMSP) (Yes/No)
2. Meteorological authority designated (Yes/No)
3. Fully equipped to make and transmit aerodrome meteorological observations (Yes/No)
4. Issues TAF operationally (Yes/No)
5. Issues SIGMET operationally (Yes/No)
6. Receives OPMET data operationally (Yes/No)
7. Receives WAFS products operationally through other channels (Yes/No)
8. Provides flight documentation to airlines (Yes/No)
9. Cost-recovery of aeronautical meteorological services implemented (Yes/No)
10. Has in place a quality management system meeting international standards (Yes/No)
11. Implements WMO-No. 258 requirements for aeronautical meteorological personnel by meeting competency requirements (current deadline is late 2013) (Fully/Partially/No)
12. Implements WMO-No. 258 requirements for aeronautical meteorological personnel by meeting education and training requirements (current deadline is late 2016) (Yes/No)
13. Verifies aviation forecasts (including TAF) and warnings using a WMO-approved set of methods (Yes/No)
14. Obtains feedback from aviation users through opinion surveys, user groups, etc. (Yes/No)

YES = O
NO = X

**IX. a) MARINE METEROLOGICAL SERVICES AND OCEANOGRAPHY** (YES/NO)

| | 4 | 5 | 6 | 7 | 8 | 9 | 11 |
|---|---|---|---|---|---|---|---|
| **AFG** | X | X | X | X | X | X | X |
| **BHR** | O | O | X | X | X | O | O |
| **BGD** | O | X | O | O | X | X | X |
| **BTN** | X | X | X | X | X | X | X |
| **KHM** | O | X | O | X | X | X | X |
| **CHN** | O | O | O | X | O | O | O |
| **HKG** | O | O | O | O | O | O | O |
| **IND** | O | O | O | O | X | O | O |
| **IRN** | O | O | X | X | O | O | O |
| **IRQ** | X | X | X | X | X | X | X |
| **JPN** | O | O | O | O | O | O | O |
| **KAZ** | O | O | O | O | O | O | O |
| **KWT** | O | O | O | X | O | O | X |
| **KGZ** | X | X | X | X | X | X | X |
| **LAO** | X | X | X | X | X | X | X |
| **MAC** | O | X | O | O | X | O | X |
| **MDV** | O | O | O | X | O | O | X |
| **MNG** | X | X | X | X | X | X | X |
| **MYA** | O | O | O | O | X | O | O |
| **NPL** | X | X | X | X | X | X | X |
| **OMN** | O | X | O | O | O | O | X |
| **PAK** | O | O | O | X | O | O | X |
| **QAT** | O | O | O | X | O | O | O |
| **KOR** | O | O | O | O | O | O | O |
| **RUS** | O | O | O | X | O | O | X |
| **SAU** | O | X | X | X | O | O | O |
| **LKA** | O | O | O | O | O | O | X |
| **TJK** | | | | | | | |
| **THA** | O | O | O | O | X | O | O |
| **UAE** | O | O | O | X | O | O | O |
| **UZB** | X | X | X | X | X | X | X |
| **VNM** | O | O | O | O | X | X | X |
| **YMD** | O | O | X | X | O | O | X |

**QUESTIONS**
4. Issues marine forecasts/warnings for coastal waters including sea state and wave/swell (Yes/No)
5. Issues marine forecasts/warnings for high seas (Yes/No)
6. Issues storm surge warnings (Yes/No)
7. Runs storm surge model(s) operationally (Yes/No)
8. Provides support for combating marine pollution (Yes/No)
9. Provides support for search and rescue (Yes/No)
11. Obtains feedback from marine users through opinion surveys, user groups, etc. (Yes/No)

**IX. (b) MARINE METEROLOGICAL SERVICES AND OCEANOGRAPHY** (NUMBERS)

| | 1 | 2 | 3 | 10 |
|---|---|---|---|---|
| **AFG** | 0 | 0 | 0 | 0 |
| **BHR** | 0 | 0 | 0 | 0 |
| **BGD** | 0 | 0 | 0 | 0 |
| **BTN** | 0 | 0 | 0 | 0 |
| **KHM** | 0 | 0 | 0 | 0 |
| **CHN** | 119 | 33 | 49 | 1 |
| **HKG** | 11 | 11 | 65 | 2 |
| **IND** | 21 | 121 | 2 | 2 |
| **IRN** | 0 | 6 | 2 | 0 |
| **IRQ** | 1 | 0 | 0 | 0 |
| **JPN** | 69 | 4 | 584 | 2 |
| **KAZ** | 0 | 0 | 0 | 7 |
| **KWT** | 8 | 5 | 0 | 0 |
| **KGZ** | 0 | 0 | 0 | 0 |
| **LAO** | 0 | 0 | 0 | 0 |
| **MAC** | 2 | 0 | 0 | 2 |
| **MDV** | 3 | 0 | 0 | 0 |
| **MNG** | 0 | 0 | 0 | 0 |
| **MYA** | 6 | 0 | 0 | 3 |
| **NPL** | 0 | 0 | 0 | 0 |
| **OMN** | 10 | 0 | 0 | 2 |
| **PAK** | 0 | 0 | 0 | 2 |
| **QAT** | 1 | 2 | 0 | 0 |
| **KOR** | 0 | 66 | 31 | 18 |
| **RUS** | 62 | 6 | 113 | 1 |
| **SAU** | 0 | 0 | 135 | 0 |
| **LKA** | 3 | 0 | 0 | 3 |
| **TJK** | | | | |
| **THA** | 0 | 0 | 0 | 3 |
| **UAE** | 3 | 3 | 0 | 0 |
| **UZB** | 0 | 0 | 0 | 0 |
| **VNM** | 300 | 0 | 0 | 0 |
| **YMD** | 0 | 0 | 0 | 0 |

**QUESTIONS**
1. Number of operational tide gauges
2. Number of operational drifting and moored buoys
3. Number of voluntary observing ships (VOS) for meteorological, oceanographic and/or upper-air observations
10. Number of systems implemented for real-time monitoring of storm surge or tsunami

YES = O
NO = X

## X. HYDROLOGICAL FORECASTS AND ASSESSMENTS (YES/NO)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **AFG** | X | X | X | X | X | X | X | O | X | X |
| **BHR** | - | - | - | - | - | - | - | - | - | - |
| **BGD** | O | O | O | X | O | X | O | X | O | O |
| **BTN** | O | O | O | X | O | X | O | X | O | O |
| **KHM** | X | X | X | X | X | X | X | X | X | X |
| **CHN** | O | O | O | O | O | O | O | O | O | O |
| **HKG** | O | O | X | - | O | O | O | O | O | O |
| **IND** | O | - | - | - | - | - | O | O | O | O |
| **IRN** | O | O | O | O | O | O | O | O | O | O |
| **IRQ** | O | O | X | X | X | X | X | O | - | - |
| **JPN** | O | O | O | O | O | O | O | O | X | O |
| **KAZ** | X | X | X | X | O | O | O | O | O | O |
| **KWT** | - | - | - | - | - | - | - | - | - | - |
| **KGZ** | O | O | O | O | O | O | O | O | O | O |
| **LAO** | O | O | O | O | O | O | O | O | O | O |
| **MAC** | O | X | X | - | O | X | X | X | - | O |
| **MDV** | - | - | - | - | - | - | - | - | - | O |
| **MNG** | X | O | O | O | O | O | X | X | X | X |
| **MYA** | O | O | O | X | O | - | - | - | O | O |
| **NPL** | O | O | O | O | O | X | X | X | O | O |
| **OMN** | - | - | - | - | O | - | - | - | - | - |
| **PAK** | O | O | O | O | O | O | O | O | - | O |
| **QAT** | - | - | - | - | - | - | - | - | - | - |
| **KOR** | - | - | - | - | O | - | - | O | - | O |
| **RUS** | O | O | O | O | O | O | O | O | - | - |
| **SAU** | X | - | - | - | O | - | X | X | - | - |
| **LKA** | O | - | - | - | O | O | O | O | O | O |
| **TJK** | | | | | | | | | | |
| **THA** | O | O | O | X | O | X | X | O | O | - |
| **UAE** | X | X | X | X | O | X | O | X | O | O |
| **UZB** | O | O | O | O | O | - | O | O | - | O |
| **VNM** | O | O | O | O | O | O | O | O | O | O |
| **YMD** | - | - | - | - | - | - | - | - | - | - |

**QUESTIONS**
1. Expands the spatial and temporal coverage of hydrological observation networks (Yes/No/Not applicable)
2. Implements reliability measures for maintenance procedures for measurement and equipment in hydrological stations and for quality control procedures applied on data collected from hydrological stations (Yes/No/Not applicable)
3. Calculates runoff with quality and accuracy (Yes/No/Not applicable)
4. Measures changes in river flow in snow/glacier-fed rivers (Yes/No/Not applicable)
5. Issues flood and flash flood warnings and constantly improves upon them (Yes/No/Not applicable)
6. Issues landslide/debris flow warnings and constantly improves upon them (Yes/No/Not applicable)
7. Improves hydrological warnings capability through enhanced and effective cooperation with other NMHSs (Yes/No/Not applicable)
8. Enhances the preparedness to predict and manage hydrological droughts and the knowledge for decision-making (Yes/No/Not applicable)
9. Improves the adaptation capacity of water resources systems in a changing climate (Yes/No/Not applicable)
10. Improves the capacity for water-related disaster management (Yes/No/Not applicable)

---
YES = O
NO = X
NOT APPLICABLE = -

## XI. a) PUBLIC WEATHER SERVICES (YES/NO)

| | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| **AFG** | X | O | O | X | X | X | X | X | X |
| **BHR** | O | O | O | O | O | O | O | O | O |
| **BGD** | O | O | O | O | O | O | O | X | X |
| **BTN** | X | O | X | O | O | O | X | X | X |
| **KHM** | O | O | O | O | X | X | X | O | X |
| **CHN** | O | O | O | O | O | O | O | O | O |
| **HKG** | O | O | O | O | O | O | O | O | O |
| **IND** | O | O | O | O | O | O | X | X | O |
| **IRN** | O | O | O | O | O | O | O | O | O |
| **IRQ** | X | O | O | O | O | O | X | X | X |
| **JPN** | O | O | O | O | O | O | X | O | O |
| **KAZ** | X | O | O | X | X | X | O | O | X |
| **KWT** | O | O | O | O | O | O | O | O | O |
| **KGZ** | X | O | X | X | O | X | X | O | O |
| **LAO** | O | O | O | O | O | X | X | O | O |
| **MAC** | O | O | O | O | O | O | X | O | O |
| **MDV** | O | O | O | O | O | O | X | X | X |
| **MNG** | O | O | O | O | O | X | O | O | O |
| **MYA** | X | O | O | O | O | O | O | O | O |
| **NPL** | O | O | X | O | O | X | X | O | O |
| **OMN** | O | O | O | O | O | O | O | X | X |
| **PAK** | O | O | O | O | O | O | X | X | X |
| **QAT** | O | O | O | O | O | O | X | O | O |
| **KOR** | O | O | O | O | O | O | O | O | O |
| **RUS** | O | O | O | O | O | O | X | O | O |
| **SAU** | O | O | O | O | O | O | X | O | O |
| **LKA** | O | O | O | O | O | O | X | O | O |
| **TJK** | | | | | | | | | |
| **THA** | O | O | O | O | O | O | X | O | O |
| **UAE** | O | O | X | O | O | O | X | O | O |
| **UZB** | O | O | O | O | O | O | X | O | X |
| **VNM** | O | O | O | O | O | O | X | X | X |
| **YMD** | X | O | X | O | O | X | O | O | O |

**QUESTIONS**
1. Provides nowcasting of high impact weather (0-6 hours ahead) (Yes/No)
2. Issues short-range weather forecasts/warnings (6-24 hours ahead) (Yes/No)
3. Issues medium-range weather forecasts/warnings (1 day – 2 weeks ahead) (Yes/No)
5. Operates a Website for real-time weather information, forecasts and warnings (Yes/No)
6. Operates and updates a website for the delivery and display of services and products (Yes/No)
7. Operates an automatic telephone answering system for weather information, forecasts and warnings (Yes/No)
8. Operates a TV weather programme (Yes/No)
9. Verifies public forecasts accuracy (Yes/No)
10. Obtains feedback from users through opinion surveys, user groups, etc. (Yes/No)

## XI. b) PUBLIC WEATHER SERVICES

| | 4 |
|---|---|
| **AFG** | 3 |
| **BHR** | 10 |
| **BGD** | 7 |
| **BTN** | 3 |
| **KHM** | 3 |
| **CHN** | 15 |
| **HKG** | 9 |
| **IND** | 7 |
| **IRN** | 7 |
| **IRQ** | 5 |
| **JPN** | 7 |
| **KAZ** | 3 |
| **KWT** | 4 |
| **KGZ** | 3 |
| **LAO** | 3 |
| **MAC** | 7 |
| **MDV** | 1 |
| **MNG** | 5 |
| **MYA** | 3 |
| **NPL** | 3 |
| **OMN** | 7 |
| **PAK** | 5 |
| **QAT** | 5 |
| **KOR** | 10 |
| **RUS** | 7 |
| **SAU** | 5 |
| **LKA** | 3 |
| **TJK** | |
| **THA** | 7 |
| **UAE** | 2 |
| **UZB** | 31 |
| **VNM** | 3 |
| **YMD** | 1 |

**QUESTION**
4. Range of public weather forecasts (Days)

---
YES = O
NO = X

### XII. a) PARTNERSHIP (YES/NO)

| | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|
| **AFG** | X | X | O | X | X | O | O | O | O | O |
| **BHR** | X | O | O | O | O | O | O | O | O | O |
| **BGD** | X | O | O | X | O | X | X | X | X | X |
| **BTN** | X | O | O | X | X | O | O | O | O | O |
| **KHM** | X | O | O | O | O | O | X | X | X | O |
| **CHN** | O | O | O | O | O | O | O | O | O | O |
| **HKG** | O | O | O | O | O | O | O | O | O | O |
| **IND** | X | O | O | O | O | X | O | X | O | O |
| **IRN** | X | O | O | O | X | O | O | O | O | O |
| **IRQ** | X | O | X | X | X | O | O | X | X | X |
| **JPN** | O | X | O | O | O | O | O | O | O | O |
| **KAZ** | X | X | O | O | X | X | X | X | O | X |
| **KWT** | X | O | O | O | X | X | O | O | O | O |
| **KGZ** | X | X | O | O | O | O | X | X | O | O |
| **LAO** | X | O | O | O | X | X | X | X | X | X |
| **MAC** | X | X | X | O | O | O | X | X | X | X |
| **MDV** | X | X | X | O | O | X | X | X | X | X |
| **MNG** | O | X | X | O | X | O | O | O | O | X |
| **MYA** | X | O | O | O | X | O | O | X | O | O |
| **NPL** | X | X | X | X | X | X | X | X | X | X |
| **OMN** | X | X | X | O | X | X | X | X | X | X |
| **PAK** | X | X | O | O | X | O | O | X | O | X |
| **QAT** | X | O | O | O | O | O | O | O | O | O |
| **KOR** | X | O | X | O | X | O | X | X | O | O |
| **RUS** | X | O | O | O | O | X | X | X | X | X |
| **SAU** | X | X | X | O | X | X | X | X | X | X |
| **LKA** | X | O | O | O | X | X | X | X | X | X |
| **TJK** | | | | | | | | | | |
| **THA** | X | O | O | O | X | X | X | X | X | X |
| **UAE** | X | X | X | X | O | X | X | X | X | X |
| **UZB** | X | O | X | X | X | O | O | X | O | O |
| **VNM** | X | X | X | X | X | O | O | O | O | O |
| **YMD** | X | X | X | O | O | O | X | X | X | X |

**QUESTIONS**
1. Collects and distributes automated meteorological observations from aircraft (Yes/No)
3. Engages in health-related studies in association with partner organizations (Yes/No)
4. Engages in socio-economic studies demonstrating the benefits of meteorological, climatological and hydrological infrastructure, information, products and services (Yes/No)
5. Contributes operational weather information to WMO's on-line World Weather Information Service (WWIS) (Yes/No)
7. Supports the exchange of official warnings of severe weather by contributing to WMO's on-line Severe Weather Information Centre (SWIC) (Yes/No)
8. Joins the RA II Pilot Project to Develop Support for NMHSs in Numerical Weather Prediction (Yes/No)
9. Joins the RA II Pilot Project on Information Sharing on Climate Services (Yes/No)
10. Joins the RA II Pilot Project to Develop Support for NMHSs in the Collection and Application of Aircraft Meteorological Data Relay Data (Yes/No)
11. Joins the RA II Pilot Project to Sustain and Enhance the Capacity of NMHSs in the Provision of Official Weather Forecasts for Medium Range (Yes/No)
12. Joins the RA II Pilot Project to Enhance the Seamless Provision of Regional Severe Weather Warnings and Advisories (Yes/No)

YES = O
NO = X

### XII. b) PARTNERSHIP (NUMBERS)

| | 2 | 6 |
|---|---|---|
| **AFG** | 0 | 0 |
| **BHR** | 0 | 1 |
| **BGD** | 0 | 0 |
| **BTN** | 0 | 0 |
| **KHM** | 0 | 0 |
| **CHN** | 3700000 | 88 |
| **HKG** | 686000 | 1 |
| **IND** | 0 | 95 |
| **IRN** | 0 | 10 |
| **IRQ** | 17280 | 18 |
| **JPN** | 6900000 | 7 |
| **KAZ** | 0 | 2 |
| **KWT** | 0 | 2 |
| **KGZ** | 0 | 2 |
| **LAO** | 0 | 5 |
| **MAC** | 0 | 1 |
| **MDV** | 0 | 2 |
| **MNG** | 0 | 5 |
| **MYA** | 0 | 25 |
| **NPL** | 0 | 5 |
| **OMN** | 0 | 34 |
| **PAK** | 0 | 30 |
| **QAT** | 0 | 1 |
| **KOR** | 0 | 6 |
| **RUS** | 0 | 94 |
| **SAU** | 0 | 14 |
| **LKA** | 0 | 10 |
| **TJK** | | |
| **THA** | 0 | 16 |
| **UAE** | 0 | 2 |
| **UZB** | 0 | 4 |
| **VNM** | 0 | 0 |
| **YMD** | 0 | 2 |

**QUESTIONS**
2. Number of automated meteorological observations from aircraft generated per year
6. Number of cities for which weather forecasts are on WWIS

# REPORT BY THE PRESIDENT OF THE ASSOCIATION

1. This report covers the period from the fifteenth session of the Association to January 2017.

**Members of the Association**

2. The number of Members of the Association has remained at 35.

**Officers of the Association**

3. Mr Abdulla Mohamed Al-Mannai (Qatar) and his predecessor Mr Ahmed Abdulla Mohammed, and Dr Ghulam Rasul (Pakistan) and his predecessors Dr Qamar-uz-Zaman Chaudhry and Mr Arif Mahmood Rana served as president and vice-president of the Association, respectively. They conducted the affairs of the Association with dedication, enthusiasm and initiative , thus contributing to the further development of weather, climate and water services in the Region.

**Subsidiary bodies of the Association**

4. At its fifteenth session, the Association established the Management Group, four working groups and two Implementation Coordination Teams: Working Group on Weather Services (WGWS); Working Group on Climate Services (WGCS); Working Group on Hydrological Services (WGHS); Working Group on WMO Integrated Global Observing System and WMO Information System (WG-WIGOS/WIS); Implementation Coordination Team on Service Delivery (ICT-SD); and Implementation Coordination Team on Disaster Risk Reduction (ICT-DRR).

5. It also established five new pilot projects: Develop Support for National Meteorological and Hydrological Services in Numerical Weather Prediction; Share Information on Climate Services; Develop Support for National Meteorological and Hydrological Services in the Collection and Application of Aircraft Meteorological Data Relay; Sustain and Enhance the Capacity of National Meteorological and Hydrological Services in the Provision of Official Weather Forecasts for Medium-Range; and Enhance the Seamless Provision of Regional Severe Weather Warnings and Advisories.

6. The Management Group and working groups worked satisfactorily and the Pilot Projects were successfully implemented. The chairpersons of the working groups and the focal points of the Pilot Projects provided the final reports on the activities of the RA II subsidiary bodies during the intersessional period. The report is given in RA II-16/INF. 3(1)

7. The important additional achievements in the Region during the intersessional include:

(a) Nomination of regional priorities 2016–2019 based on a survey to identify institutional arrangements, challenges, and future priorities, and subsequent discussion at the sixth Regional Conference on management of NMHSs in RA II (December 2014);

(b) Refinement and implementation of the RA II Operating Plan 2012–2015, and the development of the RA II Operating Plan 2016–2019 for the Enhancement of NMHSs in RA II;

(c) Provision of guidance for the regional priorities 2020–2023 and the future working mechanism of the Association;

(d) Implementation of regional WIGOS and WIS Implementation Plans in RA II, particularly progress on WIS implementation through operational services at three GISCs and trial operations at three conditionally designated GISCs, and an agreement on the preliminary list of principal GISCs;

(e) The establishment of the joint RA II/RA V WIGOS Satellite Data Project and Joint RA II/RA V WIGOS Radar Data Project in response to the Jakarta declaration at the Joint RA II/RA V Workshop on WIGOS for Disaster Risk Reduction (October 2015).

8. A survey was conducted to identify institutional arrangements, challenges, and future priorities. The survey identified that the specific challenges for RA II, among others, are:

(a) Inadequacies of climate services;

(b) Lack of qualified personnel;

(c) Need for ongoing competency assessments and implementation of a quality management system;

(d) Lack of NWP guidance material for improving service delivery;

(e) Inadequate infrastructure capabilities to deliver end-to-end multi-hazard early warning systems to support DRR.

9. The sixth Regional Conference on Management of NMHSs in RA II identified regional priorities 2016–2019 based on the survey outcomes. The key priorities include:

(a) Improvement of Early Warning System (EWS) for Disaster Risk Reduction (DRR);

(b) Implementation of WIGOS and WIS including GISC;

(c) Enhancement of hydrological, aviation and public weather services;

(d) Strengthening of climate services including GFCS and the implementation of GFCS at national and regional levels;

(e) Capacity development;

(f) Improvement of Quality Management System (QMS).

10. In this respect, the Association requested the Secretary-General and Members to give high priority to these subjects in order to be able to address future challenges of the Region. Survey report on the institutional arrangements, challenges and priorities in RA II is given in RA II-16/INF. 3/2 and the detailed information on the challenges and regional priorities in RA II for 2016-2019 is given in RA II-16/INF. 3(3).

11. The Members of RA II have been surveyed in October-November 2016 in order to gather information on the basic capability of NMHSs in the Region. In reviewing the analyses of the responses from 33 out of 35 Members, there was satisfaction with the overall steady improvement of weather, climate and water services by Members in RA II, but it also noted the gaps among the Members. The survey report on the basic capability of NMHSs in RA II is given in RA II-16/INF. 3(4).

**Major regional events and outcomes**

12. Members hosted various regional events during the intersessional period and are encouraged to continue to provide the necessary support to the activities of the Association. The list of regional events in 2012–2016 is given in the Appendix of RA II-16/INF. 7.

(a) The Sixth Regional Conference on Management of National Meteorological and Hydrological Services (NMHSs) in Regional Association II (Asia) was held in Doha, Qatar, 2–4 December 2014. This Conference made a number of important recommendations for NMHSs and WMO on delivery of weather, climate and water services for weather-, climate- and water-related natural disasters in the Region in conjunction with upgrading of service delivery capability through identifying current challenges and future priorities;

(b) Meetings of the subsidiary bodies of RA II: Management Group Meetings (seventh session, 12 May 2013, eighth session, 14 June 2014, ninth session, 27 May 2015, tenth session, 15 June 2016, and eleventh session, 7–8 December 2016); Working Group, Implementation and Coordination Team, and Task Team (WG-ICT-TT) Chairpersons' Meeting on Implementation and Development of the Strategic Operating Plan in Regional Association II (27–28 May 2014); First meeting of RA II Working Group on Hydrological Services (WGHS)(30 September–2 October 2014); Meeting of RA II Expert Group on Aeronautical Meteorological Services Delivery (EG-AeM) (10–12 November 2014); Second meeting of RA II Working Group on Hydrological Services (WGHS) (14–16 April 2015); Meeting of RA II Expert Group on Agrometeorology (EG-AgM) (9–10 November 2015); Meeting of RA II Expert Group on WIS (EG-WIS) (25–27 November 2015); Meeting of RA II Expert Group on Public Weather Services Delivery (EG-PWS) (10–11 December 2015); Working Group, Implementation and Coordination Team, Task Team (WG-ICT-TT) Chairpersons' Meeting on Strategic Planning in RA II (15–17 December 2015); third meeting of RA II Working Group on Hydrological Services (WGHS) (25–27 October 2016), and first meeting of RA II Expert Group on WIGOS (EG-WIGOS) (31 October–1 November 2016). A detailed list of the subsidiary body meetings in 2012–2016 is given in the Appendix of RA II-16/INF. 7.

**WMO Regional Office for Asia and the South-West Pacific and the WMO Office for West Asia**

13. The Regional Office for Asia and the South-West Pacific, located at the WMO headquarters in Geneva, has been providing effective support to NMHSs in their efforts to enhance their services as well as to the president, vice-president and subsidiary bodies of the Association in discharging their responsibilities.

14. The WMO Office for West Asia, located in Manama, Bahrain has been facilitating implementation of WMO regional events, maintaining close contact with Members, providing support to meet requirements of Members in the Region and also to address WMO cross-cutting programmes with relevant regional organizations. The activities of the Regional Office and the WMO Office for West Asia are documented in RA II-16/INF. 7.

15. The Regional Office for Asia and the South-West Pacific, located in Geneva, and the WMO Office for West Asia, located in Bahrain, have played an important role in various regional activities including the support for the president.

**Missions of the president**

16. In his capacity as the president of RA II, Mr Abdulla Mohamed Al-Mannai and his predecessor Mr Ahmed Abdulla Mohammed attended the Seventeenth World Meteorological Congress and the sessions of the Executive Council, the Financial Advisory Committee and the WMO Bureau as well as the Meetings of Presidents of Regional Associations and joint Meetings

of the Presidents of Regional Associations and Presidents of Technical Commissions. They also presided over MG meetings and Regional Conferences.

**Future work of the Association**

17. High priority should be given to the implementation of the RA II Operating Plan 2016–2019.

18. High priority should also be given to the implementation of the regional WIGOS Implementation Plan for RA II and the regional WIS Implementation Plan for RA II.

19. Quality management systems, cost recovery, and extreme weather events continue to be of great interest to Members. Members and WMO should give high priority to these subjects in order to be able to address the future challenges.

**Acknowledgements**

20. The president of the Association would like to express his appreciation and gratitude to all those who have contributed to the work of the Association. Particular thanks are due to the former president, Mr Ahmed Abdulla Mohammed and vice-president, Dr Ghulam Rasul, and former vice-presidents, Dr Qamar-uz-Zaman Chaudhry and Mr Arif Mahmood Rana, and the chairpersons, co-coordinators and theme leaders of Working Groups/Expert Groups/ Implementation Coordination Teams as well as focal points of pilot projects of the Association. Thanks are due to the Members of the Association who have hosted various meetings, conferences and training events during the intersessional period.

21. The president would also like to express his deep gratitude and appreciation to the Secretary-General of WMO and to the Secretariat, in particular the Regional Office for Asia and the South-West Pacific and the WMO Office for West Asia, for their valuable support and advice in the work of the Association.

World Meteorological Organization

REGIONAL ASSOCIATION II (ASIA)

Sixteenth Session

Abu Dhabi, United Arab Emirates

12 to 16 February 2017

RA II-16/INF. 4.1(1)

Submitted by:
Secretary-General

9.I.2017

# DISASTER RISK REDUCTION, RESILIENCE AND PREVENTION FOCUSING ON IMPACT-BASED DECISION SUPPORT SERVICES

## INFORMATION ON EMERGENCY ASSISTANCE TO MEMBERS INCLUDING ERAs ON ALL AIR-BORNE HAZARDS

### 1. Emergency assistance to Members in case of emergency

As noted by EC-66, the issue of assistance to Members, on their request, in situations of emergency, must be addressed. They provided the following directions:

***Paragraph 4.3.5*** *- The Council noted possible needs of some Members that may arise in their anticipation of a major meteorological or meteorology-related hazard threatening the safety and security of their populations. It therefore requested CBS to develop, in consultation with RSMCs, a concise guide on actions to be taken by NMHSs' in the run-up to extreme weather-related events. It should provide guidance on the actions and activities an NMHS could utilize to increase the preparedness to respond to an extreme event building on existing guidance and including RSMC contacts and other information regarding the role of other operational centres.*

***Paragraph 4.3.6*** *- The Council requested the Secretariat, in coordination with the TCs, RAs and operational centres including RSMCs, to analyse the issue and develop a draft working arrangement that elaborates the roles and responsibilities for coordination of WMO's response to Member's requests for assistance noting that operational responsibility lies with the Members, and to report back to EC for consideration.*

As noted further by the Seventeenth World Meteorological Congress (Cg-17), major disasters such as the earthquake in Nepal in April 2015 and the floods in the Balkan Peninsula in May 2014 have an international dimension and require coordinated response from a broad range of agencies and organizations as well as improved and effective communication mechanisms.

The Executive Council Working Group for Disaster Risk Reduction (EC WG/DRR) discussed, among other issues, how to specify the strategic approach, governance, thematic areas and running of DRR-related activities by WMO Programmes in an integrated and efficient manner and thereby assist the EC in making informed decisions. The Group also discussed the kind of support WMO as a whole could provide to Members affected by major disasters, upon their request, including the role of the Secretariat, technical commissions (especially the Commission for Basic Systems (CBS)), regional associations, Programmes (especially the DRR Programme, Emergency Response Activities (ERA), and Regional Programme), specialized centres, Members and their National Meteorological and Hydrological Services (NMHSs) and the mechanism by which it is activated. It also considered the work carried out by CBS on this issue. Examples of such support include the engagement of other NMHSs to support the continued provision of essential meteorological and hydrological services for a Member's NMHS catastrophically affected by a hazard, or assisting those NMHSs, if required, in their support to the national preparedness and response activities of Members impacted by a major disaster (as was the case, for example, in the Philippines, Vanuatu or Nepal).

The EC WG/DRR recommended that the Secretary-General, in collaboration with CBS, develop protocols/procedures and processes by which Members could be assisted by their neighbouring NMHSs or other NMHSs in the event that their capacity to provide critical services to their own communities is seriously affected. This assistance could be activated in anticipation of an expected high-impact hazard event and must be based on existing arrangements and mechanisms that are already in place, such as the WMO ERA Programme (see below).

The WMO Secretariat is now working to address the directives of EC-66, Cg-17 and of the EC WG on DRR, in particular, to develop the draft working arrangement, in consultation with the representatives of regional associations and technical commissions. Therefore, all regional associations will be requested to identify their focal points to work with the Secretariat for the development of a mechanism to assist Members in case of emergency.

## 2. Emergency Response Activity (ERA)

The nuclear Emergency Response Activity programme is mature and has been in place for over two decades supporting the International Atomic Energy Agency (IAEA). An important component of the work is to maintain real-time operational response readiness and capacities, in accordance with the roles and responsibilities defined in the *Manual of the GDPFS*. The programme examined new activities/products and new ways to improve existing products and delivery mechanisms. Some of the ongoing activities include: (1) monthly and quarterly testing between the IAEA, RTH Offenbach and the RSMCs; (2) testing and maintaining RSMC common web pages; (3) modelling for CTBTO requests; (4) maintaining and updating the WMO ERA web page; and (5) testing potential new products, such as the Time of Arrival (ToA).

The growing need and interest by WMO Members for support for non-nuclear ERA (smoke from forest, grass or peat fires; smoke from industrial fire; chemical releases not involving fire, etc.) led to the development *"Operational Procedures for non-Nuclear Emergency Response Activities"* which is now included in the revised Manual on the GDPFS. The revised Manual on the GDPFS was endorsed by CBS-16 (November 2016) and recommended for EC-69 (May 2017) approval for publication. The revised Manual also includes characteristics for designation of Regional Specialized Meteorological Centres for non-nuclear ERA.

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# GUIDANCE ON THE NATIONAL WIGOS IMPLEMENTATION

## Purpose of document

The purpose of this document is to assist WMO Members in developing their National Observation Strategy and National WIGOS Implementation Plan to design, plan and evolve their national observing system (NOS) as a national WIGOS observing component.

The guidance aligns with the WIGOS related technical regulations and guidance material developed under the governance of ICG-WIGOS.

## National WIGOS Implementation

For WIGOS to deliver on its vision for "an integrated, coordinated and comprehensive observing system to satisfy, in a cost-effective and sustained manner, the evolving observing requirements of Members in delivering their weather, climate, water and related environmental services", commitments and actions are required at the global, regional and national levels.

Member's NMHSs are expected to become the key integrators at the national level, both by strengthening their own observing systems according to the regulations and guidance provided by the WIGOS framework, and by building national partnerships and providing national leadership based on their experience in the acquisition, processing and dissemination of observational data for environmental monitoring and prediction purposes.

The leadership role of NMHSs in integrated observing systems and the engagement with national partners are central to the success of WIGOS implementation. WIGOS provides an opportunity to strengthen the role of NMHSs in all aspects of their national mandates, from national coordination and exchange of observations across all relevant domains (weather, climate, hydrology, space weather, ocean, atmospheric composition, cryosphere, environment, etc.) and reinforce their status as the national meteorological and hydrological service provider of choice.

Proactive engagement with all relevant stakeholders, users and partners, is a great opportunity to build stronger relationships. Both, formal and informal, regular and ad hoc, productive two-way communications with stakeholders is needed.

NMHSs are operating in a rapidly changing environment in terms of technological advances and the increasing demand for more and more diverse services from increasingly sophisticated and capable users. Technological advancements and related trends like "big data" and "crowd sourcing", the emergence of commercial observing networks, data and service providers, and the affordability of digital technology, all are game changers that require rapid adaptation and change in behaviour from both the NMHSs and the private sector.

The private sector may contribute by accelerating the uptake of technological innovations, and be able to assist NMHSs in providing more efficient, attractive and accessible personalized services. NMHSs will benefit in working with private sector partners to introduce those innovative methods into their own operations. There are many opportunities for optimization and efficiency through integration of networks, computing power and service delivery.

By Cg-18 (2019), all Members should be "WIGOS Ready". Per the Plan for the WIGOS Pre-operational Phase[1] this includes:

(1) OSCAR/Surface: completed WIGOS metadata of all observing stations across all WIGOS components for which observations are exchanged internationally;

[1] Final Report from EC-68, Geneva, 15-24 June 2016, Resolution 2 (EC-68)

(2) WIGOS metadata compliance achieved;[2]

(3) WIGOS Station Identifiers: implemented; [3]

(4) WIGOS Data Quality Monitoring System (WDQMS): national process for acting on quality problem information received from the WDQMS in place;

(5) Embracing all NMHS-operated observing systems and willing partners;

(6) National WIGOS governance, coordination and implementation mechanisms established;

(7) Nomination of national WIGOS focal points and OSCAR focal points completed.

Further expected outcomes above the minimum level can be as follows:

(1) Enhanced national integrated observing system delivering better, and better documented observational input to support national service needs in a more cost-effective way;

(2) Increased integration and open sharing of observations from WMO and non-WMO sources across national and regional boundaries;

(3) Progressively improved availability and quality of WIGOS observational data and metadata;

(4) Increased visibility and strengthened role of NMHSs at their national level;

(5) Enhanced cooperation with partners at the national and regional levels;

(6) Enhanced culture of compliance with the *Technical Regulations* (WMO-No. 49), Volume I, Part I – WIGOS and *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160);

(7) Improved human and technical capacity of Members for planning, implementation and operations of WIGOS.

To achieve that, the following key activities are envisaged to take place at a national level:

(1) Analysis of current and future national strategic requirements, needs and priorities, and biggest gaps in observations, systems, processes, capabilities, etc.;

(2) Analysis of the national implications of the WIGOS concept of integration, partnerships, data sharing, WIGOS relevant technical regulations and culture of compliance, etc., at a national level;

(3) Development of a National WIGOS Implementation Plan;

(4) Critical analysis of capabilities and gaps (systems, processes, people, networks, governance, issues of compliance);

(5) Specification of expected deliverables, outcomes, milestones, and key performance indicators for the national WIGOS implementation;

(6) Establishment of governance and key relationships.

***Development of a National Observing Strategy*** *(understanding national needs and priorities)*

Development of a National Observing Strategy will enable the NMHS to better meet user needs and demands, and will help ensure that the NMHS has the best basis for planning of its investment in systems, science and people. It will also permit the NMHS to make informed decisions based on user requirements for future planning purposes. Four key principles that

[2] See the *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160), 2.5 Observational metadata

[3] See the *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160), 2.4.1 General requirements

guide the Strategy are: (1) demand- and user-driven products and services; (2) a phased approach to implementation; (3) effective partnerships; and (4) building on core strengths.

The Strategy will recognize the NMHS as a strategic national asset that contributes to national security, principal of which are transport, food, water, energy and health (Key Pillars of GFCS) in addition to being vital to sustainable development, climate change mitigation and adaptation, and disaster risk reduction. To that end, the National Observing Strategy should be well-aligned with the overarching vision, mission and strategic plan of the NMHS. It should also set the scene for the partnerships that will be sought in implementing WIGOS.

Recognizing that the National Observing Strategy provides the overall strategic framework for implementing WIGOS, it should also recognize the needs, goals and users of the broader environmental observing community who may be considered partners in implementing WIGOS, including marine, atmospheric, hydrological and cryospheric observing communities.

