SWFDP in South-east Asia: SWFDP-SeA

Regional Subproject Implementation Plan (Draft ver.4)

Contents

Version History

ver0	23/4/2010	Y.Honda	First circulation to Project Development Team
ver1	30/8/2010	Y.Honda	Version submitted to the meeting to develop a strategy for preparing RSIP for SWFDP-SeA (Tokyo, 17-18/9/2010).
ver2	1/10/2010	Y. Honda	Modified version as output of the above meeting. First Circulation to RSMT
ver3	6/10/2011	Y. Honda	Modified version taking into account recent developments. To be submitted to the first meeting of the RSMT (October 2011)
ver4	11/1/2012	Y. Honda	Modified version as output of the RSMT meeting (October 2011)

1. Introduction

This section outlines the concept of the Severe Weather Forecasting Demonstration Project (SWFDP) and the foundation laid for formulation of the Regional Subproject for Southeast Asia in RA II.

1.1 Concept of SWFDP

1.1.1 Principles of SWFDP

Numerical Weather Prediction (NWP) systems have become increasingly relevant and indeed essential to the severe weather forecasting process, with a growing number and variety of sophisticated outputs, currently available from NWP producing centres, which could be beneficial to severe weather forecasting for many National Meteorological and Hydrological Services (NMHSs). The Severe Weather Forecasting Demonstration Project (SWFDP) is designed as a series of regional subprojects whose scope is to test the usefulness of NWP products produced by global and regional meteorological centres, with the goal of improving severe weather forecasting services in countries where sophisticated model outputs are currently not used.

The original focus of the project was on the phenomena of strong destructive winds and heavy precipitation that could cause serious flooding, either associated with tropical cyclones or other weather systems. Such a demonstration project would use a cascading (forecasting) approach to provide greater lead-time for severe weather and would at the same time contribute to capacity building and improving links with National Disaster Management and Civil Protection Authorities (DMCPA).

According to the recommendations of the CBS-XIII (2005), the goals of the SWFDP are defined as follows:

- to improve the ability of NMHSs to forecast severe weather events;
- to improve the lead time of alerting these events;
- to improve the interaction of NMHSs with DMCPA before and during events;
- to identify gaps and areas for improvements;
- to improve the skill of products from Global Data-Processing and Forecasting System (GDPFS) centres through feedback from NMHSs.

The CBS-Ext.(06) stressed the need to work with civil protection authorities and media organizations to improve delivery of severe weather warning services to end users. Subsequently, the Public Weather Services (PWS) and disaster risk reduction aspects have been integrated into the SWFDP.

1.1.2 The cascading process

In the framework of the general organization of the Global Data-Processing and Forecasting System (GDPFS), the SWFDP implies a coordinated functioning among three types of GDPFS centres. Conceptually, it should involve one (or more) global centre(s), one (or more) regional centre(s) and a small number of NMHSs located within the area of responsibility of the regional centre.

According to the conclusions of CBS-XIII, the proposed SWFDP is an excellent way to apply the cascading approach for forecasting severe weather in three levels, as follows:

- global NWP centres to provide available NWP products, including in the form of probabilities;
- regional centres to interpret information received from global NWP centres, run limited-area models to refine products, liaise with the participating NMCs;
- NMCs to issue alerts, advisories, severe weather warnings; to liaise and collaborate with Media, and disaster management and civil protection authorities; and to contribute to the evaluation of the project.

The SWFDP will implement a cascading forecasting process implying the participation of selected centres chosen within a geographical area affected by an agreed type of severe weather event. The cascading process aims to ensure the real-time distribution of the relevant available information produced by both a Global Centre(s) and a Regional Centre(s) to selected NMHSs. Moreover it is necessary to continue the cascade by making the final authoritative products of hazardous conditions (advisories or warnings) produced by the NMHSs available to users such as media and local Services in charge of hydrology and/or DMCPAs.

The cascading process concerns both short-range and medium-range products. In the framework of the Regional Subproject described hereafter, short-range is defined as up to and including day-3 while medium-range is defined as day-4 to day-5 inclusive. Each centre will be required to adjust and tailor the list of products to the requirements of the particular regional subproject.

A near real-time evaluation will be conducted, based on observations of the meteorological parameters collected at local meteorological stations as well as information gathered on the impacts of the severe weather phenomena as reported by DMCPA Services. This evaluation of the performance of the cascading process will then be provided as feedback to the participating centres to further fine tune the process itself.

1.1.3 Expected Benefits

The SWFDP aims to demonstrate the benefits of applying the cascading process for severe weather forecasting in the NMHSs, with the intention of not incurring research and development costs. It is viewed as way to explore how the concept could benefit several NMHSs in the same geographical region while facilitating a certain level of harmonization of forecasts and warnings to render them consistent across the region.

The SWFDP will help strengthen the links between the NMHS, the DMCPA and the media. This in turn will increase the efficiency and effectiveness of the public warning services in case of severe weather events

The SWFDP will provide the opportunity to encourage forecasters to use, and experiment with standard products and recommended procedures, which have already been introduced in GDPFS centres and which could be relevant to a number of NMHSs that have not yet used them.

The SWFDP will provide an opportunity to demonstrate and realise the benefits of new forecasting research through collaboration with the THORPEX TIGGE-GIFS project. THORPEX (The Observing System Research and Predictability Experiment) is a 10-year programme to accelerate improvements in the accuracy of 1-day to 2-week high-impact weather forecasts for the benefit of humanity. TIGGE-GIFS is developing new products, particularly from multi-model ensembles, and aims to develop the new GIFS (Global Interactive Forecast System) by developing cascading products in support of the SWFDP and involving the SERA (Societal and Economic Research & Applications) project to support effective propagation of benefits to society.

Besides, the collaboration with regional activities of other WMO programmes (i.e. research project and/or demonstration project) will produce the synergetic effect on the regional subproject of SWFDP.

1.1.4 The four phases of the SWFDP project

The SWFDP project can be divided into four phases as follows:

- Phase I: Overall Project Planning. This phase includes the preparatory work necessary to prepare the project specifications, the list of types of products to be exchanged and the work of the Project Steering Group (PSG) to identify the possible participating centres and to select suitable regional subprojects according to the geographical area, the type of severe weather and the chosen period for the experimentation.
- Phase II: Regional Subproject Implementation Planning and Execution. This phase begins with the preparation of the detailed specifications (data and products to be exchanged, performance measurements, reviewing and reporting) allowing the participants (representatives of the participating GDPFS and national centres) to develop the specific subproject implementation plan, including a training programme, and to manage its implementation and then to carry out the experimentation itself which is likely to last about one year.
- Phase III: Regional Subproject Evaluation. This phase includes the analysis and the evaluation of the entire subproject as well as contributing to the evaluation of the overall SWFDP with respect to the goals proposed initially. This phase gives the opportunity to identify gaps and deficiencies, and areas for improvement in order to ensure a sustainability of the organization tested during the regional subproject and to provide improved specifications for other similar regional subprojects.
- Phase IV: Regional Subproject Long-term Sustainability and Future Developments. This phase includes long-term sustainability of the benefits gained and a process of continual improvement. This phase gives the opportunity to continuously take

advantage of future capability and technology developments, and to foster broadening of activities in synergy with other WMO programmes. In this phase, the responsibility for management, including seeking funding, lies with the Regional Association, while the PSG continues to be informed of developments and to provide advice as appropriate.

It has to be noted that the Phase II, III and IV are specific to each regional subproject and will be repeated for each of the selected subproject. From the point of view of the project management, it is clear that the overall SWFDP project begins with the first step of the Phase I and after completion of the Phase III of the selected regional subprojects, the responsibility becomes that of the Regional Associations. It is clear also that each selected regional subproject of the SWFDP will have its own date of beginning and date of completion of Phase III and transitioning to Phase IV.

1.2 Foundation laid for formulation of the Regional Subproject for Southeast Asia

1.2.1 Regional situation in natural disaster

The region in Southeast Asia is exposed to the hazardous weather phenomena such as tropical cyclones and heavy rains that may cause the loss of human lives and properties. In 2009, the typhoon Ketsana caused the worst damage in Southeast Asia. It was formed on 23 September as tropical depression and was upgraded to typhoon early next day. After passing over Philippines, it made the landfall in Viet Nam on 29 September 2009 and hit Laos, Cambodia and Thailand. The total loss of lives is about 700 and the estimated damage reaches over $700 million to $1.0 billion USD.

1.2.2 Subproject approval

XIV-RAII (2009) recognized that the SWFDP has achieved significant results and benefits relative to the GDPFS and PWS programmes in its first regional project in Africa, and requested the Working Group on Disaster Risk Reduction and Service Delivery (WGDRS) to consider developing a SWFDP RA II project as a method for enhancing the GDPFS and PWS and contributing to disaster risk reduction goals in developing countries, for example, those in Southeast Asia that have recently experienced disasters.

The Workshop on Severe Weather Forecasting Demonstration Project (SWFDP) Development for Southeast Asia took place on 2 to 5 February 2010, in Hanoi, Viet Nam. The workshop concluded that the implementation of a SWFDP in Southeast Asia would be technically feasible and would bring benefits in terms of enhancement of technical capacity in operational forecasting and advancement in weather service delivery to Member countries in the region.

The SWFDP Project Steering Group (PSG), at its third session (Geneva, Switzerland, 23-26 February 2010) decided to promote three SWFDP Regional Subprojects, including one in the Southeast Asia.

Hereafter, SWFDP in Southeast Asia is also described as SWFDP-SeA in this document.

2. Framework of the Regional Subproject in RA II – Southeast Asia

2.1 Key objectives

The key objectives of SWFDP-SeA are to produce and to deliver improved severe weather forecasts and warnings services by the better use of NWP information from major NWP centres in countries where sophisticated model outputs are not currently used.

2.2 Participating countries / organizations

The participating countries and organizations in three levels of GDPFS centres are listed as follows:

- NMCs
  - Cambodia, Lao PDR, Thailand and Socialist Republic of Viet Nam
- Regional Centres
  - Hanoi (regional forecasting support)
  - Hong Kong Observatory (training and technical support)
  - RSMC Tokyo and RSMC New Delhi (Typhoon / Tropical Cyclone forecasting support)
- Global Centres
  - China Meteorological Administration
  - Japan Meteorological Agency
  - Korea Meteorological Administration
  - Deutscher Wetterdienst

2.3 Targeting severe weather events

Recognizing that the following hazardous weather conditions and associated impacts (such as flooding, landslides, high waves and swell) are the most relevant in the region:

(i) tropical cyclone (both from the South China Sea and from the Bay of Bengal) track, intensity, structure changes and landfall process (wind and gust, rainfall and storm surge);
(ii) heavy rain triggered by tropical cyclones, SW and NE monsoon, troughs and ITCZ migration, and orography;
(iii) thunderstorms and hail associated with severe convection;
(iv) cold conditions and frost; and
(v) extreme hot and dry conditions associated with föhn effect.

The sub-project, in its pilot/demonstration phases, is addressing heavy rain and strong winds, and may consider other hazardous weather conditions and weather-related hazards in future phases.

2.4 Target domain

The domain to be covered for monitoring, analyzing and predicting the various severe weather events is proposed to be bounded by 10°S, 40°N, 80°E and 140°E (Fig. 1).

