WORLD METEOROLOGICAL ORGANIZATION

REGIONAL ASSOCIATION V STORM SURGE WATCH SCHEME ACTION TEAM MEETING

Melbourne, Australia, 15-16 December 2008

MEETING REPORT

March 2009

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Regulation 43

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C O N T E N T S

GENERAL SUMMARY OF THE WORK OF THE MEETING

1. Opening and Welcome

1.1 The Regional Association V (RA V) Storm Surge Watch Scheme (SSWS) Action Team meeting was opened by the chair of the RA V Tropical Cyclone Committee (TCC), Mr Mike Bergin, at 0900 hrs on Monday, 15 December 2008, in the Conference Room of the Bureau of Meteorology (BoM), Melbourne, Australia. Mr Bergin welcomed participants to the meeting and to Melbourne, and introduced the Deputy Director Services of the Bureau of Meteorology and Permanent Representative of Australia with WMO, Mr Gary Foley, to address the session.

1.2 Mr Gary Foley welcomed participants in the Regional Association V (RA V) Storm Surge Watch Scheme (SSWS) Action Team meeting to the Bureau of Meteorology and to Australia. Mr Foley recalled tropical cyclone Nargis that caused such a devastation and loss of lives in the most populous and low-lying areas of Myanmar in May 2008 and the recent environmental emergency that has inflicted damage in many Pacific Islands Countries (PICs) as a result of large wind-induced waves (swell) generated from distant winds over the North Pacific, which caused widespread flooding in the exposed islands. He was pleased to note that WMO had initiated some activities to assist Members exposed to these risks by enhancing their capabilities to access and understand existing wave and storm surge products worldwide, and to make use of them for operational forecast and warning services. In this context, Mr Foley recalled that the *Fifth TCP/JCOMM Regional Workshop on Storm Surge and Wave Forecasting* was held at the BoM Training Centre, in Melbourne from 1 to 5 December, in particular to address the wave and storm surge forecasting requirements of the Pacific Islands Countries (PICs).

1.3 Mr Foley also recalled that the WMO Executive Council, at its 60th session (EC-LX, Geneva, Switzerland, June 2008), addressed the need for the provision of storm surge guidance information to Members exposed to these risks as a matter of priority, and therefore agreed that a storm surge watch scheme attached to the tropical cyclone advisory arrangements would help to increase advisory lead-time and thus contribute to saving lives and properties. He was pleased to note that, in support of this objective, the Regional Association V Tropical Cyclone Committee (RA V TCC), in its twelfth session (RA V/TCC-XII, Niue, July 2008), took a lead role and discussed the possible implementation of a storm surge watch scheme in RA V. It therefore decided to establish an Action Team to address this issue. In closing, Mr Foley assured participants of the full support of his staff and he concluded by wishing all participants a very successful meeting and an enjoyable stay in Australia.

1.4 On behalf of the Secretary-General of the WMO, Mr M. Jarraud, the Chief of the Marine Meteorology and Ocean Affairs Division, Mr Edgard Cabrera, welcomed participants to the Regional Association V (RA V) Storm Surge Watch Scheme (SSWS) Action Team meeting. In doing so, he expressed the very sincere appreciation of WMO to the Bureau of Meteorology for providing the excellent facilities as well as for the tremendous organizational effort already put into preparations for the meeting, the third of a series of back-to-back meetings, all being hosted by the BoM. Mr Cabrera stressed that the coordination of a continued provision of safety-related weather and oceanographic services, including wave and storm surge forecasting and warning services, is a fundamental activity for the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) and for WMO. He assured participants of the full support of the Secretariat, both during the meeting and throughout the implementation of actions arising from the meeting. He concluded by wishing all participants a very successful meeting and an enjoyable stay in Melbourne.

1.5 The participants introduced themselves, to facilitate future interactions throughout the meeting. The list of participants in the session is provided in Annex I to this report. Mr Bergin regretted to inform that the participant from Tonga was not able to attend the meeting as the Tropical Cyclone season had started.

2. Objectives of the Meeting, Working Arrangements and Expected Outcomes

2.1 Mr Bergin presented a brief overview of the objectives and expected outcomes of the meeting. He noted that this was the first meeting organized to address the WMO Executive Council (WMO-EC) request for the implementation of a storm surge watch scheme in regions subject to tropical cyclones. Therefore, he stressed the need for a clear understanding of WMO-EC's request and a detailed evaluation of the user (emergency managers) requirements. Noting that WMO-EC request might be focused on extreme events associated only with storm surges,, the Action Team recalled the recent event that has inflicted damage in Papua New Guinea and Kiribati as a result of long period waves. The meeting agreed that it would be necessary to examine warning arrangements for both storm surges from tropical cyclones and long period waves typically generated by mid latitude deep low pressure systems at all times of the year

2.2 The Action Team agreed to review the existing resources and facilities both in the Region and globally towards providing the most effective storm surge and wave warning system for the Region. It noted that RA V TCC Region covers both the South Pacific and Southeast Indian Ocean, and that any recommendations from the Action Team should be applied to these two basins. Even recognizing that best adaptation strategies for climate change would be reliable for a warning system, the Action Team agreed to not address climate change aspects during the meeting as the main objective of this meeting was to develop and implement an effective Early Warning System (EWS) for storm surges and waves.

