REGIONAL ASSOCIATION V (SOUTH-WEST PACIFIC)

FIFTEENTH SESSION OF THE RA V MANAGEMENT GROUP

GENEVA, 12 May 2017

FINAL REPORT

WORLD METEOROLOGICAL ORGANIZATION

FIFTEENTH SESSION OF THE RA V MANAGEMENT GROUP
(Geneva, Switzerland, 12 May 2017)

1. ORGANIZATION OF THE SESSION

1.1 The fifteenth session of the RA V Management Group (MG-15) was held at the WMO Headquarters on Friday, 12 May 2017, during the sixty-nine session of the Executive Council. Dr Andi Eka Sakya, President of RA V, opened the session at 12:30. The Group adopted the provisional agenda as given in Annex I.

2. MATTERS ARISING FROM THE FOURTEENTH SESSION

2.1 The Group recalled that the fourteenth session of the RA V Management Group (MG-14), which was held in Geneva on 17 June 2016 during EC-68, endorsed the RA V Operating Plan 2016-2019 and the new Terms of Reference for RA V Working Groups (WGs) except for Task Teams (TTs) of Tropical Cyclone Committee (TCC). The Group requested the chairperson of TCC to submit the Terms of Reference for Task Teams of TCC.

2.2 The Group was briefed about the outcomes of the Regional Forum for Directors of NMHSs in RA V and requested the leads of WGs and the chairperson of TCC to follow up, in cooperation with the technical departments of the Secretariat, the implementation of the recommendations of the Regional Forum for Directors of NMHSs in RA V.

3. PREPARATION OF THE SEVENTEENTH SESSION OF REGIONAL ASSOCIATION V

3.1 The Group recalled that the seventeenth World Meteorological Congress (Geneva, May–June 2015) established a provisional calendar for sessions of constituent bodies during the seventeenth financial period (2016–2019) and the seventeenth session of Regional Association V (RA V-17) was planned to be held in December 2017.

3.2 The Group recommended the RA V-17 be rescheduled from December 2017 due to active season of tropical cyclone from November to April.

3.3 The Group agreed the RA V-17 be scheduled in October 2018 to minimize the risks from active tropical cyclones in the Southwest Pacific.

4. PROGRESS REPORT OF THE WORKING GROUPS AND TROPICAL CYCLONE COMMITTEE

4.1 The RA V Tropical Cyclone Committee proposed its ToRs for Task Team for Coastal Inundation and Storm Surge (TT-CISS) and Task Team for Severe Weather Forecasting (TT-SWF) as given in Annex II for approval. The Group acknowledged with appreciation the efforts of TCC to develop the ToRs for two Task Teams and approve the ToRs after reviewing the proposed ToRs for these Task Teams.

4.2 The Group was informed of the activities of the RA V subsidiary bodies including: Working Group on Weather Services (WG-WXS), Working Group on Climate Services (WG-

CLS), Working Group on Hydrological Services (WG-HYS), Working Group on Infrastructure (WG-INFR), and Tropical Cyclone Committee (TCC). The progress reports of respective Working Groups and TCC are attached as Annex III.

4.3 The Group was informed and made comments and recommendations on the following achievements and activities by WGs:

<Working Group on Infrastructure: WG - INFR>

The WG-INFR Lead has arranged monthly WebEx sessions where TT Leads and Experts are encouraged to attend. Attendance has been building over the past six months. The Vice-Lead and Mr Henry Taiki (WMO Office for the South-West Pacific) attended regularly.

Task Team on WIGOS: TT-WIGOS

- The monthly WebEx sessions have served as capacity development opportunities for WIGOS Metadata Standard and OSCAR/Surface.
- The national WIP for Australia is being drafted to serve as an example for other members.

Task Team on Satellite Utilization: TT-SU

- Planning to collect RA-V satellite data requirements to support climate applications and services.

- Himawari 8/9 and HimawariCast receiving equipment and with the support of WMO-JMA and JICA, have been installed in the following Pacific SIDS/LDCs: Fiji, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu.

Task Team on Aircraft Based Observation: TT-ABO

- The possibility of holding a Regional Workshop on AMDAR in Indonesia was proposed, supported by WMO. This has now been scheduled for Jakarta, Indonesia, 22-26 May 2017.

Working Group Meetings

- Communication across TT members has been improved through the monthly WebEx meetings.

< Working Group on Hydrological Services: WG - HYS>

Pacific-HYCOS Phase 2

A concept note for a Pacific-HYCOS Phase 2 was drafted (in conjunction with SPC) and sent in April 2016 to the Secretariat for appraisal. Discussion occurred with key Secretariat staff in June 2016 and there was agreement that the concept of identifying the information products required by countries, and the associated actions required to provide them, was a key concept. The Secretariat commented that this was the way that they perceived the development of future HYCOS projects.

The Pacific-HYCOS proposal was presented to Pacific Island Met Service directors at the TCC meeting in Honiara in August 2016. Feedback was positive and useful and they looked

forward to the securing of donor funding. So far none has been secured although two means of promotion to donors are under consideration.

Global Hydrometry Support Facility (GHSF)

A concept proposal for providing appropriate hydrological database software to NHSs in small and developing countries has been submitted to the Secretariat for comment, but it has been awaiting the commencement of activities of the Global Hydrometry Support Facility (GHSF).

An assessment of the currently used and freely available hydrometric database software products is underway.

Coastal Inundation Forecasting Demonstration Project

Assistance was provided to the Coastal Inundation Forecasting Demonstration Project by recruiting a new OPACHE member to serve as an expert representative for WMO on two proposed projects in the region (Fiji and Indonesia). Dr Graeme Smart has attended three project meetings, two as an alternate to the co-chair of the Project Steering Group. This group is also looking at flood forecasting tools that may be suitable for the region.

Distance learning course

A distance learning course, specifically designed for the training needs of Pacific Island hydrology field technicians, has been compiled jointly by WMO ETRP website which is hosted by the UK Met office, the Secretariat and NIWA (New Zealand's NHS). It is planned to start the 10-week course on 22 May 2017 and it will run from the WMO ETRP website with student guidance and assessment by NIWA staff.

< Working Group on Climate Services: WG - CLS>

GFCS-related activities have been implemented through existing mechanisms such as Regional Climate Outlook Forums (RCOFs) including the ASEAN Climate Outlook Forum (ASEANCOF), the Pacific Islands Climate Outlook Forum (PICOF), National Climate Outlook Forums (NCOFs) and regional Climate Field Schools (CFS).

The demonstration phase of the RA V Southeast Asia Regional Climate Centre (RCC) Network will begin in July 2017, while RCC for the Pacific Islands region has been discussed through the PMC's PICs Panel. On this matter the Management Group requested WG-CLS to work on a unified neutral landing page that integrates the two sub-regional RCC and their contributing nodes, such that the RCC is visible as a regional facility of the Association.

<RA V Tropical Cyclone Committee: TCC>

The sixteenth session of the WMO RA V Tropical Cyclone Committee for the South Pacific and the South East Indian Ocean was held at Honiara, Solomon Islands from 29 August to 2 September 2016. The final report is attached as Annex IV.

5. OTHER BUSINESS

5.1 The Group was briefed on the following emerging issues:

(i) Concept of Regional WIGOS Centre in RA V (WIGOS).
(ii) Recent development of RA V SE Asia RCC Network and Pacific RCC (CLPA).
(iii) Regional Workshop on AMDAR for RA V (OBS).
(iv) Field Hydrology Technicians Course 2017 of SIDS in RA V (CLW).
(v) Designation of ASMC as a WIS DCPC proposed by Singapore (Singapore).
(vi) Subregional cooperation: ASEAN (Singapore) and SPREP (Fiji).

6. CLOSURE OF THE SESSION

6.1 The President adjourned the fifteenth session of the RA V Management Group at 13:30 on Friday, 12 May 2017. Before closing, the President thanked all the participants for their fruitful discussion and expressed his satisfaction with the outcomes made in the session. He also thanked the WMO Secretariat for the arrangements of the session. The list of participants is attached as Annex V to this report.

ANNEX I

FIFTEENTH SESSION OF THE RA V MANAGEMENT GROUP
(Geneva, Switzerland, 12 May 2017)

AGENDA

1. Organization of the Session
2. Matters arising from the Fourteenth Session
3. Preparation of the seventeenth session of Regional Association V
4. Review of the activities of RA V subsidiary bodies
5. Other Business
6. Closure of the Session

ANNEX II

Terms of Reference for the Task Teams for Coastal Inundation and Storm Surge (TT-CISS) and for Severe Weather Forecasting, including Global Data-processing and Forecasting System (TT-SWF)

Tropical Cyclone Committee for the South Pacific and South-East Indian Oceans (TCC)

The committee proposed TORs for its Task Teams as follows for the RAV approval:

The Task Team for Coastal Inundation and Storm Surge (TT-CISS) is responsible for:

1. Promoting the development of coastal inundation and storm surge activities in the RAV region, such as the *Coastal Inundation Forecasting Demonstration Project (CIFDP)* (currently the CIFDP is in Fiji and Indonesia);
2. Identifying the countries in the RAV region that have urgent need for early warnings of storm surge and coastal inundation;
3. Prioritizing activities to improve early warning for storm surge and coastal inundation in the identified countries;
4. Enabling the development of new operational capacity, specialized training, effective outreach and mitigation, by leveraging existing efforts under the WMO RAV working structure, such as the joint WMO Tropical Cyclone Division and Marine Meteorology and Oceanography Division Training Workshops, and output from the CIFPD capacity development activities;
5. Engaging with the broader TCC activities where relevant, to enable other severe weather and disaster risk reduction activities connected throughout the RAV region, and thereby creating a more complete implementation of disaster risk reduction activities.

The Task Team for Severe Weather Forecasting, including Global Data-processing and Forecasting System (TT-SWF) is responsible for:

1. Promoting the development of severe weather forecasting activities in RA V, such as the WMO Severe Weather Forecasting Demonstration Project (SWFDP);
2. Encouraging the prioritization of activities to improve early warning for severe weather in LDCs and SIDS of RA V;
3. Engaging with the broader TCC activities and Working Groups of RA V, to enable other severe weather forecasting and disaster risk reduction activities to be connected throughout the region. This includes taking into account the results of discussions/recommendation from the meetings of the Regional Sub-project Management Team of the Severe Weather Forecasting and Disaster Risk Reduction Development Project (RSMT-SWFDDP).

ANNEX III

PROGRESS REPORT OF THE WORKING GROUPS AND TROPICAL CYCLONE COMMITTEE

Tropical Cyclone Committee for the South Pacific and South-East Indian Oceans (TCC)

Mike Bergin
Bureau of Meteorology, Australia

1. Introduction

History of the establishment of TCC

2. Working Group Structure

The Working Group is composed of one chair, Task Team on Severe Weather Forecast and Disaster Risk Reduction including Data Processing and Forecasting System (TT-SWFD/DPFS); and Task Team on Coastal Inundation including Storm Surge (TT-CISS). Each TT consists of one leader and several experts.

3. Terms of Reference

The terms of reference of the Tropical Cyclone Committee for the South Pacific and South-East Indian Oceans (TCC) are as follows:

(a) To promote and coordinate the planning and implementation of measures for the improvement of cyclone warning systems and related meteorological services and the facilitation of efforts to minimize loss of life, human suffering and damage caused by tropical cyclones and related natural hazardous phenomena in the tropical part of Region V south of the equator;

(b) To review regularly the status of tropical cyclone warning systems in the RA V Tropical Cyclone Committee area and recommend measures for the development or improvement of these systems;

(c) To review regularly the Tropical Cyclone Operational Plan for the South-Pacific and South-East Indian Ocean and recommend any amendments to the text of the Plan to the president of RA V for approval;

(d) To coordinate its work with other activities carried out within the WMO Tropical Cyclone Programme, in particular, with the Regional Association I Tropical Cyclone Committee for the South-West Indian Ocean and the Economic and Social Commission for Asia and the Pacific(ESCAP)/WMO Typhoon Committee;

(e) To coordinate its activities with other RA V Working Groups;

(f) To develop, update and facilitate the implementation of the Technical Plan of the RA V Tropical Cyclone Committee;

(g) To seek, through RA V, financial and technical support for the programme activities;

(h) To promote and coordinate the planning and implementation of measures for the establishment of the Storm Surge Watch Scheme in the Region in collaboration with the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM); and

(i) To establish task teams as it finds necessary to carry out the work of the Committee, noting the decisions of RA V with respect to the creation of the Task Team on Severe Weather Forecasting including Global Data-processing and Forecasting System and the Task Team on Coastal Inundation including Storm Surges.

4. Membership

TCC		**Name**	**Country**
Chair		Mr Mike BERGIN	Australia
Task Team on Severe Weather Forecast and Disaster Risk Reduction including Data Processing and Forecasting System (TT-SWFD/DPFS)	TT Leader	Mr James LUNNY	New Zealand
	Expert	Mr Moleni TU'UHOLOAKI	Tonga
		Mr Tom EVANS	USA
		Mr A. Fachri RADJAB	Indonesia
		Misaeli Funaki	Fiji
Task Team on Coastal Inundation including Storm Surge (TT-CISS)	TT Leader	Dr Jamie RHOME	USA
	Expert	Mr Reginald HINGANO	Tonga
		Mr Agus Wahyu RAHARJO	Indonesia
		Terry Atalifo	Fiji

5. Task Team on Severe Weather Forecast and Disaster Risk Reduction including Data Processing and Forecasting System (TT-SWFD/DPFS)

Rather than a separate TT the RSMT for the project continues to be the focal point for arrangements for provision of outcomes. As the lead RSMC for this project, Wellington continued to provide a platform (MetConnect Pacific at http://swfddp.metservice.com) for the SWFDDP products. This website also provides helpful background material and links to global centers, other RSMCs and the NMHSs. Twice daily the RSMC staff produces the RSMC Daily Severe Weather Forecasting Guidance Products, referred to as the "South Pacific Guidance (SPG)" charts.

Users of the SWFDDP website, MetConnect Pacific, view the SPG charts on the landing page. The SPG charts continues to be published uninterrupted on MetConnect Pacific (MCP) twice a day around 0300 UTC and 1500 UTC.

Under the RSMC tab on MetConnect Pacific, the RSMC Darwin images for TC Data over the central and southwest South Pacific domains are updated twice a day without any hitches. ACCESS-TC images are loaded onto the RSMC Darwin webpage whenever there is a live tropical cyclone without having to login to the RSMC Darwin where there are more specialized charts.

Work on the Multi-centre Ensemble images on the UK Met office page was completed and was made available on the SWFDDP MetConnect Pacific Website, example of the product is given below. The Japanese Meteorological Agency made real-time 10 minute Himawari-8 images available for use for the Pacific Islands, the link as well as interpretation material was made available to SWFDDP.

Training Activities

- Rick Jones (WMO consultant) provided SWFDDP training in Samoa 8-13 March 2015
- RSMC Wellington assisted with SWFDDP training on the following Pacific islands.
- Lisa Murray – Fiji and Kiribati from 20 April to 30 April 2015
- Vive Bukto – Tonga and Tuvalu from 31 August – 11 September 2015 participants on the SWFDDP MetConnect Pacific website.

Working Group on Hydrological Services (WG-HYS)

John Fenwick
National Institute of Water and Atmospheric Research, New Zealand

1. Introduction

The previous Working Group completed little of its Work Plan due to key members retiring or having their employment direction changed. After some discussion and delay due to a small number of nominations for Task Teams, the Working Group was re-established during 2015. A meeting was held in late 2015 which was successful in setting a new Work Plan.

2. Working Group Structure

The Working Group is composed of one leader, two vice-leaders, Task Team on Training and Capacity Building in Hydrology (TT-TCB-H); Task Team of Hydrology Database Management (TT-HDM); Task Team on Disaster Risk Reduction – Water-related Disasters (TT-DRR-W); and Task Team on Water and Climate (TT-WC). Each TT consists of one leader and several experts.

3. Terms of Reference

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

(a) To monitor, promote and develop strategies and activities that will enhance the capabilities of RA V Members to improve the quality of hydrological services and to deliver and improve access to these services, with an emphasis on improved observation and monitoring systems, and on training and capacity building;

(b) To coordinate with relevant WMO bodies, particularly the Commission for Hydrology (CHy), and other groups to enable improved forecasting capabilities, including the provision of more accurate, timely and reliable forecasts and warnings and enhanced delivery of related information and services;

(c) To assist RA V Members to apply a quality management approach that will enable and support the sustainability of hydrological services;

(d) To provide hydrological advice and guidance to RA V Members regarding the development of the new WMO programme for Small Island Developing States (SIDS) and Member Island Territories;

(e) To establish and coordinate task teams, as required, complete specific activities related to the objectives, priority areas and planned deliverables of the Working Group;

(f) To report and provide advice to the RA V Management Group on the above issues.

4. Membership

WG-HYS	Name	Country
Lead	**Mr John FENWICK**	**New Zealand**

Vice-Lead		**Dr SUPRAPTO**	**Indonesia**
		Mr Roy A. BADILLA	**Philippines**
Members Task Team on Training and Capacity Building in Hydrology (TT-TCB-H)	TT Leader	Mr Petrus SYARIMAN	Indonesia
	Expert	Mr PAAT	Philippines
		Mr Taaniela KULA	Tonga
		Mr Lameko ASORA	Samoa
Task Team of Hydrology Database Management (TT-HDM)	TT Leader	Ms Margaret BAUTISTA	Philippines
	Expert	Mr Roddy HENDERSON	New Zealand
		Dr Eka NUGRAHA ABDI	Indonesia
		Mr Taaniela KULA	Tonga
		Mr Andre Siohane	Niue
Task Team on Disaster Risk Reduction – Water-related Disasters (TT-DRR-W)	TT Leader	Mr Jeff PERKINS	Australia
	Expert	Dr Christian ZAMMIT	New Zealand
		Dr William Marcus PUTUHENA	Indonesia
		Mr Taaniela KULA	Tonga
		Mr ‘Ofa FA’ANUNU	Tonga
Task Team on Water and Climate (TT-WC)	TT Leader	Dr Christian ZAMMIT	New Zealand
	Expert	Dr Fransisca MULYANTARI	Indonesia
		Dr Erwin E. S. MAKMUR	Indonesia
		Mr Taaniela KULA	Tonga
		Mr Mafutaga LEIOFI	Samoa
		Mrs Rosslznn Mitiepo	Niue

5. Activities of the Working Group

A meeting was held in Brisbane during 9-13 November 2015. It was attended by 10 members of the group, as well as by Dr. Harry Lins, the President of the Commission for Hydrology, Mr Claudio Caponi from the Secretariat, Mr Peter Sinclair from SPC and in part, by several staff members of the host agency, the Australian Bureau of Meteorology.
Noting the main decisions of interest to RA V from CHy-14, Cg-17, EC-67, and RAV-16, the Group developed the terms of reference for its four Task Teams. It also took into account the priorities identified by the Regional Forum of Directors of NMHSs in RA in the area of

hydrology were related to disaster risk reduction, development of QMSs and capacity building.

Noting also that the activities related to promoting a quality management approach in hydrology were of a cross-cutting nature and did not fit exactly under any of the Task Team titles, the Group agreed to modify the title and scope of the Task Team on Hydrology Database Management to give it the added responsibility of promoting the adoption of a Quality Management Framework - Hydrology in the Region.

The Group discussed and compiled the work plan 2016-2018 of the four Task Teams. The main points of the work plan, as established at the meeting, are:

- Implementation of FFGS and/or other appropriate tools such as coupling Himawari-8 in Region V.
- Provision of reports and web portal information on regional applications; IFAS, TopNet, IFFRM, Delft-FEWS etc.
- Propose strengthened, or establishment of, early warning systems for floods in Members of RA V.
- Promote development of hydrological products for inputs to end-to-end multi-disaster warning systems - Pac-HYCOS2, CIFDP.
- Promote regular discussions between NMSs and NHSs through a community of practice web portal.
- Strengthen or develop national joint programmes between NMSs, NHSs and NDMOs on public awareness and education on floods that is inclusive of women, girls, youth, children, disabled people, and vulnerable communities.
- Develop and help implement water sector products (climate outlooks, EHP material, workshops, etc.,) as part of GFCS and IDMP.
- Review and report on appropriate database systems for small countries/agencies.
- Assist in development of seasonal prediction products for water management purposes.
- Develop concept notes for Pac-HYCOS2, SEA-HYCOS and promote. Communicate via web portal and IWRM platforms.
- Support staff from Pacific Island Countries NHSs to post-graduate degrees in hydrology and courses based on QMF and WMO no. 1003, and investigate distance learning options for capacity building.

The Group recommended that a follow-up meeting be held before the end of the intersessional period, in late 2017 or early 2018. Tonga expressed interest in hosting such a meeting. The Chair was tasked to address all RA V Members to promote the nomination of experts in the different Open Panels of CHy Experts (OPACHEs). The Group thanked the Queensland Regional Office of the BoM for their warm hospitality throughout the meeting.

6. Progress on Work Plan tasks

- An on-line forum (web portal) has been established with the assistance of the Secretariat. Information on several topics has been posted and it has been promoted to WG-HYS members by email. Further information for a “community of practice” and other information is in preparation by TT leaders.

- A concept note for a Pacific-HYCOS Phase 2 was drafted (in conjunction with SPC) and sent in April 2016 to the Secretariat for appraisal. Discussion occurred with key Secretariat staff in June 2016 and there was agreement that the concept of identifying the information products required by countries, and the associated actions required to provide them, was a key concept. The Secretariat commented that this was the way that they perceived the development of future HYCOS projects.

- The Pacific-HYCOS proposal was presented to Pacific Island Met Service directors at the TCC meeting in Honiara in August 2016. Feedback was positive and useful and they looked forward to the securing of donor funding. So far none has been secured although two means of promotion to donors are under consideration.

- A concept proposal for providing appropriate hydrological database software to NHSs in small and developing countries has been submitted to the Secretariat for comment, but it has been awaiting the commencement of activities of the Global Hydrometry Support Facility (GHSF).

- An assessment of the currently used and freely available hydrometric database software products is underway.

- A case study on ISO 9001 QMS from the region was compiled and provided to the C-Hy Task Team on QMS. [Fenwick, J., (2016). Case Study Development of a Quality Management System for the Hydrological Service of the National Water and Atmospheric Research Ltd. (**New Zealand**) (**ISO certified**)].

- Assistance was provided to the C-Hy Task Team on QMS with review of QMS Checklist and Questionnaire reports.

- Assistance was provided to the Coastal Inundation Forecasting Demonstration Project by recruiting a new OPACHE member to serve as an expert representative for WMO on two proposed projects in the region (Fiji and Indonesia). Dr Graeme Smart has attended three project meetings, two as an alternate to the co-chair of the Project Steering Group. This group is also looking at flood forecasting tools that may be suitable for the region.

- The WMO/IGRAC workshop “Advancing Groundwater Monitoring in Small Island Developing States in the Pacific” was held in Suva in the last week of August 2016.

A distance learning course, specifically designed for the training needs of Pacific Island hydrology field technicians, has been compiled jointly by COMET, the Secretariat and NIWA (New Zealand’s NHS). It is planned to start the 10-week course on 22 May 2017 and it will run from the COMET web site with student guidance and assessment by NIWA staff.

Working Group on Weather Services (WG-WXS)

Raymond Tanabe
National Oceanic and Atmospheric Administration, United States of America

1. Introduction

The Sendai Framework for Disaster Risk Reduction (2015-2030) and the four priorities for action, including understanding disaster risk, strengthening disaster risk governance, investing in disaster risk, and enhancing preparedness will clearly require continuing development of an emerging skillset. This skillset includes impact (as opposed to criteria or threshold) based forecasting and decision support, a deep understanding of community vulnerability and resiliency, quick adoption of new technology, and integration of social science.

Significant changes in aviation are on the horizon and the subsequent challenges for NMHS's will be compliance with new WMO aviation qualification standards, cost recovery mechanisms for the provision of aviation services, and the need for long term strategic planning.

2. Working Group Structure

The Working Group is composed of one leader, two vice-leaders, Task Team on Cost Recovery (TT-CR), Task Team on Quality Management (TT-QM), Task Team on Training, Competencies and Qualifications (TT-TRG), and Task Team on Weather Services Implementation (TT-IMP). Each TT consists of one leader and expert(s) except TT-CR which does not have expert.

3. Terms of Reference

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

(a) To monitor, promote and develop strategies to enhance the capabilities of RA V Members to deliver and improve access to weather services, with an focus on sustainable aviation weather services;

(b) To coordinate with WMO, the International Civil Aviation Organization and other key organizations to assist with the implementation of an improved and sustainable weather and warning service;

(c) To identify and evaluate international best practices on the delivery of weather and warning services and communicate these to RA V Members;

(d) To establish and coordinate its Task Teams, as necessary, to complete specific tasks related to the objectives and priority areas of the Working Group; and

(e) To report and provide advice to the RA V Management Group on the above issues;

4. Membership

WG-WXS		Name	Country
Lead		**Mr Raymond TANABE**	**USA**
Vice-Lead		**Dr Landrico Ureta DALIDA Jr.**	**Philippines**
		Mr Grahame READER	**Australia**
Task Team on Cost Recovery (TT-CR)	TT Leader	Mr 'Ofa FA'ANUNU	Tonga
Task Team on Quality Management(TT-QM)	TT Leader	Ms Helen TSEROS	Australia
	Expert	Mr Lim Ze HUI	Malaysia
Task Team on Training, Competencies and Qualifications (TT-TRG)	TT Leader	Ms Lih Mei LIM	Singapore
	Expert	Dr Cynthia P. CELEBRE	Philippines
		Amit Singh	Fiji
Task Team on Weather Services Implementation(TT-IMP)	TT Leader	Dr Mohd Hisham MOHD ANIP	Malaysia
	Expert	Mr M. PRABOWO	Indonesia

5. Activities of the Working Group

WG-WXS vice leads met at the RA-V Regional Forum in October 2015 and finalized the Terms of Reference. Aviation forecasting continues to be a driver in WG-WXS activities due to anticipated and significant changes to global aviation, air traffic management, QMS, and WMO aviation qualification standards.

The 2016 WG-WXS update noted apparent overlaps between aviation related goals of WG-WGS and the PMC Pacific Islands Aviation Weather Services (PIAWS) Panel and the need to bring these goals into alignment for efficiency and eliminate duplicate efforts.

The Pacific Islands Aviation Weather Services (PIAWS) Panel was established by the Third Meeting of the Pacific Meteorological Council (PMC-3) to serve in the capacity of an advisory body to the Pacific Meteorological Council (PMC) on matters relating to aeronautical meteorological services including cost recovery, quality management and competency standards, in the Pacific region.

The final PIAWS Panel Terms of Reference (TOR) as submitted in April 2016 included comments from New Zealand encouraging the PIAWS Chair and Vice-Chair to attend other related meetings in the region to "ensure that the Panel and APAC MET groups are able to share information and possibly avoiding duplication of efforts."

Noting the similarity in scope of these two entities, it is encouraging to note the first item identified in the PIAWS Panel TOR states:

"The establishment of linkages, coordination, discussion and liaison with the WMO Regional Association V (South-West Pacific) Working Group on Weather Services' Task Team of Quality Management System (RA V WG-WX/TT-QMS), Task Team on Training, Competencies and Qualifications (RA V-WX/TT-TRG), and Task Team on Cost Recovery (RA V WX/TT-CR)"

Tonga currently serves as the PIAWS Panel Chair and represented on the WG-WXS. USA currently serves as the WG-WXS Chair. Both will participate at the upcoming WG-WXS, PMC-4, and PMMM-2 meetings to further develop the strategic alignments.

6. Working Group Meeting

A WG-WXS meeting is scheduled for August 11, 2017 in Honiara, Solomon Islands, preceding the Fourth Pacific Meteorological Council (PMC-4) and Second Pacific Ministerial Meeting on Meteorologicy (PMMM-2). This meeting will focus on strategic alignment of the WG-WXS and the PMC PIAWS Panel. Virtual meetings will be schedule in June and July to confirm the agenda.

7. Conclusion

In similar fashion to other WGs, WG-WXS faces many challenges to develop momentum among the Task Teams. Establishing key partnerships with other bodies such as PMC and PIAWS will enable strategic alignment of goals. These alignments will reduce duplication and help to ensure the success of all involved.

Working Group on Climate Services (WG-CLS)

Flaviana D. Hilario
Philippine Atmospheric Geophysical and Astronomical Services Administration, Philippines

1. Introduction

This report summarizes activities of the Working Group during the period 2015 to 2016.

2. Working Group Structure

The Working Group is composed of one leader, two vice-leaders, Task Team on Climate Information and Prediction Services including Regional Climate Centres (RCCs) and Regional Climate Outlook Forum (RCOF) (TT-CLIPS), Task Team on Climate Data Management/Data Rescue (TT-CDM), Task Team on Climate Change (TT-CC),Task Team on Use of Improved Tools for Operational Agro-meteorology including Coping with Impacts of Natural Disasters on Agriculture (TT-ITA), and Task Team on Agro-meteorological Information (TT-AIF). Each TT consists of one leader and expert(s).

3. Terms of Reference

The terms of reference of the Working Group on Climate Services (WG-CLS) are as follows:

(a) To coordinate observational aspects of climate services including thorough liaison with the Global Framework for Climate Services (GFCS), the Global Climate Observing System (GCOS) and the Global Ocean Observing System (GOOS);

(b) To provide advice on methods to strengthen and improve climate system monitoring, analyses and indices;

(c) To keep abreast of the activities of the World Climate Services Programme (WCSP), Commission for Climatology (CCl), the World Climate Research Programme (WCRP) and its core research projects, the GFCS, the Intergovernmental Panel on Climate Change (IPCC), the United Nations Framework Convention on Climate Change (UNFCCC) and other climate-related bodies, including the results of their meetings and workshops relevant to the Region, and to encourage strong regional involvement in these bodies;

(d) To provide advice on and assist in the implementation of various climate information and prediction services in the Region for climate-sensitive sectors such as agriculture, fisheries, water, renewable energy, urban and building planning, disaster risk reduction, air quality and health;

(e) To examine, coordinate, report on and encourage the use of Geographical Information Systems (GIS) in the provision of climate services;

(f) To provide advice on, assist in identifying, and coordinate attendance at climate-related education and training courses/workshops, including information technology and management courses, based on an assessment of the training requirements in the Region;

(g) To provide further advice and proposals on the role, structure and operation of the Regional Climate Centres (RCCs)/RCC-Networks in the region, and assist in the processes for seeking their formal WMO designation;

(h) To provide advice and proposals on other important climate-related issues as they develop and evolve;

(i) To collaborate and align with relevant and related initiatives in other relevant forums having a common objective, including the Pacific Meteorological Council (PMC) Pacific Islands Climate Services (PICS) Panel and Pacific Islands Education, Training and Research (PIETR) Panel; and

(j) To report to and advise the president and RA V Management Group on climate related matters.

4. Membership

WG-CLS		**Name**	**Country**
Lead		**Dr. Flaviana D. HILARIO**	**Philippines**
Vice-Lead		**Dr. Christopher GORDON**	**Singapore**
		Prof. Dr. Edvin ALDRIAN	**Indonesia**
Task Team on Climate Information and Prediction Services including Regional Climate Centres (RCCs) and Regional Climate Outlook Forum (RCOF) (TT-CLIPS)	TT Leader	Mr. John MARRA	USA
	Expert	Mr. Raizan RAHMAT	Singapore
		Mr. Simon McGREE	Australia
Task Team on Climate Data Management/Data Rescue (TT-CDM)	TT Leader	Ms. Meaghan FLANNERY	Australia
	Expert	Mrs. Seluvaia FINAULAHI	Tonga
		Mr. Howard DIAMOND	USA
Task Team on Climate Change (TT-CC)	TT Leader	Mr. Jailan SIMON	Malaysia
	Expert	Ms. Thelma A. CINCO	Philippines
Task Team on Use of Improved Tools for Operational Agro-	TT Leader	Dr. Andrew TAIT	New Zealand

meteorology including Coping with Impacts of Natural Disasters on Agriculture (TT-ITA)	Expert	Mr. Haris SYAHBUDDIN	Indonesia
Task Team on Agro-meteorological Information (TT-AIF)	TT Leader	Ms. Edna L. JUANILLO	Philippines
	Expert	Mrs. Nelly Florida RIAMA	Indonesia

5. Working Group Meeting

The first meeting of the re-constituted RA V Working Group on Climate Services (WG-CLS) was held in Singapore from 2-4 February 2016. The report of this meeting can be found in this document as Attachment 1. Note, in particular, the list of agreed actions is in Annex 3 of this report.