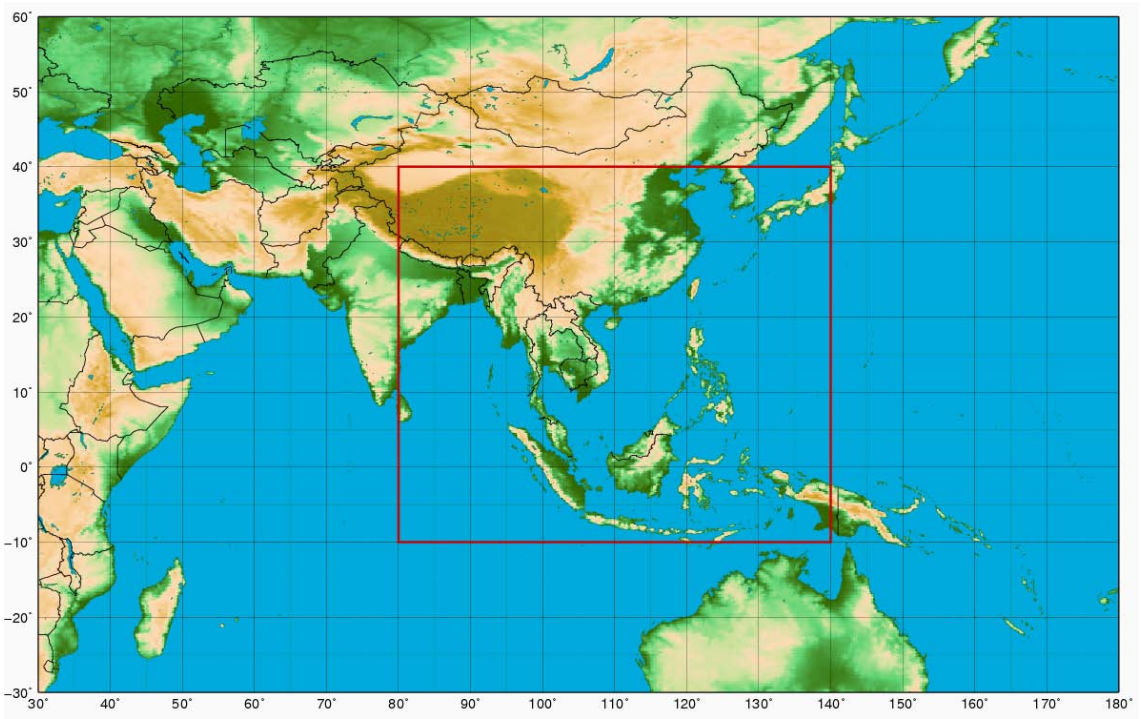

Figure 1: The red-coloured rectangle is the target domain for SWFDP-SeA.

2.5 Field phase period

The demonstration phase will be executed from April in 2012 to March in 2013 for one year. Prior to this phase, the pilot phase will be executed from November through March 2012. The pilot phase is the preparation period for Global and Regional Centres to provide products and for NMHSs to get use to the products and procedures. During the pilot phase, no evaluation report/feedback is requested.

2.6 Projects in synergy with SWFDP-SeA

The synergy with other regional projects that are on-going or will be implemented during the field phase in the target domain may benefit SWFDP-SeA.

The participating members are aware of the products of the following regional projects, that might be useful to improve severe weather forecasting and warning:

- RA-II Project on the Provision of City-Specific NWP products
- JMA Pilot Project on EPS products
- GIFS-Forecast Demonstration Project (FDP) (THORPEX/TIGGE/GIFS)
  - North Western Pacific Tropical Cyclone (Track) Ensemble Forecast Research Project (WWRP Research Development Project)
- Landfall Typhoon Forecast Demonstration Project (WMO-Project, ESCAP/WMOTC)

- Flash Flood Guidance System (FFGS) in Mekong River Basin (WMO Regional Hydrology)
- NOAA/NCEP Indo-Asia Monsoon Desk.
- Mekong River Commission : rainfall estimation using satellite data.
- UNESCAP/WMO Typhoon Committee
  - Collaboration on Sharing of Weather Radar Data.
  - Urban Flood Risk Management Pilot Project.
- RAII Pilot Project to Develop Support for NMHSs in Satellite Data, Products and Training

2.7 Possibility of development of expanded project

The SWFDP-SeA could be expanded in the future after the execution and the complete evaluation of the first field phase. During the expanded field phase, the severe weather events with lower priority (ref: Sec.2.3) could be paid more attention with additional products, some of which may be produced by new projects / initiatives in the region. Besides, more countries could also participate in the project.

The execution of the expanded phase would be discussed at the mid-term meeting, which is to be held to discuss the mid-term review and adjust the subproject.

3. Regional Subproject Management Team (RSMT)

A regional subproject management team (RSMT) is set up with the aim of preparing the implementation of the project and managing and controlling its execution. The management of the Regional Subproject is the responsibility of the RSMT and within the activities of CBS.

The RSMT will consult with regional groups and bodies such as the ESCAP/WMO Typhoon Committee, Regional Management Group and the WG on DRR and Service Delivery (WGDRS) in RA II and relevant ASEAN activities during the planning and implementation of the SWFDP in Southeast Asia.

3.1 Role and the responsibilities of the RSMT

The RSMT is responsible for the elaboration of an implementation plan for the Regional Subproject. The Regional Subproject Implementation Plan (RSIP) must include the following actions with milestones:

- to guide the participants in the development of the RSIP;
- to submit the RSIP to the PSG;
- to conduct preparatory training for the participants;
- to start the field phase;
- to conduct a mid-term project review;
- to submit the final report to PSG;
- to investigate the possible expansion of the current regional subproject;
- to liaise with regional groups and bodies.

3.2 Members of RSMT

The RSMT is chaired by Mr Nguyen Dai KHANH (National Hydro-Meteorological Service of Viet Nam). *(Need to be confirmed through official correspondence between Permanent Representative of Viet Nam and WMO)*

The members of the RSMT are appointed by the Permanent Representative (PR) of each participating NMHS and generally consist of the senior forecaster in charge of the forecasting team in the NMHS (able to direct and guide other forecasters). Each member is accountable to his/her respective PRs. The list of the members of the RSMT is as follows: (The family name is written in capital letter.)

- NMHSs:
  - Ms Bin Chann MONY, Department of Meteorology, Cambodia,
  - Ms Souvanny PHONEVILAY, Department of Meteorology and Hydrology, Laos, P.D.R.,
  - Ms Sugunyanee YAVINCHAN, Thai Meteorological Department, Bangkok;
- Regional Centres:
  - Mr Nguyen Dai KHANH, National Hydro-Meteorological Service of Viet Nam,
  - Mr LEE Lap-Shun, Hong Kong Observatory,
  - Mr Masashi KUNITSUGU, RSMC-Tokyo,
  - Dr M. Mohaptra, RSMC-New Delhi;
- Global Centres:
  - Ms ZHANG Xiaoling, China Meteorological Administration, Beijing,
  - Mr Yuki HONDA, Japan Meteorological Agency, Tokyo,
  - Mr Hyun-Cheol SHIN, Korea Meteorological Administration, Seoul,
  - Mr Detlev MAJEWSKI, Deutscher Wetterdienst, Offenbach;
- Regional PWS representative:
  - Mr LEE Lap-Shun, Hong Kong Observatory.

Mr. Yuki HONDA (Japan Meteorological Agency, the Theme Leader in Numerical Weather Prediction Systems and Products in RA-II) is the RA II representative to the Steering Group for the SWFDP.

3.3 Responsibilities of the Members of RSMT

The tasks of the members of the management team, during the preparation phase of the SWFDP are as follows:

3.3.1 The chairperson will be responsible for:

- drafting a detailed RSIP and sharing between participating countries;
- ensuring the collaboration with other regional projects in synergy with SWFDP
- determining the requirements for and co-ordinating training activities that support the demonstration project and to provide information to WMO Secretariat;
- reporting on the project to the RA II WG on DRR and Service Delivery, RA II Management Group and ESCAP/WMO Typhoon Committee.

3.3.2 The lead person for each participating NMC will be responsible for:

- coordinating all aspects of project implementation and execution at their respective centres;
- evaluating possible data-processing developments (e.g. work required to adjust or tailor NWP products);
- arranging for forecasters in the centres to receive or have access to the agreed products;
- defining the information to be exchanged with their DMCPA and other users;
- defining the information to be transmitted to the media;
- identifying training requirements;
- preparing regular evaluation of the warnings during the field phase;
- reporting on a quarterly basis on the status of the activities in the respective centres.

3.3.3 The lead person for each participating Regional Forecasting Support Centre and Regional Centre for training and technical support will be responsible for:

- coordinating all aspects of project implementation and execution at their respective centres;
- evaluating possible data-processing developments (e.g. work required to adjust or tailor NWP products);
- identifying training requirements;
- preparing regular evaluation of the Daily Regional Severe Weather Forecasting Guidance during the field phase;
- reporting on a quarterly basis on the status of the activities in the respective centres;
- providing a consolidated report to the global centres;
- arranging for verification of products from his/her global centre.

3.3.4 The lead person for each participating Global Centre and RSMC will be responsible for:

- coordinating all aspects of project implementation and execution at their respective centres;
- evaluating possible data-processing developments (e.g. work required to adjust or tailor NWP products);
- arranging for verification of products from his/her global centre.

3.3.5 The regional PWS representative will be responsible to:

- promote the awareness of the SWFDP-SeA to stakeholders (disaster management, media and the public), including through existing forums and organizations;
- enable and assist staff of participating NMHSs to build effective dialogue with stakeholders for service provision;
- in liaison with stakeholders, identify improvements and changes to products for consideration of the NMHSs' forecasting team;

- advise participating NMHSs on methods of evaluation of public forecasts and warnings and their use by stakeholders.

Each of the participating NMHSs are requested to involve their respective national PWS focal point nominated at the invitation of WMO (ref: WMO letter WDS/PWS/NFPS, GENEVA, 15 December 2010) in the SWFDP-SeA to also act as the PWS focal point for the project. Where such a national focal point has not been nominated yet, the NMHSs concerned are invited to do so and inform the Secretariat.

3.3.6 The contact person of the SWFDP Project Steering Group (PSG) will be responsible for

- liaising with the PSG on aspects of the regional subproject.

4. Responsibilities of Participating Centres in Subproject Implementation

Specific tasks are attributed to the three types of centres participating to the SWFDP in the cascading process.

4.1 The Global Centre

4.1.1 The responsibilities of the Global Centres (except DWD) are:

- to provide the other centres with medium-range NWP guidance and EPS output including probabilistic products specially adapted to the concerned severe weather events;
- to tailor products to the requirements of the Regional Centres including the provision of sub-domain and probabilistic products according to the lists given in Annex A and Annex B;
- to suggest suitable existing satellite imagery and satellite based products that are helpful in assessing the current meteorological situation, and therefore also assess the quality of global NWP/EPS products;
- to maintain a dedicated Web site to provide NWP guidance and EPS products;
- to evaluate the efficiency of products dedicated to medium-range severe weather forecasting through the feedback provided by the other centres.

4.1.2 The responsibilities of DWD are:

- to provide the necessary GME data for running the HRM (later possibly also the COSMO-model at higher resolution) to RFSC Ha Noi;
- to support RFSC Ha Noi to migrate its regional model from HRM to the non-hydrostatic COSMO-model; and
- to assist RFSC Ha Noi in verification of DWD products (models and GME data).

4.2 The Regional Centre

There are three types of Regional Centres adopted in SWFDP-SeA. The mission of each type of Regional Centres is regional forecast support, training and technical support and tropical cyclone / typhoon forecasting support.

4.2.1 The Regional Forecasting Support Centre

The responsibilities of the Regional Forecasting Support Centre are:

- to redirect toward the NMHSs relevant products issued from the Global Centres (if necessary);
- to provide NMHSs with its own interpretation of the medium-range guidance, including EPS products;
- to provide the NMHSs with the short-range NWP guidance (including products adapted to severe weather events), as frequently as possible;
- to indicate existing satellite/radar imagery and satellite/radar based products that could be used for nowcasting purposes;
- to issue Daily Severe Weather Forecasting Guidance products summarizing interpretation of NWP products with respect to severe weather over the responsibility area of the NMHSs;
- to provide the other centres with short-range NWP guidance and EPS output including probabilistic products specially adapted to the concerned severe weather events;
- to tailor products to the requirements of the National Centres including the provision of sub-domain and probabilistic products according to the lists given in Annex C;
- to evaluate its own interpretation of EPS products as well as its NWP guidance;
- to provide global centres with a feedback about the usefulness and efficiency of global products;
- to facilitate the flow of all forecasting guidance information to all participating Centres in the SWFDP through a dedicated password protected Web site and portal. Ideally this Web site would be maintained on a 24/7 basis and dedicated for the Regional Subproject;
- to coordinate real-time communications among the participating centres in the region of the project (to maintain a list of contact information; e-mail , telephone, fax).

4.2.2 The Regional Centre for Training and Technical Support

The responsibilities of the Regional Centre are to:

- help the RSMT to organize training workshops;
- provide the NMHSs with the technical support in response to their requests;
- provide guidance and advice in the use of multi-media facilties at training workshops.