2.3 The Action Team adopted the agenda for the meeting on the basis of the provisional agenda that had been prepared by the Secretariat, however agreed that this agenda would be dynamic depending on discussions at the meeting. The final agenda for the meeting is provided in Annex II to this report.

3. The WMO Executive Council request, report of the Workshop and JCOMM MAN meeting

3.1 The WMO representative, Mr Edgard Cabrera, informed the Action Team that the WMO Executive Council addressed the need for the provision of storm surge guidance information to Members exposed to these risks as a matter of priority. The Action Team noted that the WMO Executive Council requested the Secretary-General to facilitate the development and inclusion of a storm surge watch scheme into the tropical cyclone advisory arrangements and in the Tropical Cyclone Regional Operating Plans. The excerpt of the WMO Executive Council report is presented in Annex III of this report.

3.2 The Action Team agreed that in Regional Association V countries in the Southern Hemisphere; major marine weather-related threats for the Pacific Island Countries (PICs) are due to:

- Storm surges associated with tropical cyclones
- Waves associated with tropical cyclones
- Long-period waves (remotely generated swell)

In this context, the Action Team agreed that any watch scheme for Regional Association V should address all of these threats.

3.3 The Action Team was informed that both the *Fifth TCP/JCOMM Regional Workshop on Storm Surge and Wave Forecasting* and the seventh session of the JCOMM Management Committee discussed JCOMM potential contributions to the development and implementation of a SSWS. The Action Team noted that JCOMM recommended applying the "Cascading" concept of the Severe Weather Forecasting Demonstration Project (SWFDP) in the development of the Storm Surge Watch Scheme. The Action Team further noted that JCOMM offered its support and commitment to contribute to the development of such a scheme and requested the Action Team to identify areas where JCOMM might be able to contribute to the development and establishment of the SSWS.

3.4 The Action Team noted that the "SWFDP" is a project initiated by the Commission for Basic Systems (CBS) to further explore and enhance the use of outputs of existing NWP systems of the GDPFS, including ensemble prediction systems (EPS). Its aim is to contribute to capacity building and to help developing countries in particular to be able to access and make the best possible use of existing NWP products to improve forecasts and warnings of hazardous weather conditions. The SWFDP in it first implementation in Southeast Africa completed its one-year field phase in November 2007. A final report on this first regional sub-project of SWFDP is available on http://www.wmo.int/pages/prog/www/DPFS/Reports/SWFDP%20FINAL%20REPORT_27feb08.pdf

3.5 The Action Team noted that an RA V SWFDP sub-project had been initiated and would provide daily guidance for short-range (days 1 and 2) and medium-range (out to day-5) on heavy rain and strong winds to participating National Meteorological Centres of the region, and several PICs. The meeting suggested that it might be possible to include storm surge and waves as possible components of a future RA V SWFDP.

4. Requirements of Emergency Managers

4.1 The representative of the Disaster Risk Reduction Office in Samoa, Mr Vaito'a Toelupe, presented a brief report on storm surge forecasting and warning services required by Emergency Managers. Mr Toelupe informed the Action Team that there is no specific storm surge disaster management plan for Samoa. Mr Toelupe advised that hazards associated with tropical cyclones are included in the:

(a) *Disaster Emergency and Management Act 2007* – this document provides a legal framework and regulates powers and roles of the different stakeholders. It requires a National Disaster Management Plan.

(b) *National Disaster Management Plan 2006-2009* – this Plan presents detailed disaster risk management arrangements between Government agencies, NGOs, private industry, communities, international donors and other agencies, to ensure the sustainable mitigation of, preparedness for, response to and recovery from the impact of hazards. The operational structure comprises:

1. the Disaster Management Office (DMO);
2. the Disaster Advisory Committee (DAC);
3. the National Disaster Council (NDC).

The DMO and the DAC are the focal points for co-ordination and implementation of all disaster mitigation, preparedness, response and recovery programmes and activities. The National Disaster Council (NDC) is responsible for oversight and approval of all disaster management activities, as advised by the DAC. During disaster response DAC co-ordinates and manages response activities from the National Emergency Operations Centre and reports to the NDC for direction and decision making as required. Each agency is responsible to ensure that their own staff is able to respond to disasters as per their response agency or community plan.

(c) *Samoa National Tropical Cyclone Plan 2006* – This Plan was developed to (1) ensure all communities and response agencies are prepared and ready to respond to a tropical cyclone event; (2) reduce the impact of tropical cyclones in Samoa; and (3) ensure a safe and quick recovery after a tropical cyclone event.