1. Establishment of two Network Regional Climate Centres (RCCs) in RA V

At the February meeting, the WG-CLS discussed in detail the plan for implementation of Resolution 5 of the Sixteenth Session of RA V (2-8 May 2014, Jakarta, Indonesia) to establish two WMO RCC-Networks in RA V, one network for the Southeast Asian sub-region and one network for the South-West Pacific sub-region. The WG-CLS agreed on the way forward with concrete steps and actions towards the implementation of the RCC-Networks in these two regions.

Following the meeting, a letter asking for potential contributions to a Network RCC was drafted by the working group to be sent by the RA V President to the PRs in the Southeast Asian sub-region. This letter has been sent and the Secretariat will collate the responses. A proposal will then be developed for the implementation of the RCC demonstration phase.

A letter has been sent to the Chair of the Pacific Meteorological Council asking for endorsement (in principle) of a proposed PI RCC-Network structure involving the following key agencies: NOAA, BoM, NIWA, MeteoFrance, University of Hawaii, SPREP, SPC, USP, CSIRO, NZ MetService, IFRC and University of PNG. Support is being sought from WMO for a meeting of representatives from these agencies to discuss the roles and responsibilities of PI RCC. The proposed meeting will be in Hawaii in November 2016.

2. Progress with RCOFs in RA V

Two RCOF meeting have been held in the Southeast Asian sub-region in the last 12 months. The Fifth ASEAN Climate Outlook Forum (ASEANCOF-5) was organised in Singapore from 18-19 November 2015 by the Meteorological Service Singapore (MSS). This event was supported and co-sponsored by the World Meteorological Organization (WMO) and the US Agency for International Development (USAID). ASEANCOF-5 was attended by the National Meteorological Services (NMSs) of all 10 ASEAN Member countries and was also attended by experts from the WMO Global Producing Centres (GPC): Bureau of Meteorology (BoM) Australia, China Meteorological Administration (CMA), European Centre for Medium-range Weather Forecasts (ECMWF), Japan Meteorological Agency (JMA), National Centers for Environmental Protection (NCEP, NOAA), WMO Lead Center for Long Range Forecast Multi-Model Ensemble (WMO LC-LRFMME), as well as the APEC Climate Centre (APCC), the International Research Institute for Climate and Society (IRI), and the Regional Integrated

Multi-Hazard Early Warning System for Africa and Asia (RIMES). End-user representatives from the hydrological sector, coordinated by the Global Water Partnership South East Asia (GWP-SEA), and from the disaster-risk management agencies, coordinated by the ASEAN Coordinating Centre for Humanitarian Assistance, (AHA Centre) were also present.

The Sixth ASEAN Climate Outlook Forum (ASEANCOF-6) was organised by the Philippine Atmospheric, Geophysical, and Astronomical Services Administration. The ASEANCOF-was convened via email correspondence between the National Meteorological Services (NMSs) of all 10 ASEAN Member countries and experts from the WMO Global Producing Centres (GPCs): Japan Meteorological Agency, (JMA), National Centers for Environmental Protection (NCEP, NOAA), Centro de Previsão de Tempo e Estudos Climáticos (CPTEC/INPE), United Kingdom Met Office (UKMO), and WMO Lead Centre for Long Range Forecast Multi-Model Ensemble (WMO LC-LRFMME). Full reports of both ASEANCOF meetings can be found at: http://asmc.asean.org/asmc_asean_cof_about/

The first PICOF was held at the University of the South Pacific in Suva, Fiji, 12-16 October 2015. The forum had a specific focus on the current El Niño and regional and national climate outlooks and impacts on the water sector. Representatives at the forum were from regional organizations, Pacific Islands National Meteorological and Hydrological Services, National water sectors and UN organizations. A Regional Statement on the El Niño and Potential Impacts for the Pacific Islands was produced and circulated to media outlets.

The second PICOF is currently being organized and will most likely be held in Nadi, Fiji, 17-21 October 2016. It will be focused on DRR, looking back at the regional impacts of the previous El Niño and looking forward in preparation for a possible La Niña.

3. Agricultural Meteorology

The PICS Panel Gap Analysis report has been submitted to WMO Commission for Agricultural Meteorology for consideration of publication as a WMO Technical Report.

4. RA-V Workshop on Climate Early Warning

A concept note on a potential RA-V CLEWS workshop has been drafted and this can be found below as Attachment 2. At this stage, the WG-CLS would ask for WMO's feedback on this proposal.

ATTACHMENT 1

WORLD METEOROLOGICAL ORGANIZATION

MEETING OF THE
RA V WORKING GROUP ON CLIMATE SERVICES (WG CLS)

2-4 February 2016
Singapore

FINAL REPORT

1. Opening

The meeting of the RA V Working Group on Climate Services (WG CLS) was formally opened at 9 a.m. on Tuesday, 2 February 2016 by its Chair Ms Flaviana D. Hilario. She expressed her gratitude to the government of Singapore for hosting the meeting and underlined the goal of the meeting to establish a robust work plan for the Group. On behalf of the Secretary-General of the World Meteorological Organization (WMO), Mr Rupa Kumar Kolli, Chief, World Climate Applications and Services Division addressed the meeting by highlighting the tremendous capacities and potentials in the Region and the respective opportunities for the Group to provide technical support to RA V Members. Mr Chris Gordon, Director, Centre for Climate Research Singapore warmly welcomed the participants to Singapore and stressed the excellent timing of this meeting as the impacts of the current El Nino attract a great interest of governments in relevant climate services.

Eventually, meeting participants introduced themselves during a short *tour de table*.

2. Organisation of the meeting

The meeting was chaired by WG CLS Chair Ms Hilario. The agenda for the meeting (see Annex 1) was adopted with no revisions. The meeting agreed on its hours of work and other practical arrangements. The list of participants is presented in Annex 2.

3. Review of relevant decisions of Regional Association V

The meeting participants were briefed on relevant key elements of the RA V Strategic and Operating Plans. The Group also considered climate-relevant outcomes of the Sixteenth Session of RA V (2 – 8 May 2014, Jakarta, Indonesia) as well as of the RA V Regional Forum for Directors of NMHSs in RA V (28 – 30 October 2015, Nadi, Fiji). The Group then reviewed its Terms of Reference and noted, in the context of the above, the multitude of requirements and expectations versus the limited resources available and, therefore, stressed the need to prioritise its actions carefully. While acknowledging different operational arrangements in the Southeast Asian and the South-West Pacific sub-regions of RA V, the Group agreed to closely work together in a way that the entire Region will benefit

from their actions. With this understanding, the Group accepted its Terms of Reference without modifications.

4. Updates on Commission for Climatology (CCl), Commission for Agricultural Meteorology (CAgM) and World Meteorological Congress (Cg)

The Group was briefed on decisions and outcomes relevant to its work of the Sixteenth Sessions of CCl and CAgM as well as the Seventeenth Session of World Meteorological Congress. Mr Andrew Tait introduced activities of CCl OPACE 4 relevant to RA V and in particular a summary of a regional workshop on the use of sector-specific indices held in Fiji in December 2015. In order to enhance the use of sector specific climate information in various sectors for climate risk management and adaptation, the workshop was designed to build capacities in interdisciplinary analysis and interpretation of sector-specific climate indices.

5. Global Framework for Climate Services

Mr Kolli presented an overview of the current status of GFCS. The Group briefly discussed relevant aspects, such as the importance of a strong Research and Development component on Regional levels, prospects of mapping existing climate services activities in RA V into GFCS as well as the importance of in-country training.

Mr Tait introduced recent work of the Pacific Islands Climate Services (PICS) Panel, which priority areas aim at, among others, (i) the Pacific Islands RCOF process, (ii) identifying a minimum set of national climate services, (iii) the establishment of a WMO RCC-Network for the South-West Pacific region as well as (iv) defining core competencies relevant to climate service provision.

The Group discussed in detail the requirements and challenges of establishing, as a priority task, two WMO RCC-Networks in RA V, one network for the Southeast Asian sub-region and one network for the South-West Pacific sub-region. As a result, the WG CLS work plan (cf. Annex 3) includes a number of actions on WMO RCC implementation in RA V.

Mr Edvin Aldrian presented BMKG data visualisation capabilities and Mss Hilario and Juanillo informed of recent PAGASA developments in the areas of data rescue, provision of long-range forecasts (LRF) to farmers, the inauguration of a new information system for data as well as implications of the implementation of weather-based insurances and climate resilience field schools in the Philippines.

6. Current status and future work programme of WG CLS for the period 2016-2018 (Climate)

Mr Neil Plummer, Australian Bureau of Meteorology (BoM) joined the meeting by video conference. He expressed his regret for his colleague Ms Meaghan Flannery, member of WG CLS, being unable to attend the Singapore meeting. Mr Plummer briefed the Group of current and planned BoM activities relevant to the work of WG CLS, including (i) implementation of the Climate Data Management System CliDE in 14 Pacific Island countries, (ii) data rescue work attached to the CliDE implementation (Pacific Islands data inventory), (iii) PICS Panel discussions regarding WMO RCC establishment in the South-West Pacific region, (iv) the Climate and Ocean Services Program in the Pacific (COSPPac) including the SCOPIC seasonal forecasting system, and (v) plans to improve Early Warning Systems in the region. He suggested to the Group to consider extending some of the approaches above to other parts of RA V.

Mr Peer Hechler briefed the Group on recent developments in the domains of climate data management including data rescue as well as climate monitoring by referring to

respective CCl OPACE 1 and 2 Expert- and Task Team activities as well as national and regional implementation projects.

Messrs John Marra and Raizan Rahmat provided an overview of the PICOF and ASEANCOF processes.

The Group discussed the above topics and agreed on a couple of actions, which form the key elements of the WG CLS work plan (cf. Annex 3).

7. Current status and future work programme of WG CLS for the period 2016-2018 (Agricultural Meteorology)

Mr Tait introduced outcomes of a PICS Panel gap analysis, highlighting agrometeorological aspects, including gaps in (i) feedback on the use of climate outlooks by the agricultural sector, (ii) training for the agricultural sector on climate matters, (iii) research on climate impacts on the agricultural sector, and (iv) efficient communication with the agricultural sector (and vice versa). It was agreed to explore opportunities to invite Working Group member Ms Nelly F. Riama, Indonesia to one of the upcoming PICOFs in order to address the BMKG Climate Field Schools and discuss agrometeorological aspects relevant to the COF process.

8. Extra-budgetary projects and resource mobilisation

The Group noted with appreciation the support of USAID to the ASEANCOF process as well as the prospects of the on-going GFCS Canada project for the development of climate services in the Pacific Island countries.

9. Any other business

Participants agreed on the need to raise the visibility of the Working Group and its activities within the Region. It was agreed to explore opportunities to create a Web presence of the Working Group within the Webpages of the WMO Regional Office for Asia and South-West Pacific (RAP) and to reflect activities of the Group on the Webpages of the NMHS of the Philippines (PAGASA).

10. Conclusions and recommendations

The Group agreed to establish the set of actions captured in Annex 3 as work plan for the current intersessional period.

11. Review of actions and adoption of the meeting report

The Group reviewed and adopted its action list as per Annex 3 to this report.

12. Closing

The Chair thanked Mr Gordon and his team for the excellent arrangements provided, which allowed the Working Group to efficiently focus on its agenda items. She also appreciated the proactive participation of meeting attendees in the Group's discussions.

The meeting was closed by its Chairperson on Thursday, 4 February at 3.26 p.m.

WORLD METEOROLOGICAL ORGANIZATION

Original: English

MEETING OF THE RA V WORKING GROUP
ON CLIMATE SERVICES (WG CLS)
Singapore, 2 – 4 February 2016

AGENDA

1. **OPENING OF THE MEETING**
2. **ADOPTION OF THE AGENDA AND ORGANIZATION OF THE MEETING**
3. **REVIEW OF RELEVANT DECISIONS OF REGIONAL ASSOCIATION V**
4. **UPDATES ON COMMISSION FOR CLIMATOLOGY, COMMISSION FOR AGRICULTURAL METEOROLOGY AND WORLD METEOROLOGICAL CONGRESS**
5. **GLOBAL FRAMEWORK FOR CLIMATE SERVICES**
6. **CURRENT STATUS AND FUTURE WORK PROGRAMME OF WG-CLS FOR THE PERIOD 2016-2018 (CLIMATE)**
7. **CURRENT STATUS AND FUTURE WORK PROGRAMNE OF WG-CLS FOR THE PERIOD 2016-2018 (AGRICULTURAL METEOROLOGY)**
8. **EXTRA-BUDGETARY PROJECTS AND RESOURCE MOBILIZATION**
9. **ANY OTHER BUSINESS**
10. **CONCLUSIONS AND RECOMMENDATIONS**
11. **REVIEW OF ACTIONS AND ADOPTION OF THE MEETING REPORT**
12. **CLOSURE OF THE MEETING**

WORLD METEOROLOGICAL ORGANIZATION

Original: English

MEETING OF THE RA V WORKING GROUP
ON CLIMATE SERVICES (WG CLS)
Singapore, 2 – 4 February 2016

List of Participants

Neil PLUMMER (Mr), **Australia**, N.Plummer[at]bom.gov.au
Edvin ALDRIAN (Mr) (Vice-Lead), **Indonesia**, e_aldrian[at]yahoo.com
Andrew TAIT (Mr), **New Zealand**, Andrew.Tait[at]niwa.co.nz
Flaviana D. HILARIO (Ms) (Lead), **Philippines**, fhilarioph[at]yahoo.com
Edna L JUANILLO (Ms), **Philippines**, ejuanillo[at]yahoo.com
Chris GORDON (Mr) (Vice-Lead), **Singapore**, chris_gordon[at]nea.gov.sg
Raizan RAHMAT (Mr), **Singapore**, raizan_rahmat[at]nea.gov.sg
John MARRA (Mr), **United States of America**, john.marra[at]noaa.gov
Peer HECHLER (Mr), **World Meteorological Organisation**, phechler[at]wmo.int
Rupa Kumar KOLLI (Mr), **World Meteorological Organization**, rkolli[at]wmo.int

List of actions (reflecting key work plan elements of the RA V WG CLS)

Action	Facilitator	Deadline	Remarks
1: Draft a concept paper on prospects of a Regional Climate Change Forum in RA V, based on the RCOF concept, with the goal of holding such forum in 2017	TT-CC (Mr Simon)	31 Oct 16	Include aspects of keeping RA V NMHSs informed of relevant CORDEX activities in their region; *Liaise with TT-CSIS (Mr Marra), Ms Cinco and Mr Aldrian*
2: Survey on capacity building needs for climate services	TT-CSIS (Mr Rahmat)	(next ASEAN COF)	Consider template/outcome of similar South Asian COF survey (Mr Kolli) and take into account outcomes of the PICS Panel gap analysis (Mr Tait); consider conducting the survey during an ASEAN COF event
3: Liaise with ET NCMP to address RA V specifics regarding NCMP implementation	TT-CDM (Mr Diamond)	31 Aug 16	(ET NCMP contact point for RA V: Mr Karl Braganza, BoM); discuss NCMP generation for small Island countries and for complex terrain areas *Liaise with TT-CSIS (Mr Marra)*
4: Encourage and assist RA V Members in populating I-DARE	TT-CDM (Ms Flannery)	30 June 17	
5: Draft a concept note on a potential RA V Workshop on Climate Early Warning in 2017	Mr Tait	30 June 16	Consider existing capabilities and mechanisms in the Region, identify stakeholders, draft agenda elements, consider WMO Climate Watch concept and related workshop series *Liaise with Messrs Plummer (BoM), Gordon, Marra and Hechler*
6: Find out which RA V Members submit contributions to (i) WMO's Annual Statement on the Status of the Global Climate and (ii) BAMS State of the Climate article	Mr Hechler	30 June 16	Encourage more RA V Members to contribute through a P/RA V letter to RA V Members *in close liaison with the RA V WG CLS*
7: Draft a three to five years roadmap for the further evolution of RA V RCOFs	TT-CSIS (Mr Marra)	31 Oct 16	Include discussion of (i) challenges and opportunities, (ii) prospects of adding new variables to RCOF portfolios (e.g. sea level, wind at standard levels etc.), (iii) prospects of adding the sub-seasonal forecast scale to RCOF portfolios, (iv) Outlook uptake by users, (v) Outlook impacts on user decisions; (vi) aspects of NCOF liaison; (vii)

			how best to inform of ongoing projects in the region etc. *Liaise with Messrs Tait and Gordon; consider inviting Ms Riama and Mr Rahmat to one of the next PICOF face-to-face meetings*
8: Facilitate RA V RCC implementation	TT-CSIS (Messrs Marra, Tait, Gordon)	(Cf. column Remarks)	Advice P/RA V on RCC-Network arrangements and implementation steps for Southeast Asian and Southwest Pacific sub-regions with the aim of starting demonstration phases: 8.1: Southwest Pacific RCC-Network: (i) Approach potential RCC Node organizations to seek informal agreement to serve the RCC-Network **(15 Mar 16)**; (ii) seek PMC endorsement through PICS Panel **(31 Mar 16)**; (iii) develop detailed RCC-Network proposal (including suggested start date of RCC demonstration phase) **(31 Oct 16)**; (iv) conduct a face-to-face meeting of RCC Node/consortium candidate institutions to agree on organizational arrangements and technical details **(Nov 16)**; (v) seek formal commitment from PRs of proposed Node hosts and potential consortium members; (vi) provide RCC-Network proposal to P/RA for endorsement to start the demonstration and for submission to WMO SG 8.2: Southeast Asian RCC-Network: (i) Arrange for a letter from P/RA V to Southeast Asian RA V Members to inquire interest/willingness/readiness to serve as RCC-Network provider (Node lead or consortium member) **(29 Feb 16)**; (ii) develop detailed RCC-Network proposal (including suggested start date of RCC demonstration phase) **(31 May 16)**; (iii) conduct a face-to-face meeting of RCC Node/consortium candidate institutions to agree on organizational arrangements and technical details **(June/July 16)**; (iv) seek formal commitment from PRs of proposed Node hosts (and potential consortium Members); (v) provide RCC-Network proposal to P/RA for endorsement to start the demonstration and for submission to WMO SG
9: Explore ways of publishing the outcomes of the PICS Panel gap analysis as a WMO technical report	TT-ITA (Mr Tait)	30 June 16	In addition, consider provision of an article for the WMO Bulletin *Liaise with Mr Stefanski (Secretariat)*
10: Draft a report on the operational use of S2S	TT-ITA (Mr Tait)	31 Dec 16	Consider existing approaches in Southeast Asia and address relevant potential recommendations for the Southwest Pacific region

forecasts in agriculture			*Liaise with Mr Stefanski (Secretariat)*
11: Draft a brief report on the use of remote sensing data and services for agricultural applications	TT-ITA, TT-CSIS (Messrs Tait and Marra)	31 Dec 17	(Report of a length of up to five pages)
12: Draft a paper on NCOF practices and experiences	TT-AIF (Ms Juanillo)	30 June 17 (annotated paper out-line: 31 Oct 16)	Consider existing practices and experiences in countries such as Philippines and Indonesia with a special focus on agriculture (including Indonesian Climate Field Schools); provide general recommendations/guiding principles/ practices regarding NCOFs for WMO Members worldwide *Liaise with Ms Riama and Messrs Gordon and Aldrian and NN (Malaysia)*
13: Facilitate an online meeting of the RA V WG CLS	Ms Hilario, WMO RAP	Feb 17	Review status of actions and explore opportunities for additional actions, where appropriate
14: Identify RA V WG CLS members who are not able to contribute to the activities of the WG	Ms Hilario	Ongoing	Consider quarterly checks (Mr Kolli to set up a Google group for the entire WG); complement 'silent' members by engaging additional experts as appropriate
15: Update RA V-related WMO DRA Webpages	WMO RAP	30 April 16	Update information on working groups, membership in working groups and teams; consider prospects of providing space for WG activities etc.

ATTACHMENT 2

Concept note:
RA-V Workshop on Climate Early Warning

Draft version 3 (24/2/2016)

1. Introduction

As understanding of the climate system grows and society becomes more aware of the potential benefits from use of this knowledge, communities and decision makers are seeking guidance and tools for accurate early warning of climate-related impacts.

Recognizing the need to strengthen the production, availability, delivery and application of science-based climate monitoring and prediction services, the WMO World Climate Conference – 3 held in Geneva from 31 August to 4 September 2009, proposed to establish a Global Framework for Climate Services (GFCS). Subsequently, the 16th World Meteorological Congress (CgXVI, Geneva, Switzerland) decided to support and facilitate the implementation of the GFCS as a priority of the organization. The Congress also recognized that Expert and Task Teams from WMO Technical Commissions (especially the Commission for Climatology, CCl) and Regional Associations will play a central role in the implementation of the GFCS.

The WMO Regional Association V (South-east Asia and South-west Pacific) Working Group on Climate Services (WG-CLS) has five Task Teams dedicated to the advancement of studies and the sharing of knowledge on topics from climate data management to the provision of tailored climate information for farmers. Encompassing all these topics (and more) is the concept of Climate Early Warning.

Climate Early Warning is ultimately about providing timely advice to stakeholders on how the climate at a global, regional and national scale is currently evolving and the likelihood that a potentially adverse event (or events) may develop in the next few months. Such an event might be a drought, an extended period of low (or high) sea level, an enhanced risk of tropical cyclone activity, or the expectation of unusual winds and rainfall. In order to provide such advice, there are three main components that together make up a Climate Early Warning System (CLEWS). These are: infrastructure, data & products, and service delivery.
The overarching aim of this workshop is to bring together those currently responsible for issuing climate forecasts and warnings from National Meteorological and Hydrological Services (NMHSs) across the RA-V region to discuss and demonstrate (using examples) what Climate Early Warning is and how a CLEWS can be implemented. Invited guests will also include key end users, such as representatives from Disaster Management Offices and/or NGOs (such as Red Cross). The workshop will be held in Apia, Samoa where significant advances have been made over the last few years on a national CLEWS. The date of the workshop is still to be determined, but will be sometime in 2017 probably lasting three days.

2. Objectives of the workshop

1. To demonstrate the concept and key components of Climate Early Warning to representatives from NMHSs across RA-V who produce and deliver climate services;
2. To share experiences and learn from examples of Climate Early Warning Systems (or components thereof) from across RA-V (and possibly further afield);

3. To listen to end-users' perspectives on their responses to and need for Climate Early Warnings;
4. To identify linkages with other concepts such as Climate Watches; Climate Risk Management and Climate Risk and Early Warning Systems (CREWS);
5. To discuss Climate Early Warning in the context of the Global Framework for Climate Services, Regional Climate Centres, and any other regional and global programmes and initiatives; and
6. To assess gaps and needs of RA-V NMHSs in the establishment of Climate Early Warning Systems.

3. Expected outcomes

1. A description of the baseline of NMHS institutional and operational capabilities for Climate Early Warning across RA-V;
2. Improved understanding of Climate Early Warning concepts and their use in enhancing the capacity of NHMSs to better respond to key climate services requirements;
3. Identification and demonstration of the key components of a Climate Early Warning System, ultimately for implementation in all RA-V countries; and
4. Formation of a writing team to produce a WMO technical publication on Climate Early Warning in RA-V.

4. Workshop basic structure*

Day 1	• Introduction to CLEWS concept and key components • Context setting: GFCS, RCCs, National Frameworks, etc. • End-users' perspectives • Linkages with Climate Watches, CRM, CREWS, etc. • Learnings from COSPPac, Climate Dialogues, Climate Field Schools, Clide/Clidesc, other global initiatives, etc. • Field trip
Day 2	• Key component 1: Infrastructure requirements (instrumentation, comms, databases, IT hardware and support, upgrades) • Key component 2: Data & products (data ingest, QC, data rescue, data management, product generation, software, tools, training, upgrades)
Day 3	• Key component 3: Service delivery (survey of needs, timing, format, comms, NCOFs, service support, training) • NMHS gaps and needs analysis • Writing team formation and plan • Wrap up

* Note, the key components could be reversed, so that service delivery is presented first. This would help to drive the discussion from the "requirements for actionable information" side.

Working Group on Infrastructure (WG-INFR)

Karl Monnik
Bureau of Meteorology, Australia

1. Introduction

The RA V Working Group on Infrastructure was inaugurated in 2015, after the term of the previous team came to an end in early 2015.

2. Working Group Structure

The Working Group is composed of one leader and vice-leaders, Task Team on WIGOS (TT-WIGOS), Task Team on Satellite Utilization (TT-SU); Task Team on Aircraft Based Observations (TT-ABO); Task Team on Observations Quality Management (TT-OQM); and Task Team on Regional Implementation and Operation of WIS (TT-WIS). Each TT consists of one leader and one or more experts except for Task Team on WIGOS (TT-WIGOS).

3. Terms of Reference

The terms of reference of the Working Group on Infrastructure (WG-INFR) are as follows:

(a) To monitor, promote and develop strategies for the Regional development and sustainable implementation of the WMO Information System (WIS), including the steps described in the WIS Implementation Plan for Regional Association V (South-West Pacific). A high priority remains for overcoming the persistent shortcomings of the Regional Meteorological Telecommunication Network for time-critical and operation critical data exchange. Avenues include Pacific-wide satellite communications, collaboration in the development and support of the RAdio and InterNET (RANET) communication system, reception of the Emergency Managers Weather Information Network, and improved access to Internet services;

(b) To monitor, promote and develop integrated strategies for the Regional development and sustainable implementation of the observing systems of WMO Programmes and co-sponsored Programmes, in particular through the WMO Integrated Observing System (WIGOS) Implementation Plan for Regional Association V (South-West Pacific). Specific areas of focus are tabulated in that plan;

(c) To promote and facilitate the compliance of the WIGOS and WIS Technical Regulations and Manuals;

(d) To review and propose updates for the Regional WIGOS Implementation Plan;

(e) To identify means for strengthening liaison with bodies involved in the development and implementation of relevant observing and information systems;

(f) To identify education and training requirements for relevant information and communication techniques and observing systems and operations;

(g) To provide input for WMO regulatory material related to observations and information systems, in particular ensuring National Focal Points effective participation in Fast Track procedures approved under Resolution 21 (Cg-17);

(h) To coordinate its Task Teams to complete specific tasks and submit proposals to the RA V Management Group for winding up completed teams and starting new teams;

(i) To report to and advise the president and Management Group of the Association on the above issues.

4. Membership

WG-INFR		Name	Country
Lead		**Mr Karl MONNIK**	**Australia**
Vice-Lead		**Mr Edward TRIHADI**	**Indonesia**
Task Team on WIGOS (TT-WIGOS)	TT Leader	Mr Karl MONNIK	Australia
Task Team on Satellite Utilization (TT-SU)	TT Leader	Ms Agnes LANE	Australia
	Expert	Mr Vicente P. PALCON, JR.	Philippines
Task Team on Regional Implementation and Operation of WIS (TT-WIS)	TT Leader	Mr Huat Aik CHOO	Singapore
	Expert	Mrs Endang PUDJIASTUTI	Indonesia
Task Team on Observations Quality Management (TT-OQM)	TT Leader	Mr Wan Nazri WAN DAUD	Malaysia
	Expert	Mr Selusalema VITE	Tonga
Task Team on Aircraft Based Observations (TT-ABO)	TT Leader	Mr Zulkarnain	Indonesia
	Expert	Mr Douglas BODY	Australia
	Expert	Mr Wym van Dyk	New Zealand
	Expert	Mr Kevin Alder	New Zealand

The following changes are proposed.

- Mr Syamsul HUDA has retired and Mr Zulkarnain is the recommended replacement as the TT Leader for Task Team on Aircraft Based Observations.
- Mr Kevin Alder (New Zealand) and Mr Wym van Dyk (New Zealand) are added as Expert members of TT-ABO.

5. Working Group meetings

The WG-INFR Lead has arranged monthly WebEx sessions where TT Leads and Experts are encouraged to attend. Attendance has been building over the past six months. The Vice-Lead and Henry Taiki (WMO Office, South West Pacific) attend regularly. Meetings have been held on the following dates:

- 07 September 2016
- 05 October 2016
- 08 February 2017
- 08 March 2017
- 05 April 2017

The WG-INFR Lead has provided comments concerning the Pacific Islands Meteorological Strategy (PIMS) as part of their mid-term review. The comments were intended to provide greater alignment with WIGOS priorities.

The WG-INFR Lead is planning to attend the next Pacific Meteorological Council (PMC) Pacific Islands Communication and Infrastructure (PICI) Panel WebEx video meeting on 21 April 2017. An invitation has been received to the next Panel meeting in Fiji 13-15 May, though attendance has not been confirmed.

6. Task Team on WIGOS (TT-WIGOS)

Activities of the TT:
The TT Lead contributed to the development of WMO Regulatory Material concerning surface based observations (Automatic Weather Stations) and the WIGOS Metadata Standard. Furthermore, he has contributed to the preparation of Guidance material for OSCAR Surface on behalf of RA V.
The monthly WebEx sessions have served as capacity development opportunities for WIGOS Metadata Standard and OSCAR/Surface.

- Future plan/Work Plan
    - Guide the development of national WIGOS Implementation Plans;
    - Organize regional workshops for managers of weather and climate observations to discuss WIGOS.
    - Assess and provide profiles of national observing systems and networks against WIGOS requirements / standards.
    - The national WIP for Australia is being drafted to serve as an example for other members.
    - The monthly WebEx sessions have served as capacity development opportunities for WIGOS Metadata Standard and OSCAR/Surface.
- Challenges and Priorities
    - Develop national WIPs;

Facilitate that each NMHS can become WIGOS ready by 2019.

7. Task Team on Satellite Utilization (TT-SU)

Activities of the TT:

- Two WebEx sessions were held by members of the group and a number of other interested participants.
- Currently planning to collect RA-V satellite data requirements to support climate applications and services.
- Himawari 8/9 and HimawariCast receiving equipment and with the support of WMO-JMA and JICA, have been installed in the following Pacific SIDS/LDCs: Fiji, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu. More sites to follow.
- Future plan/Work Plan
    - Assist Members in the Pacific subregion to receive data from the new generation of geostationary meteorological satellites such as Japan's Himawari-8.
    - Document RA V user requirements and priorities for satellite data and products;
    - Document regional satellite requirements using CBS / Space programme guidelines.
- Challenges and Priorities

- Address constraints in providing members of the subregion to access from Himawari-8.
- Developing a process to access Himawari rapid scan data for significant weather conditions.

8. Task Team on Regional Implementation and Operation of WIS (TT-WIS)

- Future plan/Work Plan
  - Develop national WIS implementation plans or equivalents for Members of RA V based on ASBU's road map, WIS RAV Implementation Road Map
  - Implement RA V WIS implementation plan.
  - Organize regional workshops on WIS.
- Challenges and Priorities
  - Increase capability in NMHS in WIS.

9. Task Team on Observations Quality Management (TT-OQM)

- The Lead of this team was replaced in early 2016 and the team is yet to become active.
- Current activities
  - Fiji Met Service building its capacity on meteorology instrument calibration. Supported by JICA and the Government of Fiji
- Future plan/Work Plan includes:
  - To enable NMHS to access RICs to calibrate meteorological instruments;
  - Enhance the capacity of Members in RA V to achieve traceability.
  - Monitor and detect discrepancies between current performance and the metadata lodged with WMO.
  - Implement new WIGOS metadata standards in Members of RA V.
- Challenges and Priorities
  - Improve calibration of national standards in NMHS;
  - Implement new WIGOS metadata standards
  - Contribute to the development of Regional WIGOS centre.