4.2.3 The Regional Centres for Tropical Cyclone / Typhoon Forecasting Support

The responsibilities of the Regional Centre are:

- to provide the other centres with NWP guidance and EPS output, including probabilistic products specially adapted to tropical cyclone / typhoon;
- to provide NMHSs with its own interpretation of the NWP guidance and EPS products adapted to tropical cyclone / typhoon;
- to evaluate its own interpretation of EPS products as well as its NWP guidance;
- to facilitate the flow of all forecasting guidance information to all participating

Centres in the SWFDP through a dedicated password protected Web site and portal. Ideally this Web site would be maintained on a 24/7 basis and dedicated for the Regional Subproject;

4.3 The National Meteorological Centre of the NMHS

The responsibilities of the National Meteorological Centres are:

- to interpret the guidance provided by the global centre and the regional centre;
- to issue special bulletins and warnings as required by the users (hydrological services, Disaster Management Civil Protection Authorities (DMCPA) services, media…) for dissemination to the end users when severe weather is expected;
- to use available nowcasting tools (satellite imagery or satellite based products, radar products) to update warnings;
- to exchange information on warnings between participating NMHS, and between NMHSs and RFSC;
- to provide regional and global centres with a feedback on the efficiency of the global and regional products;
- to develop a communication strategy and plan with the media and end users to ensure effective response when warnings are issued;
- to establish contacts with DMCPA services and end users prior and during severe weather events;
- to obtain feedback from media, the public and other users as appropriate after the event (opportunity of warning, usefulness of warnings, lead time, degree of impacts)
- to obtain feedback from the disaster risk management agencies on utilization/benefits of warnings issued by NMHSs (under the SWFDP);
- to prepare a compiled report on the severe weather events that contains all the data needed to perform the evaluation of both RFSC Daily Severe Weather Forecasting Guidance relevant to the country, and actual warnings issued by NMHSsC;
- to evaluate the warnings;
- to develop training to facilitate improved communication with the users;
- to develop a generic basic set of standard operational procedures between a NMHS and disaster risk management agencies to ensure effective use of the SWFDP products.

5. Data and Products to be issued from participating Centres

5.1 Data and Products to be issued from Global Centres

Global NWP graphical products which can be made available by the global centres CMA, JMA and KMA should be cut and formatted to fit the project area (10°S, 40°N, 80°E and 140°E).

NWP forecasts should be updated every 12 hours, or every 6 hours if available. In addition to the daily production all the forecasts should be archived for a minimum of 7 days.

The table in Annex A gives a comprehensive list of products and indicates which centre(s) will provide them. The list in Annex B shows the selected locations where the meteograms are available.

Products which are not routinely transmitted through the GTS should be provided in graphical form (Web pages) via Internet for rapid display and dissemination. Provision of data in digital format may assist regional centres in producing charts of derived parameter.

While the ECMWF is not a participating global products centre in this project, all WMO Members have access to a significant set of ECMWF products via password access to ECMWF Website for WMO Members.

5.1.1 Current Deterministic NWP Fields up to 5 days

The products are provided at 6-h Intervals up to 2 days and 12-h intervals after 2 days. The recommended products include:

- charts to depict the large-scale flow (e.g. 500 hPa , 700 hPa, 850 hPa geopotential height, 850 hPa temperature, upper air winds, MSLP);
- surface weather elements (e.g. 6-hour accumulated precipitation, surface (10m) wind-speed).

In tropical regions other relevant products could also include:

- charts to depict the large-scale flow (e.g. surface streamlines, 850 hPa, 700 hPa, 500 hPa, 200 hPa wind flow and relative humidity, surface streamlines);
- charts to assist with forecasts of tropical cyclone formation, movement and intensification (e.g. 850 hPa, 200hPa relative vorticity and convergence, 850-400 hPa deep layer mean flow, 850-200 hPa vertical wind shear, vertical motion);

5.1.2 Probabilistic Forecast Products based on EPS

The recommended products include:

- probability of severe weather events such as precipitation and wind higher than given thresholds;
- “spaghetti” plots (e.g. 500 hPa geopotential height in extra-tropics, precipitation and wind higher than given thresholds);
- stamp maps (e.g. streamlines in the tropics, wind speed, accumulated precipitation);
- dispersion diagrams (plumes and EPSgrams) for weather elements at specific locations;
- representative members of a classification of weather pattern such as clustering or tubing (optional product depending on possibilities of Global Centre);
- severe weather risk index such as Extreme Forecast Index (where available).

If severe weather is associated with a Tropical Cyclone other relevant products could include:

- surface or 850hPa vortex track charts;

- tropical cyclone position fix and track forecast spread (strike probability);
- tropical cyclone formation probability.

5.1.3 Satellite Imagery and Satellite based Products

The available satellite imagery and satellite based products that Global Centres suggest are:

- Satellite Images of VIS, IR and WV Channels of FY-2E (operated by CMA);
- Satellite Images of VIS, IR and WV Channels of MTSAT-2 (operated by JMA);
- Diagnostic products, e.g.
  - Imagery with Heavy Rainfall Potential Areas produced by Meteorological Satellite Centre of JMA

5.2 Data and Products to be issued from Regional Centres

Regional Forecasting Support Centre and RSMC Typhoon / Tropical Cyclone provide the different set of data and products. The Annex C gives a comprehensive list of products which Regional Centres provide.

Products which are not routinely transmitted through the GTS should be provided in graphical form (Web page) via Internet for rapid display and dissemination.

5.2.1 Current deterministic Limited Area Model fields up to 2 days

Products are provided at 6-hour intervals.

Products could include:

- charts to depict the large-scale flow (e.g. 500 hPa, 700 hPa, 850 hPa geopotential height, 850 hPa temperature, tropopause height, upper air winds, MSLP);
- surface weather elements (e.g. 6-hour accumulated precipitation, surface (10m) wind-speed and gusts (if available), 2m temperature, 850 hPa specific humidity);
- maps of vertical motion, potential vorticity or height of specified PV surface;
- maps of convective indices such as CAPE, Lifting Index, helicity…,
- relevant satellite images (where NMHSs do not have satellite receiving capability);
- special products derived from satellite images (e.g. derived precipitation or images annotated with guidance notes).

In tropical regions other relevant products could also include:

- charts to depict the large-scale flow (e.g. surface streamlines, 850 hPa, 700 hPa, 500 hPa, 200 hPa wind flow and relative humidity, surface streamlines);
- charts to assist with forecasts of tropical cyclone formation, movement and intensification (e.g. 850 hPa, 200hPa relative vorticity and convergence, 850-400 hPa deep layer mean flow, 850-200 hPa vertical wind shear, vertical motion);

5.2.2 RFSC Daily Severe Weather Forecasting Guidance

Daily Severe Weather Forecasting Guidance should be issued by Regional Forecasting Support Centre Hanoi once per day at 08UTC to indicate the likelihood of severe weather occurrence:

- a short range (up to 72 h) guidance, including the risk-table, and a medium range (up to 5 days) guidance.

This guidance contains:

- Synopsis of weather (analysis and forecast);
- the interpretation of deterministic and ensemble NWP products from the Global and Regional Centres;
- severe weather predictions (risk or probability estimates) including tropical cyclone information.

The threshold values used in RFSC Daily Severe Weather Forecasting Guidance are determined as follows:

- heavy rain: 50 and 100mm (the risk over 200mm/24h should be described in discussion)
- wind speed: 30knot over the land and 30 and 50knot over the sea.

An example of RFSC Daily Severe Weather Forecasting Guidance is given in Annex D.

5.2.3 RSMC Tropical Cyclone Information/Advisory

RSMC Tropical Cyclone Information and Advisory are official information on typhoon or tropical cyclones. Annex C.2 and C.3 give the information of all products and services provided by RSMC Tokyo – Typhoon Centre and RSMC New Delhi – Tropical Cyclone Centre, respectively.

5.3 Data and Products to be delivered from other on-going projects or activities

The SWFDP-SeA expects the additional data and products from other on-going projects or activities in the target domain. These data and products are provided voluntarily by courtesy of these projects or activities so that these are additional materials.

The available data and products are listed in ANNEX E with the contact point of respective projects or activities. When the data and products become unavailable during the field phase, RSMT should contact a contact person of relevant projects or activities.

The products from Meteorological Satellite Centre (JMA) (ANNEX E.1) and GIFS products (ANNEX E.2) are evaluated through the demonstration phase in a way described in section 9. Other products are not necessary to be evaluated in SWFDP-SeA.

6. Verification of Technical Capability of participating NMCs/NMHSs

6.1 Technical feasibility

The SWFDP-SeA requests the Global and Regional Centres to provide their products on GTS or/and Internet. Therefore, the participating NMCs/NMHSs need to be equipped with the internet infrastructure enough to accommodate the high-speed access to NWP products of foreign countries.

Regarding the PWS, the NMCs/NMHSs are requested to have the infrastructure to be developed to be able to obtain feedback from users, including media, disaster risk management agencies and pubic.

6.2 Current status of internet infrastructure and requests

6.2.1 Cambodia

The bandwidth of internet line at the NMC in Cambodia is the order of Mega bps. The NMHS in Cambodia relies on the internet as essential for severe weather forecasting. The internet connection at the NMC is sometimes shutdown.

6.2.2 Lao P.D.R.

The internet access of the NMC is Asymmetric Digital Sub – Criber Line (ADSL) system whose speed normally has 128 / 256 Kbps. At the NMC the forecasters consider their internet access is slow. The forecasters rely on the Internet as essential for severe weather forecasting at the NMC such as Tropical Cyclone Advisory (RSMC products)

6.2.3 Thailand

The NMC at Thailand has the internet line whose speed has 50/10Mbps. The NMC recognized that the internet access is slow. The forecasters rely on the Internet as essential for severe weather forecasting at the NMC.

6.2.4 Viet Nam

NHMS has 3 Internet lines, including: High-speed line with 155 Mbps, normal-speed line with 5Mbps and 2Mbps. The high-speed line belongs to the Trans-Eurasia Information Network (TEIN3) and is used for accessing numeric data. The normal-speed lines are rent of ISP VDC and CMC of Viet Nam. The normal-speed line is used by forecasters for accessing graphical products from other centres.

7. PWS Aspects related to delivery of severe weather warnings

7.1 PWS Guidance on Developing Service Delivery Mechanisms in NMHSs

Effective service delivery is a fundamental requirement for NMHSs if they are to meet national needs. There are many different interpretations of the concept of service delivery as it relates to the provision of weather-, climate- and water-related services. To this end, WMO has developed a “Strategy for Service Delivery” to guide NMHSs in the provision of weather, climate and water-related services focussing on user needs. An Implementation Plan for the Strategy is under preparation and will be provided to all

Members upon completion to assist them in the implementation of the Strategy. Many of the attributes of service delivery contained in the Strategy have been incorporated into the PWS Guidance on Developing Service Delivery Mechanisms in NMHSs for the purpose of their inclusion in the development of the SWFDP in the South East Asian region. The PWS Guidance provides step by step advice on how to deliver effective services to users as indicated below:

Step 1: Focus on the user
Step 2: Focus on internal organization of your NMHS
Step 3: Improve communication skills of NMHS Staff
Step 4: Engage users
Step 5: Conduct Service Evaluation for Improvement

All steps are described in detail in the Guide. They specifically emphasize the importance of user focus and user feedback and evaluation as two elements that contribute to the success of SWFDP in meeting its objectives

7.2 Implementation Plan to improve the warnings and forecasts services in NMHSs

Participating NMHSs are expected to develop an implementation plan based on the Guide for achieving the improvement in delivering warnings and forecasts services to stakeholders. The plan will be tested during the field phase and be evaluated to verify its usefulness and indentify the area of improvement after the field phase. The improved plan will be applied in the following expanded field phase. (See Annex I on PWS Guidance on Developing Service Delivery) This RSIP contains the steps agreed to by each of the participating NMHSs as a starting point for implementing the PWS component of SWFDP-SeA as attached in Annexes F.

8. Preparatory Training

8.1 Overview

Training is necessary to ensure that forecasters from Regional Centres and NMHSs are able to correctly interpret the various NWP/EPS and guidance products made available for the SWFDP regional subproject and to prepare user-focused information. Also, the training will inform forecasters of all responsibilities as outlined in the RSIP.

The training should include specific topics on coordination and collaboration between NMHSs, DMCPAs, media, governmental and non-governmental organizations and any other relevant agencies as part of the Public Weather Services component of the SWFDP. Such training should take place with reference to any documented guidelines about service delivery principles and practices.

It is important to note that any special training session devoted to a regional subproject could be planned in conjunction with existing training programmes organized by the WMO Secretariat or WMO Members. Additionally, in-country visits, especially to centres with limited human resources (forecasters) and limited capability to pass on the training locally, are of extremely value. A combination of in-country visits and 2-week training events would be ideal in the implementation of the project.