4.2 The Action Team noted that an early warning of storm surge events is required for appropriate action. The Action Team further noted that in Samoa, once a warning/watch/advisory describing the height of the surge and the identified area which will experience storm surges is issued by the Samoa's Meteorology Division, this information is immediately circulated among member agencies of DAC for action. If the National Meteorological Service is unable to provide

warning because of failure of the Warning Weather Service , Warnings are provided by alternate Weather Services as follows::

- First Alternative – Regional Specialized Meteorological Centre-Nadi;
- Second Alternative – National Oceanographic and Atmospheric Administration, Hawaii.

Additionally, the Action Team noted that there is a requirement to raise awareness on storm surge causes and impacts in village public education programmes.

4.3 Key messages from Disaster Managers:

1. Comprehensive Disaster Management Plan involving key components of an efficient warning system – weather service, disaster management agency and media;
2. Easily understood early warning messages disseminated in a timely manner to enable adequate preparations including evacuation;
3. Public Education programmes down to village level.

5. The existing storm surge/wave warning system

Indian Ocean

5.1 Mr Achmad Frachi Radjab, from the Meteorological, Climatological and Geophysical Agency in Indonesia (BMKG), presented an overview of the marine meteorological services in Indonesia, including wave and storm surge monitoring and forecasting. The Action Team noted that BMKG provides marine meteorological services for various marine sectors (such as: sea transportation, fishing, naval, Search and Rescue, marine tourism, offshore mining, etc.). These include:

- Weather bulletin for shipping
- Port weather Information
- Wind wave and swell forecasts
- Surface wind forecasts
- Surface currents forecasts
- Tropical Cyclone warnings (issued by Jakarta TCWC)

5.2 The Action Team noted that BMKG uses the WindWaves-05 software for sea state forecasting, developed by Badan Meteorologi Dan Geofisica (BMG), and Synergie (developed by Météo-France) to visualize the wave model outputs. The Action Team was informed that currently there is no specific storm surge warning system in Indonesia, but Jakarta TCWC can monitor storm surges and/or waves using the existing wave models and a storm surge calculator (see figure 1).

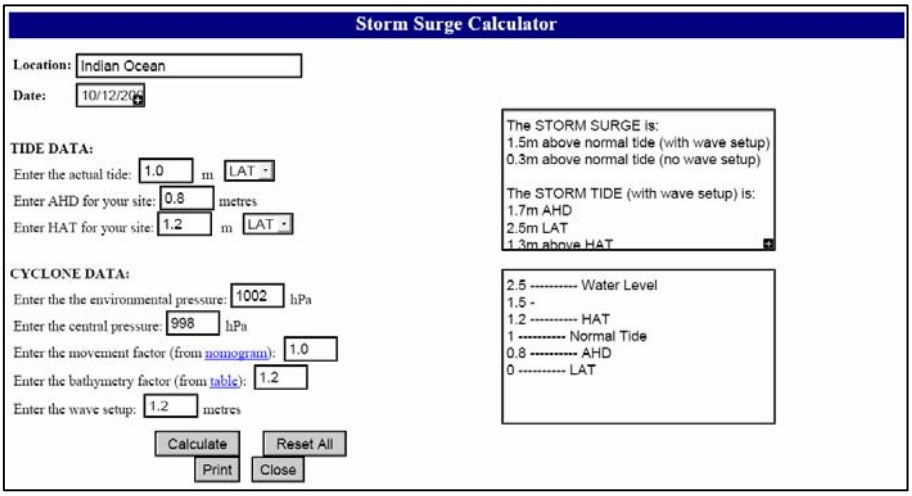

Figure 1 – Storm surge calculator used by Jakarta TCWC – courtesy of the Meteorological, Climatological and Geophysical Agency in Indonesia (BMKG).

South Pacific Ocean

5.3 Mr Rajendra Prasad presented an overview of services provided by RSMC-Nadi and Fiji Meteorological Service (FMS). The Action Team noted that the FMS objectives are: (i) to satisfy Fiji's needs for supply of weather and climatological data, archive and analyse the data, issue forecasts, warnings and other information as required; (ii) to monitor the climate of Fiji and advise on any changes due to global warming and other factors; (iii) to function as an RSMC for Tropical Cyclones, under the World Weather Watch Programme (WWW) of WMO; (iv) to function under the International Civil Aviation Organization (ICAO) as a Tropical Cyclone Advisory Centre (TCAC) for Aviation, a Meteorological Authority for Fiji and a Meteorological Watch Office (MWO) for Nadi Flight Information Region (FIR); and (v) to provide public forecasts and warning services for other South Pacific Island Countries and Territories, marine and aviation services as per international arrangements. The Action Team recalled that RSMC Nadi is one of the six regional centres (New Delhi; Tokyo; Honolulu; Miami; La Réunion and Nadi) globally designated as RSMC with activity specialization in tropical cyclones (TC RSMC).