Examples of National Observing Strategies can be found at:

- www.wmo.int/pages/prog/www/wigos/documents/Principal_Docs/OSS_eBook.pdf;
- http://bibliotheek.knmi.nl/knmipubmetnummer/knmipub233.pdf

### *Development of a National WIGOS Implementation Plan*

The National WIGOS Implementation Plan (N-WIP) builds on the National Observing Strategy, and specifies expected deliverables and outcomes, priorities, activities, milestones, timeline, resources, responsibilities, key performance indicators, etc. needed for:

(1) Establishment of national (and subregional/cross-border when appropriate) WIGOS governance and coordination and management mechanisms for planning, implementation and coordination of their national observing systems in place;

(2) Development of key national partnerships/relationships;

(3) Design, planning and evolution of the national composite observing system, including identification and mitigation of critical gaps (the national RRR process implementation)[4];

(4) Gap analysis of WIGOS related systems, processes, people, governance, issues of compliance;

(5) Sustained and standardized operation of national observing networks/systems in compliance with the *Technical Regulations* (WMO-No. 49), Volume I, Part I – WIGOS and the *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160);

(6) Operational implementation of WIGOS Metadata Standard through populating the OSCAR/Surface database and keeping its content up-to-date;

(7) Operational implementation of WIGOS Station Identifiers;

(8) Monitoring of availability and quality of their observations through the national WDQMS and taking corrective actions as necessary (Incident Management);

(9) Systematic and rigorous performance monitoring and evaluation of WIGOS capabilities;

(10) Increased integration and open-sharing of observations from NMHSs and non-NMHSs sources;

(11) Development and implementation of a data and information framework;[5]

(12) Implementation of modern data lifecycle management and practices;

(13) Availability and protection of suitable radiofrequency bands required for meteorological and related environmental operations and research;

(14) Development of an effective resource mobilization strategy;

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[4] See: 1) *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160), 2.2.2 Principles for observing network design and planning; 2) Initial version of the *Guide to WIGOS*.

[5] See example at: http://www.bom.gov.au/inside/BoMDataFramework_Final.pdf

(15) Development of a risk management plan;

(16) Development of a workforce plan and/or capacity development plan of the staff managing and operating national observing networks/systems.

The N-WIP is a plan to put the national WIGOS framework in place, not fix all problems and issues. It is a tool to start planning of observation improvements. It should be realistic and achievable.

***Planning***

Planning is the first step of the so-called Plan-Do-Check-Act (PDCA) Cycle, the chief aim of which is to ensure continued improvement of a given service or product, in the case of WIGOS observations flowing to the WMO community. In the WIGOS implementation, it is important to maintain an integrated view of user requirements and corresponding capabilities based on the Rolling Review of Requirements (RRR) process.

To fully embrace the WIGOS concept at the national level requires an integrated approach to the design, planning and operation of the full suite of national observing systems. This means, in effect, operations of a national composite observing system (that is, a system of systems) that is optimized to address diverse user needs as efficiently and effectively as possible and with just enough redundancy and overlap to provide resilience and continuity.

The implementation of a national RRR process will provide the Member with a way to understand and assess user requirements, to inform the characteristics of the observations required and to design the system solutions that will deliver them; a tool for coordinated evolution of the NOS to tackle those requirements in an integrated way.

A comprehensive strategic and operational planning process will then allow the development of staged approaches to the design, development and implementation of new and/or improved systems, processes and networks, supported by the development of well-structured business cases and budget proposals. Budget shortfalls may of course limit or delay the achievability of the overall plans, but the information gained through the RRR process will still inform decisions on priority use of existing resources.

The planning includes close collaboration and coordination with all users to assess their requirements; a review of the existing components of the NOS; assessment of their adequacy in meeting current and future requirements; identifying future opportunities; prioritizing; and finally deciding on a strategy matched with resources available.

Close collaboration and cooperation among the NMHSs and other relevant national agencies, establishment and implementation of appropriate mechanisms, defining partnerships and data policy principles, while respecting ownership, are needed to meet WIGOS requirements at national level. It specifically refers to enhanced cooperation among meteorological, hydrological and marine/oceanographic institutions/services where they are separated at the national level as well as national implementation mechanisms for related international observing programmes such as GCOS, GOOS and GEOSS

In addition to meeting requirements at a national level, the NMHSs needs to address international commitments as a part of the design, development and implementation of the NOS. Driving forces likely to impact on the design, operations and required deliverables of the NOS in the future include:

(1) Need for a holistic approach to planning and evolution of the NOS and enhanced integration of its components;

(2) Growing demand for meteorological services overall, in contrast to a decrease in the availability of public funding to support the necessary infrastructure;

(3) Greater emphasis on climate monitoring and services in addition to continued demands for weather-related services;

(4) Increased requirements for quality management, standardization and interoperability, efficiency and cost effectiveness;

(5) Available or emerging technological opportunities.

The National WIGOS Implementation Plan should reflect Member's national situation, in terms of the mandate of its NMHS, the requirements of the user community and the need to reach out to partners to develop an integrated observing system to meet national service needs. It should link NMHSs with their national partners for increased integration and open sharing of observations, including those from non-WMO sources.

There is not a one-size-fits-all approach. The WMO Members and their NMHSs differ in terms of size and available resources, whether financial, technical or scientific, and therefore their N-WIPs will naturally differ both in content and style. While Members can learn from the plans and experiences of others, through case studies and workshops, Members will be provided with additional WMO guidance materials to assist them in understanding the various steps in the planning process.

In developing their national WIGOS implementation plans, Members should be guided by the Key Activity Areas (KAA's) of the WIGOS framework Implementation Plan (WIP) that comprise the building blocks of the WIGOS framework as well as by the Regional WIGOS Implementation Plan of the respective regional association.

The WIGOS National Self-assessment Checklist was developed to help Members better understand the WIGOS Framework to be implemented in their countries; to help Members in assessing their readiness for the implementation and the challenges ahead of them, but especially to recognize that WIGOS is a natural change progress. The Self-assessment Checklist is also useful in assessing Member's priorities, plans, gaps and capabilities, etc., and will provide the basis for developing an achievable national WIGOS plan.

Members are encouraged to draw on the WIGOS National Self-assessment Checklist; some completed examples are available at:
https://www.wmo.int/pages/prog/www/wigos/checklist.html.

A wide range of other materials already exist to guide Members in relation to WIGOS, including EGOS-IP and relevant plans for GFCS, GAW, WHOS, GCW, GCOS, etc.[6]. Altogether, these assist in identifying national priorities and gaps in observations, systems, processes, capabilities, etc., and provide the basis for developing a national WIGOS plan. Alignment of WIGOS plans with national planning for GFCS, DRR, WIS and other WMO priorities is an important opportunity:

(1) To ensure that their specific observations requirements are factored in as effectively as possible;

(2) To capture efficiencies and synergies and avoid duplication of effort and potential conflict;

(3) To optimize and align capacity development and project opportunities;

(4) To demonstrate to stakeholders and donors the professionalism and joined-up approach of the NMHS.

***Data management***

Careful management of data and their associated metadata is a vital aspect of any observing network/system, with real-time monitoring centres as well as with delayed-mode analysis centres. A key component of such a data/metadata management includes non-stop monitoring of the data stream with feedback and corrective actions when needed. This includes timely quality monitoring of the observations by the monitoring centres and early notification (i.e. incident management) to observing system operators and managers of both random and systematic errors, so that timely corrective actions can be taken. Such an operational system is needed that can track, identify, and notify network managers and operators of observational irregularities, especially time-dependent biases, as close to real-time as possible.

[6] The corresponding links will be included in due course.

**Resources**

In a time with increasing demands for meteorological information and services and decreasing resources it becomes of crucial importance to invest the available resources where they create most benefit. The gap analysis of the RRR process will help identify where this is the case.

The success of the WIGOS implementation will depend critically upon protecting adequate resources for both technical programme management and specific network needs. Data/ metadata acquisition, processing and management systems that facilitate access, processing, monitoring, use, and interpretation of the data with a help of associated metadata have crucial importance.

It is important to recognize that WIGOS activities are primarily within the responsibility of the individual WMO Members and that the cost should be covered by national resources. WIGOS implementation requires planning, priority setting and committed effort over a considerable number of years. It has been learned from Members experiences that substantial changes in the national observing system depend on substantial adjustments to resource commitments. Such adjustments are not easy without planning and priority setting with a long lead time.

**Conclusion**

Establishing a comprehensive 'system of systems' that meets the observational needs of multiple users and applications areas will take effort, and each Member will need to assess the size of that challenge and weigh up the costs and benefits. Through engagement of non-NMHS organizations in a national 'system of systems', the NMHS may consolidate and strengthen its role as the national meteorological authority, especially in areas where it may not already be firmly established, for example in climate monitoring and delivery of climate services. Integration does not mean that 'one size fits all'. Where opportunities exist to serve multiple needs with a single solution, real efficiencies can be delivered, but as a rule, integration is more about finding an optimum balance between needs and solutions.

As the integration process moves forward, gaps and shortcomings, incompatibilities, deficiencies in national observing system capabilities and duplications of efforts will be identified and addressed. This is the most cost-effective and efficient way to make better use of existing infrastructure and improve the timeliness, quality and utilization of observational information for enhanced services and decision-making.

**ASSISTANCE PROVIDED BY THE WMO SECRETARIAT**

Within the WMO Secretariat, the WIGOS Project Office of the Observing and Information Systems Department (OBS) provides the necessary support to Members when implementing WIGOS at a national level. Any WIGOS related inquiry and request for assistance should be sent to the Secretariat to the following address: wigos-help@wmo.int.

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Annex: 1

**ANNEX**

***The Plan-Do-Check-Act (PDCA) cycle***

The PDCA cycle is an efficient tool for continual improvement. The methodology applies to both high-level strategic processes and to simple operational activities. It consists of:

- ***P***-Plan: plan the improvement (based on the Gap analysis: what is required to be done; where, when and how to do it; who should do it);
- ***D***-Do: implement the plan;
- ***C***-Check: monitor and measure the results against the plan, requirements, policies and objectives;
- ***A***-Act: take actions and measures to improve the process / performance.

The PDCA cycle is the never ending cycle that can be applied within any individual process or across a group of processes within the organization. Further information can be found at:

http://asq.org/learn-about-quality/project-planning-tools/overview/pdca-cycle.html,
http://9001quality.com/plan-do-check-act-pcda-iso-9001/
http://9001quality.com/continual-improvement-process-iso-9001/ .

***Gap analysis***

Gap analysis is a technique for determining the steps to be taken in moving from a current state to a desired future state. It is also called "need-gap analysis" or "needs analysis".

Gap analysis allows the organization to compare an 'as is' scenario with a desired 'future state'. Gap analysis generally follows 5 steps: (1) reviewing a current [as is] system (2) determining requirements of the proposed [future state] system and (3) comparing these two states in order (4) to determine the implications and (5) requirements involved in getting from one state [as is], to the other [future state]. Key gaps in observing capabilities identified will result in proposals for activities to fill these gaps reflecting priorities and taking into account resources available. (See also: https://www.wmo.int/pages/prog/dra/eguides/index.php/en/)

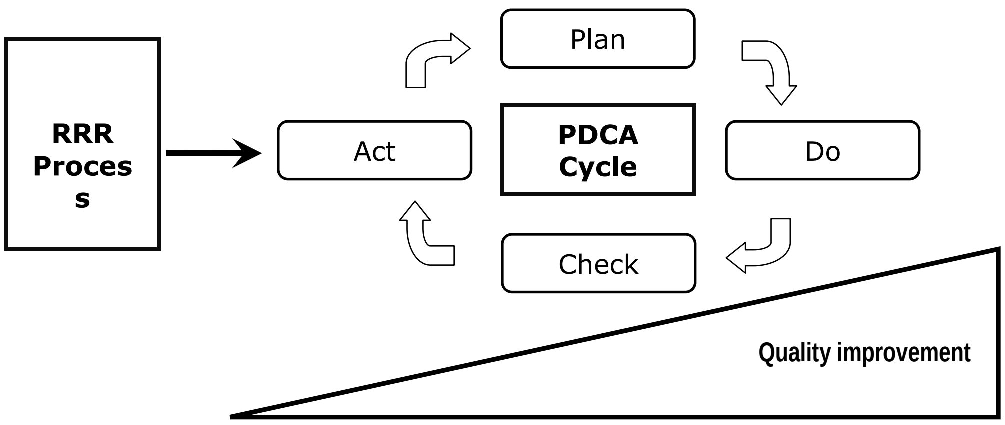
***Rolling Review of Requirements (RRR) process***

The RRR process described by the *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160), section 2.2.4., is used to compare user observing requirements with the capabilities of present and planned observing systems to provide them. The process consists of four stages:

1. A continuous review of user requirements for observations;
2. A continuous review of the observing capabilities of existing observing systems and available or emerging technological opportunities;
3. A Critical Review of the extent to which the capabilities (2) meet the requirements (1);
4. A Statement of Guidance based on (3).

The RRR process will "continuously" issue new Statements of Guidance to be implemented in the NOS management. It is a process directly linked to the Act step of the PDCA cycle.

The relationships between the RRR process and PDCA cycle is shown in Figure below.



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# WMO INFORMATION SYSTEM (WIS)

**References:**

1. RA II Regional WIS Implementation Site: http://wis.wmo.int/page=RA2-WIS

2. *Manual on WIS* (WMO-No. 1060) - http://wis.wmo.int/wis-manual

3. *Guide to WIS* (WMO-No. 1061) - http://wis.wmo.int/wis-guide

## Introduction

1. Reliable information is needed to support Disaster Risk Reduction (Sendai Framework priority 1 (paragraph 25a) and priority 4 (paragraph 33(b)), the Global Framework for Climate Services' Climate Services Information System pillar, international air navigation (Manual on the Digital Exchange of Aeronautical Meteorological Information, ICAO 10003) and many other key WMO activities.

2. Although WIS is operational at the global and regional level, it is apparent that the national implementation of WIS has some way to go.

## Progress on implementing WIS in RA II

4. A routine survey of WIS National Focal Points updated in October 2016 (Attachment) reveals that five out of the more than 20 responders from RA II reported a lack of knowledge on WIS and seven had not moved beyond planning to implement WIS. Although better than the global average, there is still a need to get WIS implementation on track by addressing Members' knowledge of WIS and to assist those centres that have not yet started implementing WIS. The survey also shows that although the majority can send TDCF messages, there is still a high usage of TAC in operations. For the migration to TDCF to be completed, it will be necessary to identify why Members are still using TAC in operations and implement solutions, such as updating of forecaster workstations and visualization tools to be fully TDCF compatible. Failure to address WIS implementation across the Region will result in further increases in the technology gap between Members and, as WIS evolves and old GTS processes are retired, those not having implemented the new functionality will have less and less access to time and operational critical data needed for the provision of NMHS core functions.

5. The Attachment summarizes the 2016 survey of National WIS focal points and explores these issues further.

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Attachment: 1

**Attachment 1: Survey WIS National Focal Points (October 2016)**

A survey was conducted among WIS National Focal Points. Of the 88 responses, there were 22 from RA II. The current survey is online at http://wis.wmo.int/page=WIS-RA-II-Survey

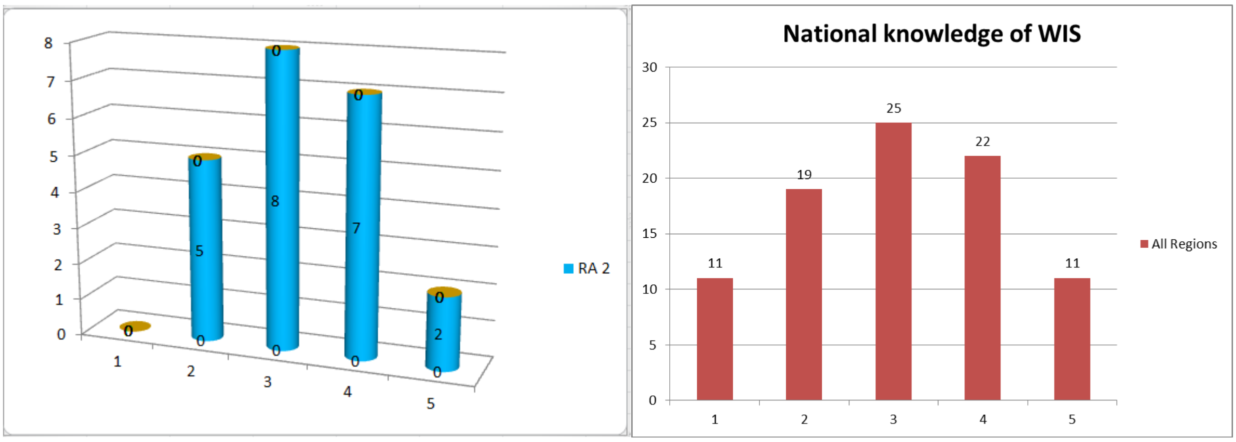


**Figure 1 National Knowledge of WIS**

Although only half the National WIS Focal Points completed the survey, the results indicate that although globally the level of WIS knowledge is normally distributed, RA II is further on the path to having a good or better knowledge of WIS. A key focus for 2017 to 2020 should be to have all Members' focal points completing the survey and to have all countries scoring level 3 or above.

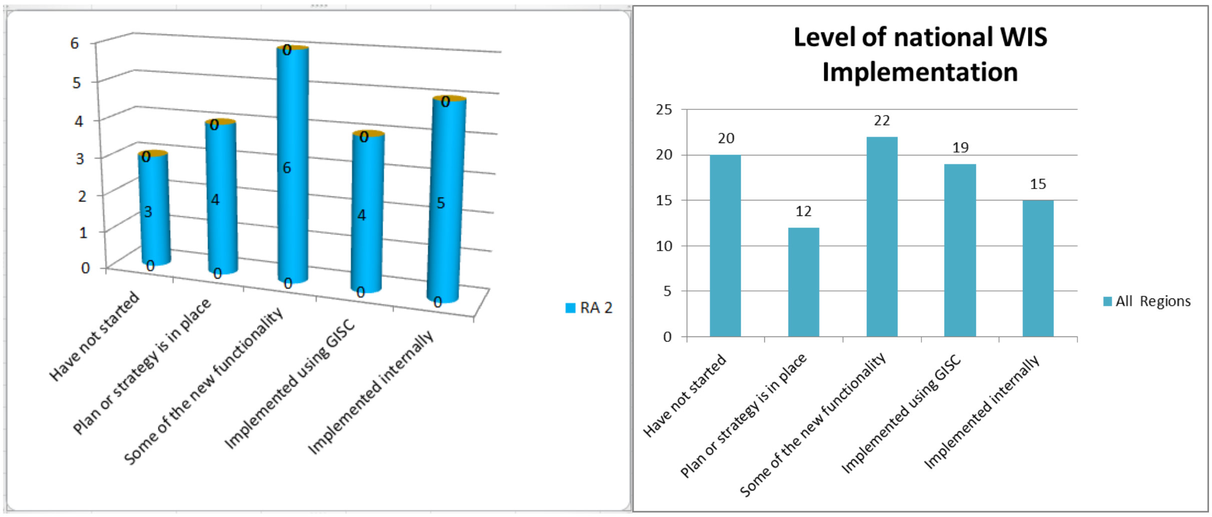


**Figure 2 Status of WIS implementation**

The target set by Cg-XV for completion of national implementation of WIS was Cg-17 in 2015. The survey shows that there is still a significant lag in national implementation of WIS. A priority should be to assist those Members that have not started or are only at the planning stage to have at least some of the new functionality in place, making use of the infrastructure and services of their principal GISC. All eight GISCs in RA II should be encouraged to take the lead for those centres in their area of responsibility, especially those that they are the principal GISC for, and help those centres to implement WIS using the GISC infrastructure and services. A major factor in implementing and using WIS is the ability to create and manage WIS Discovery Metadata (see WIS Competency 4 "Manage data discovery" as described in paragraph 1.8 of the *Manual on WIS* (WMO-No. 1060) and its Appendix E (available online at http://wis.wmo.int/wis-manual)).

Figure 3 shows the regional distribution of responses for the 2016 survey. The level of response from RA II is good but still only represents about half the Members. Completing this survey should be seen as an important role of National WIS Focal Points as the information will be a key factor in prioritizing support for WIS implementation. The information is also used for determining the status of the Regional Meteorological Telecommunication Networks and how Members access information. It also monitors the level of progress on implementing Table Driven Code Forms (TDCF) and residual dependency of Members on TAC. Work will be done in the Secretariat to improve the survey to a more user friendly system.

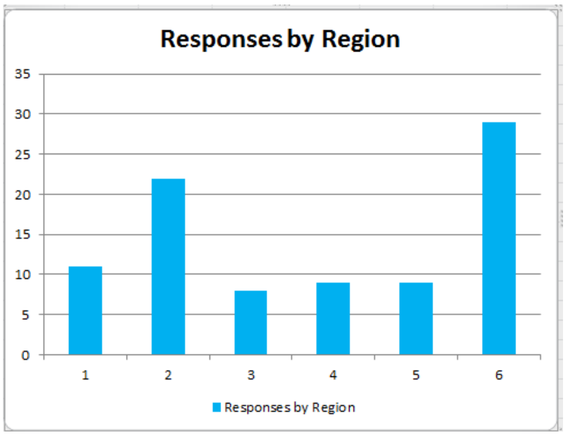


**Figure 3 Regional Distribution of Responses**

***Communications in use in RA II***

Figure 4 shows that the GTS and Internet are the most popular communication pathways and that Satellite Data Collection Platforms are also popular

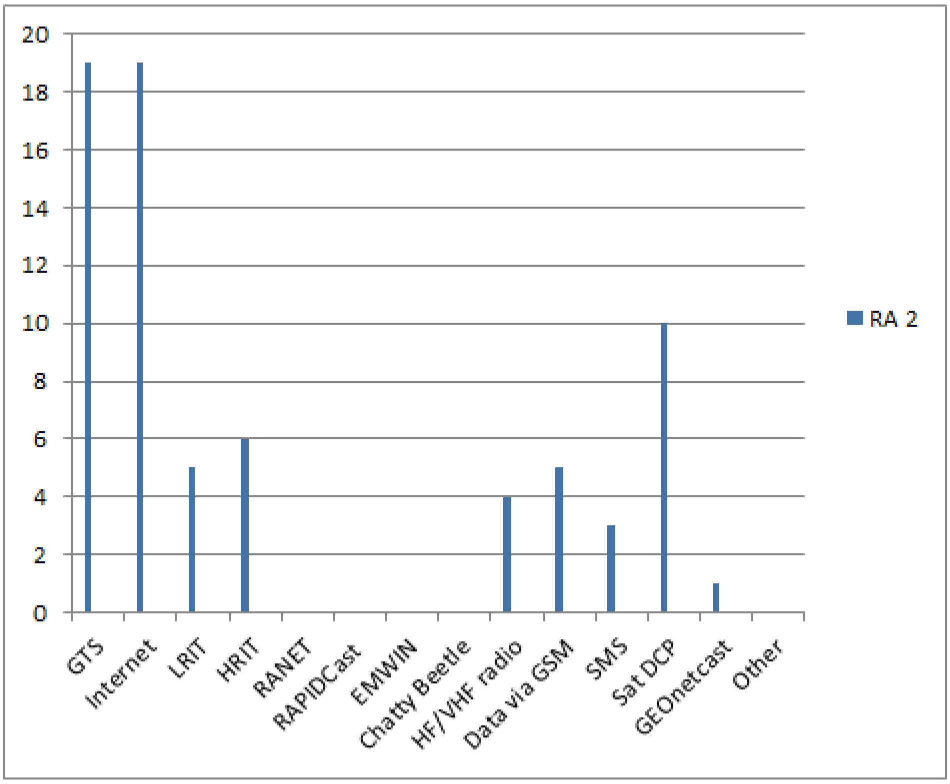


**Figure 4 Communications used in RA II**

***Migration to TDCF and reliance on TAC***

With regards to migration to TDCF, although the majority of responses (16) from RA II confirmed that they can send in TDCF, many still use TAC operationally.

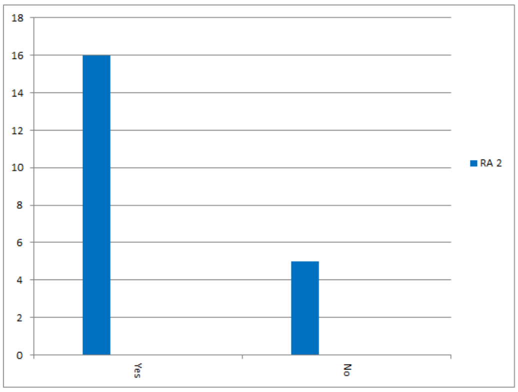


**Figure 5 Progress of TDCF migration in RA II**

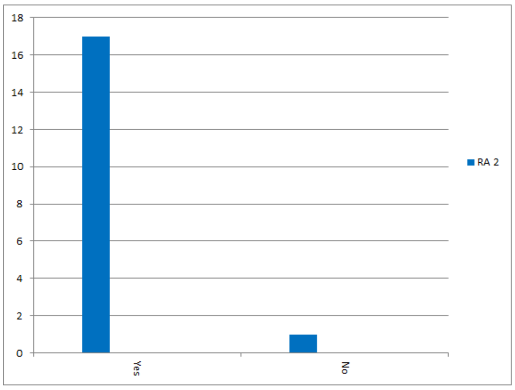


**Figure 6 Use of TAC in RA II**

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## OBSERVATIONS AND DATA EXCHANGE

### Global Climate Observing System (GCOS)

In 2016 GCOS produced The Global System for Climate: Implementation Needs (GCOS-200). Many of the actions identified in the GCOS Implementation Plan will need to be implemented by NMHSs and are important components of WMO Integrated Global Observation System (WIGOS).

### 1. Introduction

There is an urgent need to improve climate observations globally. While the existing system has proved effective in supporting climate science and policy development, including the UNFCCC Paris Agreement, mitigation and adaptation are leading to new and pressing needs. Regional gaps in the observing system remain. Meeting the needs of adaptation requires local observations targeted at specific local risks such as flooding, droughts, higher temperatures, sea level rise and storms.

GCOS has been recognized by the UNFCCC since 1997 as the programme that leads the improvement of systematic observations to meet the needs of the convention. WMO has also recognized the fundamental importance of GCOS to the Global Framework for Climate Services.

GCOS has reviewed the current global observing system for climate and identified those actions that are needed to improve climate observations. These are described in the GCOS Implementation Plan.

Many of these actions will need to be implemented by NHMSs and Members will need guidance and support in doing this. Many climate observations are already made by NHMSs in areas such as atmospheric physics and composition, hydrology and cryology. This should continue and the role of NHMSs in climate observations strengthened. Cooperation with other observing systems such as those focussed on the oceans or biosphere will also be needed.

Climate Observations are a key input into climate services and the Global Framework for Climate Services (GFCS) has recognized the role of GCOS in coordinating, assessing and defining the observational needs.

Some Members will need support in implementing these actions, especially in vulnerable areas, and support from other Members and donors is needed.

### 2. 2016 GCOS Implementation Plan

In 2015 GCOS produced the Status of the Global Observing System for Climate (GCOS-195) which presented an extensive account of how well climate is currently being observed, where progress had been made, and where progress was lacking or deterioration had occurred. While the current observing system has enabled great advances in understanding of the climate system and in the unequivocal identification of change and its human causes, more is still needed, especially at regional scales. With the increasing importance of climate mitigation and adaption new demands are being made on climate observations. Both mitigation and adaption are locally based and improved monitoring and prediction, on local as well as global scales are needed.

Building, inter alia, on the Status of the Global Observing System for Climate report, GCOS has produced The Global System for Climate: Implementation Needs (GCOS-200). This document identifies those actions needed to maintain and improve the global observing system for climate to meet the increasing requirements of science, the UNFCCC, including adaptation and mitigation, and the provision of climate services in general.

This new implementation plan assures continuity of the overall observing system for climate and builds on past achievements to ensure the system evolves as long-standing users' needs change and new users are established. The new plan responds to the growing need for systematic observations and climate information expanding from science-based assessments to include adaptation and mitigation needs. The plan also acknowledges that these observations are not just relevant to the UNFCCC, but also to a broader community.

## 3. GCOS Cooperation Mechanism (GCM) – Activities in WMO Regions

It was noted at Cg-17 that managing the impacts of climate change have and will present major challenges for developing countries. The information needed to design effective policies for mitigating the effects of – and adapting to – climate change and facilitating sustainable development fundamentally depends on the availability of climate observations. However, such observations must be of a high quality, have a long period of operations and be incorporated in a network of sufficient density to be useful in decision-making. Meeting these challenging requirements will be difficult for many developing countries unless they are provided with sustained assistance. The GCOS Cooperation Mechanism directly contributes to fulfilling the repeated requests of NMHSs to provide financial and technical support to developing countries to improve their climate observing systems, which will also contribute to meeting the countries' needs for improved global networks.

The GCOS Cooperation Mechanism was established to identify and make the most efficient use of resources available for improving climate observing systems in developing countries, particularly to enable them to collect exchange and utilize data on a continuing basis. In recent years, several countries have provided funds and participated on the GCOS Cooperation Mechanism Donor Board. The GCOS sponsors are constantly seeking additional countries that are willing to participate towards the goal of improved climate observing networks in developing countries. Since 2005, the GCOS Cooperation Mechanism has received and distributed over 3 million USD in support of the GCOS networks, primarily for the atmospheric domain through the GCOS Surface Network (GSN) and the GCOS Upper-Air Network (GUAN). The support provided has been wide-ranging and covers all aspects of the observing system life-cycle.

Recent projects of particular relevance have been:

- The supply of radiosondes and balloons (to Gan, Maldives; Nairobi, Kenya and Yerevan, Armenia), which was made possible through funding from Japan, Switzerland and the UK;

- The repair and service of the hydrogen generator in support of the upper-air observations at Gan, Maldives and Harare, Zimbabwe, which was made possible through funding from Germany and the UK;

- The provision of a consultant, based in Africa, to focus on improving the data availability from the GSN and GUAN stations in the region and working on high priority projects.

The following statistics are an annual summary of the monthly CLIMAT messages in the GCOS Climate Archive (National Climate Environmental Information, NCEI, US). According to the GCOS requirements a fully compliant GSN/RBCN shall have 12 CLIMAT reports. The values represent the 2016 percentage (Oct 2015 – Sept 2016) of stations that are compliant and those that are partially or non-compliant. In brackets are the statistics for 2015, 2014, 2013, 2012 and 2011 respectively.

## GCOS Surface Network (GSN)

| Region | No. | 12 Monthly CLIMAT | 6 - 11 Monthly CLIMAT | 1 - 5 Monthly CLIMAT | 0 Monthly CLIMAT |
|---|---|---|---|---|---|
| RA I | 155 | **35%** (29, 29, 32, 28, 23) | **30%** (31, 33, 33, 36, 39) | **7%** (15, 10, 10, 11, 14) | **28%** (25, 28, 25, 25, 24) |
| RA II | 258 | **80%** ( 78, 71, 73, 73, 75) | **12%** (14, 21, 19, 19, 19) | **2%** (2, 3, 2, 2, 1) | **6%** (6, 5, 6, 6, 5) |
| RA III | 101 | **63%** ( 61, 76, 89, 84, 69) | **30%** (35, 20, 6, 13, 28) | **3%** (0, 1, 0, 0, 0) | **4%** (4, 3, 5, 3, 3) |
| RA IV | 178 | **91%** (88, 88, 88, 81, 80) | **6%** (9, 10, 11, 17, 18) | **2%** (2, 1, 1, 1, 1) | **1%** (1, 1, 0, 1, 1) |
| RA V | 151 | **68%** (66, 70, 63, 58, 52) | **15%** (16, 17, 16, 23, 34) | **3%** (4, 1, 7, 7, 1) | **14%** (14, 13, 14, 12, 11) |
| RA VI | 138 | **83%** (77, 80, 82, 78, 81) | **7%** (14, 9, 12, 17, 15) | **2%** (3, 5, 2, 1, 0) | **7%** (6, 6, 4, 4, 4) |
| ANTON | 42 | **81%** (77, 79, 60, 45, 50) | **13%** (19, 19, 36, 43, 33) | **4%** (2, 2, 2, 5, 12) | **2%** (2, 0, 2, 7, 5) |

## Regional Basic Climatological Network (RBCN, includes the GSN above)

| Region | No. | 12 Monthly CLIMAT | 6 - 11 Monthly CLIMAT | 1 - 5 Monthly CLIMAT | 0 Monthly CLIMAT |
|---|---|---|---|---|---|
| RA I | 723 | **21%** (16, 17, 19, 13, 12) | **19%** (22, 20, 20, 23, 22) | **8%** (11, 8, 7, 12, 13) | **52%** (51, 55, 54, 52, 53) |
| RA II | 664 | **80%** (73, 71, 73, 67, 57) | **12%** (17, 18, 15, 22, 30) | **1%** (2, 4, 4, 1, 2) | **7%** (8, 7, 8, 10, 11) |
| RA III | 298 | **65%** (63, 73, 81, 73, 65) | **22%** (25, 14, 6, 15, 23) | **1%** (0, 1, 1, 1, 0) | **12%** (12, 12, 12, 11, 12) |
| RA IV | 337 | **77%** (78, 78, 72, 67, 66) | **11%** (10, 11, 18, 18, 18) | **3%** (3, 3, 2, 2, 3) | **9%** (9, 8, 8, 13, 13) |
| RA V | 247 | **64%** (63, 64, 59, 56, 50) | **16%** (18, 21, 17, 24, 34) | **3%** (4, 1, 9, 6, 3) | **17%** (15, 14, 15, 14, 13) |
| RA VI | 594 | **85%** (79, 81, 77, 77, 74) | **5%** (12, 8, 13, 15, 18) | **1%** (1, 3, 3, 1, 1) | **9%** (7, 7, 7, 7, 7) |

RA I is the poorest performing Region, with only 35% of stations meeting the minimum requirement, and 28% not providing any CLIMAT messages. This continues to reinforce the need for GCOS to focus its support in this Region. For the RBCN network, which includes the GSN, the situation is even worse in RA I with only 21% of stations meeting the minimum requirement. All other Regions show an increase in the percentage of stations with zero reports, suggesting that not all countries are sending CLIMAT messages for their RBCN stations, in addition to the GSN stations.

RA II is one of the best performing Regions for both the GSN and RBCN, with less than 10% of the stations not providing any CLIMAT messages.

The following table is the 2016 summary for the GCOS Upper-Air Network (GUAN) monitoring against the GCOS minimum requirements (25 daily soundings to 30hPa per month) for each Region, according to the monthly statistics provided by NCEP. In brackets are the same statistics for 2015, 2014, 2013, 2012 and 2011. For 2012 and 2011 these are based on availability according to NCEI.

| Region | Number of GUAN stations | **%** meeting minimum GCOS requirements in 2016 (% for 2015, 2014, 2013, 2012 and 2011) |
|---|---|---|
| RA I | 23 | **39%** (35%, 39%, 46%, 48%, 57%) |
| RA II | 32 | **87%** (87%, 87%, 87%, 87%, 87%) |
| RA III | 18 | **61%** (67%, 72%, 67%, 89%, 78%) |
| RA IV | 24 | **87%** (79%, 83%, 75%, 83%, 87%) |
| RA V | 38 | **84%** (79%, 76%, 74%, 84%, 87%) |
| RA VI | 24 | **87%** (87%, 87%, 83%, 92%, 87%) |
| Antarctica | 12 | **58%** (67%, 58%, 58%, 83%, 83%) |

Seven (7) of the GUAN stations (4%) were 'Silent' (zero reported TEMP observations) during 2016, which was the same as 2015 but a deterioration from 2014 (3 stations). In 2013 there were three (3) 'Silent' stations, four (4) in 2012 and five (5) in 2011.

RA II is one of the best performing Regions for the GUAN, with the below requirement stations being; 41780 (Karachi) which only has a PILOT balloon programme; 43599 (Gan) fault with hydrogen generator; and 48327/48453 (Thailand) which had radiosonde supply issues.

It is proposed that six (6) stations from India, operated by the India Meteorological Department, will be included in the GUAN from 2017.

## 4. GCOS Reference Upper-Air Network (GRUAN)

GRUAN is a global network site that, to the extent possible, builds on existing observational networks and capabilities. To date there are 25 sites of which 8 have undergone a rigorous certification procedure out of a target of 30-40 stations globally. The Lead Centre for the GRUAN has been established at the Lindenberg facility of the German Meteorological Center (DWD) and oversees day-to-day operations. GRUAN measurements are reference quality: long-term, accurate climate data records from the surface, to the stratosphere. These allow a reliable determination of upper-air climate trends, constrain data from more spatially comprehensive observing systems (including satellites and current radiosonde networks), and fully characterize the properties of the atmospheric column. Many of the GRUAN sites operate frost-point hygrometers capable of measuring water vapour through the lower stratosphere. GRUAN is not expected to operate in isolation and operating protocols developed within GRUAN are expected to be disseminated to GUAN sites and to the wider global radiosonde network with overall improved data quality as a result. In RA II there is an active GRUAN site at Tateno, Japan and a proposed GRUAN site at Xilin Hot, China.

## 5. Tropical Pacific Observing System (TPOS) 2020 project

The TPOS 2020 project is a finite lifetime development activity which will deliver important outcomes for the Global Climate Observing System. The first of three reports from the Project has been published following community review, which outlines recommendations and actions for the backbone observing system, and proposed pilot projects and process studies required to refine future observing system design, to improve forecast model parameterizations, etc. TPOS 2020 has now been approved as a WIGOS Pre-Operational Regional Pilot; and the transition and implementation will be coordinated through a Cross Cutting Task Team of JCOMM, which is being established following the thirteenth session of the JCOMM Management Committee (January 2017). Further information is available from www.tpos2020.org/first-report/.

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# SERVICE QUALITY AND SERVICE DELIVERY

## WMO Quality Management Framework

Resolution 7 (Cg-17) on furthering the WMO Quality Management Framework (WMO QMF) requested the Executive Council to establish an appropriate mechanism of promoting and guiding the further development and implementation of QMF.