10. Task Team on Aircraft Based Observations (TT-ABO)

- A WebEx meeting was held jointly with members of TT-ABO on 8 April 2016. Attendance included: Dean Lockett (WMO Secretariat); Frank Grooters (Chair CBS ET-ABO); Doug Body (BOM, Member RA V INFRA-ABO); Karl Monnik (BOM, Chair RA V INFRA); Wim Van Dijk (NZ MetService, NZ AMDAR Focal Point). Key items discussed included:
  - Draft RA V Regional Implementation Plan (developed prior to RA V Meeting in May 2014) was discussed – in particular the areas that need to be updated to reflect changes in ABO in RA V.
  - The addition of Mr Wim Van Dijk (New Zealand MetService) to RA V INFRA-ABO as an Associate member.
  - The possibility of holding a Regional Workshop on AMDAR in Indonesia was proposed, supported by WMO. This has now been scheduled for Jakarta, Indonesia, 22-26 May 2017.
- Future plan/Work Plan
  - Implement Aircraft-Based Observations Implementation Plan for RA V within the perspective of GANP.
  - Discuss with Pacific national and regional airlines participating in AMDAR observations programme.

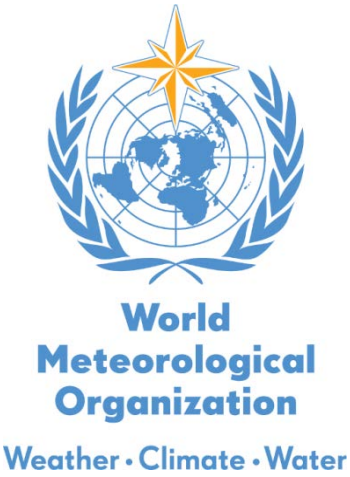
- Challenges and Priorities
    - Identify new potential airline opportunities for access to AMDAR observations;
    - The effective running of the AMDAR workshop in Jakarta during May 2017, including engagement with airlines based in Indonesia, Malaysia and Singapore.

11. Working Group Meeting

- Members of WG-INFR participated in the Regional Forum for Directors of National Meteorological and Hydrological Services in Regional Association V (South-West Pacific), Nadi, Fiji, 28–30 October 2015.
- A meeting of the WG is provisionally scheduled for early 2017. The details of the meeting are still under the discussion.
- Challenges and Priorities (Annex)
    - Develop active participation by TT Leads in pursuing their plans.
    - Improve communication between TT members across RA V.

12. Conclusion

WG-INFR faces challenges to develop momentum among all the Task Teams. Following the Regional Forum for Directors of National Meteorological and Hydrological Services in Regional Association V (South-West Pacific), where some face-to-face meetings were held, there has been a substantial improvement in engagement via email and WebEx.



REPORT OF THE SIXTEENTH SESSION OF THE WMO RA V TROPICAL CYCLONE COMMITTEE FOR THE SOUTH PACIFIC AND SOUTH-EAST INDIAN OCEAN

Honiara, Solomon Islands
29 August - 02 September 2016

Table of contents

1 Organization of the session

1.1 Opening of the session

At the kind invitation of the Government of Solomon Islands, the sixteenth session of WMO Regional Association V Tropical Cyclone Committee for the South Pacific and South-East Indian Ocean (RAV/TCC-16) was held in Honiara, Solomon Islands, from 29 August to 2 September 2016. The opening ceremony commenced at 0900 hours on Monday, the 29 August 2016.

1.1.1 The Deputy Director of Meteorology of Solomon Islands, Mr Lloyd Tahani played the role of the MC and invited Mr Noel Sanau to say a prayer for a successful meeting.

1.1.2 Mr. Chanel Iroi, Permanent Representative of the Solomon Islands with WMO welcomed the participants to Honiara, and to the sixteenth session of the RA V/TCC, on behalf of the Minister responsible of Environment, Climate Change, Disaster Risk Reduction and Meteorology. He indicated that the meeting is to look at the project achievement in the Pacific and to find the way to inform the partners and to improve the severe weather forecasting in the region. He assured the Ministry team was at the disposal of the meeting to assist in any way possible.

1.1.3 On behalf of Pr. Petteri Taalas, Secretary-General of WMO, Dr. Taoyong Peng, Chief, Tropical Cyclone Programme, welcomed all the participants and expressed the sincere appreciation of WMO to Honorable Minister Samuel Manetoali, Ministry of Environment , Climate Change, Disaster Risk Reduction and Meteorology (MECDM) and through him to the Government of Solomon Islands for hosting the RA V/TCC-16. He also expressed his gratitude to Mr. David Hosiara and his staff at the Solomon Islands Meteorological Service for the warm welcome and hospitality and for the excellent arrangements made to ensure the success of the session. He thanked all the delegates of the Members of the Committee, in particular, those hosting RSMC/TCWCs for their dedicated efforts to reduce the risk of tropical cyclone disasters in their countries during the previous two tropical cyclone seasons. The Congress requested that WMO should continue to give high priority to capacity development in tropical cyclone forecasting, particularly in SIDS and LDCs and make the necessary arrangements to extend training activities to cover all the five regional tropical cyclone bodies. WMO TCP shall continue to contribute to WMO strategic priority on DRR via impact-based forecasting and warnings.

Dr. Peng assured WMO's continued support through the TCP for the Committee's programmes and activities, and wished all the participants a very successful session and an enjoyable stay in Honiara.

The Chair Mr Mike Bergin welcomed the Honorable Simon Manetoali Minister responsible for the Solomon Islands Meteorological Service, Mr David Goutx, the Chair of the RA 1 TCC; Mr John Fenwick, the Chair of the RA V WG on Hydrology; other members of the RA V TCC and invited guests from a variety of organizations in the Region. The Chair thanked the Minister and the Government of the Solomon Islands for their on-going support for the Solomon Islands Meteorological Service and in particular this meeting of the TCC. The Chair also thanked the governments of Australia and the United States of America as well as WMO, for their financial support for this meeting. Mr Bergin reminded the meeting of the vastness of the area of responsibility of the RA V TCC which covers the eastern half of the Southern Indian and the Southern Pacific Oceans. The countries in the area ranged from Indonesia with several hundred million people to small nations such as Niue with only a few thousand residents as well as a diverse range of cultures and languages. Further he acknowledged the comprehensive representation from countries across the Region as well as the range of organizations such as IOC, SPREP, ESCAP, JMA, JICA, IFRC and SPC who are attending the meeting.

While acknowledging the significant achievements of the TCC in the past 30 years the Chair noted that recent significant cyclones such as Pam and Winston that had killed many people and caused enormous economic losses, reminding the Committee that there was still much work to be done in protecting the communities of the Region.

1.1.4 His Honorable Minister Samuel Manetoali, Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM) welcomed the participants to Honiara and to RA V/TCC-16.

The Minister reminded the meeting the Solomon Islands were located in one of the areas most prone to natural disasters in the world, with significant earthquakes, triggering sometimes destructive tsunamis. SI is located both in the genesis region of tropical cyclones development and also in its path of movement. Therefore SI were vulnerable to storm surges, destructive winds and flooding.

The Minister defined the MECDM as a "safeguards" Ministry and said one of the essential duties of the Solomon Islands Meteorological Service is to provide TC warnings to the government and its people. SI was situated in both the areas of Brisbane TCWC and RSMC Nadi and the Minister conveyed their thanks and appreciation to both centers for such a partnership and assistance.

The Minister noted that to show the SI government seriousness in dealing with the threats of TCs, the national government has continued to build both its human resources and infrastructures. He informed the meeting, a new building was being established to house the National Disaster Management Office and the Weather Forecasting Services. The Ministry further announced that to address the challenge of the Climate Change, it was currently pursuing the review of its relevant legislations. The Minister emphasized that the recommendations from TCC would assist their region and their countries building resilient people, resilient communities and resilient countries. He then thanked the WMO in having accepted their request for support to host this meeting in Honiara. Their appreciation also went to the Secretariat of the Pacific Regional Environmental Programme and the governments of Australia and of the United States of America for the support provided towards this meeting.

He officially declared the meeting opened.

1.1.5 The Chair Mr Mike Bergin noted that the role of the Tropical Cyclone Committee (TCC) continues to grow as reflected in the contributions scheduled from a variety of organizations for this 16th session and as a focus for additional meetings associated with a variety of issues relevant to South Pacific NHMs. The SWFDDP continues to be most important to the ongoing work of NHMs in the Region in the provision of services for high impact weather and flooding. Later in the week we will discuss the SWFDDP but clearly the MetConnect website has become integral to the operations of NHMs in the Region.

1.1.6 The session was attended by 35 participants, including 24 from the Committee's member States and 11 participants from regional and international organizations, RA1 TCC Chairman as ex-officio member, RAV Chairman of the WG for Hydrology. The list of participants is given in Annex 1.I.

The Chair noted that it has been 30 years since the first meeting of the RA V TCC which was established to ensure the provision of quality and well integrated warning services for tropical cyclones across the RA V Region south of the equator, to ensure the safety of people and property both on land and across the oceans.

1.2 Adoption of the agenda

1.2.1. The Committee adopted the agenda for the session as given in Annex 1.II.

1.3 Working arrangements for the session

1.3.1 The Committee decided on its working hours and the arrangements for the session.

1.3.2 In the early part of the season tropical cyclone Bakung formed in the Indonesian AOR to the southwest of Java. The cyclone reached category 2 intensity before dissipating over the Indian Ocean.

2 Report of the chairperson of the Committee

2.1.1 The recent meeting of the SWFDDP RSMT last week was another example of the value of the TCC meeting in providing an opportunity for discussions amongst NHMs on topics beyond tropical cyclones. Earlier in the week there was also a meeting of the IOC Pacific tsunami WG, a RANET meeting addressing communication issues for the South Pacific Region and a Panel on Education. While this range of meetings piggy-backing on the TCC meeting is of great benefit to NHMs, care needs to be taken to ensure fatigue of participants does not become a problem.

2.1.2 The Chair reported on the 2014/15 season which was described as neutral from an ENSO perspective. Expectations were for a near normal number of named tropical cyclones across the Region. There were 5 named cyclones in the Fiji RSMC Area of Responsibility (AOR, east of 160E) with 2 of them reaching severe tropical cyclone intensity i.e. category 3 or higher on the Australian tropical cyclone scale. While the number of named cyclones was below expectations there were a further 9 Tropical Depressions that did not attain cyclone intensity; so the season could not be described as quiet. Tropical cyclone Pam was easily the most intense reaching high category 5 intensity before impacting on the central islands of Vanuatu. Pam is one of the most intense cyclones analyzed in the weather satellite era with sustained winds estimated at 250km/h. There were 11 deaths caused by Pam with many villages, key pieces of infrastructure and crops destroyed. Total damage was estimated at $USD450 million. While any deaths from tropical cyclones are tragic the death toll from the impact of such an intense cyclone could have been much higher and we will discuss during the meeting the reasons for this statistic. No doubt an effective warning system that led to many people taking precautions, was a key factor.

2.1.3 In the Australian TCWCs AOR there were 8 cyclones with 7 of them reaching severe intensity at some stage. Tropical cyclone Raquel was named on 30 June so is counted in the 2014/15 season. There were 3 major impacts of severe cyclones on the Australian mainland with Marcia causing an estimated $750 million dollars on the central Queensland coast, Lam impacting the far north coast of Queensland and the coast of the Northern Territory (estimated damage $82million) and Olwyn the northwest coast of Western Australia (estimated damage $100 million). Forecasting the intensity of these cyclones was a major challenge and we saw each of them intensify rapidly at various times in their life cycle. Forecasting the intensity of tropical cyclones remains a serious ongoing challenge.The 2015/16 season was characterized by a strong El Niño circulation and expectations were for a very active season and the number of cyclones to be well above average, in the Fiji AOR with between 10 and 14 tropical cyclones; and a below average number of cyclones in the area west of 160E. However in the Fiji AOR there were 8 tropical cyclones with 5 reaching severe tropical cyclone intensity. The most destructive of these was Winston which impacted the central islands of Fiji in February 2016. There 44 fatalities of which around two-thirds were caused by storm surge. The lack of a comprehensive storm surge warning service for many countries in the Region remains a major problem that needs urgent attention from major partners both within and external to the Region.

2.1.4 In the Australian AOR there were only 3 tropical cyclones with none of them reaching category 3 intensity. This was the first season in the satellite era when there has not been at least one severe tropical cyclone in the Australian Region and 3 was the lowest number of cyclones on record for any season.

2.1.5 An important task for this meeting will be to establish Terms of Reference for 2 Task teams (TT) established by RA V Management Group. These TTs focus on Severe Weather and Coastal Inundation. The SWFDDP and 2 CIFDPs within the Region are 3 projects that directly or indirectly come under the auspices of both these TTs. The SWFDDP continues to be the most active area of work of the committee with the RSMT meeting just last week. There has been some achievements against the criteria to transition the project to operational status but at present it remains in phase 3. Additionally, while RSMC Wellington will continue to produce the guidance products (South Pacific Guidance, SPG) the overall management of the project will need to transition to a regional body. To that end and in order to move the project to phase 4, the RSMT made a number of recommendations that will be considered by this meeting including:

- Undertaking a review of the project to inform both the transition to phase 4 and a business case for the establishment of a coordinating post most likely at SPREP and

- Transform the existing reporting arrangements through simpler templates and video conference arrangements on a monthly basis

2.1.6 The Chair noted the ongoing excellent work of the Pacific Desk in Honolulu and of the training opportunities being providing for staff from NHMS in the Region around tropical cyclone being delivered by the governments of Australia, Japan, United Kingdom and Finland. The Chair thanked the respective countries for their ongoing support and urged that efforts be made to ensure the training activities are well coordinated.

2.1.7 Since the last meeting the JMA satellite Himawari has been launched and much higher resolution data in time and space and for a greater range of channels is being received by many NHMs in the Region including some of the quite remote countries. The Chair acknowledged this very valuable addition to the forecasters of the Region in combating the threat from tropical cyclones. JMA have not only launched the satellite but have provided reception facilities in many countries as well as extensive training in utilization of the data.

2.1.8 The Chair noted that the 8th session of the International Workshop on Tropical Cyclones (IWTC) was held in Republic of Korea in December 2014 and thanked WMO for the ongoing commitment to this important engagement between operational cyclone forecasters and the cyclone research community. We look forward to implementation of the recommendations of the workshop. The Chair noted the request from researchers for greater engagement with operational centres in relation to major or difficult to predict tropical cyclones.

2.1.9 Finally Mr Bergin reminded the Committee that the Operational Plan for the co-ordination of cyclone warning services across the Region remains its most important and significant responsibility. Indeed that Plan is the major reason for the existence of the committee.

2.1.10 In conclusion the Chair thanked those who have contributed to the arrangements for this meeting.

Comments

2.1.11 The Committee commented on the challenges associated with forecasting TC intensity and the need to be informed on the developments related to TC intensity forecasting.

2.1.12 The Committee commented on the problem of communicating forecast uncertainties for the communities and for disaster managers to understand the range of possibilities, especially when intensity changes occur close to the islands

2.1.13 The meeting noted that in the 2014/15 and 2015/16 tropical cyclone seasons, 2 Category 5 Tropical Cyclones developed and made landfall. Severe tropical cyclones “Pam” and "Winston" reached peak estimated 10-minute wind speed in excess of 145 knots. Given that

these 2 systems were at the higher end of the Category and there are predictions that more intense cyclones could be experienced in the future, questions were raised by member countries whether it was necessary to revise the category system to include a Category 6 for TC intensity numbering.
Noting the challenges in dealing with extra-ordinary strong tropical cyclones, the meeting requested for a comprehensive study on the various mechanisms involved in cyclogenesis and on high intensity tropical cyclones where Dvorak techniques are challenged to be carried out. It was recommended that this would be best carried out by the research community with close collaboration with operational meteorologists in the region.

2.1.14 The Committee commented on the need for better storm surge warning information and need to explain the risk in appropriate language.

2.1.15 The Committee commented on the difficulty of providing adequate warnings for communities impacted by waves generated by cyclones remote from the area.

2.1.16 The Committee commented on the necessity to provide surface observations to augment satellite data for NWP purposes and to provide ground truthing as a basis for verification.

Comments/request

2.1.17 There is a need to explore the development of coastal impact forecasting caused by sea level inundation associated with tropical cyclones. Storm surge and waves associated with tropical cyclones pose a real threat to coastal areas in the Pacific. Recent storm surge events associated with tropical cyclones damaged and destroyed infrastructure, buildings and food crops and claimed lives. Experiences in Fiji, Kiribati, Niue, Tonga, Tuvalu and Vanuatu have stressed the need for storm surge to be considered with tropical cyclone warnings. Recognizing the ongoing CIFDPF and SWFDDP efforts, the meeting recommended that given the urgency and need for a storm surge forecasting solution, options are explored such as that developed in RA I by SW Indian Ocean.

2.1.18 The Committee discussed the challenge of issuing tropical cyclone advisories prior to the system being named as a tropical cyclone and that were challenges as people do not usually react to these warnings.

2.1.19 The meeting noted the challenges faced by member countries in increasing the profile of hydrological services, in particular flood forecasting. Support from the national government to hydrology/flood forecasting is minimal, and the profile remains low. The meeting also noted that in member countries, flood forecasting is not a unit of the national met service, and there is a strong need for changes in institutional arrangements, moving hydrology units/flood forecasting to the National Met Service. The members request support for this, noting the example from Fiji and Samoa. The meeting noted that such institutional change will allow for progress, improvement and strengthening of hydrology/flood forecasting.

3 Review of the 2014/2015 and 2015/2016 cyclone seasons

All the presentations are available on the following website
https://www.wmo.int/pages/prog/www/tcp/TCC-16-DOCPLAN.html

3.1 RSMC Nadi

Summary of the Cyclone Seasons 2014/15 and 2015/16 - Activities inside RSMC Nadi's area of responsibility

3.1.1 The 2014/15 Tropical Cyclone Season was an average season for the Southwest Pacific region. The season started as a warm neutral season with an El-Niño building up to the later part of the season. A total of 15 significant tropical disturbances were monitored, of which 6 attained tropical cyclone status, 5 of which were named by RSMC Nadi and the remaining tropical cyclone was named by Brisbane TCWC before entering into Nadi AOR. 2 of these tropical cyclones attained Hurricane intensity, 2 attained storm force intensity and the remaining 2 attained Gale force intensity. *Niko* developed to the far east, *Reuben* developed along the 180 meridian while the remaining 3 systems developed to the west of the International Dateline. *Solo* and *Reuben* spent their entire lifetime over open waters, the associated heavy rain and strong winds affected New Caledonia. *Pam* was the strongest system which developed in the season and made landfall in Vanuatu as a Category 5 tropical cyclone with estimated sustained winds of 145knots. It caused a lot of damages to Vanuatu and resulted in 11 fatalities. *Pam* moved out of RSMC Nadi AOR into Wellington TCWC AOR as a Category 5 system. *Pam* weakened at a very slow rate and remained a Category 3 system when it moved to the east of New Zealand.

Interestingly, *Raquel* was the first system in recorded history to develop in the month of June. It formed in RSMC Nadi AOR before it moved into Brisbane TCWC, it was named by Brisbane TCWC before it recurved back into RSMC Nadi AOR.

3.1.2 The 2015/16 Tropical Cyclone Season was an above average and active season. Climatologically a strong El-Niño season was prevalent at the start of the season which gradually decayed towards the end of the season.

A total of 18 significant tropical disturbances were monitored of which a total of 8 attained tropical cyclone intensity. 5 attained Hurricane force intensity, 1 attained Storm force intensity while the remaining 2 system attained Gale force intensity. RSMC Nadi named 7 tropical cyclones, while TCWC Brisbane named *Tatiana* before it entered into Fiji AOR. While the developments of the systems were evenly distributed either side of the 180 meridian, majority of the tropical cyclones development within the 170ºE and the 170ºW. *Tuni* was the first system of the season. Though it remained over open waters, the associated active rainbands affected Samoa and Niue. *Ula* broke the record for being the longest system to be monitored, a total of 23 consecutive days. Similar to *Tuni,* TC *Victor* remained over open waters in between the Cook Islands and Niue. *Winston* was the fourth system and was also the most intense system in history ever to develop in RSMC Nadi AOR. *Winston* initial developed to the west of Fiji before entering and remaining in Wellington TCWC for a 24 hour period before recurving northeastward back into RSMC Nadi AOR. It affected Tonga twice, initially as a Category 2 system and only a few days later it affected Tonga again as a Category 4 system. *Winston* made landfall in Fiji as an intense Category 5 system with estimated 10 minute average winds of 160knots and momentary gusts to 210 knots. *Winston* caused a lot damages to Fiji with its intense devastating winds and also with the inundation of Fiji's coastal communities who live in islands affected. A total of 44 lives were lost and damages to Fiji's economy was estimated at USD1.4billion. *Zena* developed to the west of Vanuatu and caused some damages to Vanuatu before it tracked southeastward over open waters, passing very close to the southern islands of Fiji. *The* last system to be named by RSMC Nadi was *Amos.* It caused some damages to Samoa and American Samoa. *Tatiana* was the only system to be named by Brisbane TCWC which moved into RSMC Nadi AOR but continued to be named by Brisbane TCWC because

RSMC Nadi was monitoring *Winston.*

3.1.3 Some critical issues raised and requiring urgent actions include,

- The need for NMSs in the Southwest Pacific to upgrade their own synoptic observations network to required standards to support regional routine and severe weather forecasting needs;
- Urgent training workshops for forecasters on media skills;
- NMSs to engage in open dialogue as well as provide feedback to RSMC Nadi on operational matters during cyclone events;
- Capacity development in SIDs through short attachments of personnel or formal exchange of skills/tools between SIDs and our developed counterparts,
- WMO to develop competency standards for Tropical Cyclones and
- also the need for active engagement in the area of Tropical Cyclone genesis and how it responds to its environment noting the well-established El-Niño season which occurred in the 2015/16 season.

Comments

3.1.4 The Committee discussed about the continuity in the issuance of the warnings, in case of weakening of a TC, or when a TC tracks from an AOR to another. The Committee discussed a specific request from Tonga whether it would be possible or relevant for RSMC Nadi to issue more frequently TC location satellite fixes to match the population requirements to have more regular warnings considering the availability of 10 minute Himawari satellite imagery. The current advisories being issued my RSMC Nadi is 6hrs apart and is not adequate for use of centers doing their own forecasts such as Tonga, Samoa, Vanuatu and Solomon Islands.

3.1.5 The Committee discussed about the contingency plan between Fiji and New Zealand. The Committee has been informed by RSMC Nadi that before the cyclonic season, there is an exchange of correspondence by email to confirm contact details and addressing, and when there is a hand over between centres the warning specifies who will be issuing the next warning.

3.1.6 The Committee discussed about the communication being a main issue and considered the possibility a staff from the TCC Members could assist the RSMC Nadi for the workload.

Recommendation

3.1.7 Following the report of RSMC Nadi and a discussion of contingency plans between Fiji and New Zealand as outlined in Attachment 6A of the Operational Plan, the TCC recommends that a backup test be performed by TCWC Wellington for the purpose of confirming product delivery to other member countries as would be expected in a backup scenario. Further, consideration should be given to performing a backup test annually.

Development of RSMC Nadi

3.1.8 RSMC Nadi has through the years continued to develop and improve its infrastructure, foremost through the support of the Government of Fiji and also through other agencies who provide support for specific programs in FMS. Since 2012, the Government of Fiji has invested approximately FJ$16m. to various capital projects and infrastructure developments for FMS. This projects a mostly aligned to the role of FMS but more importantly to enhance its role as a WMO designated RSMC from tropical cyclones in the southwest Pacific.

3.1.9 RSMC Nadi also recognized the efforts of other agencies who have provided assistance

through programs. In particular, Japan International Cooperation Agency (JICA) who provided funding for various projects and infrastructure developments for RSMC Nadi to the amount of FJ$5,000,000.00

3.1.10 A detailed listing of the various projects are listed as Annex 3.I to this report.

3.2 Review of the Members

AUSTRALIA

3.2.1 During the 2014/15 Australian TC season, there were eight tropical cyclones in the region with seven of these reaching severe tropical cyclone intensity (category 3 or stronger on the Australian TC intensity scale). Severe tropical cyclone *Marcia* was noted as being a very significant system as it managed to rapidly intensify from a category 2 to a category 5 system within 24 hours on approach to the Queensland coast. The season marked the first instance where two severe TC's have made landfall in Australia within 24 hours of each other (*Marcia* – Qld, *Lam* – NT) since at least the start of the satellite era (1970). TC events during this season highlighted the fact that TC forecast intensity remains a challenge and that the communication of uncertainty is important when liaising with emergency services, media, stakeholders and/or the general public.

3.2.2 The 2015/16 Australian TC season was the quietest season since at least the start of the satellite era in 1970. Only three tropical cyclones occurred in the Australian region, well below the average number of 11. It was noted that there was some good collaborative work between Brisbane TCWC and Nadi TCC during the period where Nadi TCC was occupied with operations relating to severe tropical cyclone *Winston*. Tropical cyclone *Tatiana* moved into the Nadi TCC area of responsibility at the same time as *Winston* and the Brisbane TCWC worked with the Nadi TCC in issuing warnings for this system.

3.2.3 During the 2014/15 and 2015/16 tropical cyclone seasons, the Australian Bureau of Meteorology provided the following support products and services to other RA-V members, including:

- 171 Satellite Analysis Bulletins
- 62 Special Advisories for the Solomon Islands
- 1 Special Advisory for Indonesia
- Adhoc liaison with Port Moresby TCWC in the lead up to any tropical cyclone events

COOK ISLANDS

3.2.4 The Cook Islands had no cyclones that affected it in the 2014-15 Tropical Cyclone Season, although Tropical Depressions 14F on March 28-31 2014; 13F on April 20-27 2014 and 3F on 20-26 December 2014.

3.2.5 In the season 2015-16, although TC Victor was the only one that affected the Cook Islands, TCs Winston and Yalo were in their waters or close to their waters but did not affect them. Tropical Cyclone Victor generated to the northwest of Palmerston Island and moved southwards just to the west of the island. 23 SWBs were issued for the island but no severe damage was caused and no casualties were reported.

3.2.6 The Cook Islands has closely monitored the seasons with close collaboration with the Emergency Management Cook Islands and the Disaster Risk Management Team. The Seasonal Outlook Summary indicated a severe El Niño episode that could affect the Cook Islands. This prompted the DRM Team to do an awareness program for cyclones and for all of the Cook Islands.

FIJI

3.2.7 In the 2014/15 Tropical Cyclone Season, Fiji was spared from any direct effects of tropical cyclone activity. *Reuben* initially developed as a tropical disturbance to the east of Fiji and maintained a southward track thus passing to the far east of Fiji. It did not pose any direct threat to the country. However, other tropical disturbances and depression passed close to Fiji causing strong winds and localized heavy rain caused flooding in some parts of Fiji.

3.2.8 The 2015/16 Tropical Cyclone Season was a very active season for Fiji. *Ula* developed to the far northeast of Fiji and moved in a southwestward direction. It intensified in its movement and entered the Eastern part of Fiji (Lau group) as a Category 3. The damages incurred were minimal but the rain received from the system was beneficial to Fiji. While *Ula* was approaching Fiji, tropical depression *TD07F* moved over Vanua Levu then onto the central part of Fiji on the 1st of January. Near gale force winds and heavy rain was observed. This caused flooding of certain places and resulted in the loss of 3 lives.

3.2.9 In February, 2016 *Winston* made landfall in Fiji as the most severe Tropical Cyclone to make landfall in the WMO Southwest Pacific region.

Tropical Disturbance *TD09F* was analyzed to the far west of Fiji. It was subsequently named *Winston* when it was approximately 820km west-northwest of Suva. Initially it was moving in a southward direction but on 14th it turned northeastward. It passed to the south of Fiji later on 15th as a Category 2 system and affected Ono-i-lau, the southernmost island of Fiji. It moved out of Fiji's area into Tonga's area on 16th. Initially, *Winston* maintained its northeastward track but on early on 18th it changed slowed down in its movement and started to track westwards. It moved over Northern Lau group on 20th as a Category 5 system. The Vanua Balavu observation centre recorded sustained winds of 120 knots and momentary gust of 160 knots It made landfall towards the northeastern part of Fiji later on 20th and exited Fiji on later on 21st. Winston inflicted extensive damage on many islands and killed 44 people. Communications were temporarily lost with at least six islands, with some remaining isolated more than two days after *Winston's* passage. A total of 40,000 homes were damaged or destroyed and approximately 350,000 people, roughly 40 percent of Fiji's population were significantly impacted by *Winston*. Total damage from Winston amounted to FJ$2.98 billion (US$1.4 billion). The nation's government declared a state of emergency on 20 February which remained in place for 60 days.

During the later part of the season, a few tropical disturbances and depression came close to Fiji but did not not cause any damage to Fiji.

KIRIBATI

3.2.10 Kiribati covers a vast region in the Pacific and comprises of 33 small islands scattered few degrees north and south of the Equator. Although Kiribati located in a non-cyclonic belt but the islands are remain prone to impacts from the nearby systems (TC/TD/TS) from Northern and Southern Hemisphere.

3.2.11 During the last 2 cyclone seasons 2014/15 and 2015/2016 there are 2 TC related severe events Kiribati impacted from and that happened in March 2015 and January 2016. The first event occurred from Tropical Cyclone Pam developed in South Hemisphere and Tropical Storm Bavi in the Northern Hemisphere coincided with spring tide on 8th – 11th March 2015. Even though the Advisory information issued but Strong winds, heavy rain and big waves affecting islands caused critical damages to some islands particularly Arorae and Taman Islands in southern Kiribati. The public were complained that the information on expected impacts was not issued and they didn't expect to reach that extreme. The other event caused from Tropical Storm (TS) Pali from the Northern Hemisphere located north of Kiritimati (Christimas) Island in the far Eastern part of Kiribati which contributed to devastating impacts of waves affecting Kiritimati Island on the 9th of January, 2016 look lives of 4 people who on

wharf on that particular day. It is noted that impacts of swell, spring tide, wind waves and El Niño events are compounded together causing this extreme event ever experienced on Kiritimati Island. The advisory on the contributing factors are all issued but not reached Kiritimati island due to AM Radio communication issues between this island and capital island Tarawa.

3.2.12 Kiribati raised the need of supports to improve wave height, storm surges and inundation forecasting at a national level and establishment of reliable communication system to link Kiribati Meteorological Service (KMS) and RSMC Nadi or Honolulu in providing head up information on the possible impacts. KMS is now in an early stage of trying to localize the services in issuing public weather and warning on severe weather events and acknowledges support provided from RSMC Nadi and SWFDDP.

INDONESIA

3.2.13 Between 2008 (beginning of the JaKarta TCWC) until August 2016, three TCs have developed within the Area of Responsibility (AoR) of Jakarta TCWC; Durga, Anggrek, and Bakung. These TCs generally occurred in southwestern part of Lampung and Jakarta. Bakung was the latest TC to occur within the Area of Monitoring (AoM), in 2014. During its life time (11 - 13 December 2014), maximum winds reached 55 knots and pressure 998 mb.

3.2.14 To get the general overview of the impact of TC events to the weather condition over Indonesia. Jakarta TCWC attempted to make a graph of climatological events of TC within the AOR. During the season 2015/2016 -until the beginning of August 2016, 16 TCs had been monitored by Jakarta TCWC in the northern part of the AOM, and 2 TCs in the southern part of the AOM. From January to the beginning of August 2016, 5 TC events have occurred in Jakarta TCWC AoM; 2 TCs in the Southern part of AoM, and 3 TCs in the northern part of AoM. The very small number of TCs in the southern part of AoM in the beginning of 2016 could be explained by El Niño event.

3.2.15 To support the strengthening of TC forecasters skills, Jakarta TCWC has sent a forecaster to attend the international workshop / training associated to tropical cyclone organized by WMO, such as;

- The 10th Southern Hemisphere Training Course on TC and PWS, Fiji, Sept-Oct 2013.
- 8th International Workshop on Tropical Cyclones, Jeju, Korea, Dec 2014.
- RA V TCC for the South Pacific and South East Indian Ocean, Vanuatu, May 2014.
- 11th Southern Hemisphere Training Course on TC and PWS, Melbourne, Oct 2015.