8.2 Training topics for the course

A preparatory training workshop combining DPFS and PWS requirements will be held before the start of the field phase in 2011. The SWFDP homepage and the products from Global and Regional Centres should have been available at that time. Possible contents of this workshop are listed as follows:

- Interpretation and best practice use of deterministic and probabilistic NWP products for the forecasting of severe weather;
- Understanding and interpretation of specialized NWP products for forecasting severe weather associated with tropical cyclones:
  - Madden-Julian Oscillation (MJO) diagnostics and predictors;
  - tropical cyclone genesis parameters;
  - environmental controls on tropical cyclone movement and intensification;
  - strike probability maps;
  - Lagrangian meteograms;
  - feature-based tropical low probability maps;
  - sea state probability maps;
- Feedback mechanisms and contingency plans;
- Use of probabilities in the preparation of weather forecasts;
- Model verification as part of the forecast process;
- Interpretation of Daily Severe Weather Forecasting Guidance produced by RC Hanoi and TC guidance products produced by RSMC Tokyo and RSMC New Delhi;
- Use and applications of the SWFDP-SeA project website;
- Guidance on the completion of the SWFDP-SeA evaluation form(s);
- Coordination activities with DMCPAs
- Perhaps constructing a case-study.

Especially, PWS-related topics should typically include the following:

- User Focus
- Coordination with Disaster Prevention and Mitigation (DPM)
- Innovative Ways to Improve Working Relationships between NMHSs and DMA
- Communication Skills
- Media Skills Workshop
- Working with the Media
- Writing Workshop
- Public Education and Outreach
- Communicating Uncertainty in Forecasts
- Service Evaluation

The further more detailed information will be available later before the training workshop.

9. Evaluation

9.1 Overview

The aims of the SWFDP evaluation are:

- to assess the performances of the Daily Regional Severe Weather Forecasting Guidance;
- to assess the performances of the NMHS warning system,
- to inform about the efficiency of the SWFDP system and the level of satisfaction of the users.

During the demonstration phase, a continuous evaluation procedure using spot evaluation and regular progress report must be implemented to check if the cascading process works efficiently.

At the end of the demonstration phase, a final evaluation of the regional subproject needs to be carried out by the RSMT to identify gaps and areas for improvement to ensure future sustainability of the demonstrated procedures and for other similar subprojects. In this evaluation, a qualitative assessment will be made of the success of the SWFDP related to the specific benefits of the Project and in particular the measurable improvements that have been noted in the warning services that are provided to the National Disaster Management Offices (NDMOs) and the media.

9.2 Spot evaluation of the specified severe weather event during the field phase

To ensure that the needed information is reliably completed it is proposed that the information for the evaluation be collected by using an “evaluation form”. This evaluation form has to be completed by the NMHS when a severe weather event has been observed or when a severe weather event has been forecast. This should be completed within a week of the event and passed to the RFSC Hanoi.

The evaluation form needs to be formatted in a convenient form (Excel file) in order to simplify the processing and archiving of the data. A sample template of the evaluation form is given in Annex G. The products that have been used in the production of severe weather forecasts must also be archived for use in future case studies.

9.3 Regular progress report during the field phase

To keep regularly informed the Management Team it is proposed that each participating NMHS prepares a progress report. This report should contain information about the way the SWFDP is working, the evaluation form and the feedback of the users. A template of this progress report is given in the Annex H.

Regular progress reports should be prepared according to the schedule in Section 10.

9.4 Feedback from users from the viewpoint of PWS

During the field phase it will be particularly important for participating NMHSs to keep regular contacts with users (disaster management authorities and the media to ensure smooth flow of information with a view to measuring the level of user satisfaction. The information in this continuous evaluation should be consolidated into regular quarterly progress reports. The feedbacks from users are quite useful to improve the severe weather forecasting services. The NMCs/NMHSs regularly obtain

these feedbacks using the user assessment questionnaire for the public, NDMOs and the media in ANNEX I. This should be included in regular progress report.

10. Timetable of implementation of the field phase

When	What Task	Who RSMT Member
Feb 2010 – Oct 2011	Preparatory Work	All
July 2011	Preparatory training workshop (GDPFS/PWS)	P.Chen, WMO H. Kootval, WMO L.-S. LEE, HKO
Oct 2011	SWFDP-SeA RSMT meeting to review the RSIP	All
Nov. 2011	Start a pilot phase	All
March/April 2012	Second preparatory training workshop (GDPFS/PWS)	P.Chen, WMO H. Kootval, WMO L.-S. LEE, HKO
Apr. 2012	Start a demonstration phase	All
August 2012	First quarterly report (Apr. 2012 – July 2012)	NMHSs: Cambodia, Lao P.D.R., Thailand, Viet Nam.
Dec. 2012	Second quarterly report (Aug. 2012 – Nov. 2012)	NMHSs: Cambodia, Lao P.D.R., Thailand, Viet Nam.
Dec 2012 (or later)	Mid-term meeting (adjust and discuss the expand phase)	All
April 2013	Third progress report (Dec. 2012 – March 2013)	NMHSs: Cambodia, Lao P.D.R., Thailand, Viet Nam.

11. Costs

For the purpose of evaluating the total cost of the regional subproject, participating centres are required to estimate all additional costs associated with the SWFDP. This should include human costs (equivalent person-months) as well as expenditures of funds if any directly related to the project.

Financial assistance from a variety of sources will be needed to complete the project. There is potential for additional assistance as part of ongoing projects and activities in the region. The potential impact of field phase project-related activities on operational staffing should be considered by all participating centres.

The WMO DPFS, PWS, DRR, Regional and ETR (Education and Training), TCP programmes and RMO may be able to source funding to assist with conducting RSMT meetings and training. CBS-XIV commended the efforts of the Secretariat in supporting the SWFDP through optimising activities across WMO programmes and in seeking support from aid donors. Following the recommendations of CBS, Members are urged to seek funds from potential development partners and other agencies who stand to benefit from the important results of the SWFDP.

12. Communication and publicity of the project (Stakeholder engagement)

Informing stakeholders about the Project is an important on-going task. There should be publicity about the initiation of the Project as well regular progress reports.

Stakeholders include:

- NMHSs in the region, including spreading information within the NMHS of the participants;
- RA II President and Management Group;
- Relevant RA II Working Groups and Theme Leaders;
- Executive Council;
- Aid agencies and development partners : Asian Development Bank, World Bank;
- ASEAN Sub-committee on meteorology and geophysics
- UNESCAP/WMO Typhoon Committee
- Mekong River Commission
- WMO Secretariat

Communication could be through newsletters, information pamphlets, presentations (e.g., at the TC sessions, regular session of RA II and other regional meetings)

This Regional Subproject Implementation Plan should be passed to stakeholders for information and feedback. Responsibility for communicating the Project and publicity is a task for all participants, but with overall coordination by the Chairman.

13. List of the Annexes

- ANNEX A: Availability of Minimum Required NWP Products from Global Centres
- ANNEX B: List of the Stations of EPSgrams provided by Global Centres
- ANNEX C: Data and Products List issued from Regional Centres
- ANNEX D: Example of RFSC Daily Severe Weather Forecasting Guidance
- ANNEX E: Data and Products delivered from other Projects / Activities
- ANNEX F: Action Plan for Improvement of PWS element in NMHSs
- ANNEX G: Template of Severe Weather Event Evaluation Form
- ANNEX H: Template of Progress Report
- ANNEX I: User Assessment Questionnaire

14. References

- Final Report of the 13th session of CBS (St. Petersburg, 23 February - 3 March 2005)
- Final Report of the Extra-ordinary session of CBS in 2006 (Seoul, Republic of Korea, 9-16 November 2006)
- Final Report of the 14th session of Regional Association II (ASIA) (Tashkent, Uzbekistan, 5–11 December 2008), WMO-No.1037,(2009).
- Final Report of the Workshop on Severe Weather Forecasting Demonstration Project Development for Southeast Asia (Hanoi, Vietnam, 1-4 February 2010).
- Final Report of the 3rd meeting of CBS Steering Group for the Severe Weather Forecasting Demonstration Project (Geneva, Switzerland, 22-26 Febrary, 2010).

ANNEX A: Availability of Minimum Required NWP Products from Global Centres

Deterministic Forecasts:	Availability		
6-hourly out to 72 hours, then 12-hourly up to 144 hours	CMA	JMA	KMA
Parameters: wind (streamlines and speed/direction), temperature, geopotential height, humidity Levels: sfc, 925mb, 850mb, 700mb, 500mb, 300mb, 200mb Purpose: General forecasting parameters to gain a perspective on the overall atmosphere. For determination of frontal system and pressure maxima locations.	YES	YES	YES
Parameter: vorticity Level: 500mb, 300mb Purpose: Determination of frontal and low pressure system locations. Crucial in locating potential severe weather outbreak locations. Can be used in determination of severe weather type	YES	YES	YES
Parameter: vertical velocity Level: 850mb, 700mb, 300mb Purpose: Determination of mesoscale patterns of rising and sinking air masses (convective updrafts)	YES	YES	YES
Parameter: 850mb wet bulb potential temperature Level: 850mb Purpose: Frontal position diagnosis and change in airmass	850mb potential pseudo-equivalent temperature (Theta-SE) replacing 850mb wet bulb potential temperature	NO	NO
Parameters: instantaneous and accumulated precipitation, minimum temperature, maximum temperature, sea level pressure, relative humidity Level: sfc Purpose: General forecasting parameters	YES, but instantaneous precipitation is unavailable	YES except instantaneous precipitation	Accumulated precipitation and sea level pressure are only available
Parameter: 1000-500mb thickness Level: partial atmospheric column Purpose: Freezing level determination and air mass distinguishing	NO	YES	YES
Parameter: precipitable water Level: atmospheric column Purpose: Determination of total liquid water in the atmosphere and thus potential rainfall	NO	YES	YES
Parameter: convective available potential energy (CAPE), Theta-E Level: atmospheric column Purpose: Amount of energy available in the atmosphere for storm production	Theta-SE replacing Theta-E. Parameters is available in the North hemisphere	YES	NO

Parameter: lifted index, K index, total totals index Level: stability index Purpose: Pre-calculated indices to generalize severe weather potential	Parameters is available in the north hemisphere	K index is only available	YES
Parameter: convective inhibition (CIN) Level: stability index Purpose: Strength of force preventing convective initiation. The amount of energy (frontal forcing or daytime heating) that is needed to begin convection.	Parameters is available in the north hemisphere	YES	NO
Ensemble Forecasts:	Availability		
12-hourly out to 144 hours	CMA	JMA	KMA
Probability of 6-hour accumulated precipitation exceeding 50mm and 100mm threshold value	YES	YES	YES
Probability of 24-hour accumulated precipitation exceeding 100mm threshold value	YES	YES	YES
Probability of 10-meter wind speed exceeding 20kt and 30kt threshold value	YES	YES	YES
Probability of significant wave height exceeding 2 m, 4 m and 6 m threshold value	NO	NO	NO
Probability of significant wave period exceeding 10 s and 15 s threshold value	NO	NO	NO
Ensemble Prediction System meteograms for specified locations	YES	YES	YES
Spaghetti diagrams for 500mb geopotential height	YES	YES	YES
Thumbnails of probability of precipitation in excess of threshold of 50mm/6h at 6 hours intervals	NO	YES	NO
Extreme Forecast Index for precipitation and wind	NO	NO	NO
Tropical cyclone occurrence and genesis probability maps	NO	NO	NO
Tropical cyclone strike probability maps	NO	NO	NO
Tropical cyclone forecast tracks from ensemble members, including ensemble mean, deterministic and control tracks	NO	NO	NO
Tropical Cyclone Lagrangian meteograms	NO	NO	NO
Other REQUESTED Products:	Availability		
	CMA	JMA	KMA
SKEW-T logarithmic forecast plots for selected grid points based on NWP output (out to 144 hours, 12-hourly)	YES	NO	YES

ANNEX B: List of the Stations of EPSgrams provided by Global Centres

Remark: ECMWF provides EPSgrams at stations in the form of italic style.