A comprehensive analytical report on the current status of the WMO QMF was presented to the joint meeting of presidents of technical commissions and presidents of regional associations (PRA/PTC 2016) in January 2016. The meeting agreed on a set of five actions recommended to the Executive Council Working Group on Strategic and Operational Planning (EC WG-SOP).

EC-68 in June 2016, having considered the recommendations of the EC WG-SOP, agreed on the proposed Organization-wide approach to QMF and related roles of the Members, technical commissions, regional associations and the Secretariat as described in the Annex to Decision 76 (EC-68) which is reproduced below.

## Agreed actions for developing further the WMO Quality Management Framework

### 1. WMO QMF – follow up of Resolution 7 (Cg-17) and EC-67 recommendations

1.1 Following recommendations by PRA/PTC 2016 and EC WG/SOP-I meetings, the following actions have been agreed:

(a) Review and update the Quality Policy Statement to reflect the evolving requirements and nature of the WMO Quality Management Framework (QMF);

(b) Align and streamline the quality management activities of different programmes, technical commissions and expert bodies to ensure their consistency as part of the overarching Organization-wide QM policy. To facilitate this process, it is proposed to develop and publish a new high-level document “WMO Quality Management Framework”;

(c) Review and enhance relevant regulatory and guidance material. This includes development of new provisions/requirements for the implementation of Quality Management Systems (QMS) for certain service areas and updates of the existing WMO QMS guidance material to reflect the changes in the new ISO 9001:2015;

(d) Continue monitoring of implementation of the QMS requirements for aviation and related assistance to Members;

(e) Promote further the general recommendations for implementation of QMS by NMHSs stipulated in the WMO Strategy for Service Delivery and highlight the benefits for NMHSs. This implies continuation of the mechanisms of twinning and mentoring arrangements between Members.

1.2 Working arrangements (recommended by EC WG/SOP-I)

1.2.1 **Actions (a) and (b)**: the update of the WMO policy objectives (reference: WMO Quality Policy Statement (2007)) and the development of an overarching concise document on WMO Quality Management Framework will be overseen by EC. The two deliverables should be submitted for review by EC-69 in 2017. A mechanism of utilizing the accumulated expertise by Members in quality management primarily through online collaboration should include, inter alia, forming a Community of Practice (CoP) as an efficient way to engage experts in such collaborative work. For finalizing the deliverables, a one-week "writeshop" may need to be organized at the Secretariat. QM focal points of the TCs should be engaged in the preparation of the draft deliverables and a mature draft should be presented to PTC-2017 for coordination.

1.2.2 **Action (c)** on the update of the existing regulatory and guidance material (WMO-No. 49, Technical Regulations Vol. IV; WMO-No. 1001 and WMO-No. 1100) in order to align these documents with the new ISO 9001:2015, should be dealt with as a routine management and amendment of WMO publications. This would involve consultancy arrangements with appropriate experts from Members.

1.2.3 **Actions (d) and (e)** are considered of an operational nature and the working mechanisms being already utilized, e.g., twinning and mentoring, training (supported through existing or future development projects), should continue to be supported by Members and coordinated by the regional associations, as part of the implementation of the WMO Service Delivery Strategy.

1.2.4 The five actions will need support from the Secretariat. The Secretary-General has been requested to establish the most appropriate and efficient mechanism taking into consideration the cross-cutting and organization-wide nature of the QM tasks.

1.3 Organization-wide approach to quality management

1.3.1 This approach should engage all levels of the Organization with coordinated relevant roles, as follows:

(a) **Members** – to be encouraged and enabled through capacity development to implement QMS as part of their development plans linked to the WMO Strategic Plan and other relevant strategies, such as the WMO Strategy on Service Delivery and the WMO Capacity Development Strategy;

(b) **Regional associations –** to coordinate and facilitate the actions of their Members towards QMS implementation, e.g., establishment of twinning and mentoring arrangements; to encourage regional centres such as RICs, RTCs, RSMCs, RCCs to adopt relevant QMS approaches; to monitor the QMS implementation and address identified deficiencies thereof;

(c) **Technical commissions** – to further coordinate and develop QM elements in their respective areas, including regulatory provisions, as appropriate;

(d) **Secretary-General** – to enable with appropriate resources and assigned responsibilities the overall coordination of the implementation of the QMF by the Secretariat; to promote in the work of the Secretariat broader implementation of QMS elements and principles.

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# POLAR AND HIGH MOUNTAIN REGIONS

## YEAR OF POLAR PREDICTION

**Short introductory text:**

Following decisions and guidance from Cg-17 and EC-68, the Polar Prediction Project (PPP) Steering Group continued with development of the Year of Polar Prediction with a view of the implementation of its core phase from mid-2017 to mid-2019. This included, among others, development of: (a) an updated version of the Implementation Plan for the Year of Polar Prediction (version 2.0); (b) the educational and social components; and (c) a communication plan of the Polar-related WMO activities taking advantage of the Year of Polar Prediction field and modelling campaign.

***Update of the Year of Polar Prediction Implementation Plan***

The Year of Polar Prediction (YOPP) Summit, a major event in the further planning of the Year of Polar Prediction, was held from 13 to 15 July 2015 at the WMO Secretariat in Geneva. The Summit was attended by 116 participants from 20 different nations including scientists, stakeholders, as well as representatives from operational weather and climate prediction centres, international bodies and funding agencies. Live streaming of the plenary sessions turned out to be very popular with up to 750 users online at the same time. A number of important commitments and contributions to YOPP were offered at the Summit. The Climate and Cryosphere Programme (CliC) of WCRP, for example, in presenting their plans, identified the involvement of two new CliC fellows (Francois Massonnet and Alice Bradley) to define CliC's contributions to YOPP. Another high-level commitment was made by Met Norway, which offered to contribute to the development of a YOPP data portal based on the GCW experience. Furthermore, the International Arctic Systems for Observing the Atmosphere (IASOA) is in the process of designing a coordinated experiment plan for enhanced observations across their network during YOPP (for example: 4xdaily radiosonde launches). The main YOPP period is scheduled from mid-2017 to mid-2019. Given the relatively high costs of taking observations in polar regions, an agreement, on at least two intensive observing periods (IOPs) during the YOPP core phase, has been reached (May to October 2018 and January to March 2019). All details can be found in the new version of the YOPP implementation plan, which is available from www.polarprediction.net.

***Polar Regions Communication Plan***

The World Weather Research Programme promoted, in collaboration with GCW and WCRP, the development of a communication plan for disseminating the WMO activities on Polar Regions. The communication strategy will be developed around the tangible activities (that is ship and aircraft campaigns) organized in the framework of YOPP, but promoting all WMO initiatives.

**YOPP Special Observing Periods**

This section provides the details of the Special Observation Periods (SOP), which are planned for YOPP, and to request your participation in, and support to, YOPP.

Three core SOPs are planned:

- From 1 February–31 March 2018 in the Arctic;
- From 1 July–30 September 2018 in the Arctic;
- From 16 November 2018 to 15 February 2019 in Antarctic.

A fourth observing period in the Arctic is also under consideration to complement the Multidisciplinary drifting Observatory for the Study of Arctic Climate in winter-spring 2020.

The purpose of the SOPs is to serve as an enhancement of the routine observations. A first step would be to ensure that all observations which are currently done are shared through the Global Telecommunication System (GTS), in order to make them accessible to all Member States. A second step would be to enhance the current observation network by: (a) more frequent observations; and/or (b) adding observations in regions where the observation network is not dense enough – that is filling the gaps. Additional and/or more frequent observations will serve to improve predictions on all timescales through data assimilation processes.

WMO would value the Members' participation in logistical support and more and more frequent observations on atmospheric, marine, sea-ice conditions through surface observations, Automatic Weather Stations, the Aircraft Meteorological Data Relay (AMDAR) or flight data, buoys, radiosonde observations and surface synoptic observations (SYNOP) during the SOPs. One possibility would be to increase the frequency of radiosondes sounding north of 60° latitude to up to four times per day, if feasible.

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# PROGRAMME ACTIVITIES – REGIONAL ASPECTS

## DATA-PROCESSING, MODELLING AND FORECASTING

## SEAMLESS DATA-PROCESSING AND FORECASTING SYSTEMS

## SUMMARY

This information paper presents some of the results of the activities of the Steering Group on Seamless Global Data-processing and Forecasting Systems (GDPFS). It includes the GDPFS imperative for future Seamless Data-processing and Forecasting Systems and a draft white paper.

**(A) Future Seamless Data-processing and Forecasting Systems: The GDPFS Imperative**

**1. The proposed vision for the future GDPFS is:**

- The GDPFS will be an effective and adaptable monitoring and prediction system enabling Members and partners to make better-informed decisions.
- The GDPFS will facilitate the provision of impact-based forecasts and risk-based warnings through partnership and collaboration.
- The GDPFS will do so through the sharing of weather, water, climate and related environmental data, products and services in a cost-effective, timely and agile way, with the effect of benefiting all WMO Members, while also reducing the gaps between developed and developing Members.

The GDPFS will become increasingly integrated and seamless - following the discussion at the WWOSC (Montreal 2014) seamless spans over several dimensions including:

- Space and time (nowcasting, through weather and ocean forecasts for days and weeks ahead to long-range forecasts on seasonal and up to multi-annual scales).
- Disciplines and socioeconomic applications (hydrology and oceanography: flood, inundation, and water management; ocean forecasting, marine and coastal: wave and storm surge, sea ice; air quality and sand and dust storm; natural resources, energy, tourism, transport, etc.).
- Prediction of non-weather-related elements, including the assessment of likelihood and probabilities of impacts and risks associated with hazards taking into account vulnerability and exposure information to support risk-based decision-making.

And finally, the GDPFS will facilitate the transition of capability from research to operations and minimize the gaps between prediction skills and user’s needs. One may imagine the GDPFS in 2031, 16 years later, with the following characteristics:

- The overall accuracy of state-of-the-art global prediction models have improved enough to add 1.5 days of overall predictability, if the historical rate of progress of one day per decade is sustained: the goal set by Jule Charney and others when they launched GARP in the 1970s was achieved. Global models have resolutions below 5km, and mesoscale-to-submesoscale models significantly below 1km, down to a few tens of meters in urban and coastal areas for example.

- The sub-seasonal time scales are achieved, ensembles have routinely hundreds of members, shared between many global centres, and forecast products provide accurate and detailed information on such things as closed water budgets over most watersheds, wind, temperature and air quality information, including global greenhouse gases emissions information, from urban street canyons and outwards to the surrounding country side, regions and countries, finely detailed agrometeorological information from hourly cycles to seasonal, precise storm surges and wind damage estimates for cyclone landfall, sea state, including rogue waves, and dangerous shore currents, telecommunications and electricity blackouts from solar eruptions form the surface to satellites orbital heights, toxic algae blooms , pest migrations, etc.
- Most or even all this information is accessible as a public good product to all WMO Members, and their partners, and most of this information is available either in raw format, or directly as impact information. It is disseminated and presented in accordance with user's formats, and using point-to-point or, increasingly, cloud-to-point communication broadband technologies. It is quality controlled, validated and have metadata information associated, and in the case of forecast information, it is verified. Imbedded in the design of the system is a two-way feedback real-time communication capacity between the provider and the receiver of the data.
- The system has evolved through partnership agreements that allow it to absorb or carry information produced either by the private sector, academic institutions or by other closely related organizations to the traditional NMHSs.

## 2. Drivers – System and Service Requirements for Members

The requirements associated with this exercise can be framed as follows:

- The need to support and enable enhanced service delivery by Members' NMHS/ partners to their countries and customers.
- The need for NMHSs/partners/users to access GDPFS data, products and algorithms through a common user interface platform with information on quality and performance.
- The need to devise a system that would be flexible and easily adaptable.
- The need to expand collaboration with many other partners.
- The need for a clear focus on high impact products.
- The need for effective feedback mechanisms from users for quality management purposes.
- The need to involve users in product development.
- The need to enable NMHSs and other institutions with different levels of capabilities to share, discover and leverage each other's data resources.
- The urgent need to transit the GDPFS towards a system capable of producing impact-based forecasting and risk-based warning (IBF & RBW).
- The need to facilitate technological advances and science pull-through to operations.
- The need to enhance global efficiency by wider exploitation of collective capabilities.
- The need to increase the capacity development and training of the users in order to make the optimal use of the products of the seamless prediction system.
- The need to address policy issues associated with the seamless GDPFS.

## 3. Scope

To achieve its objectives GDPFS will:

- Build upon the existing network of GDPFS systems, services and centres to span the wider, seamless operational activities of WMO.

- Improve access to and utilization of seamless monitoring and prediction systems, products and data.
- Improve WMO's ability to support impact-based forecasts and risk-based warnings through enhanced collaboration through partnerships;
- Enhance integration between seamless monitoring and prediction capabilities of the TCs.
- Provide a mechanism to meet new predictive requirements of its Members.
- Make a major and unique contribution to United Nations agencies that are focused on protection of life, property and the environment.
- Improve the quality, interoperability, diversity and relevance of GDPFS information, data and products.
- Transit towards a new optimized global, regional and national production infrastructure.
- Provide multi-disciplinary training and capacity-building.
- Consider policy and open data considerations.
- Consider of the role of the private sector and academia.
- Develop methodologies for assigning quality and performance assessment.

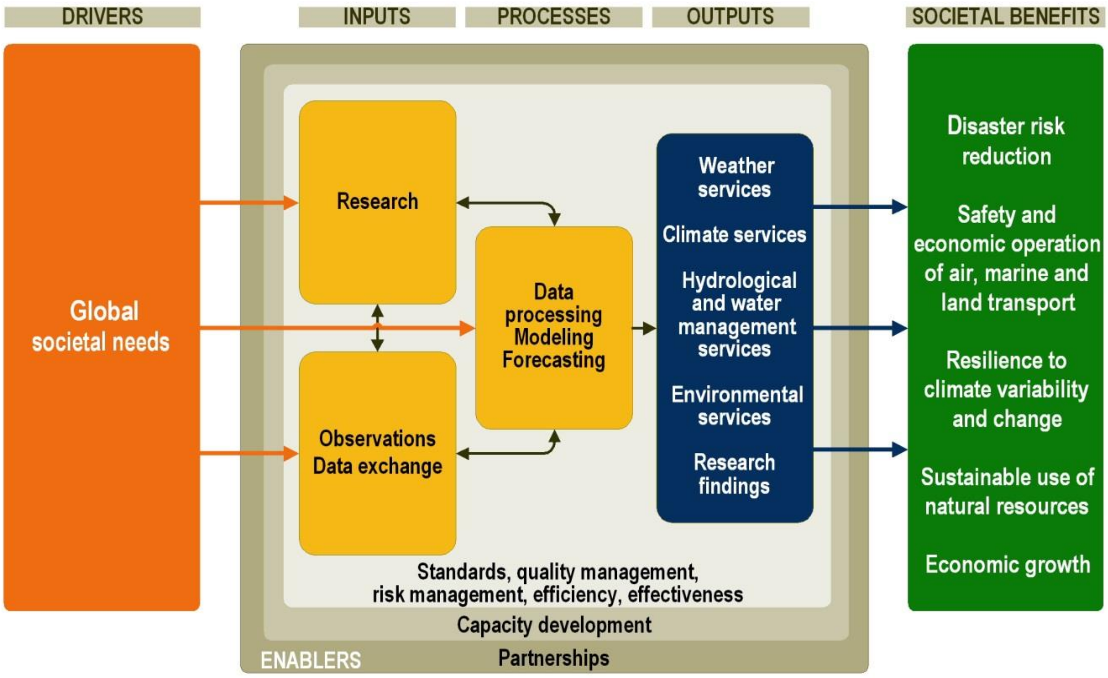


Figure 1: WMO Operational System (from WMO Strategic Plan 2016-2019) – GDPFS, the Heart of the System

## 4. Benefits

The benefits of the future GDPFS can be articulated along three axes: contribution to the UN and WMO agendas, the quality, diversity and relevance of GDPFS information and furthering existing and developing new partnerships. Improved seamless monitoring and prediction capabilities in a more cost-effective manner to enable improved service delivery because:

- The GDPFS will enable the wider exploitation and service delivery of science through seamless prediction capabilities, including ensembles, among WMO Members and enhance collaboration with its partner organizations for improved decision-making.
- This will allow access to an expanded set of predictive data and products resulting in wider protection of life and property in a cost-effective manner.

- The GDPFS will better enable NMHSs to meet expanding national mandates and achieve higher national visibility. In doing so, WMO Members will be able to better respond to natural hazards, improve environmental monitoring, and adapt to climate change and man-made environmental impacts. In this regard, the GDPFS will greatly enhance operational components of WMO Programmes, especially in developing and least developed countries and contribute to UN Agendas and international agreements.
- Integration will lead to efficiencies and cost savings that can be reinvested to focus on impacts and service delivery.

Members will be able to better access information from TCs with predictive capabilities including CBS, JCOMM, CCl and CHy in a consistent and seamless network of systems, centres and services and an improved pull-through of science from CAS and CCl. It will also better enable users to access and select the most appropriate data sources and algorithms to meet their requirements. Finally, TCs with a strong application focus such as CAeM, CAgM and CHy, will benefit from better access to quality assured seamless products, services and data.

## 5. Collaborative contribution to WMO Expected Results

The WMO Operating Plan 2016–2019 provides details on key outcomes, deliverables and activities to be implemented to achieve results defined in the WMO Strategic Plan, with the resources provided under WMO Results-based Budget. It is organized around eight Expected Results:

- Improved service quality and service delivery: Enhanced capabilities of Members to deliver and improve access to high-quality weather, climate, hydrological and related environmental predictions, information, warnings and services in response to users' needs and to enable their use in decision-making by relevant societal sectors.
- Reduced disaster risk: Enhanced capabilities of Members to reduce risks and potential impacts of hazards caused by weather, climate, water and related environmental elements.
- Improved data-processing, modelling and forecasting: Enhanced capabilities of Members to produce better weather, climate, water and related environmental information, predictions and warnings to support, in particular, reduced disaster risk and climate impact and adaptation strategies.
- Improved observations and data exchange: Enhanced capabilities of Members to access, develop, implement and use integrated and interoperable Earth- and space-based observation systems for weather, climate and hydrological observations, as well as related environmental and space weather observations, based on world standards set by WMO.
- Advance targeted research: Enhanced capabilities of Members to contribute to and draw benefits from the global research capacity for weather, climate, water and related environmental science and technology development.
- Strengthened capacity development: Enhanced capabilities of Members' NMHSs, in particular in developing and least developed countries and Small Island Developing States, to fulfil their mandates.
- Strengthened partnerships: New and strengthened partnerships and cooperation activities to improve NMHSs' performance in delivering services and to demonstrate the value of WMO contributions within the United Nations system, relevant regional organizations, international conventions and national strategies.
- Improved efficiency and effectiveness: Ensured effective functioning of policy-making and constituent bodies and oversight of the Organization.

Over time the GDPFS has contributed to the top seven ERs. Over the past decade, the GDPFS has contributed to improving services to NMHSs through the cascading forecasting process of the SWFDP and the move to seamless GDPFS will expand the breadth of services to a number of socioeconomic sectors, through application of cascading process to a variety of socioeconomic sectors such as hydrology, transport, and energy for efficient and timely decision-making.

Seamless GDPFS will take advantage of and facilitate the synergy between a number of existing and developing activities in other disciplines such as:

- **JCOMM**

Lead Centre for Wave Forecast Verification (LC-WFV). The JCOMM Expert Team on Waves and Coastal Hazards (ETWCH) established a Lead Centre for Wave Forecast Verification (LC-WFV) at ECMWF. The project involves 17 institutions around the world.

Coastal Inundation Forecasting Demonstration Project (CIFDP). The CIFDP aims to assist countries with issues of coastal inundation from oceanographic and/or hydrological phenomena, resulting from severe hydrometeorological events, to operate and maintain a reliable forecasting system that helps the national decision-making for coastal management. The main focus of the CIFDP will be to facilitate the development of efficient forecasting and warning systems for coastal inundation based on robust science and observations.

- **CHy**

The FFGS Flash Flood Guidance System (FFGS) project with global coverage has 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, the US Hydrologic Research Center (HRC) and USAID/OFDA. The collaboration between the Severe Weather Forecast Demonstration Project and the FFGS in the region of South Africa has demonstrated benefits of close cooperation among meteorological and hydrological forecasting.

- **CAgM**

CAgM expects a high-resolution information production (downscaling of climate/ observation/forecast and projection data) for agriculture and food security, which is one of the early warning targets for climate extremes. To estimate a prospect of crop yield, agricultural communities have requested the GDPFS to provide high-resolution seamless daily information of the necessary variables to be used in agrometeorological models. It also needs some ICT sharable platform under cloud computing environment for developing countries to support enhanced national AgMet services.

- **CCl**

The definition, implementation and operationalization of the GPCs galaxy (individual GPCs and associated Lead Centres on MME and SVS on the seasonal time scales) is a very successful example of benefits gained for the entire climate community linked to CBS/CCl joint efforts, through the GDPFS. The establishment of mandatory products made available via individual GPCs websites and LCs websites under the WMO umbrella improved significantly the access to seasonal forecasts and their possibility of post-processing (especially downscaling and tailoring) at the RCCs and RCOFs levels and then consequently at the national levels. Last but not least one of additional products from the GPCs galaxy is the GSCU (Global Seasonal Climate Update), which is recognized to be a key element in support to their global, regional and national users, especially for preparation of relevant seasonal outlooks.

- **CAeM**

The ICAO Global Air Navigation Plan (2014-28) based on the implementation of the phased Aviation System Block Upgrades (ASBU) approach will require the increasing integration of high-resolution meteorological data into 4-D Air Traffic Management (ATM) decision support systems to support and enable more efficient trajectory-based (gate-to-gate) operations. This transition from the traditional product-based 'briefing and advising' approach to one based on the application of best data by ATM decision support systems will inevitably result in significant changes to the current models of aviation meteorological service delivery with consequent impacts on and challenges for MET Services within the overarching framework of the WMO GDPFS. There is a significant opportunity to further enhance the relevance of the GDPFS given that high quality meteorological science, modelling, observations and interoperable data will be key enablers in ensuring the successful implementation of the ICAO GANP.

- **ECMWF**

ECMWF has been and continues to advance weather science by incorporating an increased level of complexity of physical and chemical processes and the interaction between atmosphere, ocean, sea-ice and land into the model. As a contributor to the GDPFS, ECMWF expects that by 2025 it will provide ensemble predictions of high-impact weather up to two weeks ahead. It will also provide a seamless approach, aiming towards predictions of large-scale patterns and regime transitions up to four weeks ahead and global-scale anomalies up to a year ahead.

- **CAS**

CAS was the originator[1] of the decisions by EC-LXI in May 2009 to implement:

- A unified approach to multidisciplinary weather, climate, water and environmental prediction research and to a step up in high-performance computing investments for coordinating and accelerating weather, climate, coupled chemical and hydrology model development, validation and use.
- Closer linkages between research, operations and users through Forecast Demonstration Projects (FDPs) that accelerate technology transfer.
- The review and rationalization of the roles and mandates of the WMO Commissions, and the improvement of their effectiveness in capturing optimal science input through WMO decision-making, thereby enhancing WMO Member’s capabilities in research, observations, prediction and services.

CAS has also delivered the Sand and Dust Storm operational service (an example of multidisciplinary product), as well as being behind a number of significant improvements in NWP technologies. Looking forward, CAS is now ready to move up to IG3IS, HIW, S2S, GURME, Air Quality and GURME production of new products, which will have potentially large impacts on climate change mitigation policies or life shortening and illness resulting from bad air.

[1] EC-RTT report to EC-LXI in May 2009, titled: Challenges facing Prediction Research: A report of the EC Task Team (EC-RTT) on Research Aspects of an Enhanced Climate, Weather, Water and Environmental Prediction Framework

## (B) DRAFT WHITE PAPER – SEAMLESS GDPFS

## 1. Preamble

### 1.1 The successes of the past

WMO, and its Members, have, since its creation, successfully met a number of major technology jumps: for example, the switch from data plotting and map drawing by hand, and more or less subjective synoptic analyses to a NWP-based system using supercomputers and automation technologies, then later on to global modelling, highly efficient and accurate numerical methods and sophisticated data analysis systems, then further on to global operational usage in data assimilation of space-based observing systems in real-time, then on to ensemble methods that allowed a probabilistic estimate of the accuracy of the forecast and finally, recently, to the so-called seamless and integrated modelling approach which expands by orders of magnitude the potential applications of weather and climate modelling systems.

It is thus with a high level of confidence that we should approach the next technology transitions: correctly managed, our responses will, as in the past, result in further improvements of the excellence, relevance and impacts of our products, and thus contribute, overall, to further improvements in the security and socioeconomic progress of all our Members, thus reducing further the gaps that separate some of us today.

### 1.2 Challenges for the future

The World Meteorological Congress, at its seventeenth session (Cg-17), noted the rapidly evolving transformations in the practice of operational numerical weather prediction, particularly the integrated or seamless modelling approach, and recognized:

- That all WMO constituent bodies and numerous subsidiary expert level groups provide a complex framework for coordination and collaboration in which a large number of decision-makers and experts from virtually all Members and partner organizations address matters related to the Data-processing and Forecasting System (DPFS).
- That emerging requirements from the services-oriented programmes, such as aeronautical, marine, agriculture, health, and public weather services, as well as requirements from a wide range of hydrometeorological-related emergencies, or from implementing disaster mitigation strategies, require an enhanced integrated, holistic and seamless DPFS in order to be relevant to users' decision-making.
- That an enhanced integrated, holistic and seamless Data-processing and Forecasting System could have the potential to lead to important benefits for Members and their National Meteorological and Hydrological Services (NMHS) and the Organization as a whole.
- That the integration of the technical support to meet the on-going and emerging requirements from different sectors of society in a single system (in a multi-dimensional/multi-disciplinary approach) would be more cost-effective and relevant to decision-makers and users.

Cg-17 therefore decided, through Resolution 11 (Cg-17), to initiate a process for the gradual establishment of a future enhanced integrated and seamless WMO DPFS, in light of the conclusions of the first World Weather Open Science Conference (WWOSC-2014, Montreal, Canada, August 2014), and requested the Executive Council to formulate Terms of Reference for this process, and a description of the set of products the system should produce, for consideration by the eighteen session of the World Meteorological Congress (Cg-18) in 2019. This paper responds to this request by describing: (a) the requirements; (b) the reason why we are doing this; (c) the vision and scope for the future Global Data-processing and Forecasting System (GDPFS); (d) linkages with observations and data exchange, applications and services, research, regional bodies, and capacity development; (e) the benefits;

(f) opportunities, success factors and challenges; and (g) the mechanism for implementation and timelines.

## 2. Considerations

### 2.1 System and service requirements by WMO technical programmes

The requirements associated with this exercise can be framed as follows:

- The need for a clear vision for the future of the GDPFS that would contribute significantly to the long-term positioning of WMO as a world leader in facilitating the provision of both data and forecast products encompassing not only traditional weather-related products, but also increasingly a widening spectrum of environmentally-related information, in the spirit of the integrated and seamless approach.
- The need to devise a system that would be flexible and easily adaptable to the many technical and expanding service needs and requirements emerging in the user and producer communities, without necessitating a complete rebuild of the system, now, or in the future (for example, standardization on model/system output formats "or" transformation scripts to achieve transformation of standardized formats).
- The need to expand collaboration with many other partners, not necessarily in the traditional family of NMHSs, and adjust the GDPFS to facilitate this openness; for example, earth system modelling, including atmosphere, oceans, land, cryosphere, chemistry interactions, etc.
- The need for a clear focus on high impact products, whilst respecting the professionalism of some users, particularly in the marine, hydrological and agrometeorological sectors, who are well trained and aware of the impact which certain environmental conditions create and as well, the need to have all Members of WMO benefit from state-of-the-art data and products specific to their particular needs.
- The need for a system where two-way feedback between producers and users is not only facilitated but also recognized as a key to success. This could be achieved through the creation of a User Interface Platform (UIP).
- The need to enable NMHSs and other institutions to share and leverage each other's data resources and to identify other sources of data e.g. Crowd Sourcing, future mobile phone systems as meteorological observation platforms, road/rail/ marine vehicles as data sources through similar systems as AMDAR on aircrafts, Nano-technology, etc.
- The need to clearly separate policy issues (EC and Cg domains of governance) from internal operational and management issues.
- The urgent need to transit the GDPFS towards a system capable of producing impact-based forecasting and risk-based warning (IBF & RBW).

The future GDPFS system will need to be designed to help deliver in the most satisfactory and efficient way the new types of services required by the users with the overarching objective to contribute to Disaster Risk Reduction. This will necessitate a close interaction between the providers and the users of the services, and the requirement for a mechanism which strongly encourages and facilitates feedback between these two parties, such as a User Information Platform (UIP), something which is seen as lacking for now and that could be enabled by social media.

Another very important aspect to consider is the move towards impact-based forecasts and risk-based warnings, e.g. not merely providing a future state of the environment to the users, but actually providing the potential impact of this future state: and for many, if not the majority of the impacts, they will be at the State level, and will depend on socioeconomic type information (preparedness, local transportation, building and power infrastructure status and disaster management rules, etc.), as on the quantitative physicallybased information itself. One example that was provided is that unless one has access to hydrological reservoir management rules and practices, a global attempt to provide an operational flood forecasting service runs the risk of being seriously flawed.

In defining a future state of the GDPFS (in connection with WIGOS, WIS) one will need to make decisions on what priorities the core services provided to WMO Members shall be addressing, and what position WMO, and its services oriented programmes and Commissions wish to retain for themselves and their partners.

The service aspects requirement is one of the fundamental dimensions and reason for the existence of the GDPFS. This will define in a significant way the structure of the GDPFS itself. We will consider six of these services areas in particular, but will also discuss briefly Earth system environmental and socioeconomic services.

### 2.1.1 Observations and data exchange

The GDPFS, WIGOS and WIS constitute the World Weather Watch (WWW) components and as such, evolution of the GDPFS is closely linked to WIGOS and WIS. If indeed one wishes to proceed with a global implementation of the seamless and integrated forecasting system, it is necessary that access to enhanced observation data through WIGOS and WIS is coordinated with non-traditional partners.

Looking for example at the data needs for hydrological, agrometeorological and marine forecasts, this will represent a formidable challenge, for a number of reasons. An important characteristic of these three particular applications is the need for both global, regional and very fine spatial scale data requirements for informed decision-making, and this at all timescales. Another one is the fact that these three sectors have developed their own data-related processes or procedures, often quite dissimilar to traditional weather or even climate-related usage. They are also very often outside the traditional world of NMHSs organizationally, and have developed their own dissemination and decision processes, as well as different partner and user bases.

The rapid development of data related technology (big data, crowd-sourcing, cloud computing, etc.), which has already led to the creation by the private sector of fine scale user tailored agrometeorological services in Africa, totally outside of the WMO programme structures. We can, therefore, expect many more similar initiatives for different sectors of environmental predictions.

### 2.1.2 Public Weather Services (PWS)

- While the increased resolution of the Limited Area Models (LAMs) has helped to provide good information for PWS, convective weather activities remain a challenge to predict accurately. Data suites derived from radar-based nowcasting systems, merged into model output at time ranges of 2-4hrs, can address this challenge but the technology is still out of reach for many NMHSs, even in the developed world.
- Ensemble Prediction Systems (EPS) consume a very significant percentage of the resources of the major centres running global models, but we are not exploiting this rich information to its full extent. Many users simply do not have decision-making systems that are sophisticated enough to incorporate this probability-based information.
- User-education is needed here, and also more social-science research into how users make decisions, and to what extent they can absorb this complexity of information or sharing. In other words, training is a major gap.
- Primarily the training of front-line forecasters in, for example, the use of RSMC products and guidance, in the proper interpretation of EPS data, etc. If the NMHSs cannot properly organize for the adequate training of their own staff, what hope is there in providing training for users?

- New requirements: The need to incorporate weather information with data from other sources (vulnerability and exposure data, crowd-sourced observations of weather itself or its impacts etc.) means that there is a need to develop visualization platforms that allows all of this diverse data to be coherently presented and examined by forecasters (or consulting meteorologists, which is what forecasters may become). These platforms will probably be GIS-based, so the meteorological world needs to get to grips with how best to incorporate this technology.

### 2.1.3 Climate services, including support to the GFCS

- Specialized centres: Their designation and monitoring processes should be improved and should evolve. It is important to have some clear criteria and metrics to assess the compliance of the labelled centres and their activities. It is also important to elaborate standards for operations, especially at the regional level (e.g. RCCs and RCOFs), including the need to label products and services (with WIS compliance). New functionalities should also be introduced (e.g. help desk function, user support, etc.). Last but not least, global monitoring centres do not presently exist, whereas this is the case for data and forecast products.
- Climate services perspective: There is a clear need to add this dimension within the GDPFS, especially with respect to CSIS and its interface with the User Interface Platform (UIP). In this respect, the involvement of organizations or entities, which are not operational (in the NMHS sense), but are nevertheless providing information routinely should be addressed. Adaptations will be necessary for tailored information for decision-making (especially impact forecasts), and of course, these should be evaluated and monitored.
- Climate Service Toolkit: The development of such tools should be conducted in close collaboration with CBS and have strong linkages with the GDPFS (functionalities, standards, etc.), noting that the necessary downscaling/upscaling functions should be part of the process.
- Feedback processes: Some feedback processes are missing or are not efficient, particularly with people outside our traditional climate community, and for the RCCs and GPCs.
- Verification: It should be adapted to the service provision, especially beyond the products themselves, focusing on the impact of the use of the information (e.g. demonstrated value of the services provided).
- Climate change information and the new GDPFS: It should be integrated in the functionalities described in the GDPFS. Likewise, we should extend the described functionalities across all the timescales (making sure we preserve and ensure the consistency within the seamless provision of information).
- Additional points: Using a system approach will allow a full picture to emerge, and the possibility of assigning the necessary priorities and importance for each component of the system. There will be a need to create and monitor relevant labels for the tools used, and the provision of the information (e.g. clear identification of authoritative voices on Internet, labels for candidates to the CST, etc.).

### 2.1.4 Hydrological services

The Commission for Hydrology (CHy) shapes the water-related activities of WMO and addresses issues related to the basic hydrological observation network, water resources assessment, flood forecasting and management, adaptability to climate variability and change and promotes exchange of technology and capacity-building. In particular the outcomes of its deliberations provide guidance to WMO Member countries and the WMO Secretariat for the implementation of the Hydrology and Water Resources Programme of WMO.

- Its major activities are: (1) quality management framework; (2) data operations and management; (3) water resources assessment; (4) hydrological forecasting and prediction; and (5) water, climate and risk management.
- The responsibilities of NHSs are: (1) observation of surface waters (stages and discharges); (2) data quality control and primary processing; (3) hydrological balance and water resources management; (4) hydrological forecasting; and (5) water quality, ground water monitoring and assessments, etc.
- Concerning runoff or flood generation processes, one needs to consider that initial conditions (soil moisture, groundwater, snow, reservoirs) are very important, the high spatial variability, and the temporal and spatial development of floods (basin-scale determines a forecast lead time).
- The forecast ranges in hydrology extend from hours to years. Whilst flood forecasting is a national responsibility, depending on the basin scale, it often requires international and regional cooperation (for example, in Europe, EFAS) and also GloFAS (GFP) and G-WADI (UNESCO-IHP).
- NHSs are users of meteorological and climatological services (data, forecasts) usually not within one NMHS. Also, levels and ways of cooperation between NMSs and NHSs differ significantly among countries and regions.

The needs of CHy and NHSs are: (1) observations and short-term forecasts (basic); (2) service delivery as a tailored product for hydrological application (no GRIB); and (3) bias corrected and downscaled to the resolution of the hydrological model, and verification, preferably from an authoritative source.

It is unclear at this time what form the contributions of CHy and NHSs should or would be: developed hydrological services typically provide observations in near real-time, flash flood guidance, short- to medium-range flood forecasting, and seasonal runoff prediction, with an aim to provide these in a seamless way to users.

### 2.1.5 Marine meteorological and oceanographic services

The long-term objectives of WMO Marine Meteorology and Oceanography Programme include, as a priority, enhancing the provision of marine meteorological, oceanographic and climate services. The coordination of implementation and development is made through JCOMM, primarily in generation and analysis of observations and knowledge of the marine atmosphere and ocean in support of numerous applications, including:

- Enhanced safety of life and property at sea and coastline through improved forecasts of natural and anthropogenic hazards such as storm surge, sea level rise, harmful algal bloom, tsunami, ocean acidification, and oil spill trajectory.
- Contribute to the prevention and control of marine pollution, sustainable development of the marine environment, coastal area management and recreational activities, and in support of the safety of coastal habitation and activities.
- Contribute to development of ocean-based economic and industrial activities.
- Contribute to coordination and enhancement of the provision of data, information, products and services required to support atmosphere and ocean weather forecasts and detection and prediction of climate variability and change.
- Advance understanding and improve predictability of the global integrated Earth system.
- Contribute to improve marine and ocean forecasting from the global to the coastal scales by incorporating research innovation in operational systems.
- In doing so, JCOMM promotes a state-of-the-art, globally distributed, and fully integrated marine observing, data management, and services system based on present and next generation technologies and capabilities. The main challenges that the Marine Meteorology and Oceanography Programme (MMOP) is facing are:
    - Enhancing the coordination of global real-time, near-real-time and delayed-mode (up to 1 month) data acquisition of ocean data between the

"oceanographic community" and the National Meteorological and Hydrological Services, including the national navies, oceanographic institutions and centres, operational and research centres, etc.
- Moving from the "full scale global operations" to the regional and national implementation in order to meet user needs. This may be achieved through developing a marine equivalent of the WAFC concept, where a very few global centres are responsible for the deep water areas, with regional and national inputs being provided for near shore and coastal areas.
- Meeting the user's requirements and establishing good connections between the end product users, their producers, as well as with data providers, and observational programmes. Within this, the role of governance of the safety services must be considered, where ensuring connections with, for example, the International Maritime Organization (IMO), are paramount.
- Sustaining the global ocean observing system (in situ and satellite based) in order to achieve optimal sampling capabilities for analysis, reanalysis and forecasts.
- Organizing training workshops and on-line learning modules for Capacity Development at the different stages of the production line.
- Ensuring that relationships with other agencies engaged in the provision of safety information, such as IMO and the International Hydrographic Organization (IHO) are robust and resourced appropriately.

