World Meteorological Organization

# GUIDELINES ON INTERNATIONAL AND CROSS-BORDER COLLABORATION IN THE WARNING PROCESS

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**Authors: Messrs Charles Dupuy (France) and H.G. Wai (Hong Kong, China)**

**Contributions from: Messrs Jim Davidson (Australia), Michael Staudinger (Austria) and Ms Gayah Ismail (Malaysia)**

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# CHAPTER 1

# INTRODUCTION

Severe weather threats are not constrained by national boundaries. High-impact weather phenomena may affect a number of neighbouring countries simultaneously or successively. While National Meteorological and Hydrological Services (NMHSs) are responsible for issuing forecasts and warnings of these phenomena for their own national territories, the advances in communication technology and increasing globalization of the media result in increased capability of the public and various stakeholders to have access to information on severe weather events, including warnings, from neighbouring NMHSs. Unless this information is properly coordinated or even harmonized when possible, their effectiveness to motivate those at risk to take appropriate action may be reduced. There is, therefore, a need to establish and maintain an effective system of cross-border exchange of warnings among NMHSs.

Basic meteorological information consisting mainly of data and products tailored for use by meteorologists, is widely exchanged and circulated internationally among NMHSs, through the Global Telecommunication System (GTS) or regional networks. The Twelfth World Meteorological Congress (Cg-XII, Geneva, Switzerland, 30 May – 21 June 1995), Resolution 40 decided on WMO policy and practice for the international exchange of meteorological and related data and products, and conditions on their use. In particular, Resolution 40 identified "severe weather warnings and advisories for the protection of life and property targeted upon end-users" as data for unconditional exchange among Members.

At its Twelfth Session, the Commission for Basic Systems (CBS-XII, Geneva, Switzerland, 29 November – 8 December 2000) recognized that although the exchange of information existed in some regions, there was still room for improvement and expansion, especially with respect to warnings. The Commission recommended that bilateral and/or regional cooperation be encouraged and expanded according to local requirements and that guidelines to initiate or enhance bilateral agreements on the exchange of warnings be prepared.

In response to the Commission's recommendation, the Public Weather Services (PWS) Expert Team on Warnings and Forecast Exchange, Understanding and Use prepared "Guidelines on Cross-border Exchange of Warnings" *[PWS-9, WMO/TD No. 1179*] in 2003. At the Fourteenth Session of the Commission for Basic Systems (CBS-XIV, Dubrovnik, Croatia, 25 March – 2 April 2009), it was noted that for some regions, real progress had been made during the previous inter-sessional period towards cross-border exchange of warnings, including some harmonization in their production, display and dissemination through the Internet, notably through the Severe Weather Information Centre (SWIC) and METEOALARM. The present publication "Guidelines on International and Cross-border Collaboration in the Warning Process" is an update to PWS-9, and has been prepared by the Commission for Basic Systems Open Programme Area Group on PWS Expert Team on PWS in Support of Disaster Prevention and Mitigation (CBS/OPAG-PWS ET/DPM), to provide guidance to Members for corresponding action.

Chapter 2 of this document discusses general principles regarding cross-border exchange of warnings, and includes the role of the media in raising the public's expectations, focus on public safety, threshold criteria and the scope of cooperation. Chapters 3 and 4 provide examples from different parts of the world to illustrate the factors to be considered in developing international or cross-border collaborations in the warning process. Based on the general principles and experiences gained from the examples, Chapter 5 offers a number of observations and suggestions for consideration by Members who may wish to set up bilateral, regional or international collaboration in the framework of establishing internationally effective systems of warnings.

# CHAPTER 2

# GENERAL PRINCIPLES

## 2.1 MEDIA AS A DRIVING FORCE

Important meteorological events, sometimes affecting several countries, are often reported extensively by the media, including numerous websites or portals which post, almost world-wide, information with different degree of reliability in an unprecedented quantity. These reports may even become available to a wide audience before the relevant meteorological authority has issued any warnings. While the increased volume of information may be potentially useful, there is an associated increase in the need to ensure that this information is harmonized so that it does not contradict the official warnings issued by the responsible meteorological authorities. A key to meeting this need will be to ensure that NMHSs systematically share information and warnings among themselves as may be applicable to the particular circumstance. Doing so will enrich the quantity and quality of available information and help in the fine-tuning of alternative scenarios and increasing confidence in the final products. This will in turn enhance the reliability and credibility of the warnings and forecasts issued by NMHSs.

## 2.2 FOCUS ON PUBLIC SAFETY

Over the last few decades, and for the primary objective of enhancing public safety, a well-tested mechanism has evolved to coordinate, harmonize and disseminate meteorological information concerning *international waters* and for major meteorological hazards affecting large coastal areas, such as *tropical cyclones*. Similarly, there exist well-established procedures for the exchange of *aeronautical information.* However, as regards the much larger land-based communities which either share a common terrestrial border or are separated by narrow stretches of water, and which are potentially affected by the same synoptic features, there is little in place in the form of formal agreements and procedures. Every day, NMHSs issue a range of public forecasts and warnings as required, on both national and local scales, which are of interest to the media, the general public or professional meteorologists in a neighbouring country (or countries). Clearly, there is no particular need that every piece of such information should be circulated and eventually published by adjacent NMHSs. However, some examples of successful exchange of information to meet the requirements of the public and the media have appeared recently. Such an example is the now well established World Weather Information System (WWIS) developed under the auspices of WMO, which provides forecasts and climatological information for a growing number of major cities the world over. Moreover, due to the increasing importance of harmonizing warnings across sensitive areas to avoid public confusion, the necessity of addressing exchange of warnings, or even joint dissemination of warnings across borders, has lead to successful accomplishments in the recent years. Two of these systems, namely, the SWIC, and the EMMA METEOALARM, are described in these guidelines. Building on the growing experience, these guidelines aim to provide some of the basic considerations for establishing and maintaining successful exchange programmes.

## 2.3 FLEXIBLE THRESHOLD CRITERIA

The subject of threshold criteria to determine which warnings are of international significance will be considered later in these guidelines. But the basic principle remains that each hazardous phenomenon should be considered individually to determine if it is of a type likely to cross boundaries or if it is likely to generate an international response. The overriding consideration for exchange of warnings should be based on how significantly a meteorological event might impact more than one country in terms of loss of life, damage and disruption rather than stipulating the same meteorological threshold criteria for all such events.

The diversity of infrastructure resilience and natural climatological variability means that precise thresholds should be determined by neighbouring countries embarking on an exchange programme. A list of suggested hazards is included in the present guidelines with examples of threshold criteria and warning lead times. However, it should be noted that these are not prescriptive but form a basis for discussion between cooperating NMHSs.

## 2.4 SCOPE OF COOPERATION

The scope of cooperation between neighbouring countries goes beyond setting up an exchange mechanism in respect of selected meteorological phenomena and agreed threshold criteria. Such exchanges of warnings should be viewed as a cooperative venture specified in terms of intended recipients (between NMHSs only, or available to important stakeholders, or also to the public at large), timeliness, frequency, content, format and delivery. Of equal importance are formal supporting agreements, regular reviewing, de-briefing, training, and exchange visits of operational personnel.

Cross-border exchanges of warnings should not be limited to relatively short-lived meteorological hazards. NMHSs are also encouraged to engage in dialogue for hazards of longer-time scale, such as hot, cold, wet or dry spells.

Even though NMHSs may be regarded as the official authority for issuing warnings within their own areas of responsibility, the format of such information, when intended also for cross-border exchange must be designed in such a way as to facilitate timely dissemination, understanding and response. This means that apart from a necessary political will, a successful system of exchange must be based upon previous exchange of technical expertise and respective national requirements.

# CHAPTER 3

# EXAMPLES OF BILATERAL AND REGIONAL EXCHANGE

To illustrate the essential aspects of bilateral and regional exchanges, some examples of actual and planned exchange practices are given in this chapter. Such exchanges are normally confined to local warnings for reference or for harmonization purposes. The examples are by no means exhaustive, but allow a systematic approach to be developed for coordinating an effective exchange mechanism. They provide a glimpse into a more user-oriented approach whereby the public will be provided with integrated warning products that span boundaries and borders of neighbouring countries. As a result, more effective mitigation actions could be taken by those at risk.

## 3.1 CHINA – THE PEARL RIVER ESTUARY

### *3.1.1 Background*

NMHSs belonging to three WMO Members separately provide services to the communities at the head of and on both sides of the Pearl River estuary in southern China. They are the China Meteorological Administration (CMA), Hong Kong Observatory (HKO) and the Macao Meteorological and Geophysical Bureau.