B.1 Cambodia
B.1.1 List of stations for EPSgrams

WMO ID	Station Name	Latitude_N	Longtude_E	Altitude[m]	CMA	JMA	KMA
48969	*Bantey Meanchey*	13°37'	102°58'	31m		○	○
48962	Battambang	13°06'	103°12'	13m		○	○
48990	*Kandal*	11°26'	104°49'	8m		○	○
48986	*Koh Kong*	11°38'	102 59'	13m		○	○
48995	*Kompomg Cham*	12°	105°27'	14m	○	○	○
48967	Kompong Chhnang	12°13'	104°40'	15m		○	○
48992	*Kompong Speu*	11°28'	104°34	27m		○	○
48965	*Kompong Thom*	12°41'	104°54'	13m	○	○	○
48985	*Kompot*	10°36'	104°11'	4m		○	○
48970	Krotie	12°29'	106°10'	23m		○	○
48991	*Pochentong*	11°33'	104°50'	11m		○	○
48964	*Preh Vihear*	14°06'	105° 09'	62m	○	○	○
48997	*Prey Veng*	11°29'	105°19'	13m	○	○	○
48968	Pursat	12°33'	103°51'	18m	○	○	○
48973	Rattanakiri	13°44'	106°59'	330m		○	○
48966	Siemreap	13°22'	103°51'	15m		○	○
48983	*Sihanouk Ville*	10°37'	103°29'	13m		○	○
48972	Stung Treng	13°31'	105°58'	54m		○	○
48998	Svay Reing	11°50'	105°48'	6m		○	○
48993	Takeo	10°59'	104°48'	6m		○	○
48971	Mondul Kiri	12°27'	107°11'	690m		○	○
48963	Pailin	12°48'	102°36'	170m		○	○

B.2 Lao P.D.R.
B.2.1- List of stations for EPSgrams

WMO ID	Station Name	Latitude_N	Longtude_E	Altitude[m]	CMA	JMA	KMA
48921	Phongxali	21.6763	102.0921	1300		○	○
48924	*Louangnamtha*	20.9310	101.4165	600	○	○	○
48925	Oudomxai	20.6967	101.9915	636		○	○
48926	Houayxay	20.2619	100.4372	401		○	○
48930	*Louangphbang*	19.8984	102.1652	305	○	○	○
48938	Xaignabouli	19.2438	101.7103	326		○	○
48927	Viangxai	20.4174	104.2309	913		○	○
48935	Phonsavan	19.4438	103.1711	1094		○	○
48941	Phonhong	18.4930	102.4488	179		○	○
48940	*Vientiane*	17.9700	102.5704	171	○	○	○

48945	*Pakxan*	18.3911	103.6657	157		○	○
48946	*Thakhek*	17.4048	104.8084	151		○	○
48947	*Savannakhet*	16.5523	104.7545	144	○	○	○
48952	Salavan	15.7119	106.4127	168		○	○
48953	*Xekong*	15.3424	106.7199	143		○	○
48955	*Pakxe*	15.1201	105.8561	104	○	○	○
48957	Attapu	14.8111	106.8302	105		○	○

B.3 Thailand
B.3.1 List of stations for EPSgrams

WMO ID	Station Name	Latitude_N	Longtude_E	Altitude[m]	CMA	JMA	KMA
48327	*Chiang Mai*	18.8	99	314	○	○	○
48378	*Phitsanulok*	16.8	100.3	46		○	○
48354	*Udon Thani*	17.4	102.8	178	○	○	○
48407	*Ubon Ratchathani*	15.2	104.9	124	○	○	○
48400	*Nakhon Sawan*	15.8	100.2	35		○	○
48455	*Bangkok*	13.7	100.6	4	○	○	○
48462	*Aranyaprathet*	13.7	102.6	49		○	○
48500	*Prachuap Khirikhan*	11.8	99.8	5		○	○
48568	*Songkhla*	7.2	100.6	7		○	○
48565	*Phuket Airport*	8.2	98.3	9	○	○	○
48331	Nan	18.78	100.78	200 m		○	○
48421	Thong Phaphum	14.74	98.64	97.36 m		○	○
48357	Nakhon Phanom	17.42	104.78	145 m		○	○
48431	Nakhon Ratchasima	14.96	102.07	186 m		○	○
48501	Trad	11.77	102.88	2 m		○	○
48551	Surat Thani	9.14	99.15	5 m		○	○

B.4 Viet Nam
B.4.1 List of stations for EPSgrams

WMO ID	Station Name	Latitude_N	Longtude_E	Altitude[m]	CMA	JMA	KMA
48808	Cao Bang	22.67	106.25	243		○	○
48803	Lao Cai	22.5	103.97	97		○	○
48830	Lang Son	21.83	106.77	263	○	○	○
48806	*Son La*	21.33	103.9	676		○	○
48820	*Ha Noi*	21	105.88	7	○	○	○
48826	*Phu Lien*	20.8	106.63	116		○	○
48823	Nam Đinh	20.43	106.15	3		○	○
48839	Bach Long Vi	20.13	107.72	56		○	
48840	*Thanh Hoa*	19.75	105.78	5		○	○
48845	*Vinh*	18.67	105.68	6		○	○
48848	Đong Hoi	17.48	106.6	8		○	○

48852	*Hue*	16.43	107.58	9	○	○	○
48855	*Đq Nqng*	16.03	108.2	7		○	○
48866	*Pleiku*	13.98	108	779		○	○
48870	Quy Nhon	13.77	109.22	6		○	○
48877	Nha Trang	12.22	109.22	4		○	○
48892	Song Tu Tay	11.42	114.33	5		○	○
48887	Phan Thiet	10.93	108.1	5		○	○
48900	*Ho Chi Minh*	10.82	106.67	10	○	○	○
48917	Phu Quoc	10.22	103.97	4		○	○
48916	Tho Chu	9.28	103.47	0		○	
48914	Ca Mau	9.18	105.15	3	○	○	○
48918	Con son	8.68	106.6	9		○	
48920	Truong Sa	8.65	111.92	3		○	
48919	Huyen Tran	8.02	110.62	19		○	

ANNEX C: Data and Products List issued from Regional Centres

C.1 Regional Forecasting Support Centre Hanoi

Deterministic Forecasts from global models that received at NCHMF (present and near future)						
All product is provided every 6-hourly out to 72 hours	Availability					
	GSM (JMA)	GFS (NCEP)	NOGAPS (US Navy)	GME (DWD)	GEM (CMC)	IFS (ECMWF)
Surface parameters						
Every 6 hours and 24 hours total accumulated precipitation	x	x	x		x	x
2 meters temperature and dewpoint temperature	x	x	x	x	x	x
2 meters relative humidity or specific humidity	x	x	x	x	x	x
10 meters wind (speed and direction)	x	x	x	x	x	x
Pressure of mean sea level	x	x	x	x	x	x
Upper parameters						
Parameters: wind (streamlines and speed/direction), temperature, geopotential height, humidity Levels: 1000mb, 925mb, 850mb, 700mb, 500mb, 300mb, 200mb, 200mb	x	x	x	x	x	x
Parameter: vorticity Level: 850mb, 700mb, 500mb, 300mb	x	x	x	x	x	x
Parameter: divergence Level: 500mb, 300mb, 200mb	x	x	x	x	x	x
Parameter: vertical velocity Level: 850mb, 700mb, 500mb	x	x	x	x	x	x
Parameter: potential temperature and equivalent potential temperature Level: 850mb, 700mb	x	x	x	x	x	x
Atmospheric column or instable indices						
Parameter: lifted index, K index, total totals index, CAPE, CIN, Shalwater index, etc	x	x	x	x	x	x
Parameter: 1000-500mb thickness	x	x	x	x	x	x
SkewT and Meteogram at given locations						
List of location is requested by participating countries	x	x	x	x	x	x

Deterministic Forecasts from high resolution regional models at NCHMF (present and near future)						
All product is provided every 6-hourly out to 72 hours	Availability					
	HRM	WRF				
Surface parameters						
Every 6 hours and 24 hours total accumulated precipitation	x	x				
2 meters temperature and dewpoint temperature	x	x				
2 meters Max and Min temperature						
2 meters relative humidity or specific humidity	x	x				
10 meters wind (speed and direction)	x	x				
Pressure of mean sea level	x	x				
Upper parameters						
Parameters: wind (streamlines and speed/direction), temperature, geopotential height, humidity Levels: 1000mb, 925mb, 850mb, 700mb, 500mb, 300mb, 200mb, 200mb	x	x				
Parameter: vorticity Level: 850mb, 700mb, 500mb, 300mb	x	x				
Parameter: divergence Level: 500mb, 300mb, 200mb	x	x				
Parameter: vertical velocity Level: 850mb, 700mb, 500mb	x	x				
Parameter: potential temperature and equivalent potential temperature Level: 850mb, 700mb	x	x				
Atmospheric column or instable indices						
Parameter: lifted index, K index, total totals index, CAPE, CIN, Shalwater index, etc	x	x				
Parameter: 1000-500mb thickness	x	x				
SkewT and Meteogram at given locations						
List of location is requested by participating countries	x	x				

Ensemble Forecasts from EPS at NCHMF (present and near future)							
Products	Availability						
	SREF (6hrs out to 3 days)	LEPS (6-12hrs out to 5 days)	NAEFS (12-24hrs out to 15 days)	EPS - ECMWF (6-12hrs out to 15 days)	Wave EPS - ECMWF (6hrs out to 15 days)	Monthly EPS-ECMWF (4 periods of 7 days in a month)	Seasonal EPS-ECMWF (out to 1-7 months)
Probability of 6-hour accumulated precipitation exceeding 50mm and 100mm threshold value	x	x	x	x			
Probability of 24-hour accumulated precipitation exceeding 100mm threshold value	x	x	x	x			
Probability of 10-meter wind speed exceeding 20kt and 30kt threshold value	x	x	x	x			
Probability of significant wave height exceeding 2 m, 4 m and 6 m threshold value					x		
Probability of significant wave period exceeding 10 s and 15 s threshold value					x		
Ensemble Prediction System meteograms for specified locations	x	x	x	x			
Spaghetti diagrams for 500mb geopotential height	x	x	x	x		x	x
Thumbnails of probability of precipitation in excess of threshold of 50mm/6h at 6 hours intervals or more	x	x	x	x			
ECMWF Extreme Forecast Index for precipitation and wind				x			
Tropical cyclone occurrence and genesis probability maps	x	x	x	x			
Tropical cyclone strike probability maps	x	x	x	x			
Tropical cyclone forecast tracks from ensemble members, including ensemble mean, deterministic and control tracks	x	x	x	x			
Tropical Cyclone Lagrangian meteograms (ECMWF)				x			
For monthly EPS: Weekly means of ensemble means, Weekly mean anomalies of ensemble means For seasonal EPS: Monthly means of ensemble means, Monthly mean anomalies of ensemble means							
10 metre U-velocity anomaly						x	x
10 metre V-velocity anomaly						x	x
2 metre temperature anomaly						x	x
2 metre dewpoint temperature						x	x

Ensemble Forecasts from EPS at NCHMF (present and near future)							
Products	Availability						
	SREF (6hrs out to 3 days)	LEPS (6-12hrs out to 5 days)	NAEFS (12-24hrs out to 15 days)	EPS - ECMWF (6-12hrs out to 15 days)	Wave EPS - ECMWF (6hrs out to 15 days)	Monthly EPS-ECMWF (4 periods of 7 days in a month)	Seasonal EPS-ECMWF (out to 1-7 months)
anomaly							
Maximum temperature at 2 metres since last 24 hours anomaly						x	x
Mean sea level pressure anomaly						x	x
Minimum temperature at 2 metres since last 24 hours anomaly						x	x
Sea surface temperature anomaly						x	x
Total precipitation anomalous rate of accumulation						x	x
Geopotential height anomaly, Temperature anomaly and U, V anomaly at 850mb, 500mb 300mb and 200mb						x	x
Forecast probabilities (weekly averaged): 2 metre temperature anomaly of at least +/-1K						x	
Forecast probabilities (weekly averaged): 2 metre temperature anomaly of at least +/-2K						x	
Forecast probabilities (weekly accumulated): Total precipitation anomaly of at least 10 and 20mm						x	
Probability distributions of 2 metre temperature and total precipitation						x	

C.2 RSMC Tokyo – Typhoon Centre

C.2.1 Products via GTS and AFTN

Information provided by RSMC Tokyo - TC includes the results of TC satellite image analysis issued in satellite report (SAREP), as well as TC forecasts up to 72 hours ahead and TC track forecasts up to 120 hours ahead issued as RSMC TC advisories. TC information and products provided mainly via GTS and AFTN are shown in the Table.