Moreover, end-users will soon require new application areas, driven both by safety at sea, and socioeconomic pressures. Some examples are:

- Offshore resource exploration.
- Military and defence operations.
- Marine engineering.
- Sub-surface communications.
- Tsunami prediction and warning systems.
- Storm surges and coastal defence communities.
- Ship routing and navigation.
- Operations in the marginal ice zone.
- Pollution monitoring prevention and clean-up.
- Marine and coastal environmental management.
- Space weather impacts on safe navigation.
- Synoptic, seasonal and other long-term forecasting.
- Climate prediction at different time scales.
- Sustainable management of commercial fishing.

Many of these, if not most, will require crosscutting collaborations between programmes of WMO and IOC but also others: a recent example is the WMO coastal inundation forecasting demonstration project (CIFDP) which was initiated jointly by JCOMM and the Commission for Hydrology.

### 2.1.6 Aeronautical meteorology services

International aviation meteorological service provision is coordinated and overseen by the International Civil Aviation Organization (ICAO) and is supported by and contributes to the GDPFS. The services, underpinned and informed by the necessary guidelines, manuals and standards, are delivered through two World Area Forecast Centers, seven Tropical Cyclone Advisory Centers, nine Volcanic Ash Advisory Centers and the numerous Meteorological Watch Offices (MWO) and Airport Meteorological Offices. In addition there are plans for the development of regional hazardous (aviation) weather advisory centers for space weather, other meteorological hazards and nuclear emergencies.

The ICAO Global Air Navigation Plan (2014-28) based on the implementation of the phased Aviation System Block Upgrades (ASBU) approach will require the increasing integration high-resolution meteorological data into 4-D Air Traffic Management (ATM) decision support systems to support and enable more efficient trajectory-based (gate-to-gate) operations. This transition from the traditional product-based 'briefing and advising' approach to one based on the application of best data by ATM decision support systems will inevitably result in significant changes to the current models of aviation meteorological service delivery with consequent impacts on and challenges for MET Services within the overarching framework of the WMO GDPFS. There is a significant opportunity to further enhance the relevance of the GDPFS given that high quality meteorological science, modelling, observations and interoperable data will be key enablers in ensuring the successful implementation of the ICAO GANP.

### 2.1.7 Agricultural meteorology services

The Commission for Agricultural Meteorology (CAgM) is proposing an AgMet Data Collection and Production Centers (DCPC) to support climate and weather services innovations for the sector of Agriculture and Food Security.

Global centers (WAMIS DCPC) would develop:

- Operational activities for downscaling NWP outputs for applications in the agriculture and food security sectors including S2S in space, time and element.
- Operational activities for reanalysis on historical/in-situ data including non-meteorological data (i.e. crop monitoring) from remote sensing platforms.
- Operational data services for high resolution agrometeorological products and supplementary RS information (on a semi-real-time basis).
- Operational activities for ICT sharable platforms under cloud environments with GIS-online interfaces for agricultural and food security applications.

Whilst regional centers (WAMIS Portal) would provide:

- Operational services for Agrometeorological Bulletin archival and dissemination.
- Operational activities for Early Warning services on agrometeorological hazards/ extremes, based on region specific needs.
- Operational data services to support regional Agrometeorological Outlook Services.
- Training in the use of operational Agrometeorological products and services including promising tools.

This vision will clearly necessitate significant changes in the traditional GDPFS operations, as well in WIS and by extension WIGOS. Non-traditional data, computing needs and products dissemination and visualization will need to be addressed. For example, a specialized or dedicated GISC/DCPC of WIS to support WAMIS grid/cloud portal will be a promising solution in improving resource sharing among CAgM member countries by allowing them to make better use of remotely located ICT resources for agrometeorological services at national/regional scale, especially when it provides interactive forecast-based agrometeorological services via simple Internet access.

Also the need for very high resolution climate and weather products (obtained through downscaling or other means), spanning a time interval from minutes to years, is a challenge that present seamless modelling technology (Sub-seasonal to seasonal (S2S) is an example) has not yet successfully resolved, and many countries do not yet have the capacity or the resources to run the kilometre or even meter scale models that will be needed. Nevertheless, the modernization of agrometeorological services under a WMO leadership role, and involving evolved GDPFS, WIS and WIGOS components could be an interesting option.

### 2.1.8 Earth system environmental and socioeconomic services

Clearly the ability to assimilate large volumes of data and to run ever more complex Earth system models has been a major achievement of the GDPFS over the past few decades.

The Sand and Dust Storm (SDS) forecasting system is a good recent example. Can these models be expanded to either: (1) incorporate all natural and man-made hazards, such as space weather, air quality issues, from urban bad air events to regional events such as forest and slash and burn smoke, vector-borne diseases, toxic algae events, etc.; or: (2) provide an increasing diversity of decision-making support systems in fields like integrated ecosystem management tools, food production (fisheries, agriculture), air, land and sea transport, energy production, particularly renewable in a context of a carbon-free economy, urbanization and megacities environmental management issues, and many other products, so that science can deliver to society a truly holistic multi-hazard forecast and warnings system? If this is so, then how are the other actors and partners to be brought into the picture? The organizational and technical framework that global meteorology has developed could be expanded to encompass many other hazards or decision-making aids to civil society, but is this desirable and, if so, how does WMO go about leading or sharing this development?

## 2.2 Regional requirements

In order to expand the scope of the GDPFS stronger linkages with WMO constituent bodies (Congress, EC, RAs and technical commissions) and related programmes will need to be established. Therefore, a close interaction of CBS with CAS, CCl, CHy, CAeM, CAgM, and JCOMM, as well as most of their main programmes (GAW, WWRP, WCRP, GCOS, GOOS, WHOS, PWS, HWRP, WSP, PWSP, WIS, WIGOS, DRR, etc.) will be necessary in order to successfully evolve the present structure of the GDPFS by ensuring all facets of requirements impacted by the GDPFS are accounted for in the design of the future system. Also, given the more local aspects of some of the new services, RAs will need to become more closely involved, depending on the specific focus and scope of the new services.

To expand a bit on the links with regional bodies (e.g. TCP regional bodies, RAs working groups) one should note that regional bodies, by their very nature, represent classes of both providers and users of observational, data and forecasting products. RAs also provide a governance mechanism to plan and coordinate activities as well as providing a mechanism to enable supra-national discussions and decision-making. Those bodies vary immensely in their capacities and political influence, and specific products' needs, this being driven by both socioeconomic, administrative and political factors, and the specific regional characteristics that weather, climate, hydrological and other environmental impacts display in the specific global areas which they cover. As the GDPFS evolves towards the provision of an expanding set of products, and focuses increasingly on forecasting impacts, close coordination with regional bodies will become more and more essential. Forecasting impacts at an increasing space and time resolution requires access to whole new sets of observations and data, as well as an expanding suite of numerical models, ensemble products, etc., coupled with a diverse suite of dissemination and presentation technologies: these will vary greatly between regional bodies. The challenge of closing the gaps between 191 NMHSs spread across the Earth will require increased linkages, through better feedbacks and interactions.

## 2.3 Requirements of other international organizations

Linkages with a number of other international organizations, including humanitarian agencies, some in the UN family, UNEP, UNESCO, IAEA, WHO, some outside, like GEO, or ICSU are also required to ensure the GDPFS system of the future can respond to their needs.

## 2.4 Research

The value chain in meteorology is rapidly being diversified. From mainly providing weather forecasts to the general public, the NMHSs and the weather enterprise progressively develop and apply downstream models/post-processing of NWP forecasts or reanalysis for a range of applications in specific societal sectors. Marine forecasts, GCM climate projections and environmental predictions are also included. Many of these have been rendered possible by adopting the seamless and integrated modelling approach.

Examples of specific applications include road traffic, aviation (civil and military), shipping, energy production and consumption (wind, solar, hydro, fossil), air quality, integrated global greenhouse gas information system, biogeochemical fluxes (ecosystem including freshwater impact), estimation of emissions of trace chemical species, agriculture, tourism, high impact weather (wind, precipitation, temperature), avalanches and mud slides, coastal erosion, storm surges, offshore weather including waves, icing on infrastructure, emergency preparedness (search and rescue), oil spill, drifting infrastructure; volcanic ash dispersion, dispersion and deposition of radioactivity, large explosions and fires, forest fires, sand and dust storms. The list can be made even longer.

The important point here is to note the foundational role of research in making this evolution possible. WMO, largely through the CAS (GAW, WWRP, GURME), CCl, JCOMM and other research programmes, some of which are co-sponsored, such as the WCRP, GCOS, and others, has played a key role in making it an operational reality. It should also be noted that most of the research initiated, coordinated or facilitated through partnerships by WMO are services and policy driven, as is most of the research conducted within the NMHSs. Research activities provides an important 'sentinel' role in that it facilitates an over the horizon S&T watch, which allows better strategic planning for future operational programme and the GDPFS.

The future evolution of the GDPFS will require stronger links with research, and eventually the capacity to test novel operational products. Some examples that have been discussed are TIGGE and TIGGE LAM, S2S, Polar-related experimental products, CHAMP, and IG3IS. By making these prototypes available to WMO users, it will be possible to obtain feedbacks from the whole WMO community and, hopefully, their partners: these feedbacks will be essential to assess their accuracy, identify potential improvements, and in the end help tailor them more closely to their needs. In other words the new GDPFS will need to facilitate a smooth transfer of research results into operations.

## 2.5 Capacity development, including education and training

The evolution of the GDPFS will require a strong focus on capacity development, education, training and support to those countries facing difficulties in assessing and using the new types of products that will be made available to them. There will be a challenge in interpreting the value (accuracy, relevance and impact on decision-making processes) of specific products, as well as disseminating and presenting them to users. A key issue here will be for WMO to ensure that the progresses made in a subset of countries in providing a more diverse, probabilistic based and impact focused set of products is actually useful to those countries that presently lack the capacity to make best use of these, countries which are often those who need them most.

## 2.6 Why are we doing this? Evolution, instead of revolution

There are a number of reasons for re-examining the GDPFS. On the one hand, we are witnessing rapid advances in information and computing technologies (including such objects as smartphones, cloud computing and data storage and retrieval, big data and deep data analytics concepts, fast broadband links, extremely powerful computing technology (capacity doubling every 18 months), novel visualization and display techniques, etc.). On the other hand, we are seeing steadily increasing demands from users for highly-localized weather forecast data provided at a high temporal resolution (at least hourly for the first 12-24 hrs.), spanning a much broader level of dimensions than traditional weather products, and focusing on risk warnings and impact forecasts. In other words, both the "system" and the "services" aspects will need to evolve.

Moreover, with the successful introduction of the seamless or integrated approach in Earth system modelling, and the possibility through coupled modelling techniques to touch many non-traditional weather-related applications, there will also be a need to re-examine if, how and how much the GDPFS needs to evolve in order to interact or liaise with non-traditional providers of data and services (such as climate services, hydrological services, atmospheric air quality services, space-weather services, maritime or polar services, etc.).

Simultaneously, while adapting to these changes, the GDPFS will need to maintain its role as a global enterprise which enables NMHSs to fulfil their national obligations, keep on enhancing WMO’s role in disaster risk reduction and mitigation, increasing its linkages with the Climate Services Information System (CSIS) of the GFCS, and ultimately contributing to the reduction of service capability gaps between developed and developing countries.

## 3. The Vision

The proposed vision for the Future GDPFS is:

- The GDPFS will be an effective and adaptable monitoring and prediction system enabling Members and partners to make better-informed decisions.
- The GDPFS will facilitate the provision of impact-based forecasts and risk-based warnings through partnership and collaboration.
- The GDPFS will do so through the sharing of weather, water, climate and related environmental data, products and services in a cost effective, timely and agile way, with the effect of benefitting all WMO Members, while also reducing the gaps between developed and developing Members.

A good way to crystalize this vision is to project us in 2031, that is, 14 years from now, and have a look at what the GDPFS might be.

At that time, the overall accuracy of state-of-the-art global prediction models will have improved enough to add 1.5 days of overall predictability, if the historical rate of progress of one day per decade is maintained; we will finally have achieved the goal set by Jules Charney and others when they launched GARP in the 1970s. Global models will have resolutions below 5km, and mesoscale models significantly below 1km, down to a few tens of meters in urban areas for example. We will have achieved:

- Full predictive skill at the sub-seasonal time scales and Ensemble Prediction Systems (EPSs) will routinely have hundreds of members and outputs shared between many global centers.
- Forecast products providing accurate and detailed information on such things as closed water budgets over most watersheds, wind, temperature and air quality information in urban street, canyons and outwards to the surrounding country side.
- Detailed agrometeorological information from hourly to seasonal cycles.
- Precise storm surges and wind damage estimates from cyclone, sea state, including rogue waves, and dangerous shore currents.
- Products on telecommunications and electricity blackouts due to solar eruptions and on toxic algae blooms, pest migrations, etc.

Most or even all of this information will be made accessible as a public good product to all WMO Members, and their partners[2], and most of this information will be made available either in raw format, or directly as impact information. It will be disseminated and presented in whatever medium or format the users have chosen, and use point-to-point or, increasingly, cloud-to-point communication broadband technologies. It will be quality controlled, it will be validated and will have metadata information with appropriate publications in the peer-review literature and in the case of forecast information, it will be verified. Imbedded in the design of the system will be two-way feedback and real time communication capacities between the provider and the receiver of the data.

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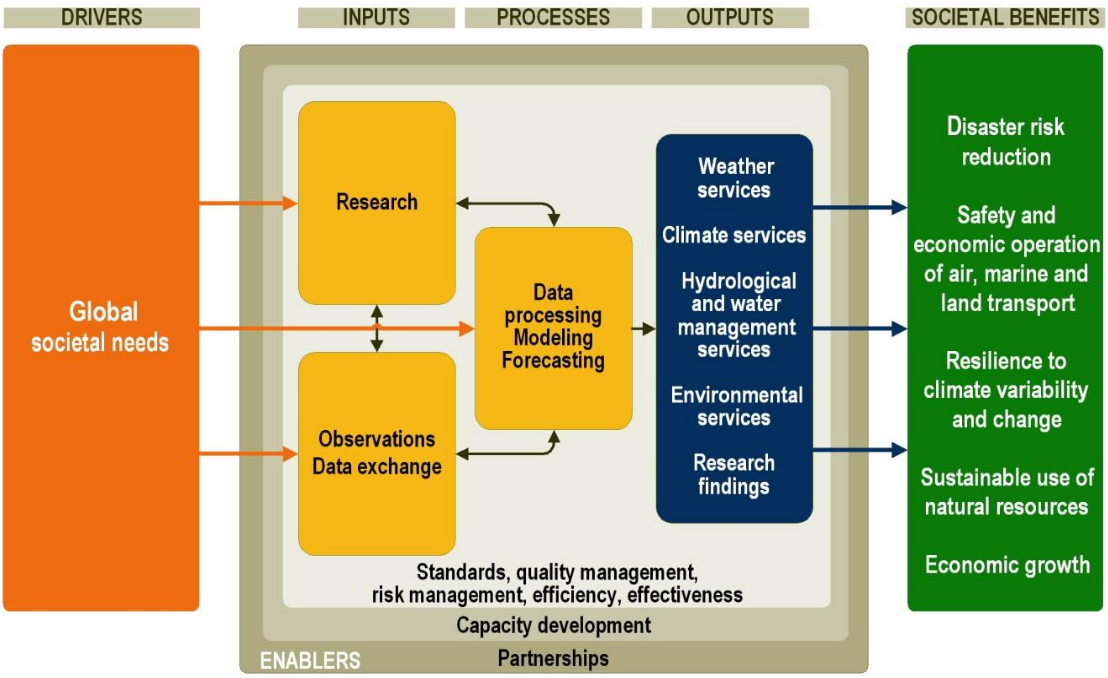
[2] The assumption here is that the public funding of computing facilities that NMHSs can use is maintained at a sufficient level; if not, the possible landscape described above may not be entirely funded or controlled by state-owned institutions

The system will also have evolved through partnership agreements that allow it to absorb or carry information produced either by the private sector and academia, or by other closely related organizations to the traditional NMHSs, and by using alternate and less expensive technologies, such as cloud computing, crowdsourcing, smartphones, open source software, big data storage, etc., as well as potential partnerships with the private sector or other non-traditional information providers, gaps between WMO Members in terms of ease and cost of access and positive user impacts will have decreased significantly.

In fact, these recent technology changes open up the possibility of both NWP and GCM future development strategies (both science content and operational implementation and capacity) being "community driven", relying on distributed computing and data storage capacities, thus making relatively obsolete the need for purely national facilities. By inference, it thus follows that a potential path for the future GDPFS will be the development and provision of tools giving access to pooled resources, so that NMHSs can obtain the tailored information they need to address requirements of their users of services, thus bypassing the need to implement modelling capacities at home. An extension of this approach, is for the users to directly access the information they need to link to their decision-making processes directly.

## 4. Scope (integration, standardization and interoperability)

The WMO Strategic Plan 2016-2019 will largely determine the scope of the evolution of the GDPFS. It will be driven by the need to support the role of NMHSs in their response to global societal needs facing the world's population at large, focusing not only on those sectors for which they traditionally have had a leading role to play, mainly in reducing the socioeconomic impacts of weather- and climate-related disasters in their respective countries, but more broadly on contributing to an expanding number of sustainable development issues related to weather, climate, water and related environmental factors, such as contributions to a carbon-free economy. This expansion or broadening of the role of the GDPFS will be made possible by a number of factors, a key one being the seamless and integrated modelling approach, which allows the delivery of new environmental services in support of sustainable development across all timescales and disciplines (agriculture, hydrology etc.). Standardization and interoperability of data and products will also be important factors in providing this broadening. The figure below, extracted from the WMO Strategic Plan 2016-2019, illustrates the role of the NMHSs in responding to those needs.



The GDPFS, whilst maintaining its traditional role for standards, validation, verification and overall quality management for data-processing and forecasting services, will expand its linkages with other WMO constituent bodies and Programmes, with emphasis on regional bodies (TCP regional bodies, RAs) and programmes. It will also contribute to the capacity development of its client and user base, and will strengthen its interactions with research, through participation in the design and operational testing or validation of novel products emerging from RDPs and FDPs.

## 5. Benefits

The benefits of the future GDPFS can be articulated along three axes: contribution to the UN and WMO agendas, the quality, diversity and relevance of GDPFS information and furthering existing and developing new partnerships.

### 5.1 Contribution to the UN and WMO agendas

Quoting from the 2016-2019 WMO Strategic plan (p. 10, The need for Sustainable Development), the following three Global Societal Needs (GSN) are of fundamental importance in defining priorities:

- **Improved protection of life and property** by mitigating the impacts of hazardous weather, climate, water and other environmental events and addressing the need for improved safety of transport on land, at sea, and in the air.
- **Poverty eradication, sustainable livelihoods, food security, sustainable access to water and energy, and economic growth** by making available weather, climate, water and related environmental services to support the post-2015 sustainable development agenda, climate risk management, climate resilience, green economy, disaster risk reduction, food security, improved health and social well-being of citizens, water management, and tapping renewable energy resources such as hydro-, solar- and wind-power.
- **Sustainable use of natural resources and improved environmental quality** by designing weather, climate, water and related environmental services to manage atmospheric, terrestrial and water resources at all timescales, and the development and management of other natural resources.

From the preceding sections, it is clear that the proposed evolution of the GDPFS will benefit this important and central item in the UN Agenda. It also will contribute to a number of WMO priorities for 2016-2019, in particular improvement of the effectiveness of high quality impact-based forecasts and early warnings for extreme weather, climate and water events for disaster risk reduction, the GFCS and aviation

### 5.2 Improving the quality, diversity and relevance of GDPFS information, data and products

The new GDPFS will allow testing and eventual operational inclusion of many projects, all focusing on one or more of these priorities: SWFDP expanding to other regions on the globe, GLOFAS exploring the capacity to forecast flood risks on the globe, MAP providing a successful example in a mountainous area, CHAMP looking at forecasting the hydrological budget of the North American Great Lakes area, CREWS, an initiative which aims to significantly increase the capacity for seamless Multi-Hazard Early Warning System (MHEWS) in the climate realm in order to generate and communicate effective impact-based early warnings, and risk information for hazardous hydrometeorological and climate events, IG3IS which could provide at a very high spatial resolution an integrated 4D snapshot of GHG and other related atmospheric chemical constituents budget over a given area of interest, GAMOS and ChiNAMOS, a global agrometeorological outlook system, space weather operational forecasting system, mitigating risks of solar eruption activity to satellites, electrical and communication networks, etc. This list is a subset of the full number of initiatives now being examined by WMO, its Members and partners.

## 5.3 Opening a door for new partnerships

The common thread here is that the seamless and integrated modelling paradigm (with a high resolution core of atmospheric, oceanic and land surface modelling capacity, coupled with complex Earth system modelling subsystems, and benefitting from powerful supercomputing capacity, broadband communication capacity, massive data storage capacity) will be easily accessible by an increasing number of non-traditional users. Moreover, using new dissemination technologies (cloud-to-point delivery of the information, smart phone access, emerging social media technologies), client focused adjusted means of product presentation or communication as opposed to traditional methodologies, will bring in new partners to the WMO world, including private sector operators and academia. It is unclear at this time how this will all evolve, but in the end, this transformation should yield direct benefits to decision-makers or ordinary clients and users in optimizing either their business practices, risk mitigation of threatening environmental high-impact events, or longer range adaptation and sustainable strategies.

# 6. Opportunities, success factors and challenges

## 6.1 The context

The business of weather, water, climate and Earth system observations and predictions is, first and foremost, a science-based, high technology (largely IT-related) just in time information enterprise.

This information has global reach and relevance, and is key to countless decision-making processes, be it on: (1) global policymaking issues (UNFCC, UNCDD, Ozone, COP 21, transport of atmospheric pollutants and toxics and associated morbidity, nuclear weapons controls, etc.); (2) global weather-, water- and climate-related disaster risk reduction; and (3) important and steadily growing socioeconomic impacts.

Recently, significant scientific progresses in both observational technology (particularly space-based observing systems), as well as novel climate and weather data assimilation and modelling practices, have led us to the possibility of vastly expanding the diversity of its environmental information potential.

At the same time, it is fair to say that both the information technology and dissemination related processes are evolving at an accelerating pace (the transition of the traditional paper-based written media to a largely IT-based dissemination process (tablet, smart-phone, etc.) provides a good example of this acceleration. Given that there is a global market for the types of products NMHSs and GPCs, largely publicly funded, are on the verge of making available, it is reasonable to expect an increasing interest from the private sector with potential partnerships with the academia to take a share of the market (in fact, this has already started).

## 6.2 Important issues needing consideration

Throughout this information paper, and in many of the discussions with the group of experts, it is possible to identify a number of important issues that need some consideration if the proposed evolution of the GDPFS is to be a success.

### 6.2.1 Access to data and observations

One important consequence of moving towards a seamless and integrated modelling approach is access to new, and sometimes non-traditional observations, and at much higher spatial and temporal resolutions than has been customary. This follows from the fact that forecast products will expand to new disciplinary or thematic domains, which so far have not been part of the traditional inputs and outputs of production centres of NMHSs.

There are also other dimensions to consider: standards and formats, interoperability of the information, information storage, telecom bandwidth and downstream computing and post-processing (this may lead the GDPFS to establish globally distributed storage farms such as what CERN has done to manage the information generated by LHC; make available the basic information along with the approved piece of code to generate the post-processed information on a cloud computing platform). This will require discussions on availability and data exchange protocols between WMO Members and other international, national and regional organizations.

Similarly, the concept of "risk-based warnings" and "impact forecasting" requires access and sharing of novel types of data (infrastructure, emergency decision-making policies, population distribution, transportation networks, etc.), not easily amenable to present guidelines on formats, metadata, validation, etc. Moreover, some countries could be reluctant to make this data available for any number of reasons. Again, there will be a need for extensive discussions between WMO Members and the other organizations controlling access to these data.

#### 6.2.2 Future products: optimal production, dissemination and usage

Many of the future warning and forecast data and information, such as those related to air quality, hydrological, marine, aviation, agrometeorological information, and more generally speaking socioeconomic applications, are often of use for organizations outside traditional NMHSs. These organizations have their own internal decision-making processes, data and forecast-related protocols, partners and user bases. A good example was provided for hydrological forecasting, and similar issues exist for other services. Again, WMO will need to establish the necessary partnerships, in order expand the current GDPFS menu to these new products. In fact, concerning so-called "big data" related issues and applications, WMO has already started such a process.

Another key aspect, which requires further consideration, is user information and feedback. The creation by WMO of some form of user information platform (UIP), geographically or thematically structured, is perhaps worth some further consideration.

#### 6.2.3 Transition towards a new global, regional and national production infrastructure

Many of the products also depend on very high-resolution observational and modelling grids, often at the kilometre size and less. A relatively small number of countries actually have the capacity (human and technical) to operate at these resolutions, and at this time, at least, it does not seem feasible to generate these products at a small number of central locations (e.g., GPCs) for global distribution. In order to help prevent the widening of a gap between the countries which possess the capacity and those that do not, some transitory and eventually permanent solutions will have to be found, perhaps involving private sector or academia-led initiatives, or use of new computing technologies, such as cloud-computing.

#### 6.2.4 Training and capacity-building.

The increasing complexity of many of the products will in turn increasingly require an increase in the capacity of the users (NMHSs or others) to make optimal usage of their information content. This will represent a challenge for many countries, and necessitate a strategic re-think of WMO's and its Members approach to training and capacity-building initiatives.

#### 6.2.5 Organizational impacts (impacts on GDPFS Centers)

Finally, as this expansion of the scope of the GDPFS happens, and numerous agreements and partnerships with new international, national and regional organizations are struck, there could be pressures from countries and partners to revisit the current membership structures. For example, it could be that some countries will wish to be represented by different types of managers or administrators along with the current Directors or CEOs of NMHSs.

### 6.3 Policy considerations

From the preceding sections, it becomes clear that whilst the evolution of the GDPFS proper remains an internal management and operational issue, it will also require EC and Congress to consider a number of policy issues, which will guide, clarify and facilitate this evolution.

#### 6.3.1 Open data policies

In order to fulfil WMO's vision, and a successful evolution of the GDPFS, free and open access to all necessary data, particularly observations, is critical. We are already witnessing initiatives, some led by the private sector, where new observations are either not shared openly, or if so, at reduced spatial and temporal resolutions, or against cost. At the same time, while most observations paid for by the public purse have open access some are not. There are also related issues linked with formats, validation and quality control. Eventually, some policy decisions will be required to clarify these issues and propose some solutions.

#### 6.3.2 Role of the private sector and academia

This issue is closely linked with open data policies. However, there is also increasing evidence that some major corporations are moving towards establishing their own internal data-processing and forecasting capacities, including global analyses and predictions. Given the potential value of applications derived from such capacities, mostly targeting specific socioeconomic sectors, they will in a sense potentially duplicate or compete with public good products, made available through the future GDPFS. At some point, some policy decisions might be needed to as to how the GDPFS should take these developments into account.

#### 6.3.3 Training and capacity-building

We have already alluded to the linkages of this aspect to the evolution of the GDPFS. In the discussions leading to this paper, there was often mention of the high priority that should be given to this issue. As the products become even more complex, both in their content, as well as in their formats (ensemble products, impact based, etc.), and target many new and different non-traditional sectors, training and capacity-building will become essential to the success of the GDPFS evolution, unless one accepts the possibility of increasing gaps between Members. Discussions between Members, and eventually policy decisions, will probably be needed.

#### 6.3.4 GDPFS products quality assessment

One of the key benefits obtained by WMO Members from using GDPFS products should be assurance on their quality, accuracy and reliability. Concerning weather prediction activities, for which the WMO is the UN lead agency, and which is its core business (GDPFS, WDS, etc.), there is no official external scientific assessment (produced say by an international team of experts) of these aspects. Yet, we do produce an assessment for weather modification activities, which clarifies what is scientifically validated, and what isn't.

Perhaps WMO should consider proposing to put together a core team of experts, under the leadership of its RES and WDS programmes, and reinstate a similar activity, which was dropped some years ago.

This would set the bar for what are good products, and those that fail to be based on good science! It would reaffirm WMO global leadership in these matters, but would also contribute very positively to the future evolution of the GDPFS, help its users in their decision-making activities, and facilitate the discussions with potential new partners.

## 7. Terms of Reference (ToRs) for the Steering Group on Seamless GDPFS

The Steering Group on Seamless GDPFS (following the request by Cg-17), will be chaired by the president of CBS and will comprise of representatives of technical commissions and regional associations, with the following Terms of Reference:

(1) Provide guidance and monitor the development of the process for the gradual establishment of a future enhanced integrated and seamless WMO Data-processing and Forecasting System;

(2) Manage the integration of new components in the GDPFS, including addressing synergies with and requirements of all WMO Programmes and Regions, through active consultations with technical commissions and regional associations;

(3) Develop a description of the set of products the system should produce;

(4) Complete the White Paper along with the Implementation Plan for the process, for consideration by EC-69.

## 8. Roadmap (phases)

### References

### List of Acronyms

**Annex:** Outline of the Implementation Plan (see RA II-16/Doc. 4.6(1))

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# PROGRAMME ACTIVITIES – REGIONAL ASPECTS

# RESEARCH

**Research advancements in early warning systems**

**Support of Sand and Dust Storm Warning Advisory and Assessment System**

**Major Achievements, Remaining Gaps and Challenges**

## I. Introduction

The WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) performs its research activities following its recently adopted Science and Implementation Plan 2015-2020 by Cg-17. The SDS-WAS, which is a federation of partners organized around regional nodes, integrates research and user communities (such as health, aeronautical, and agricultural users). Presently there are three nodes: the Northern Africa-Middle East-Europe Node (hosted by Spain), the Asian Node (hosted by China) and the Pan America Node (hosted by Barbados and the USA). Upon request of the United Nations General Assembly 2015, a joint UN Environment Programme (UNEP)–WMO-UN Convention to Combat Desertification (UNCCD) 'Global Assessment of SDS' report was published and presented to the United Nations General Assembly 2016. Further joint efforts of UNCCD, WMO and UNEP to elaborate a Technical Guide for SDS are planned. Good progress was made within the SDS-WAS Asian Regional Node, building the dust operational center hosted by CMA, together with other countries of the region. More efforts for the West Asia region are needed.

## II. Key achievements

- On request of the United Nations General Assembly 2015 a joint UNEP-WMO-UNCCD 'Global Assessment of SDS' report (with Preface signed by the United Nations Secretary-General)was presented to the United Nations General Assembly 2016 and published.
- SDS-WAS nodes produce and distribute dust forecasts, together with verification analysis and additional ad hoc parameters. The Barcelona Dust Center provides operational SDS forecast since 2014 for the Northern Africa-Middle East-Europe region, and CMA hosts a new operational SDS center for Asia (under approval).
- The first Africa/Middle East Expert Meeting and Workshop on the Health Impact of Airborne Dust, combined with the kick-off meeting of the WMO SDS-WAS Steering Committee, was held from 2 to 5 November 2015 in Amman, Jordan, and organized by WMO, WHO, UNEP, EUMETSAT and the State Meteorology Agency of Spain (AEMET). The outcome of the workshop was a set of recommendations addressed to policymakers, managers, service providers and researchers aimed at raising awareness of the negative impacts of airborne dust on health, and designing and implementing preparedness and mitigation measures for the region.
- The second SDS-WAS Steering Committee (SC) meeting for global coordination, together with the International Workshop on Asian dust and aerosol, and the Asia Node SDS-WAS Steering Group (SG) meeting, were held from 20 to

23 September 2016 in Jeju, Korea, hosted by the Korean Meteorological Administration (KMA). The current status/progress in three Regional Nodes and coordination of further plans were discussed and reported by the SC. It was stressed that joint efforts are needed to help Middle East countries to build facility(ies) for regional SDS-WAS. The workshop addressed the effects of high dust aerosols concentration in Asia. It concluded that good progress in SDS research and modelling/ forecasting in the Asian region has been made, including satellite observations data utilization for dust forecasting and verifications.

- The application to build the dust operational center hosted by CMA together with other countries of the Region (such as Korea, Japan, Mongolia, Kazakhstan) was approved by the Asia Node SDS-WAS SG, SDS-WAS SC, PRA-II, WWRP SSC, CAS and will be further considered by CBS (almost all steps that have been done now, and will be reported in CBS-16). The Steering Group stressed that more attention should be paid to dust observations and networking (integration with GAW). The Steering Group decided to support the drafting of a white paper on dust observation requirements and modelling needs. Due to the good achievements in data assimilation for SDS modelling, it was decided to build a working group for data assimilation within the Asian Node.
- International Workshop on Sand and Dust Storms (SDS) held in Istanbul from 4 to 7 October 2016, hosted by the Turkish Ministry of Forestry and Water General Directorate of Combating Desertification and Erosion (ÇEM) and the Turkish Meteorological Service (TSMS), with technical cooperation from WMO, UNEP and UNCCD. One of the main goals was to coordinate actions for West Asia among different United Nations and national agencies; the recommendations are provided.
- WMO SDS-WAS presented suggestions for United Nations consultations regarding the developing Sand and Dust Storms UN resolution being put forward by the G77 political grouping.
- The Islamic Republic of Iran Meteorological Organization (IRIMO), EUMETSAT and the WMO Barcelona Dust Forecast Center (BDFC) jointly organized the fifth Training Course on WMO SDS-WAS Products (Satellite and Ground Observation and Modelling of Atmospheric Dust) that was held in Tehran, Iran, from 5 to 9 November 2016. More than 30 people were trained.

## III. Remaining gaps and challenges

- Gap No. 1: Better coordination and harmonization between UN bodies, countries in the Region and different national agencies are needed for realization of the West Asia regional research plan and establishment of regional SDS-WAS centre(s).
- Gap No. 2: Dust observation regional/national networks need to be integrated and harmonized with the WMO GAW system. Data access to the existing aerosol observations is still very limited.
- Challenge No. 1: To provide WMO SDS-WAS part/contribution (SDS observations, prediction, early warning and assessments) to the Technical Guide for SDS, coordinated by UNCCD, within the year 2017.
- Challenge No. 2: The SDS-WAS Trust Fund is opened, but it is empty; contributions from interested countries are critically needed, especially for the Middle East and East Asia regions.

## IV. Partnerships and resources mobilized

- Joint closer coordinated efforts of RES, WDS and DRA/CAS and CBS for the research-product development chain are needed. Good outcome was demonstrated through cooperation between CAS and CBS on the establishment of SDS-WAS with the research and operational components. This example can be used as a prototype and provide clear rules and road maps needed for other projects 'from Research to Operation'.

## V. References:

1. UNEP-WMO-UNCCD report on Global Assessment of Sand and Dust storms: http://uneplive.unep.org/media/docs/assessments/global_assessment_of_sand_and_dust_storms.pdf
2. Sendai Framework for Disaster Risk Reduction (2015-2030)
3. 2016 International workshop on Forecasting Emissions from Vegetation Fires and their Impacts on Human Health and Security in South East Asia
4. 2016 Jeju SDS-WAS meetings: http://sds-was.aemet.es/events/international-asian-dust-workshop-wmo-sds-was-meeting
5. 2016 Istanbul SDS workshop: http://www.cem.gov.tr/erozyon/AnaSayfa/uktf1.aspx?sflang=tr

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**CAPACITY DEVELOPMENT**

**EDUCATION AND TRAINING PROGRAMME**

**REPORT ON EDUCATION AND TRAINING ACTIVITIES**

## 1. Introduction

As an important part of the overall capacity development activities of WMO, since the last session of RA II, namely during the 2013-2016 period, the thrust of the Education and Training Programme derived from the overall direction of WMO's priority programme areas. Activities also took into account the need to foster internal cooperation between development partners, increase networking among experts and assisting countries to build their internal capacity for national training. These activities and their outcomes are highlighted in this report, with a special section focusing on policy matters and how to enhance its effectiveness in the overall scheme of support to Members.

## 2. Key achievements

(a) *Ad hoc interventions through cooperation with development partners and institutions*

(i) Forecast competency

WMO has made arrangement with the China Meteorological Administration to host its fellows who are interested in enhancing their forecast competency after graduation. CMA hosts these fellows for up to 4 months on an annual basis immediately after graduation before they return to their home country. This experience has proved to be of great help to the beneficiaries.

(ii) Instrument maintenance and calibration course

The contribution made by Canada and Norway to the WMO GFCS enabled the mounting of courses on instrument maintenance and calibration in China and India, with experts from RA II and RA V as beneficiaries.

(iii) Research

Experts from a number of countries had the opportunity to benefit from short-term attachment up to 6 months at a time, in Kyoto University, Japan for training under Kyoto University's Global Centres of Excellence (GCOE) Programme on "Sustainability/Survivability Science for a Resilient Society Adaptable to Extreme Weather Conditions". The programme focuses on adaptation to climate change, extreme weather phenomena such as cyclones, storms, floods, droughts, and sea level rise, and subsequent water-related hazards that seriously affect people and societies around the world.

(iv) Others on meteorology and hydrology

RTCs in India, provided support to fellowships through waiver of tuition fees. The Philippines provided substantial support as host to fellows of RA V to stage specific long-term courses.

(b) *Coordination of management practices*

It is broadly understood that development of management capacity is not done through one avenue. Aside from the basic education that is acquired by managers, there is no doubt that the primary responsibility rests on various entities to put in place machinery for ensuring that an appropriate framework is put in place for enabling adequate management skills and practices. However, given the need to harmonize a number of activities at the international level, share experiences that matter, and also in light of the tradition of cooperation between Members, WMO has a number of activities in place in support capacity development on management of meteorological and hydrological services.