5.4 The Action Team was informed that the FMS natural hazard responsibilities cover the preparation, issuance and dissemination of meteorological services and information, including warnings, for:

- Tropical Cyclones (Winds, Surge and Waves, and TC Related Rainfall/Flooding)
- Heavy Swells generated by Deep Low Pressure Systems moving south of Fiji
- Non-TC Related Heavy Rainfall and associated Flash Floods (River floods to be included in due course)

5.5 The Action Team noted that RSMC-Nadi already provides qualitative information on the phenomena associated with tropical cyclones (including storm surge) in their Special Weather Bulletins (if required), on behalf of those PICs (through bilateral agreements) not currently having forecast capabilities. RSMC-Nadi also issues a damaging/heavy swell warning for swells over 4 metres. The Action Team stressed the need to enhance the capabilities of RSMC-Nadi to produce storm surge and wave forecasts. The Action Team noted that there is a need to review the threshold for issuing these swell warnings as many of the islands in the region are quite low lying (ref section 8.6).

New Zealand

5.6 Mr Steve Ready presented the New Zealand storm surge and wave warning system. The Action Team noted that the Meteorological Service of New Zealand Ltd (MetService) provides weather and information services around the world, and its focus is operational meteorology. Development and research activities are the responsibility of the National Institute of Water & Atmospheric Research (NIWA). MetService is a designated Tropical Cyclone Warning Centre (TCWC) for area 25-40S from 160E to 120W and a back-up TCWC for Fiji's area of responsibility.

5.7 The Action Team noted that MetService issues very rarely, abnormal high sea water advisories (deliberately not called 'storm surge'). These advisories, issued for a limited stretch of the North Island coast, tend to advise Regional Councils of potential coastal inundation situations. Three main factors are considered before the high sea water advisory is issued:

- Tidal level – Spring if not King Tides (Key factor!)
- Storm Surge (MSLP < 1000 hPa and strong onshore winds)
- Wave conditions (Moderate to heavy sea and swell)

The combination of these factors determines the risk of high sea level at a particular location (see Figure 2).

5.8 The Action Team noted that the MetService more regularly issues wave/swell warnings to Regional and District Councils on the east coast of the Islands, as well as the west and south of the North Island. Criteria to issue these warnings vary from area to area depending on the

requirements of the relevant Regional Council. The Action Team noted that MetService also issues *ad hoc* advisories to Near Whangarei Harbour (gales and/or combined waves 2m or more) and Cook Strait (southerly gales and combined waves 4m or more).

5.9 Dr Richard Gorman informed the Action Team that NIWA had developed an operational multi-hazard forecasting system, which includes:

- A leading edge data assimilating weather forecasting system (NIWA operates and maintains the sea level and wave buoy networks)
- The first high resolution wave forecasting models for NZ region
- The first sea-level forecasting model for NZ region that includes tides and storm surge
- A forecasting model for inundation due to tides, storm surge and/or tsunami
- A river flood inundation model

	All 3 factors	2 factors only	Only 1 factor	None prevail
Reclassified TC within 3°	High	Moderate	Low	Low
Reclassified TC within 6°	Moderate	Low	Low	Unlikely
Low < 1000hPa within 3°	Moderate	Low	Low	Unlikely
None of the above	Low	Low	Unlikely	Unlikely

Figure 2 – Risk high water at a particular location – courtesy of the NZ MetService.

Australia

5.10 Mr Graham Warren presented an overview of the marine meteorological services provided by the Australian Bureau of Meteorology, with emphasis on wave forecasting capabilities. The Action Team noted that most of the forecasts and warnings are generated manually in the Bureau's seven Regional Offices, utilising centralized guidance from the National Meteorological and Oceanographic Centre (NMOC), which runs the NWP suite, including the ocean model. BoM has three wave model domains operationally implemented, as described in Figure 3.

	Forcing	Domain	Resolution	Data assimilation	Shallow water
Global	GASP 96-hours	78S – 78N 0 - 360	1° 3-hourly	Yes	No
Regional	LAPS 48-hours	60S -12N 69E -180.	0.5° 1-hourly	Yes	No
Mesoscale	MESO_LAPS 48-hours	50S – 0 100E – 165E	0.125° 1-hourly	No	Yes

Figure 3 – Operational implementation of the wave model – courtesy of the BoM, Australia.

5.11 The Action Team noted that BoM provides access to the Significant Wave Height forecasts from the global model through the EMWIN broadcast. BoM (NMOC) can provide guidance on long period waves from the global wave model, but this requires a clear definition of the warning criteria (height/period).

5.12 Mr Mikhail Entel provided a briefing on the existing storm surge forecasting and warning capabilities at the BoM. These include:

- Two hydrodynamic 2D models forced by a synthetic vortex (of the Holland type);
- A set of pre-calculated storm surge runs for most vulnerable and densely-populated locations along the Qld, WA and NT coast stored in DB;
- A hydrodynamic model forced by NWP (TC LAPS).

5.13 The Action Team noted that BoM had been integrating hydrologic and storm surge models for improved flood warning. Additionally, BoM had been studying the risk of inundation due to climate change.

5.14 Dr Gary Brassington presented the ocean dynamical conditions that can impact the local sea level. He provided some comments on the available products from BLUElink for nowcast and forecast coastal trapped waves. The Action Team noted that low frequency variability can account for O(50cm) anomalous sea level, and queried if this was substantial enough to turn a significant event into an extreme event in some situations.