Products	Provided through	Frequency	Contents
RSMC Tropical Cyclone Advisory	GTS, RSMC website	8 times/day	Center position, Direction and speed of movement, Maximum sustained wind speed (10-minute average), Maximum gust wind speed (analysis and forecast), Accuracy of determination of the center position, Radii of wind areas over 50 and 30 knots (analysis)
RSMC Tropical Cyclone Advisory for Five-day Track Forecast	GTS, RSMC website	4 times/day	In addition to 72 hours forecast (same as RSMC Tropical Cyclone Advisory), Center position, Direction and speed of movement for 96 and 120 hour forecasts
RSMC Guidance for Forecast	GTS	4 times/day	Center position, Central pressure, Maximum sustained wind speed (Central pressure and Maximum sustained wind speed are given as deviations from those at the initial time)
SAREP	GTS, NTP website	8 times/day	Center position and its accuracy, Direction and speed of movement, Mean diameter of the overcast cloud, Apparent 24-hour change in intensity, Dvorak Intensity (CI, T, DT, MET, PT number), Cloud pattern type of DT number, Trend of past 24-hour change, Cloud picture type of PT number, Type of the final T-number
RSMC Prognostic Reasoning	GTS, NTP website	2 times/day	General comments on the forecasting method, the synoptic situation of the subtropical ridge, the movement and intensity of the TC as well as relevant remarks.
RSMC Tropical Cyclone Best Track	GTS, RSMC website		Center position, Maximum sustained wind speed, Radii of wind areas over 50 and 30 knots
Tropical Cyclone Advisory for SIGMET	AFTN	4 times/day	Center position, Maximum sustained wind speed (analysis and forecast), Direction and speed of movement, Central pressure (analysis)

C.2.2 Products via JMA radio facsimile broadcast

The Analysis and 24 and 48 hours Prognostic Charts of 850 hPa / 200 hPa Stream Line are distributed via JMA radio facsimile broadcast (JMH) twice a day at 00 and 12 UTC.

C.2.3 Products via RSMC Data Serving System

RSMC Data Serving System provides NWP GPV and observational data. This system prepares the outputs of GSM as well as those of Global Wave Model and MTSAT data in GRIB format. SAREP in BUFR format and observation data such as SYNOP, SHIP and TEMP are also available.

C.2.4 Products via RSMC Tokyo - Typhoon Centre Website

The RSMC Tokyo - TC Website (RSMC website) provides TC advisories on a real-time basis, and non-real-time products including TC analysis archives. The website address is http://www.jma.go.jp/ jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm.

C.2.5 Products via Numerical Typhoon Prediction (NTP) website

The RSMC Tokyo - TC Numerical Typhoon Prediction (NTP) website provides predictions of TC tracks performed by models of nine major NWP centres. The main contents of the NTP website are

1) TC track predictions, in table and chart format, of the participating NWP centres with several useful functions such as deriving an ensemble mean from any combination of predictions by the centres
2) Weather charts of the NWP models of the participating NWP centres (up to 168 hours)
3) Operational TC analysis using satellite image
4) Storm surge distribution maps

C.3 RSMC New Delhi – Tropical Cyclone Centre

C.3.1. Bulletins and products available through GTS, AFTN and IMD website

The information provided by RSMC, New Delhi includes the products and bulletins as mentioned in the following Table 1.

Table 1. Tropical cyclone information, bulletin and product from IMD

Bulletins/ Products	Mode of dissemination	Frequency and time of issue	Content
Tropical Weather Outlook	GTS, website	Once a day at 0600 UTC based on 0300 UTC	(i) Description of convection (ii) Location of low pressure area (one closed isobar with maximum sustained wind (MSW) speed of less than 17 knots) (iii) Large scale environmental features including location of upper tropospheric ridge etc.
Special Tropical Weather Outlook	GTS, Website	Twice a day at 0600 and 1500 UTC based on 0300 and 1200 UTC respectively when there is a depression/ deep depression (17-33 knots) It is issued more frequently as and when required.	(i) Current position and intensity, estimated central pressure and maximum sustained surface wind (MSW) (ii) Past movement (iii) Quantitative Forecast track and intensity up to 72 hrs from deep depression stage onwards (+6, +12, +18, +24, +36, +48, +60, +72 hrs). (iv) Description of associated convection, T number based on INSAT/Kalpana, Cloud top temperature, pattern of convection (v) Sea condition (vi) Significant observational data, if any. (vii) Prognostic and diagnostic features including SST, Ocean heat content, lower level convergence, lower level vorticity, upper level divergence, vertical wind shear, wind shear tendency, phase and amplitude of MJO index, any other synoptic features and NWP model guidance etc.
Tropical Cyclone Advisory bulletin	GTS, Website	8 times a day based on 00, 03, 06, 09, 12, 15, 18 and 21 UTC observation	(i) Current position and intensity, estimated central pressure and maximum sustained surface wind (MSW) (ii) Past movement (iii) Quantitative Forecast track and intensity up to 72 hrs from deep depression stage onwards (+6, +12, +18, +24, +36, +48, +60, +72 hrs). (iv) Description of associated convection, T number based on INSAT/Kalpana, Cloud top temperature, pattern of convection. (v) Sea condition (vi) Significant observational data, if any. (vii) Storm surge guidance, as and when necessary (viii) Prognostic and diagnostic features including SST, Ocean heat content, lower level

			convergence, lower level vorticity, upper level divergence, vertical wind shear, wind shear tendency, phase and amplitude of MJO index, any other synoptic features and NWP model guidance etc.
Cone of uncertainty	Web site	4 times a day based on 00, 06, 12 and 18 UTC from deep depression stage onwards	(i) Given in graphical form along with track forecast
Quadrant wind forecast	GTS, Website	4 times a day based on 00, 06, 12 and 18 UTC from deep depression stage onwards	(i) Radius of 28, 34, 50 and 64 knots forecast winds in four quadrants up to 72 hrs (+6, +12, +18, +24, +36, +48, +60, +72 hrs) (ii) The product is available in both text and graphics form
Ship avoidance area*	Website	4 times a day based on 00, 06, 12 and 18 UTC from deep depression stage onwards	(i) Area of 34 knots or more winds as predicted by RSMC, New Delhi (ii) The product will be available in graphics form only
Tropical cyclone advisory bulletin for SIGMET	GTS/AFTN	4 times a day based on 00, 06, 12 and 18 UTC from cyclonic storm (MSW of 34 knots or more) stage onwards	(i) Current position and intensity, estimated central pressure and maximum sustained surface wind (MSW) (ii) Past movement (direction and speed) (iii)Forecast location and intensity up to 24 hrs (+6, +12, +18, +24 hrs). (iv) In addition, there will be advisory graphics in PNG format for transmission.
Tropical cyclone warnings for the high seas	INMARSAT safety system, Website	Twice daily, thrice during depression and six times during cyclone	(a) Type of warning and name of the centre (b) Name of the system (c) Date and time of reference in UTC (d) Type of disturbance (depression, cyclonic storm, etc.); (e) Location in terms of latitude and longitude or with reference to well-known landmarks (f) Direction and speed of movement of the disturbance (g) Extent of affected area (h) Wind speed or force and direction in the

			affected areas (i) Sea and swell condition in affected areas (in qualitative terms) (j) Other important information such as future position of disturbances Items (a), (b), (c), (d),(e), (f) ,(g) and (h) listed above are always included in the warning bulletins.
Satellite bulletin	GTS, Website	8 times a day based on 00, 03, 06, 09, 12, 15, 18 and 21 UTC observation	(i) Centre position (ii) Intensity (T /CI number) (iii) Cloud description (area coverage and intensity of convection (iv) Pattern based on Dvorak's technique (v) Cloud top temperature (vi) Characteristics of eye, if any (vii) Environmental features based on satellite observation
Satellite imagery of cyclone	Website	Every half hourly	(i) VIS, IR, WV and colour composite imageries
INSAT/ Kalpana Satellite derived products		Every three hourly	(i) Derived products including cloud top temperature, upper tropospheric humidity, sea surface temperature, quantitative precipitation estimate, Outgoing longwave radiation, Cloud motion vectors, water vapour wind vectors etc.
NOAA and MODIS satellite products	Website		(i) The satellite imageries and products based on NOAA and MODIS satellites are available
NWP products	Website	Twice daily based on 00 and 12 UTC	(i) IIT Delhi Storm Surge Model Guidance (ii) Cyclone Strike Probability, based on ensemble and super ensemble technique (iii) Quasi-Lagrangian Model for prediction of track of cyclone up to 72 hrs twice daily based on 00 and 12 UTC (iv) Multi-model ensemble (MME) product twice daily for prediction of track of cyclone up to 72 hrs (v) *Genesis potential based on IMD GFS Model (vi) *Probability of rapid intensification
Preliminary reports	Website	Within a week after the dissipation of the low pressure system	(i) Salient features, (ii) Life history (genesis, intensification, movement), (iii) Satellite and radar observed features, (iv) Associated adverse weather, (v) Damage, if any, (vi) Performance of RSMC (statistics of bulletin issued and verification of forecast and warning)
RSMC tropical cyclone	website	Once a year during March	(i) Date and time (ii) Centre location (iii) Intensity category

best track			(iv) MSW (v) Estimated central pressure (vi) Pressure drop at the centre (vii) CI number

* Products will be available from ensuing cyclone season (Oct-Nov., 2011)

Explanatory notes:

(i) Tropical weather outlook

The tropical weather outlook is prepared once daily by RSMC tropical cyclones, New Delhi throughout the year. It is transmitted on the GTS at 06 UTC every day. The outlook covering the North Indian Ocean indicates possible development of tropical depressions over the sea.

(ii) Special Tropical Weather Outlook

Special Tropical Weather outlook is transmitted on the GTS at 0600 UTC and 1500 UTC when a depression is located over the north Indian Ocean region. The additional bulletin will be issued as and when felt necessary by RSMC, New Delhi.

The special tropical weather outlook issued in association with the depression provides brief descriptions of tropical depressions affecting the area. It will give the location, intensity and movement of the system as well as a general statement of land areas coming under threat. It will also contain description of the convective clouds in satellite imageries and diagnostic & prognostic features of the system. When the depression intensifies into a deep depression, the special tropical weather outlook issued twice a day based on 0300 and 1200 UTC observation will in addition contain the 72 hrs forecast track and intensity of the system in a tabular form. These track and intensity forecasts are issued for +6, +12, +18, +24, +36, +48, 60 and +72 hrs since December 2008.

(iii) Tropical cyclone advisories

When a tropical low pressure system reaches the cyclonic storm stage, or is shortly expected to reach that intensity, RSMC tropical cyclones, New Delhi will issue tropical cyclone advisories. Advisories are issued at 00, 03, 06, 09, 12, 15, 18 and 21 UTC. The area of responsibility for the issue of tropical cyclone advisories by RSMC Tropical Cyclones, New Delhi covers sea areas of north Indian Ocean between long. 45° E to 100° E. Supplementary advisories may be issued as necessitated by circumstances, e.g., change in intensity or movement.

Tropical cyclone advisories contain the information of tropical cyclone, name of the cyclone, the present location, intensity and movement (present and past twelve hours) of the storm, and its forecast position, movement, intensity, maximum average surface wind speed with highest gust wind speed and sea conditions (in qualitative terms). These track and intensity forecasts are issued for +6, +12, +18, +24, +36, +48, 60 and +72 hrs. It also contains description of the convection as seen in satellite imageries and brief description of the diagnosis and prognosis of the system. The bulletin contains the storm surge guidance based on IIT, Delhi Storm Surge prediction model in case of the cyclone landfalling over any member countries. Important information obtained from radar, synoptic, ship observations from the affected areas will also be reported in the advisory bulletin.

Advisories are exchanged under appropriate headings for regional distribution by RTH, New Delhi on the GTS.

(iv) Tropical cyclone warnings for the high seas

The World Meteorological Organization (WMO) in its Manual on Marine Meteorological Services has recommended the issue of weather and sea bulletins for the high seas in six parts. The cyclone warning centres of India issuing forecasts and warnings for the benefit of the ships on the high seas, area covered by these stations in their bulletins, name of the coastal radio stations with their call signs from where the tropical cyclone warnings are broadcast, are given in **Table 2.**

Table 2. Stations issuing cyclone warnings for ships on the high seas

Station	Area covered
India, Mumbai	Arabian Sea north of Lat. 5°N and east of Long. 60°E excluding the area north of Lat. 20°N and west of Long. 68°E. The eastern boundary of the Arabian Sea for which these bulletins are issued by Mumbai is Long. 80°E meridian excluding the Gulf of Mannar.
India, Kolkata	Bay of Bengal north of Lat. 5°N except the area between the coastline on the east and the line drawn through the points 18°N 94.5°E, 18°N 92°E, 13.5°N 92°E, 13.5°N 94°E, 10°N 94°E, 10°N 95°E and 5°N 95°E. The western boundary of the sea area for which bulletins are issued by Kolkata is up to and inclusive of the Gulf of Mannar (i.e., 77.5°E meridian).
India, Chennai	Bay of Bengal bulletins issued by ACWC Kolkata are being broadcast through Navtex, Chennai by Narrow Band Direct Printing (NBDP)

Under the new Marine Meteorological Broadcast system, GMDSS (Global Marine Distress Safety System) of IMO/WMO, India issues two bulletins at 0900 and 1800 UTC everyday for broadcast through INMARSAT SAFETY SYSTEM. Additional bulletins are broadcast during Cyclone period.