The ongoing activities include preparation and update of guidelines, support to online courses, offer of long term fellowships and cooperation with China in the coordination of the annual Study Tour of Permanent Representatives and Senior Managers, inter alia, as a way of exchanging views and experiences on management issues. As WMO and those Members who have participated over the years have seen the great benefit of the China Study Tour, plans are underway to develop a similar activity with another Member on an experimental basis, while others are being encouraged to consider initiating such activities.

In continuation of the WMO initiatives on management training, plans are underway for a one-day discussion session and exchange of views on management training within regional association sessions. The WMO Education and Training Office will also work with the WMO RTCs on how to incorporate management issues into their training curricula and schedules (see Annex I).

(c) *Continuing education, development of competencies and bringing new science into curricula and support to VLab*

(i) Continuing education

In 2015 and 2014, the combined RTCs of RA II offered 41 and 32 short courses, respectively, addressing continuing education and training needs in the Region. Over 950 foreign students were served by the RTCs during these two years for both fellowships and continuing education. However, many of those supported were from outside RA II. The level of productivity of the RA II RTCs is impressive, accounting for about 25% of the activity reported by all WMO RTCs (see Annex II).

The RA II RTCs have been proactive in developing and delivering courses to address WMO focus areas, including recent courses on delivery of climate services for agriculture and health (including pollution and dust monitoring), natural hazards and disaster risk reduction (including general forecasting for weather hazards), aeronautical meteorology, and improving weather and climate observations. The RA II RTCs are encouraged to design continuing education courses in concert with the advice of WMO technical programmes to ensure consistency with their latest guidance.

(ii) Competencies

Over the last 4 years the WMO technical commissions have been implementing new competency frameworks in many services areas of NHMSs. While the BIP-M, MT, H, and HT describe qualifications achieved most often through university study, competencies are usually develop through training and on-the-job experience.

The competency frameworks that have been approved so far by the WMO Executive Council or Congress, as well as those in development, are listed in Annex IV.

These competency frameworks are expected to aid Members by:

- Promoting high standards and consistency of services;
- Assisting in defining job skill requirements in the new areas, such as climate services;
- Guiding human resource allocation for developing climate services;
- Guiding personnel assessment;
- Specifying the contents of courses and other learning opportunities that will develop critical job skills;
- Specifying desired learning outcomes, learning activities and learning assessment approaches for training.

All RA II Member countries will benefit from careful study of these frameworks, particularly with the intention of adapting them to the unique service requirements and mandates of their NMHSs. All RA II Regional Training Centers should work diligently to meet the education and training responsibilities to aid regional Members in developing a competent workforce. They should do this by implementing training that directly addresses the competency frameworks, and document which parts of the frameworks their courses address. This will include orienting training toward applications, and not only background knowledge, using a variety of learning solutions to provide more support for competency development to more staff members of Members. It will also include better assessment and feedback practices to learners, as well as documentation of competency development. RTCs may also be asked to guide Members in assessing the competence of their staff members to help determine the most critical learning needs.

(iii) Bringing new science into curricula

WMO's technical programmes work with Members to continually upgrade the level of science and operational practices. RA II RTCs, NMHS training centers, and other education institutions, should remain aware of these developments by carefully reviewing the published WMO Guides and additional guidance offered to inform the creation of up-to-date courses. One of the goals of the ETR Office is to support this guidance with more direct recommendations for course designs, but to also encourage the RTCs and other training partners to package and share their up-to-date learning resources with other education and training partners in the Region. A principle goal of the WMO Global Campus feasibility study is to develop a shared calendar of course offerings and also a catalogue of learning resources that address recommended practices based on the latest science. All RA II Members are encourage to contribute to this important effort. Finally, as described in the newly published criteria for RTCs, all RTCs are encouraged to continue creating opportunities for their faculty members to keep their technical and pedagogical knowledge and skills up to date through continuing education and training—taking advantage of regional and WMO courses, WMO guidance materials, professional journals, and other self-study opportunities. A WMO VLab/KMA Training on 21-22 October 2016 in Jincheon, Republic of Korea, focussing on: (i) using data from next-generation meteorological satellites; (ii) cyclogenesis and tracking of convective clouds; and (iii) introduction of software and processing tools, travel support to participants is shared between WMO and KMA. KMA commits to fund around 20 participants. In addition to technical input, WMO committed to resources to fund travel of nominees of eight NMHSs that are members of the RA II WIGOS Project, and an additional six NMHSs representatives from countries that have recently benefited from new equipment to receive data from new-generation satellites

(Himawari-8). AOMSUC-7 and associated events was an excellent opportunity for these representatives to learn about technical details and applications of the satellite data.

## 3. Gaps and challenges

- *Status of Regional Training Centres*

The WMO RTCs were established on the basis of the need to fill the gaps in training facilities at regional level, and they have all been working in various ways to meet that objective. With the support of Members and particularly their host governments, RTCs remain important partners of the WMO Education and Training Programme in the development and implementation of its training activities at national, regional and international levels. As expected, mode of operation and level of delivery of the RTCs in the Region depend on the primary goal for which their parent institution is set, level of support they receive from their governing body, other resources available to them, cost of procuring training by potential beneficiaries, catchment population, language consideration, their outreach and to a certain extent their relationship with WMO, such as funds available for co-funding. A summary of the profile and recent activities of RTCs is attached as Annex I to this report.

With the primary support provide by the host country, WMO has been working closely with the RTCs as important partners in the delivery of education and training activities. These include working together to ensure adherence to a certain level of standards in their curricula, management of their activities, organization of training events and placement of short- and long-terms trainees. Annex II shows a list of WMO-related trainees hosted by the RTCs in RA II between 2013 and 2015.

As part of the ongoing effort to refocus WMO support to and cooperation with the RTCs and enhance regional delivery and network among institutions at regional and global levels, a plan is underway to promote exchange of experts between the RTCs as a way of enhancing cooperation between them. Under the proposed plan, WMO is facilitating the exchange programme through the Education and Training Office for experts who are interested in teaching and research as well as in participating in WMO activities outside their home country. While the nominee will be referred to as WMO Expert, the role of WMO will be limited to the process of screening, selection and facilitation of a bilateral contractual arrangement between the experts and the host institutions. The Secretary-General has already invited interested Members to: (a) provide information the area of specialization in which an experts are needed; and (b) indicate the duration for which they intend to host the expert.

## 4. Partnership and resource mobilization

- *China*

China is a major destination of WMO fellows. The arrangement for this is based on the Memorandum of Understanding (MoU) between WMO and the Ministry of Education of the People's Republic of China (MOE-PRC) which was signed in April 2007 for cooperation in the implementation of long-term fellowships in the fields of meteorology and operational hydrology. Up to 15 fellowships for BSc and MSc studies can be awarded each year to candidates from African countries under the initial agreement. Most candidates are to be selected from African countries, while the remaining will be selected from Least Developed Countries in Asia and Pacific Regions, and Small Island Developing States (SIDS). This MoU is under review.

- *Hohai University, Nanjing, China – Hydrology and water resources*

WMO and Hohai University in Nanjing China have been cooperating under the aegis of an agreement between WMO and the Government of China, signed in 2007, on the training of experts from least developed and developing countries. In order to strengthen this collaboration, a Memorandum of Understanding was signed in May 2014 between the two partners which should provide up to three MSc scholarships per year to the WMO Members, with preference given to nominations from least developed and developing countries. Plans are ongoing to sign an agreement with Hohai to increase to 20, the number of annual fellowships it offers.

- *Nanjing University of Information Science and Technology, Nanjing, China – Meteorology and postgraduate research*

A Memorandum of Understanding was signed in January 2012 between WMO and the Nanjing University of Information Science and Technology (NUIST) which should provide up to five scholarships per year to the WMO Members, with preference given to nominations from Least Developed and Developing Countries (LDDCs) and Small Island Developing States (SIDS). This agreement, which is specific to NUIST, was negotiated with university administration in response to the growing requests for fellowships in China. NUIST also gives a rare opportunity, through this arrangement, for fellows to purse PhD scholarships, as that level of studies is not usually supported by WMO.

## 5. Gender Equality

- *Ewha Womans University, Seoul, Korea*

There is increasing importance being given to higher education for female professionals so that women in developing countries are properly represented and fully integrated into the decision-making process regarding issues related to weather, water and climate. It is in this regard that WMO entered into an agreement with Ewha Womans University in May 2012 to jointly promote education of women in meteorology. This opportunity is exclusively open to women, and it has proved to help in the development of research capability of many experts in least developed and developing countries.

## 6. Conclusions and recommendations

Based on series of interactions with Members, experts and development partners, the following have been identified as issues of priority:

(a) Development and implementation of appropriate competency frameworks and augmentation of existing curricula with new science and technology issues;
(b) Continuous education, enhancement of research capability to keep track with developments in science and technology research;
(c) Broadening of partnerships with organizations, agencies and resource mobilization for formal and continuous education;
(d) Fellowships for the education of future generations of meteorologists and hydrologists, to boost succession management endeavors;
(e) Embedding of education and training as critical elements in the management and modernization of NMHSs;
(f) Promotion of research capability through stronger connections to WMO research programmes, graduate level fellowships and personnel exchanges;
(g) Exchange of experience and competencies through exchange of human resources;
(h) Enhancement of capacity of RTCs to deliver learning opportunities to meet the broad regional education and training needs;
(i) Participation in the developing WMO Global Campus, in terms of sharing resources, information on upcoming events, and collaboration in education and training projects with partner institutions;
(j) Need to support career of the female gender in meteorology and hydrology;
(k) Resource mobilization in support of national needs and institutional development.

The Regional Training Centres are required to continue to play various important roles in promoting the delivery of priority areas on education and training in the Region. In this regard, it is important for them to get as much support and possible from their respective host countries. It is also necessary to requests RTCs to ensure that they all:

(a) Align their courses along the lines recommended in WMO publication No. 1083 "Manual on the Implementation of Education and Training Standards in Meteorology and Hydrology";
(b) Send their annual major reports, and plans for their course offerings on a regular basis;
(c) Broaden the focus of their activities in the areas of management and application of meteorological and hydrological knowledge to socioeconomic development;
(d) Work more closely with other WMO centers such as the Regional Climate Centres (RCCs) and Regional Instrument Centres (RICs), and with scientific and research institutions in the areas of education and training;
(e) Aim at continuous improvement of their approach to delivery of education and training activities, especially by taking into account relevant information provided by WMO.

Annexes: 4

**ANNEX I**

**STATUS REPORT ON THE REGIONAL TRAINING CENTERS IN REGION ASSOCIATION II**

RA II is served by seven RTCs with 11 RTC components based in the Region, but it is also well served by RTCs such as Russia, Turkey, and Israel, as well as other institutions. This report covers the RTCs based in RA II only.

**CHINA**

Nanjing University of Information, Science and Technology (NUIST) – Nanjing

NUIST was approved by the WMO Executive Council as an RTC in 1993. The last review was conducted in April 2011, while the next intended review is yet to be confirmed. However, Cg-17 has extended CMATC's RTC status until 31 December 2017. RA II-16 intends to consider recommending "Reconfirmation" in September 2016, with EC-69 responding by deciding on "Reconfirmation" in May 2017.

NUIST specializes in international training courses designed to support the sustainable development of developing countries. From 2014-2016, NUIST has run 57 courses, with topics covering: long-range weather forecasting; monsoon meteorology; satellite meteorology; meteorological instruments; agrometeorology; radar meteorology; meteorological hazards and early warning.

China Meteorological Administration Training Centre (CMATC) - Beijing

CMATC was recognized as an RTC in 2002 with the last review being conducted in April 2011. The next intended review is yet to be decided; however, Cg-17 has extended CMATC's RTC status until 31 December 2017. RA II-16 also intends to consider recommending its "Reconfirmation" in September 2016, with EC-69 planning to decide on "Reconfirmation" in May 2017.

CMATC's special focus is meteorological training at graduate and technician-level. From 2013-2015 the Center has held 19 training courses which are focused on addressing meteorological theory and technology, including in: met observing techniques, weather forecasting, satellite and radar met, NWP, Graphic software applications in meteorology.

**2011 Extended Review**

The 2011 extended review held in October illustrates that both CMATC and NUIST offer outstanding facilities and equipment, which are conducive to meteorology and related fields in education/training. Noted was NUIST's strength in providing an international experience and the center's contribution to education and training. CMATC is also acknowledged for its tight linkage with the China Meteorological Administration, and its experience in distance education.

On the other hand, the two centers have faced challenges regarding the nature of training requirements of NMHSs in developing countries, due to social, political, economic, environmental and scientific and technological developments. There are also difficulties in teaching due to poor knowledge of the English language by some participants and short duration of training courses, which affect how the courses are understood by enrolled participants. Adding further to these limitations is: the low meteorological knowledge of some participants, scholarships only being available for undergraduate and MSc students, shortage of funds which has placed barriers for offering more courses, and the lack of some advanced equipment.

**NUIST** was recommended to:

- Assist fellows in overcoming their difficulty of integrating with the Chinese learning environment. This could be done by: utilizing a survey of the experience of other universities in coping with problems of international students to guide solutions, or using Hohai University's current approach in supporting international students.
- Establish tutorial time for each course.
- Maintain awareness that training must be localized when international fellows return to their countries.

WMO was recommended to support NUIST by:

- Supporting students in localizing their training by encouraging countries to supply local data from their home countries.
- Encouraging NUIST and other host institutions in China to give priority to students who wish to continue their studies, in terms of seeking local scholarship opportunities.
- Considering granting scholarships to candidates from other regions in the world, not only Africa.

**CMATC** was recommended to:

- Increase the already existing involvement of universities with CMATC, to better fulfill the mission of filling the gap between theory and operational work.
- Translate training material, particularly regarding climate change and increase the service to other countries by making English texts available on the web.
- Interact with international trainees before their arrival to Beijing using distance learning methods.
- Develop distance learning alternatives for the international courses that are normally delivered face-to-face.

WMO was recommended to support CMATC by:

- Working more closely with the Center in organizing and holding more operational meteorological training and on-the-job training related activities.
- Assisting CMATC in closing the gap between climatology and hydrology, as well as biology in view of the relationship between climate and water issues, biodiversity, desertification, health and others; by working more closely with other institutions and experts dealing with those issues.

## INDIA

<u>India Meteorological Department Training Centre (IMD) - New Delhi and Pune</u>

The India RTC components at Pune and New Delhi are part of the India Meteorological Department. They were both established in 1986; however, the Centers were formally recognized in 1988 with their last review being carried out in March 2011. Although the next intended review is yet to be decided, Cg-17 has extended the RTC status of the two Centers until 31 December 2017. Moreover, RA II-16 aims to consider recommending their "Reconfirmation" in September 2016, followed by EC-69 deciding on their "Reconfirmation" in May 2017.

The <u>*Indian Meteorological Department Training Centre in New Delhi*</u> specializes in 4 month initiation courses for met. Telecomm operators; and 4-6 months specialization/refresher courses in satellite and radar meteorology, atmospheric electricity, digital telecommunication and instruments. From 2013-2016 the center has offered 3 courses.

The *Indian Meteorological Department Training Centre in Pune* specifically focusses on: advanced meteorological training course, forecasters training course, intermediate met training course, no tuition fees & subsidized accommodation. Since 2013-2015 the Centre has run 10 courses, with 6 courses currently running from 2016-2017.

**2011 Extended Review**

The key problems noted for both Centers regards past participants with poor English and/or academic background. To bypass such difficulties, IMD was encouraged to utilize written tests, or similar, to assist the selection and admissions process to reduce the recurrence of this problem.

In addition, considering IMD in PUNE and New Delhi mainly meet the requirements for being reconfirmed as an RTC, the following recommendations were suggested in order to improve training for both centers. These include:

- IMD actively promoting education and training opportunities for RA II Members and annually contacting the regional association to address wider regional training needs.
- Regularly monitoring and maintaining hostel facilities in par with international standards.
- Courses to clearly state the learning outcomes and individual subject areas, including information on syllabus, reference material, study hours and term information.
- Requiring training staff to undergo train-the-trainer courses and linking the courses with the review of subject material and teaching approaches.
- For easy accessibility, establish a central register for international education and training activities to ensure that education and training activities are recorded. Additionally, any secondments and training undertaken as part of these Centers should be linked to RTC activities.
- Regarding processes and forms for course evaluations, the New Delhi RTC component should coordinate with Pune RTC.
- Establishing a consultative committee to ensure the training programme is meeting the needs of IMD and the Region, and that training courses keep the updated knowledge to weather and climate prediction and other related services offered by NMHSs.
- IMD continuing its pursuit with universities activities for gaining academic credit for long courses like the Advanced Meteorologist training Courses (AMCT).

National Water Academy

The National Water Academy was recognized as the third component for RA II in 2015. Considering it is one of the most recent Centers, the review of NWA is yet to be confirmed. However, Cg-17 has extended the RTC status of NWA until 31 December 2017. Moreover, RA II-16 aims to consider recommending its "Reconfirmation" in September 2016, followed by EC-69 deciding on NWA's "Reconfirmation" in May 2017.

NWA is functioning as a `Center of Excellence' for in-service training of water resources engineering personnel and specializes in: hydrological data, flood forecasting and design flood analysis, etc. The center offers International Distance Learning (DL) Programmes, with courses in Hydrology for professionals from RA II since November 2015.

Indian Institute of Technology Roorkee (IITR) – Roorkee

The Department of Hydrology of the IITR was recognized by Cg-17 as the fourth component of the RA II RTC in 2015. The center has further received, from Cg-17, extended RTC status until 31 December 2017. RA II-16 aims to consider recommending "Reconfirmation" in September 2016, followed by EC-69 deciding on "Reconfirmation" in May 2017. Considering it is the most recent Center the review of IITR is yet to be confirmed.

The Department of Hydrology offers short-term programmes that are need-based and tailor-made, and long-term regular academic PG, PhD, M.Tech and PG diploma programmes. It specializes in: international post graduate course in hydrology; courses in surface water hydrology (floods, droughts), water resources systems, watershed management, geo-hydrology, ground water geophysics, stochastic hydrology, hydro-informatics, and environmental hydrology etc. Since 2014-2015 the Department has offered 3 PG Diploma/M.Tech courses.

## IRAN

Islamic Republic of Iran Meteorological Organization (IRIMO) – Tehran

IRIMO was established in 1993 and RA II-16 aims to consider recommending its "Reconfirmation" in September 2016. EC-69 will follow suit in deciding on IRIMO's "Reconfirmation" in May 2017. The last review was conducted in August 2016.

The training Center has two components: IRIMO Training Centre which specializes in long and short-term training for national needs, and the local component which is considered to be the RMTC for international courses. Between 2014 and 2015 the Center has held 17 short- and long-term courses in meteorology, which cover a range of topics such as: radar applications and productions, statistical post processing, severe weather forecasting, maintenance instruments etc.

## IRAQ

Iraqi Meteorological Organization (IMO) – Baghdad

IMO was established in 1976 and has never been assessed. However, the next intended review is scheduled for 2016/2017, while RA II-16 is aiming to consider recommending its "Reconfirmation" in September 2016. Also planned is the decision of EC-69 on IMO's "Reconfirmation" in May 2017.

IMO specifically focusses on short-term courses in meteorology, with 9 courses being offered in 2015. Topics have ranged from: surface observation, LINEX system, maintenance and gauging Met. Instruments, geographical data, refreshing and restoration data for weather forecasters and observatories, hydrometeorology, remote senses, satellites, in using computer in meteorological applications etc.

## QATAR

Qatar Aeronautical College (QAC) - Doha

QAC was approved as the Regional Training Center for Regional Association II in 2010. Given that it is a new RTC, the Center has not yet been assessed. However, the Center specializes in full-time, approved courses for Pilots, Aircraft Maintenance Engineers, Air Traffic Controllers, Meteorologists and Flight Dispatchers, as well as short courses in a wide variety of aviation-related disciplines. As a training center QAC has run 20 courses from 2013-2016.

## REPUBLIC OF KOREA

Korea Meteorological Administration - (KMA)

KMA was established in 2015 as a Regional Training Center, but it has not yet been assessed due to it being a new RTC. However, RA II-16 will consider recommending the Center's "Reconfirmation" in September 2016, and EC-69 will decide on "Reconfirmation" in May 2017.

KMA is focused on short-term training courses, with international training courses specializing in: weather forecasting for operational meteorologists, information and communication technologies, weather and agrometeorological information, Numerical Weather Prediction (NWP) products, Automatic Weather Station (AWS) Network etc.

**UZBEKISTAN**

<u>Tashkent Hydrometeorological Professional College (THMPC) – Tashkent</u>

THMPC was established as a Regional Training Center in 1994, with the Center being last assessed in April 2011. Although the next review is yet to be confirmed, RA II-16 will consider recommending "Reconfirmation" in September 2016. EC-69 will also decide on "Reconfirmation" in May 2017.

THMPC specializes in: 26 months training programmes to qualify Meteorological, Hydrological and Environmental Technicians; and 1-2 weeks short-term training for Meteorological and Hydrological Technicians, hydrometeorological observations, aviation, radar, forecasting, environment. In 2013-2014 the Center conducted 9 courses.

**2011 Extended Review**

The assessment notes the high quality of facilities and training delivered by the college, with the curricula being in compliance with WMO standards. Also noted was the regularly run 3 year courses for Meteorological/Hydrological Technicians from different countries. However, 95% of the students are Uzbek nationals, illustrating the lack of WMO fellows being hosted. In addition, the visibilities of the activities conducted by the college are basically unknown.

**Recommendations**

- To have an effective global training network, the college is encouraged to have active relationships with other RTCs. This includes relationships with Centers: using similar working languages, with common training projects, to exchange documents and having direct informal contacts through Internet between teachers etc.
- Increasing the visibility of the Center and advertisement for the courses, in liaison with the WMO Secretariat, can foster the Center's attractiveness among international clients and students with appropriate language mastering. Therefore this implies:
    - An implementation of a real training offer policy, such as increasing short professional courses, as necessary, according to item II.2 of the official agreement signed with WMO.
    - The college taking advantage of the WMO fellowship cooperative scheme, at least at the minimum level of one student per year hosted.

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**ANNEX II**

**REPORT ON TRAINEES SERVED BY THE REGIONAL TRAINEES CENTRES IN RA II, AS REPORTED TO WMO EDUCATION AND TRAINING OFFICE**

2015

| Country | City | RTC Component | Local Students | Foreign Students | Degree-level Courses | Short Courses | Male | Female |
|---|---|---|---|---|---|---|---|---|
| China | Nanjing | NUIST | | 303 | 16 | 13 | 239 | 95 |
| China | Beijing | CMATC | 66 | 104 | 1 | 5 | 71 | 33 |
| India | Pune | MTI | 311 | 53 | 6 | 4 | 43 | 10 |
| India | Delhi | IMD | No Report | | | | | |
| India | Pune | NWA | 48 | 34 | 0 | 2 | 19 | 15 |
| India | Roorkee | IITR | New RTC Component | | | | | |
| Iran, Islamic Republic of | Tehran | IRIMO | 284 | 1 | 2 | 8 | 0 | 1 |
| Iraq | Baghdad | IMO | 103 | 0 | 0 | 9 | 0 | 0 |
| Qatar | Doha | QAC | 6 | 10 | 6 | 0 | 9 | 1 |
| Republic of Korea | Seoul | KMA | New RTC | | | | | |
| Uzbekistan | Tashkent | THMPC | - | 2 | 1 | 0 | 2 | 0 |

2014

| Country | City | RTC Component | Local Students | Foreign Students | Degree-level Courses | Short Courses |
|---|---|---|---|---|---|---|
| China | Nanjing | NUIST | 27 | 227 | 5 | 11 |
| China | Beijing | CMATC | 67 | 133 | 0 | 8 |
| India | Pune | MTI | 328 | 26 | 11 | 1 |
| India | Delhi | IMD | | | | |
| India | Pune | NWA | 25 | 19 | 0 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **India** | **Roorkee** | **IITR** | **New RTC Component** | | | |
| **Iran, Islamic Republic of** | **Tehran** | **IRIMO** | **275** | **5** | **2** | **7** |
| **Iraq** | **Baghdad** | **IMO** | **No Report** | | | |
| **Qatar** | **Doha** | **QAC** | **13** | **29** | **3** | **4** |
| **Republic of Korea** | **Seoul** | **KMA** | **New RTC** | | | |
| **Uzbekistan** | **Tashkent** | **THMPC** | **495** | **3** | **4** | **0** |

2013

| | **2010 & 2011** | | | **2012 & 2013** | | |
|---|---|---|---|---|---|---|
| **WMO Member** | **Local Students** | **Foreign Students** | **No. Courses*** | **Local Students** | **Foreign Students** | **No. Courses*** |
| | | | | | | |
| China | 214 | 409 | 37 | 325 | 801 | 35 |
| India | 5 | 1 | 1 | 557 | 36 | - |
| Iran | 4 | 4 | 4 | Reported during external review | | |
| Iraq | 86 | 0 | 9 | 0 | 0 | - |
| Qatar | New RTC | | | 77 | 224 | 3 |
| Uzbekistan | 30 | 0 | 2 | 113 | 3 | 1 |

| Report on fellowships applications and awards | | | | | |
|---|---|---|---|---|---|
| | **2013** | **2014** | **2015** | **2016** | **Total** |
| **Requests** | 30 (21+9) | 23 (10+13) | 32 (12+20) | 29 (14+15) | 114 (57+57) |
| **Awards** | 12 (10+2) | 9 (4+5) | 21 (7+14) | 17 (7+10) | 59 (28+31) |

| RA II Institutions | | | | | |
|---|---|---|---|---|---|
| | **2013** | **2014** | **2015** | **2016** | **Total** |
| **Requests** | 66 (25+41) | 46 (14+32) | 73 (25+48) | 50 (18+32) | 235 (82+153) |
| **Awards** | 30 (13+17) | 25 (6+19) | 43 (16+27) | 30 (11+19) | 128 (46+82) |

| Applicants from RA II with requests outside RA II | | | | | |
|---|---|---|---|---|---|
| | **2013** | **2014** | **2015** | **2016** | **Total** |
| **Requests** | 14 (6+8) | 11 (4+7) | 32 (12+20) | 13 (7+6) | 70 (29+41) |
| **Awards** | 4 (2+2) | 4 (2+2) | 21 (7+14) | 4 (2+2) | 33 (13+20) |

**ANNEX III**

**SHORT COURSES, 2014-2015 FROM ANNUAL REPORTS, 2016 TENTATIVE LISTINGS**

| Name | 2014 Courses |
|---|---|
| **China (CMATC)** | International Training Course on Short-term Climate Prediction Methods |
| | International Training Course on Thunderstorm Nowcasting |
| | The 3rd International Training Course on Aeronautical Meteorological Services |
| | The 4th International Training Course on Weather Modification |
| | The 3rd International Training Seminar on Meteorological Disasters Risk Management for Officials from Developing Countries |
| | The 3rd International Training Course on Climate Monitoring, Prediction and Application |
| | AOMSUC-5 Training Workshop |
| | The 3rd CMATC Pre-post Forecaster Training Course for WMO Fellowship Students |
| | |
| **China (NUIST)** | Training Course for Aeronautic Meteorological Observers |
| | Seminar on Climate Change and Climate Information Service for English-speaking African Countries |
| | International Training Course on Tropical Cyclone |
| | Seminar on Philippine Disaster Mitigation and Relief |
| | International Training Course on Use of Meteorological Instruments |
| | Training Workshop on Synergized Standard Operating Procedures for Coastal Multi-Hazards Early Warning System |
| | Seminar on Management for Meteorological Officials from English-Speaking African Countries |
| | Seminar on Meteorological Disaster Management and Weather Information Service for Latin-America, the Caribbean and the South Pacific |
| | International Training Course on Agrometeorology |
| | Seminar on Pakistan Meteorological and Earthquake Forecast, Mitigation and relief |
| | The WCRP ESGF Training Workshop for CORDEX Asia |
| | |

| | |
|---|---|
| **India Pune (MTI-IMD)** | WMO Group Training Course on Instrument Maintenance and Calibration |
| **Iran (IRIMO)** | Agrometeorology |
| | Synoptic and Dynamic Meteorology in Mid. Latitudes |
| | Marine Meteorology |
| | Dust Monitoring and Forecasting |
| | WIS and Tehran GISC |
| | Workshop on Integrated Collection System (ICS) |
| | Workshop on New Methods of Measurement and Modelling of Air Pollutants |
| | |
| **Qatar (QAC)** | Introduction to Meteorology, Observation, Coding and Transmission |
| | Met Observation, Met Instruments and Calibration |
| | Aviation Meteorological Forecasting |
| | UK MET Office Aviation Seminar |
| | |
| | **2015 Courses** |
| **China (CMATC)** | International Training Course on Global Framework for Climate Services (GFCS) |
| | International Training Course on Aeronautical Meteorology Services |
| | International Training Course on the Application of Meteorological Satellite Products |
| | International Training Seminar on Meteorological Disasters Risk Management for Officials from Developing Countries |
| | International Training Workshop on Public Weather Service |
| | The 4th CMATC Pre-post Forecaster Training Course for WMO Fellowship Students |
| | |
| **China (NUIST)** | Training Course for Aeronautical Meteorological Observers from Macao, China |
| | Training Course on Radar Meteorology for Developing Countries |
| | International Training Course on Numerical Weather Prediction |
| | Seminar on Climate Change and Climate Information Service for Developing Countries |
| | Seminar on Management for Meteorological Officials from the Asia-Pacific Countries |
| | International Training Course on Use of Meteorological Instruments |
| | Seminar on Meteorological Disaster Management and Weather Information Service for Developing Countries |
| | International Training Course on Agrometeorology |
| | Applied Meteorology Course for Forecasters from Macao, China |

| | |
|---|---|
| | Seminar on Meteorological and Earthquake Forecast, Mitigation and Relief for Developing Countries |
| | International Training Course on Instrument Maintenance and Calibration |
| | Seminar on Disaster Prevention Experiences and Policy for Afghanistan |
| | International Training Workshop on Tropical Cyclone Forecasting and Warnings |
| | |
| **India Pune (MTI-IMD)** | Basic Operational Meteorology (For Bhutan Met Personnel) |
| | Advanced Refresher Course on Operational Climate Services |
| | International Training Workshop on Tropical Cyclone Forecasting |
| | International Refresher Training Course on Aviation Meteorology |
| | |
| **Iran (IRIMO)** | Statistical post-processing of NWP model outputs |
| | Radar applications and productions |
| | Aeronautical meteorology |
| | Cloud physics and weather modification |
| | Applications of GIS in agrometeorology |
| | Seasonal Drought outlook using statistical post processing |
| | Nowcasting using Satellite Images and Weather Radar" |
| | Severe Weather Forecasting in Middle East using NWP Products Course |
| | |
| **Iraq ( IMO)** | Measurement and Calculation of Visibility |
| | ARC GIS |
| | Automatic Weather Observation System |
| | Earthquake Location Course (Manually and using SEISAN Software) |
| | English Language (Lessening Level 1) |
| | English Language (Lessening Level 2) |
| | Visual Basic Language |
| | English Language (Lessening Level 3) |
| | Observation and Forecasting of Dust Storms |
| | Plotting of Meteorological data (Surface and Upper levels) |
| | |
| **Qatar (QAC)** | Refresher course for Observers |
| | |
| | **2016 Courses (incomplete data)** |
| **China (CMATC)** | International Training Course on Global Framework for Climate Services (GFCS) |
| | International Training Course on the Application of Meteorological Satellite Products |
| | International Training Course on Aeronautical Meteorology Services |
| | International Training Course on Nowcasting Techniques on Thunderstorm and Severe Convection |
| **China (NUIST)** | International Training Course on Agrometeorology |
| | International Training Course on Radar Meteorology |
| | International Training Course on Tropical Cyclones |

| | |
|---|---|
| **India Pune (MTI-IMD)** | No courses announced through WMO ETR |
| | |
| **Iran (IRIMO)** | 5th Training Course on WMO SDS-WAS Products |
| | |
| **Iraq ( IMO)** | No courses announced through WMO ETR |
| | |
| **Qatar (QAC)** | Workshop on Aviation Meteorology for Forecasters |
| | |
| **Korea (KMA)** | International Training Course on Weather Radar Data Utilization for Meteorological Services |
| | International Training Course on Weather Forecasting for Operational Meteorologists |
| | |

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## ANNEX IV

## WMO COMPETENCY FRAMEWORKS

- Aeronautical Meteorological Forecasters (CAeM)
- Aeronautical Meteorological Observers (CAeM)
- Marine Weather Forecasters (JCOMM)
- Education and Training Providers (EC Panel of Experts on ETR)
- Climate Services personnel (CCl)
- WIS (CBS)
- Public Weather Forecasters (CBS)
    - PWS Forecaster
    - Weather Broadcasters and Communicators
    - Advisors engaged in user interaction, media liaison, and outreach activities
    - Disaster prevention and mitigation weather advisor
    - Innovation, improvement, and deliver of meteorological and hydrological services and products
- Tropical Cyclone Forecasting (each Region has its own, with a global framework to be developed)
- Observations (CIMO)(under review)
    - Meteorological Observations
    - Observing Programme and Network Management
    - Instrument Calibration
    - Instrumentation (installation and maintenance)
- Hydrology (CHy) (in development)

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Abu Dhabi, United Arab Emirates
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# PARTNERSHIPS

**Short introductory text**:

Members of the regional association continued to benefit from targeted cooperation activities undertaken by WMO in collaboration with fellow UN system agencies, including regional entities and other international organizations. Further to decisions taken by Congress at its seventeenth session (Cg-17) and the Executive Council at its sixty-eighth session (EC-68) regarding WMO's contribution to the 2030 Agenda for Sustainable Development, the Secretariat is developing practical and focused actions to support Members' implementation of the Agenda at a regional level. Members of the Region increasingly recognize the value of communications for raising the visibility of NMHSs and WMO in the Region.

***WMO cooperation with the UN system and other international organizations***

***WMO/United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) Panel on Tropical Cyclones (PTC) and Typhoon Committee (TC)***

In the context of activities under the Panel on Tropical Cyclones (PTC) and the Typhoon Committee (TC), WMO continued to work with the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) to enhance regional cooperation and provide support for establishing early warning systems of tropical cyclones with a multi-hazard approach. Close collaboration with UNESCO Intergovernmental Oceanographic Commission (UNESCO-IOC) has taken place towards improving the effectiveness of the Indian Ocean Tsunami Warning System (IOTWS) in the Indian Ocean and the Pacific Tsunami Warning System over the Pacific. With the International Civil Aviation Organization (ICAO), WMO has worked together to meet the requirements of ICAO in implementing Quality Management System (QMS) (ISO 9001:2008 certification) in the Meteorological Offices of RA II PTC/TC Members. Support for implementation of Amendment 75 to ICAO Annex 3/WMO Technical Regulations [C.3.1], by the seven Tropical Cyclone Advisory Centers (TCACs) was also provided. Engagement with the International Federation of Red Cross and Red Crescent Societies (IFRC) has focused on work in the field of DRR through community preparedness and community-based disaster risk management.

***Regional organizations***

***Association of South-East Asian Nations (ASEAN) Sub-Committee on Meteorology and Geophysics (SCMG)***

Members of the Association of South East-Asian Nations (ASEAN) Sub-Committee on Meteorology and Geophysics (SCMG) with WMO and other RA II Members, have been actively focused on the development and subsequent adoption of the Strategic Plan of the SCMG from 2016 to 2025, as well as improving information exchange and sharing services, capacity-building and research and development as well as work on an Early Warning System (EWS) in the ASEAN sub-region for disaster risk reduction.

### *League of Arab States Permanent Committee on Meteorology (LAS/PCM)*

WMO and the United Nations Economic and Social Commission for Western Asia (ESCWA) have been working together with the League of Arab States (LAS) on creating an Arab Climate Outlook Forum (ArabCOF). A scoping meeting was convened in October 2014, with wide participation of Arab countries including LAS Members of RA II, as well as a number of other UN organizations. Terms of reference for establishing ArabCOF have been prepared and are currently under discussion by the Permanent Committee of Meteorology (PCM). LAS and WMO have also collaborated with a number of international development partners, development banks and UN and international organizations to develop the Jeddah Roadmap of the LAS Forum on Capacity Development of Meteorology and Climate Services in the LAS Region. The Roadmap which has been endorsed at the Ministerial level, inter alia, formalizes the LAS Forum on Capacity Development, promotes regional cooperation through a Strategy and Implementation Plan on Meteorology (Weather and Climate Services) and establishes a resource mobilization and financing strategy for the development of NMHSs in Arab countries.

### Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)

WMO has been supporting the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) with 7 members and 11 collaborating states in RA II. The Second Ministerial Conference, held in conjunction with the seventh meeting of the RIMES Council on 9-10 July 2015, adopted the RIMES five-year plan, Master Plan 2016-2020, which details country-specific capacity-building priorities of RIMES member and collaborating states for user-centered multi-hazard risk-based early warning, and for maximizing opportunities associated with climate.

### *Other international organizations*

WMO, with the World Health Organization (WHO), the United Nations Environment Programme (UNEP), the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and the Spanish Agencia Estatal de Meteorología (AEMET), conducted a Regional Workshop in November 2015 on the impact of Sand and Dust Storms on Human Health, that brought meteorologists, environmentalists, health experts and academics from the Middle East and North African Members together. The workshop produced a number of recommendations to strengthen the capacities of national institutions in meteorology, air quality and health fields and provided an opportunity to advance interregional collaboration with RA I Members.

### *Review of existing MoUs established by the Organization and principles for the development of cooperation agreements*

The Memorandum of Understanding (MoU) signed between WMO and the Cooperation Council of the Arab States of the Gulf (GCC) in 2012, was formally reviewed and proposals made for a more robust follow-up mechanism and for an extension of the MoU for the next 4 years, in line with the provisions of the agreement.