3.2.16 Since BMKG has a limited funding to send forecasters to attend international trainings or workshops, BMKG try to planning the local training by inviting the experts in every year. In September 2015, Jakarta TCWC managed to hold a local TC training for internal forecasters. This training was aimed to refresh and strengthen the forecaster skills in TC operations in order deal with the coming TC season.

3.2.17 Around October-November 2016, BMKG plans to hold an event of Strengthening of multi-hazards risk assessment and early warning systems with application of the geographic information systems for Pacific Island Countries. This event is an outcome of the collaboration of BMKG with UN-ESCAP (Economic and Social Commission for Asia and Pacific). This project for participants from Pacific countries is planned to be held in BMKG Training Center Citeko Bogor (InaRTC), and to address the basic of GIS concept, multi hazard assessment, SOP of early warning system and information dissemination techniques.

3.2.18 To strengthen the capabilities of TC forecasters, BMKG still needs an additional

support from WMO for opportunities and funding to attend TC trainings or workshops. BMKG also needs support to get an easiness to invite the TC experts as lecturers for local training in Indonesia.

NEW CALEDONIA and WALLIS AND FUTUNA

3.2.19 Meteo-France New-Caledonia Met Service has defined a warning zone for New Caledonia for which special bulletins are issued (tropical cyclone and special marine bulletins). A cyclone warning zone has also been defined for Wallis-and-Futuna.

3.2.20 If a cyclonic system enters the cyclone warning zone and is forecasted to remain for a while, the Met Service recommends the Civil Safety Authorities to issue a pre-alert warning.

If a cyclonic system is forecasted to threaten or strike New Caledonia within 18 hours, the Met Service recommends the alert to be upgraded to level 1. Schools and businesses have to close and people are supposed to secure their housing and belongings.

If the system is within 6 hours of striking the territory, the alert switches to level 2 and the population must shelter in sturdy buildings.

The same system applies for Wallis-and-Futuna Islands.

3.2.21 The 2015/2015 season was less active than usual, especially across the Southwest Pacific basin with 3 phenomena observed in New-Caledonia area and only one in Wallis-and-Futuna area.

OLA

Heavy rainfall was observed (200 to 500 mm within 24 hours) and caused landslides. It was mainly located on the eastern coast of the main island and on the relief, and caused flash floods, cut roads and power outage. Values range from 150 to 300 mm in 48 hours. Gusts up to 100 km/h were observed, particularly in the far North.

PAM

Heavy rainfall was observed in the South of the main island but it was not exceptional. Gusts up to 130 km/h were observed on Maré Island. Damage was minor: some blown off roofs and power cuts.

SOLO

Heavy rainfall was observed. It was mainly located on the eastern coast of the main island and caused flash floods and cut roads. Values range from 100 to 200 mm in 24 hours. Gusts up to 90 km/h were observed, particularly in the far North.

3.2.22 The 2015-2016 Cyclone season took place during a strong "El Niño" phase. The cyclonic activity was focused on the centre of the basin. Note the unusual tropical cyclone tracks of Ula and Winston which had a very long life cycle. These two phenomena affected our two warning areas.

Four cyclonic phenomena crossed the warning zone of New Caledonia but these systems moved remotely enough and had no significant impact. Pre-Alert was only issued when severe tropical cyclone Ula and tropical cyclone category 2 Tatiana moved closer to New Caledonia.

No significant impacts were observed in New Caledonia.

Four cyclonic phenomena crossed the warning zone of Wallis-and-Futuna. Only severe tropical cyclone Amos generated some light impacts (high swell on the coast of Futuna, some gusts near 100 km/h in Wallis causing a significant power fail and uprooted trees).

AMOS

Amos was named on 20 April 2015 at 12 UTC by the RSMC Nadi and reached the stage of tropical cyclone cat. 2 on 21 April at 12 UTC, while about 240 km in the Northwest of Futuna. **Pre-alert** was issued. That same night, AMOS initiated a U-turn, to adopt a generally eastern track. On 22 April at 03 UTC, Amos became a severe tropical cyclone, 110 km in the Northeast of Wallis. **Alert 1** was issued. **Alert 2** was issued on 22 April at 07 UTC. Amos moved closest to Wallis Island during the night of Friday 22 to Saturday 23 April at a distance of 90 km in the North and reached its maximum intensity (average winds of 150 km/h and gusts up to 200 km/h). The strong wind extension was highly concentrated around the centre and, despite the proximity of the phenomenon, Wallis was not exposed to storm force wind.

During the day of Saturday, Amos kept tracking eastward and significantly accelerated its speed. Alerts was lifted on 23 April at 08 UTC.

3.2.23 It is noted that

- Both Dvorak analysis and tropical cyclone intensity forecast have been performed by New Caledonian forecasters since 2014-2015 tropical cyclone season.
- A new tropical cyclone track map has been produced since April 2016.
- A new high resolution (2.5 km) model, AROME, is available for New Caledonia region.

NEW ZEALAND

3.2.24 TCWC Wellington has tropical cyclone warning responsibility for the area from 25°S to 40°S between 160°E to 120°W. Besides the cyclone warning service, RSMC Wellington Lead meteorologists also perform the Severe Weather Forecasting and Disaster risk reduction Demonstration Project (SWFDDP) tasks including production of the South Pacific Guidance (SPG) charts that appear on the MetConnect Pacific website.

3.2.25 During the 2014/15 season, a total of four of the eight named tropical cyclones in the South Pacific and Coral Sea basins moved into the Wellington area of responsibility as a named system; Niko, Ola, Pam and Reuben. Of these, Pam was the most intense and crossed into the Wellington area as a category 5 severe tropical cyclone, before continuing southeast to pass close to the North Island of New Zealand producing strong winds, heavy rain and coastal inundation in some places.

3.2.26 During the 2015/16 season, a total of four of the eight named tropical cyclones in the South Pacific and Coral Sea basins moved into, or near the border of, the Wellington area of responsibility either as a named, or significant reclassified, system. These were; Ula, Victor, Winston and Tatiana. Ula was the most intense system that Wellington assumed warning responsibility for and Victor was the most impactful system on New Zealand as it passed very close to the east coast of the North Island after exiting the tropics. An interesting feature of Winston's track was a brief dip below 25°S into the Wellington area as a severe tropical cyclone before it moved north again – only the second time on record this has happened. RSMC Nadi retained warning responsibility during this time. Later as Winston approached Fiji as a category 5 system, RSMC Nadi and TCWC Wellington initiated a check message procedure to monitor communications in/out of Fiji. Eventually, Winston was handed over to Wellington as a category 1 system.

3.2.27 Further comments on systems that moved into the Wellington area during the 2014/15 and 2015/16 seasons, along with impacts on New Zealand, and updated position error verifications are provided in the full report from TCWC Wellington.

NIUE

3.2.28 Niue Meteorological Service (NMS) is the Tropical Cyclone Warning Centre for Niue. NMS issues weather forecasts on a daily basis through the Broadcasting Corporation of Niue (BCN) where it reaches all stakeholders and village communities. Dissemination of Tropical Disturbance Advisories follows the same process. In a case where there is a potential development of a disturbance into a cyclone NMS contacts and informs the Niue Disaster Council (NDC). The NDC is then activated and the decision on declaring the alert phases is made.

3.2.29 The Niue Disaster Council, the Core Group is set up in a way that is easier to make decisions at the top level especially in considering the TC briefing from the Met Service. The Core can call another meeting that will involve the Director Generals of Infrastructure, Social Services and Natural Resources to take action. Keeping in mind those Departments would have activated their own Disaster Plans prior and not having to wait for the alerts. Blue Alert is issued to state there is a cyclone nearby and to be prepared. Met Staff will start their 24 hour shift work including the BCN. When a yellow alert is issued, schools are closed, tourists are evacuated to a safer location and all public functions are cancelled. Consideration is taken for basic utilities to be turned off. A red alert is issued when it is certain that the Cyclone will directly hit and this means Telecoms is on lock down, Police, Niue Fire Rescue and Outside Service is on Standby.

3.2.30 NMS received 63 TD Summary and 73 TD (Tropical Disturbance) Advisory. Five cyclones passed close to the vicinity of Niue and one severe cyclone for the 2014-2015 Season, TC Pam. There was no direct hit from the five cyclones on Niue. There were 16 tropical systems in the area. Tropical Disturbance systems TD 01F and TD 08F affected Niue. Tropical Pacific Ocean El Niño-Southern Oscillation (ENSO) was neutral around this time. Climate models suggested persistence of neutral indicators over the Pacific Region. An El Niño situation for Niue can bring dry periods or drought and few cyclones but noting the intensity can be high. The TD systems that affected Niue were TD O1F and TD 08F for the 2014-2015 TC Season. TD 01F brought 107.mm of rain over Niue on 23rd November 2014. This was the highest daily rainfall for the year 2014. TD 08F was nearest to the island at about 583 kilometers to the northwest of Niue on the 27th January, and posed no threat to Niue.

3.2.31 Tropical Cyclone Season 2015-2016 captured five cyclones within the Pacific Region and was close to Niue, but no direct hit. Tropical Cyclone Tuni's closest position to Niue was 114 km northeast of Niue at 7am, Sunday 29 November 2015 and on this day it recorded its lowest pressure of 997.8hPa at 2am, the highest average wind speed of 69 kph at 2am and strongest wind gust of 106kph. The total rainfall from the 27 – 29 November 2015 from TC Tuni was 77.6mm. Two phases of the alert was issued from blue to yellow alert. There was vegetation damage, heavy swells on the west coast, and battening up of houses and buildings was a response coordinated by the NDMO.

Tropical Cyclone Ula's (Category 3) closest position was 182 to the NNW of Niue at 7pm, Thursday 31 December 2015. The lowest pressure was 1000 hPa and strongest winds gust 70 kph. There was not much rain produced from this cyclone and as a result only 28.4 mm from 28 December to 1st January 2016. Blue Alert was issued.

Tropical Cyclone Victor (Category 3) was closest to Niue 275km northeast of the Island at 7am, Wednesday 20 January 2016. The lowest pressure was 996.1 hPa at 5pm, Tuesday 19 January 2016, the strongest wind gust of 74 kph at 3pm on the same day. Rainfall captured was low 23.9mm from 15 to 20 January 2016. Blue alert and yellow alerts was issued. The damaging heavy swells and high seas caused coastal damage on the eastern coast of the island.

Tropical Cyclone Winston's (Category 3) closest position was 230km northwest of Niue at 4pm on Tuesday 16 February 2016. The lowest pressure was 995.4hPa at 3.40am on Wednesday 17 February with the strongest wind gust at 87 kph. Rainfall for the period from 16-18

February was 101.8 mm. The Blue Alert and Yellow Alert were issued.

Tropical Cyclone Amos (Category 3): No alert issued, but Niue Met Service continued to monitor the system. The NDMO advised the general public and reemphasized the notice sent out by NMS of TC Amos in the area. Amos was predicted to move towards Niue by the JTWC and RSMC Nadi including reports on the media. This did not eventuate. RSMC Nadi removed Strong Wind Warning (SWW) over land areas for Niue in the weather forecast for Niue, but maintained a SWW for Marine areas. A strong high pressure system to the south of Niue pushed the system away from the island and maintaining it NE of the island. NE-East coast sector experienced moderate winds and moderate-heavy swells. Local winds maintained at 15 to 20 knots.

3.2.32 Niue Meteorological highlighted the need of extra computers for the use of forecasting and cyclone warning dissemination and including 2 monitors. The current status is that only one computer is used to disseminate weather warnings and disseminate Metars and Synop observations. This is an issue during the TC Season when having to multitask between the different operational responsibilities and having to accommodate this through the use of one computer. There is a need for better resolution of the NOAA Satellite imagery. There is also a need for better forecasting in high seas and storm surges during TCs.

3.2.33 NMS acknowledged the services provided by RSMC Nadi during the two cyclone seasons. Including the guidance of the Met Connect tool under the SWFDDP and the support and training programs provided by the Pacific Desk Training, COSPPac-BoM, JICA and WMO.

PAPUA NEW GUINEA

3.2.34 In 2014/2015 season Tropical Cyclone Nathan formed in the Coral Sea on 21 March 2015 and reached category 3. The combined but indirect effect from other systems, TC Pam east of Nathan, Typhoon Bavi across the equator near Guam and Olywn in the eastern Indian Ocean enhanced northwest monsoon surges across Papua New Guinea. The Port Moresby TCWC issued storm wind warnings for Central, Milne Bay and West New Britain. There was substantial damage of Oil Palms costing several millions of dollars in the West New Britain Province.

3.2.35 In 2015/2016 season, there were no tropical cyclone activity in Port Moresby's area of responsibility, however, several Gale warning were issued during the peak of the Season (January & February and during the SE Trade season (June – August).

3.2.36 In 2014-2016 PNGNWS participated in the number of training and thank WMO, JMA, Australia, Pacific Desk and SPREP for the continued support.

3.2.37 During the period 2014-2016, number of installations took place; the Himawari 8/9 Satellite Receiving system became operational in February 2016 and under the Recurrent Budget Funding, Internet link was upgraded to 2mbps. Government made some funding available to address the Rabaul Queen Inquiry COI and Recommendations and Mini Diagnostics Report on the status of the PNG National Weather Service Report and Recommendations and to upgrade its Communications and Data Centre facilities. LRIT, RANET, Chattee Beetle and HF email options to be considered for last mile remote communications.

3.2.38 Preliminary Assessment has been completed by RIMES for establishment of country's multi-hazard early warning centre and the RIMES Sub Regional Hub for the Pacific in Port Moresby, Papua New Guinea. This is consistent with RIMES overarching goal for delivery of

RIMES programs, products, and services (figure 1) through its Sub Regional Mechanism, RIMES Sub-Regional Center for the Pacific is being established in Papua New Guinea and shall cater for different needs and demands of RIMES Member States in the Pacific Region for provision of early warning services for enhanced disaster preparedness, response to, and mitigation of natural hazards. Specifically, the Sub-Regional Center shall:

1) Facilitate establishment and maintenance of observing and monitoring networks that are of significance to the Pacific region, to ensure data availability for early warning purposes;
2) Downscale RIMES products to make them relevant to the countries in the region;
3) Customize RIMES tools according to national and local contexts of countries in the region;
4) Undertake research and development for delivery of cutting edge technologies that are low-cost, efficient, and appropriate for the countries in the region;
5) Build capacities of early warning information generators in the countries on new products, tools, and technologies; and
6) Enhance capacities of national systems in the region to respond to early warning information of different lead times at national, sub-national, local, and at-risk community levels, within each national early warning framework.

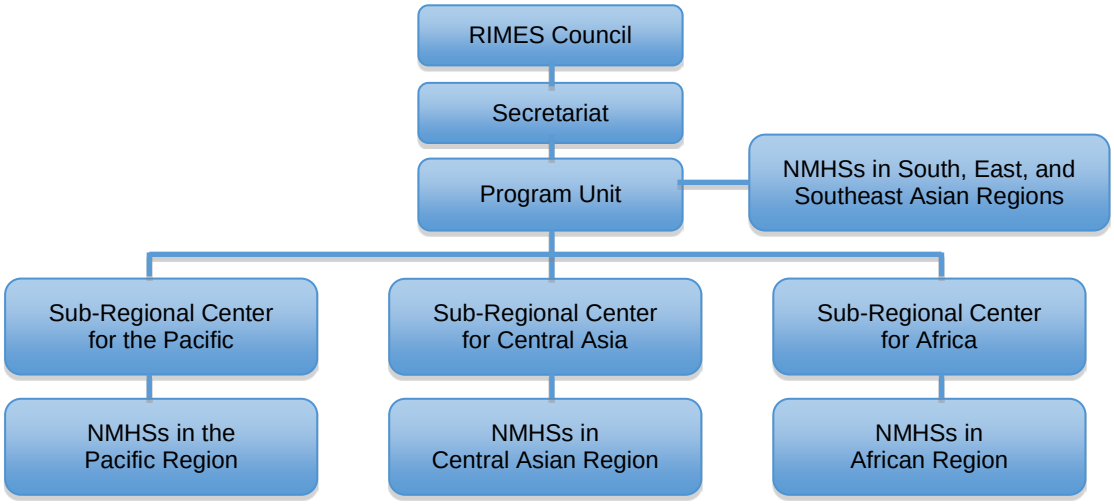


Figure 1. Institutional setup for delivery of RIMES programs, products, and services

SAMOA

3.2.39 The Samoa Meteorological Division (SMD) contains its own Standard Operation Procedures (SOPs) to be followed for TC Operation. The Samoa Meteorology Division (SMD) is responsible for producing of a TC outlook before every TC season starts. This is part of the Samoa Early Warning System (EWS). SMD also considers TC outlooks from other Centers (BOM, NIWA, RSMC Nadi).

3.2.40 There were 5 named storms developed within the South West Pacific region for the 2014/2015 season and 10 for the 2015/2016 season. For the 2014/2015 Season SMD through the EWS predicted elevated cyclone activity for Samoa. Two or more named cyclones were predicted to interact with the Samoa islands during the season, from 01st November 2014 to 30th April 2015. The outlook was based on statistical analysis of historical TC events that have occurred in similar ENSO conditions

3.2.41 For the 2015-2016 season, SMD predicted an elevated risk of 2-3 cyclones that can cross the 400km circular diameter of Samoa. Based on analogue historical tropical cyclone data, for the existing El Niño Southern Oscillation (ENSO) conditions, at least 1-2 tropical cyclones was predicted on Category 3 (mean wind speeds of at least 118km/h or 73 miles/h) with a possibility of a Category 4 (mean wind speeds of at least 159km/h or 98 miles/h) or even stronger (Category 5) . Again the outlook was based on statistical analysis (analog

approach) of historical tropical cyclone events that have occurred in similar ENSO conditions.

3.2.42 Three (3) Tropical Depressions (TDs) that influenced the weather of Samoa during the 2014-2015. They (TD01F, TD05F, TD08F) brought heavy rain and strong winds. SMD issued Heavy rain warnings, Wind advisories, Coastal water advisories, Coastal Flood Advisories while these TDs were in the vicinity of Samoa.

3.2.43 Four TCs influenced the weather of Samoa during the 2015/2016 season (TC Tuni, TC Ula, TC Victor and TC Amos). As a result of these storms, SMD issued 10 SWBs for TC Tuni and 12 SWBs for TC Amos while the normal routine advisories and warnings issued for the other two TCs.

3.2.44 SMD managed a large network of surface observations. These include manned and automatic weather stations. These observations were used to justify and verify the advisories and warnings that issued from SMD.

3.2.45 SMD forecasters access the predictability skill of models been used for TC operation during the last two TC season. It was found that ECMWF EPS is more skillful than the other EPS in predicting both the location and intensity of TCs. It was also found that the deterministic provides more accurate forecasts during the first 3 days on average. For each EPS system, its mean forecast is considerably the most skillful and more accurate forecast compared to the deterministic and the control forecast

3.2.46 Challenges faced by SMD during the past season include the accuracy and timeliness of forecasts, good collaboration and coordination with relevant partners, the need for more research to address some of the unexplained nature of TCs. Having an effective early warning system is highly recommended, not only in collaboration with relevant agencies but also the dissemination of information.

3.2.47 SMD acknowledge the WMO, RSMC Nadi, Met Service NZ (Met Connect- SWFDDP), Global Centres and Regional Met services for their contribution to the TC operation during the last TC seasons.

SOLOMON ISLANDS

3.2.48 During the 2014/2015 cyclone season, the Solomon Islands experienced the effects of three cyclones namely Cyclone Pam, Cyclone Solo and Cyclone Raquel.

Tropical Cyclone Pam
Severe Tropical Cyclone Pam of 2015 was the most intense tropical cyclone in the Solomon Islands in 2015.

Pam formed on March 06th east of the Solomon Islands and tracked slowly in a generally southward direction, slowly intensifying as it did so. Two days later, the disturbance reached tropical cyclone intensity and, over subsequent days, Pam gradually strengthened before reaching Category 5 cyclone status.

Severe Tropical Cyclone Pam slowly developed from gale to storm and hurricane force winds over Anuta and Tikopia on the 10th March 2015 while travelling from position approximately 117nm north-northeast of Anuta on a South–Southeast Track at 04 knots towards Anuta.

The cyclone had varying speeds of movement ranging from 02 to 09 knots and in a general southerly track. Severe Pam developed to category 5 before reaching Vanuatu and leaving widespread damages on in the Temotu province Outer-islands of Anuta ,Tikopia and Duff Islands which experienced hurricane force winds as the Tropical cyclone intensifies and finally moved out of the Solomon Islands waters. Tropical Cyclone Pam brought widespread heavy rain which caused flooding , strong winds and storm surges that impacted the provinces of Temotu and Malaita. More than 30,000 people have been affected with damages to fruit trees, vegetable gardens, agricultural crops, houses, water supply, infrastructure and communications to most provinces in Solomon Islands. People living near the coastlines were evacuated due to storm surges.

Although Anuta island in Temotu was the most affected, it is not heavily populated.

Tropical Cyclone Solo

Tropical Cyclone Solo developed within the monsoon trough during April 09th 2015. On the t10th April 2015 it was located approximately 182 nautical miles south-southeast of Rennell Island and tracking southwards at 14 knots.

At 2:00 am local time, Saturday 11th of April 2015, the Solomon Islands Meteorological Service issued a Tropical Cyclone Watch for Rennell & Bellona, Makira and Guadalcanal provinces. By 11:00 pm local time, Tropical cyclone Solo (category one) with a central pressure of 990 hP was re-located approximately 245 nautical miles south of Rennell Island.

At 5:00 am on the 11th of April 2015, tropical cyclone Solo (category two) with a central pressure of 989 hP was located approximately 284 nautical miles south of Rennell Island and so the Solomon Islands Meteorological Service cancelled all watches as the cyclone moves further away from the southern Solomon Islands.

The impacts of Cyclone Solo was only felt in the Makira Province. In Marou bay, Makira - Ereteria river was flooded on Tuesday 7th April and uprooted food gardens , bananas and cocoa.

Flash flood has also destroyed food garden and even rushed in the villages of Puira to Macedonia in the Makira Province.

Also in Makira land slide caused by heavy rain impacted Haura Community High/ Primary School. The school of 186 students and 10 Staff members suspended classes for 2 days due to this impact.

Tropical Cyclone Raquel

Tropical Cyclone Raquel was one of the short-lived tropical cyclones and formed as a tropical low on a persisting trough north of the Solomon Islands towards the end of June 2015 and become a named cyclone on the 01st of July 2015. The tracking of this cyclone was quite difficult due to no proper steering flow and also moving very slowly.

This Tropical Cyclone is one of that developed well outside the cyclone season since 1958.

Tropical Cyclone Raquel developed gale force winds of 34 to 47 knots about the Malaita, Isabel, Western, Central and Guadalcanal provinces during Wednesday 01st of July 2015. Tropical Cyclone Raquel impacted Western, Choiseul, Isabel, Malaita, and parts of Central and Guadalcanal.

Tropical Cyclone Raquel was downgraded to a Tropical Low with a centre pressure of 1000 hpa while located approximately 52nm south of Ontong Java Atolls.

<u>Impacts</u>

In the western province the house roof of the Western Province Premier was partly removed by strong winds. A bridge was rooted by flood due to heavy rain while two buildings reportedly destroyed by landslide in Chupikopi, Marovo; and gardens were destroyed.

In Malaita and Guadalcanal Provinces coastal flooding destroyed swamp taro gardens damages to fruit trees, vegetable gardens, agricultural crops and dwelling houses. Similar damages were also experienced in the Isabel and in Choiseul province one person died due to a fallen coconut tree.

3.2.49 During the 2015/2016 TC Season, the only notable depression was 07F when a tropical low formed within a active monsoon trough. Strong winds, rough seas and high swells battered most parts of the country. As a result a Anglican Priest, his son and another friend died when their outboard motor capsized and they perished in rough seas and high swells.

TONGA

3.2.50 In general the Tonga's cyclone season 2014-2015/2015-2016 had brought many effects on several islands over the group especially from damaging storm surges, heavy damaging swell, strong winds, gale strong and hurricane force winds. Six TCs crossed over Tonga's boundaries/area of responsibility. During these TC Seasons, all were develop and crossed Tonga waters which are not unprecedented but of course a clear evidence of the enhanced activity brought about by El Niño. The 2015-2016 TC Season surpassed the previous record for most cyclones for Tonga which was the 5 tropical cyclones during the 1972/73 season.

3.2.51 Highlights & Discussions of TC Events during TC Season 2014-2016:

TC Tuni:

FTWC was activated at 10pm, 27th Nov. 2015 and deactivated at 5pm 29th Nov. 2015; A total of 10 Tropical Cyclone Advisories/Bulletins.The strongest winds estimated was 30KTS gusting 50KTS from the East between 12:00AM and 4AM on 29 November 2015 and the lowest observed central pressure was 994hPa at 0400AM the same morning all reported from Niuatoputapu. Both Niuatoputapu and Niuafoou stations provided hourly reports on 28-29 November 2015*Sev. TC Victor:*

Notable damages during the passage of TC Victor was being evident over the islands of Ha'apai group of which destructive storm surges and heavy damaging swells affected the causeway connecting islands in this group as well severe coastal inundation along the coastal areas.

Sev. TC Winston:

Warnings:

The Fua'amotu Tropical Cyclone Warning Centre (FTCWC) was activated at 04:00pm local time,15th February, 2016 and was deactivated at 11:50pm local time, 20th January 2016. A total of 36 Tropical Cyclone Advisories was issued from the FTCWC

Media Releases:

A Total of 7 media releases was also issued and distributed to all media outlets and was within the ministry's information portal also posted on the Tonga Met Services website and facebook page.

3.2.52 To summarize the works and activity done during the TC Seasons 2014-2015/2015-2016, the Tonga Meteorological Services has shown improvements and generally responded well to the general public and other relevant stakeholders through the services it provides such as the consistent collaboration and interactions with the National Disaster Management Office and Committee, live crossover interviews with local media and radio stations, the dissemination of information via the internet, radio and social media.

3.2.53 In addition the above, was the constant and consistent weather briefing and discussions being carried out between forecasters during their respective shifts. Some of the communication challenges still faced during TC events still relates to internet connectivity during operation events. There is also a need for more TC Module software as a need for NADI RSMC to provide more regular fixes of tropical cyclones as advisories currently issued is only once every 6 hours.

TUVALU

3.2.54 The 2014/2015 season Tuvalu affected by 2 un-named and 1 named tropical systems. The 2 un-named systems have an impact of strong winds leading in issuing "strong wind warnings" for the group; strong winds threshold of 20knots or more due to our low elevation. TC PAM developed between Tuvalu and Solomon Islands and later named TC PAM as slowly drifting down south towards Vanuatu. TC PAM located far away from Tuvalu, yet, we still affected by its trails of strong winds, heavy rainfall and storm surges 2 – 5m reaches our coastlines, caused significant damage to agriculture and infrastructure on all islands. Water supplies were contaminated by seawater and hundreds of people were temporarily displaced, food crops, boat ramps were damaged and boulders, coral and other debris were deposited inland. Significant land losses due to coastal erosion and most islands experienced sea encroachments as much as 20 – 50m. As a results, our Government issued a State of Emergency from 14th – 27th March 2015. The economic impact of TC Pam is estimated to be well above 25 percent of 2015 projected GDP.

3.2.55 The 2015/2016 season experienced a number of tropical systems forming near our waters as they develop and move southward, yet, trails from these system continue to affected our atolls. TC Ula which develops near Samoa and reaches Category 4 intensity has the severe impact on Tuvalu before Christmas till New Year. We issued a Gale warning after New Year as winds intensify with maximum gust reached 46knots. Some household roofs were blown off, uprooted trees; wreck one fishing boat and even blown off part of our Met office roofing. No casualties with minor damages.

3.2.56 Need more improvement in communication for effective delivery of forecast & warnings. More work needed in explore and understand on storm surges and their impacts. Coastal inundation modelling and forecasting may significantly guide in provide good decision making, early response and in saving lives and properties.

VANUATU

3.2.57 The TC Season for 2014 – 2015 was expected to be average. A total of three systems affected Vanuatu.

TC Ola (30 Jan – 01 Feb 2015)

Tropical Cyclone Ola started as a tropical low on the 30th of January 2015 roughly 740 km west of Malekula Island. The system travelled in the east southeast direction and moved into Vanuatu area at 11:00 am on the same day. At this time, a severe weather warning for heavy

rainfall and flash flooding is forecast for the northern and central Vanuatu. By 11:00 am on the 31st January 2015, the system was name. 11:00 am on the same day the system was upgraded to Cat2 and on the 1st of February the system moved away from the Vanuatu Area of responsibility. The Vanuatu Tropical Cyclone Warning Center (VTCWC) issued 6 information, 3 advisory and 9 forecast tracks.*Severe TC Pam (9-14 March 2015)*

Severe Tropical Cyclone Pam initially developed as a low pressure on the 6th of March 2015 some 800km northeast of Torres group. Pam was named at 6:00 pm on the 9th of March 2015. The first information was issued on the 10th of March 2015 and the first Advisory was issued at 6:00 pm on the 10th of March 9am, on the 11th of March 2015, the first warning was issued for the northern provinces. Pam intensified to CAT 4 system at 11am, on the 12th of March 2015. It became a CAT 5 system at 11am and on the 13th of March.

VTCWC started issuing hourly warnings from an original three hourly warnings as of midday on Friday the 13th of March 2015. As TC Pam was leaving Efate Island, it took a south-southeast direction. It made landfall on the island of Erromango at 5:00am on the 14th of March 2015. At 8:00am the following morning on the 14th of March 2015, it was approximately 20 kilometers west of Tanna. The last warning on the system was issued at 8:00pm on Saturday the 14th of March 2015. A total of 1 Information, 3 advisories, 48 Forecast Track Maps, 47 Warnings and 38 SMS warning Messages were issued.

Severe tropical cyclone Pam caused widespread and severe damage over central and southern Vanuatu. MALAMPA province, on the island of Paama, 50 - 90% of the buildings were destroyed. SHEFA province on Shepherd islands, 60 to 70% of houses were destroyed. Still on SHEFA province particularly on Efate Island, 70% of the buildings were destroyed. In Port Vila, 70% of the buildings were destroyed, water supply was out for a day in most areas, and electricity was out for a period of at least four days. Over TAFEA province, in particular Tanna and Erromango islands, between 80 to 90% of the buildings were destroyed. In total there were eleven (11) lives were lost during the passage of the Cat5 Severe Tropical Cyclone Pam. The damage caused by Pam amounted to US$449.50 million (VT 48.5 billion).

TC Solo (10 – 12 April 2015)

It is a hybrid of two low pressure systems that form over PNG and Solomon Seas. On the 10th of April 2015, the central pressure drop to 996hPa as it turned into a tropical cyclone. Tropical Cyclone Solo entered Vanuatu area on the 11th of April 2015 and was some 630 KM west southwest of Santo. The information bulletin was upgraded to advisory bulletin at 8:00 pm on the 10th of April 2015, at this time it was name TC Solo (Cat 1) and is about 730 KM west southwest of Torres Islands with its central pressure estimated at 996 hPa. By 09:52 pm on the 11th of April 2015, Tropical Cyclone Ola was upgrade to Category 2. At 6:03 pm on the 12th of April 2015, a final information was issued as Tropical cyclone Solo, (997 hPa) dissipated and moved away from the Vanuatu area of responsibility. A total of 4 information, 15 advisory bulletins, 19 forecast tracks issued during the passage of TC Solo.

3.2.58 The TC Season for 2015 – 2016 was also expected to be average. A total of three systems affected Vanuatu.

TC Ula (8 -10 January 2016)

Tropical Cyclone Ula formed south of Fiji Islands and rapidly reached Cat 3 as it moves south then northwest towards Vanuatu. Tropical Cyclone Ula entered VAoR at 11:00 am on the 8th of January 2016 as a Cat 2 system. TC Ula intensify to Cat 3 at 5am on the 9th of January 2016. The first Tropical Cyclone advisory bulletin was issued at 11am on the 9th of January 2016. The TC bulletin was upgraded to warning phase at 3 pm in the afternoon on the 9th of January while Ula was still a Cat 2 cyclone. The system was upgraded to Cat 4 at 5am on the 10th of January 2016 after which it move away from VAoR. A total of 3 information, 2 advisory, 14 warning bulletins, 20 forecast tracks and 8 SMS were issued during the passage of of Ula.