### *3.1.2 Warnings*

All three Members issue tropical cyclone warnings to the public within their own jurisdiction with number or colour signals on approaching tropical cyclones and the onset of strong winds, gales, storm and hurricane winds. Warnings including track and intensity forecasts issued by these centres are readily obtainable by the public via the Internet. Thus, there is a need to maintain close liaison among the three neighbouring centres in warning operations.

Rainstorm is another weather hazard that affects all three territories. The three NMHSs issue colour warning signals for various levels of rainfall recorded or forecast. As the system scale of rainstorms is smaller than that of tropical cyclones, the extent of cross-border referencing of warnings is generally less for the former.

### *3.1.3 Coordination and Consultation*

The three meteorological services of Guangdong (the Chinese province next to Hong Kong, China and Macao, China), Hong Kong, China and Macao, China will inform one another via the GTS, supplemented by fax when warnings of tropical cyclone or rainstorm are issued or cancelled. Sample messages exchanged during warning operations are given in Table.1 (see below). Telephone and video conference channels have also been set up for the exchange of tropical cyclone operational information, particularly the assessment of the intensity category, the location and timing of the landfall of tropical cyclones in the vicinity.

### *3.1.4 Enhanced Data Exchange*

To facilitate the operation of weather warning, arrangements are also in place for the real-time exchange of weather information among the three centres. Meteorological data including rainfall, wind and temperature recorded by automatic weather stations around Guangdong, Hong Kong, China and Macao, China are exchanged in real-time via data lines. Figure 1 is a sample display. In addition, the three meteorological centres jointly operate a lightning location network and, exchange reflective and Doppler radar data in real time. The data exchange enables the three centres to access a common data set for high-impact weather affecting the region.

| Sample 1<br>(message issued by Guangdong) | Sample 2<br>(message issued by Hong Kong) | Sample 3<br>(message issued by Macao) |
|---|---|---|
| 200909141422 BCGZ A2000<br>meaning a blue tropical cyclone warning issued for Guangzhou at 1442UTC on 20090914 | HONG KONG RED RAINSTORM WARNING WAS ISSUED AT 070200UTC | THE GALE SIGNAL NO.8 NW WILL BE REPLACED BY THE STORM SIGNAL NO.9 AT 160300UTC |

**Table 1 - Sample messages on weather warnings issued by meteorological centres at Guangdong, Hong Kong, China and Macao, China**

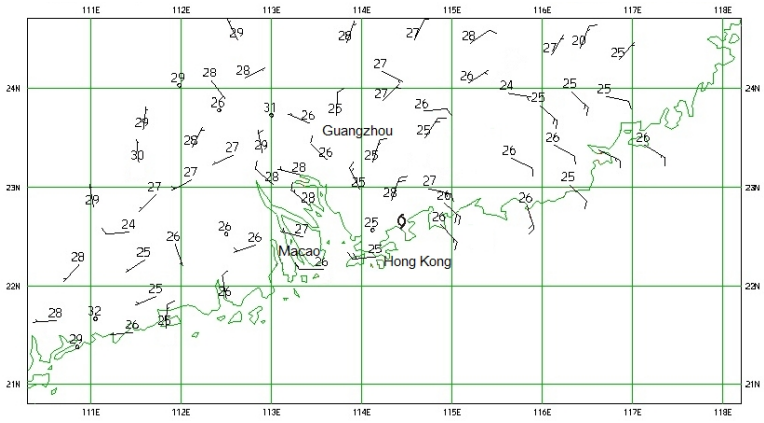



**Figure 1. Automatic weather station data exchanged among the meteorological centres in the Pearl River estuary**

### *3.1.5 Greater Pearl River Delta Weather Warning Webpage*

With the rapid development of the Greater Pearl River Delta, people are traveling more frequently in the region. To provide weather warning information for people commuting in the region, the HKO collaborated with the Guangdong Meteorological Bureau of CMA and the Macao Meteorological and Geophysical Bureau to develop a portal webpage showing real-time weather warning information from 11 cities, viz. Dongguan, Foshan, Guangzhou, Hong Kong, Huizhou, Jiangmen, Macao, Shenzhen, Zhaoqing, Zhongshan and Zhuhai in the Greater Pearl River Delta region (see Figure 2). As the weather warning systems in Hong Kong, Macao and the Mainland China are a little different from each other, the portal webpage also provides a guide to the weather warning signals for all the cities in the region


**Figure 2. Greater Pearl River Delta Weather Warning Webpage**

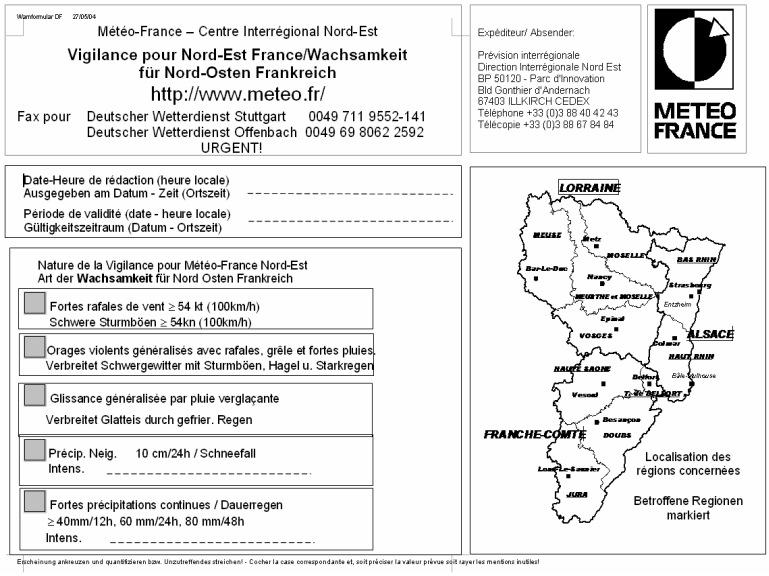
### *3.1.6 Annual Technical Conferences*

Annual meetings to review the cooperative arrangements are held among the senior management of three centres. Cooperation projects in observation, forecast system development and operational collaboration are discussed. In particular, requirements of their respective users regarding weather warnings may be discussed and necessary collaboration arrangements among the three centres would then be developed.

## 3.2 CROSS-BORDER EXCHANGES BETWEEN FRANCE AND GERMANY

Following bilateral agreements between the bordering regional offices of the NMHSs of France (North east region of "Lorraine/Alsace/Franche-Comté") and Germany ("Rheinland-Pfalz/Saarland" and "Baden-Würtemberg"), warnings will be exchanged on the occasion of "vigilance" orange or red in France and "Unwetterwarnung" (crossing of thresholds for relevant parameters) in Germany. The exchange takes place via fax or e-mail using standardised procedures and forms shown in Figures 3(a) and 3(b).

Expansion of bilateral exchanges of weather warnings using a similar mechanism, among Regional Association (RA) VI Members was endorsed in 2002. Simple procedures, similar to the above, would be set up for bilateral exchanges between neighbouring countries taking into consideration different warning parameters and language barriers. Within Europe the EUMETNET consortium has now focused on the EMMA/METEOALARM system, considered as a pilot project for RA VI, which is described in Chapter 4.


Météo-France – Centre Interrégional Nord-Est

**Vigilance pour Nord-Est France/Wachsamkeit für Nord-Osten Frankreich**

http://www.meteo.fr/

Fax pour Deutscher Wetterdienst Stuttgart 0049 711 9552-141
Deutscher Wetterdienst Offenbach 0049 69 8062 2592
URGENT!