Longstanding Working Arrangements between WMO and the League of Arab States (LAS) continue to guide cooperation activities between the entities, as provided under the Letters of Exchange signed in 1972. New joint activities or projects will require a separate annex to the original agreement.

It will be recalled that following the Cg-17 appeal to review the status of all cooperation agreements, EC-68 through Decision 71 (EC-68), Review of Cooperation Agreements, decided on 7 guiding elements to be considered for contractual agreements such as MoUs or their equivalent, prior to signature by the Secretary-General.

***WMO contribution to the 2030 Agenda for Sustainable Development***

The 2030 Agenda for Sustainable Development, the centrepiece of the global development agenda adopted by the United Nations General Assembly in September 2015, identifies 17 Sustainable Development Goals (SDGs), 169 associated targets and highlights a number of international mechanisms for supporting its implementation. It is recognized that WMO and its community, through their explicit mandates to protect lives and property, already contribute to the overall Agenda and various SDGs, both directly and indirectly, as well as through active participation in related processes of the Sendai Framework for Disaster Risk Reduction 2015-2030, the Paris Agreement on Climate Change and the new urban agenda under Habitat III.

Members can benefit from WMO's status as a UN specialized agency through the unique network of partnerships and opportunities developed and generated with other communities, sectors and disciplines, through platforms like the Global Framework for Climate Services (GFCS) in the area of climate services.

Additionally, the WMO Strategic Plan for 2016-2019, sets out WMO priorities that are fully aligned with actions to enable its Members to meet the demands of the new agenda for improved information, products and services across the weather, climate, hydrological, marine and related environmental spectrum. At the regional level, Decision 70 (EC-68) WMO contribution to the 2030 Agenda for Sustainable Development, outlines ways through which the Organization and its Members can support implementation of the Agenda in the sectors of food security, health, water and sanitation, urban development, climate change and ocean and coastal management.

***Communications and Public Affairs***

The Communications and Public Affairs (CPA) Office has remained firmly committed to strengthening the interaction between IPA Focal Points at NMHSs and UN communication staff in promoting WMO's messages, developing materials and sharing best practices. This collaboration has contributed to meeting the needs of the media and the public at large for accurate and in-depth information about weather, climate and water and the value provided to society by NMHSs. The CPA Office also regularly sent by e-mail to Focal Points the daily update "In the Media" to inform NMHSs about the press coverage received by WMO and WMO issues.

NMHSs are assisted every year in the celebration of the annual World Meteorological Day (WMD) as a way of increasing the visibility of NMHSs. WMO implemented outreach activities to support the Sendai Conference on DRR and other events in the Region.

The CPA Office is now fully active and present on the main social media channels of Twitter, Facebook, YouTube and Flickr. in particular to engage younger meteorologists and other new audiences through these channels. It has encouraged collaboration with IPA Focal Points on these efforts. The Office has also relaunched the public WMO website at the new URL public.wmo.int with the goal of advancing the image and messages of the WMO community.

A project to engage weather presenters as climate communicators was launched in 2014. CPA organized workshops featuring IPCC scientists and communications experts in Hanoi and Tokyo in 2015, and it sponsored weather presenters from NMHSs and TV stations in RA II as participants in climate change COPs and workshops in Paris and elsewhere. CPA has also facilitated the provision of media-friendly graphics and climate stories to international weather presenters.

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# DECISION 84 (EC-68) — GOVERNANCE REVIEW

## Decision 84 (EC-68)

## GOVERNANCE REVIEW

THE EXECUTIVE COUNCIL,

**Recalls**:

(1) That the Seventeenth Congress requested the Executive Council to continue to introduce specific measures for improvement of WMO processes and practices and also to undertake a holistic review of the Organization, including its processes and working practices, in implementing the Strategic Plan 2016–2019;

(2) That Seventeenth Congress also requested it to provide recommendations to the Eighteenth Congress on constituent body constructs, as appropriate, including possible new structures for TCs, RAs, EC, and also to provide recommendations on rules, procedures, processes, mechanisms, and duties, of constituent bodies, WMO Officers (President, Vice-Presidents, PRAs and PTCs) and the relationship between them and the WMO Secretariat to enhance the efficiency and effectiveness of the Organization and good governance;

(3) That in Resolution 1 (EC-67), the Council requested its Working Group on Strategic and Operational Planning to:

- (a) Undertake a holistic review of the Organization, and provide recommendations to the Executive Council on constituent body constructs, as appropriate, including possible new structures for the technical commissions, regional associations and the Executive Council together with rules, procedures, processes, working mechanisms and duties of constituent bodies, WMO officers presidents of regional associations and technical commissions, and on their relationship with the Secretariat to enhance the efficiency and effectiveness of the Organization and good governance for further consideration by the Eighteenth Congress;

- (b) Review the practices and operation including the selection process of members of the Executive Council and propose relevant amendments to the WMO Convention and related General Regulations for submission to the Eighteenth Congress;

**Having considered** the recommendations of its Working Group on Strategic and Operational Planning related to governance review;

**Observes** the need to take into consideration the provisions of the WMO Convention and existing agreements for partnerships involving WMO and other institutions;

**Agrees** that the current Convention of the WMO provides a good framework for the current and future work of WMO and its constituent bodies, and no changes to the articles of the Convention are envisaged at this stage;

**Endorses** the following recommendations of its working group related to the WMO Executive Council, regional associations and technical commissions:

(1) WMO Executive Council:

(a) EC would continue to fully comply with its functions according to Article 14 of the Convention of WMO;

(b) EC is the right body to lead on the strategic and operational planning;

(c) EC should factor in its processes the preparation of operating plans for TCs and RAs thus assisting Congress in establishing an optimal and balanced structure for their implementation along with the approved Strategic Plan;

(d) EC would welcome the advice from oversight bodies (Audit Committee and FINAC);

(e) EC should not be an implementing body for WMO regular Programmes/activities;

(f) EC could establish special purpose time-bound groups to advise it on emerging issues, and benefit from diverse/blended expertise (PRs, external experts, partner institutions), and engage expertise beyond WMO constituencies, e.g. socio-economical. This could also be a feasible approach in technical areas of the work of WMO;

(g) The EC should improve its means for monitoring the implementation of Cg resolutions and track the progress as is done for, for example, AEM QMS;

(h) Regarding the composition of the EC and the process of election of EC members, the group made the following suggestions:

(i) Terms of rotation of elected EC members could be considered, while taking into account:

a. The value of having in EC Directors of NMHSs making major contributions to the activities of the Organization;

b. The need for institutional memory in the EC;

c. Engagement of Directors from developing countries and LDCs;

d. Promoting gender balance;

(ii) Mechanisms to engage the PRs who are members of the EC should be explored, such as appointing them to lead or contribute in the subsidiary bodies of EC;

(2) Regional associations:

(a) The process should be defined clearly to enable the RAs to fulfill their role as defined in the Convention;

(b) The EC should request the Congress to establish ToR and assist RAs and TCs based on the Operating Plan to fulfill their roles;

(c) RAs should set their regional priorities within the priorities established by Congress;

(d) The RAs should be better integrated in the budgeting process;

(e) The work of RAs should be phased in a way to accomplish the guidance by Congress as follows:

(i) All RAs should have a management group meeting a few months after Congress to work out a Regional Operating Plan based on the Strategic Plan and in line with the WMO Operating Plan, to be consistent with Congress approved ToR. The Regional Operating Plan should be realistic and feasible, identifying the required expertise, external partners and funds;

(ii) RA sessions should be in the mid-term after Congress;

(iii) Another management group meeting should be held prior to the last EC before Congress to focus on future priorities;

(iv) The RAs should be provided with an indicative budget, matching the needs indicated in the deliverables of their Regional Operating Plans;

(f) The roles, capacities and terms of references of Regional Offices, and the sequencing of constituent body meetings and operational planning processes should be improved;

(g) TCs, as well as related programmes, should be invited to meetings on identified priorities to enhance support and coordination among RAs, TCs and Programmes;

(3) Technical commissions:

(a) The Congress should review the TCs every four years on the basis of the approved Strategic Plan to adapt, establish, merge, continue or discontinue them as appropriate;

(b) The Congress should provide the TCs with clear ToR and tasks in a financial period;

(c) The performance progress of TCs should be reviewed at the end of a financial period against the ToR and tasks provided by Congress to decide as to whether they should be continued or terminated, taking into consideration the Strategic Plan;

(d) The TCs should be established as required on the basis of "big themes" related to WMO key activities from Article 2, the Preamble and the Strategic Plan, in such a way so that the "big themes" are the basis for the major WMO Programmes, with TCs to accompany the work and progress, and a corresponding management in the Secretariat (Departments) to support this in a coherent way;

(e) The intergovernmental TC sessions are needed when all Members should be able to participate and give their input, while (non-governmental) working groups (substructure of constituent bodies including EC WGs) should be used for specific themes for a limited period, recognizing that full members of such groups - if required - may be selected from outside the WMO community;

(f) The process of electing presidents of TCs should consider the leadership attributes necessary to fulfil the strategic functions of the TCs;

(g) WMO should continue to invite relevant institutions' as experts or observers at sessions of EC, TCs and RAs;

(h) The M&E should be improved to be more of a full cycle with a clear workplan from Congress;

**Requests** the working group to continue to review WMO Governance and make further recommendations to the next session of the Council;

**Requests** the working group to also consider:

(1) The matter of the number and the distribution of seats of the Executive Council with the aim of maintaining efficiency and effectiveness;

(2) Within the context of the holistic review of the Organization, the effectiveness of the current and possible future composition and structures of the regional associations;

**Requests** the Secretary-General, the Executive Council, regional associations, and technical commissions to continue to implement improvements in WMO processes and practices to improve efficiency and cost savings.

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# PROPOSED REGIONAL PRIORITIES 2020–2023 FOR RA II

- Risk information and seamless Multi-Hazard Early Warning Systems (MHEWS) for Disaster Risk Management (DRM): meet the increasing demands for timely, accurate, understandable and actionable weather and climate information that enable key stakeholders to make critical weather-related decisions; increase the access to and ability to use multi-hazard early warning systems and disaster risk information and assessments by communities, in particular, through the development of impact-based forecasts and risk based warnings, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030;

- Service Delivery (SD) as a Cross-Cutting Framework: improve the capacity for the provision and delivery of meteorological, climatological and hydrological services for safety of life, livelihood and property as well as for economic prosperity and sustainable development;

- Implementation of the results-based framework and mechanism for WMO contributions to the GFCS: implementation of GFCS at national and regional levels including identification of GFCS support needs in specific countries, coordination of scientific and technical support, sharing of results, lessons learned and tools;

- Implementation of WIGOS and WIS including information management practices: maintain and improve real-time observing systems including metadata, quality and quantity of observations, communication and information sharing, telecommunication and ICT infrastructures and database management; complete the implementation of WIGOS and WIS, including ensuring Members’ staff are equipped with the full scope of necessary competencies as laid down in the Manuals on WIGOS and WIS with review of information management practices;

- Seamless Data-processing and Forecasting System: evolve the operational monitoring, prediction and forecasting system to enable Members in supporting decision-makers to take better informed decisions and to facilitate the provision of impact-based forecasts and risk-based warnings;

- Aviation meteorological services: address existing deficiencies in the provision of aeronautical meteorological services through focused assistance to Members in need of developing their capacity to achieve required service levels in terms of quality, reliability and sustainability of service; promote cooperative regionalized service delivery models where needed to build collective capacity in an efficient and sustainable manner; enhance the overall compliance with the ICAO and WMO requirements, in particular with respect to QMS, competency and qualification of personnel serving aviation; facilitate the uptake of research and development achievements into operational practice of Members.

**Additional priorities to support the above regional priorities**

- Capacity development with emphasis on gender equality to support the implementation of regional priorities in terms of budget and staffing resources with gender balance, education and training needs, twinning of experts;

- Scientific research and development focusing on the innovation for urban and highly-dense populated regions including regional and urban air pollution, new tools for high impact weather forecasts and communication, and research advancements in multi-hazard early warning systems including biomass burning and impacts on air-quality and sand/dust storms;

- Partnerships with national stakeholders, regional partners, bilateral donor agencies and private sectors to leverage the synergies and resources in the provision of meteorological and climate services, outreach to the community.

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Sixteenth Session
Abu Dhabi, United Arab Emirates
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Submitted by:
Secretary-General
3.II.2017

## AWARD CERTIFICATES

Certificates are awarded to the individuals as a token of appreciation for their outstanding and valuable contribution to the activities in support of the Association for the intersessional period 2012–2016. A list of recipients of certificates is given below.

### LIST OF RECIPIENTS OF CERTIFICATES

| Recipient | Member | In recognition of ... |
|---|---|---|
| Boon-leung CHOY | Hong Kong, China | His outstanding contribution to the activities of Regional Association II as chairperson of the Working Group on Weather Services |
| Akihiko SHIMPO | Japan | His outstanding contribution to the activities of Regional Association II as chairperson of the Working Group on Climate Services |
| Sung KIM | Republic of Korea | His outstanding contribution to the activities of Regional Association II as chairperson of the Working Group on Hydrological Services |
| Yongqing CHEN | China | His outstanding contribution to the activities of Regional Association II as chairperson of the Working Group on WIGOS and WIS |
| Qingliang ZHOU | China | His outstanding contribution to the activities of Regional Association II as chairperson of the Implementation Coordination Team on Service Delivery |
| K.J. RAMESH | India | His outstanding contribution to the activities of Regional Association II as chairperson of the Implementation Coordination Team on Disaster Risk Reduction |
| Marina PETROVA | Russian Federation | Her contribution to the activities of Regional Association II as co-coordinator of the Expert Group on Aeronautical Meteorological Services Delivery |
| Yuki HONDA | Japan | His contribution to the activities of Regional Association II as co-coordinator of the Expert Group on Operational Forecasting |
| Irina ZAYTSEVA | Uzbekistan | Her contribution to the activities of Regional Association II as co-coordinator of the Expert Group on Operational Forecasting |
| Muhammad HANIF | Pakistan | His contribution to the activities of Regional Association II as co-coordinator of the Expert Group on Public Weather Services Delivery |
| Lap-shun LEE | Hong Kong, China | His contribution to the activities of Regional Association II as co-coordinator of the Expert Group on Public Weather Services Delivery |
| Evgeny VASILYEV | Russian Federation | His contribution to the activities of Regional Association II as co-coordinator of the Expert Group on Public Weather Services Delivery |

| Recipient | Member | In recognition of … |
|---|---|---|
| Nabansu CHATTOPADHYAY | India | His contribution to the activities of Regional Association II as co-coordinator of the Expert Group on Agrometeorology |
| Alexander KLESCHENKO | Russian Federation | His contribution to the activities of Regional Association II as co-coordinator of the Expert Group on Agrometeorology |
| Muhammad RIAZ | Pakistan | His contribution to the activities of Regional Association II as vice-chairperson of the Working Group on Hydrological Services |
| Jaegwang WON | Republic of Korea | His contribution to the activities of Regional Association II as co-coordinator of the Expert Group on WIGOS |
| Xiang LI | China | Her contribution to the activities of Regional Association II as co-coordinator of the Expert Group on WIS |
| Kenji TSUNODA | Japan | His contribution to the activities of Regional Association II as co-coordinator of the Expert Group on WIS |
| Jun RYUZAKI | Japan | His contribution to the activities of Regional Association II as Theme Leader in Meteorological Support to Air Traffic Management and Provision of SIGMETs, Expert Group on Aeronautical Meteorological Services Delivery |
| Masami SAKAMOTO | Japan | His contribution to the activities of Regional Association II as Theme Leader in Emergency Response Activities, Expert Group on Operational Forecasting |
| Yoshiro TANAKA | Japan | His contribution to the activities of Regional Association II as Theme Leader in Implementation and Updating of R-WIP, Expert Group on WIGOS |
| Shyamlal Singh | India | His contribution to the activities of Regional Association II as Theme Leader in WIS-GTS operations, including Early Warning, Expert Group on WIS |
| Pak-wai CHAN | Hong Kong, China | His dedicated services for the implementation of the Pilot Project to Develop Support for National Meteorological and Hydrological Services in Numerical Weather Prediction |
| Hyun Cheol SHIN | Republic of Korea | His dedicated services for the implementation of the Pilot Project to Develop Support for National Meteorological and Hydrological Services (NMHSs) in Numerical Weather Prediction and the Pilot Project to Sustain and Enhance the Capacity of NMHSs in the Provision of Official Weather Forecasts for the Medium-Range |
| Kiyotoshi TAKAHASHI | Japan | His dedicated services for the implementation of the Pilot Project on Information Sharing on Climate Services |

| **Recipient** | **Member** | **In recognition of …** |
|---|---|---|
| XU Jianliang | China | His dedicated services for the implementation of the Pilot Project to Develop Support for National Meteorological and Hydrological Services in the Collection and Application of Aircraft Meteorological Data Relay (AMDAR) Data |
| ZHANG Qiang | China | His dedicated services for the implementation of the Pilot Project to Develop Support for National Meteorological and Hydrological Services in the Collection and Application of Aircraft Meteorological Data Relay Data |
| Wai-kin WONG | Hong Kong, China | His dedicated services for the implementation of the Pilot Project to Sustain and Enhance the Capacity of National Meteorological and Hydrological Services in the Provision of Official Weather Forecasts for the Medium Range |
| CHENG Yuen-chung, Armstrong | Hong Kong, China | His dedicated services for the implementation of the Pilot Project to Enhance the Seamless Provision of Regional Severe Weather Warnings and Advisories |

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## Public-Private Engagement

The RA II Members shared experiences and views on risks, opportunities, lessons and concerns of public-private engagement in RA II.

The meeting emphasised the following key points:

1. Private engagement in weather, climate and water enterprise is a rapidly increasing and the Secretariat and Members need to keep abreast of developments and have a realistic understanding of the evolving nature of the weather, climate and water enterprise and the risk and opportunities provided by private sector engagement therein;

2. Regulatory role of WMO is fundamental foundation for the entire weather, climate, and water enterprise and to ensure quality of data and services;

3. Private sector in the data provision, data processing and information services could become a major concern and the opportunities and threats need to be better identified;

4. A structured to dialogue at all levels, including global, regional and national is necessary;

   (a) WMO should engage/organize an ongoing dialogue at the Global level to stay informed of developments in the private sector in the weather climate and water enterprise;

   (b) RA II members, with the support of the Secretariat, need to reach out proactively and look for opportunities for engagement and at the same time identify the risks/threats;

5. WMO policy on public-private engagement is required. A high-level policy document (e.g., Congress Declaration or Resolution) could be useful to establish roles and responsibilities and promote win-win approaches. Policy Framework (and a Declaration/Resolution) should be adopted by Cg-18;

6. WMO Secretariat should develop guidance material for Members relevant and useful for all weather, climate, and water enterprise stakeholders including the private sector, in particular with relation to free and unrestricted exchange of data and build up a compendium of case studies to illustrate the various current and potential models for public-private partnerships;

7. Members should consider putting in place adequate legislation that clearly defines relative roles in the market space including the authoritative voice of the NMHS in provision of warning services and if possible also defining a regulatory role of the NMHS with respect to 3rd party weather and climate information service providers that provide for validation of accuracy and quality of forecasts provided and action to be taken if quality standards are not adhered to.

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# WMO REGIONAL OFFICE FOR ASIA AND THE SOUTH-WEST PACIFIC INCLUDING WMO OFFICE FOR WEST ASIA

## 1. Regional Office for Asia and the South-West Pacific

1.1 The Regional Office for Asia and the South-West Pacific has played a role as a focal point for information on regional activities and for assisting Members in implementing WMO Programmes and activities that had a regional focus. The Regional Office has continued efforts to facilitate the provision of appropriate advice and assistance through relevant technical departments in the Secretariat and to assess the needs of the Region and individual Members as well as to maintain partnership and collaboration with relevant United Nations agencies and inter-regional organizations.

1.2 The Regional Office supported the facilitation of the provision of assistance for the regional meetings and activities in cooperation with Members and relevant technical departments in the Secretariat. The Regional Office also coordinated with Members who hosted various regional/sub-regional events during the intersessional period. *[List of regional events in 2012–2016 is given in the Appendix.]*

1.3 The Regional Office will continue and further strengthen inter-regional cooperation activities to promote weather-, climate- and water-related issues and to increase the awareness of policy-makers in the Region of the role of NMHSs and WMO in contributing to sustainable development. In this connection, the Intergovernmental Council of Hydrometeorology of the Commonwealth of Independent States (CIS) decided to establish a special WMO office for the Euro-Asian sub-region and supported this proposal as an effective mechanism for further strengthening inter-regional cooperation with Regional Association VI.

1.4 Members continued to benefit from development cooperation activities carried out within the framework of various funding sources such as the WMO VCP and Trust Fund arrangements *[see also RA II-16/Doc. 4.8(3)].* Trust fund projects have been implemented by the Regional Office in Saudi Arabia, Sri Lanka and the countries in the Bay of Bengal for the procurement and installation of equipment, education and training, and improvement of services and VCP projects in Bhutan, Maldives, Mongolia, Myanmar and Uzbekistan.

1.5 A WMO Post-Typhoon *Haiyan* Expert Mission to Viet Nam was carried out from 14–16 April 2014 by representatives and experts of the Hong Kong Observatory, RSMC Tokyo – Typhoon Centre/Japan Meteorological Agency, UK Met Office and the WMO Secretariat. The mission assessed the current capacity and capability of NMHSs and requirements of the relevant authorities in Viet Nam and made recommendations to address specific aspects identified during the mission. The Regional Office is expected to enhance support for such missions to identify Members' needs and requirements and to support the restoration of key operational hydrological and meteorological facilities and for human resources development.

1.6 RA II Members in Southeast Asia actively participated in the realization of a RA II WIGOS project regarding capacity-building in radar techniques with a possibility of integration of other surface-based remote sensing data to enhance the observational data and product utilization for better early monitoring and warning of extreme events.

## 2. WMO Office for West Asia

2.1 The WMO Office for West Asia has been supported by the Government of Bahrain since its inauguration at the UN House in Manama, Bahrain, on 12 March 2007. The Office has played a key role in coordinating communications with NMHSs in West Asia for identifying the requirements for the development of the NMHSs.

2.2 The Office have developed and maintained close working relationships with other UN agencies and regional and sub-regional organizations in West Asia, including LAS, GCC, UNEP and WHO, in particular in the areas of disaster risk reduction, sand and dust storms, and climate change. The Office also contributed to development of Strategic Cooperation Framework with other UN agencies.

2.3 The Office has been centred around the support to individual WMO Members in West Asia and to the UN Country Team in Bahrain on hydrometeorology-related matters in cooperation with other UN regional agencies.

2.4 Through the WMO Office for West Asia, the Regional Office is expected to promote interregional coordination among Regional Associations I (Africa), II (Asia) and VI (Europe), and further strengthening of the WMO Office for West Asia is desirable through increased financial and human resources. The WMO Secretariat is expected to take the necessary actions for thanking the Government of Bahrain on behalf of RA II and for seeking continued support to the Office.

## 3. Review of Regional Office location

3.1 On the recommendation of Cg-XVI, the Secretariat initiated a comprehensive review of resources and location of the Regional Office for Asia and the South-West Pacific, with a special focus on efficient and effective management and operation of the Office including an analysis of benefits for the location of the Regional Office in Geneva or in the Region.

3.2 In response to the WMO circular letter to Members of RA II and RA V, five Members (India, Indonesia, the Philippines, Qatar and Singapore) indicated their Governments' interest in hosting the Regional Office.

3.3 In accordance with WMO Congress Resolution 55 (Cg-17) and the procedures and criteria established after consultation with the RA II and RA V Management Groups, the Secretary-General decided that Singapore was the most appropriate location for the Regional Office based on the results of the evaluation along established criteria of efficiency, cost-effectiveness, as well as sustainability and quality of environment, the findings from site visits and with due consideration of the geographical balance.

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Appendix: 1

**APPENDIX**

**LIST OF REGIONAL EVENTS IN RA II**

**(December 2012–December 2016)**

| Date | Event | Place |
|---|---|---|
| **Part I: WMO constituent body sessions and RA II Regional Conferences / Regional Seminars** | | |
| **2016** | | |
| 23–29 November 2016 | Sixteenth session of the Commission for Basic Systems (CBS-16) | Guangzhou, China |
| **2014** | | |
| 2–4 December 2014 | Sixth session of Regional Conference in Regional Association II (RECO-6) | Doha, Qatar |
| 10–16 July 2014 | Sixteenth Session of the WMO Commission for Instruments and Methods of Observation (CIMO-16) | Saint Petersburg, Russian Federation |
| **2012** | | |
| 13–19 December 2012 | Fifteenth session of Regional Association II (Asia) (RA II-15) | Doha, Qatar |
| 10–12 December 2012 | Regional Seminar on Strategic Capacity Development of National Meteorological and Hydrological Services (NMHSs) in Regional Association II (Asia) | Doha, Qatar |
| **Part II: RA II subsidiary bodies' meetings / sessions** | | |
| **2016** | | |
| 7–8 December 2016 | Eleventh session of RA II Management Group | Abu Dhabi, UAE |
| 31 October–1 November 2016 | First meeting of RA II Expert Group on WIGOS (EG-WIGOS) | Abu Dhabi, UAE |
| 25–27 October 2016 | Third meeting of RA II Working Group on Hydrological Services (WGHS) | Seoul, Republic of Korea |
| 15 June 2016 | Tenth session of RA II Management Group | Geneva, Switzerland |

| Date | Event | Place |
|---|---|---|
| | **2015** | |
| 15–17 December 2015 | Working Group, Implementation and Coordination Team, and Task Team (WG-ICT-TT) Chairpersons' Meeting on Strategic Planning in RA II | Doha, Qatar |
| 10–11 December 2015 | Meeting of RA II Expert Group on Public Weather Services Delivery (EG-PWS) | Hong Kong, China |
| 25–27 November 2015 | Meeting of RA II Expert Group on WIS (EG-WIS) | Tokyo, Japan |
| 9–10 November 2015 | Meeting of RA II Expert Group on Agrometeorology (EG-AgM) | Pune, India |
| 27 May 2015 | Ninth session of RA II Management Group | Geneva, Switzerland |
| 14–16 April 2015 | Second meeting of RA II Working Group on Hydrological Services (WGHS) | Gyeongju, Republic of Korea |
| | **2014** | |
| 10–12 November 2014 | Meeting of RA II Expert Group on Aeronautical Meteorological Services Delivery (EG-AeM) | Hong Kong, China |
| 30 September–2 October 2014 | First meeting of RA II Working Group on Hydrological Services (WGHS) | Seoul, Republic of Korea |
| 18 June 2014 | Eighth session of RA II Management Group | Geneva, Switzerland |
| 27–28 May 2014 | Working Group, Implementation and Coordination Team, and Task Team (WG-ICT-TT) Chairpersons' Meeting on Implementation and Development of Strategic Operating Plan in Regional Association II | Doha, Qatar |
| | **2013** | |
| 12 May 2013 | Seventh session of RA II Management Group | Geneva, Switzerland |
| | **Part III: Other meetings, workshops and training courses** | |
| | **2016** | |
| 6–8 December 2016 | Fourth WIS Implementation Workshop | Tokyo, Japan |

| Date | Event | Place |
|---|---|---|
| 21–22 November 2016 | CBS-TECO-2016 | Guangzhou, China |
| 15 November-12 December 2016 | Training on Instrument Maintenance and Calibration | Pune, India |
| 14–18 November 2016 | Seventh ASEAN Climate Outlook Forum (ASEANCOF) | Manila, Philippines |
| 14-15 November 2016 | Southeast Asian RCC-Network Implementation Planning Meeting | Manila, Philippines |
| 8–9 November 2016 | Fourth session of East Asia winter Climate Outlook Forum (EASCOF) | Ulaanbaatar, Mongolia |
| 7–9 November 2016 | Arctic Polar Regional Climate Centre (PRCC) Network Implementation Planning Meeting (crosscutting for RA II, RA IV, RA VI) | Geneva, Switzerland |
| 28 October 2016 | 4th Meeting of the RA II WIGOS Project Coordination Group to Develop Support for NMHSs in Satellite Data, Products and Training | Songdo-Incheon, Republic of Korea |
| 24–27 October 2016 | Seventh Asia/Oceania Meteorological Satellite Users' Conference | Incheon, Republic of Korea |
| 3–7 October, 2016 | WMO Workshop on Enhancing Climate Indices for Sector Specific Applications in South Asia region (joint WCAS/CCl ET-SCI) | Pune, India |
| 27–29 September 2016 | Ninth session of the South Asian Climate Outlook Forum (SASCOF) | Nay Pyi Taw, Myanmar |
| 26 September–14 October 2016 | International Training Course on Information and Communication Technologies for Meteorological Services | Seoul, Republic of Korea |
| 26–28 September 2016 | Stakeholders Workshop to Initiate the Implementation of Impact-based Forecasting and Risk-based Warnings | Male, Maldives |
| 6–9 September 2016 | Workshop on Implementation of new NWP and Impact-based Forecast and Warning Technics | Nay Pyi Taw, Myanmar |
| 29–31 August 2016 | Thirty-eighth Meeting of the ASEAN Sub-Committee on Meteorology and Geophysics | Yangon, Myanmar |
| 23–24 August 2016 | CAP Implementation Workshop | Bangkok, Thailand |

| Date | Event | Place |
|---|---|---|
| 15–26 August 2016 | Sixteenth Typhoon Committee Attachment Training Course at the RSMC Tokyo | Tokyo, Japan |
| 10–14 August 2015 | Meeting of the Regional Subproject Management Team of the Severe Weather Forecasting and Disaster risk reduction Demonstration Project for SE Asia | Hanoi, Viet Nam |
| 11–29 July 2016 | International Training Course on Weather Forecasting for Operational Meteorologist | Seoul, Republic of Korea |
| 27 June–1 July 2016 | Joint meeting of the CBS OPAG/PWS Task Team on Impact of Multi-hazard Prediction and Communication (TT/IMPACT) and the Expert Team on Meeting User Needs in Reducing the Impacts of Hydrometeorological Hazards (ET/DPM) | Shanghai, China |
| 27–30 June 2016 | WMO/JMA SIGMET Workshop | Tokyo, Japan |
| 23–26 May 2016 | Task Team on Definitions of Extreme Weather and Climate Events (TT-DEWCE) | Guangzhou, China |
| 16–18 May 2016 | Workshop on Managing Climate Risks in Central Asia | Tashkent, Uzbekistan |
| 10–13 May 2016 | Sixth WMO Impact Workshop | Shanghai, China |
| 2–6 May 2016 | Forty-third session of the Panel on Tropical Cyclones | New Delhi, India |
| 26–28 April 2016 | South Asia Flash Flood Guidance (SAsiaFFG) Steering Committee Meeting | New Delhi, India |
| 19–28 April 2016 | Eighth session of the South Asian Climate Outlook Forum (SASCOF-8), Training Workshop (Pre-COF) and Climate Services User Forum (CSUF) for the Water Sector, and CSUF for the Health Sector | Colombo, Sri Lanka |
| 18 April–6 May 2016 | International Training Course on Weather Radar Data Utilization for Meteorological Services | Seoul, Republic of Korea |
| 7–9 April 2016 | Twelfth session of the Forum on Regional Climate Monitoring, Assessment and Prediction for Asia | Guangzhou, China |

| Date | Event | Place |
|---|---|---|
| | (FOCRAII) | |
| 9–11 March 2016 | Regional Consultation on Climate Services for the Third Pole Region | Jaipur, India |
| 22 February–4 March 2016 | Severe Weather Forecasting Demonstration Project (SWFDP) - Central Asia, Workshop on Forecasting and Public Weather Services (PWS) for Forecasters and Users from Central Asia | Almaty, Kazakhstan |
| 22 February–4 March 2016 | Severe Weather Forecasting Demonstration Project (SWFDP) - Central Asia, Workshop on Forecasting and Public Weather Services (PWS) for Forecasters and Users from Central Asia | Almaty, Kazakhstan |
| 22–25 February 2016 | Forty-eighth session of the Typhoon Committee | Honolulu, United States of America |
| **2015** | | |
| 2–27 November 2015 | Training on Instrument Maintenance and Calibration | Nanjing, China |
| 18–19 November 2015 | Fifth ASEAN Climate Outlook Forum (ASEANCOF) | Singapore |
| 17–19 November 2015 | Scoping workshop on climate services for Polar Regions: Establishing Polar Regional Climate Centres towards implementing an Arctic PRCC-network (cutting across RA II, RA IV and RA VI) | Geneva, Switzerland |
| 14 November 2015 | 3rd Meeting of the RA II WIGOS Project Coordination Group to Develop Support for NMHSs in Satellite Data, Products and Training | Tokyo, Japan |
| 10–12 November 2015 | Ninth session of North Eurasia Climate Outlook Forum (NEACOF) | Moscow, Russian Federation |
| 10–12 November 2015 | Sixth Asia/Oceania Meteorological Satellite Users' Conference | Tokyo, Japan |
| 10–12 November 2015 | Workshop on climate change in Asia for weather presenters: communicating the science | Tokyo, Japan |
| 6–7 November 2015 | WMO Sand and Dust Storm Warning | Amman, Jordan |

| Date | Event | Place |
|---|---|---|
| | Advisory and Assessment System (SDS-WAS) Steering Committee Kick-off Meeting | |
| 3–5 November 2015 | Third Session of East Asia winter Climate Outlook Forum (EASCOF) | Seoul, Republic of Korea |
| 2–5 November 2015 | First Africa/Middle East Expert Meeting and Workshop on the Health Impact of Airborne Dust | Amman, Jordan |
| 19–21 October 2015 | National Stakeholder Consultation (NSC) on Climate Services and First National Climate Outlook Forum | Thimphu, Bhutan |
| 19–20 October 2015 | Regional Workshop on Climate Services for Commonwealth of Independent States (CIS) NHMSs | Sochi, Russian Federation |
| 18 October–7 November 2015 | Multi-year Capacity Development Programme on ICT for meteorological services | Seoul, Republic of Korea |
| 14–15 October 2015 | Seventh session of the South Asian Climate Outlook Forum (Winter SASCOF) and Climate Services User Forum for Agriculture | Chennai, India |
| 12–14 October 2015 | Joint RA II/RA V Workshop on WIGOS for Disaster Risk Reduction | Jakarta, Indonesia |
| 28–30 September 2015 | Stakeholders Workshop to Implement a Pilot Project on Impact-based Forecasting and Risk-based Warnings | Nay Pyi Taw, Myanmar |
| 21–25 September 2015 | Severe Weather Forecasting Demonstration Project (SWFDP) – Regional Subprojects for the Bay of Bengal and Southeast Asia – Training Workshop on Severe Weather Forecasting and Warning Services | Bangkok, Thailand |
| 14–25 September 2015 | Severe Weather Forecasting Demonstration Project (SWFDP) – Regional Subprojects for the Bay of Bengal and Southeast Asia – Training Workshop on Severe Weather Forecasting and Warning Services | Bangkok, Thailand |
| 14–16 September 2015 | First Steering Committee Meeting (SCM) of the Central Asia Region Flash Flood Guidance (CARFFG) Project | Astana, Kazakhstan |
| 7–11 September 2015 | CALMet XI Conference | Seoul, Republic of |

| Date | Event | Place |
|---|---|---|
| | | Korea |
| 25–27 August 2015 | Thirty-seventh Meeting of the ASEAN Sub-Committee on Meteorology and Geophysics | Kuala Lumpur, Malaysia |
| 10–14 August 2015 | Meeting of the Regional Subproject Management Team (RSMT) of the Severe Weather Forecasting Demonstration Project (SWFDP) for Southeast Asia | Hanoi, Viet Nam |
| 10–14 August 2015 | Meeting of the Regional Subproject Management Team (RSMT) of the Severe Weather Forecasting Demonstration Project (SWFDP) for Southeast Asia | Hanoi, Viet Nam |
| 28 July–5 August 2015 | 35th annual meeting of the Space Frequency Coordination Group (SFCG-35) (Hosted by JAXA) | Tsukuba, Japan |
| 22–31 July 2015 | Regional Specialized Meteorological Centres Attachment Training at RSMC Tokyo | Tokyo, Japan |
| 20–24 July 2015 | Third meeting of the Inter-Programme Expert Team On Data Representation Maintenance And Monitoring (IPET-DRMM), | Beijing, China |
| 10 July 2015 | Second Regional Integrated Multi-Hazard Early Warning System (RIMES) Ministerial Conference | New Delhi, India |
| 9 July 2015 | Seventh Regional Integrated Multi-Hazard Early Warning System (RIMES) Council | New Delhi, India |
| 7–27 June 2015 | International Training Course on Weather Forecasting for Operational Meteorologist | Seoul, Republic of Korea |
| 21–22 May 2015 | Fourth ASEAN Climate Outlook Forum (ASEANCOF) | Jakarta, Indonesia |
| 11–13 May 2015 | Eleventh session of the Forum on Regional Climate Monitoring, Assessment and Prediction for Asia (FOCRAII) | Beijing, China |
| 5–7 May 2015 | Central Asia Region Flash Flood Guidance (CARFFG) System Planning Workshop | Ankara, Turkey |