Severe TC Winston (10 – 23 February 2016)

Tropical Cyclone Winston started as a tropical low east of Vanuatu on the 10th of February 2016 within Vanuatu area of responsibility. TC Winston was named on the 11th of February 2016. It intensified on Friday the 12th of February and became a Cat 2 severe tropical cyclone by 5:00pm and then a Cat 3 only six hours later as it moved south southeast. It left Vanuatu area of responsibility as a cat 3 system on the 13th of February 2016 at 5:00 am VUT. Winston continued and re-entered VAoR again as Cat 5 system at 11 am, on the 21st of February 2016 at least 13 days after leaving VAoR. It continued to move west as a Cat 5 system and gradually turned south and southeast at 5am on the 23rd of February 2016. Severe Tropical Cyclone Winston continued to moved southeast as a Category 3 cyclone and left Vanuatu area at 11am on the 23rd of February 2016. A total of 9 information, 3 advisory, 5 warning bulletins, 17 forecast tracks and 7 SMS were issued during the passage of TC Winston.

TC Zena (5 – 6 April 2016)

This system starts as a Tropical Low formed some 305 kilometers west of TORBA province on the 5th of April 2016. The first information on the system was issued at 11:34am on the 5th of April. Vanuatu Tropical Cyclone warning center issued severe weather warning for heavy rainfall for northern and parts of central Vanuatu. 6 hours later, the information was upgraded to warning as it headed east southeast with rapid development. It became a tropical cyclone and named tropical cyclone Zena Cat 1 at 12:00 am, on the 6th of April 2016. Damaging gale force winds of 70 to 90 km/h were experienced over SANMA, PENAMA and south of TORBA province. Tropical cyclone Zena was upgraded to Cat 2 at 9am on the 6th of April 2016 when it was 325 kilometers east southeast of Efate Island. It remained a Cat 2 system as it moved out of Vanuatu Area of responsibility at 11am on the 6th of April 2016. A total of 1 information, 8 warning bulletins, 9 forecast tracks and 2 SMS were issued during the passage of Zena.

Request

3.2.59 The meeting noted the comments from Tonga that there is an increasing need for Meteorological Services in the Regions to advise their Governments on the need to issue a state of emergency before impact to mobilize resources for early response. Particularly for Severe Tropical Cyclones. considering the importance of impact forecasting and interests from the user community requested that such criteria and guidance be considered and developed by the Tropical Cyclone and DRR Programs of WMO for consideration to guide National Tropical Cyclone Warning Centers and Disaster Management Offices to provide this advice which could lead to better preparedness and safety of life and property.

4 Coordination within the WMO Tropical Cyclone Programme

4.1.1 The Committee was informed by the WMO Secretariat that the 17th WMO Congress endorsed/approved the TCP Programme to arrange and take necessary actions particularly for the following:

- to expand and consolidate further the regionally coordinated systems to cover all Members prone to tropical cyclones;
- to enhance the capacities of Members to provide more accurate forecasting and warning services which are impact-based and in multi-hazard approach (which was also a decision of EC-66);

- to improve forecasting and warning capabilities of Members through advances in sciences and technologies, and capacity development; and
- to reduce damage and loss of lives through the above institutionalized activities and arrangements, and in step with the developmental goals of the Sendai Framework.

4.1.2 The Committee was further informed by the WMO Secretariat about decision made by the 68th session of WMO Executive Council (EC-68). Under the initiative of the Tropical Cyclone Regional Specialized Meteorological Centres (RSMC)/TCWC, and in collaboration with Members with experience in impact-based tropical cyclone forecast and warning services, new products be developed and corresponding training opportunities be provided to assist Members in accelerating their implementation of impact-based tropical cyclone forecasts and warnings.

The document of the EC-68 (15-24 June 2016) regarding tropical cyclone forecasting is available at http://www.wmo.int/pages/prog/www/tcp/TCC-16-DOCPLAN.html

4.1.3 The Committee was informed that TCP activities during the inter-sessional period were mainly focused on following aspects:

- Training and Capacity Development
- Support to Operational Forecasting
- Global and Regional Coordination of Forecasting Services
- Storm Surge Services

4.1.4 The Committee was informed that the scope of activities of the regional Tropical Cyclone Committees had been expanded through involvement with the WMO's cross-cutting projects such as the Severe Weather Forecasting Demonstration Project (SWFDP), Coastal Inundation Forecasting Demonstration Project (CIFDP) and Disaster Risk Reduction projects for Early Warning Systems in Regions I, II, IV and V. The Committees' annual/biennial sessions serve as venues for information sharing for the projects and their technical plans have incorporated collaborative actions with those projects. Wider cross-cutting project coverage is further needed to reach all the Member countries of the regional TC committees. In addition, a synergistic relationship with other UN agencies and international/regional entities has also been developed.

4.1.5 The Committee was presented by WMO Secretariat about the outcomes and recommendations from the 8th session of the Tropical Cyclone RSMCs/TCWCs Technical Coordinating Meeting (TCM-8, Miami, Florida, USA, 2-6 November 2015), the 3rd session of the International Best Track Archive for Climate Stewardship (IBTrACS-3) and the 2nd session of the International Workshop on Satellite Analysis of Tropical Cyclones (IWSATC-2), both in Honolulu, Hawaii, USA, 16-19 February 2016.

The full document is available on
http://www.wmo.int/pages/prog/www/tcp/TCC-16-DOCPLAN.html

Comments

4.1.6 The committee discussed the frequency of the TCC meetings and felt that there would be considerable advantages in meeting annually as is the case with equivalent meetings in northern hemisphere basins. Whilst the Operational Plan would not require review annually workshop activities around impact forecasting for example as well as discussions of projects operating in the region, would be of great benefit to Members.

Recommendation

4.1.7 The committee recommended that outcomes of the IWSATC should be circulated to RA V members as satellite analysis is the primary method used in inferring tropical cyclone intensity in the Southeast Indian and South Pacific Oceans. It is also recommended that RA V members with TCWC responsibilities should be invited to future IWSATCs.

5 Review of the technical components

5.1 Meteorological component

Full documents available @
http://www.wmo.int/pages/prog/www/tcp/TCC-16-DOCPLAN.html

Global Observing System

Regional Basic Synoptic Network (RBSN)

5.1.1 The Regional Basic Synoptic Network (RBSN), being a minimum regional requirement to permit members to fulfill their responsibilities within the WMO World Weather Watch (WWW) Programme, continued to provide a fundamental basis for weather analysis and forecast and for tropical cyclone warning services in Region V. The countries in the area of the RA V Tropical Cyclone Committee are contributing to the implementation of the RBSN by operating 352 surface and 74 upper-air synoptic stations. Overall, the status of observations implemented by these RBSN stations continued to remain stable at around 75% for surface observations (at the 4 main standard hours or more per day) and 90% for upper-air observations (at least one or more observations per day), as recorded in WMO Weather Reporting Publication No. 9, Volume A1 .

5.1.2 The Annual Global Monitoring (AGM)[2] provides information on the performance level of the observing and telecommunications systems. A summary of the analysis following the results of the monitoring carried out in October, 2013 and 2015, showing the availability of SYNOP and TEMP reports from the RBSN stations in the area of the RA V Tropical Cyclone Committee, are provided in the following table. It should be noted that although the availability of SYNOP reports from some areas was not yet satisfactory, the overall percentage of reports received had shown a marginal increase during the intersessional period. The overall availability of TEMP reports also increased slightly during the same period. It should also be noted that SYNOP reports were not received from Nauru or Timor-Leste (similar to 2013) during the 2015 monitoring period but that all expected reports were available from Tokelau in 2015 (no reports had been received in 2013), while no TEMP reports were received from Cook Islands or Nauru during both the monitoring periods 2013 and 2015, and Papua New Guinea reports were not received during the 2015 monitoring period.

[1] http://www.wmo.int/pages/prog/www/ois/volume-a/vola-home.htm
[2] Monitoring results see: http://www.wmo.int/pages/prog/www/ois/monitor/index_en.html

RBSN stations operated by countries in the area of the RA V Tropical Cyclone Committee
Annual Global Monitoring (AGM) of the Operation of the WWW, availability of SYNOP/TEMP data at MTN Centres (1-15 October 2013/2015)

Country/Area	Number of surface stations / % of SYNOP reports received				Number of upper-air stations / % of TEMP reports received			
	2013		***2015***		***2013***		***2015***	
Australia	128	81%	128	96%	35	45%	34	48%
Cook Islands	7	26%	7	61%	1	0%	1	0%
Fiji	12	79%	12	100%	1	97%	1	90%
French Polynesia	9	100%	9	99%	4	50%	4	50%
Indonesia	60	94%	59	99%	13	87%	13	99%
Kiribati	5	25%	5	59%	1	43%	1	47%
Marshall Islands	10	26%	10	22%	2	50%	2	62%
Micronesia, Federated. S	21	41%	21	40%	3	100%	3	100%
Nauru	1	0%	1	0%	1	0%	1	0%
New Caledonia	6	83%	5	100%	1	100%	1	100%
New Zealand	29	98%	29	100%	4	87%	4	86%
Niue	1	27%	1	30%	-	-	-	-
Palau	2	50%	2	50%	1	100%	1	100%
Papua New Guinea	11	28%	11	33%	2	50%	2	0%
Pitcairn Island (UK/NZ)	1	100%	1	100%	-	-	-	-
Samoa	7	28%	7	29%	-	-	-	-
Solomon Islands	5	82%	5	100%	-	-	-	-
Timor-Leste	2	0%	2	0%	-	-	-	-
Tokelau	1	0%	1	100%	-	-	-	-
Tonga	5	97%	5	100%	-	-	-	-
Tuvalu	4	35%	4	50%	1	40%	1	43%
USA (Islands-Pacific / American Samoa)	19	31%	20	30%	4	100%	4	100%
Vanuatu	6	99%	6	100%	1	20%	1	7%
Total	**352**	**73%**	**351**	**75%**	**75**	**61%**	**74**	**63%**

Aircraft-based observations

5.1.3 The WMO Aircraft Based Observing System, comprising the Aircraft Meteorological Data Relay (AMDAR) observing system[3] supplemented by aircraft based observations (ABO) derived from ICAO systems, now produces around 700,000 upper air observations per day on the WMO GTS, with the AMDAR system contributing the vast majority from 40 participating airlines and a global fleet of over 4000 aircraft. This important sub-system of the WMO Integrated Global Observing System produces both en-route and vertical profile (from AMDAR aircraft at airport locations) high quality, upper air data, that continues to demonstrate a significant positive impact[4] on global, regional and high resolution NWP and other forecasting and meteorological applications.

[3] http://www.wmo.int/pages/prog/www/GOS/ABO/AMDAR/index_en.html
[4] See : http://www.wmo.int/pages/prog/www/GOS/ABO/data/ABO_Benefits.html

5.1.4 While the WMO AMDAR programme has continued to grow, there has been no growth in the programme in recent years in WMO RA-V (Southwest Pacific).

Additionally, there remain large gaps in ABO/AMDAR over Central Asia and the tropical Southwest Pacific

5.1.5 This is despite the fact that there is ample potential for new development that would contribute strongly to improved upper air observations coverage over this region and, as a result, improved forecast skill and benefit to severe weather applications.

5.1.6 In line with a WMO Congress decision, the WMO Commission for Basic Systems (CBS) through its relevant work teams is currently working with WMO Regional Associations (RAs) to develop ABO and AMDAR strategy and implementation plans for each WMO region. This activity will be based in part on the results of a WMO study on airline capabilities for future AMDAR participation[5], which has identified the key target airlines that might contribute to AMDAR data coverage improvement over this region. The study identified 42 airlines with over 1500 aircraft capable of contributing to the AMDAR programme over the Middle East, Central Asia and the Southwest Pacific. The meeting might like to consider how support might be given to the relevant WMO RAs so as to encourage and foster further AMDAR programme development in the region, in the interests of improved monitoring and forecasting of regional severe weather systems.

Recommendation

5.1.7 The TCC recommends more information be provided on the collection method and criteria for report success to assist members investigate slippage or low figures. The TCC also recommends WMO consider more frequent reporting to members (beyond annual figures or bi-annual reports), and whether it is appropriate to report data this way given valid operational requirements for data collection and dissemination that may not fit the AGM criteria for success. TCC members are requested to check their station lists and reporting intervals lodged with WMO and to supply updates and/or comments to WMO as necessary.

Surface-based remotely-sensed observations

5.1.8 Of critical importance for severe weather and tropical cyclone monitoring and prediction are weather radar systems and the data and products derived from them. WMO and the Commission for Basic Systems (CBS) in partnership with the Turkish State Meteorological Service (TSMS) have continued to maintain the WMO Weather Radar Database (WRD[6]). The database now contains metadata for over 900 weather radar systems operated by 88 WMO member countries. This database is making an important contribution to the WIGOS Information Resource and the WMO Information System as a source of radar metadata and will be used in the near future to seed and maintain the OSCAR/Surface[7] system, which is now the repository for the metadata of all stations that contribute to WIGOS. WMO encourages its Members to continue to nominate WMO radar metadata focal points to ensure that all weather radars are included and routinely maintained and updated in the WRD.

5.1.9 Further in relation to weather radar systems, WMO and its technical commissions, CBS and the Commission for Instruments and Methods of Observation (CIMO) are working to strengthen the international coordination and standardization of weather radar systems through a range of initiatives and activities in relation to data processing and quality control and international data exchange. In particular, the CBS Task Team on Weather Radar Data

[5] See: http://www.wmo.int/pages/prog/www/GOS/ABO/AMDAR/resources/AMDAR_Coverage_Recruitment_Study.html
[6] http://wrd.mgm.gov.tr/default.aspx?l=en
[7] http://oscar.wmo.int

Exchange will meet again in the second half of 2016 and expects to significantly advance progress towards a WMO standard for radar data exchange. Also in 2016, work toward finalization of the results of the CIMO Radar Quality Control and Quantitative Precipitation Intercomparison (RQQI) is expected to be advanced. Additionally, WMO has recently (2015) formed an agreement with EUMETNET for cooperation on international weather radar activities. Future WMO international collaboration and coordination of weather radar systems activity, including data exchange and other standardization, will be focused within a new Inter-Programme Expert Team on Operational Weather Radars (IPET-OWR) currently being formed under CIMO and expected to meet for the first time within the next twelve months.

Marine and Ocean Meteorological Observations

5.1.10 The Observations Programme Area (OPA) of the Joint WMO-IC Technical Commission for Oceanography and Marine Meteorology (JCOMM), in 2015 developed a five year work plan (2015-2020), taking into considerations of observational requirements, observing systems performance monitoring, risk assessment etc. The observing system is proposed to meet both climate requirements, and the requirements of non-climate applications, including NWP, tropical cyclone prediction, global and coastal ocean prediction, and ocean forecasting and marine services in general. Detailed requirements are documented in the 2010 Implementation Plan of the Global Climate Observing System update (GCOS No. 138[8]).

5.1.11 In the past years, there has been some progress in the marine observing networks at global and regional levels. The observing system met 66% its global implementation targets by December 2015, a slight increase from last reporting period. All data are made freely available to all Members in real time. There are several observing networks that fully meet their implementation goals, such as surface measurements from Voluntary Ships (VOS), global drifting surface buoys, Argo profiling floats 100% completion[9]. The progress results from investment and efforts from Members/Member States, including in the WMO Regional Association V (RA-V), while sustainable investment is still needed to maintain and implement the observing systems target.

5.1.12 The global surface buoy network coordinated through the Data Buoy Cooperation Panel (DBCP) has now been sustained and stable (historical target of 1,250 drifters operational). The Implementation Plan of the Global Climate Observing System (2010) required to increase number of drifters carrying pressure sensors, and 57% operational drifters currently available for sea level pressure. The Seventeenth Session of WMO Congress (Cg-17, May-June, 2015, Geneva, Switzerland) urged Members to follow DBCP recommendations on vandalism prevention. Cg-17 also invited all Members to commit appropriate resources to the barometer drifters, and the tropical moored buoy arrays, with a view to support Members improving NWP. New technologies such as surface gliders also have the potential for contributing useful data to typhoon prediction.

5.1.13 DBCP conducted two training workshops for the Pacific Islands, first in May 2015 Palau[10], and second in May 2016 New Caledonia[11]. These workshops aimed to increase awareness of ocean processes, capacity of ocean observations, data collection, analysis, and applications for socio-economic benefits. The workshops actively engaged with Pacific Small Island States, and regional intergovernmental organizations (e.g. Secretariat of the Pacific Regional Environment Programme, SPRP, etc) to conceptualize a Pacific Islands Ocean Observing System for improved ocean observations and services against weather and climate related extremes.

[8] http://www.wmo.int/pages/prog/gcos/Publications/gcos-138.pdf
[9] http://www.osmc.noaa.gov/images/JCOMM_cartoon.pdf
[10] http://jcomm.info/PI-1
[11] http://jcomm.info/PI-2

5.1.14 The Argo profiling float programme reached completion in November 2007, and about 90% of Argo profiles are distributed electronically within 24 hours of acquisition, efforts to reduce delays in the Global Data Acquisition Centres (GDACs) data distribution are increasing their timeliness. In 2015, about 800 floats were deployed, with several deep Argo floats tested, and a growing number of Bio-Argo floats. This added up to 3846 floats operational in mid-April 2016. Argo floats are continuously providing essential upper ocean thermal and salinity data for Tropical Cyclones research, monitoring and forecast activities. This also makes it possible to map detailed structure of global ocean temperature and salinity fields at both surface and subsurface levels. However, with the current deployment rate, it has been demonstrated (see study[12], Durack et al., 2016) that the level of reporting profiles could not be sustainable in the long term, and the Argo array would decline over the next decade to about 2400 floats.

5.1.15 The Global Sea Level Observing System (GLOSS) continues to provide tide gauge data for understanding the recent history of global sea level rise and for studies of interannual to multi-decadal variability. In the meantime, tide gauges are now playing a greater role in regional tsunami warning systems and for operational storm surge monitoring. Over 88% of the GLOSS Core Network (GCN) of about 290 stations can be considered operational. GLOSS now plans to expand high quality core network beyond initial slate of stations to meet higher level of standards.

5.1.16 In addition, JCOMM Observations Programme Area (OPA) also coordinates the Ship Observations Team[13] (SOT), including the Voluntary Observing Ship scheme (VOS, for the making of marine meteorological observations), the Ship of Opportunity Programme (SOOP, for the making of oceanographic observations, including upper ocean thermal profiles), and the Automated Ship Board Aerological Programme (ASAP, for the making of upper air observations). The SOOP programme is providing useful upper ocean thermal profile data in complement of similar data from the Argo profiling float programme, and the Global Tropical Moored Buoy Array. Such data are essential for providing estimates of heat content fluxes between the ocean and the atmosphere in support of typhoon prediction.

5.1.17 Data availability for the tropical moored buoy arrays in the Pacific (TAO, now complete with 67 units but with a drastic decrease in the 2013 data return to 40%). To address the abrupt decline in the performance of the TAO array and the need for a broad engagement in the design and implementation of the Tropical Pacific Observing System 2020 (TPOS-2020, see 2014 workshop report[14]), OOPC (the GCOS-GOOS-WCRP Ocean Observing Panel for Climate), in coordination with JCOMM OPA, is leading a process to evaluate the broad requirements for sustained observations, and how existing and new technologies can be used in combination to meet these needs.

5.1.18 The Committee is invited to consider sustained and enhanced contributions of WMO Members in the region in support of the implementation of the ocean observing systems, including buoy, Argo, and ship-based networks in the tropical oceans and the provision of ship time to assist in the deployment and servicing of tropical moored buoys, and for the deployment of drifters and XBTs. Members interested to contribute are invited to contact the Technical Coordinator of the Data Buoy Cooperation Panel (DBCP), Ms Champika Gallage (support@jcommops.org and cgallage@jcommops.org).

---

12 http://www.nature.com/nclimate/journal/v6/n3/full/nclimate2946.html?WT.feed_name=subjects_hydrology

13 http://www.wmo.int/pages/prog/amp/mmop/sot.html

14 Report of the Tropical Pacific Observation System 2020 (TPOS 2020) Workshop, Vol.1 - Workshop report and recommendations, Vol.2 - White papers, La Jolla , United States, 27-30 January 2014 - http://www.wmo.int/pages/prog/gcos/Publications/gcos-184_I.pdf

Satellite Observations

5.1.19 Satellite observations of particular importance to tropical cyclone tracking and forecasting in RA V. Operational geostationary satellites covering RA V are: NOAA GOES-15 (West) centered above 135°W; CMA FY-2E (86.5°E), FY-2F (112.5°E, for regional scanning), and FY-2G (105°E); KMA COMS-1 (128.2°E); and JMA Himawari-8 (140°E). More technical details on these and other, including low-Earth orbiting, satellites and payload instruments is available at the WMO OSCAR/Space database http://www.wmo-sat.info/oscar/spacecapabilities.

5.1.20 The JMA Himawari-8 satellite is the first of the new-generation geostationary satellites with a 16-channel imager. It began operation at 02 UTC on 7 July 2015, centered above 140°E. Imagery from the multi-band, high-frequency and high-resolution observations of Himawari-8 is highly expected for severe weather monitoring and forecasting. Real-time imagery and RGB composites for full disk and selected areas in real time is available at http://www.data.jma.go.jp/mscweb/data/himawari/index.html

5.1.21 The next generation NOAA GOES spacecraft (GOES-R, S, T, U) will be deployed operationally in the 2016-2035 time frame at 137°W and 75°W. (See: http://www.wmo-sat.info/oscar/satelliteprogrammes/view/65). Current launch date of GOES-R is 4 November 2016. The precise deployment schedule will be defined in due time by NOAA based on technical constraints and operational priorities. The planning status of new-generation geostationary satellites and their payload is given below. To support user readiness activities by Members, WMO has established the Satellite User Readiness Navigator (SATURN) portal with up-to-date information about the new-generation systems https://www.wmo-sat.info/satellite-user-readiness/.

Table 1: Planning status of new-generation geostationary meteorological satellite systems (Status: July 2016)

Satellite	Operator	Launch date	Longitude	Imager	Number of spectral channels	Spatial resolution	Temporal resolution (full disk)	On-board Sounder / Lightning Mapper
Electro-L N2	ROS-HYDROMET	11 Dec 2015	78E	MSU-GS	10	1-4km	15min	- / -
INSAT-3DR	ISRO	2016	74E	IMAGER	6	1-8km	30min	S / -
GOES-R	NOAA	2016	137W	ABI	16	0.5-2km	15min	- / L
Himawari-9	JMA	2016	140E	AHI	16	0.5-2km	10min	- / -
FY-4A	CMA	2017	86.5E	AGRI	14	1-4km	15min	S / L
Geo-KOMPSAT-2A	KMA	2017	128.2E	AMI	16	0.5-2km	10min	- / -
GOES-S	NOAA	2017	75W	ABI	16	0.5-2km	15min	- / L
MTG-I/S	EUMETSAT	2019-21	9.5E	FCI	16	0.5-2km	10min	S / L
FY-4B	CMA	2019	105E	AGRI	14	0.5-4km	15min	S / L

Source: OSCAR/Space

In the framework of the WMO Sustained Coordinated Processing of Environmental Satellite Data for Nowcasting (SCOPE-Nowcasting) initiative Pilot Project 1, JMA provide Himawari-8 composite images for the Severe Weather Forecasting and Disaster Risk Reduction Demonstration Project (SWFDDP) in RA V http://www.wis-jma.go.jp/swfdp/ra5_swfddp_spi_sat.html. Himawari-8-derived potential areas of heavy rainfall associated with deep convective clouds are also made available:
http://www.data.jma.go.jp/mscweb/data/himawari/sat_hrp.php?area=r5s
More imagery and products made available online are discoverable through the WMO Product Access Guide: https://www.wmo-sat.info/product-access-guide/

5.1.22 The RA II/V Satellite Data Pilot Project for Disaster Risk Reduction (DRR), launched at a WIGOS Joint Workshop for RA II and V in Jakarta, Indonesia (12-14 October 2015) aims at (i) strengthening the capabilities of all Members to use geostationary satellite images and derived products in support of DRR and (ii) developing a protocol for the National Meteorological and Hydrological Services (NMHSs) in the project countries to request event-driven rapid-scan imagery for their respective national areas of interest. The satellite operators of China, Japan and the Republic of Korea are considering to make digital data at the full resolution available to all Members involved in this Project. In a supporting pilot study, JMA and the Australian Bureau of Meteorology (BOM) are testing the triggering of Himawari-8 rapid scans using command files generated by BOM. After approval by RA II and RA V Management Groups, a joint RA II/V Coordination Group will be established for the Pilot Project that liaises with the existing RA II WIGOS Project to Develop Support for NMHSs in Satellite Data, Products and Training, and with the RA V Task Team on Satellite Data Requirements.

5.1.23 Since July 2015, the JMA HimawariCast service provides primary sets of Himawari satellite imagery via a communication satellite to increasing numbers of operational users in RA II and V (another data service is HimawariCloud using the internet). Numerous NMHSs in the Asia Pacific region now incorporate Himawari-8 data from the HimawariCast service into their weather monitoring and forecasting activities for disaster mitigation. A communication satellite switchover from JCSAT-2A to JCSAT-2B is currently ongoing, leading to a modified polarization of the receiving signal, and a much larger coverage area now including many more Pacific countries (see Figure). JCSAT-2B is located in the same position and has the same downlink frequency as JCSAT-2A, but their polarization directions intersect at right angles. HimawariCast users should complete the necessary transition work during the period by 20 July 2016 at the latest, to enable reception of HimawariCast data via JCSAT-2B. http://www.data.jma.go.jp/mscweb/en/himawari89/himawari_cast/himawari_cast.html

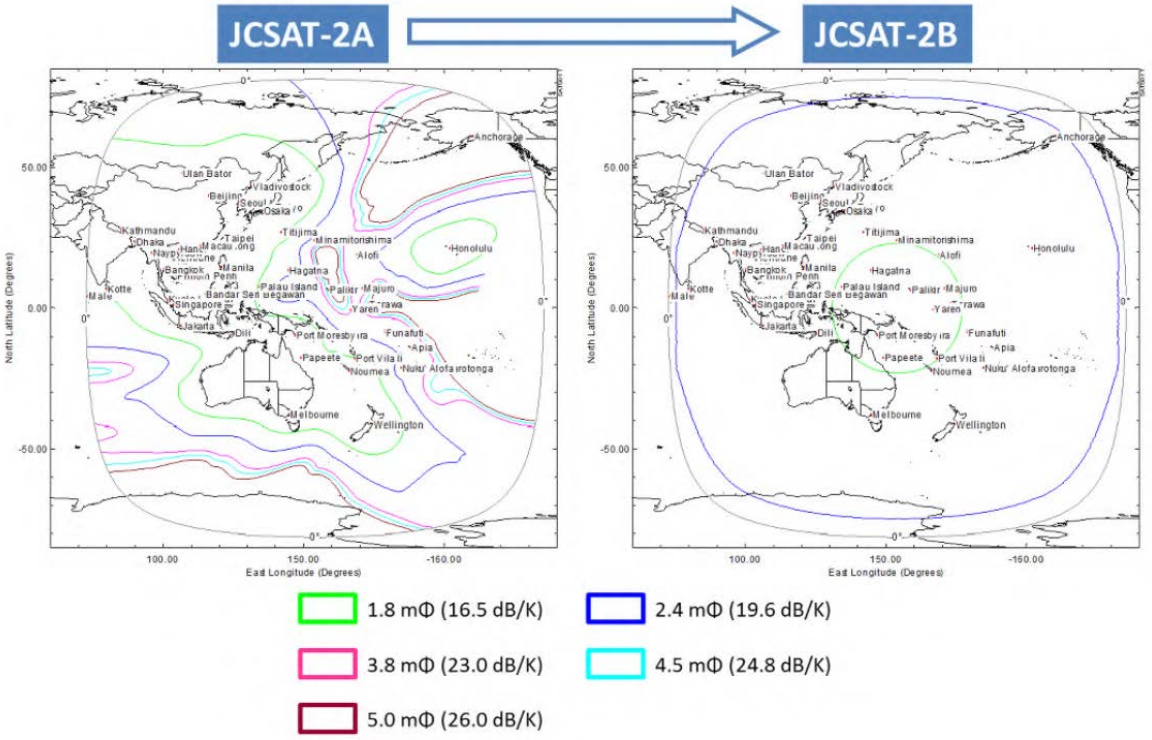


Figure 3. Antenna diameters needed for HimawariCast data reception

Figure: With the switch-over of communication satellite from JCSAT-2A (left) to JCSAT-2B (right), HimawariCast will now have complete coverage of the Pacific over to around 135°W and will cover locations in RA V that were previously only covered with large antennas or not at all. Most RA V Members can thus benefit from Himawari-8 near real-time imagery using antennae no larger than 2.4m in diameter.

5.1.24 In support to the multi-partner Indian Ocean Data Coverage (IODC) service continuity beyond 2016, on 28 June 2016, the EUMETSAT Council approved the relocation of the geostationary Meteosat-8 satellite to 41.5 degrees East. This decision follows the roadmap agreed by EUMETSAT, CMA, ISRO/IMD, and Roshydromet through the Coordination Group for Meteorological Satellites (CGMS) to ensure IODC continuity after the planned decommissioning of the ageing Meteosat-7 satellite at the end of 2016. Considering that Meteosat-8 has exceeded its design lifetime, EUMETSAT's support to the IODC services will be on a best effort basis. The relocation will start on 4 July 2016 and is expected to be concluded around mid-September 2016.

5.1.25 At a ceremony held on the side-lines of the 68th WMO Executive Council meeting in Geneva in June 2016, representatives from Australia, China, India, Indonesia, Japan, the Republic of Korea, the Russian Federation and WMO have signed a Memorandum on the Asia-Oceania Meteorological Satellite Users Conference (AOMSUC). The participating countries and the broader meteorological community have been meeting annually through the AOMSUCs to enhance the use of satellite data and products for better weather, climate, and disaster mitigation services, including tropical cyclone tracking and forecasting. The new Memorandum confirms that the Conferences will be continued and will seek to encourage participation from all countries in the region. The next AOMSUC is hosted by the Republic of Korea on 24-27 October 2016 in Songdo, Incheon.

WMO Information System (WIS/GTS)

5.1.26 Communication systems are a core component of all NMHSs' infrastructure. Being essential for the access to the data, guidance and products needed by an NMHS to prepare forecasts and warnings, their maintenance and development should remain a high priority for all Members in RA V. The WMO Information System (WIS) encompasses all communication systems used by NMHSs with a focus on those for international exchange. Three principal WIS channels of communication in the region are the WMO Global Telecommunications System (GTS) terrestrial networks, GTS satellite broadcast systems and the Internet. Other RA V WIS communication channels include RANET, EMWIN and NOAA's International Services and Communications Systems (ISCS). Parts of the region are also supported by GEONetcast. More details on these systems are provided below.

5.1.27 The GTS comprises a dedicated network of surface-based, Internet based and satellite–based telecommunication links and satellite broadcast systems interconnecting all NMHSs for the round-the-clock rapid and reliable collection and distribution of all meteorological and related data, forecasts and warnings. Several centres in RA V now utilize VPN over the Internet as their primary GTS link with RTH Melbourne or RTH Wellington, sometimes keeping the dedicated lines for backup purposes.

5.1.28 RTH Washington (in regards to the eastern part of the Pacific) and the World Area Forecast Center Washington (WAFC Washington) have been employing new dissemination services since June 2012 and the International Satellite Communications System (ISCS) broadcast service has evolved into the International Services and Communications Systems which is still referred to as ISCS. All WMO Member States supported by RTH Washington were successfully transitioned to the ISCS Global Telecommunication System (GTS) Internet File Service (ISCS/GIFS) in 2012. The ISCS/GIFS uses an HTTPS Internet connection to make products available to authorized users for downloading. ISCS/WAFS workstation vendors participated in the transition. NWS has also incorporated the broadcast of products over the existing NOAA GEONETCast Americas (GNCA) satellite dissemination service as a part of the ISCS since 2013: http://www.geonetcastamericas.noaa.gov/. Additional information on ISCS can be found at: http://www.nws.noaa.gov/iscs/. NOAA can also receive data over the NWS eMail Data Input System (EDIS). The EDIS provides designated meteorological data providers the capability to input weather bulletins to the National Weather Service Telecommunication Gateway (NWSTG) - also known as the Regional Telecommunication Hub (RTH), via eMail (See http://www.nws.noaa.gov/tg/emailingest.php).