Expéditeur/ Absender:
Prévision interrégionale
Direction Interrégionale Nord Est
BP 50120 - Parc d'Innovation
Bld Gonthier d'Andernach
67403 ILLKIRCH CEDEX
Téléphone +33 (0)3 88 40 42 43
Télécopie +33 (0)3 88 67 84 84

METEO FRANCE

Date-Heure de rédaction (heure locale)
Ausgegeben am Datum - Zeit (Ortszeit)

Période de validité (date - heure locale)
Gültigkeitszeitraum (Datum - Ortszeit)

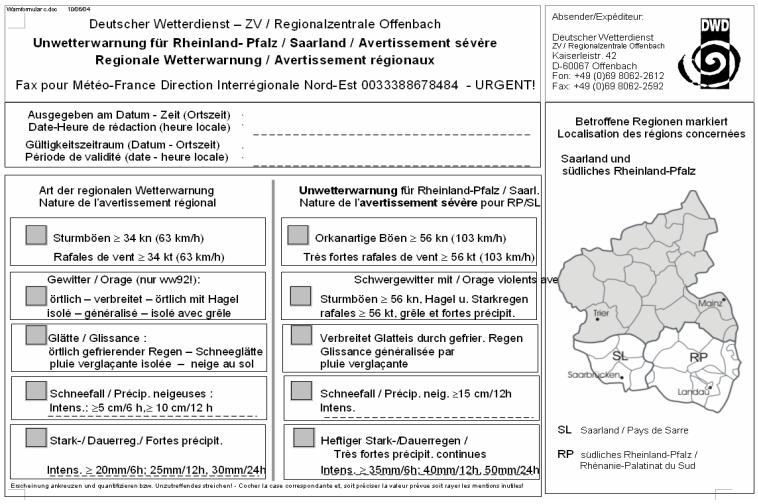
Nature de la Vigilance pour Météo-France Nord-Est
Art der **Wachsamkeit** für Nord Osten Frankreich

- Fortes rafales de vent ≥ 54 kt (100km/h)
  Schwere Sturmböen ≥ 54kn (100km/h)
- Orages violents généralisés avec rafales, grêle et fortes pluies
  Verbreitet Schwergewitter mit Sturmböen, Hagel u. Starkregen
- Glissance généralisée par pluie verglaçante
  Verbreitet Glatteis durch gefrier. Regen
- Précip. Neig. 10 cm/24h / Schneefall
  Intens. _____
- Fortes précipitations continues / Dauerregen
  ≥ 40mm/12h, 60 mm/24h, 80 mm/48h
  Intens. _____

Eréheinung ankreuzen und quantifizieren bzw. Unzutreffendes streichen! - Cocher la case correspondante et, soit préciser la valeur prévue soit rayer les mentions inutiles!

LORRAINE
MEUSE
Bar-Le-Duc
Metz
MOSELLE
Nancy
BAS RHIN
Strasbourg
MEURTHE et MOSELLE
Epinal
VOSGES
Colmar
ALSACE
HAUT RHIN
HAUTE SAONE
Vesoul
Belfort
TERRITOIRE DE BELFORT
Besançon
FRANCHE-COMTE
DOUBS
JURA
Localisation des régions concernées
Betroffene Regionen markiert

**Figure 3(a). Standardised form for transmitting warnings from a regional office of France to those of Germany**


Deutscher Wetterdienst – ZV / Regionalzentrale Offenbach

**Unwetterwarnung für Rheinland- Pfalz / Saarland / Avertissement sévère Regionale Wetterwarnung / Avertissement régionaux**

Fax pour Météo-France Direction Interrégionale Nord-Est 0033388678484 - URGENT!

Absender/Expéditeur:
Deutscher Wetterdienst
ZV / Regionalzentrale Offenbach
Kaiserleistr. 42
D-60067 Offenbach
Fon: +49 (0)69 8062-2612
Fax: +49 (0)69 8062-2592

DWD

Ausgegeben am Datum - Zeit (Ortszeit)
Date-Heure de rédaction (heure locale)

Gültigkeitszeitraum (Datum - Ortszeit)
Période de validité (date - heure locale)

Art der regionalen Wetterwarnung
Nature de l'avertissement régional

- Sturmböen ≥ 34 kn (63 km/h)
  Rafales de vent ≥ 34 kt (63 km/h)
- Gewitter / Orage (nur ww92!):
  örtlich – verbreitet – örtlich mit Hagel
  isolé – généralisé – isolé avec grêle
- Glätte / Glissance :
  örtlich gefrierender Regen – Schneeglätte
  pluie verglaçante isolée – neige au sol
- Schneefall / Précip. neigeuses :
  Intens.: ≥5 cm/6 h,≥ 10 cm/12 h
- Stark-/ Dauerreg./ Fortes précipit.
  Intens. ≥ 20mm/6h; 25mm/12h, 30mm/24h

**Unwetterwarnung** für Rheinland-Pfalz / Saarl.
Nature de l'**avertissement sévère** pour RP/SL

- Orkanartige Böen ≥ 56 kn (103 km/h)
  Très fortes rafales de vent ≥ 56 kt (103 km/h)
- Schwergewitter mit / Orage violents ave
  Sturmböen ≥ 56 kn, Hagel u. Starkregen
  rafales ≥ 56 kt, grêle et fortes précipit.
- Verbreitet Glatteis durch gefrier. Regen
  Glissance généralisée par
  pluie verglaçante
- Schneefall / Précip. neig. ≥15 cm/12h
  Intens. _____
- Heftiger Stark-/Dauerregen /
  Très fortes précipit. continues
  Intens. ≥ 35mm/6h; 40mm/12h, 50mm/24h

Eréheinung ankreuzen und quantifizieren bzw. Unzutreffendes streichen! - Cocher la case correspondante et, soit préciser la valeur prévue soit rayer les mentions inutiles!

Betroffene Regionen markiert
Localisation des régions concernées

Saarland und
südliches Rheinland-Pfalz

Trier
Mainz
SL
RP
Saarbrücken
Landau

SL Saarland / Pays de Sarre

RP südliches Rheinland-Pfalz /
Rhénanie-Palatinat du Sud

**Figure 3(b). Standardised form for transmitting warnings from a regional office of Germany to that of France**

## 3.3 COORDINATION OF TROPICAL CYCLONE WARNINGS BETWEEN AUSTRALIA AND OTHER METEOROLOGICAL CENTRES

The Australian Bureau of Meteorology (BoM) operates a major forecasting office in the capital city of each Australian state, called a "Regional Forecast Centre" (RFC). There are seven RFCs in all. Australia also has three Tropical Cyclone Warning Centres (TCWCs) – located in Brisbane, Darwin and Perth. Darwin doubles up as a Regional Specialized Meteorological Centre (RSMC) with responsibility in tropical cyclone warnings. Figure 4 shows the areas of responsibilities under these TCWCs.

There are established procedures for coordination between Australian forecast/warning centres and meteorological services in neighbouring regions, including the RSMCs in Jakarta, La Réunion, Nadi and Wellington TCWC.

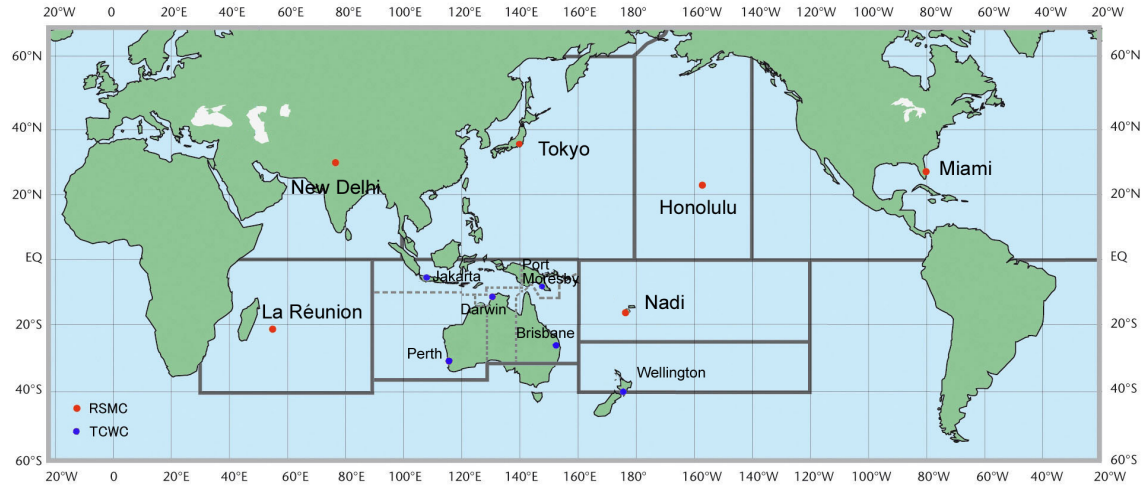



**Figure 4. Areas of responsibilities of the TCWC and TC RSMC**

*3.3.1 Coordination with Meteorological Services in the neighbouring regions*

The Tropical Cyclone Operational Plan for the South Pacific and Southeast Indian Ocean (WMO/TD No. 292) which has been developed by the Tropical Cyclone Committee for the South Pacific and Southeast Indian Ocean sets out the responsibilities of and the relationships between the TCWCs and other meteorological authorities in the south Pacific and southeast Asia. The requirements of this plan are observed by Australian TCWCs. Australian TCWCs coordinate operationally with the following NMHSs:

(a) Isle de la Réunion, Mauritius, Indonesia and USA (Honolulu JTWC) – with the Perth TCWC;

(b) Indonesia, United States of America (Honolulu JTWC), and Papua New Guinea – with the Darwin TCWC; and,

(c) Papua New Guinea, United States of America (Honolulu JTWC), Solomon Islands, Fiji, New Caledonia and New Zealand – with the Brisbane TCWC.