6. Scientific limitations

6.1 Dr Jens Kruger, from the Ocean and Islands Programme of the South Pacific Islands Applied Geoscience Commission (SOPAC), informed the Action Team of the main resource and capacity limitations of storm water predictions in the Pacific Island Countries, which include:

- Baseline Data:
  - Nearshore bathymetry and land topography
  - Common vertical datum for seamless DTMs and storm surge reporting
- Data Records and Access:
  - Temporal and spatial record of extreme events
  - Access to remotely sensed data: awareness and internet connection
- Modelling:
  - Software licensing fees
  - Capacity to operate models
  - Science limitation of models: wave run-up and overtopping
- Disaster Risk Management:
  - Political will for mainstreaming
  - Cross-sectoral commitment, community awareness and support
  - Practical implementation and emergency communication

6.2 Dr Richard Gormon, from NIWA, presented an overview of the existing scientific limitations for an effective storm surge and wave forecasting system, listed as follows:

- interpolation of wind/MSLP fields in travelling storm systems
- physics of coastal-trapped waves in models
- nearshore bathymetry including reefs and bars
- seamless topography data to a common datum
- physics of wave set-up and run-up on reef-lagoon systems or narrow shelves
- combining wave set-up and run-up with storm surge in a model with good overland flow (wetting and drying capability)
- role of tides in storm inundation;
- need for historic information for past events e.g.:
  - storm-tide levels from visual observations, waves, tides
  - hindcasts for validating storm surge models and as inputs to an extreme value analysis of storm tide to get a handle on return periods for forecasts

- data assimilation of near real-time measurements of waves and sea level
- computer power on high resolution grids for forecasting
- boundary conditions on open sea boundaries
- converting inundation maps to evacuation maps
- probabilistic modelling of cyclone tracks and resulting storm-tides as another angle to return period extremes
- other …

7. Global/Regional Centres' products

7.1 The WMO representative, Ms Alice Soares, provided an overview of the existing wave models or forecasts freely available to WMO Members, which include:

- ECMWF (http://www.ecmwf.int – password protected);
- Met.no (http://openmetoc.met.no);
- BoM (http://www.bom.gov.au);
- NCEP (http://polar.ncep.noaa.gov/waves);
- FNMOC (https://www.fnmoc.navy.mil/public/).

7.2 The Action Team noted that after the environmental emergency that inflicted damage in many exposed islands of the Maldives, as a result of large wind-induced waves (swell), the ECMWF developed a new product to facilitate the identification of long period waves propagation (see Figure 4).