5.1.29 The ICAO World Area Forecast System (WAFS) Internet File Service (WIFS) is available for use as the primary means to receive the WAFS data products broadcast over the ISCS. ISCS Aviation Users having been encouraged to complete their transition from ISCS to the WIFS before April 2012. Information on WIFS can be found in "The WIFS Users Guide" published in English and Spanish at http://aviationweather.gov/wifs under "Documents".

5.1.30 The Internet and commercial satellite distribution systems used to collect and send information to countries throughout the region, include digital radio broadcasts that can be received by VHF/HF radio and processed by computers. This allows messages to be exchanged as digital emails where public Internet is not available or cost effective. NOAA also provides EMWIN, LRIT services off its GOES-15 satellite, which also distributes data collected through a combination of satellite, Internet and radio broadcast services. EMWIN may also be accessed over internet if the user purchases weather message software: http://weathermessage.com/. The NWS POC (Jennifer.Lewis@noaa.gov) can be contacted for more information and training materials.

5.1.31 RANET and EMWIN[15] are essential communication mechanisms for WIS in these regions. The RANET Chatty Beetle systems uses Iridium short burst messaging to collect and disseminate meteorological observations from remote islands onto the GTS.

5.1.32 GEONetcast is being provided to the Western Pacific and East Indian Ocean from China's meteorological satellite (CMACast). It complements the GEONetcast services from EUMETSAT over the West Indian Ocean and GEONetcast Americas over the Eastern Pacific CMACast is a part of the WIS under the WMO Integrated Global Data Dissemination Service (IGDDS). Further details are online at http://www.nsmc.cma.gov.cn/NewSite/NSMC_EN/CMACast/index.html

5.1.33 The Japan Meteorological Agency began a HimawariCast service in July, 2015, prior to phasing out its MTSAT II LRIT Broadcast in December, 2015. HimawariCast receiving stations were installed at most MTSAT II LRIT sites in the fall of 2015. See

http://www.data.jma.go.jp/mscweb/en/himawari89/himawari_cast/himawari_cast.html

5.1.34 In addition to the various communication channels, WIS has provided discovery, access and retrieval services (DAR) which are based mostly on the Internet and the use of discovery metadata. Just as the use of electronic library catalogues help users of libraries to find books and publications in any library, the role of this service is to allow Members to find what information is circulating on WIS or available from WIS centres, and to provide quick access to current data.

5.1.35 WIS has been operational from January 2012. GISC Melbourne[16] has the leading role in ensuring Members in RA V also implement and benefit from the new functionality of WIS. RA V is also supported by GISC Washington[17], and to some extent by GISCs Beijing[18], Tokyo[19] and Toulouse[20]. Centres' Principal GISCs are listed in Annex B of the Manual on WIS (WMO No. 1060). Information about WIS is available in the Technical Regulation (WMO No49), the Manual on WIS (WMO No. 1060) and the Guide to WIS (WMO No. 1061). These combined with online guidelines for WMO Metadata for WIS (https://wis.wmo.int and https://wis.wmo.int/page=WmoCoreMetadata) will allow all Members to begin to implement and benefit from the new WIS functionality. A web page (http://wis.wmo.int/page=RA5-WIS) includes information on WIS implementation in RA V, including the RA V WIS implementation plan (http://wis.wmo.int/file=671).

5.1.36 WIS is an important enabler for Members addressing WIGOS, GFCS and other WMO priority areas. However, for Members to benefit fully from WIS, it is essential that NMHS implement plans to deploy WIS functionality in their programme plans and that committees such as the RA V Tropical Cyclone Committee work with the GISC Melbourne, their principal GISC and the WMO Secretariat to ensure their programmes include WIS implementation as a priority activity over the current and next WMO financial periods.

5.1.37 The world weather watch monitoring details for RA V show that there are still quite a few silent stations in RA V observing networks. Summary images are shown below for Synops, Temps and Climat reports. See figures 1, 2 and 3 in the annexes. More detailed analytics are available online at http://www.wmo.int/pages/prog/www/ois/monitor/index_en.html.

[15] EMWIN http://www.goes-r.gov/users/hrit.html
[16] GISC Melbourne - http://wis.bom.gov.au/
[17] GISC Washington - http://giscportal.washington.weather.gov/
[18] GISC Beijing - http://wisportal.cma.gov.cn/wis/
[19] GISC Tokyo - http://www.wis-jma.go.jp/cms/
[20] GISC Toulouse - http://gisc.meteo.fr/

5.2 Hydrological component

WMO Flood Forecasting Initiative

5.2.1 Notable progress had been made in the implementation of the Flood Forecasting Initiative including establishment of an overarching Advisory Group for the Flood Forecasting Initiative (FFI-AG), as decided by Congress (Resolution 15 (Cg-XVI)), aiming to ensure adequate monitoring, evaluation and guidance with respect to the implementation of the Strategy and Action Plan on the Flood Forecasting Initiative. RA-V had encouraged Members to further develop national and regional projects that would contribute to the achievement of the objectives of the initiative. The Regional Association felt in particular that priorities include: strengthened institutional capacities; use of state-of-the art observation platforms; upgraded monitoring networks; use of modeling approaches; and joint development of requirements-driven forecasting products including urban floods.

5.2.2 An initial Planning Meeting of the Southeastern Asia-Oceania Flash Flood Guidance (SAOFFG) project took place in Jakarta, Indonesia on 2-4 February 2016. Representatives of Indonesia, Malaysia, Papua New Guinea, Philippines, and Singapore attended. Participants agreed on the development and implementation of the SAOFFG project, stressing that the project will enable participating National Meteorological and Hydrological Services to issue timely and accurate flash flood warnings. Participants also appreciated the advanced features of the Flash Flood Guidance System (FFGS) such as Urban Flash Flood Early Warning, Landslide Acceptability Mapping, Multi-Model Quantitative Precipitation Estimation (QPF) ingestions, and Riverine Routing. Because FFGS is currently the most advanced flash flood guidance tool available, its implementation in other countries in RA-V region would contribute considerably to saving lives and preventing economic damage.

5.2.3 Efforts are under way to establish closer links between the Severe Weather Forecasting Demonstration Project-Southeastern Asia-Oceania (SWFDP-SAO) and the SAOFFG to improve flash flood forecasting.

5.2.4 Further, a CHy draft report on the Intercomparison of Flood Forecasting Models developed by a Task Team, has been prepared for the development of a methodology to improve the effectiveness of flood forecasting services.

WMO Quality Management Framework for Hydrology

5.2.5 The World Meteorological Organization (WMO) and the International Organization for Standardization (ISO) have agreed to increase their cooperation in the development of international standards related to meteorological and hydrological data, products and services. The recognition of WMO as an international standardizing body for technical standards provides a valuable opportunity to further emphasize the role and benefits of applying the Quality Management Framework–Hydrology and providing Members with the necessary guidance on technical standards from data collection through to service delivery.

5.2.6 A draft publication: "A Practical Guide for the Implementation of a Quality Management System for National Meteorological and Hydrological Services" is available at

http://www.wmo.int/pages/prog/amp/aemp/documents/QM_Guide_NMHSs_V10.pdf.

It represents the most authoritative blueprint for WMO Members to follow in pursuing a quality management approach to the delivery of such services.

5.2.7 The following publications are seen as of particular interest for the RAV TCC, namely: the Manual on Estimation of Probable Maximum Precipitation (PMP) (WMO N° 0145), the Manual on Stream Gauging (WMO N° 1044), the Manual on Flood Forecasting and Warning (WMO N° 1072), the Guidelines for the Assessment of Uncertainty of Hydrometric Measurements, the Technical Report on Climate and Meteorological Information Requirements for Water Management (WMO N° 1094), the Technical Report on Water Quality Monitoring, and the Technical Report on Technical Material for Water Resources Assessment (WMO N°1095). All these publications are available online at http://www.wmo.int/pages/prog/hwrp/index_en.php.

RA V Working Group on Hydrological Services-Ninth Session

5.2.8 The WG-HYS met in November 2015 in Brisbane and adopted its work plan for the period 2016-2018 on the following theme areas:

- Disaster risk reduction - water-related disasters;
- Hydrology database management and QMF-H;
- Water and Climate; and
- Training and capacity building in hydrology.

5.2.9 Progress on Work Plan tasks

- An on-line forum (web portal) has been established with the assistance of the Secretariat. Preliminary information has been posted and it has been promoted to WG-HYS members by email. Further information for a "community of practice" and other information is in preparation by TT leaders.
- Assistance was provided to the CHy Task Team on QMS with review of QMS Checklist and Questionnaire reports, and a case study on ISO 9001 QMS from the region was provided.
- Assistance was provided to the Coastal Inundation Forecasting Demonstration Project by recruiting a new OPACHE (Open Panel of Commission for Hydrology Experts) member to serve as an expert representative for WMO on two proposed projects in the region (Fiji and Indonesia). Dr Graeme Smart has attended two project meetings as an alternate to the co-chair of the Project Steering Group.
- The WMO/IGRAC (International Groundwater Resources Assessment Centre) workshop "Advancing Groundwater Monitoring in Small Island Developing States in the Pacific" is being held in Suva in the last week of August 2016.

- A distance learning course for Pacific Island hydrology technicians using the Moodle framework and modules from COMET, ICAR and NIWA is currently planned to start before the end of 2016.
- A concept proposal for providing appropriate hydrological database software to NHSs in small and developing countries has been submitted to the Secretariat for comment.

5.2.10 A concept note for a Pacific-HYCOS Phase 2 project was drafted in conjunction with SPC, with a focus on providing relevant water resources and water-related DRR products for the Pacific Island countries. The next major steps are to seek feedback on the concept from the countries, and subsequently canvas and encourage potential donors for their feedback. The concept note was presented to this meeting as a separate document, and is downloadable at http://www.wmo.int/pages/prog/www/tcp/reports.html

Comments

5.2.11 Samoa's representative informed the Committee that the communiqué (Nukualofa Declaration) Pacific Meteorological Council (PMC) meeting he will present a hydrology paper based on the priority need for the region. He also informed on Samoa's Meteorological Services (SMS) collaboration with the Hydrological services in country for the development of a Multi-Early Warning System for Floods, implemented under a World Bank Pacific climate resilient project are installation of water level recorders and radio-linked communications network and training to achieve this goal. The SMS is also benefitting from real-time rainfall data from the NEON hydrological stations.

5.2.12 The Hydrology issue have constantly being brought up by the National Meteorological and Hydrological Services directors during the Pacific Meteorological Council (PMC) meetings. While, flood early warning system is reflected under the Pacific Island Meteorological Strategy (PIMS) 2012-2021 as one of the priority areas, there was not much progress made in implementing the activities under this priority. During the second PMC (2013) and in third PMC (2015), members requested support from WMO, SPREP, SPC, USP and other regional organizations to improve the capacity of National Hydrological Services in the region to ensure adequate level of service delivery in PICTs for flood and flash flood forecasting and early warnings; and CALL for further collaboration between WMO, SPREP and SPC to increase operational hydrology as part of the Pacific Meteorological Desk Partnership. This call is further reiterated by the first Pacific Ministerial Meeting on Meteorology (PMM-1) reflected in the Nuku'alofa Ministerial Declaration for Sustainable Weather and Climate Services for a Resilient Pacific. The presentation and the project proposal by the RA-V on hydrology is an opportunity to link the hydrology and the meteorological community to address gaps at the national level and SPREP through the Pacific Meteorological Desk Partnership will be happy to collaborate on the proposal as well as implement the project.

5.2.13 In May 2012, The Government of Fiji, in its efforts to address gaps in its national early warning system for flooding, decided to transfer the flood forecasting and warning mandate to the Fiji Meteorological Service (FMS). Over the years, FMS has spent almost FJ$1m to increase the number of water level and rainfall monitoring along the different rivers and catchment in Fiji. This has enabled FMS to provide flood alert and warning for different catchments and tributaries Fiji. Though FMS has been able to produce flood warning and alerts, it is still faced with the issue of the lack of Flood models in Fiji. While global models are well advanced in providing rainfall intensity, they still need to do a lot more Flood forecasting. Further, WMO through its various training programs should build capacity in the region by providing training which will address the lack of certified Hydrologists in the region. These hydrologists upon graduating will further the work of the Hydrology in the various NMHS's by developing Flood models which will complement the network of water level and rainfall monitoring station in the different countries.

5.3 Public Weather Services delivery and Disaster Risk Reduction, Disaster Risk Management components

Public Weather Services Delivery Component

5.3.1 The services delivered under the PWS component must meet the needs of users, and specifically the **general public**, the **media** and the **disaster management organizations**. These user groups may fall into a category with specific needs such as disaster managers, or be defined as the general public which forms a much broader group and whose information needs are broader and not so clearly defined. Media is a special user group since it functions both as a client and as a partner of NMSs and serves the role of intermediary in the provision of services and information to all other user groups For the most part, national PWS programmes and activities provide public forecasts and warnings which meet most of the needs of these user groups, although in some cases, special products and services may be required which fall outside of the NMSs' PWS mandate.

5.3.2 Delivering PWS and other services to the user sectors mentioned above, need to follow a number of stages which are similar in principle and which need to be applied to ensure the maximum benefit derived from those services by the intended users. These stages are outlined below.

Stage 1: User Engagement - identifying users and understanding their needs, as well as understanding the role of weather, climate, and water-related information in different sectors;

Stage 2: Service Design and Development - process between users, providers, and partners of creating, designing, and developing services, ensuring user needs are met;

Stage 3: Delivery - producing, disseminating, and **communicating** data, products and information (i.e., services) that are fit for purpose and relevant to user needs; and,

Stage 4: Evaluation and Improvement - process to collect user **feedback** and performance metrics to continuously evaluate and improve upon products and services.

5.3.3 These stages are clearly laid out in detail in the WMO Strategy for Service Delivery and the Implementation Plan for the Strategy (WMO-No.1129).

5.3.4 The complexity of the relationship between service delivery and effective response to extreme meteorological and hydrological events requires that multi-hazard early warning systems be embedded within the operational end-to-end forecasts and warnings service delivery framework of National Meteorological and Hydrological Services (NMHSs) to be delivered through the PWS national programmes and channels for the full benefit to the public and other users. This is a major area of focus of the WMO Public Weather Services (PWS) Programme.

5.3.5 In order to overcome the complex challenge of delivering effective public weather services for improving public understanding and response to warnings, it is essential that NMHSs develop close partnerships with the media, emergency management, and experts in social sciences, so that they understand how the public interprets and reacts to warnings. The PWS Programme has published a number of guides on various aspects of effective delivery of services to the public and other users. These guides are available on the following web-link:

http://www.wmo.int/pages/prog/amp/pwsp/publicationsguidelines_en.htm .

The TCC region Members are strongly encouraged to benefit from the information gathered in these guides.

The WMO Strategy for Service Delivery

5.3.6 The WMO Strategic Plan for the period 2016-2019 has recognized "Improved service quality and service delivery" as an Expected Result for the Organization. This Expected Result is aimed at improving the operational, end-to-end framework for NMHSs to translate leading-edge science into information that is actionable and easy to interpret by different sectors of society. The Plan highlights the fact that it is through effective and timely delivery of services that users derive a high level of return on NMHSs' investment in basic infrastructure (such as observing systems, modelling, communications and human resources) and that nations derive a high level of return on their investments in NMHSs. The WMO Congress has recognized Service Delivery as the core business of NMHSs, that is, providing essential meteorological, hydrological and related environmental services and information to communities, for the purpose of saving lives and livelihoods, and for improving the quality of life as well as enhancing national economies

5.3.7 Congress approved the "WMO Strategy for Service Delivery" in 2011 to guide all activities and programmes of the Organization. At the request of Congress an implementation plan was prepared to guide Members' efforts in implementing the Strategy at the national level (WMO-No. 1129). Congress strongly encouraged Members to implement the Strategy, using the Implementation Plan, with a view to improving the quality and delivery of the services they provide to the public. The Implementation Plan outlines an approach as a practical tool to assist Members, through the Service Delivery Progress Model (SDPM), to improve their respective levels of Service Delivery.

5.3.8 The TCC members are strongly encouraged to make use of the Strategy and its Implementation Plan for assessing their level of service delivery as well as how to attain higher levels and the tools which are available to assist them in this endeavour.

Delivery of Impact-Based Forecasts and Warnings

5.3.9 Each year the impacts of severe hydrometeorological hazards cause multiple casualties as well as significant loss and damage to property and infrastructure. These hazards have adverse economic consequence for communities, in spite of the fact that many of these severe events had been well forecast, with accurate warning information disseminated by the responsible NMHSs. The reasons for this apparent disconnect lie in the gap between forecasts and warnings of hydrometeorological events and an understanding of their potential impacts, both by the authorities responsible for civil protection/emergency management and by the population at large. Closing this gap, and improving the understanding of the potential impacts of severe hydrometeorological events poses a challenge to NMHSs and their partner agencies, particularly Disaster Reduction and Civil Protection Agencies (DRCPAs).

5.3.10 Progressing from weather forecasts and warnings to multi-hazard impact-based forecast and warning services represents a paradigm shift in service delivery for many NMHSs, but is a necessary step to enable those at risk take appropriate action to avoid harm. Congress agreed that historically, all NMHSs have featured forecasting of the weather as central to their mission, and most also issue weather warnings in the case where hazardous weather is expected. In the case of both weather forecasts and warnings, the focus is on what the weather will *be*. It is now advocated that this weather-based paradigm evolve to one, which is focused primarily on forecasting impacts. In other words, the focus should evolve to what the weather will *do*. Impact-based forecasts and warnings should be accurate and understandable

and be delivered in a timely manner.

5.3.11 The merit of advancing toward this paradigm shift, despite the complexity of impact-based forecasting and risk-based warnings has been recognized, leading to the preparation of the *WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services* by PWS experts and its publication following approval by the extraordinary session of CBS (CBS-Ext.(2014))

5.3.12 Development of solid working relationships with DRCPAs is vital to the success of the delivery of impact-based weather and warning services to all user groups. As a first step, all NMHSs in the TCC region should have a Disaster or Emergency Response Plan which clearly spells out individual and collective responsibilities in the face of catastrophic events. The Plan should identify responsible managers, focal points, spokespersons, the procedures for emergency communication, and key contacts in the disaster management agencies. The emergency plan should be coordinated with corresponding plans of agencies with emergency responsibilities, and be exercised on a regular basis to ensure that all staff is familiar with their responsibilities.

Delivery of public warnings

5.3.13 An effective warning message, as noted in paragraph 6.3.8, should recommend ways that the public and other users can achieve protection, including safety rules or guidelines for appropriate action. These recommended actions should be worked out in agreement with disaster managers, following established regulations, and based on the expected impacts of severe weather hazards. Language and vocabulary used should be appropriate for the region and should easily be understood by the intended recipients. Warnings should not only be issued in the official language, but also in the most common ones. The use of metrological jargon, abbreviation and codes should be avoided for the general public. Clear, concise, simple words are usually most effective in minimizing potential confusion.

5.3.14 The use of social media communication methods such as Facebook, Twitter, YouTube and Blogs in communicating forecasts and warnings have become popular in recent years. The PWS Programme has produced a set of guidelines on strategies for use of social media in PWS. These guidelines can be accessed through the web-link given in paragraph 5.3.5.

5.3.15 The Severe Weather Information Centre (SWIC) Website (http://severe.worldweather.wmo.int) continues to be a source of official warnings of tropical cyclones on a global scale, including those in the RAV TCC region. The site also provides information on heavy precipitation and thunderstorms.

5.3.16 The PWS Programme is leading the implementation by NMHSs of the Common Alerting Protocol (CAP). CAP facilitates the communication of all warnings through all forms of media including broadcast radio and television as well as new technologies such as Web services, to the public and all user communities. CAP is also very useful where alerting systems serve multilingual and special-needs populations. The PWS Programme has assisted Members in RAV in the implementation of CAP protocol. Members in the RAV-TCC region are further encouraged to call on WMO for assistance in adopting CAP for dissemination of their severe weather warnings.

5.3.17 The online "Register of WMO Members Alerting Authorities" (http://alerting.worldweather.org/) is an important step taken by the PWS Programme towards achieving a "single official voice" for dissemination of weather warnings, a priority area

identified by WMO Members. The RAV-TCC region Members are strongly encouraged to contribute to the Register, to keep it updated, and to refer to their membership of this Register when asserting their authoritative role with respect to issuing national warnings.

Service Evaluation

5.3.18 In terms of PWS delivery, service evaluation involves ensuring that the warnings and forecasts are accurate and skilful from a technical point of view and useful. Determination of forecast skill, timeliness and product accuracy, while an essential step, is not in itself sufficient for a meaningful programme evaluation of public weather services.

5.3.19 The assessment of the utility or value of the services to users must be built within the forecast and warning system. Service evaluation determines whether PWS and other services are meeting user requirements and ascertains whether users understand the products and services provided and are making optimum use of them. To be effective, the service has to contribute significant social or economic benefits to its users. Consequently, evaluation must include an assessment of the value added to users by the products and services. Surveys are the common means of obtaining user feedback. The evaluation process should be kept simple with the aim of producing results which can be used when talking to decision-makers and in response to media enquiries. A summary guide on preparation of surveys and examples of surveys from a number of NMSs are given on the PWS Programme Website: http://www.wmo.int/pages/prog/amp/pwsp/surveys.htm

Public Education and Outreach

5.3.20 It is no longer sufficient for NMHSs to employ good science and provide accurate forecasts; they also need to educate and inform the public, and more specialized users, in how to make best use of the fruits of the scientific endeavour, through public education and outreach.

5.3.21 Public education and outreach programmes aim to strengthen links between the providers and users of public weather services so that individuals, communities and organizations can make effective use of the available products and services. While the initiative to develop such public education and outreach programme should normally come from the NMHS, it is preferable that these activities be undertaken together with partners such as educational authorities, emergency management agencies and the media.

5.3.22 To receive the information, the public must be aware of the services available, and the means by which they can be received. Because of the breadth and diversity of this audience, the most effective means of reaching it are the mass media. For the public to believe the information, NMHSs must have a public image of credibility, reliability, accuracy and timeliness. Equally important is a general programme of public education and awareness. Education ensures that warnings and forecasts provided by NMHSs are understood by its intended users. The PWS Programme has prepared a guidance document (WMO/No. 1354, PWS-14) entitled, “Strategy for Developing Public Education and Outreach”, available on the PWS webpage, and members of the TCC are encouraged to make use of this guidance in developing and strengthening their own public education and outreach programmes and activities.

Disaster Risk Reduction And Disaster Risk Management Component

The Sendai Framework For Disaster Risk Reduction 2015-2030

5.3.23 The Committee noted that the Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework) was adopted by 187 countries at the Third United Nations World Conference on Disaster Risk Reduction (WCDRR) held in Sendai, Japan, from 14 to 18 March 2015. The new Framework addresses four priorities for action:

1. Understanding disaster risk;
2. Strengthening disaster risk governance to manage disaster risk;
3. Investing in DRR for resilience; and,
4. Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction;

and defines the role of stakeholders and of international cooperation and global partnerships.

5.3.24 The Committee further noted that WMO Members contribute with a number of activities to each priority for action of the Framework, especially for priority action 4. While WMO members produce forecasts and warnings for hazardous conditions, it is essential that societies are prepared to act appropriately in response. Education and training is the key to improving preparedness for response, recovery, and reconstruction. Early warning systems for natural hazards work only if communities have access to appropriate systems and the members of those communities know how to respond when they receive them. Ensuring access to timely environmental hazard information and communicating (issuing and disseminating) impact-based forecasts and risk-informed hazard warnings to end-users in a manner that is efficient, timely, understandable and actionable are crucial for disaster risk reduction. Such an approach would require a framework for standardized and interactive operations and partnerships for preparedness and response, as well as indicators to monitor processes, performance, and expected outcomes.

5.3.25 It also highlighted that the Framework's global target number 7, which reads "substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030", is particularly relevant to WMO and disaster risk reduction in particular.

Comments

5.3.26 The opportunities for the implementation of the Sendai Framework transformed to UNISDR Science and Technology Road Map discussed in the UNISDR Science and Technology Conference on the Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030, which was held in January 2016. The Science and Technology Roadmap includes expected outcomes, actions, and deliverables under each of the four priority of actions of the Sendai Framework. Pacific countries would be beneficial and could plan around the implementation of the Roadmap.

https://www.wmo.int/edistrib_exped/grp_prs/_en/2016-08-26-PR-6922-WDS-DRR-2017%20Global%20Platform_en.pdf

Disaster Risk Reduction Programme (DRR)

5.3.27 The Committee noted that Congress 17 highlighted the enormous significance of the Sendai Framework for DRR 2015–2030 to the DRR priority of WMO and the need for assisting WMO Members in the effective implementation of this Framework through:

(a) Developing DRR knowledge products (e.g. guidelines, standards, training modules) in thematic areas such as hazard and risk assessment, MHEWS, humanitarian planning and response, and disaster risk financing;
(b) Assisting with the coordinated national and regional DRR capacity development activities and demonstration projects in these thematic areas;
(c) Promoting, engaging in, and facilitating multi-stakeholder partnerships in DRR on different levels;

International Network For Multi-Hazard Early Warning Systems (IN-MHEWS)

5.3.28 The Committee was informed that the Sendai Framework calls for the strengthening of MHEWS and, as one of its global targets, a substantial increase in the availability of and access to MHEWS and disaster risk information and assessments to the people by 2030. The Committee noted that in response to this call, WMO, together with other United Nations agencies and international organizations concerned with early warning, has established a new multi-stakeholder partnership initiative to advance MHEWS – the IN-MHEWS. The network, co-chaired by WMO and UNISDR and including agencies such as UNESCO, UNOOSA, WHO, WFP and a number of others, will facilitate the sharing of knowledge and good practices and making available to governments and other key stakeholders policy-relevant guidelines to strengthen MHEWS as a national strategy towards building disaster and climate resilience. A key output of IN-MHEWS is likely to be the International Conference on Multi-hazard Early Warning Systems (IC-MHEWS).

International Conference On Multi-Hazard Early Warning Systems (IC-MHEWS)

5.3.29 The increasing emphasis on a more holistic multi-hazard approach to early warning advocated by the Sendai Framework defines a new era for early warning services built on good practices and lessons learnt by countries, organizations, and communities and the gains of earlier international efforts to advance EWSs. For example, the International Early Warning Programme (IEWP) was first proposed at the Second International Conference on Early Warning (EWC II) held in 2003 in Bonn, Germany. As an implementation mechanism, the Platform for the Promotion of Early Warning (PPEW) was launched in 2004 and remained operational until 2008.

5.3.30 Currently, efforts are needed to determine how MHEWSs should use and communicate risk and impact information from multiple sources and integrate technical, social and financial capacities through coordination mechanisms among multi-disciplinary stakeholders, including effective feedback mechanisms for continuous improvement. In this way, a multi-hazard approach to EWSs can provide economies of scale and, eventually, sustainability of the system as a whole.

5.3.31 Cg-17 noted that for more effective and wider implementation of MHEWSs, it is important to document the good practices and other national experiences in implementing MHEWSs and prepare guidelines on institutional coordination and cooperation and the role of NMHSs in implementing MHEWSs. There is also an urgent need for addressing trans-boundary and regional issues in developing and disseminating early warnings. To address these issues,

Cg-17, supported by EC-68, encouraged the organization of the International Conference on MHEWSs (IC-MHEWS) in collaboration with appropriate international, regional and national agencies and institutions. Accordingly, WMO and the United Nations Office for Disaster Risk Reduction (UNISDR), in collaboration with a number of other UN agencies, international and regional organizations as well as national agencies from a number of Member States, are planning to organize IC-MHEWS as a preparatory meeting immediately prior to the UNISDR organized Global Platform, which is to be held in Cancun, Mexico in May 2017.

5.3.32 The IC-MHEWS will build on the outcomes of the three International Conferences on Early Warning that were held between 1997 and 2006. It will also address the priorities highlighted in the UN Plan of Action on DRR for Resilience which was endorsed by the UN Chief Executives Board (CEB) in 2013. IC-MHEWS will appropriately address the call for enhancing and strengthening MHEWS in the Sendai Framework adopted by WCDRR in Sendai, Japan. One of the major outcomes of the Working Session on Early Warning during the Multi-Stakeholder Segment of WCDRR was the endorsement of the proposal for the establishment of an International Network for MHEWSs (IN-MHEWS). This multi-stakeholder partnership will facilitate the sharing of expertise and best practice on strengthening MHEWS as a national strategy for DRR, CCA, and building resilience. In doing so, it will support the implementation of Sendai Framework, including the global target for MHEWSs, and the UN Plan of Action on DRR for Resilience. WMO Members are encouraged to attend both the Global Platform and the IC-MHEWS whilst also encouraging related disaster management agencies to accompany them.

MHEWS initiatives in the region

5.3.33 WMO has several initiatives that support the development and strengthening of early warning systems, such as the documentation of good practices, development of guidelines and training materials, and national and regional capacity development/demonstration projects. WMO is promoting the establishment and strengthening of institutional collaboration for MHEWS supported by Standard Operating Procedures (SOP) that could facilitate the efficient and effective interaction between and among various key stakeholders on MHEWS. In this regard, WMO has responded to requests made by the Government of the United Republic of Tanzania to assist them in developing and strengthening their SOP relating to their early warning systems and the related interactions between the NMHS and the Civil Protection Authorities.

5.3.34 The Climate Risk and Early Warning Systems (CREWS) initiative was launched on 1 December 2015 at the twenty-first session of the Conference of the Parties (COP) and the eleventh session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) – the 2015 Paris Climate Conference (COP21-CMP11) in Paris, France. Implementation of this initiative is supported by WMO, the UNISDR and the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR) which are actively involved in reducing the vulnerability and exposure of nations and communities to natural hazards. The governments of Australia, Canada, France, Germany, Luxembourg and The Netherlands have agreed to give more than US$ 80 million to equip up to 80 countries with better climate risk early warning systems. These systems have been proven to reduce loss of life and economic hardship caused by meteorological hazards such as tropical cyclones, floods, severe storms, forest fires, and heat waves. It is quite likely that projects related to CREWS will be initiated in Region V. It is expected that IC-MHEWS will provide a good platform for the participants from these countries to appraise themselves about the latest advances with MHEWSs and the strategies to implement them in their countries.

Comments

5.3.35 Samoa's representative commend on the DRR paper and emphasis on the involvement

and linkages of the Committee mainly through the NMHSs' to the Sendai and Hyogo frameworks. He also notes some concerns at the little contribution of national meteorological services in the preparation of the current regional strategy SRDP (Strategy for Disaster and Climate Resilient), thus urges more collaborative efforts towards this end. Further mention on a World Bank project (PREP) implementation collaboratively working with the Disaster Management Office in Samoa.

5.4 Training component and capacity Development

5.4.1 The Committee noted the training events and workshops which were organized during the intersession

- Attachment Training, *RSMC Tokyo, 22-31 July 2015 and 15-26 August 2016*
- WMO International Training Workshop on Tropical Cyclone Forecasting and Warning, *Nanjing, China, 7-11 December 2015*
- Eleventh Southern Hemisphere Training Course on TC and PWS, *Melbourne, Australia, 5-16 October 2015*
- RA I Training Course on Tropical Cyclones and Public Weather Services, *La Reunion, France, 4-25 September 2015*
- International Training Workshop on TC Forecasting, *New Delhi, India, 3-14 August 2015*

https://www.wmo.int/pages/prog/www/tcp/Activities.html

5.4.2 The Committee noted the forthcoming training events, and the Members were encouraged to make maximum benefit of attachments, training seminars, workshops and courses to be organized or co-sponsored by WMO.