International coordination arrangements are made by the Disaster Mitigation Programme Office (in the Bureau's head office in Melbourne) to determine appropriate communications channels and agreed schedules for information exchange. Details are then incorporated in local regional Tropical Cyclone Warning Directives.

Warning messages originated by overseas NMHSs are repeated without alteration by TCWCs and RFCs in the gale/storm/hurricane warning services for shipping provided through Australian coastal radio stations, but messages are prefixed with the name of the originating Meteorological Service.

*3.3.2 Coordination with the Honolulu Joint Typhoon Warning Centre (JTWC) and the United Kingdom (UK) Meteorological Office (UKMO)*

Arrangements have been made for all Australian TCWCs to provide the Central Forecast Office of UKMO and the Honolulu JTWC with cyclone location, Dvorak intensity analysis, extended period track predictions, etc. In return, the JTWC provides similar information from their own data sources for cyclones that may affect the Australian area while UKMO provides numerical predictions of cyclone movement based on their global model. Brisbane and Perth TCWCs provide the Darwin RSMC with appropriate information which is then coordinated into a bulletin and sent to Honolulu and UKMO.

For cyclones within radar range, radar imagery is now available via the Bureau of Meteorology radar website: http://www.bom.gov.au/weather/radar/.

*3.3.3 Coordination with New Zealand*

Coordination procedures have been agreed between Australia and New Zealand for the Tasman Sea. Warnings are exchanged between the two NMHSs and major discrepancies are resolved by telephone between the Brisbane and Sydney RFCs and the New Zealand Meteorological Service in Wellington.

*3.3.4 Coordination with Port Moresby TCWC*

The Brisbane TCWC maintains continuous cyclone surveillance over the Papua New Guinea (PNG) Region. When a cyclone or developing

cyclone threatens the PNG region, discussions are initiated with the Port Moresby TCWC. Subsequent assistance is provided as required.

Port Moresby, Brisbane and Darwin TCWCs also exchange gale/storm/hurricane warnings for tropical cyclones in their respective areas of responsibility.

*3.3.5 Services for the Solomon Islands*

The Solomon Islands straddles the 160°E longitude border between the areas of warning responsibility of the Brisbane and Nadi TCWCs. To ensure consistency in the formatting of warnings for land areas in the Solomon Islands, Brisbane issues all Special Advisory Messages (which are used by Solomon Islands authorities as the basis for public warnings), regardless of the position of the tropical cyclone concerned. Close liaison is maintained and all warnings are exchanged between the Brisbane and Nadi TCWCs whenever cyclones are in this area and agreement is reached on the position of the cyclone and other characteristics to be used in warnings.

In the event of failure or partial failure of the Brisbane TCWC, the Nadi TCWC will take over full responsibility for Special Advisory Messages for the Solomon Islands.

*3.3.6 Coordination with Indonesia*

The Darwin and Perth TCWCs maintain continuous cyclone surveillance over the Indonesian Region. When a cyclone or developing cyclone threatens the Indonesian region, discussions are initiated with Jakarta TCWC. Subsequent assistance is provided as required. Darwin, Jakarta and Perth TCWCs also exchange gale/storm/hurricane warnings for tropical cyclones in their respective areas of responsibility.

*3.3.7 Warnings near boundaries*

Whenever a tropical cyclone is within five degrees of the boundary of an area of responsibility, the other tropical cyclone warning centre sharing that boundary, receives all the gale, storm and hurricane warnings for that tropical cyclone which are issued by the tropical cyclone warning centre with prime responsibility for the area.

*3.3.8 Communication in Regional Association V (RA V)*

In RA V, warnings are routinely distributed via the AFTN/GTS telecommunication links. Forecasts are also distributed where a requirement exists. Most RSMCs and TCWCs have external websites where current forecasts and warnings can be readily accessed. RSMC/TCWC forecasters often converse by telephone to develop warning strategy where a weather feature (e.g., a tropical cyclone) is close to a common border – which is generally maritime in RA V.

### 3.4 EXCHANGE OF EARTHQUAKE AND TSUNAMI INFORMATION AMONG THE ASSOCIATION OF SOUTH EAST ASIAN NATIONS (ASEAN) COUNTRIES

The Malaysian National Tsunami Early Warning System (MNTEWS) was established in 2006 and located at the Malaysian Meteorological Department (MMD) Headquarters in Petaling Jaya. The center operates on a 24/7 basis with watch over the occurrence of earthquake and tsunami in the Indonesian and the Philippines subduction zones as well as in the Indian Ocean and Pacific Ocean and is responsible for issuing earthquake information and tsunami early warning. To monitor earthquakes and tsunamis in the region, MMD has installed a network of 17 seismic stations, six (6) tide gauge stations, two (2) tsunami buoys and four (4) coastal cameras. The dissemination process of earthquake information and tsunami warning is done via various channels such as: SMS; hotline; internet; phone; facsimile; and website. The MMD has also implemented Fixed Line Alert System (FLAS) to ensure that the warnings reach the communities at risk.

The cross-border exchange of earthquake and tsunami data, as well as earthquake information and tsunami early warning, greatly enhance the capacity and capability of countries to provide early warning on tsunamis. The networking between regional centres, the Pacific Tsunami Warning Center (PTWC), International Tsunami Information Centre (ITIC) and national centres is critical for an efficient and effective global tsunami warning system that would ensure that warnings can reach the people in the path of the impending disaster.

At the international level, MNTEWS sends real-time seismic data of its seven (7) seismic stations for international sharing and receives real-time seismic data from 26 regional and international seismic stations through the linked with Incorporated Research Institutions for Seismology (IRIS). The MNTEWS also receive seismic data directly from Jakarta. Through sharing of real-time seismic data, especially from the neighbouring countries, information on an earthquake will be more quickly obtained by MNTEWS and this is important especially in the case of large-scale earthquakes. Besides the seismic data sharing, MNTEWS also receives data from 35 tidal stations and ten (10) tsunami buoys through the Global Telecommunications System (GTS).

Earthquake information and tsunami early warnings issued by MNTEWS are faxed to ASEAN countries. The MNTEWS receives earthquake information and tsunami warnings from Jakarta. MNTEWS is also linked directly with the PTWC, Hawaii and Tsunami Early Warning Center in Japan to receive tsunami advisory services for tsunami that occur in the Pacific, South China Sea and Indian Ocean areas.

# CHAPTER 4

# EXAMPLES OF INTERNATIONAL COLLABORATION

## 4.1 THE SEVERE WEATHER INFORMATION CENTRE (SWIC)

### *4.1.1 Background*

The SWIC (http://severe.worldweather.wmo.int/) Website started off as a pilot project of ESCAP/WMO Typhoon Committee and RSMC Tokyo in 2001. The main objectives of the Project are to:

(a) provide a centralized source of official tropical cyclone information and severe weather warnings for the public;

(b) render tropical cyclone information and severe weather warnings easily accessible for international and regional media to raise public's awareness;

(c) enhance the visibility of NMHSs, RSMCs and TCWCs to strengthen public recognition of the weather warnings and services they provided; and,

(d) develop and enhance international collaboration for the exchange of tropical cyclone information and severe weather warnings.

Over the following two years, the Website was enhanced and extended from the Western North Pacific Ocean and South China Sea to other tropical cyclone basins. It became operational on 23 March 2005.

The SWIC Website was developed and is maintained by the Hong Kong Observatory (HKO) for WMO. As of 2011, a total of 21 WMO Members (see Table 2 below) participate in the SWIC Project.

Table 2. WMO Members participate in SWIC

| | |
|---|---|
| Australia | Macao, China |
| Cambodia | Malaysia |
| China | New Zealand |
| Cuba | Philippines |
| D.P.R. of Korea | Papua New Guinea |
| Fiji | Republic of Korea |
| France | Singapore |
| Hong Kong, China | Viet Nam |
| India | Thailand |
| Indonesia | United States of America |
| Japan | |

### *4.1.2 Coverage*

The SWIC provides a centralized and authoritative source for the public to efficiently and effectively access official warnings and information issued by the NMHSs, RSMCs and TCWCs.