(v) Warnings and advisories for aviation

In accordance with the International Civil Aviation Organization (ICAO) Annex 3 — *Meteorological Service for International Air Navigation*/ WMO Technical Regulations [C.3.1], tropical cyclone warnings, required for the international air navigation, are issued by designated meteorological watch offices (MWO) as SIGMET messages * , including an outlook, giving information for up to 24 hours ahead concerning the expected positions and maximum surface wind of the centre of the tropical cyclone. Each MWO provides information for one or more specified Flight Information Regions (FIRs) or Upper Information Regions (UIRs). The boundaries of the FIRs/UIRs are defined in ICAO Air Navigation Plans (ANP) for the Asia (ASIA), Middle East (MID) and Pacific (PAC) Regions.

The content and order of elements in a SIGMET message for tropical cyclone are in accordance with WMO Technical Regulations [C.3.1]. The data type designator to be included in the WMO abbreviated header of such messages shall be T1T 2 = WC (WMO No. 386, Manual on GTS refers).

The designated Tropical Cyclone Advisory Centre (TCAC), New Delhi monitors the development of tropical cyclones in its area of responsibility, in accordance with the ASIA/PAC ANP and issue advisory information concerning the positions of the centre of the cyclone, its direction and speed of movement, central pressure and maximum surface wind near the centre. These advisories are disseminated to the MWOs in the TCAC New Delhi area of responsibility, to be used in the preparation of the OUTLOOK appended to SIGMETs for tropical cyclones. In addition, the tropical cyclone advisories are disseminated to the other TCACs, whose areas of responsibility may be affected, to the World Area Forecast Centres (WAFC) London and Washington and international OPMET data banks and centres operating the satellite distribution systems (SADIS and ISCS).

C.3.2. Observational data provided through GTS

(i) All the observational data including SYNOP, PILOT, TEMP, SHIP, BUOY, ARGOS data are made available through GTS.
(ii) Many of these including current weather observation and upper air data of Indian stations are also available in IMD website (www.imd.gov.in)

C.3.3. NWP products available in IMD website (twice daily based on 00 and 12 UTC)

(i) The IMD GFS model (T382, 35 km resolution) products (circulation fields and rainfall) for analysis and forecast up to 168 hrs at the interval of 6 hrs.
(ii) IMD GFS Model (T382, 35 km resolution) based derived dynamical and thermo-dynamical products like vorticity, divergence, wind shear, CAPE, CINE etc on experimental basis.
(iii) The WRF ARW and NMM models analysis and forecast (circulation fields and rainfall) up to 72 hrs with resolutions of both 27 km and 09 km.
(iv) WRF ARW Model (9 km resolution) based derived dynamical and thermo-dynamical products like vorticity, divergence, wind shear, CAPE, CINE etc on experimental basis.
(v) WRF NMM Model (27 km resolution) based derived dynamical and thermo-dynamical products like vorticity, divergence, wind shear, CAPE, CINE etc on experimental basis.
(vi) IMD GFS (T 574, 27 km resolution) model products (circulation fields and rainfall) for analysis and forecast up to 168 hrs at the interval of 6 hrs.

C.3.4. Extended range forecast

(i) Extended range forecast up to two weeks of rainfall and circulation features based on NCEP-CFS, ECMWF and MME once a week.

C.3.5. Wave model products from Indian National Centre for Ocean Information Services (INCOIS) are available in IMD website (cyclone page) through a link to INCOIS website.

ANNEX D: Example of RFSC Daily Severe Weather Forecasting Guidance

ANNEX E: Data and Products delivered from other Projects / Activities

E.1 Special Products from Meteorological Satellite Center, JMA

E.1.1 Products

The Meteorological Satellite Center (MSC) of JMA will provide MTSAT geostationary satellite imagery with the information of potentially raining heavily associated with deep convective clouds over the South-East Asia region. The imagery will be available on the MSC Web page (http://mscweb.kishou.go.jp/sat_dat/index.htm).

E.1.2 Contact Point

Mr. Yasushi Izumikawa
Meteorological Satellite Center / Japan Meteorological Agency
Email: y-izumikawa@met.kishou.go.jp

E.2 GIFS-Forecast Demonstration Project (FDP) (THORPEX/TIGGE/GIFS), including North Western Pacific Tropical Cyclone (Track) Ensemble Forecast Research Project (WWRP Research Development Project)

E.2.1 Products via website

The MRI/JMA will provide TC track forecast and TC strike probability maps through (http://tparc.mri-jma.go.jp/cyclone/login.php) and maps for genesis potential of high-impact weather through http://tparc.mri-jma.go.jp/TIGGE/tigge_SWFDP.html.

Products	Provided through	Frequency	Content
TC track forecast and TC strike probability maps	Website	4 times / day	Deterministic and ensemble TC track forecast by major NWP centres.
Genesis potential of high-impact weather	Website	1 time / day	Genesis potential such as heavy rainfall, extremely high/low temperature, and strong wind based on the ECMWF, JMA, NCEP and UKMO EPSs

E.2.2 Contact Point

Dr. Munehiko Yamaguchi
Meteorological Research Institute / Japan Meteorological Agency
Email: myamagu@mri-jma.go.jp

E.3 RA-II Project on the Provision of City-Specific NWP products

E.3.1 Products via website

The products are available from the following websites:

Products provided by HKO
http://nwp.weather.gov.hk/cityfc/cambodia/
http://nwp.weather.gov.hk/cityfc/laos/
http://nwp.weather.gov.hk/cityfc/vietnam/
http://nwp.weather.gov.hk/cityfc/thailand/

Products provided by JMA:
http://ra2-nwp.kishou.go.jp/cityfc/Cambodia/
http://ra2-nwp.kishou.go.jp/cityfc/Lao/
http://ra2-nwp.kishou.go.jp/cityfc/VietNam/
http://ra2-nwp.kishou.go.jp/cityfc/Thailand/

Products provided by KMA
http://www.kma.go.kr/ema/ema03/ra2d_eng_city1.html

E.3.2 Contact Point

Mr. LS Lee
Senior Scientific Officer
Hong Kong Observatory
Coordinator of the RA II Project on the Provision of City-Specific NWP Products

E.4 JMA Pilot Project on EPS products

E.4.1 Products

The detail of products is shown in the following table. All products are provided on the website: http://eps.kishou.go.jp/EPSMRFA .

Daily EPS product		Variable	Area or point
EPS charts	- Ensemble mean - Normalized spread - Spaghetti - Stamp map	- Mean-Sea-Level Pressure (MSLP) - 500hPa geopotential height	- Northwestern Pacific - Asia
		- MSLP - Surface Wind	- South China Sea (100°E -130°E,5°N -30°N)
Probabilistic maps		- 850 hPa temperature anomalies with thresholds ±2, ±4, ±8 K - Precipitation with thresholds 24, 48, 72 mm/24hours	- Northwestern Pacific - Asia - Northern Hemisphere
Point forecast	EPSgram (Box plot diagram)	- Surface, 925, 850, 700, 500, 300hPa temperature (°C) - Precipitation rate (mm/6hr) - MSLP (hPa)	- Major cities in Asia
	Plume diagram	Accumulated precipitation (mm)	

E.4.2 Contact Point

Mr. Haruki Yamaguchi
Numerical Prediction Division
Japan Meteorological Agency
Email: eps-admin@naps.kishou.go.jp

E.5 RAII Pilot Project to Develop Support for NMHSs in Satellite Data, Products and Training

E.5.1 Products

Products are provided on the website:
http://www.wmo.int/pages/prog/sat/ra2pilotproject-intro_en.php

E.5.2 Contact Point

Mr. Toshiyuki KURINO
Senior Coordinator for Meteorological Satellite Systems
Satellite Program Division, JMA
Email: tkurino@met.kishou.go.jp

Dr. Dohyeong KIM
Senior Researcher
National Meteorological Satellite Center, KMA
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E.6 Landfall Typhoon Forecast Demonstration Project (WMO-Project, ESCAP/WMO TC)

E.6.1 Products via website

Products are provided on the website: http://tlfdp.typhoon.gov.cn/

E.6.2 Contact Point

Mr. Koji Kuroiwa
Chief, Tropical Cyclone Programme Division, WMO
Email: kkuroiwa@wmo.int

ANNEX F: Action Plan for Improvement of PWS element in NMHSs

F.1 Cambodia

A: Disaster Management

1. The Department of Meteorology works with the National Committee on Disaster Management (NCDM) through the Chief of Cabinet of the Ministry of Water Resources and Meteorology. The Focal Point for weather at NCDM is responsible to liaise with the officials who are in charge of taking actions in response to severe weather. Any feedback from the response action officials may get back to the Met Service via the Chief of Cabinet. As such there is no direct engagement between the Met Service and NCDM, since the two ministries responsible for weather and disaster management operate without close interaction. The Red Cross is active in responding to emergency situations.

2. An indirect way of engaging the NCDM is through the improvement of accuracy of forecasts and warnings which in turn will get the attention of the media and will be a good step towards increasing the visibility and credibility of the Met Service.

B: Media

1. Daily weather broadcasts are made on TV twice per day, and more frequently on radio, by broadcast companies own presenters, although the content is provided by the Met Service. In case of severe weather, live interviews are conducted with the Chief of Cabinet or with the head of forecasting at the Met Service. Radio broadcasts are not at fixed times or regular intervals, and depends on the media schedule.

2. The media relations could benefit from certain improvements. For example, there is no direct feedback from media, although the media reflects the opinion of the public on the performance of the forecasts or warnings, such as the requirements for more location or time specific forecasts and long-range forecasts.

3. It is hoped that SWFDP will help the Met Service achieve these improvements in its performance and consequently enjoy better relations with media, more appreciative feedback from the public, and closer collaboration with NCDM.

Actions to take

1. Establish the Met Service official website in 2012 and directly disseminate improved forecasts and warnings to the public and other users.

2. Establish own TV studio in 2012 with the help of Meteo France International and use this channel to disseminate improved forecasts and warnings.

3. Inform WMO and the training coordinator (HKO) of the progress in the establishment of the studio.

4. Discuss the objectives and benefits of SWFDP with the Met Service management, in terms of improved services to the users and improved relations with media and National Committee for Disaster Management.

5. Try to explain the SWFDP feedback mechanism to the management of the Met Service with a view to obtaining their support for providing input to the report of the project on the agreed schedule.

F.2 Lao PDR Implementation Plan

Lao PDR Department of Meteorology and Hydrology (DMH) will undertake activities described below to improve its interaction and working relationships with two main target audiences, namely the disaster management and the media.

A. National Disaster Management Organization

1. Secretariat will prepare revised questionnaire in the SOP for Flood EWS
2. Lao representative will consult DMH on the revised questionnaire and give feedback to the Secretariat
3. Revised questionnaire will be included in the SOP for Flood EWS
4. Feedback from the provincial, district and village level officials who are users of the SOP will be obtained using the revised questionnaire in the pilot sites during the agreed phase of the project (e.g., first year of the field phase) for reporting in the SWFDP feedback form
5. DMH will follow up the development of the UNDP supported SOP for daily and weekly forecasts and climate and inform the Secretariat
6. DMH will send the UNDP SOP for review to the Secretariat, when draft is available
7. In addition to the Flood EWS, and while waiting for the UNDP SOP to be drafted, DMH will make sure to prepare a list of focal points at the NDMO and DMH, together with the contact details for the purpose of briefing and receiving feedback for weather hazards affecting the country
8. While waiting for the UNDP SOP, use similar questionnaire for other hazards during the period of reporting to gather information from NDMO on the usefulness of the warnings and forecasts and their satisfaction with service delivery functions of DMH.

B. Media

1. DMH to initiate dialogue with the different media organizations (TV, Radio and Newspapers)
2. DMH to compile a list of contacts within each media organization
3. Negotiate with TV and Radio channels the broadcast of warnings of severe weather at regular intervals agreed with DMH
4. Conduct a familiarization and training workshop for invited media representatives
5. Mr. LS Lee to provide resource materials from HKO for the purpose of the above training

6. Negotiate putting in place formal working agreements with mass media, to replace the more ad-hoc arrangements currently in place.

7. Use the questionnaire developed in order to get feedback from the media for the purpose of reporting on outcome through the SWFDP feedback process.

F.3 Thai Meteorological Department

A. **Disaster Management**

1. The working arrangements between Thai Met Department (TMD) and the disaster management is relatively well-established and a structure is in place whereby the warnings from TMD are disseminated through multiple channels including the Internet, Intranet, telephone, fax, and own radio studio. The contact lists of disaster management officials are available at TMD and feedbacks from disaster management are obtained during weekly meetings.