- Workshop on Storm Surge and Wave Forecasting (jointly with MMOP, dates and venue TBD)
- Attachment Training, *RSMC New Delhi, 19-30 September 2016*

5.4.3 Support to operational forecasters

- Global Guide to Tropical Cyclone Forecasting

The Guide is now available on-line at https://www.wmo.int/cycloneguide/

- WMO/TCP Tropical Cyclone Forecaster Website

It was recognized and appreciated that the Hong Kong Observatory (HKO) hosts the website. New material is continuously being added following international workshops and training courses. This site includes TCP technical publications, regional operational plans; best track archive; the Global Guide; and links to tropical cyclone research. The TCP invited members to add additional links for research efforts in order to improve the information available on the site.

The website has been lately enriched with the training material from RSMC Miami Workshop on Hurricane Forecasting (2016) and RSMC La Réunion Workshop on TC Forecasting (2015).

5.4.4 Distance Learning access to training with connections to:

1. The COMET program offerings

New TC related COMET modules have been added: Introduction to Tropical Cyclone Storm Surge; Understanding Heights and Vertical Datums; Storm Surge and Datums; Forecasting Tropical Cyclone Storm Surge; Use of Probabilistic Surge Guidance in Local Storm Surge Forecasting; Determining the Onset and Risk of Tropical Cyclone Winds; Tropical Cyclone Forecast Uncertainty; and Use of Probabilistic Guidance in Local Tropical Cyclone Wind Forecasting. They can be found at:

https://www.meted.ucar.edu/training_detail.php?topicSorting=8&languageSorting=1&module_sorting=publishDateDesc

2. The Australian VLab Centre of Excellence

Regional Focus Group meetings with number of tropical Cyclone forecasting training sessions
http://www.virtuallab.bom.gov.au/archive/regional-focus-group-recordings/

Science Week: in 2015, discussion about "Using NWP for Tropical Cyclone forecasting: updates for 2015" by Joe Courtney. The recording of the presentation is at http://www.virtuallab.bom.gov.au/events/science-week-2015/science-week-2015-recordings/

5.4.5 Tropical Cyclone Forecast Competencies

Following 17th WMO Congress, there was a commitment to follow up on ensuring the tropical cyclone competencies are aligned with the ongoing competencies efforts of the aviation and marine programmes globally, as well as with each other. It was noted that the completion of a global set of TC competencies can be used to develop training priorities for the programme.

At the last Tropical Cyclone RSMCs/TCWCs Technical Coordination Meeting (TCM-8, 2-6 November 2015), RSMCs and TCWCs have shared the progress in this matter in their respective regions. TCM-8 has therefore made the following recommendations:

(final report available at https://www.wmo.int/pages/prog/www/tcp/reports.html)

Recommendation (2.6.5): The TCM endorsed that a minimum set of common tropical cyclone forecast competencies should be developed across the RSMCs/TCWCs, ensuring there is also recognition of a tier of competencies that address the communication or interpretation of the available products for individual countries' purposes. Individual Regional bodies have the flexibility to develop, adopt and implement specific TC competencies to help frame development opportunities and training requirements within the Region

Recommendation (2.6.6): The TCM recommended that in order to complete this task in a timely manner that the TCP establish a Task Team, naming a lead coordinator, with representation from all of the Regional bodies to develop draft global TC competencies (similar to the Aviation and Marine Programmes). The RSMCs/TCWCs will nominate experts from within the Regions to this Task Team.

5.4.6 The Committee is invited to consider creating a small working group to consider the potential for the proposed TC forecaster competency framework to assist in improving the effectiveness of training courses provided to Committee members and prepare a draft training plan for the next Committee session.

The training plan could include seeking information on:

- the types and ranges of TC services provided by the Committee members
- the number of personnel involved in developing, delivering and communicating these services. It may be best to break these personnel numbers down into topic groupings as not all staff may be doing the same types of activities.
- types of systems used by the forecasters for their work
- whether the TC services are based upon the RSMC forecasts or are developed nationally (interpretative vs full forecasting capacity)
- coordination mechanisms and roles with the national emergency authorities (to see what common roles may exist)
- what education and training opportunities may exist and what is being used (secondments to RSMC or other advanced centre, twinning or option for staff from one country to travel to another to assist in training, face-to-face courses, fellowships, online training as a course or stand-alone self-directed training, participation in regular online meetings or weather briefings such as those offered by the WMO Virtual Laboratory for Satellite Meteorology)
- what financial or other resources may be available to support training (for example use of the COMET MetEd website)
- proposed course frameworks based on competency standards and good practices-- including priorities for learning outcomes based on existing competencies; target audiences; suggestions for learning activities and training approaches; ways to use distance learning to extend reach, expand content coverage and create persistent resources; assessment and impacts evaluation strategies.
- Introducing training planning templates for future training.

Comments

5.4.7 The PMC has established a Pacific Island Education, Training and Research (PIETR) Panel, an expert Panel chaired by Cook Islands and vice chaired by the University of Hawai'i to look at training and education priorities for the region. It will be great to have some linkages between the Working group for the TCC competency and PIETR Panel to ensure coordination. Any progress made in this area is also a progress for the region in training.

Agreements

5.4.8 Recognising the importance of developing competencies for tropical cyclone forecasters, the committee agreed to establish a working group comprising Mr Joe Courtney (BoM) and representatives from Tonga, Fiji and USA to undertake further work on the draft competencies considered at previous meetings. The committee noted that the draft RAV competencies are being considered by other regions and agencies as part of a process to develop internationally agreed competencies for WMO. The committee noted the need for training to ensure optimal utilization of TC Module across the Region.

5.4.9 The committee agreed that they suggest to RA V management Group that the TCC WG on cyclone competencies be upgraded to TT status to provide added profile and focus on achieving progress towards adoption

5.5 Research component

5.5.1 The Committee was informed that the Eighth International Workshop on Tropical Cyclones (IWTC-VIII) and Third International Workshop on Tropical Cyclone Landfall Processes (IWTCLP-III) was successfully held in Jeju, Republic of Korea from 2-10 December 2014. WMO Members from all the five tropical cyclone regional bodies were represented in the workshop attended by 134 participants. The closing ceremony on 10 December 2014, the last day of the combined workshops, was preceded by a recapitulation of the recommendations of IWTC-VIII and IWTCLP-III. Documents and Presentations related to the two workshops have been published in CD format in May 2015.

5.5.2 The Committee noted that the High Impact Weather (HIWeather) Project Kick-off meeting was held at the UK Met Office Headquarters in Exeter, UK from 27-29 April 2016. HIWeather will make a key contribution to two issues highlighted in the Sendai Framework namely: the need for more and better hazard early warning systems and the provision of better information on hazard risk. These will be accomplished firstly through the development of better warning systems and secondly through HIWeather's contribution to understanding the processes that cause disasters and hence what policies are needed for communities to be more resilient. A key focus is on identifying research gaps across the whole chain from observation to community response. The HIWeather implementation plan identifies not just the overall bottlenecks in the warning process, but also weaknesses in each step of the process. It is these gaps that the HIWeather task teams will be filling in the most effective way. The kick-off meeting provided an opportunity to start concrete activities in these areas.

5.5.3 Steps have been initiated to organize a meeting of the WMO/CAS Working Group on Tropical Meteorology Research in Shanghai, China. The meeting, tentatively scheduled for 17-18 October 2016 will discuss the progress and status of ongoing projects it is involved in, arrangements for the 4th International Workshop on Tropical Cyclone Landfall Processes (2017) and 6th International Workshop on Monsoons (2017) including proposals for future activities. A Progress Meeting for the Typhoon Landfall Forecast Demonstration Project (TLFDP) and Understanding and Prediction of Rainfall Associated with Landfalling Tropical Cyclones (UPDRAFT) will be held after the WGTMR meeting to discuss where the projects stand with respect to its schedule and any issues affecting progress. In between the progress meetings will be a one day workshop which will feature scientific papers from the two aforementioned research projects. The progress meetings of the two projects and the workshop are being organized by WWRP in close collaboration and cooperation with the Tropical Cyclone Programme.

5.5.4 As mentioned above, plans are in progress to organize the 4th International Workshop on Tropical Cyclone Landfall Processes in 2017. Members of the Committee are therefore urged to actively participate in the above-mentioned workshop. Operational and research meteorologists from RA V Tropical Cyclone Committee Members who intends to participate at the IWTCLP-IV (with or without WMO travel support) should, in a timely manner, inform the Chairman of RA-V TCC of their intent to attend the said workshop.

5.5.5 The Committee noted that the Three World Weather Research Programme (WWRP) projects on tropical cyclones below had been extended to 2018:

a) North Western Pacific Tropical Cyclone Ensemble Forecast Project (NWP-TCEFP) for Typhoon Committee members covering the period 2010 to 2018 (Lead: Japan Meteorological Agency);

b) Typhoon Landfall Forecast Demonstration Project (TLFDP) covering the period 2010 to 2018 (Lead: Eastern China Regional Meteorological Center/CMA).

c) Understanding and PreDiction of Rainfall Associated with landFalling Tropical cyclones covering the period 2014-2018 (UPDRAFT) (Lead: Nanjing University)

5.5.6 The NWP-TCEFP, is a collaborative effort between WMO and the Typhoon Committee and aims to explore the utility of ensemble forecast products through THORPEX interactive Grand Global Ensemble (TIGGE) and thus promote application of the products to the operational forecasting of tropical cyclones. It is closely linked with the TLFDP. The TLFDP is a collaborative effort with the NWP-TCEFP which had been extended to 2018 to continue its work on tropical cyclone genesis and verification of tropical cyclone forecasts and also include collaborative activities with the work of the Typhoon Committee's The Experiment on Typhoon Intensity Change in Coastal Area (EXOTICA). It is envisioned that all the above-mentioned projects will be instrumental in transferring the recent research advances to operational forecast centers in NMHSs, especially those which have been affected by the recent increase in the severity of tropical cyclone events in highly populated coastal areas. UPDRAFT in 2015 successfully held its' first project-related workshop at the Nanjing University from 30-31 November with the participation of several world-renowned tropical cyclone experts.

5.5.7 WWRP's Joint Working Group on Forecast Verification Research had published a report documenting an annotated (or commented) survey of verification methods available for tropical cyclone (TC) forecasts. In the preparation of the document (available for download in the WWRP website), the authors realized that the verification of TCs is a very broad subject. There are many weather and marine parameters to consider, including storm surge and wave height, storm track and intensity, minimum pressure and maximum wind speed, (land) strike probabilities, and wind and precipitation for landfalling storms. User needs for TC verification information are rather diverse, ranging from the modeller's need for information on the accuracy of the detailed three dimensional structures of incipient storms at sea to the disaster planner's need for information on the accuracy of forecasts of landfall timing, location and intensity. It also soon became clear that the science of TC verification is developing rather quickly at the present time. All of these factors led the authors to decide that it would not be wise to make specific pronouncements on "recommended" verification methods at this time, thus the survey report. While an attempt was made to include discussion of verification methods for all of the parameters of interest in TC forecasting, and also for monthly and seasonal TC forecasts, it is possible that some interesting methods have been left out. As the survey is certainly not exhaustive, the authors would be happy to hear from the tropical cyclone community with suggestions for improvements.

5.5.8 The Sub-seasonal to Seasonal Project (S2S) is one of 3 THORPEX Legacy projects established in 2013 to improve forecast skill and understanding on the subseasonal to seasonal timescale with special emphasis on high-impact weather events. Recently established under the S2S project is an "Extremes" subproject to assess the predictability of extreme weather events and promote the use of sub-seasonal to seasonal forecasts of extreme weather and improve the prediction of these events in operational forecasts. Although the sub-projects' main focus are on long-lasting events it also covers extreme synoptic scale events such as tropical cyclones. Extended-range forecasts can successfully simulate the impact of large-scale conditions on the statistics of extreme events, for example tropical cyclones. The Committee learned that the S2S project had published in June 2016 a special article on Tropical Cyclogenesis in the S2S Database (available on the S2S website: http://s2sprediction.net/).

Comment

5.5.9 Samoa's representative commended on the paper and the progress this far. However, his hope is that all the above-mentioned projects will be instrumental in transferring the recent research advances to operational forecast centers in NMHSs, especially those which have been affected by the recent increase in the severity of tropical cyclone events in highly populated coastal areas.

6 Linkage with the WMO Regional Projects

6.1 Report to TCC from the meeting of the Regional Sub-project Management Team (RSMT) for the Severe Weather Forecast and Disaster Risk Reduction Demonstration Project (SWFDDP)

6.1.1 The Regional Sub-project Management Team (RSMT) of the Severe Weather Forecasting and Disaster Risk Reduction Demonstration Project (SWFDDP) met 25-27 August 2016 in Honiara, Solomon Islands with the objectives to:

a. Review compliance with criteria established by the RSMT in 2013 to inform a decision to move the Project to the "operational phase" (Phase 4). This review was based on the assessment of the six-monthly progress reports produced by the member countries since 2013;
b. Address the issue of sustainability of the project, in particular, to identify a regional entity that will be responsible for the Management of the SWFDDP (coordination of: training; reporting; meetings; and resource mobilization).

6.1.2 The RSMT found, through the presentations of the participating countries, that a lot of good work was done in relation to the criteria established by the RSMT in 2013 and this was not necessarily reflected in the countries regular progress reports. This triggered some discussion around the adequacy of the current reporting.

6.1.3 The RSMT identified two small groups to discuss options for the progress reports mechanism and for the sustainability of the project.

6.1.4 A case study was presented on TC Winston by the Fiji Meteorological Service. This led to discussion on other natural hazards that are not within the scope of the SWFDDP. In particular, storm surge was deemed as a significant threat to many within the region.

6.1.5 The discussion on the above subjects lead to the following recommendations

Recommendations/Decisions

1. On the sustainability issue: The RSMT recommended that:
    a. SPREP be the regional entity responsible for the Management of the project and that the SG of WMO and SPREP explore funding a position within SPREP to assist with this Management responsibility.
    b. A full independent review of the SWFDDP be conducted and requested WMO/SPREP/US NOAA NWS to facilitate its realization.
2. On the progress reporting: Recognizing the need for a better way to capture the on-going work of participating NMHSs, it was recommended that there be a more frequent exchange between the participating NMHSs and RSMC Wellington. The RSMT recommended trialing a monthly exchange (this may be in the form of tele/video-conference) and requested WMO/US NOAA NWS to facilitate its implementation. This would be supplementary to the current six-monthly reporting.
3. On the Storm Surge issue: The RSMT recognized the threat posed by storm surge to countries in the Region and also identified sea inundation as a major issue requiring urgent focus. It therefore recommended actions be taken to enhance storm surge forecasting capability and to address sea inundation issues **through research and enhanced modelling.**

4. On the issue of moving to Phase 4 – Operational status: The RSMT decided that pending the implementation of Recommendation 1 a) and 1 b) above, and for the participating NMHSs fulfilling the criteria set at the RSMT in Nadi, August 2013, the SWFDDP will maintain the status quo and continue with the Demonstration Phase (Phase 3).

6.2 1/Report on the Coastal Forecasting Demonstration Project-Fiji

6.2.1 The Committee was informed about the progress on development and implementation of the Coastal Inundation Forecast Demonstration for Fiji (CIFDP-Fiji). Forecasting of coastal inundation from storm surge and other weather phenomena is very important as populations in coastal areas are rapidly growing worldwide – more than 44% people live within 150km of the coast; coastal inundation threatens lives and livelihoods; historically, storm surges have killed more people than winds generated by tropical cyclones, and inundation from earthquake-triggered tsunamis; and storm surges are the most underestimated and misunderstood of natural hazards. Recognizing the extreme vulnerability of coastal areas and reducing the risk of disaster is a priority in WMO, the Joint Inter-governmental Oceanographic Commission and WMO (IOC-WMO) Technical Commission for Oceanography and Marine Meteorology (JCOMM) and the Commission for Hydrology (CHy) established the Coastal Inundation Demonstration Forecasting Project (CIFDP) in 2012. CIFDP is a multi-hazard early warning system, integrating river flow, storm surge, wave and flood forecasting to enhance coastal inundation forecasting and warning systems that could be sustained by the responsible national agencies. The aim of the CIFDP include a reliable open source coastal inundation end to end operational forecasting and warning system; providing specialized training for operators/forecasters and disaster managers; and leveraging cross-cutting cooperation among different scientific disciplines and user communities.

6.2.2 CIFDP is being implemented on national and regional scales to support end-user needs and upon completion, operation forecasting coastal inundation would be provided by National Meteorological and Hydrological Services. It is implemented on a phased approach with full collaboration between individuals and institutions with expertise in storm surge, wave and hydrological flooding; focused on transfer of technology to countries participant in the CIFDP, in particular developing capacity in the National Meteorological and Hydrological Service; public outreach to increase awareness of storm surges; and implemented as demonstration projects.

6.2.3 The Phase 1 of the CIFD-Fiji was from 2013 to 2014, started in 2013 and the outcomes included published Definitive National Agreement signed by Fiji Prime Minister's Office (June 2013); National Capacity Assessment (December 2013); and User Requirements Plan (January 2014). The CIFDP-Fiji's overall co-ordination rest with the WMO Marine Meteorology and Oceanography Division, Hydrology Division, with support from the JCOMM and the Commission on Hydrology (CHy); overall guidance rest with the CIFPD Project Steering Group (PSG); national coordination team led by the Fiji Meteorological Service; and system developer would be led by the Pacific Community (SPC) with advice from the Australian Bureau of Meteorology (BoM), and National Institute of Water and Atmosphere (NIWA) and others.

6.2.4 The Phase 2 of the CIFDP-Fiji was from 2016 to 2019. It started with a Review Meeting in August 2016 to refine the system design, followed by installation of wave buoys; development of wave model; development of storm surge model; meeting of the Project Steering Committee; and national stakeholders consultation. It will also focus on the 2 primary sources of coastal inundation - wind driven storm surge from tropical cyclones (episodic) and wave/swell driven inundation from long period waves from distant storms (e.g; Southern Ocean swells); riverine flooding included, primarily for storm surge inundation, not as a sole source of inundation and Nadi basin will be treated separately from rest of the Fiji Island). The

future plan for CIFDP-Fiji included the finalisation of wave and storm surge development; development of models for tides, sea surface height anomaly and river flooding; pre-operational testing and then Integration of all these models into a combined operational forecast and warning system; development of training materials and conducting subsequent training workshops when relevant; final end to end forecast simulation; going “live” or operational in 2019.

6.2.5 In conclusion, the best methods for river flood forecasting are still to be explored; in the interim, river flood products could be a simple lookup table of flood scenarios, based on local knowledge, for impact based decision support tools and these could be developed further; Nadi basin will be treated separately and NIWA will explore how to address this; training needs to be established, in line with the Users Requirement Plan; and the priority is to train forecasters and raising public awareness of storm surge warnings. The Climate and Oceans Support Program in the Pacific (COSPPac) has been considered a potential program to support training needs. US NOAA, Japan and Korea are also offering training support for forecasters.

6.2.6 The CIFDP-Fiji is supported by the Government of Korea through KOICA and the Korean Meteorological Agency (KMA).

6.2.7 In acknowledging the link between CIFDP-Fiji and the need for better Storm Surge Warnings throughout the region, it was noted that there are strong synergies with the RA-V Task Team for Coastal Inundation and Storm Surge (TT-CISS).

Comments

6.2.8 The committee noted that CIFDP will deliver enhanced capability in the RSMC over a long period of time but there was an urgent need to improve storm surge warning capability in the region as soon as possible. The committee noted the different approaches to regional storm surge warnings in RA I and RA II and called on WMO to explore implementation of either one of these approaches. Further the committee noted the upcoming storm surge workshop in Samoa conducted by the University and requested that the urgent need for regionally based warning services be considered at that forum.

6.2.9 Samoa's representative noted the presentation of the pilot CIFDP project and commend WMO on this initiative that will contribute greatly to Fiji's development. However, other member countries need not wait until the project is rolled-out. As stated in the last couple of days the reality of severe impacts of tropical cyclone related storm surges leading to coastal inundation. We will continue to pursue other avenues such as JMA, BKMG and others for assistance in this field.

6.2 2/ Storm surge product operational in South-West Indian Ocean

6.2.10 At the kind invitation of the Chair of RA V TCC, the Chair of RA I TCC presents the KOUDVAN projects lead by Météo-France from 2011 to 2015, dealing with Storm surge estimations on the whole South-West Indian Ocean basin. 3 million simulations of a simple DANIEL storm surge model which wind speed and air-pressure are forced by a HOLLAND analytic tropical cyclone structure, with optimized variations of the main parameters and fine bathymetry (12s resolution near small islands and 1min resolution near continental coasts) have been performed.

6.2.11 Through those simulations, a database of maximum Storm surge was elaborated in order to provide the members with:

(1) an atlas of maximum storm surge expected among the coasts; and
(2) a standalone tool enabling them to estimate real-time storm surge related with a forecasted TC track and uncertainties.

6.2.12 Météo-France will kindly offer the optimized methodology, the theorical model and also the webservice standalone software to any RA V member interested.

Comments

6.2.13 The committee noted that bathymetric data is an essential input for ocean and coastal wave modelling. The sparseness of medium to high resolution bathymetry for areas of interest requires the use of various technologies and techniques to acquire better datasets. Bathymetric LiDAR data presents the best dataset however, the high costs prevents most countries from acquiring it. Techniques such as extracting bathymetric data from satellite imagery should be pursued with research institutes. A recent proposal by the Government of Japan to extract bathymetry from satellite imagery to be used in storm surge modelling should be looked at as a potential way forward for both acquiring bathymetry for special interest areas as well as undertake storm surge modelling for critical coastlines in the Pacific.

Recommendation

6.2.14 The committee urged WMO and partner agencies on behalf of the countries to pursue opportunities to obtain higher resolution bathymetric data as a basis for delivery of storm surge waning services. Opportunities could include developing algorithms for extracting bathymetry from satellite imagery as well as using technologies such as UAV borne LiDAR to collect bathymetry for target areas in the Pacific to improve storm surge warnings.

6.3 Terms of Reference for the Task Teams for Coastal Inundation and Storm Surge (TT-CISS) and for Severe Weather Forecasting, including Global Data-processing and Forecasting System (TT-SWF)

6.3.1 The committee proposed TORs for its Task Teams as follows for the RAV approval:

6.3.2 The Task Team for Coastal Inundation and Storm Surge (TT-CISS) is responsible for:

6. Promoting the development of coastal inundation and storm surge activities in the RAV region, such as the *Coastal Inundation Forecasting Demonstration Project (CIFDP)* (currently the CIFDP is in Fiji and Indonesia);
7. Identifying the countries in the RAV region that have urgent need for early warnings of storm surge and coastal inundation;
8. Prioritizing activities to improve early warning for storm surge and coastal inundation in the identified countries;
9. Enabling the development of new operational capacity, specialized training, effective outreach and mitigation, by leveraging existing efforts under the WMO RAV working structure, such as the joint WMO Tropical Cyclone Division and Marine Meteorology and Oceanography Division Training Workshops, and output from the CIFPD capacity development activities;
10. Engaging with the broader TCC activities where relevant, to enable other severe weather and disaster risk reduction activities connected throughout the RAV region, and thereby creating a more complete implementation of disaster risk reduction activities.

6.3.3 The Task Team for Severe Weather Forecasting, including Global Data-processing and Forecasting System (TT-SWF) is responsible for:

4. Promoting the development of severe weather forecasting activities in RA V, such as the WMO Severe Weather Forecasting Demonstration Project (SWFDP).

5. Encouraging the prioritization of activities to improve early warning for severe weather in LDCs and SIDS of RA V.
6. Engaging with the broader TCC activities and Working Groups of RA V, to enable other severe weather forecasting and disaster risk reduction activities to be connected throughout the region. This includes taking into account the results of discussions/recommendation from the meetings of the Regional Sub-project Management Team of the Severe Weather Forecasting and Disaster Risk Reduction Development Project (RSMT-SWFDDP).

7 Review of the Tropical Cyclone Operational Plan including technical assistance for the South Pacific and South-East Indian Ocean

7.1.1 In reviewing and updating the Tropical Cyclone Operational Plan for the South Pacific and South-East Indian Ocean (the Plan), the Committee clarified that the representatives of the Committee Members in the session were representing their country in proposing changes and modifications of the Plan.

7.1.2 The Committee reviewed the name lists and approved a number of changes to the Operational Plan. The revised Plan will be forwarded to the RAV MG to TCP for inclusion on their website

7.1.3 The TCOP (Tropical Cyclone Operational Plan) of RA V mentions that the area of responsibility of Meteo-France at the French Polynesia Met service, for its specific production (chapter 3.2.9), includes coastal waters and land areas of Pitcairn Islands (chapter 2.1.1). In practice, Meteo-France at the French Polynesia Met service does not provide special warning bulletins for Pitcairn and in particular no special marine warnings. Meteo-France at the French Polynesia Met service requests that the TCOP be updated, removing the mentions for Pitcairn Islands for French Polynesia in Chapters 2.1.1 and 3.2.9.

As the Pitcairn Islands are a British Overseas Territory, the meeting recommends the UK PR to WMO is advised of this update to the Operational Plan to reflect the current level of service. Further consultation is required to establish what products (if any) Pitcairn is already receiving from Fiji and/or New Zealand and whether there should be any change to the current service.

Recommendations

7.1.4 The Committee noted that the Operational Plan is in need of a comprehensive review and called on WMO to arrange for that to occur as a matter of urgency.

8 Assistance required for the implementation of the Committee programme for future development

Annexes to this chapter (Item8, ANNEXES) are available @
http://www.wmo.int/pages/prog/www/tcp/TCC-16-DOCPLAN.html

8.1 Introduction

8.1.1 The document summarizes decisions and actions from the World Meteorological Congress (Cg), the Executive Council (EC) and Regional Associations (RAs) in particular the Regional Association V (South-West Pacific, RA V).

8.2 Background

8.2.1 The Seventeenth World Meteorological Congress (Cg-17, May 2015) recognized that tropical cyclones, sea-level rise and other adverse impacts of climate change continue to pose significant risk to WMO Small Island Developing States and Member Island Territories (SIDS-MITs) and their efforts to achieve sustainable development; and that international cooperation and partnerships of various kinds and across a wide variety of stakeholders are critical for the implementation of the sustainable development of SIDS-MITs. In this regard, the Cg-17 approved the creation of a programme and adopted Resolution 54 (Cg-17) – Programme for WMO Small Island Developing States and Member Island Territories, with long-term objectives to:

(1) Strengthen the capabilities of WMO Members to meet the needs of their governments and communities through the provision of comprehensive weather, climate and water and related environmental services with particular emphasis on public safety and welfare;

(2) Support the NMHSs of the SIDS-MITs to enhance their capabilities to participate and contribute actively to priority areas such as agriculture, food security and rural development, disaster risk reduction, health, water resources management and climate change adaptation and mitigation; and

(3) Requested the Secretariat through the Development and Regional Activities (DRA) Department of WMO to ensure that this Programme and its activities are reflected in the WMO Operating Plan (OP) 2016–2019 and are supported to the extent possible within available resources.

8.2.2 Following after the Cg-17, the Sixty-eight session of the Executive Council (EC-68, June 2016) supported the priorities identified by the Ad Hoc Advisory Group and the proposal to invite inter-regional representation of Permanent Representatives from WMO SIDS and MITs to an Advisory Group for the SIDS-MITs programme. EC-68 document regarding Implementation of the Small Island Developing States (SIDS) and Member Island Territories (MITs) Programme is given in Annex 8.I. At the 1st 2016 meeting of the president of Regional Associations (20 January 2016, Geneva) Dr Sakya, president of RA V recalled that Cg-17 adopted a new Programme for Small Island Developing States and Member Island Territories and noted the importance of the Programme in RA V. He mentioned that it is necessary to discuss how to implement the Programme and allocate necessary resources to the Programme as given in Annex 8.II.

8.3 Assistance Required for the Implementation of the Committee Programme for Future Development

Re-establishment of the RA V Tropical Cyclone Committee for the South Pacific and South-East Indian Ocean (RA V TCC)

8.3.1 The Committee recalled the outcome of the sixteenth session of RA V (Jakarta, Indonesia, May 2014) agreeing to take up the re-establishment of RA V TCC and endorsed recommendation proposed by the tenth session of the RA V Management Group (MG-10, Jakarta, Indonesia, March 2014) to expand the mandates of the RA V TCC to other severe weather and related events through a creation of a Task Team on Severe Weather Forecasting including Global Data Processing and Forecasting System (TT-SWFD/DPFS), and another Task

Team on Coastal Inundation including Storm Surges (TT-CISS).

Membership of RA V TCC

8.3.2 The Committee was informed that the thirteenth session of RA V Management Group (MG-13, Geneva, May 2015) approved the membership of all RA V subsidiary bodies including TCC as given in Annex 8.III.

Terms of Reference (ToR) of RA V TCC

8.3.3 The Committee was informed that the fourteenth session of RA V Management Group (MG-14, Geneva, June 2016) endorsed the ToR of working groups and TCC as given in Annex 8.IV except for Task Teams of the RA V TCC, the TT-SWFD/DPFS and the TT-CISS which are not completed yet. The MG-14 requested the chairperson of the TCC to complete the ToRs for these 2 Task Teams and submit to the president of RA V for approval.

8.4 Regional Operating Plan and Regional Activities

8.4.1 The Committee recalled that the RA V-16 agreed on the priority areas of concern for Region V and decided to develop an Operating Plan 2016–2019 for the Enhancement of NMHSs in RA V that focuses on the specific needs and requirements within the Region.

8.4.2 The Committee noted that the draft RA V Operating Plan 2016-2019 as part of the WMO-wide Operating Plan 2016-2019 was initially developed by the previous Leads of the RA V Working Groups and Chairperson of the TCC. The Committee noted that the draft RA V Operating Plan 2016-2019 has been further improved by newly elected Leads/Vice-Leads of the WGs and Chairperson of the TCC in consultation with the WMO Technical Departments. The draft Operating Plan has been aligned with the regional priorities in RA V decided by the RA V-16 and also with activities contained in the Pacific Islands Meteorological Strategy (PIMS) 2012-2022 as requested by the RA V-16.

8.4.3 The Committee was also informed that the MG-14 endorsed the RA V Operating Plan 2016–2019 and requested the chairperson of TCC to develop a work plan for 2016–2017 based on the endorsed RA V Operating Plan 2016-2019 as given in Annex 8.V.

8.4.4 The Committee was informed of the most important achievements in RA V since the fifteenth session of RA V TCC (TCC-16, Port Vila, Vanuatu, May 2014), which included:

(1) Refinement and implementation of the Strategic Operating Plan for the Enhancement of National Meteorological and Hydrological Services in Regional Association V (South-West Pacific) 2012–2015 (RA V Strategic Operating Plan) and the development of its subsequent RA V Operating Plan (OP) 2016–2019 reflecting the regional priorities approved by the sixteenth session of RA V for the enhancement of National Meteorological and Hydrological Services in the South-West Pacific;
(2) Development of the RA V work plan 2014–2015 for newly established four working groups with thematic task teams and the TCC, and finalization of the membership of subsidiary bodies based on a new working mechanism by strengthening the Management Group for effective implementation of the RA V Strategic Operating Plan;
(3) Assistance provided by Members and the Secretary-General to support the disaster-affected Member NMHSs, in particular to Tonga following Tropical Cyclone Ian in 2014, Vanuatu following Tropical Cyclone Pam in March 2015;
(4) Implementation of the Global Framework for Climate Services (GFCS) through existing mechanisms such as Regional/Subregional Climate Outlook Forums (RCOFs) including the establishment of the ASEAN Climate Outlook Forum (ASEANCOF) and the Pacific Islands Climate Forum (PICOF) and the organization of the first PICOF (Nadi, Fiji, July 2015); the third meeting of the Pacific Island Meteorological Council (PMC-3) and the

first Pacific Islands Ministerial Meeting on Meteorology (PIMMM-1), both (Nuuku'alofa, Tonga, July 2016); the re-establishment of the Pacific Islands Climate Services (PICS) Panel and the Radio Internet (RANET) Communication Panel, the establishment of the Pacific Islands Aviation Weather Services (PIAWS) Panel), the Pacific Islands Education, Training and Research (PIETR) Panel and the Pacific Islands Marine and Oceans Services (PIMOS) Panel, to provide advice to the PMC; and progress on National Climate Outlook Forums for Kiribati (September & October 2015), Papua New Guinea (March 2015) and Vanuatu (March 2016); National Stakeholders Consultation on climate services for Papua New Guinea (October 2015) and Vanuatu (March 2015); and development of National Framework for Climate Services for Papua New Guinea and Vanuatu;

(5) Adoption and implementation of the Regional WIGOS Implementation Plan (R-WIP-V) and the Regional WIS Implementation Plan for 2016–2019;
(6) Installation of a new Automatic Weather Station (AWS) in Niue, with support from the Finland-Pacific (FINPAC) project;
(7) Upgrading of selected Regional Basic Synoptic Network (RBSN) stations in Pacific SIDS, with support from the FINPAC project;
(8) Community-Based early warning system established in selected communities in Cook Islands, Tonga and Vanuatu, all supported by the FINPAC project;
(9) Media training for Pacific Islands' NMHSs, with support from the FINPAC project;
(10) Installation of SMARTMET in Papua New Guinea, Samoa, Solomon Islands, Tonga and Vanuatu, with support from the FINPAC project.