The Website provides information of the current tropical cyclones issued by RSMCs and TCWCs, and official warnings issued by NMHSs for their respective countries or regions. It covers tropical cyclones in the following regions:

- Western North Pacific Ocean and South China Sea;
- South-East Indian Ocean, Arafura Sea, Gulf of Carpentaria, Coral Sea, Solomon Sea and Gulf of Papua;
- South-West Pacific Ocean;
- Tasman Sea;
- Central North Pacific Ocean;
- South-West Indian Ocean;
- Bay of Bengal and the Arabian Sea; and,
- Caribbean Sea, Gulf of Mexico, North Atlantic and eastern North Pacific Oceans.

Apart from tropical cyclones, the Website also covers other severe weather types such as heavy rain/snow and thunderstorms.

### *4.1.3 Tropical cyclone warnings*

Whenever a tropical cyclone develops, a tropical cyclone symbol will be displayed on the world map of the front page of the Website with both positions and past tracks (see Figures 5(a) and (b)). On clicking the tropical cyclone icon, the name, latest location and strength of the tropical cyclone, as well as the name of the NMHS, RSMC or TCWC which issued the tropical cyclone warning in the corresponding region will be displayed.

### *4.1.4 Operation*

As severe weather warnings are updated minute-by-minute, participating NMHSs are committed to disseminating the latest information

by the quickest and most convenient means. The SWIC warnings are collected by HKO from NMHSs through GTS and Internet via ftp or http services (Figure 6). The data collected at HKO is consolidated and uploaded to the SWIC Website within minutes.

Tropical cyclone warning information is collected from RSMC/TCWC tropical cyclone advisories, RSMS tropical cyclone web pages or NHMS metafiles through GTS and the Internet by HKO. When a tropical cyclone report is received, information about the tropical cyclone, including the name, latest location, strength and the past track is extracted, decoded and published on the SWIC Website.

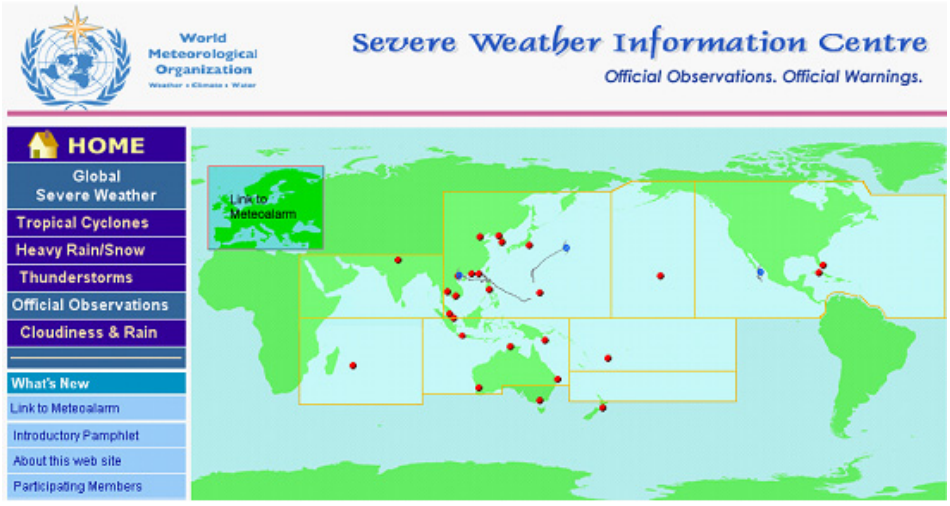



***Figure 5(a). World map on the front page of the SWIC Website showing the location and past track of all tropical cyclones over the world***

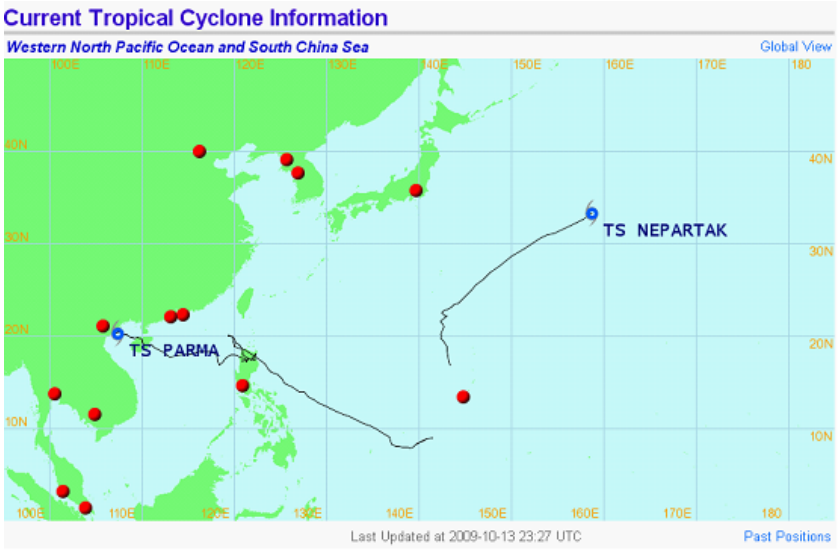



***Figure 5(b). A zoom-in map showing tropical cyclones over the western North Pacific Ocean and South China Sea***

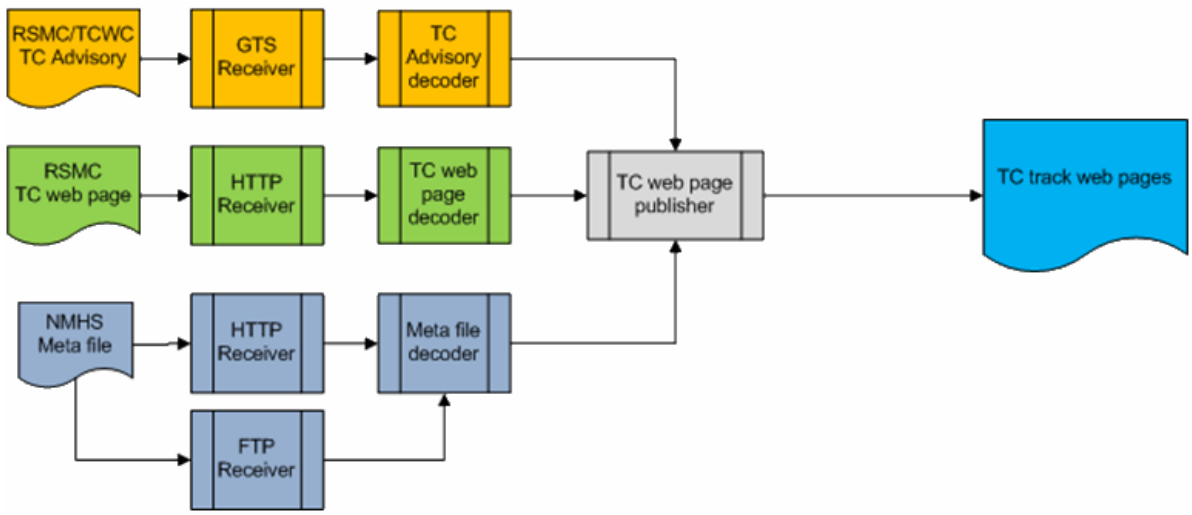



**Figure 6. Data flow of the SWIC**

## 4.2 THE EUROPEAN MULTI-PURPOSE METEOROLOGICAL AWARENESS (EMMA) PROGRAMME AND THE WEBSITE "METEOALARM"

### *4.2.1 Background*

Most European countries are relatively small in comparison with the scale of typical synoptic meteorological phenomena. Many important weather events, including windstorms, heavy rains, coastal surges or cold spells can affect large geographical areas containing several countries simultaneously; and these can occur within very short timescales. There are also numerous seas with shorelines in multiple countries such as the Baltic Sea, Channels, the Mediterranean and the North Sea. This means that the need for effectively exchanging warnings has existed in various European countries, and there have been relevant developments for some time. It is important in this respect to mention the system of warnings at sea, whereby a division of zones and associated responsibilities has been agreed upon by neighbouring NMHSs, under a unified system of warning bulletins. Similarly, in the 1990s, a common scale of warnings (and an associated educational programme) was implemented for avalanches in the Alps. Some general purpose exchanges also exist bilaterally, as mentioned in the last chapter.