| Date | Event | Place |
|---|---|---|
| 29–30 April 2015 | Regional Forum on Meteorological Services for Aviation Safety in Southeast Asia | Jakarta, Indonesia |
| 26–27 April 2015 | First National Climate Outlook Forum (NCOF) in Maldives | Male, Maldives |
| 21–23 April 2015 | Preparatory meeting for Joint RA II/ RA V Workshop on WIGOS for Disaster Risk Reduction | Jakarta, Indonesia |
| 19–23 April 2015 | Sixth session of South Asian Climate Outlook Forum (SASCOF) and Second Climate Services User Forum for Water sector | Dhaka, Bangladesh |
| 9–13 February 2015 | Third Joint session of the Typhoon Committee (47th session) and the Panel on Tropical Cyclones (42nd session) | Bangkok, Thailand |
| | **2014** | |
| 9–10 December 2014 | National Climate Outlook Forum | Male, Maldives |
| 1–10 December 2014 | The 8th WMO International Workshop on Tropical Cyclone (including IWTCLP-III) | Jeju, Republic of Korea |
| 2–29 November 2014 | Training on Instrument Maintenance and Calibration | Pune, India |
| 19–21 November 2014 | Fifth Asia/Oceania Meteorological Satellite Users' Conference | Shanghai, China |
| 18–20 November 2014 | Third WIS Implementation Workshop | Tokyo, Japan |
| 17–19 November 2014 | Third ASEAN Regional Climate Outlook Forum (ASEANCOF) | Singapore |
| 29–31 October 2014 | Second session of East Asia winter Climate Outlook Forum (EASCOF) | Tokyo, Japan |
| 24–27 October 2014 | Bangladesh Workshop on Coastal Flood Management | Dhaka, Bangladesh |
| 14–16 October 2014 | Scoping Meeting for the Establishment of the Arab Climate Outlook Forum (ArabCOF) | Amman, Jordan |
| 5–25 October 2014 | International Training Course on Weather Forecasting for Operational | Seoul, Republic of Korea |

| Date | Event | Place |
|---|---|---|
| | Meteorologists | |
| 9–11 September 2014 | WMO Regional Workshop on the provision of weather- and climate-related services in Least Developed Countries (LDCs) in Asia | Thimphu, Bhutan |
| 1–3 September 2014 | Thirty-sixth Meeting of the ASEAN Sub-Committee on Meteorology and Geophysics | Vientiane, Lao PDR |
| 4–6 August 2014 | International Training Course on WMO Information System(WIS) and Tehran GISC | Tehran, Islamic Republic of Iran |
| 23 July–1 August 2014 | Fourteenth Typhoon Operational Forecasting Training at RSMC Tokyo | Tokyo, Japan |
| 17–18 June 2014 | CAP Implementation Workshop | Negombo, Sri Lanka |
| 16 June 2014 | Common Alerting Protocol (CAP) Jump-Start Workshop | Negombo, Sri Lanka |
| 15–26 May 2014 | International Training Course on Tropical Cyclone Forecast | Nanjing, China |
| 13–23 May 2014 | International Training Course on Thunderstorms and Severe Convection Nowcasting | Beijing, China |
| 14–24 April 2014 | International Training Course on Short-term Prediction Methods | Beijing, China |
| 23–25 April 2014 | 10th session of the Forum on Regional Climate Monitoring, Assessment and Prediction for Asia, Training Courses undertaken by ETR/WMO in RA II | Beijing, China |
| 14–25 April 2014 | 5th session of the South Asian Climate Outlook Forum (SASCOF), Training Workshop for Capacity-building in Seasonal Forecasting for South Asian Countries, and First Climate Services User Forum for Water Sector | Pune, India |
| 10 April–1 May 2014 | Multi-year Capacity Development Program on ICT for Meteorological Services | Seoul, Republic of Korea |
| 26 March–1 April 2014 | The 19th International TOVS Study Conference (ITSC-19) | Jeju Island, Republic of Korea |
| 25–27 March 2014 | Informal Planning Meeting of the | Seoul, Republic of |

| Date | Event | Place |
|---|---|---|
| | Voluntary Cooperation Programme (VCP) | Korea |
| 2–15 March 2014 | International Training Course on Weather Radar Operation | Seoul, Republic of Korea |
| 24–28 March 2014 | EC Panel of Experts on Education and Training - 26th session | Seoul, Republic of Korea |
| 22–24 March 2014 | IPCC WG II - Preparatory Writing Team Meeting and associated Meeting for AR5 | Yokohama, Japan |
| 13–19 March 2014 | Sixth International Workshop on Verification Methods | New Delhi, India |
| 10–13 March 2014 | Thirtieth session of the Permanent Committee of Meteorology of League of Arab States | Kuwait |
| 2–6 March 2014 | Forty-first session of WMO/ESCAP Panel on Tropical Cyclones | Dhaka, Bangladesh |
| 27 Feb–1 March 2014 | Meeting of the Scientific Advisory Group (SAG) for Aerosols | Hong Kong, China |
| 18–20 February 2014 | League of Arab States (LAS) Subcommittee on Training, Capacity Development and Research | Cairo, Egypt |
| 17–28 February 2014 | Training on Operational Tropical Cyclone Forecasting at RSMC Tropical Cyclone | New Delhi, India |
| 10–13 February 2014 | Forty-sixth session of the ESCAP/WMO Typhoon Committee | Bangkok, Thailand |
| **2013** | | |
| 11–12 December 2013 | Fifth Expert Group Meeting on the Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR) | Amman, Jordon |
| 9–13 December 2013 | International Training Workshop on Effective Media Communication | Hong Kong, China |
| 3–5 December 2013 | 1$^{st}$ session of ASEAN Climate Outlook Forum (ASEANCOF) | Singapore |

| Date | Event | Place |
|---|---|---|
| 3–5 December 2013 | League of Arab States (LAS) Subcommittee on Meteorological Applications | Cairo, Egypt |
| 20–21 November 2013 | WMO/SDC National Stakeholder Workshop, Blue Peace - Water Security in the Middle East: Strategic Management of Hydrological and Meteorological Data and Information Product Generation Project | Beirut, Lebanon |
| 3–7 November 2013 | International Training Workshop on Aviation Meteorology for Forecasters | Doha, Qatar |
| 28 October–8 November 2013 | International Training Workshop on Agrometeorology | Nanjing, China |
| 28 October–1 November 2013 | WMO Interregional Training Workshop on Verification of Operational Seasonal Forecasts | Nanjing, China |
| 28 October–1 November 2013 | Meeting of the Commission for Basic Systems Open Programme Area Group on Public Weather Services Expert Team on Communication, Outreach and Public Education Aspects of PWS Delivery (CBS/OPAG-PWS ET/COPE) | Nanjing, China |
| 21–25 October 2013 | Seminar on Social and Economic Benefits of Service Delivery for Meteorological and Hydrological Services | Bendar Seri Begawan, Brunei Darussalam |
| 15–25 October 2013 | International Training Course on Regional Climate Prediction and Drought Monitoring | Beijing, China |
| 14–25 October 2013 | International Training Workshop on Tropical Forecast | Nanjing, China |
| 13–24 October 2013 | International Training on Producing High Resolution Climate Information: Scientific Basis and Application | Seoul, Republic of Korea |
| 6–26 October 2013 | Multi-year Capacity Development Programme on ICT for Meteorological Services | Seoul, Republic of Korea |
| 1–3 October 2013 | League of Arab States (LAS) Subcommittee on Climate and Climate Change | Cairo, Egypt |
| 12–25 September 2013 | International Training Workshop on Use of Meteorological Instruments | Nanjing, China |

| Date | Event | Place |
|---|---|---|
| 3–13 September 2013 | International Training Course on the Application of Meteorological Satellite Products | Beijing, China |
| 15–18 July 2013 | Expert Team on WIS Centres (ET-WISC) | Beijing, China |
| 2–4 July 2013 | Thirty-fifth Meeting of the ASEAN Sub-Committee on Meteorology and Geophysics | Manado, Indonesia |
| 24–25 June 2013 | DESA/ESCWA Expert Group and Inception Meeting on Strengthening National Capacities to Manage Water Scarcity and Drought in West Asia and North Africa | Beirut, Lebanon |
| 26–28 June 2013 | ESCWA Regional Workshop on Linking Regional Climate Model Projections to Hydrological Models | Beirut, Lebanon |
| 17–18 June 2013 | WMO/SDC Regional Stakeholder Workshop of the Blue Peace - Water Security in the Middle East: Strategic Management of Hydrological and Meteorological Data and Information Product Generation Project | Amman, Jordan |
| 27–29 May 2013 | WMO Workshop on Climate Monitoring including the Implementation of Climate Watch Systems for Arab Countries in West Asia | Amman, Jordan |
| 18–19 April 2013 | 4$^{th}$ session of South Asian Climate Outlook Forum (SASCOF-4) | Kathmandu, Nepal |
| 8–10 April 2013 | Twenty-ninth session of the Permanent Committee of Meteorology of League of Arab States | Marrakesh, Morocco |
| 3–16 March 2013 | International Training Course on Weather Radar Operation and Data Utilization | Seoul, Republic of Korea |
| 19–22 February 2013 | JMA/WMO Training Workshop on Calibration and Maintenance of Meteorological Instruments in RA II (Asia) | Tokyo, Japan |
| **Part IV: Other WMO and RA II sponsored and/or co-sponsored meetings, workshops, and training courses** | | |
| **2016** | | |

| Date | Event | Place |
|---|---|---|
| 8–11 November 2016 | The 2nd ICE-POP 2018 Workshop | Seoul, Republic of Korea |
| 5–9 November 2016 | 5th Training Course on WMO SDS-WAS Products (Satellite and Ground Observation and Modelling of Atmospheric Dust) | Tehran, Iran |
| 17–21 October 2016 | 8th Asia-Pacific GAW Workshop on Greenhouse Gases | Seoul, Republic of Korea |
| 4–6 October 2016 | Regional consultation meeting on Climate Services in the Arab Region and Workshop on the Role of Climate Information and Services in support of Decision-making in the Context of Climate Change | Casablanca, Morocco |
| 28–29 September 2016 | The first meeting of Working Group for Follow-up the Implementation of Arab Working Plan for Climate Change | Rabat, Morocco |
| 20–23 September 2016 | SDS-WAS Asian Dust and Aerosol workshop and Asian Regional SDS-WAS Coordination Group Meeting | Jeju, Republic of Korea |
| 17–21 September 2016 | Tropical Meteorology Research | Shanghai, China |
| 24–31 July 2016 | Nowcasting Symposium | Hong Kong, China |
| 20–23 July 2016 | Aviation Training and Aviation RDP Steering Committee | Hong Kong, China |
| 30 May–3 June 2016 | GAW Scientific Advisory Group on Aerosols meeting | Seoul, Republic of Korea |
| 23–25 May 2016 | Polar Prediction Project Steering Committee | Beijing, China |
| 18–20 May 2016 | The 2nd Pan-Eurasian Experiment (PEEX) Science Conference & the 6th PEEX Meeting | Beijing, China |
| 12 May 2016 | The meeting of the Arab Council of Ministers responsible for Meteorology and Climate | Abu Dhabi, UAE |
| 10–11 May 2016 | 32th session of the Permanent Committee of Meteorology of League of Arab States | Abu Dhabi, UAE |

| Date | Event | Place |
|---|---|---|
| 8–9 May 2016 | The first meeting of the Arab Forum for Meteorology and Climate | Abu Dhabi, UAE |
| 24 March 2016 | ICE-POP 2018 Observation Working Group Workshop | Gangneung, Republic of Korea |
| 28–29 February 2016 | League of Arab States (LAS) Subcommittee on Weather and Climate Hazard Information Management | Amman, Jordan |
| 27–28 January 2016 | League of Arab States (LAS) Subcommittee on Media | Abu Dhabi, UAE |
| 18–19 January 2016 | League of Arab States (LAS) Subcommittee meeting on Aeronautical Meteorology | Cairo, Egypt |
| **2015** | | |
| 9–12 November 2015 | Meeting of the WMO GAW Urban Research Meteorology and Environment (GURME) Scientific Advisory Group (SAG) and the Weather Information Service Engine (WISE) Project International Workshop | Seoul, Republic of Korea |
| 3–5 November 2015 | League of Arab States (LAS) Working Group on Quality and Media for Meteorological Services | Cairo, Egypt |
| 28–30 October 2015 | Kick-Off Meeting for 2018 Pyeongchang International Joint Research Project | Seoul, Republic of Korea |
| 19–23 October 2015 | The 7th Asia-Pacific GAW Workshop on Greenhouse Gases and the 2nd WCC-SF6 Training and Education Course | Jeju, Republic of Korea |
| 12–16 October 2015 | The 6th International Wildland Fire Conference (IWFC) | Pyeongchang, Republic of Korea |
| 29 September–1 October 2015 | The 5th Session of the Scientific Advisory Committee (SAC15) on the EANET | Da Nang, Viet Nam |
| 21–24 September 2015 | 3rd Heavy Monsoon Rainfall Workshop | New Delhi, India |
| 24–26 June 2015 | Aviation RDP | Shanghai, China |
| 22–27 June 2015 | S2S Monsoon meeting | Jeju, Republic of Korea |

| Date | Event | Place |
|---|---|---|
| 30 April 2015 | LAS Meeting of Ministers responsible for Meteorology | Jeddah, Saudi Arabia |
| 28–29 April 2015 | The League of Arab States (LAS) Forum on Capacity Development of Meteorology and Climates Services in the LAS region | Jeddah, Saudi Arabia |
| 26–27 April 2015 | 31th session of the Permanent Committee of Meteorology of League of Arab States | Jeddah, Saudi Arabia |
| 10–11 March 2015 | Sand and Dust Storm - Asian Node Meeting | Beijing, China |
| 23–25 February 2015 | Climate and Clean Air Coalition Working Group Meeting | Kathmandu, Nepal |
| 9–20 February 2015 | Targeted Training Activity: Modelling and Prediction of Asian Monsoons; Improving Physical Processes | Pune, India |
| 13–15 January 2015 | League of Arab States (LAS) Subcommittee on Telecommunication and Information Systems | Cairo, Egypt |
| **2014** | | |
| 23–25 December 2014 | League of Arab States (LAS) Subcommittee on Meteorological Applications | Cairo, Egypt |
| 18–20 November 2014 | League of Arab States (LAS) Subcommittee on Training, Capacity-building and Research | Cairo, Egypt |
| 23–24 October 2014 | GAW Scientific Advisory Group on Reactive Gas Meeting | Seoul, Republic of Korea |
| 22–24 October 2014 | The 6th Asia-Pacific GAW Workshop on Greenhouse Gases | Seoul, Republic of Korea |
| 21–23 October 2014 | League of Arab States (LAS) Subcommittee on Climate and Climate Change | Cairo, Egypt |
| 20–22 October 2014 | 5th GAW VOC Expert Meeting | Seoul, Republic of Korea |
| 14–16 September 2014 | Scoping Meeting for the Establishment of the Arab Climate Outlook Forum (ArabCOF) | Amman, Jordan |
| 14–18 July 2014 | 34th Meeting of the Open-Ended Working Group of the Parties to the | Bangkok, Thailand |

| Date | Event | Place |
|---|---|---|
| | Montreal Protocol | |
| 11–12 July 2014 | Workshop on Hydrofluorocarbon Management | Bangkok, Thailand |
| 9–10 July 2014 | 52nd Meeting of the Implementation Committee Under the Non-Compliance Procedure of the Montreal Protocol | Bangkok, Thailand |
| 28 June–5 July 2014 | International Conference and Early Career Scientists School on Environmental Observations, Modelling and Information Systems (ENVIROMIS-2014) | Tomsk, Russian Federation |
| 7–9 June 2014 | ICIMOD's Second Annual Regional Atmospheric Science (SARAS) Workshop | Pokhara, Nepal |
| 22–23 May 2014 | LRTAP Task Force on Hemispheric Transport of Air Pollutants meeting | Beijing, China |
| 19–20 May 2014 | GURME NRT China project meeting | Beijing, China |
| 12–16 May 2014 | iLeaps Science Conference | Nanjing, China |
| 14–16 April 2014 | WMO Post-Typhoon Haiyan Expert Mission to Viet Nam | Viet Nam |
| 19–20 March 2014 | GURME Air Quality Forecasting workshop for Youth Olympic Games | Nanjing, China |
| 16–17 March 2014 | WISE project meeting | Jeju, Republic of Korea |
| 27 February–1 March 2014 | GAW Aerosol Scientific Advisory Group meeting | Hong Kong, China |
| 21–23 January 2014 | Meeting of the Expert Team on GAW World Data Centres | Tokyo , Japan |
| **2013** | | |
| 24–25 October 2013 | The 5th Asia-Pacific GAW Workshop on Greenhouse Gases | Jeju, Republic of Korea |
| 16–22 August 2013 | Expert meetings on MHEWS prototype project and Megacity Implementation Plan development for meteorological and related services | Shanghai, China |

| Date | Event | Place |
|---|---|---|
| 14 June 2013 | Scientific Advisory Group on Greenhouse Gases meeting | Beijing, China |
| 10–13 June 2013 | 17th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases and Relater Measurement Techniques (GGMT-2013) | Beijing, China |
| 6–13 June 2013 and 23 June–4 July 2013 | Fact-finding and needs assessment mission to assess the current status and requirements of the Maldives Meteorological Service | Maldives |
| 3–7 June 2013 | 9th International Carbon Dioxide Conference | Beijing, China |
| 3–5 June 2013 | 12th International Conference on Atmospheric Sciences and Application to Air Quality (ASAAQ) | Seoul, Republic of Korea |
| 1–3 May 2013 | Changing Chemistry in a Changing Climate: Monsoon - C4 Monsoon | Pune, India |
| 30 April 2013 | Metropolitan Air Quality Forecasting and Services - SAFAR | Pune, India |

# BACKGROUND INFORMATION
# NOT TO BE INCLUDED IN THE SESSION REPORT

# PROVISIONAL ANNOTATED AGENDA

## 1. OPENING OF THE SESSION

The sixteenth session of Regional Association II (Asia) will open at 9.30 a.m. on Sunday, 12 February 2017 at the Dusit Thani Hotel, Abu Dhabi, United Arab Emirates. Information on material arrangements for the session is given in RA II-16/INF. 1.

## 2. ORGANIZATION OF THE SESSION

### 2.1 Consideration of the report on credentials

The representative of the Secretary-General will present the report on credentials taking into account the documents received prior to and during the session. The Association is invited to consider this report.

### 2.2 Adoption of the agenda

In accordance with General Regulations 173 and 176, the provisional agenda will be submitted for approval by the Association as soon as possible after the opening of the session and may be amended at any time during the course of the session.

Additional items for the agenda may be forwarded by Members to the Secretariat before the session, but preferably not later than thirty days before the opening of the session. Working documents on additional items proposed by Members should be provided by the Member concerned as early as possible, but preferably not later than sixty days before the opening of the session.

### 2.3 Establishment of committees

The Association will be invited to work in plenary throughout the session. Committees for the session will be established. These will include:

(a) Credentials Committee;

(b) Nomination Committee;

(c) Drafting Committee (if required);

(d) Coordination Committee.

The Association may wish to nominate a Rapporteur on Previous Resolutions and Recommendations of the Association and relevant Resolutions of the Executive Council, and establish, for the duration of its session, other committees as it deems necessary.

**2.4 Other organizational matters**

The Association will agree upon:

(a) Working hours of the meetings: 9:30–12:30 and 14:30–17:30;

(b) Tentative programme of work for the session.

**3. REPORT BY THE PRESIDENT OF THE ASSOCIATION**

The report will deal with the activities of the Association and any other matters related to the Association since its fifteenth session. The Association will have a general discussion on the report by the president and will refer any points requiring detailed study or subsequent action to the appropriate agenda items.

**4. PROGRAMME ACTIVITIES – REGIONAL ASPECTS**

**4.1 Disaster Risk Reduction, resilience and prevention focusing on impact-based decision support services**

Under this agenda item the Association is invited to discuss and make decisions, as necessary, on issues related to disaster risk reduction, resilience and prevention focusing on impact-based decision support services in connection with:

4.1(1) Implementation of the WMO DRR Roadmap in RA II including major activities on DRR services;

4.1(2) Public Weather Services and the provision of multi-hazard impact-based forecast and warning services;

4.1(3) Flood Forecasting;

4.1(4) Severe Weather Forecasting Demonstration Project (SWFDP) – Reporting and identification of regional entity;

4.1(5) Tropical Cyclone Forecasting to guide actions for enhancing capability of the NMHSs in tropical cyclone impact-based forecasting and warning services, following the multi-hazard early warning approach;

4.1(6) Coastal Inundation Forecasting to provide guidance on further development of the Coastal Inundation and Forecasting Demonstration Project (CIFDP), as part of a multi-hazard approach to coastal inundation caused by various phenomena (especially storm surge).

**4.2 Climate Services, Action and Resilience**

Under this agenda item the Association is invited to discuss and make decisions, as necessary, on issues related to:

4.2(1) Paris Agreement

- Invite Members to engage in National Action Plan (NAP) preparation;

- Invite Members to contact Nationally Designated Authorities to get involved in Green Climate Fund (GCF) proposal development.

4.2(2) Global Framework for Climate Services (GFCS) and WMO contribution to the GFCS

- Definition of national frameworks for climate services with other ministries and non-NMHS partners, and establishment of inter-ministerial governance mechanisms;

- Modification of the task team in line with the mechanism for WMO contributions to the GFCS, key regional priorities for support from the technical commissions.

4.2(3) Climate Service Information System (CSIS)

- Regional architecture for CSIS implementation, including RCCs, objective regional forecasting systems, institutional regional responsibilities.

**4.3 Observations and Data Exchange**

Under this agenda item the Association is invited to discuss and make decisions, as necessary, on issues related to:

4.3(1) WMO Integrated Global Observing System (WIGOS)

- The Association will be invited to review the implementation activities and projects, and proposed plans for Regional WIGOS Centre(s) in Region II;

- The Association will be invited to decide on the list of stations to compose the Regional Basic Synoptic Network (RBSN), the Regional Basic Climatological Network (RBCN), and the pilot Regional Basic Observing Network (RBON) for Regional Association II;

- The Association will also be invited to endorse an update to the Regional WIGOS Implementation Plan for Region II (R-WIP-II).

4.3(2) WMO Information System (WIS)

**4.4 Service Quality and Service Delivery**

Under this agenda item the Association is invited to discuss and make decisions, as necessary, on issues related to:

4.4(1) Further implementation of the WMO Strategy for Services Delivery and harmonization of service delivery in RA II

4.4(2) Meteorological services for aviation

4.4(3) Meteorological services for agriculture

4.4(4) Meteorological services for marine operations

**4.5 Polar and High Mountain Regions**

Under this agenda item the Association is invited to discuss and make decisions, as necessary, on issues related to:

- Considering and acting upon specific recommendations of the Executive Council Panel of Experts on Polar and High Mountain Observations, Research and Services, regarding: (i) the development of the Global Cryosphere Watch (GCW), and its Cryonet, and participation in the CryoNet Asia working group; (ii) the development of observations at high elevation in the third pole region; (iii) the Association support to the Year of Polar Prediction (YOPP); and (iv) the development of Polar Regional Climate Centres (PRCCs) in the Region.

**4.6 Data Processing, Modelling and Forecasting**

Under this agenda item the Association is invited to discuss and make decisions, as necessary, on issues related to:

4.6(1) Seamless Data-processing and Forecasting System

4.6(2) Implementation of forecast verification activities, high resolution NWP and impact-based forecast and warning

4.6(3) Hydrology and Water Management

**4.7 Research**

Under this agenda item the Association is invited to discuss, as necessary, on issues related to:

4.7(1) Research advancements in early warning systems

- Support of Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS)

**4.8 Capacity development**

4.8(1) WMO capacity development priorities for 2016–2019

Under this agenda item the Association is invited to discuss the completion of focal point for a successful implementation and operation of Country Profile Database (CPDB) and consider recommendations of the EC Panel of Experts on Capacity Development including capacity development priorities for 2016–2019 and the Capacity Development Strategy Implementation Plan 2016–2019.

4.8(2) Education and training

The Association is invited to:

- Discuss and make suggestions on how education and training could more effectively support NMHSs and Members to deliver effective services to support the implementation of socioeconomic and development initiatives;

- Discuss and report on regional priorities for education and training;
- Review status of RTCs and discussions on how to strengthen them.

4.8(3) Resource mobilization

The Association is invited to review, from the regional perspectives, the resource mobilization strategy for the Organization for 2016–2019 endorsed by EC-68.

### 4.9 Partnerships

Under this agenda item the Association is invited to:

- Provide directions for strengthening WMO cooperation with the UN system and other international organizations;
- Guide a comprehensive review of existing MoUs established by the Organization and principles for the development of cooperation agreements;
- Provide direction on recognition of partner organizations contributing to the WMO Programmes and constituent bodies and vice versa;
- Provide guidance for positioning and strengthening WMO contribution to, and support Members implementation of, the 2030 Agenda for Sustainable Development and the role of the Association in this regard.

## 5. IMPROVED EFFICIENCY AND EFFECTIVENESS

### 5.1 WMO Strategic and Operating Plan – regional aspects

Under this agenda item, the Association will be invited to discuss the issues related to the WMO strategic and operational planning processes and the WMO Strategic and Operating Plan 2020–2023 focusing on the regional aspects. The session will consider and endorse the proposed regional priorities for 2020–2023 submitted by the president of the Association. The Association will review the RA II Operating Plan (2016–2019) in comparison with the consolidated WMO Operating Plan and will agree on principles of further planning of activities during the next intersessional period.

### 5.2 Internal matters of the Association

Under this agenda item the Association will address the need for enhancing its working mechanisms towards an action and results-oriented approach that would bring more benefits to its Members. This would include a critical analysis of conduct of regional events and other activities, the role and operation of the Management Group and other subsidiary bodies using the lessons learnt during the preceding intersessional period. The Association will decide on the new structure and tasks of its subsidiary bodies for the next intersessional period.

## 6. EMERGING ISSUES AND SPECIFIC CHALLENGES

### 6.1 Private sector engagement

Under this agenda item the Association is invited to:

- Review the position paper prepared by EC-68 and provide directions from the regional perspectives regarding the development of public-private partnerships related to data, service delivery and other areas of the WMO mandate.

### 6.2 Gender equality

The Association will be invited to:

- Recall Decision 77 (EC-68) on the WMO Gender Action Plan (GAP) and use the Action Plan as guidance to undertake relevant actions at national level;

- Nominate more females as members of WMO constituent bodies and their working structures.

## 7. WMO REGIONAL OFFICE FOR ASIA AND THE SOUTH-WEST PACIFIC INCLUDING WMO OFFICE FOR WEST ASIA

The Association will review the performance of the Regional Office for Asia and the South-West Pacific in conducting its tasks within the framework of Regional Programmes. The Association will advise on enhancing the role and performance of the Regional Office as the main focal point for the regional activities in view of the relocation of the Regional Office to Singapore.

## 8. REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMEDATIONS OF THE ASSOCIATION AND OF RELEVANT EXECUTIVE COUNCIL RESOLUTIONS

The Association will be invited to consider the relevant resolutions which are presently in force, in accordance with the provisions of Regulation 163(c) of the General Regulations and Rule 21 of the Rules of Procedure of the Executive Council.

## 9. ELECTION OF OFFICERS

The Association will elect a president and a vice-president to hold office until the end of the next session of the Association. Details regarding eligibility and procedures for election are given in Regulations 11, 27, 57–65, 80–90, 141, 168, 174(11) of the General Regulations, the Convention Part V article 6, as well as the relevant provisions of Resolution 37 (Cg-XI) concerning the eligibility of candidates for these offices.

## 10. DATE AND PLACE OF THE SEVENTEENTH SESSION

The Association will be invited to set the tentative dates for its seventeenth session in order to facilitate organizational arrangements.

Taking into consideration any relevant decisions taken by the Association on the future conduct of its session, Members attending the session will be invited to present invitations from their Governments for hosting the seventeenth session of Regional Association II. Members interested in extending such invitation should take into consideration the provisions of Regulations 18, 169, 170(a) and 171 of the General Regulations. The Association may wish to record any such invitations or suggestions in the report of the session.

## 11. CLOSURE OF THE SESSION

The sixteenth session of the Association is scheduled to close on Thursday, 16 February 2017.

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# BACKGROUND INFORMATION SUPPORTING DECISION NOT TO BE INCLUDED IN THE SESSION REPORT

## 1. Introduction

1.1 The text at hand provides a short status report on some major activities of the WMO Disaster Risk Reduction (DRR) Programme, coordinated by the DRR Services Division at the WMO Secretariat, in relation to the development of the Implementation Plan for the WMO DRR Roadmap.

## 2. Meeting of the WMO Disaster Risk Reduction Focal Points of Regional Associations, Technical Commissions and Technical Programmes (DRR FP RA-TC-TP)

2.1 The second meeting of the WMO DRR Focal Points of Regional Associations, Technical Commissions and Technical Programmes (DRR FP RA-TC-TP) was held from 3 to 5 November 2015 at the WMO headquarters in Geneva, Switzerland. The meeting was co-chaired by Mr Michel Jean (DRR Coordinator and Focal Point of the Commission for Basic Systems (CBS)) and Prof Kevin Horsburgh (DRR Focal Point of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)).

2.2 The third meeting of the DRR FP RA-TC-TP took place from 14 to 16 December 2016 at the WMO headquarters in Geneva, Switzerland.

## 3. Endorsement by EC-68 to establish an inter-programme task team for the implementation of Resolution 9 (Cg-17)

3.1 In support of the Sendai Framework's first Priority for Action, Cg-17, through adoption of its Resolution 9, decided to standardize weather, water, climate, space weather and other related environmental hazard information. Cg-17 also requested CBS to develop, in collaboration with all TCs and RAs, a proposal on standardized identifiers for cataloguing hazardous and extreme weather, water and climate events for consideration by EC. These measures will promote interoperability among datasets and facilitate Members' efforts to assess risks and track climate-related loss and damage. Enhanced capabilities to monitor and model future climate conditions will improve the attribution of extreme weather, water and climate events to climate change. These capabilities will also facilitate preparedness and adaptation at all timescales and will provide quality assurance of these data, including the official designation/validation of extreme events and archiving of event data and trend indices. WMO, through its TCs, is already active and in some cases well advanced in addressing different aspects of the characterizing and cataloguing issue.

3.2 To address the decision of Cg-17 the CBS Management Group, at their sixteenth meeting in February 2016 and the EC WG/DRR at their first meeting in April, made a recommendation to EC-68, which was subsequently endorsed, to establish an Inter-Programme Task Team on Cataloguing Extreme Weather, Water and Climate Events (IPTT-CWWCE) that would coordinate activities of the various programmes in the standardization of weather, water, climate, space weather and other related environmental hazard and risk information and the development of identifiers for cataloguing extreme weather, water and climate events. The IPTT-CWWCE is co-chaired by both CBS and the Commission for Climatology (CCl) and commenced work at its first meeting in September 2016.

## 4. WMO international activities related to multi-hazard early warning systems (MHEWS)

4.1 In line with the Sendai Framework and building upon the WMO community's considerable capacities that contribute to multi-hazard early warning systems (MHEWS), WMO is playing a key role in developing and promoting the International Network for MHEWS (IN-MHEWS) as well as in the conduct of a Multi-Hazard Early Warning Conference from 22 to 23 May 2017 as a pre-meeting to the 2017 Global Platform for DRR from 24 to 26 May 2017, both taking place in Cancún, Mexico. The Conference brings together multiple stakeholders and will facilitate the sharing of expertise and good practice in strengthening MHEWS as a national strategy for DRR, climate change adaptation and building resilience. The Conference will build upon the three international conferences on early warning (1998, 2003, and 2006, hosted by the Government of Germany) and three WMO expert symposia on MHEWS (2006, 2009 and 2015) and will identify effective strategies and actions needed to promote and strengthen MHEWS in support of the implementation of the Sendai Framework.

4.2 Furthermore, the first meeting of the WMO DRR User-Interface Expert Advisory Group on MHEWS (UI-EAG MHEWS), since EC-68 called User-Interface Working Group on MHEWS (UI-WG MHEWS), took place from 19-21 April 2016 in Geneva.

## 5. Other notable WMO DRR activities

5.1 National technical agencies such as meteorological, hydrological, geological and marine services play crucial roles in collecting, analysing and providing hazard and risk information. Their collaboration with DRM agencies, natural and social scientists and the media, for example, is important for making effective use of this information and the services provided. It is also important for supporting risk-informed decision-making and development planning at national and local levels. One can note the capacity development projects of WMO with activities covering RA II, namely for example the Severe Weather Forecasting Demonstration Project (SWFDP) which uses the cascading forecasting process to bring high-value information from global models run by developed NMHSs to Least Developed Countries' NMHSs for timely and accurate forecasts and warnings for efficient decision-making, the Coastal Inundation Forecasting Demonstration Project (CIFDP) and the Flash Flood Guidance System (FFGS).

5.2 The Common Alerting Protocol (CAP) provides the international standard for emergency alerting and public warning for all hazards, including those related to weather events, earthquakes, tsunamis, volcanoes, public health, power outages and many other emergencies. This Protocol also applies to all media, including communications media ranging from sirens to mobile phones, faxes, radio, television and various web-based communication networks. WMO organizes annual CAP training workshops in collaboration with other organizations such as the International Federation of Red Cross and Red Crescent (IFRC), the International Telecommunications Union (ITU) and the OASIS (Advancing open standards for the information society) consortium which helps in the advancement of CAP.

5.3 It can be noted that many NMHSs in RA II are actively engaged in DRR-related activities within the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) as well as within regional organizations such as the Regional Integrated MHEWS for Africa and Asia (RIMES), the Association of Southeast Asian Nations (ASEAN), the ESCAP/WMO Typhoon Committee, and the WMO/ESCAP Panel on Tropical Cyclones. NMHSs in RA II are encouraged to continue this work and coordinate with the Association and engage in regional DRR-related platforms, networks and partnerships (such as IN-MHEWS), in particular in the fields of MHEWS and the identification/cataloguing of extreme weather, water and climate events.

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# BACKGROUND INFORMATION SUPPORTING DECISION NOT TO BE INCLUDED IN THE SESSION REPORT

**Moving towards forecasting impacts**

1. Despite the science, technology, data, and other resources that exist in the collective meteorological community, some recent severe weather and associated events have been the cause of many deaths and destruction of properties and loss of livelihoods. The question frequently asked is: how should we, as the meteorological community, change what we are doing so that we can better contribute to mitigating the impacts of severe meteorological events and in particular the loss of life. It is generally agreed that the primary responsibility of National Meteorological and Hydrological Services (NMHSs) is to provide timely and accurate forecasts and warnings of meteorological events and hazards. However, in order for governments, economic sectors and the public to take appropriate action, they need to know how the meteorological hazard will impact their lives, livelihoods, property and the economy.

2. Understanding disaster risk and forecasting meteorological impacts are generally beyond the remit of meteorologists and hydrologists. However in most countries, those affected are demanding more than statements of expected weather conditions from their NMHSs (*Ref.*: CBS-15, Abridged Final Report, Annex VI). Solving this problem is a challenge to developing and developed economies alike. The risk associated with a meteorological hazard depends on knowing how that hazard impacts human beings, their livelihoods, and assets due to their vulnerability and exposure. The sixty-fifth session of the WMO Executive Council (EC-65, Geneva, 15-23 May 2013, ref.: EC-65 – Abridged Final Report, general summary – paragraphs 4.1.26-4.1.38) discussed the NMHSs' move towards impact-based forecasting and risk-based warnings in the provision of public warning services in support of social resilience through behaviour modification in society. Subsequently, CBS tasked the PWS Programme to prepare a set of guidelines to assist Members in the implementation of impact-based forecast and warning services. Responding to this task the PWS experts developed The *WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services* (WMO-No. 1150), which was published in 2015. CBS-16 requested the preparation of a step-by-step implementation strategy, including examples of good practice by Members, based on the above-mentioned WMO Guidelines.

3. Issues related to impact-based forecasts and warnings are complex and require planning and forging of partnerships at many levels and with many other government agencies and stakeholders: not only with disaster managers, but also with those responsible for urban planning, education authorities, health authorities, etc. These complexities often lead to reluctance of meteorologists to forecast impacts since extensive knowledge of vulnerability and exposure are required and can only be addressed through data sharing among different agencies and departments. However, forecasting the impact of a hazard (what the weather will do), is often more important than the meteorological forecast (what the weather will be) because it is defined in terms of parameters more readily understood by those at risk and those responsible for mitigating those risks. Such forecasts will ensure that critical weather information is communicated about societal impacts to individuals and sectors most at risk. This information should be made available to the community in a variety of easy-to-understand formats.

4. Due to the emerging and somewhat unfamiliar nature of the subject, the *WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services* have been introduced to a number of Members during national stakeholder workshops in order to familiarize them with the challenges and issues involved. In RA-II, two countries, namely Myanmar and Maldives, have so far benefitted from such in-country workshops in order to assist them with their activities for the implementation of a multi-hazard approach to reducing impacts. It is hoped that this approach can be rolled out in more Members in RA II.

5. The implementation of The WMO Strategy for Service Delivery will be an important tool for integrating impact-based forecasting and risk-based warnings into a common planning framework to maximize benefits and allow for planning and maintenance of observing infrastructure, and efficient implementation of predictive services of Members in support of social resilience and mitigation of impacts. The PWS and underpinning observing capabilities of Members need to be upgraded and strengthened on a continuous basis to cope with the optimum delivery of new services, ranging from day-to-day operations to providing guidance informing decision-makers and policymakers on longer timescales.

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# BACKGROUND INFORMATION SUPPORTING DECISION
# NOT TO BE INCLUDED IN THE SESSION REPORT

**References:**

1. Report of RSMT Meeting of SWFDP South-East Asia
2. Report of Steering Group of SWFDP
3. Information on SWFDP-Southern Africa (which is in operational phase)

**Introduction**

WMO's Severe Weather Forecasting Demonstration Project (SWFDP) through its "Cascading Forecasting Process" has been successfully strengthening capacity in NMHSs in developing countries, LDCs and SIDSs to deliver improved forecasts and warnings of severe weather to save lives, livelihoods and property. Following the recommendation by Cg-XV (2007), the development process for initiating SWFDP regional subprojects in RA II, in Southeast Asia, the Bay of Bengal and Central Asia was started in 2010, 2012 and 2014 respectively. These subprojects have shown steady progress during recent years.

The SWFDP South-East Asia (Cambodia, Lao PDR, Philippines, Thailand and Viet Nam) entered into demonstration phase from1 January 2015 after the decision of the Regional Subproject Management Team (RSMT) meeting in Hanoi, Viet Nam in August 2015. The Global NWP centres of ECMWF, CMA, JMA, KMA and DWD are contributing to SWFDP-Southeast Asia, while Viet Nam is providing support as lead Regional Forecast Support Centre, with the support of RSMC Tokyo (for typhoon forecast support) and RSMC New Delhi (for tropical cyclone forecast support).