9 Partnerships

9.1 Pacific Meteorological Desk Partnership (PMDP).

9.1.1 The Pacific Meteorological Desk Partnership (PMDP) is the secretariat established by the members of the Pacific Meteorological Council (PMC) and endorsed by the SPREP council meeting to provide support to the NMHSs of the Pacific region. The SPREP based secretariat is composed of SPREP staff and the WMO sub regional office. The PMC is held on a bi-annual basis where directors are invited to report on their progress in implementing the Pacific Islands Meteorological Strategy (PIMS) 2012-2021. Since its inception of the PMC in 2011, it has attracted potential partners and continues to grow. The PMC has now established five expert working groups on Climate Services, Aviation Weather Services, Education and Training, Communication and Infrastructure, and Marine and Ocean Services Panel.

9.1.2 In 2015, the first Pacific Ministers Ministerial Meeting on Meteorology (PMMM-1) was convened back-to-back with the PMC-3 held in Nuku'alofa Tonga in an attempt to raise the visibility of investing in meteorological services. Ministers for meteorology during the meeting endorsed the Nuku'alofa Ministerial Declaration on sustainable weather and climate services for a resilient Pacific. The declaration recognised the collective effort to build meteorology and early warning services in the region as well as highlighted key issues for the region and seek support from partners and donors.

9.1.3 SPREP through the PMDP is currently implementing a number of projects supporting the NMHSs including the FINPAC Project funded by the Government of Finland; a Climate Prediction project supported by the Government of Korea, the APCC and the Pacific Island Forum Secretariat; a project on climate support by WMO and the Government of Canada; upper air programme for Tuvalu and Kiribati supported by UKMO and MetService New Zealand; and the COSPPac transition.

9.1.4 The PMDP provides a framework for collaboration with partners to better coordinate activities in the region.

9.2 Support to Tsunami Early Warning System in the South-West Pacific

9.2.1 The meeting noted the presentation by the IOC SWP working group on warning and mitigation and the meeting that took place on the 22-23 August 2016, in Honiara, Solomon Islands with the following out comes

1. Establishment of the task team on competency of warning center staff
2. Establishment of the task tem on tsunami ready for communities and
3. The Establishment of the working group to improve local tsunami warnings

9.2.2 Recommendations from the working group to the TCC included

1. The meeting to note report and the needs, challenges and steps being taken to improve EWS for tsunami and other coastal hazards in the Southwest Pacific by IOC/PTWS and other partners .
2. Agree to collaborate on common issues to strengthen Multi-hazard EWS.
3. Agree to organize back-to-back meetings of the two Working Groups in 2018 and to continue to have an Agenda Item on Tsunami Early Warning and Mitigation in the TCC Agenda during the TCC meeting.

9.2.3 The meeting agreed to consider the recommendations.

9.3 WMO Coordination with regional or international organizations

JMA Activities *(Hiroshi Koide, Head, Office of International Affairs, JMA)*

9.3.1 Mr. Koide appreciated the opportunity for JMA to participate in RA-V TCC for the first time and presented updates on JMA's Himawari-8 satellite and its products, launched 7 October 2014 and started operation on 7 July 2015, having replaced MTSAT-2.

9.3.2 The Committee was informed that observation capabilities, especially the spatial and temporal resolutions were significantly enhanced, as well as spectral bands, which were increased from 5 to 16. Accordingly, data and products distribution/dissemination services were enhanced.

9.3.3 Mr. Koide explained the major two ways of data supply: HimawariCloud and HimawariCast, and their specifications. JMA is also coordinating projects with WMO and JICA to install HimawariCast receiving systems in National Meteorological and Hydrological Services (NMHSs) followed by on-site training events, for the purpose of ensuring reception and the use of satellite imagery for the operational meteorological services even in an unstable internet environment.

9.3.4 Mr. Koide introduced JMA's satellite-related activities, including the SATellite Animation and Interactive Diagnosis (SATAID) application service and new Himawari-8 products such as RGB imagery.

Japanese International Cooperation Agency (JICA): Recent Assistance of JICA for SIDS. *(Kyoji Mizutani (JICA INSI))*

9.3.5 JICA is the executing agency of Japanese ODA to assist developing countries to resolve various issues. Human Resource Development and Capacity Development of meteorological institutions in Pacific countries are one of the priority area. Pacific-LEADS program for 14 PICs offer opportunities for 100 officers to study for Master degree at 42 universities in Japan. A regional technical cooperation project entitled "Reinforcing Meteorological Training Function of FMS" was launched in Dec. 2014and is now fully in

progress with training activities. HimawariCast Receiving System has been provided to Solomon Islands, Vanuatu and Fiji in July 2016 along with JICA/JMA collaborating training-seminars in all these countries for a follow-up

WMO/ESCAP Partnership Framework for RAV TCC

9.3.6 The Economic and Social Commission for Asia and the Pacific (ESCAP) is the multi-disciplinary and multi-sectoral inter-governmental regional arms of the United Nations with the mandate to promote regional cooperation towards achieving the goals and targets of the 2030 Agenda for Sustainable Development as well as the Sendai Framework for Disaster Risk Reduction. ESCAP, together with WMO, has been supporting the member States in the Northern Pacific Ocean and the Indian Ocean to jointly address risk from tropical cyclones. The ESCAP/WMO Typhoon Committee (TC) and the WMO/ESCAP Panel on Tropical Cyclones (PTC) were established in 1968 and in 1974 respectively, and these two inter-governmental platforms have been promoting the knowledge and information sharing related to the tropical cyclones. In particular, ESCAP, with its Trust Fund on Tsunami, Disaster and Climate Preparedness, has supported several capacity development activities of TC and PTC member Countries – particularly those having high risk and low capacities. The engagement of ESCAP through these platforms has helped in promoting multi-sectoral approach by bringing national meteorological and hydrological services as well as disaster management authorities together through their working groups on meteorology, hydrology and disaster risk reduction. Recently, ESCAP has initiated several capacity development activities on multi-hazard early warning systems through RSMC Tokyo and New Delhi.

9.3.7 At 71st Session of ESCAP Commission in May 2015, the member States, particularly those from Pacific SIDS, have requested the ESCAP secretariat to guide regional actions in addressing common and transboundary disasters by deepening and expending regional cooperation mechanisms. Further, at the 4th session of the ESCAP Committee on Disaster Risk Reduction in October 2015, they recommended ESCAP to support the WMO Tropical Cyclone Committee for the South Pacific.

9.3.8 It's with the above context that ESCAP at the 16th session of RA V (South-West Pacific) Tropical Cyclone Committee for the South Pacific and South-East Indian Ocean proposes to outline the WMO/ESCAP partnership framework for TCC members. Based on the learning experience of the two regional platforms (TC and PTC), the framework aims at inviting the views and suggestions from the member Countries on the feasibility of configuring a regional WMO/ESCAP platform associated with TCC. Further, ESCAP has made concerted efforts to expand its activities related to multi-hazard risk assessment and early warning in TCC countries. ESCAP would brief the TCC member Countries how these activities fits well with the proposed WMO/ESCAP framework.

Comments

9.3.9 The committee noted with appreciation the geographic extension of ESCAP into the SW Pacific and look forward to additional projects partnered by ESCAP.

On the recommendation to partner or engage with ESCAP in the operation of the RA V Tropical Cyclone Committee, the committee would require significantly more information about the financial, governance and overall consequences of such a significant change to the structure of the committee. Further the committee noted that the current financial, governance and administrative arrangements with WMO around the operation of the committee are quite satisfactory and meet the needs of the members. The committee would however be prepared to consider a detailed proposal from ESCAP secretariat regarding an alternative structure at its next meeting in 2018.

International Federation of Red Cross and Red Crescent Societies

Building on FINPAC project for Forecast-based Financing (FbF) Initiatives in the Pacific (*Stephanie Zoll, DRM Coordinator, IFRC Country Cluster Support Team in Suva, and Sanna Salmela-Eckstein, Operations Coordinator, IFRC Asia Pacific Regional Office in Kuala Lumpur)*

9.3.10 International Federation of Red Cross Red Crescent (IFRC) is the Secretariat of 190 Red Cross Red Crescent National Societies, including the 14 Pacific Red Cross National Societies (RC NS). The main role of the IFRC is to support strengthening of National Society capacities in different areas of focus DRR, Shelter, Livelihoods, Health, WASH, etc. One of the core functions of IFRC is to assist National Societies in strengthening the Institutional Disaster Preparedness which includes the development or updating of DM/ Contingency Plans, support to Emergency Response Team trainings and Pre-disaster meetings amongst others.

9.3.11 One of the initiatives immediately related to the discussions at the WMO meeting is the Finnish Pacific (FINPAC) project implemented by 8 Pacific RC NS in Cook Islands, Tuvalu, Tonga, Vanuatu, Marshall Islands, Kiribati, Solomon Islands and Samoa. The RC NS were identified as key implementing partners due to their network of volunteers, branches and community-based work. The objectives of the FINPAC include the enhancement of the working relationship between the RC NS, Met Offices and the National Disaster Management Offices (NDMO). Another objectives was to look at the simplification of the key weather messages and relaying these messages to communities in a way they can make better and timelier decisions based. Secretariat of the Pacific Regional Environment Program (SPREP) and IFRC provided overall guidance and technical support to the National Coordination Team which was established under the FINPAC project.

9.3.12 What is forecast-based Financing (FbF)?[21] FbF is a system to finance preparedness and readiness for response actions. Funds are released and actions are triggered by a climate or weather forecast with a certain level of probability that a danger level threshold will be crossed. A danger level is worked out well in advance by multiple stakeholders for climate conditions that will cause unacceptable problems for people.

9.3.13 Because of increasing climate related risks, people in need, stagnating humanitarian funding, an anticipatory humanitarian system is needed. Since forecasts are available , and if humanitarian actors work more closeley with scientist, we can create an anticipatory, more effective and efficient humanitarian system. An FbF system requires strong collaboration between national Met Services, NDMOs, local government, Red Cross and other organisations supporting communities.

9.3.14 We already do “Early Warning Early Action” in our humanitarian work, but institutional learning within the Red Cross Movement shows that the bottle necks are frequently:

- Lack of *funding* available to be used in the window after early warning information is received and before a disaster strikes and
- Lack of *standard operational procedures* for mobilizing action in this window

9.3.15 For partnership opportunities with RC NS/IFRC in the Pacific, we propose to base them on the RC NS strengths: weather and warning messaging through RC NS networks to community level, understanding of vulnerabilities and risks through Vulnerability and Capacity Assessments (VCAs), and actions by local responders. We propose to build in a FbF component into new initiatives through partnerships with the aim to boost end-user application of the

[21] https://vimeo.com/153078147

hydro-meteorological products developed.

9.3.16 The Red Cross is supporting number of FbF pilot projects globally, especially flood FbF pilots. Most of the first pilots are being implemented by the National Societies with the support of the German Red Cross with funding from the Government of Germany, technically supported by the Red Cross Red Crescent Climate Centre. Australian Red Cross supported a scoping study in the Pacific that focused on PNG, Solomon Islands and Fiji. FbF at community level (as opposed to institutional level) is to some extent problematic in the Pacific as the 'risk of acting in vain' is high, meaning that FbF could be triggered multiple times as a cyclone shifts tracks. Based on good skills of forecasts for long lead-time hazards, e.g. droughts, the feasibility of drought FbF in the Pacific could be high. Looking into flood FbF could be interesting as well (despite the short lead-times) as the related HYCOS-2 proposal was presented during the meeting. Pacific Community (SPC) shared that Cook Islands, Samoa and Marshall Islands (of the above mentioned 8 Pacific countries) implemented a World Bank-lead initiative to provide disaster risk financing tools (insurance/risk pooling and mutual insurance fund) to the countries. There are also opportunities for collaboration with the Pacific Resilience Programme on EW and preparedness and risk resilient initiatives implemented by Samoa, Tonga, SPC and PIFS.

9.3.17 Globally and in the Asia Pacific IFRC is committed into moving ahead these innovative initiatives at different levels. At the World Humanitarian Summit (WHS) in May 2016, IFRC pledged its commitment to increase the use of forecast-based financing and to integrate this mechanism into our global disaster risk management funding tools (e.g. Disaster Relief Emergency Fund (DREF)), in order to systematically trigger early action based on reliable early warning.

TC Winston Post Assessment & Integrated Disaster Risk Reduction Framework
(Bapon Fakhruddin, PhD, Tonkin+Taylor International & PSG member of CIFDP of WMO)

9.3.18 Mr Fakhruddin has presented the tropical cyclone Winston response (Rapid Damage Mapping) and integrated disaster risk reduction framework for coastal community resilience. Tonkin and Taylor International (T+TI) deployed engineers to Fiji immediately following Cyclone Winston (arrived on first flight from New Zealand) to undertake damage reconnaissance. A GIS web based platform called Project Orbit was set up to facilitate access to factual and interpretative reconnaissance information to assist aid organisations and UNOCHA to coordinate their response, Key information added to this platform comprised high resolution oblique aerial imagery taken by the New Zealand Defence Force in the days following the cyclone. Regional scale building damage assessments were undertaken by data analysts in New Zealand within 2 days of these photographs becoming available. Evacuation centre locations and aid deployment information was also added at the request of aid organisations who were utilising this information. Other relevant information relating to the cyclone path, storm tide levels and road closure information were also provided.

9.3.19 TC Winston in February 2016 proved how vulnerable Fiji's community was, and scientific information alone cannot make them resilient. An end-to-end-to-end early warning system, together with the appropriate infrastructure, is essential to enable the community to build resilience. In general, the Pacific island communities; livelihoods, infrastructure and national economies are highly vulnerable to climate change. Sea level rise, storm surges, changing rainfall patterns, and extreme weather events and geo-hazards like tsunamis and earthquakes are severe threats as the majority of the population lives near the coast. In order to support communities' socio-economic and eco-environmental endeavors, strategies must be adopted to achieve sustainability and resilience, and to reduce vulnerability to natural disasters. The country needs an integrated multi-hazard risk management approach.

PREP Pacific Resilience Programme by the Secretariat of the Pacific Communities (SPC)

9.3.20 The Pacific Resilience Programme (PREP) is being implemented by Samoa, Tonga, the Republic of the Marshall Islands, Vanuatu, the Pacific Community (SPC) and the Pacific Islands Forum Secretariat (PIFS) as a series of projects. PREP aims to:

- Strengthen the disaster early warning capacity of participating countries through improved hazard forecasts, with more user friendly, impact-based warning messages provided to populations at risk.
- Implement priority pilot investments which will strengthen the resilience of key public infrastructure such as schools and hospitals.
- Strengthen the financial capacity of participating countries to respond to disaster events.

9.3.21 PREP promotes the local implementation of shared resilience objectives and will potentially expand to other PICs involved in future phases.

9.3.22 The investments by Samoa and Tonga in strengthening early warning and preparedness capacities will be complemented by work undertaken by SPC to develop operational hazard models for forecasting of impacts and providing preparedness and response capacity as well as support to Post Disaster Needs Assessments. Additional investments by Samoa and Tonga to prepare feasibility studies for investments in Phase 2 and retrofit public buildings. The development of decision support tools to prioritise investments including for communities is also part of the work to be undertaken.

9.3.23 Collaborations between NIWA, GNS, GA, SPC and WB to develop risk tools that will inform decision making as well as impact forecasting have progressed with studies being undertaken in Vanuatu, Samoa and Tonga.

9.3.24 The meeting noted the potential opportunities for collaboration with the Pacific Resilience Programme on initiatives relating to early warning and preparedness and investments in resilience.

9.3.25 The meeting noted the continuation of the catastrophe risk insurance under the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) and concerns raised by countries on the parameters used to trigger the process for payouts reflecting on the experience of the Solomon Islands in 2014 where a tropical depression caused severe flooding prior to a cyclone being named.

Recommendation (proposed by SPC)

9.3.26 Recommend that SPC raise with the World Bank the concerns raised around the lack of observation data from the region used in the calculation of event losses as part of the Pacific catastrophe risk insurance and facilitate a discourse between NMHS to making observation data available to the WB reporting agent.

10 Date and place of the Seventeenth session

10.1.1 The Committee noted and appreciated that the representatives from Samoa and New Caledonia offered to host the seventeenth session in 2018. Dates will be determined during the

intersession.

10.1.2 The committee noted the significant advantages in holding additional meetings in conjunction with the TCC e.g. Tsunami WG, RSMT of the SWFDDP and several Panels under the PMC and urged WMO to work towards adopting that concept for the next TCC meeting. On occasions it has been practice to hold TCC in conjunction with the RA V meeting however it was felt there were greater synergies to be achieved if the TCC met separately and the additional regional WGs and Panels were able to leverage off the TCC meeting.

11 Closure of the session

11.1.1 The sixteenth session of the RAV Tropical Cyclone Committee closed at 12:00 hours on Friday 6nd September, 2016.

12 Annexes

12.1 Annexe 1.I: List of participants

1. MEMBER

COUNTRY	PARTICIPANT
AUSTRALIA	**Mr Mike BERGIN** Tel. No: + 61.8.9263.2210 Fax No: + 61.8.9263.2211 E-mail: m.bergin@bom.gov.au **Mr David GRANT** Tel. No: Fax No: E-mail: David.Grant@bom.gov.au
COOK ISLANDS	**Mr Arona NGARI** Tel. No: + 682.20603 Fax No: + 682.21603 E-mail: angari@met.gov.ck
FIJI	**Mr Misaeli Mavoa FUNAKI (RSMC)** Tel. No: + 679.6724.888 Fax No: + 679.6720.430 E-mail: misaeli.funaki@met.gov.fj **Mr Stephen MEKE (FMS)** Tel. No: + 679.6724.888 Fax No: + 679.6720.430 E-mail: stephen.meke@met.gov.fj
FRENCH POLYNESIA and NEW CALEDONIA	**Mr Patrice LECHANTEUR** Tel. No: + 687.27.93.03 Fax No: + 687.27.93.27 E-mail: Patrice.lechanteur@meteo.fr
INDONESIA	**Mr Miming SAEPUDIN** Tel. No: + 62.21.654.6315 Fax No: + 62.21.654.6318 E-mail: misae4u@yahoo.com

KIRIBATI	**Mr Ueneta TOORUA** Tel. No: + Fax No: + E-mail: uenetat@gmail.com
NEW ZEALAND	**Mr Chris NOBLE** Tel. No: + 64.4.470.1175 Fax No: + E-mail: noble@metservice.com
NIUE	**Ms Rossy PULEHETOA MITIEPO** Tel. No: + Fax No: + E-mail: Rossy.Mitiepo@mail.gov.nu
PAPUA NEW GUINEA	**Mr Jimmy GOMOGA** Tel. No: + 675.325.2788 Fax No: + 675.325.5544 E-mail: jgomoga@pngmet.gov.pg
SAMOA	**Mr Ausetalia TITIMAEA** E-mail: ausetalia.titimaea@mnre.gov.ws **Mr Luteru TAUVALE** Tel. No: + 685 20855 Fax No: + 685 20857 E-mail: luteru.tauvale@mnre.gov.ws

SOLOMON ISLANDS	**Mr. David HOSIARA** E-mail : d.hosiara@met.gov.sb **Mr Lloyd TAHANI** Tel. No: + 677.24218 Fax No: + 677.23029 E-mail: l.tahani@met.gov.sb **Mr Noel SANAU** E-mail: noel.sanau@met.gov.sb **Mr Solomon SAMMY** E-Mail: s.sammy@met.gov.sb **Mr Freddy FERAH** E-mail: f.ferah@met.gov.sb
TONGA	**Mr Ofa FA'ANUNU** E-mail: ofaf@met.gov.to **Mr Laitia FIFITA** E-mail: laitiaf@met.gov.to Tonga Meterological Service Domestic Terminal Fua'amotu Airport Nuku'alofa TONGA Phone : (676) 35 355 Fax : (676) 35123
TUVALU	**Mr Tauala KATEA** E-mail: tauala.k@gmail.com
UNITED STATES OF AMERICA	**Mr Tom EVANS** E-mail: tom.evans@noaa.gov

VANUATU	**Mr Davidson GIBSON** Tel. No: + 678.24686 Fax No: + 678.27414 E-mail: dgibson@meteo.gov.vu **Mr Jerry GOGON** Tel.No: + 678 24 586 Fax No: + 678 22310 E-Mail: jtimothy@meteo.gov.vu

2. EX OFFICIO MEMBER

Chairperson of the RA I TCC	**Mr David GOUTX** Tel. No.: +262 262 92 11 01 Fax No.: +262 262 92 11 47 E-Mail: david.goutx@meteo.fr

3 INVITED EXPERT

Chairperson of the RA V WG-HYS	**Mr John FENWICK** E-Mail: John.Fenwick@niwa.co.nz

4. INTERNATIONAL AND REGIONAL ORGANIZATIONS AND OBSERVERS

SPC	**Ms Litea Biukoto** E-mail : liteab@spc.int
UNESCO IOC	**Mr Rajendra PRASAD** Tel. No: + 679.3381.377 & 9437.647 (Mobile) Fax No: + 679.3370.040 E-mail: r.prasad@unesco.org

JMA	**Mr Hiroshi KOIDE** **E-mail:** hkoide@met.kishou.go.jp
JICA Solomon Islands Office	**Mr Kyoji Mizutani** E-mail : Mizutani.Kyoji@jica.go.jp
IFRC	**Ms Stephanie ZOLL** E-mail: stephanie.zoll@ifrc.org **Ms Sanna Pauliina SALMELA-ECKSTEIN** E-mail : sanna.salmela@ifrc.org
SPREP	**Mr Salesa NIHMEI** E-mail: salesan@sprep.org **Mr Alexander MONTORO** E-mail: alexanderm.ext@sprep.org
Tonkin + Taylor	**Mr. Bapon FAKHRUDDIN** Senior Specialist DRR and Climate Resilience Tel: + 64 9 355600 & +64 22 0891622 Email: bfakhruddin@tonkintaylor.co.nz

5. WMO SECRETARIAT

Dr Taoyong PENG	Chief, Tropical Cyclones Programme (TCP) Weather and Disaster Risk Reduction Services Department (WDS), WMO Tel. No: + 41.22.730.8145 Fax No: + 41.22.730.8128 E-mail: tpeng@wmo.int
Mr Abdoulaye HAROU	Chief, Data Processing and Forecasting Systems, Weather and Disaster Risk Reduction Services Department (WDS), WMO Tel.No.:+41 22 730 8231 Fax:+41 22 730 8128 E-Mail: aharou@wmo.int

Ms Anne-Claire FONTAN	Scientific Officer, Tropical Cyclone Programme Weather and Disaster Risk Reduction Services Department (WDS), WMO Tel. No: + 41.22.730.8151 Fax No: + 41.22.730.8128 E-mail: acfontan@wmo.int
Mr Henry TAIKI	WMO Sub-regional Office for the South-West Pacific Development and Regional Activities Department Tel. No: + 685.25706 Fax No: + 685.25771 E-mail: htaiki@wmo.int

12.2 Annexe 1.II: Agenda

Day 1 – Monday, 29 August 2016	
08:30 – 09:30	➢ Registration for participants
09.30-12.00	**Morning session**
Coffee break (30 mn)	➢ Item 1.1: Opening of the session ➢ Item 1.2: Adoption of the agenda (5mn) ➢ Item 1.3: Working arrangements (5 mn) ➢ Item 2: Report of the Chairperson of the Committee (30mn) ➢ Item 3.1: RSMC Nadi o Summary of the cyclone season o Development of RSMC Nadi
12.00- 13.00	*Lunch Break*
13.00-16.30	**Afternoon session**
Coffee break (30 mn)	➢ Item 3.2: Reports of Members (15 mn for each country)- *to be continued*
Day 2 – Tuesday, 30 August 2016	
08.30-12.00	**Morning session**
Coffee break (30 mn)	➢ Item 3.2: Reports of Members (15 mn for each country) ➢ Item 9.3/1 : Partnerships / JMA o Presentation by Hiroshi Koide : JMA's activities, including Himawari-8. ➢ Item 9.3/2 : Partnerships / JICA o Presentation by Kyoji Mizutani
12.00- 13.00	*Lunch Break*
13.00-16.30	**Afternoon session**
Coffee break (30 mn)	➢ Item 6.1: Report of the meeting of the Regional Subproject Management Team for the SWFDDP for the South Pacific Islands (30 mn) ➢ Item 5.1: Meteorological component ➢ Item 5.2: Hydrological component o Presentation by the Chairperson of the RAV WG-HYS (60) mn ➢ Item 5.3: Disaster Risk Management, Disaster Risk management and Public Weather Services delivery component
Day 3 – Wednesday, 31 August 2016	
08.30-12.00	**Morning session**
Coffee break (30 mn)	➢ Item 5.4: Training component and capacity development ➢ Item 7: Review of the Operational Plan
12.00- 13.00	*Lunch Break*

13.00-16.30	**Afternoon session**
Coffee break (30 mn)	➢ Item 6.2/1: Report on the Coastal Forecasting Demonstration project-Fiji and Strom Surge Watch Scheme ➢ Item 6.2/2: Storm Surge product, operational in SW Indian Ocean (by David Goutx, RA1 TCC Chairman) ➢ Item 9.2: Support to Tsunami Early Warning System in the South-West Pacific ➢ Item 6.3: Terms of Reference of the Task Teams (TT) o TT on Severe Weather Forecasting including Global Data-processing and Forecasting System (TT-SWF) o TT on Coastal Inundation including Storm Surges (TT-CISS)
Day 4 – Thursday, 1 September 2016	
08.30-12.00	**Morning session**
Coffee break (30 mn)	➢ Item 4: Coordination within the WMO TCP ➢ Item 5.5: Research component ➢ Item 8: Assistance required for the implementation of the Committee programme for future development ➢ Item 9.1: Pacific Meteorological Desk Partnership (PMDP)
12.00- 13.00	*Lunch Break*
13.00-16.30	**Afternoon session**
Coffee break (30 mn)	➢ Item 9.3/3: Partnerships/ESCAP ➢ Item 9.3/4: Partnerships/Tonkin and Taylor (Bapon Fakhruddin) ➢ Item 9.3/5: Partnerships/IFRC ➢ Item 9.3/6: Partnerships/Secretariat of the Pacific Community (SPC)
Day 5 – Friday, 2 September 2016	
08.30-12.00	**Morning session**
Coffee break (30 mn)	➢ Review of the session report ➢ Item 10: Date and place of the 17th session ➢ Item 11: Closure of the session
12.00- 13.00	*Lunch*

12.3 Annexe 3.I: Development of RSMC NADI, list of the various projects

Listed below are the projects and infrastructure development which FMS has undertaken since 2012.

Year	Project Title	Cost (FJD)
2012	Upgrade of Nadi and Nausori Conventional radar to Doppler	$1,790,000.00
	Construction of new office building in Nausori Radar	$160,000.00
	Upgrade of Outer Island Station (on-going)	$150,000.00
	Installation of AWS in 5 islands	$300,000.00
2013	Upgrade of Laucala Bay Office	$1,825,000.00
	Replacement of Hydrogen Generator *Previous installed by NOAA-1980*	$292,000.00
	CliDE Services Application	$105,000.00
	Installation of AWS in 3 islands	$200,000.00
	Replacement of HF Radio for Outer Island Station *Some were installed in the 1940's*	$302,000.00
	Supply & Installation of Water Level and Rainfall Equipment	$450,000.00
	Installation of AWS in 3 islands	$200,000.00
	Replacement of HF Radio for Outer Island Station *Some were installed in the 1940's*	$302,000.00
	Supply & Installation of Water Level and Rainfall Equipment	$450,000.00
2014	Upgrade of National Climate Monitoring Telemetric System (2013 – 2015) *13 Electronic Climate Station*	$1,240,000.00
	Data rescue & Digitization	$402,000.00
	Replacement of Nadi & Nausori Airport Wind Sensor *Sensor used came into operation in 1942*	$603,000.00
	Upgrade of National Climate Monitoring Telemetric System (2013 – 2015) *13 Electronic Climate Station*	$1,240,000.00
	Data rescue & Digitization	$402,000.00
	Replacement of Nadi & Nausori Airport Wind Sensor *Sensor used came into operation in 1942*	$603,000.00
2015	Supply of FIMS Server and Workstation Replacement (2014 – 2016) *Operates the AIF since 1998* *Migrate FMS AIFS system to a new virtualised cluster system* *IBL – Visual weather*	$2,800,000.00
2016	Nadi Airport Runway Threshold AWOS upgrade	$1,290,000.00
	Nadi Radar Antenna Upgrade	$1,900,000.00

ANNEX V

LIST OF PARTICIPANTS

1. Members of Management Group and Representatives of RA V

Mr Andi Eka SAKYA President of RA V, Chairperson	Indonesia	Andi.eka.sakya@bmkg.go.id
Ms Helminah HERAWATI	Indonesia	Helminah.herawati@bmkg.go.id
Mr Ardhasena SOPAHELUWAKAN	Indonesia	ardhasena@bmkg.go.id
Ms Anni ARUMSARI	Indonesia	anni.arusmsari@bmkg.go.id
Mr Andrew JOHNSON	Australia	andrew.johnson@bom.gov.au
Mr John GILL	Australia	j.gill@bom.gov.au
Mr Ravind KUMAR	Fiji	Ravind.kumar@met.gov.fj
Mr John FENWICK	New Zealand	j.fenwick@aiwa.co.nz
Ms WONG Chin Ling	Singapore	wong_chin_ling@nea.gov.sg

2. WMO Secretariat

Regional Office for Asia and the South-West Pacific, DRA

Dr Chung Kyu PARK Director	cpark@wmo.int
Mr Ryuji YAMADA Programme Manager	ryamada@wmo.int
Mr Yan F. PERMADHI Seconded Expert	yfpermadhi@wmo.int
Ms Hyo Ji KANG Intern	hjkang@wmo.int

Development and Regional Activities Department

Ms Mary POWER Director	mpower@wmo.int
Mr Kuniyuki SHIDA Senior Coordinator, Regional and Technical Integration	kshida@wmo.int

Observing and Information Systems Department

Mr Dean LOCKETT dlockett@wmo.int
Scientific Officer, WMO Observing System Division

Mr Lars Peter RIISHOJGAARD LRiishojgaard@wmo.int
Project Manager, WMO Integrated Global Observing System Branch

Mr David THOMAS dthomas@wmo.int
Chief of Information and Telecommunications

Climate and Water Department

Mr Claudio CAPONI ccaponi@wmo.int
Head of Capacity Building Hydrology and Water Resources Management

Mr Rupa Kumar KOLLI rkolli@wmo.int
Chief of World Climate Application Service

Weather and Disaster Risk Reduction Services Department

Mr Jochen LUTHER jluther@wmo.int
Junior Professional Officer, Disaster Reduction Risk and Service Delivery Branch

Language, Conference, and Publishing Service Department

Mr Elhousseine GOUAINI egouaini@wmo.int
Chief of Conferences Services

_____