Around the beginning of the Twenty-first Century, the availability of new information technologies allowed new developments in hazard warnings in response to several major events. For example, the French "Vigilance" [1] system was launched shortly after the devastating storms of 26 – 27 December 1999 ("Martin" and "Lothar") affected large parts of Austria, France and Germany. From 2000 onward, the European NMHSs Directors decided to launch a follow-up project through a "Working Group of European Forecasters".

### *4.2.2 The EMMA Programme of EUMETNET*

In 2000, the EUMETNET[2] Council decided to task the "Working Group of European Forecasters" to assess the requirements and the feasibility of an integrated graphical warning system to inform the public of imminent danger due to severe weather. The demonstration programme "EMMA I" (2001-2005) outlined the definition of the warning platform, and produced a "beta" Internet platform for the first time. In 2005, the Central Institute for Meteorology and Geodynamics, Austria (ZAMG) was tasked with the development of EMMA II. The website "METEOALARM" became fully operational in 2006. A new EMMA III Programme was agreed upon in November 2009, under the responsibility of ZAMG with support from the Royal Netherlands Meteorological Institute (KNMI). The current programme is mainly tasked with consolidation of the existing system, described in the following sections. The EMMA Programme is based on the concept of **meteorological awareness** and its general objective is to develop a graphical

[1] The "French Vigilance System" was designed to improve on previous warning communications with authorities and the public. Notification time to the public of potential dangers had been reduced and improvement made in the perception of warnings. This was partly inspired by the experience gained from the procedures established for countries exposed to tropical cyclones countries and avalanche-prone areas.

[2] EUMETNET is the networking organization of a number of NMHSs in Regional Association VI, now a European Interest Grouping. Its membership is similar to that of EUMETSAT and the European Centre for Medium Range Weather Forecasts (ECMWF). For those latter organizations, members are not NMHSs but states.

information system accessible by the general public. However, the interests of European forecasters and concerned authorities for the provision of expected meteorological hazard information are also addressed in the development of the Programme. The time horizon of this information is typically a couple of days.

The System is intended to complement the existing national warning systems by providing a simple and efficient way of making users aware of possible meteorological risks beyond their national borders. It therefore allows an efficient method of exchanging meteorological information related to high-impact weather events.

*4.2.3 Main characteristics of the System*

(i) Regions are colour-coded in accordance with the meteorological awareness level for the severe weather phenomena covered by the System. The awareness level colour code is defined as shown in Table 3.

| | |
|---|---|
| Green | No particular awareness of the weather is required. |
| Yellow | The weather is potentially dangerous. The weather phenomena that have been forecast are not unusual, but be attentive if you intend to practice activities exposed to meteorological risks. Keep informed about the expected meteorological conditions and do not take any avoidable risk. |
| Orange | The weather is dangerous. Unusual meteorological phenomena have been forecast. Damage and casualties are likely to happen. Be very vigilant and keep regularly informed about the detailed expected meteorological conditions. Be aware of the risks that might be unavoidable. Follow any advice given by your authorities. |
| Red | The weather is very dangerous. Exceptionally intense meteorological phenomena have been forecast. Major damage and accidents are likely, in many cases with threat to life and limb, over a wide area. Keep frequently informed about detailed expected meteorological conditions and risks. Follow orders and any advice given by your authorities under all circumstances, and be prepared for extraordinary measures. |

**Table 3 - The awareness level colour code definition within EMMA and METEOALARM Website**

(ii) A core of severe weather phenomena is addressed across Europe and displayed through a homogeneous set of pictograms, to be augmented, as necessary, by other phenomena, on an optional basis for the participant countries. The standard set of awareness situations covered by almost all countries and recommended by the EMMA Programme is:

- Wind (mean wind speed or wind gusts, or any combination);
- Rain (heavy rainfall in intensity or in cumulated amount or any combination);
- Snow/ice (heavy snowfall, drifting snow and icing phenomena on the ground resulting from precipitation); and,
- Thunderstorms

An additional set of awareness situations is about:

- Fog;
- Temperature extremes (heat or cold waves);
- Coastal events (such as storm surge);

- Forest fire (risk of forest fire related to meteorological conditions);
- Avalanches; and,
- Flooding

It is not mandatory for all countries to address each of the extensive number of potential hazards available within the System. Each country is free to define those situations it will address within EMMA.

(iii) Flexible updating procedures have been designed to account for individual NMHS modus operandi, geographical areas and time zones.

A time horizon of 24 hours is adopted within the EMMA Programme as the standard for warning exchange. Most countries will cover up to 48 hours and the corresponding information to be displayed by the EMMA System.

The issuing frequency on the EMMA server of new awareness charts covering new shifted validity periods is twice per 24 hours at fixed times. Each NMHS will be responsible to renew or update the awareness information sent to the EMMA System at least once per 24 hours at fixed times. In addition to those fixed time updates, the EMMA System will also enable amendments of the awareness information at any time.

(iv) Textual information is available in several languages, at least for the upper levels of access.

(v) An archive enables NMHSs to access past awareness charts.

(vi) The System is implemented using the Internet technologies with hyperlinks providing simultaneous access to awareness information contributed by different participant countries.

(vii) The EMMA System has been designed to be well and easily understood by colour-blind people. As the adopted colours are difficult to recognize for the colour-blind, black and white shaded versions of the awareness maps are available as an option.

*4.2.4 METEOALARM Website*

The specifications laid down by EMMA Programme have been developed into a Website http://www.meteoalarm.eu **"METEOALARM"**, which allows inclusion of Internal links and all available technology for flexible access. Three presentation levels are provided within the EMMA System and METEOALARM Website. Interactive access is provided to additional levels of information, such as risk qualification for the identified phenomena in order to develop awareness.

***First: European level of access***

The home page, METEOALARM features a geographical map of Europe presenting all status colours (level of awareness) within participating countries and for their regions. It provides both a synchronized view of the awareness status in the different participant countries or "regions" and the capability to select a working language from among 28 different choices (see Figure 7). Hyperlinks lead to explanation of the pictograms ("captions"), background information, terms and conditions, and links to other relevant sites and information (including the SWIC Website).

***Second: National level of access***

At the second level of access, one can zoom over different regions of individual countries. The nature of risks is defined according to national regulations for warnings/awareness and presented in pictograms which are designed to be easily interpreted visually and agreed upon by participating NMHSs. The zoom-in feature helps to elucidate the situations where different types of risks co-exist locally, each being shown with the appropriate colour (see Figure 8).

***Third: Regional level of access and other national information***

At this level the current alert or warning awareness, bulletins issued by each country can usually be found posted in the relevant national language, with a translation to English for many countries. The European and national contexts are recalled in right-hand side captions (see Figure 9)

This third level within METEOALARM allows a linkage to the Website of the NMHS (clicking on the corresponding logo) where specific national information can be found, such as:

- Thresholds or other criteria that trigger awareness levels;
- Updating strategy; and,
- Explanation of national warning systems (optional) including:
  - Targeted users/dissemination system;
  - Timeframe/time horizon in/for which different warnings are issued; and,
  - Any other relevant information to be identified.