The SWFDP-Bay of Bengal initially involved six countries: Bangladesh, India, Maldives, Myanmar, Sri Lanka and Thailand and was expanded in 2016 to benefit Bhutan, Nepal and Pakistan. The SWFDP-Bay of Bengal is ready to start demonstration phase subject to decision by the first meeting of the Regional Subproject Management Team (RSMT) in 2017. ECMWF, UKMO and IMD are contributing as global NWP centres for SWFDP-Bay of Bengal with RSMC New Delhi as lead Regional Centre.

The SWFDP-Central Asia involves four countries: Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan. Planning of the subproject started in 2014. The contributing global NWP centres include Roshydromet, ECMWF, CMA, JMA and KMA. RSMC Tashkent will serve as the lead Regional Centre. The project website, which is in the Russian language, is currently maintained by Roshydromet.

Since inception of these subprojects, regular specialized training workshops have been conducted for participating NMHSs on interpretation of satellite-based information and NWP products and their use in severe weather forecasting and warning services for improved decision-making at national levels. The following training workshops were held:

(a) Two-week SWFDP Training Workshop, Macao, China, 8-19 April 2013, jointly organized for participating countries of both SWFDP South-East Asia and SWFDP-Bay of Bengal. Bhutan, Nepal, Pakistan, Indonesia and Macao also participated;

(b) Two-week SWFDP-Southeast Asia Training Workshop in Quezon City, Metro Manila, Philippines, 2-13 June, 2014;

(c) One-week SWFDP-Central Asia Workshop on Analysis and Interpretation of Numerical Weather Prediction (NWP) products, Moscow, Russian Federation, 6 to 10 July 2015;

(d) Two-week SWFDP Training Workshop, Bangkok, Thailand 14-25 September 2015 jointly organized for all participating countries of SWFDP-South-East Asia and SWFDP-Bay of Bengal;

(e) SWFDP–Central Asia Workshop on Forecasting and Public Weather Services (PWS) for Forecasters and Users from Central Asia, Almaty, Kazakhstan, 22 February to 4 March 2016.

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# BACKGROUND INFORMATION SUPPORTING DECISION NOT TO BE INCLUDED IN THE SESSION REPORT

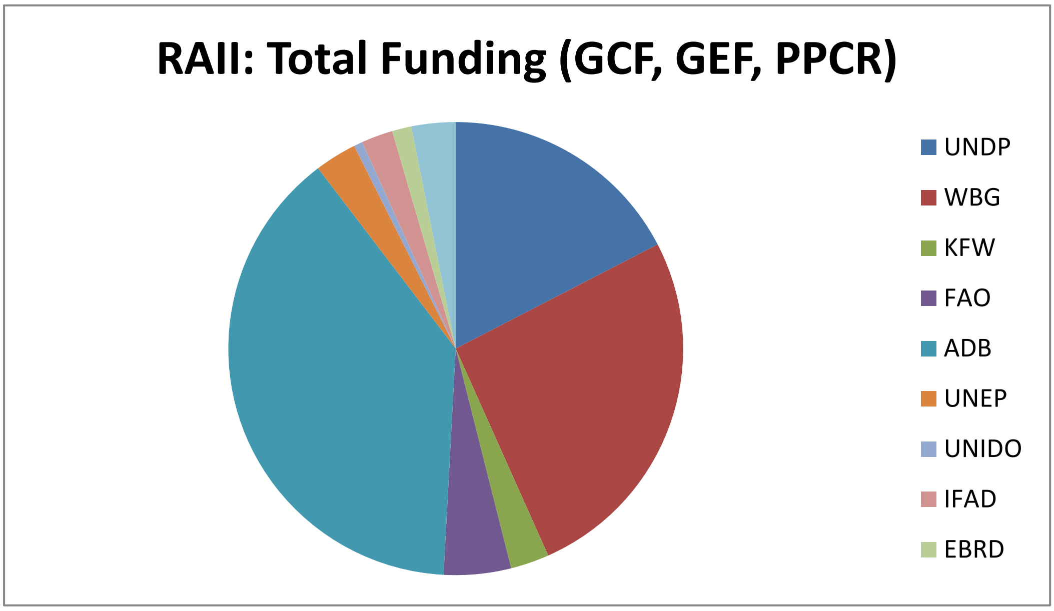
**Ongoing and planned investments**

1. RA II countries currently enjoy USD 3 billion in climate change adaptation and climate resilience investment in 68 projects benefitting approximately 20 countries. This figure reflects financing from just three sources:

   (a) The Pilot Programme on Climate Resilience – USD 1,497,200,000;
   (b) The Green Climate Fund – USD 1,104,567,381;
   (c) The Global Environment Facility – USD 307,100,000.

2. Ongoing WMO Programmes contribute another USD 5,311,000, and substantial additional resources are being programmed though bi-lateral sources.

3. The Asian Development Bank, World Bank Group and UNDP have received the largest allocations



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4. These funding sources and associated projects constitute an important potential resource for climate services implementation.

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# BACKGROUND INFORMATION SUPPORTING DECISIONS NOT TO BE INCLUDED IN THE SESSION REPORT

**WMO climate statements on the global climate**

1. In November 2016 WMO published a climate assessment covering the five-year period 2011-2015 (WMO-No. 1179). The five-year climate statement was presented at the "Earth Info Day" event organized by the UNFCCC secretariat at the occasion of the Conference of Parties (COP 22). The 5-year report can be found at: http://unfccc.int/files/science/workstreams/systematic_observation/application/pdf/wmo_1179_statement2016_5years_web_en.pdf.

2. WMO released a provisional statement on the global climate in 2016. It is available at: https://public.wmo.int/en/media/press-release/provisional-wmo-statement-status-of-global-climate-2016.

3. In 2013 WMO published a ten-year climate report: *The Global Climate 2001-2010 a Decade of Climate Extremes*. A complete version (WMO-No. 1103) is available at http://library.wmo.int/pmb_ged/wmo_1103_en.pdf and a summary report (WMO-No. 1119) is available at: http://library.wmo.int/pmb_ged/wmo_1119_en.pdf.

4. WMO has been publishing an annual Statement on the Status of the Global Climate since 1993 the complete series of these statements can be found at: http://www.wmo.int/pages/prog/wcp/wcdmp/statement.php.

**Data Rescue**

5. The Indian Ocean Data Rescue (INDARE) initiative was launched at the first international workshop on the recovery of climate heritage in the Indian Ocean rim countries and islands, 21-24 April 2014, Maputo, Mozambique. INDARE aims at generating reliable climate instrumental time series and historical reanalysis that both improve the monitoring, prediction and projection of climate extremes. Collaboration among INDARE members will help to locate existing disperse data, provide them to the originating countries, enhance and safeguard climate records to prevent them from being lost, and to convert historical long-term climate records into accessible and digitized climate datasets that underpin climate research, applications and climate services. The INDARE Implementation Plan can be found at: http://www.wmo.int/pages/prog/wcp/wcdmp/documents/INDAREimplementationPlan.pdf.

**RA II Regional Climate Centres**

6. EC-PHORS is actively promoting the PRCC concept for the Arctic, Antarctic as well as the Third Pole. The proposal for the Third Pole RCC-Network is mainly a result of the GFCS consultation held in Jaipur, India, in March 2016 (http://www.wmo.int/pages/prog/wcp/wcasp/meetings/regional_consultation_third_pole.php). RA II endorsement of this initiative will help us to move forward with its implementation, including resource mobilization.

7. The Arctic PRCC-Network implementation planning meeting held in Geneva in November 2016 agreed on its structure including Node leads and contributing consortia members and on the organization of the first Polar Regional Climate Outlook Forum (PCOF) in 2017, in conjunction with the research and user communities (http://www.wmo.int/pages/prog/wcp/wcasp/meetings/PRCC_IPMeeting.html).

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**Average Availability of SYNOP, TEMP and CLIMAT data at MTN centres from RA II AGM/IWM: 1 to 15 October (2012–2015)**

| Year | Surface (SYNOP) | | Upper-air (TEMP) | | CLIMAT | |
|---|---|---|---|---|---|---|
| | Number of stations | Reports received (%) | Number of stations | Reports received (%) | Number of stations | Reports received (%) |
| 2012 | 1366 | 91.68% | 274 | 74.54% | 666 | 85.14% |
| 2013 | 1364 | 92.30% | 274 | 79.51% | 664 | 84.66% |
| 2014 | 1648 | 93.31% | 286 | 75.86% | 664 | 86.30% |
| 2015 | 1638 | 93.71% | 286 | 80.20% | 662 | 89.57% |

*Note: Results based on the RBSN/RBCN in RA II*

***Regional Basic Observing Network (RBON)***

4. The existing RBSN and RBCN are based essentially on a design representing the late 1990s status of the observing networks. Also, the majority of stations in the RBSN and RBCN are multipurpose, serving both synoptic and climatological purposes. While the concepts behind the RBSN and RBCN are becoming outdated as Members implement a wider range of observing systems in integrated composite networks serving multiple purposes, the need to integrate the two networks into one Regional Basic Observing Network (RBON) is recognized under the WIGOS implementation. The stations/platforms currently comprising the RBSN and RBCN are therefore the primary candidates for the RBON, and are expected to constitute the backbone of the RBON. It is expected that the new re-designed RBON would also take into consideration the inclusion of new surface-based observing systems, such as weather radars, wind profiler systems, lightning detection systems, data buoys, voluntary observing ships and aircraft that make meteorological, climatological and marine observations. The network re-design would also be coordinated with satellite observations. The existing scheme of two separate networks (RBSN and RBCN) is expected to be continued until such time a new RBON is designed following the development of the RBON Concept as adopted by CBS-16 Decision 5.4.1(4)/1.

5. Accordingly, the Association is invited to note that CBS-16 adopted Decision 5.4.1(4)/1 endorsing the development of the RBON Concept. Corresponding standards and recommendations supported by best practices and procedures for implementation of the RBON by the Association will be incorporated into a new edition of the *Manual on the WMO Integrated Global Observing System* (WMO-No. 1160) in 2019.

6. RBON will lead to improved services by delivering more and improved observations to stakeholders, and enable the full benefit of regional observing capabilities to be realized. As it will also be a substantive and valuable subset of WIGOS, the Association is invited to adopt Decision 4.3(1)/2 (RA II-16) and thereby: (i) establish a RBON Pilot for RA II to initially include the merging of all the Association's RBSN and RBCN stations; (ii) request the Association's Members to propose additional observing stations in the RBON Pilot; (iii) task the RA II regional Working Group on WIS and WIGOS to recommend to the president of RA II the list of stations to be included in the proposed RBON Pilot for RA II; and (iv) authorize the president of RA II to approve changes to the list of stations.

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Annex: 1

**ANNEX**

**(Annex to draft Decision 5.4.1(4)/1 (CBS-16))**

**THE REGIONAL BASIC OBSERVING NETWORK CONCEPT PAPER**

## 1. Preamble

The Regional Basic Synoptic Network (RBSN) and Regional Basic Climatological Network (RBCN)[22] consist of surface stations and upper-air stations designated by the regional associations. They have proven to be highly effective and made valuable regional contributions to the activities of WMO and its Members. The observations from these stations, which are maintained by WMO Members, have been exchanged globally in real-time without restriction. Originally designed to support operational meteorology and climatology, these observations have produced significant benefits across a wide range of applications.

Additional and emerging requirements for observations across diverse application areas are driving the need to redefine the Regional Basic Synoptic and Climatological Networks. New and improved observational technologies provide the opportunity to reassess regional observational strategies. The WIGOS framework calls for a more integrated view of WMO observing systems to serve the needs of multiple application areas. The new Regional Basic Observing Network (RBON) will lead to improved services by delivering more and improved observations to stakeholders, and enable the full benefit of regional observing capabilities to be realized. As such, RBON will be a substantive and valuable subset of WIGOS.

Cg-17 decided that the development of WIGOS will continue during its pre-operational phase as one of the WMO strategic priorities in the period 2016-2019, with a focus on the regional and national implementation. As part of the regional WIGOS implementation, the RBON is being introduced to replace the existing RBSN and RBCN networks.

## 2. Draft concept of Regional Basic Observing Network (RBON)

RBON will be a subset of WIGOS, typically used in combination with space-based and remaining surface-based observing elements of WIGOS in any given application. By design, the RBON will be interoperable with many such remaining observing capabilities. RBON will help to address many, but not all, of the requirements that Members have for WIGOS. Design, execution and management of an RBON will be made in the context of the broader WIGOS.

### 2.1 Definition of a RBON

2.1.1 In each WMO Region, and in Antarctica, the RBON consists of surface-based meteorological and related observing stations/platforms; it responds to the collective needs of its Members, allowing them to fulfil their mandates and responsibilities in the provision of products and services. The RBON is established and managed by the respective regional associations and the WMO Executive Council (in the case of Antarctica).

2.1.2 The RBON constitutes a selected subset of existing observing systems within WIGOS arising from the Region. The network capabilities will respond to user observational requirements at the national, regional and global levels, identified by the Rolling Review of Requirements (RRR) process[23].

2.1.3 The RBON will operate in support of not only weather forecasting and climate monitoring, but also aiming to address as many as possible of the following WMO application areas:

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[22] RBSN and RBCN are defined in the *Technical Regulations* (WMO-No. 49), Volume I, Definitions, and further elaborated in the *Manual on the Global Observing System* (WMO-No. 544), Part III

[23] see the *Manual on WIGOS* (WMO-No. 1160), section 2.2.4 and Appendix 2.3

(a) Global numerical weather prediction (GNWP);
(b) High-resolution numerical weather prediction (HRNWP);
(c) Nowcasting and very short-range forecasting (NVSRF);
(d) Sub-seasonal to longer prediction;
(e) Aeronautical meteorology;
(f) Ocean applications;
(g) Agricultural meteorology;
(h) Climate monitoring (as undertaken through the Global Climate Observing System (GCOS));
(i) Climate applications;
(j) Atmospheric chemistry related application areas.

2.1.4 The RBON will comply with the Principles for observing network design and planning[24], paying particular attention to those aspects of the principles as will be regulated in a new section on the RBON in the Manual on WIGOS.

**2.2 The key attributes of the new RBON encompasses (not exclusive):**

(a) Requirements for real-time and near-real-time data exchange at the global level;
(b) Requirements for regular updates of WIGOS metadata in the Observing Systems Capability Analysis and Review tool (OSCAR);
(c) Requirements for data exchange in defined WMO formats;
(d) Commitment to operate and maintain the station/platform in the RBON for a minimum of four (4) years;
(e) Requirements for a higher frequency of data (hourly and sub-hourly data) and daily climate summaries;[25]
(f) Requirements for provision of required climate messages;
(g) Requirements for complying with the WIGOS quality management according to the Manual on WIGOS;
(h) Requirements for change management according to the Manual on WIGOS;
(i) Requirements for (Regional) multilateral arrangements for inclusion of systems that cover more than one Region;
(j) Requirements to support as many as possible of the WMO application areas;
(k) Stations/platforms are not limited to those under the responsibility of the National Meteorological and Hydrological Services (NMHSs).

**2.3 Process for the selection of stations/platforms into RBON**

(a) The regional association (RA) will prioritize the WMO application areas relevant to its Region;
(b) The stations/platforms will be selected so that the RBON observations together with other sources of observations available regionally, including satellite observations, allow horizontal resolution requirements as recorded in OSCAR are met at least at the threshold level;
(c) The stations/platforms will be selected in such a way that at least the threshold, but preferably breakthrough, user observational requirements as recorded in OSCAR for vertical resolution (profile data), observing cycle, timeliness, uncertainty and stability are met;

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[24] See the *Manual on WIGOS* (WMO-No. 1160), section 2.2.2 and Appendix 2.1

[25] Details on frequency of observations depending on the observing system and type of the observation will be specified in the technical regulations

(d) The selection will be done by the relevant Regional Group designated by the respective RA (e.g., a future possible Regional WIGOS Centre or other dedicated groups) with participation of experts, including users and data providers, from its Members, and well-coordinated with bodies (e.g. JCOMM) governing some of these observing systems;

(e) The proposal for RBON, including an action plan to deal with the identified gaps, will be submitted to the RA session for consideration and adoption through a resolution.

### 2.4 Criteria for the selection of stations/platforms into RBON

Only those stations/platforms that meet the following requirements can be selected:

(a) Stations/platforms will be capable of exchanging data in real-time or near-real-time on a global level;

(b) Stations/platforms will be capable of exchanging data in the WMO data representation formats (note: other parties may provide a conversion from local to WMO formats);

(c) Stations/platforms recorded in OSCAR will be considered;

(d) Stations/platforms will have a commitment to operate for a minimum of four (4) years;

(e) Stations/platforms will be capable of providing preferably hourly and sub-hourly data;

(f) Stations/platforms will comply with the Regional Quality Assessment;

(g) Change management procedures, including reporting, will be respected.

### 2.5 Monitoring of RBON

(a) RBON will be monitored against the requirements on a regular basis by one or more recognized global/regional centres, which will identify non-conforming stations/platforms;

(b) Members will respond to any incident management finding within a defined and agreed time frame appropriate to regional capabilities and expectations.

### 2.6 Management of RBON

(a) The Regional Group will regularly analyse monitoring reports and assist those Members whose stations/platforms do not conform with the regional quality assessment;

(b) Members will inform the Regional Group on action taken to address long-term deficiencies vis-à-vis regional monitoring findings;

(c) Stations/platforms that, in the long-term, do not conform with the defined Regional WIGOS quality standards will be proposed for removal from the RBON and the relevant Members consulted;

(d) In the intersessional period, minor changes in RBON can be authorized by the president of the RA based on the request of the corresponding Permanent Representative if supported by the relevant Regional Group;

(e) Identified gaps in the RBON observing capabilities will be documented and submitted to the RA session and an action plan will be proposed on how to fill the gaps.

### 2.7 Types of stations/platforms expected to be included in a RBON

According to the classification used in the OSCAR/Surface, the type of station/platform to be included in the RBON could be as follows:

(a) Land (fixed/mobile/on ice);
(b) Sea (fixed/mobile/on ice);
(c) Lake/River (fixed/mobile);
(d) Air (fixed/mobile).

For fixed stations/platforms, a commitment is made to observe at that location, whereas for mobile types the commitment is to assuring the observing programme as a whole to the extent declared.

### 2.8 Possible candidate stations for a RBON

The stations/platforms currently comprising the Regional Basic Synoptic Networks (RBSN) and the Regional Basic Climatological Networks (RBCN) are the primary candidates for the RBON, and are expected to constitute the backbone of the RBON. Those will be supplemented by other types of stations/platforms, such as weather radars, aircraft-based meteorological stations, wind profilers, lightning detection systems, voluntary observing ships and buoys. These stations/platforms need not necessarily be operated only by NMHSs.

More specifically:

(a) Automatic Weather Stations (AWS) are particularly significant as they provide a convergence of technology which is being used for weather forecasting and climatological requirements;
(b) Conversely, there is a divergence of technologies providing upper-air observations, so RBON will be a composite system of radiosondes, ground-based remote sensing, and the regional observations from aircraft based observing systems (e.g. AMDAR);
(c) Weather radar stations provide observations for which there are new requirements for international exchange, and hence will be an important element of RBON.

## 3. Further background and reference material for the Regional Basic Observing Network concept

The RBON is a subset of WIGOS stations selected essentially for global exchange, addressing the Vision for the Global Observing System in 2025 and responding to the Rolling Review of Requirements (RRR) and the Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP)( the period up to 2025) (WIGOS Technical Report No. 2013-4) (as listed in Annex).

The RBON complies with the Observing Network Design Principles as defined in the Manual on WIGOS. OSCAR is a key tool for: (i) recording user observational requirements agreed at the global and regional levels; and (ii) for collecting and recording RBON station metadata and their capabilities; hence particularly facilitating monitoring activities, gap analysis, and the planning for the evolution of RBON. Relevant reference material is provided below.

**References**

1. Manual on the WMO Integrated Global Observing System (WMO-No. 1160)
2. Vision for the Global Observing System in 2025 (available at http://www.wmo.int/pages/prog/www/OSY/Publications/Vision-2025/Vision-for-GOS-in-2025_en.pdf).
3. WIGOS OND Principles Guidance (under development)
4. Guidance on the RRR process (Manual on WIGOS, Appendix 2.3; Guide to the Global Observing System (WMO-No. 448), Part II, Observational Data Requirements, 2.3.1)
5. Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP) (WIGOS Technical Report No. 2013-4)

# BACKGROUND INFORMATION SUPPORTING DECISION
# NOT TO BE INCLUDED IN THE SESSION REPORT

**References:**

1. RA II Regional WIS Implementation Site: http://wis.wmo.int/page=RA2-WIS

2. *Manual on WIS* (WMO-No. 1060) - http://wis.wmo.int/wis-manual

3. *Guide to WIS* (WMO-No. 1061) - http://wis.wmo.int/wis-guide

4. RA II-16/INF. 4.3(2)

## Introduction

1. Reliable information is needed to support Disaster Risk Reduction (Sendai Framework priority 1 (paragraph 25a) and priority 4 (paragraph 33(b)), the Global Framework for Climate Services' Climate Services Information System pillar, international air navigation (Manual on the Digital Exchange of Aeronautical Meteorological Information, ICAO 10003) and many other key WMO activities.

2. Cg-XIV decided to implement WIS, extending beyond the private dedicated communication system of the World Weather Watch Global Telecommunications System (GTS) used only to exchange time-critical meteorological data and corresponding data from other WMO Programmes, to be more flexible, to provide more data from a larger range of WMO Programmes and to support a broader range of connections to the system and in particular ad hoc data requests. Although based on interoperability, certain unified processes need to be maintained to ensure WIS operates efficiently and effectively and only those entities appropriately authorized can publish in WIS**.**

3. Resolution 33 (Cg-17) tasked CBS to lead in developing guidance and standards to support good information management practices.

## Progress on implementing WIS in RA II

4. A routine survey of WIS National Focal Points updated in October 2016 (see RA II-16/INF. 4.3(2)) showed that, although RA II is ahead of many Regions in implementing WIS, there was still work to be done in improving the national knowledge of WIS and in helping NMHSs to implement and benefit from WIS, including completion of migration to Table Driven Code Forms (TDCF) both for transmission and receiving data used by NMHSs. As such, training in WIS competencies should be a priority for the coming four years.

5. Members should note the new capability of monitoring the status of WIS through the WIS common dashboard (see https://wiswiki.wmo.int/WIS-Status).

## Approach to preparing a training plan

6. A WIS Training and Development Plan should address the roles of Regional Training Centres and Global Information System Centres and be focussed on the WIS competencies as defined in the Manual on WIS. A priority would be to address Members that have indicated in their WIS survey responses that they have an organizational knowledge of below level 3. Any training should make use of the trainees' principal GISC metadata management interfaces.

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# BACKGROUND INFORMATION SUPPORTING DECISION NOT TO BE INCLUDED IN THE SESSION REPORT

A consistent and common approach should be applied to all areas and Programmes of WMO in terms of service delivery, in order to provide useful guidance to Members in effectively serving their users.

In order to progress towards a coherent service delivery approach across WMO Programmes based on the Strategy, it is proposed to consider the following:

- The necessity to require from all WMO Programmes to develop further their ability and mechanisms for interaction with users and identifying user requirements as the first step; to encourage Members to develop their services in a coherent way to optimize the use of limited resources;

- Most of the generic principles and attributes of effective service delivery are inherent in the Quality Management System (QMS); therefore, Members are strongly encouraged to implement QMS in all range of activities and programme areas that involve delivery of services to users;

- The WMO Technical Regulations should be expanded to cover generic aspects of service delivery based on relevant standardized operational procedures (SOP), in addition to the specific aspects covered by the existing regulations (e.g., aviation, marine, etc.); service areas poorly covered by the current technical regulations should be addressed as a priority; the overall culture of compliance with WMO's and other relevant standards and regulations should be enhanced and regarded as an important performance indicator of a successful service provider;

- Improving services and service delivery, as well as efficient arrangements for effective application through fast uptake of science and technology developments should be regarded as a main factor for success;

- Cross-cutting demonstration projects with coherent actions should be initiated on a national or regional basis in a harmonized fashion to help implement the current WMO strategies, programmes and projects including those related to the WMO Strategy for Service Delivery;

- Priorities should be set for the delivery of harmonized weather, climate, hydrological, and environment-related services to meet the rapidly changing needs of society, including introduction of impact-based forecast and warning services to address the needs of different sectors, such as: health; energy; agriculture; food security; transport and urban service delivery;

- Training and capacity development primarily for the forecasters and managers of NMHSs, to be followed in an extended scope for the users, on the principles of service delivery and QMS. The Regional Training Centres (RTCs) may provide a basic framework to extend and expand relevant training by all WMO Programmes to Members;

- Competency requirements: these currently exist for Aeronautical Meteorology, PWS and Marine Meteorology and Oceanography Programmes. The competencies should cover not only basic sets of knowledge/skills/behaviour in producing and delivering forecasts and warnings, but also should outline requirements for delivering services for specified user groups and partners.

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# BACKGROUND INFORMATION SUPPORTING DECISIONS NOT TO BE INCLUDED IN THE SESSION REPORT

**Background**

The objective of the Integrated Drought Management Programme is to support stakeholders at all levels by providing them with policy and management guidance through globally coordinated generation of scientific information and sharing of best practices and knowledge in support of integrated drought management. The IDMP aims to do this though the following:

- To shift the focus from reactive (crisis management) to proactive measures through drought mitigation, vulnerability reduction and preparedness;
- To integrate the vertical planning and decision-making processes at regional, national and community levels into a multi-stakeholder approach including key sectors, especially agriculture and energy;
- To promote the evolution of the drought knowledge base and to establish a mechanism for sharing knowledge and providing services to stakeholders across sectors at all levels;
- To build capacity of various stakeholders at different levels.

Based on the High-level Meeting on National Drought Policies, the IDMP and its partners have adopted three pillars of drought management: (i) drought monitoring and early warning systems; (ii) vulnerability and impact assessment; and (iii) drought preparedness, mitigation and response.

The International Global Drought Information System (GDIS) Workshop was held from 11 to 13 December 2014 to review the physical mechanisms and predictability of drought world-wide, review and discuss regional capabilities and needs versus global capabilities and develop the next steps in the development of pilot projects to demonstrate current GDIS capabilities.

The GDIS web portal is supported by United States National Integrated Drought Information System (NIDIS) and hosted by the United States National Centers for Environmental Information (NCEI).

There is a need for consistent information on drought that is easily accessible to all users, including such information as our understanding of the physical mechanisms and predictability of drought, real-time assessments of on-going drought, and predictions. As part of an on-going effort to address this problem, the international workshop focused on the necessary next steps, including the identification of research gaps, for moving forward with an experimental global drought information system (GDIS).

Sponsors of the workshop were the NASA Jet Propulsion Laboratory's Climate Center, NIDIS, the World Climate Research Programme (WCRP), Global Energy and Water Cycle Exchanges Project (GEWEX) of the WCRP, the World Meteorological Organization (WMO), the Group on Earth Observations (GEO), and the European Commission Joint Research Centre (JRC).

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# BACKGROUND INFORMATION SUPPORTING DECISION
# NOT TO BE INCLUDED IN THE SESSION REPORT

**References:**

1. CryoNet, the core component of the *Global Cryosphere Watch observing network:* http://globalcryospherewatch.org/cryonet/

2. Global Cryosphere Watch meeting reports, Implementation Plan, Journal and Conference Papers: http://globalcryospherewatch.org/reference/documents/

**Introduction**

Resolutions 17 and 43 (Cg-17), and Resolutions 50 and 51 (EC-68), decided to continue the implementation of the Global Cryosphere Watch (GCW) as an international mechanism for supporting observations of all components of the Earth's cryosphere, including snow cover, glaciers and ice sheets, sea ice, freshwater ice and permafrost. GCW aims to provide authoritative, clear, and useable data, information, and analyses on the past, current and future state of the cryosphere.

**Key achievements**

***Asia GCW Workshops***

1. GCW held two workshops focusing on the high mountain areas of Asia (CryoNet Asia), recognizing the need for increased density and quality of cryosphere observations:

(a) Beijing, China (3-5 December 2013) focusing on identifying goals and benefits for increasing observations in the high mountain regions of Central Asia;

(b) Salekhard, Russian Federation (2-5 February 2016) attended by international experts and representatives of Members of RA II. The workshop identified a framework for establishing a CryoNet Asia Working Group reporting to the GCW Steering Group and Regional Association II.

2. A third workshop on the CryoNet Asia Project is planned to be held from 21 to 23 February 2017, in Bishkek, Kyrgyzstan. Representatives of the Members in the high mountain region of Asia will be invited to propose stations for inclusion in the GCW observing network, including CryoNet, and contribute to the GCW Best Practices:

(a) The workshop outcome will be a scientific and operational CryoNet plan, to be used to garner interest among potential donors, for contributing to the development of CryoNet stations in the high mountains of Central Asia.

***International Exchange of snow data***

1. Recommendation 5.8(2)/2 (CBS-16) refers to the International Exchange of Snow Data, recommending the approval of the amendment to the *Manual on the Global Observing System, Volume I: Global Aspects* (WMO–No. 544) by adding new provisions on the reporting of snow cover and snow depth from all stations where snow is experienced, four times a day, namely 00, 06, 12 and 18 UTC. Also, Members shall report values of zero snow depth (0 cm) from the above stations when snow is not present, for the entire period during which snow can be expected.

2. Additionally, CBS recommended that Members exchange in situ snow measurements in real-time in BUFR through the Global Telecommunication System (GTS) and the WMO Information System (WIS) (Decision 50 (EC-68)).

***Remaining gaps***

- Nomination of national focal points for all Members in the Region, contributing to the development of the GCW observing network;

- Availability of competent experts specialized in high mountain cryosphere observations (e.g. glacier monitoring);

- Availability of long-term commitments (human and financial resources) to sustain the long-term operation of high mountain stations.

***Remaining challenges***

- Firming up partnerships to address the noted gaps;

- Solutions for transmission of data from CryoNet stations located in very remote areas, rugged terrain, and with extremely difficult access;

- Long-term archival of the CryoNet Asia data and achieving interoperability with the GCW Data Portal.

***Partnerships and resources mobilized***

The development of the CryoNet Asia is planned in partnership with the National Hydrometeorological Services (Agencies) of the Members in the Region, other organizations, both national and international, engaged in disaster risk reduction and capacity -building, for example the World Bank, the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Association of Cryospheric Sciences ( IACS), the International Centre for Integrated Mountain Development (ICIMOD), the Association of Hydro-Meteorological Equipment Industry (HMEI), the Swiss Development Cooperation Agency, etc.

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# BACKGROUND INFORMATION SUPPORTING DECISION NOT TO BE INCLUDED IN THE SESSION REPORT

**References:**


1. Cg-17 (June 2015), Abridge final report

2. Meetings of TC/RA representatives on seamless GDPFS (10-12 February and 1-4 November 2016) – Report

3. Meeting of CBS-MG (15-19 February 2016) – Report

4. EC-68 (June 2016), Abridged final report


## 1. Introduction

The World Meteorological Congress at its sixteenth session (Cg-XVI) noted that the output of the GDPFS enables Members to meet their diverse service provision requirements including: immediate meteorological support to emergency management organizations, routine weather forecasts and warnings for the general public and for air traffic operations, environmental predictions such as sea-state or air quality, products that create economic advantage for members, tailored products and services to different economic sectors.

The World Meteorological Congress, at its seventeenth session (Cg-17), through Resolution 11 (Cg-17), decided to initiate a process for the "gradual establishment of a future enhanced, integrated and seamless WMO Data-processing and Forecasting System", in light of the conclusions of the first World Weather Open Science Conference (WWOSC-2014, Montreal, Canada, August 2014). It requested the Executive Council to formulate Terms of Reference for this process, and a description of the set of products the system should produce, for consideration by the eighteen session of the World Meteorological Congress (Cg-18) in 2019.

## 2. Meeting of the CBS MG (15-19 February 2016)

The results of the meeting of representatives of technical commissions were briefed to the CBS-MG. The MG group felt that it is better to establish a Steering Group reporting to the MG. It was agreed to bring forward to EC-68 the vision, scope and the white paper for approval.

## 3. EC-68 (June 2015)

EC-68 endorsed the ToR for the SG on Seamless GDPFS and also the Vision. It requested CBS to develop the implementation and a white paper for its consideration at EC-69 (June 2017).

## 4. Meetings of Representatives of Technical Commissions and Regional Associations (10-12 February and 1-4 November 2016)

A first meeting of the Experts, composed of representatives of technical commissions, including the president of CBS and the co-chairpersons of the OPAG on DPFS was held from 10-12 February 2016 to discuss how to address Resolution 11 (Cg-17). The meeting resulted in the definition of the Vision of the future GDPFS. Rough outlines of a white paper were discussed including the idea to set up a task team to focus on the issue.

A second meeting of the experts was held from 1-4 November 2016 in Geneva were the outline of the implementation plan was fine-tuned and the development of an action plan initiated.

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## BACKGROUND INFORMATION SUPPORTING RESOLUTION NOT TO BE INCLUDED IN THE SESSION REPORT

### LIST OF PREVIOUS RESOLUTIONS OF RA II (ASIA) STILL IN FORCE AT THE TIME OF ITS SIXTEENTH SESSION

(Reference: Abridged Final Report of RA II-15)

| Resolution No. | Title | Suggested Action* | | |
|---|---|---|---|---|
| | | To be kept in force | To be replaced | Not to be kept in force |
| 9 (VII-RA II) | INCLUSION OF INFORMATION ON WAVES AND PRESSURE SYSTEMS IN WEATHER AND SEA BULLETINS | o | | |
| 11 (VII-RA II) | PROVISION OF MARINE METEOROLOGICAL SERVICES FOR COASTAL AND OFF-SHORE ACTIVITIES | o | | |
| 12 (X-RA II) | USE OF INMARSAT FOR THE COLLECTION OF SHIPS' METEOROLOGICAL AND OCEANOGRAPHIC REPORTS | o | | |
| 14 (XII-RA II) | SUPPORT FOR JOINT WMO/IOC TECHNICAL COMMISSION FOR OCEANOGRAPHY AND MARINE METEOROLOGY (JCOMM) | o | | |
| 1 (RA II-15) | THE IMPLEMENTATION OF THE WMO STRATEGY FOR SERVICE DELIVERY IN REGIONAL ASSOCIATION II (ASIA) | o | | |
| 2 (RA II-15) | IMPLEMENTATION AND OPERATION OF REGIONAL CLIMATE CENTRES | | o | |
| 3 (RA II-15) | REGIONAL WMO INTEGRATED GLOBAL OBSERVING SYSTEM IMPLEMENTATION PLAN | | o | |
| 4 (RA II-15) | REGIONAL BASIC SYNOPTIC NETWORK AND REGIONAL BASIC CLIMATOLOGICAL NETWORK IN REGION II | | o | |
| 5 (RA II-15) | WMO INFORMATION SYSTEM | | | o |
| 6 (RA II-15) | AMENDMENTS TO THE *MANUAL ON THE GLOBAL TELECOMMUNICATION SYSTEM*, (WMO-No. 386), VOLUME II | | | o |
| 7 (RA II-15) | REGIONAL ASSOCIATION II MANAGEMENT GROUP | | o | |
| 8 (RA II-15) | REGIONAL ASSOCIATION II WORKING GROUP ON WEATHER SERVICES | | o | |
| 9 (RA II-15) | REGIONAL ASSOCIATION II WORKING GROUP ON CLIMATE SERVICES | | o | |
| 10 (RA II-15) | REGIONAL ASSOCIATION II WORKING GROUP ON HYDROLOGICAL SERVICES | | o | |
| 11 (RA II-15) | REGIONAL ASSOCIATION II WORKING GROUP ON WMO INTEGRATED GLOBAL OBSERVING SYSTEM AND WMO INFORMATION SYSTEM | | o | |

| **Resolution No.** | **Title** | **Suggested Action*** | | |
|---|---|---|---|---|
| | | **To be kept in force** | **To be replaced** | **Not to be kept in force** |
| 12 (RA II-15) | REGIONAL ASSOCIATION II IMPLEMENTATION COORDINATION TEAM ON SERVICE DELIVERY | | | o |
| 13 (RA II-15) | REGIONAL ASSOCIATION II IMPLEMENTATION COORDINATION TEAM ON DISASTER RISK REDUCTION | | | o |
| 14 (RA II-15) | PILOT PROJECT TO DEVELOP SUPPORT FOR NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES IN NUMERICAL WEATHER PREDICTION | | o | |
| 15 (RA II-15) | PILOT PROJECT ON INFORMATION SHARING ON CLIMATE SERVICES | | | o |
| 16 (RA II-15) | PILOT PROJECT TO DEVELOP SUPPORT FOR NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES IN THE COLLECTION AND APPLICATION OF AIRCRAFT METEOROLOGICAL DATA RELAY DATA | | | o |
| 17 (RA II-15) | PILOT PROJECT TO SUSTAIN AND ENHANCE THE CAPACITY OF NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES IN THE PROVISION OF OFFICIAL WEATHER FORECASTS FOR THE MEDIUM RANGE | | o | |
| 18 (RA II-15) | PILOT PROJECT TO ENHANCE THE SEAMLESS PROVISION OF REGIONAL SEVERE WEATHER WARNINGS AND ADVISORIES | | | o |
| 19 (RA II-15) | STRATEGIC OPERATING PLAN FOR THE ENHANCEMENT OF NATIONAL METEOROLOGICAL AND HYDROLOGICAL SERVICES IN REGIONAL ASSOCIATION II (ASIA) (2012–2015) | | | o |
| 20 (RA II-15) | REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE ASSOCIATION | | o | |

* proposed by the WMO Secretariat

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