Steps to take to further improve the relationship

1. Prepare in writing the exact instructions to follow for contact for severe weather events (before, during, after)
2. Improve and simplify the language of warnings sent to the disaster management or at least provide them with a list of technical terminology to assist in the interpretation of the message
3. Organize a short (perhaps only one day) workshop for the disaster management to provide some familiarization or training in meteorological terms
4. Make sure all dissemination channels are in good working order through regular testing
5. Investigate the availability of video-conferencing facilities to be used during severe weather to allow the sharing of maps and other information during severe weather, and if possible take action to initiate the acquiring of such facilities.
6. Obtain and provide feedback from disaster management using the questionnaire provided.

B .Media

1. On the whole relationships with the media are satisfactory. Some problems related to the media getting its information from sources other than TMD.
2. Currently the forecasts are presented on TV and radio by presenters, using the TV produced graphics. Plans are in place for TMD to have its own TV studio with own forecasters trained as broadcasters

Steps to take

1. Inform WMO and the training coordinator (HKO) of progress in the establishment of TV studio
2. Prepare a list of contact for media organizations and keep it up to date
3. Obtain and provide feedback from various media using the evaluation questionnaire provided.

F.4 Vietnam Hydro and Meteorological Service

A. Disaster Management

1. The relationship between the Met Service and DPM has improved recently. A climate outlook forum was organized in recent times with the participation of DPM.
2. A contact list for Met Service and DPM exists as well as a group email listing.
3. Dissemination of warnings is done directly through FTP server to DPM at the national level and the warnings then follow through to the provincial level.
4. Pre-warnings are sent to DPM by fax and email.
5. DPM also organizes exercises and invites the Met Service but the Met Service lacks funds for end user education, although a workshop with the mass media is planned to be organized.

Steps to take to further improve the relationship

1. There is a need to establish formal relationship with disaster management authorities.
2. As a first step need to start a dialogue with these authorities.
3. Establish the requirements of DPM and explain the capabilities of the Met Service on how best to meet those requirements.
4. Draft official agreement between the two organizations (MOU or SOP).
5. Appoint a focal point to continue the dialogue on a routine basis following official agreements.

B. Media

The Meteorological Service has decided to limit this process of engagement with the DPM organization as the first step, to be followed by media at a later stage.

ANNEX G: Template of Severe Weather Event Evaluation Form

The proposed evaluation form should allow to evaluate the performance of the RSMC/RFSC Severe Weather Forecasting Guidance and as well as the efficiency of the NMHS warning system.

It must be completed by the NMHS in both of the following cases:

- **a severe weather event has been observed; and**
- **a severe weather event has been forecast.**

The evaluation form should document the characteristics of the severe weather event (whether observed or forecast) and allow to evaluate the efficiency of the forecasts given by the RSMC/RFSC Daily Severe Weather Forecasting Guidance as well as the performance of the warnings issued by the NMHS. Therefore it should include the three following sections.

Section A – Identification of the severe weather event:

- NMHS concerned;
- number of the event;
- type of event;
- region affected.

Section B – Information about the observed weather event:

- start and end times of the severe weather event;
- maximum observed value of the characteristic parameter;
- assessment about the efficiency of the warning given the DMCPA;
- information from the end-users (number of interventions, casualties, damages, usefulness of the warning).

Section C – Information about the forecast and warning issued from the NMHS:

- lead-time of the warning;
- start and end time of the severe weather event according to the forecaster's assessment;
- level of risk as indicated in the RSMC Severe Weather Forecasting Daily Guidance;
- probabilities of medium-range in the RSMC Severe Weather Forecasting Daily Guidance;
- usefulness of the various products (RSMC Guidance, various models);
- comments including information on usefulness and applicability of used tools.

How to use this evaluation form to evaluate the performance of warnings ?

The common way to evaluate the performance of a warning system is based on the 2 x 2 contingency table matrix including the number of justified warnings ("hits") "a", the number of missed severe events "b" and the number of false alarms "c". The POD index (Probability of Detection) is defined as the ratio of the number of hits by the total number of severe events, i.e., a/(a+b) ; the FAR (False Alarm Ratio) is defined as the ratio of the number of false alarms by the number warnings issued, i.e., c/(a+c).The information contained in the proposed evaluation form enables to computes the performance indicators of the warning issued by the NMHS as long as the assessment of the DMCPA (in section C) is correctly taken into consideration.

A template of an evaluation form is provided in the following pages. The evaluation form is to be filled by the NMHSs (preferably by a forecaster or manager of the forecasting unit)

participating to the SWFDP regional subproject. This template can be modified with respect to the products selected for preparing the severe weather forecasts and warnings.

It is important that the design of the evaluation form be adapted to allow the data and information to be easily gathered and transformed into a tabular form. Avoid unnecessary and repetitive typing, and as much as possible to encourage and allow reliable creation and maintenance of the dataset that is needed to analyze and evaluate the performance indicators.

Severe Weather Event Evaluation Form

NMC: / PERIOD: MM/YYYY to MM/YYYY

Event No.	Event type	Region	OBS start time (to nearest h in UTC)	OBS end time (to nearest h)	Observations (list all reports in region)	Severe weather observed? (Yes=1, No=0)	Warning Issued? (Yes=1, No=0)	FCST start time (to nearest h)	FCST end time (to nearest h)	Lead time of warning (0=time of observed start)	Impact of event	Impact of the warning
1												

Please fill out this table for each event, either forecast or observed or both, for each region of the country where an event occurred and/or an event was forecast. For "false alarms" only columns F to J and M need to be filled. For missed events, only columns A to H and L need to be filled in; but please also evaluate the guidance in those cases.

Guidance:	RFSC Guidance (o=checked, x=not)		Evaluation: 1 to 4 (1=Poor, 4=Excellent)	Other Products (o=checked, x=not)		Evaluation: 1 to 4 (1=Poor, 4=Excellent)
	DAY 1 Map			CMA: Global		
	DAY 2 Map			CMA: Ensemble		
	DAY 3 Map			JMA: Global		
	Risk Table			JMA: Ensemble		
	Discussion			KMA: Global		
	Medium-range			KMA: Ensemble		
				NCHMF: Regional		
				NCHMF: Ensemble		
				TIGGE: TC Track		
				TIGGE: SW Potential		
				MTSAT: Heavy Rain		

ANNEX H: Template of Progress Report

PROGRESS REPORT OF THE SEVERE WEATHER REGIONAL SUBPROJECT

NMC : - - - - - - - -
PERIOD: (Start date to end date)

1. HIGHLIGHTS OVER THE PERIOD

2. OVERVIEW OF PRODUCTS

a. Usefulness of RFSC Daily Severe Weather Forecasting Guidance
b. Usefulness of SWFDP NWP/EPS Products received from each global centre and RFSC Limited Area Model

3. PROJECT EVALUATION AGAINST SWFDP GOALS

SWFDP GOAL	**COMMENTS ON PROGRESS TOWARDS EACH GOAL**	**Questions to help you with an answer for each box**
To improve the ability of NMHSs to forecast severe weather events		How did the products on the RFSC Ha Noi help you make better severe weather forecasts and warnings?
To improve the lead time of alerting these events		How much earlier do you issue severe weather forecasts & warnings now compared to before?
To improve the interaction of NMHSs with Disaster Management and Civil Protection authorities (DMCPAs), the media, and the public, before, during and after severe weather events		Comment on any interactions with your disaster agency, media agencies and the public. Please indicate if there hasn't been any interaction since the last repor,.
To identify gaps and areas for improvements		What are the weaknesses in your forecast system?
To improve the skill of products from Global Centres through		What weaknesses have you found in the products from RFSC

feedback from NMHSs		Ha Noi,CMA, JMA, KMA, etc.?

4. EVALUATION OF SEVERE WEATHER FORECASTS AND WARNINGS

4.1 The Public

A) Have you received any feedback from the general public?

B) Have you taken any actions to obtain feedback from the general public? Please elaborate on these actions.

C) Have you received any comments from the public on how they reacted when they heard or received the warnings?

D) What have been specific difficulties in getting these feedbacks? Please elaborate on these.

E) How have improved forecasts and warnings impacted the areas of activities of the public?

4.2 Disaster Management

F) Have you had any feedback from the disaster management authorities about the timeliness and usefulness of the warnings?

G) Have you taken any actions to obtain such feedback? Please elaborate on these actions.

H) Have you had any comments from your emergency management organisations on how they worked with other organisations in response to your warnings?

I) Were messages and calls to action issued from your emergency management organisation in agreement with the forecasts/warnings issued by you?

4.3 Media

J) Have you received any feedback from the media?

K) Have you taken any actions to obtain feedback from the media?

L) How did the relationship with the media work in getting forecasts/warnings out as quickly as possible?

M) What particular issues or difficulties emerged in working with media during the period under consideration?

N) Complete the Progress Evaluation Table if you experienced a severe weather event

5. SUMMARY (general comments, challenges, etc)

6. **CASE STUDY** (PowerPoint presentation to include guidance products (RSMC and NWP), satellite imagery, warnings issued, impact evidence etc)

Case studies for each severe weather event ***DON'T*** need to be completed at the same time as the rest of this report.

Comment: Case studies don't need to be long. What's important is the learning experience that you gain from actually doing the case study.

7. **Severe Event Evaluation**
(Attach all Severe Weather Event Evaluation Form)

ANNEX I: USER ASSESSMENT QUESTIONNAIRE

I.1 Evaluation Questionnaire for the Public

Q1. Do you get the warnings and forecasts issued by the National Meteorological Service?

Yes ☐ No ☐

Q2. Do the warnings and forecasts arrive early enough for you to take any actions?

Yes ☐ No ☐

Q3. How Do you get the forecasts and warnings? (Can choose more than one)

Radio	TV	Internet	Telephone	Local radio network	Other(s)
☐	☐	☐	☐	☐	☐

If other(s), please specify: _____

Q4. Do you understand the warnings and forecasts?

Yes ☐ No ☐

Q5. Do you take any action in response to the warnings and forecasts?

Yes ☐ No ☐

If yes, what did you do? _____

Q6. The warning was useful to protect your (Can choose more than one)

family	home	boat	farm	animals	other(s)
☐	☐	☐	☐	☐	☐

If other(s), please specify: _____

Q7. Are warnings issued by the National Meteorological Service correct?

Yes ☐ No ☐ More or less ☐

Q8. Are forecasts issued by the National Meteorological Service correct?

Yes ☐ No ☐ More or less ☐

Name: _____ Date: _____

I.2 Evaluation Questionnaire for Disaster Management

Q1. Did you get the warnings for the severe weather events in the period…to….? (Specify)

Yes ☐ No ☐

Q2. Did the warnings arrive early enough for you to take the necessary actions according to your specified responsibilities?

Yes ☐ No ☐

Q3. How did you get the warnings? (Can choose more than one)

Radio	TV	Fax	Internet	Telephone	Local radio network	Other(s)
☐	☐	☐	☐	☐	☐	☐

If other(s), please specify: _____

Q4. Did you understand the warnings?

Yes ☐ No ☐

Q5. Did you take any action in response to the warnings?

Yes ☐ No ☐

If yes, what did you do? _____

Q6. In your opinion were the warnings correct?

Yes ☐ No ☐ More or less ☐

Q7. Do you have any suggestions on how to improve the warning process, including dissemination methods, format, language etc.

Post and name: _____ Date: _____

I.3 Evaluation Questionnaire for Meida

Q1. Do you get the warnings for the severe weather events and forecasts from the National Meteorological Service?

Yes ☐ No ☐

Q2. Do the warnings and forecasts arrive early enough for you to take the necessary actions according to your specified responsibilities?

Yes ☐ No ☐

Q3. How do you get the warnings and forecasts? (Can choose more than one)

Radio	TV	Fax	Internet	Telephone	Local radio network	Other(s)
☐	☐	☐	☐	☐	☐	☐

If other(s), please specify: _____

Q4. Do you understand the warnings and forecasts?

Yes ☐ No ☐

Q5. Are the language and format clear enough for you?

Yes ☐ No ☐

Q6. Do you take any action in response to the warnings and forecast you receive?

Yes ☐ No ☐

If yes, what do you do? _____

Q7. In your opinion are the warnings and forecasts accurate?

Yes ☐ No ☐ More or less ☐

Q8. Do you have any suggestions on how to improve the warning and forecast process, including dissemination methods, format, language etc.

Post and name: _____ Date: _____