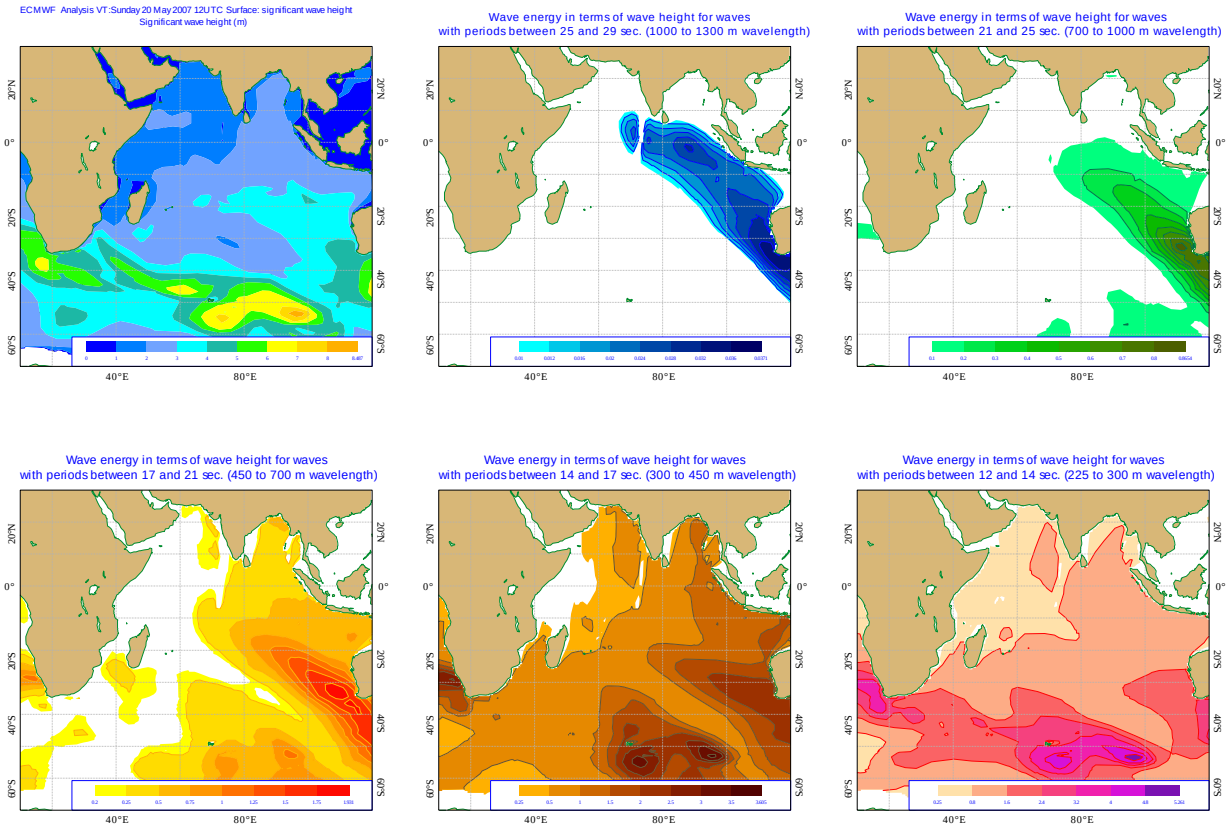

Figure 4 – The ECMWF model (Indian Ocean, May 2007): significant wave height and low frequency wave energy propagation (in terms of equivalent wave height) – courtesy of the ECMWF.

8. Summary of the discussions and recommendations to president of RA V

8.1 The Action Team noted that, in accordance with the Operating Plan for Regional Association V, storm surge information is not mandatory in Tropical Cyclone technical advisories. During the discussions, the Action Team enquired if an additional product would be required to provide specific information to threatened countries for storm surges. It was agreed that a specific

section in tropical cyclone advisories would be sufficient to meet these requirements. It therefore recommended that storm surge information associated with tropical cyclones be formally incorporated into all Tropical Cyclone-related bulletins issued by the RSMC-Nadi, and Special Advisories issued by the TCWC-Brisbane (for Solomon Islands), TCWC-Darwin and TCWC-Perth (for Indonesia). Informal bilateral arrangements with PNG should be considered. The Action Team noted that next TCP RSMC Technical Coordination meeting is expected to discuss the ToR for the RSMCs.

8.2 Due to limitations in the current bathymetric and topographic datasets and no capability in the RSMC-Nadi to run storm surge models covering the required geographic area, the Action Team recommended that in the short term storm surge guidance information would have to be qualitative. It recognized that technical terminology, such as storm surge, is not very well understood by local communities and recommended the use of level of threats/impacts and uncertainty in the advisory messages which can be easily translated into local languages. The Action Team agreed that capacity building initiatives are required between disaster managers and storm surge forecasters to ensure better communication with recipients. The Action Team therefore suggested the following terminology:

> ***Example One:*** *There is a (low/moderate/high) probability of sea flooding above normal tide levels along with (large and dangerous/damaging) waves about (coastal areas and/or low-lying islands) in the direct path of the cyclone.*
>
> ***Example Two:*** *Expect (serious or widespread or abnormally high/dangerously high) sea flooding around the time of high tide <tomorrow morning> with damaging/dangerously high waves about (e.g. the west coast of Viti Levu from Ba to Sigatoka or about Rennel and Bellona, and the south coast of Guadalcanal) as the cyclone passes close by.*

The Action Team acknowledged that this language must be adequately developed in collaboration with the disaster management agencies in the region.

8.3 The Action Team recalled the request by the WMO Executive Council to examine the capabilities and willingness of storm surge forecast producing centres to participate in possible regional storm surge guidance information arrangements. It stressed the need to further enhance the capabilities of the RSMC-Nadi on storm surge modelling and forecasting. Noting that NIWA, BoM, NOAA/NWS Honolulu, and Météo-France (New Caledonia) could be suitable agencies in the region capable to act as 24/7 storm surge forecasting producing centres, the Action Team recommended that the WMO Secretariat examine the willingness of those agencies to provide storm surge modelling guidance information to RSMC-Nadi. However, it recognized that there are some significant limitations (e.g., non- or limited available nearshore bathymetry, topography, etc.) that will make accurate site specific quantitative forecasts very difficult.

8.4 An important component of the RA V storm surge forecasting system is the accurate assessment of tropical cyclone intensity analysis, track forecasts and associated wind fields produced by the RSMC-Nadi.

8.5 Regarding long-period waves (remotely generated swell), the Action Team noted that several agencies already have capabilities to provide graphical model outputs (BoM, NOAA/NCEP, UKMO, Météo-France, NIWA and ECMWF); some of these products are already freely available on the Internet. In particular, the Action Team acknowledged the products from the ECMWF which are not available to WMO Members as yet, and requested the WMO Secretary-General to continue the dialogue with ECMWF for facilitating access to these products, which would further enhance their relevance and usefulness in future cases of long-period wave events. The Action Team, recognizing that these products are useful and would enhance the capability of WMO Members in the region to provide wave forecast and warning services, recommended that guidance products be developed and provided by regional centres (e.g. Northern Hemisphere – NOAA-Honolulu; South Hemisphere – RSMC-Nadi and RSMC-Wellington). The Action Team noted that these developments might be incorporated into the RA V SWFDP and requested the RA V-SWFDP Management Team to consider inclusion of these issues in its Implementation Plan. The Action

Team noted that these products would provide good guidance for deep water. However, it agreed that they do not address the nearshore and coastal effects due to the limited availability of nearshore bathymetric and topographic data, which limits the ability to provide detailed description of expected impacts and their magnitude.