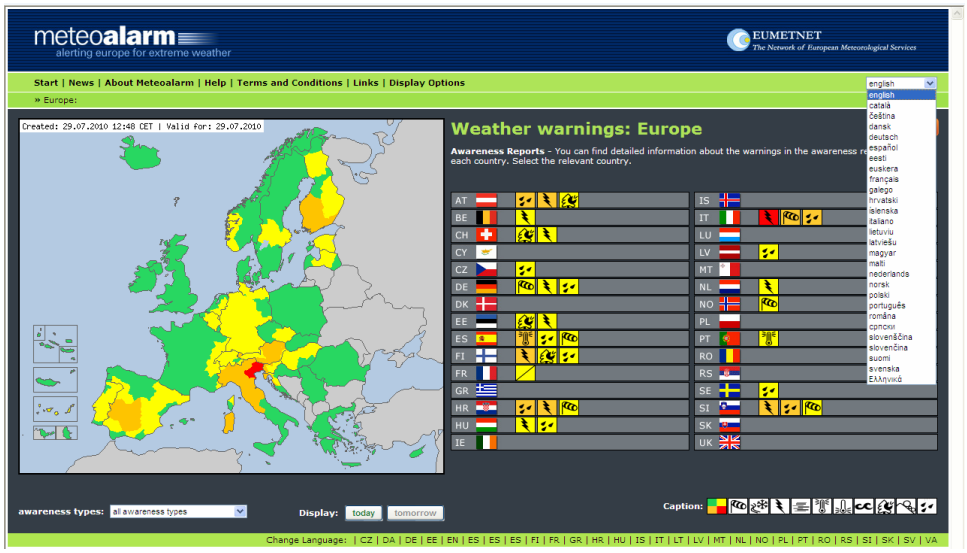



**Figure 7. Homepage of METEOALARM**

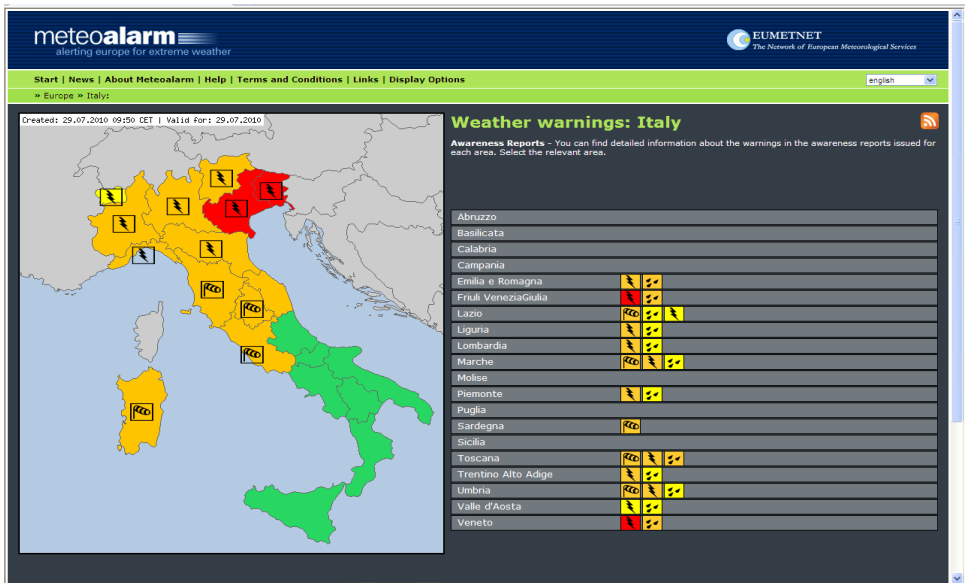



**Figure 8. National level access of METEOALARM**


**Figure 9. METEOALARM access to regional warning information within a country (Finland in this example)**

*4.2.5 Lessons learned*

***Successes:***

- Since the operational launch of the Website in 2007, METEOALARM has proved to be increasingly popular. Hits grew by 23% in 2009 compared to the previous year.

- A number of new countries joined, mainly after the launch of the operational Website, resulting in a current total number of participants of 30, almost doubling the initial number of participants.

- A straightforward 4-level colour coded table is used to define and connect potential impact to meteorological criteria. This gives the civil protection organizations, the general public and specially targeted user groups a clear signal of potential danger.

- The involvement of other parties from civil protection, crisis management, hydrologist, avalanche experts, forest fire fighters etc. has significantly improved the quality of the warning in those countries where these methods have been employed. A common strategy and clear operational agreements with these organizations have been proven to be very helpful.

- In nearly all cases the coordination with national civil protection agencies before issuing higher level warnings (orange and red) has improved the quality of the warnings. This is due to the fact that information on increased vulnerability of the infrastructure is often crucial for the determination of the correct warning message.

- Good relationship with the media has been equally important when issuing warnings. The advice of the media on the use of the best wording for different warning scenarios, or conducting interviews in crisis situations is crucial in the dissemination of warnings to the public.

- Through the efforts of the EUMETNET members and the EMMA Programme, harmonization of the use of different warning levels has been developed, by the means of internal debriefing meetings within EUMETNET. This is considered by users as a major benefit.

- Cross hyperlinks have been established, with SWIC, International Strategy for Disaster Reduction (ISDR, Hyogo Framework) and other sites (e.g., temporarily with the Volcanic Ashes Advisory Centre of London).

- Governance of the Programme proved effective within the EUMETNET structure, with a stable Programme Manager (ZAMG), assisted by an active Advisory Board comprised of representatives of NMHSs from: Austria, Finland, France, Germany, Italy, the Netherlands, Slovenia, Spain and the United Kingdom.

Annex I describes the methodology that was proposed within EMMA for designing meteorological thresholds, in relation to the awareness levels and colours.

***Challenges and perspectives:***

- The experience from EMMA I clearly indicated the need for close collaboration and consultation between NMHSs and civil protection agencies as key users of warnings, in the design of a system for the dissemination of warnings to the public.

- The METEOALARM Website needs to be more resilient in order to cope with peak demands during crisis situations, and it should be monitored round the clock. EMMA III includes the corresponding provisions for this requirement.

- To address the legal/technical issues regarding the re-use of EMMA contents by other users, e.g., the media, which benefit from the newly implemented direct RSS feeds, the respect of intellectual property rights and above all, of the integrity/timeliness of the information was underscored in the “General terms and conditions”. Subsequently, stringent requirements for very quick update of the information by participating members are implemented by the EMMA III Programme.

# CHAPTER 5

# CONSIDERATIONS IN COLLABORATION IN THE WARNING PROCESS

Based on the general principles in Chapter 2 and utilizing the essential elements in the examples in Chapters 3 and 4, the following areas are highlighted for consideration in setting up collaborative arrangements for international and cross-border exchange of warnings, and for international co-operation in the production of the same.

## 5.1 COORDINATION

NMHSs may set up bilateral and/or regional coordination arrangements according to circumstances. Some severe weather phenomena tend to be localized and of short duration and would not necessitate regional coordination. But, if the countries are geographically small, it may be necessary to consider regional coordination with respect to localized and short duration hazardous weather phenomena too. On the other hand, a mid-latitude large-scale phenomenon, or tropical cyclone, can easily have a widespread disastrous effect and would necessitate multilateral coordination.

Depending on geographical and climatological considerations, an NMHS can be partner to more than one regional group. It may be desirable for each regional association where at least a group of countries feel concerned by this issue, to designate an existing centre, for example a RSMC with geographical specialization, to monitor the coordination and exchange of warnings for the region and publish the relevant information from time to time.

The value of such an exchange procedure is to inform neighbours of:

- Perceived threats;
- Forecast onset of severe weather; and,
- Observed development of severe weather.

When considering proposed exchanges, NMHSs should decide whether the warnings exchanged are purely for the sake of harmonization and coordination between themselves or are also to be disseminated from them to public authorities, media and general public. In the former case, the participating NMHSs would remain the sole authority for issuing warnings and additional information for their own areas of responsibility. In the latter case, the nature of the sectors receiving the information would strongly influence the form and content of the messages and would depend on special supporting arrangements involving the NMHS partners.

The exchange of warnings should in general be restricted to the collaborating NMHSs, unless mutually agreed otherwise. Onward transmission and dissemination is the responsibility of each NMHS within its own area of responsibility, subject to the detailed conditions regarding the exchange arrangements.

Collaborative arrangements on larger scales such as EMMA/METEOALARM and SWIC, facilitate the extension of the scope of warnings on hazardous weather over the whole continents and globally. Via the Internet, warnings and information on weather hazards issued by NMHSs may be accessed in a timely manner by the public and the international and regional media to raise their awareness. They also help to promote the visibility of NMHSs as the warning authorities on a global level. In this type of collaboration, a centre is usually designed as the coordinator or information collating centre such as Hong Kong, China for SWIC and Austria for METEOALARM who collect warnings from participating Members and deliver consolidated display of the warnings in graphical format.

## 5.2 HAZARD TYPES

Severe weather is defined as a weather condition, which can cause significant disruption to a country's infrastructure or pose a threat to life and property. The selection of high impact weather phenomena to be exchanged in bilateral warnings should be made in terms of the general areal and temporal characteristics. If hazardous phenomena are of a local nature and of short duration, they may be of less interest for incorporation into bilateral or regional warnings. The phenomena, which can be subject to exchange, include among others:

- Extreme temperatures;
- Heat waves/cold spells;
- Heavy rain;
- Snow/blizzard;
- Severe thunderstorms (including hail, lightning, tornadoes, strong wind and flash floods);
- Widespread sandstorms;

- Conditions conducive to forest/veldt fires;
- Gale-force winds;
- Storm surge and coastal events;
- Drought;
- Freezing rain;
- Fog;
- Avalanches; and,
- Flooding (this phenomena needs careful cooperation between hydrologists and meteorologists, in case they do not belong to the same institute).