8.6 The Action Team, noting the 9 December 2008 long-period waves event that inflicted damage in some Pacific Islands Countries (PICs) and, the requests by PNG for ongoing BoM assistance in future events, recommended that interim bilateral arrangements (i.e. between Australia-PNG/Solomon Islands and New Zealand-Fiji) for the provision of guidance services be established as soon as possible. It requested WMO Secretariat to initiate, immediately a dialogue with BoM-Australia and Meteorological Services of New Zealand to facilitate the establishment of these bilateral agreements. In the same context, the Action Team requested the WMO Secretariat to determine which predictive services are provided by NOAA/NWS-Honolulu for events generating in the Northern Hemisphere.

8.7 The Action Team noted that in order to issue effective damaging/heavy swell warnings, appropriate period and height thresholds need to be determined for vulnerable countries in the region. It therefore requested JCOMM to address this issue in collaboration with RSMC-Nadi for the Pacific Ocean basin and BMKG for the Indonesian archipelago .

8.8 The Action Team noted that communicating information from agencies proving global model outputs to national services should be considered as part of the SWFDP for RA V. The Action Team suggested that National Meteorological Services should use the existing channels to disseminate locally the warnings of long-period waves and swell.

8.9 The Action Team noted that the simultaneous occurrence of storm surges, waves and high tides produces the most damaging impacts. It therefore recommended that spring tide periods be calculated and identified for different locations. The Action Team further noted that enhanced tide prediction service for the region is required and therefore requested WMO Secretariat to approach BoM and other centres to expand the current tide prediction service for the region.

9. Closure of the meeting

9.1 The Team reviewed and approved the final report of the meeting.

9.2 In closing the meeting, the Action Team chair, Mr Mike Bergin, expressed the team's appreciation to the WMO Secretariat, in particular to Ms Alice Soares, for her excellent work in the preparation and during the meeting. He thanked all participants for their very positive and valuable input to the discussions, to what had been a very successful meeting. He looked forward to seeing all participants in the near future.

9.3 The Regional Association V (RA V) Storm Surge Watch Scheme (SSWS) Action Team meeting closed at 1530 on Tuesday, 16 December 2008.

Annex I

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Annex II

AGENDA

1. Opening and welcome

2. Objectives of the Meeting, Working Arrangements and Expected Outcomes

3. The WMO Executive Council request, report of the Workshop and JCOMM MAN meeting

4. Requirements of Emergency Managers

5. The existing storm surge/wave warning system
   - for the Indian Ocean
   - for the South Pacific Ocean
   - in New Zealand
   - in Australia, including ocean dynamical conditions that can impact the local sea level. Comments on the available products for nowcast and forecast

6. Scientific limitations

7. Global/Regional Centres' products

8. Summary of the discussion and recommendations to president of RA V

9. Closure of the meeting

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Annex III

Excerpt of the WMO Executive Council Report

4.1.16 The Council recalled the environmental catastrophes during 2007-2008 resulting from tropical cyclones and their associated coastal marine hazards (mainly storm surges), including the recent tropical cyclone Nargis that caused major devastation and loss of lives in the most populous and low-lying areas of Myanmar in May 2008.

4.1.17 The Council recognized that storm surge warnings are a national responsibility. The Council noted that some tropical cyclone RSMC advisories did not include storm surge information. It agreed that a storm surge watch scheme would help to increase advisory lead-time and thus contribute to saving lives and properties, and would be the first step towards a comprehensive and integrated marine multi-hazard forecasting and warning system for improved coastal risk management.

4.1.18 The Council therefore:

(a) Requested the Secretary-General, in consultation with UNESCO/IOC to facilitate development of such schemes for regions subject to tropical cyclones;

(b) Urged regional associations concerned to incorporate a storm surge watch scheme in the tropical cyclone advisory arrangements and in the TCP Regional Operating Plans and/or Manuals;

(c) Noting that some RSMCs with Activity Specialization in Tropical Cyclones were not equipped to function as a storm surge forecast producing centres, requested the Secretary-General, based on the technical advice of JCOMM, to examine the capabilities and willingness of such Tropical Cyclone RSMCs and other storm surge forecast producing centres to participate in regional storm surge watch schemes, and to develop proposals for consideration by the concerned regional Tropical Cyclone Programme bodies and regional associations;

[…]

4.1.20 The Council recognized that sea level observations are critical for enhancing storm surge forecasting and invited the Members to continue efforts to collect routinely and share such observations.

4.1.21 The Council recognized that storm surges are not only caused by tropical cyclones but may also originate by extra-tropical systems and other causes. Furthermore, the severity of impacts could be amplified due to river flooding. In this regard, the Council requested JCOMM, CAS and CHy, in close cooperation with other relevant UNESCO/IOC subsidiary bodies, to implement the scientific/technical recommendations from the First JCOMM Scientific and Technical Symposium on Storm Surges (Seoul, October 2007), including coastal inundation and linkages to storm surge forecast and warning operations in all relevant regions.

4.1.22 The Council noted that the Fifth TCP/JCOMM Regional Workshop on Storm Surge and Wave Forecasting would be convened in Melbourne, Australia, from 1 to 5 December 2008 and that RMSC-New Delhi could be considered for conducting training workshops for South Asian countries. With reference to the JCOMM Guide to Storm Surge Forecasting, the Council urged the completion and publication of the Guide and the expansion of training workshops on storm surge and wave forecasting for the benefit of all Members exposed to these risks.

Annex IV

LIST OF ACTIONS

Para	Action	By whom	When/target
8.4	To continue the dialogue with ECMWF for facilitating access to these products, which would further enhance their relevance and usefulness in future cases of long-period wave events	WMO Secretary-General	Ongoing
8.4	To consider inclusion of marine aspects, including wave guidance products, in the RA V SWFDP implementation plan	RA V-SWFDP Management Team	ASAP
8.5	To initiate, immediately a dialogue with BoM-Australia and Meteorological Services of New Zealand to facilitate the establishment of bilateral agreements between Australia-PNG/Solomon Islands and New Zealand-Fiji	WMO Secretariat	Immediately
8.5	To determine which predictive services are provided by NOAA/NWS-Honolulu for events generating in the Northern Hemisphere	WMO Secretariat	ASAP
8.7 and 5.5	To determine appropriate period and height thresholds in order to issue effective damaging/heavy swell warnings	JCOMM, RSMC-Nadi and BMKG	ASAP
8.8	T approach the BoM-Australia and other centres to expand the current tide prediction service for the whole RA V	WMO Secretariat	ASAP

LIST OF RECOMMENDATIONS

Para	Recommendation
3.2	The RA V Storm Surge Watch Scheme include storm surge associated to Tropical cyclones, waves associated to Tropical cyclones, and long-period waves (remotely generated swell)
8.1	Storm surge information associated with tropical cyclones be formally incorporated into all Tropical Cyclone-related bulletins issued by the RSMC-Nadi, and Special Advisories issued by the TCWC-Brisbane (for Salomon Islands), TCWC-Darwin and TCWC-Perth (for Indonesia)
8.1	Informal bilateral arrangements with PNG be established
8.2	Storm surge guidance information be descriptive
8.3	WMO Secretariat to examine the willingness of those agencies to provide storm surge modelling guidance information to RSMC-Nadi
8.4	Guidance products be developed and provided by regional centres (e.g. Northern Hemisphere – NOAA-Honolulu; South Hemisphere – RSMC-Nadi and RSMC-Wellington)
8.5	Interim bilateral arrangements (i.e. between Australia-PNG/Solomon Islands and New Zealand-Fiji) for the provision of guidance services be established as soon as possible
8.8	Spring tide periods be calculated and identified for different locations

Annex V

ACRONYMS AND OTHER ABBREVIATIONS

BMG	Badan Meteorologi Dan Geofisica (Indonesia)
BMKG	Meteorological, Climatological and Geophysical Agency (Indonesia)
BoM	Bureau of Meteorology (Australia)
CBS	Commission for Basic Systems (WMO)
DAC	Disaster Advisory Committee
DB	Database
DMO	Disaster Management Office
DTM	Digital Terrain Models
EC	WMO Executive Council
ECMWF	European Center for Medium-range Weather Forecast
EMWIN	Emergency Managers Weather Information Network
EPS	Ensemble Prediction System
EWS	Early Warning System
FIR	Flight Information Region
FMS	Fiji Meteorological Service
FNMOC	Fleet Numerical Meteorology and Oceanography Center (USA)
GDPFS	Global Data Processing and Forecasting System (WMO)
ICAO	International Civil Aviation Organization
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
LAPS	Limited Area Prediction System
MAN	Management Committee (JCOMM)
MSLP	Mean Sea-level Pressure
NCEP	National Centers for Environmental Prediction (NOAA)
NDC	National Disaster Council
NGO	Non-governmental Organization
NIWA	National Institute of Water and Atmospheric Research (New Zealand)
NMOC	National Meteorological and Oceanographic Centre
NOAA	National Oceanic and Atmospheric Administration (USA)
NT	Northern Territory (Australia)
NWP	Numerical Weather Prediction
NWS	National Weather Service (NOAA)
NZ	New Zealand
PIC	Pacific Island Country
PNG	Papua New Guinea
Qld	Queensland (Australia)
RA	Regional Association
RSMC	Regional Specialized Meteorological Centre
SOPAC	South Pacific Islands Applied Geoscience Commission
SSWS	Storm Surge Watch Scheme
SWFDP	Severe Weather Forecasting Demonstration Project
TC	Tropical Cyclone
TCAC	Tropical Cyclone Advisory Centre
TCC	Tropical Cyclone Committee
TCP	Tropical Cyclone Programme (WMO)
TCWC	Tropical Cyclone Warning Centre
ToR	Terms of Reference
UKMO	Met Office (UK)
UNESCO	United Nations Educational, Scientific and Cultural Organization
WA	Western Australia
WMO	World Meteorological Organization
WWW	World Weather Watch (WMO)