Consideration for exchange of information should not only be given to hazards in the relatively short-term and immediate risks, but also to longer-term impacts and hazards such as prolonged hot, cold or dry spells.

## 5.3 TYPES OF INFORMATION FOR EXCHANGE

### *5.3.1 Observations and Reports*

Exchange of synoptic and hourly weather observations on the GTS is routine as is the relay of several other forms of observational data (e.g., buoy reports, radiosondes, aircraft and ship reports). At the same time, a significant amount of observational information (e.g., from spotter networks, radars, automatic weather station data, wind profiler data and even regional numerical model products, etc.), and damage reports used in national severe weather programmes are not transmitted on the GTS because of limited communication bandwidth or national policy motives (see Cg-XII, Resolution 40). It would often be helpful to the severe weather warning programmes of neighbouring countries to have access to this enhanced information through multilateral arrangements.

### *5.3.2 Guidance*

Major centres routinely issue guidance on the expected evolution of weather systems. This guidance is often exchanged internationally (e.g., hurricane and tropical cyclone advisories). Similar guidance could be generated for other types of hazardous weather which might be of assistance to NMHSs in assessing threats to their respective territory.

### *5.3.3 Forecasts*

A wide range of regularly scheduled forecasts is routinely available on the GTS. A number of NMHSs also prepare specialized products for domestic use which identify areas at risk from hazardous weather (e.g., charts outlining areas with high potential for severe convective weather). Such specialized forecasts produced by major WMO global and regional centres are becoming increasingly available on the Internet. Further development along this direction should be encouraged.

### *5.3.4 Warnings*

Weather warnings are intended to alert the public in dramatic or attention-grabbing fashion and are usually issued in plain language. In some regions they are sent directly to neighbouring countries as issued and this can be an effective means of information exchange, where language differences do not pose a problem. For international exchange, translation into a single agreed language or coded format such as XML is still necessary for practical reasons. Communication among neighbouring countries enables consistent warnings about the hazards be issued to the public and concerned organizations. The efficient exchange of warnings of severe phenomena with the potential for cross-border impacts must clearly be a high priority component of any well-coordinated system for multi-national disaster preparedness and response.

## 5.4 HAZARD THRESHOLDS

The thresholds for issuing weather warnings vary from one country and one region to another, usually for reasons of climatology and vulnerability. Thresholds and intensities for which these phenomena are considered potentially harmful should be decided by mutual agreement between NMHSs concerned, in accordance with the warning purposes and criteria of each country.

Considering the various climatic conditions in the world, it may not be possible and useful to develop regional standards as far as thresholds are concerned. Chapter 5 of the second edition of the “WMO Guide to Public Weather Services Practices” (WMO-No. 834) gives many useful examples of criteria used by different countries. The Guide also demonstrates the wide variations in threshold levels for the same criteria.

For each phenomenon, in addition to the threshold criteria, lead-time and update intervals along with acknowledgement procedures should also be established. It will also have to be decided if messages are to be exchanged only at the start and end of a risk period or at regular intervals throughout the duration of an event. All messages should be acknowledged and all messages must be

cancelled when the danger has passed or no longer thought to exist. The mechanism becomes simpler and more reliable if there is a routine exchange of information including nil events.

It is practically impossible to specify warning lead-times for all events because they each have different scales of evolution in time and space. It is useful, however, to develop warning procedures that consist of initial alerts that a threat may exist. At this stage a threat may have a low probability of occurrence (e.g., 20 per cent) but a high-impact if it occurs. The purpose is to alert emergency authorities that a risk exists so that they can be put on a heightened state of awareness - even if this is just to monitor the situation more closely. A higher confidence rating (e.g., 60 per cent) may put them into a "stand-by" mode.

These initial alerts should be followed by regular updates as the timing, scale and intensity can be more accurately observed and forecast. In practice the most effective mitigating actions are usually taken from three (3) to six (6) hours before an event. Within the limits of current forecasting capabilities, realistic objectives for forecasting the onset of a severe weather event would be:

- Three (3) days for initial alerts for large-scale events; and,
- Three (3) hours for details on intensity, duration and location.

Table 4 shows a list of severe weather phenomena, criteria for issuing warnings and their target lead time.

| **PHENOMENA:** | **CRITERIA:** | **TARGET LEAD-TIME (HOURS):** |
|---|---|---|
| Strong winds | Mean speed 20 m/s | 24 |
| Heavy rain | 25mm < 6hours | 3 |
| Heavy or drifting snow | 150mm in 24 hrs | 6 |
| Severe thunderstorms | Gusts > 40 m/s<br>Hail >15 mm diameter<br>Rain >25mm/h | 3 |
| Rapid snowmelt | 15 mm in 24hrs | 12 |
| Storm surge | 1m but vary dependent on local conditions | 12 |

**Table 4 - A suggested list of severe weather phenomena and some threshold criteria already in use**

### 5.5 MEANS OF EXCHANGE

Communication methods for the exchange of warning information may include:

- Global telecommunication system (GTS);
- Telephone;
- Facsimile;
- Direct link for bilateral exchange;
- Web form;
- E-mail; and/or
- Satellite system.

The essence of any warning is to give timely notice that a risk exists. It therefore follows that mechanisms for exchange of information must be as fast and reliable as possible. To achieve effectiveness and consistency, the system should be designed around the most reliable technology that is mutually available. Although the GTS and the Internet potentially offer fast solutions, in many cases it is still advisable to consider the use of telephone and fax facilities - for sending initial messages and for direct consultation.

Longer lead-time situations can rely on communication forms such as the GTS and the Internet. Reliable e-mail communication channels may also be used.

In using Websites for posting warnings automatically for exchange purpose, care should be taken to display clearing/cancellation messages at the end of the weather event. It is essential that the site displays only the latest information.

In some countries greater use is being made of Very Small Aperture Terminals (VSAT) by national air traffic control organizations. This may be an

avenue to explore for the transmission of high-impact weather warnings. But the high cost and requirement of technical capability of this method may inhibit its use in developing countries.

Irrespective of the form of communication, acknowledgement of receipt of the message must be incorporated into the system. It is also advisable to use more than one communication medium so that the message will still be received in the event of the failure of one of the communication methods.

### 5.6 LANGUAGE, TERMINOLOGY, FORMAT AND CONTENT

The exchange of information in plain and simple language, or in graphic form, is preferable to coded messages. The language and vocabulary used must be appropriate for the country or region.

For regional exchange, the warning may be written in the language of origin and where applicable in a language, which is common to all the countries in the region. For regional exchange involving multiple countries with different languages and international exchange, it may be appropriate to issue the message in an agreed language or a coded format.

New technologies, allowing the exchange of graphical information based on mutually agreed symbols and colours can also give a simple solution to the language problem, as shown by the METEOALARM website for Europe.

Terminology should be appropriate to the country or region. The use of technical terms is best avoided. Clear, concise and simple text is most effective in conveying the desired meaning, thereby minimizing potential confusion. Ambiguity and vagueness must be avoided. Location references used must refer to well-known places.

It is advisable to reach consensus to use a standard format for exchange of warnings by NMHSs participating in the collaboration arrangement. This is to ensure that all the necessary information is conveyed to other NMHSs and to eliminate confusion. An example of such a format is given below in Table 5.

### 5.7 REVIEW

Maximum benefit and success of any programme of cooperation in exchange of warnings will be realized if there are regular reviews of the process and if all operational staff is adequately trained. Reviews of the process should be held at least once per year and it is highly recommended that they also take place after a significant event. Through these review meetings, shortcomings and training needs could be identified and steps could be taken to rectify them.

The review should also include the continual assessment of the following:

- User requirements;
- Means to meet those requirements;
- Ensuring that the users know how to make best use of the products and services provided by the NMHSs; and,
- Assessing the accuracy and usefulness of those products and services.

The purpose of such assessment is to ensure that the exchange of warnings does serve its intended function. It will also provide the motivation to maintain continued improvement of the arrangements.

### 5.8 TRAINING

Joint training sessions, including workshops and drills, should be arranged for severe weather forecasters from neighbouring countries in regional and bilateral exchange in order to familiarize them with practices and procedures in the region. This can be very beneficial for creating confidence and facilitating cross-border communication among forecasters. It is recommended that the training include topics such as:

- Interpretation and use of processed products;
- Use of conceptual models;
- The development, coordination and implementation of special indices for warnings of severe weather;
- Incorporation of local severe weather research results into operational practices;
- Improved communication skills; and,
- Familiarity with practices and procedures of neighbouring NMHSs.

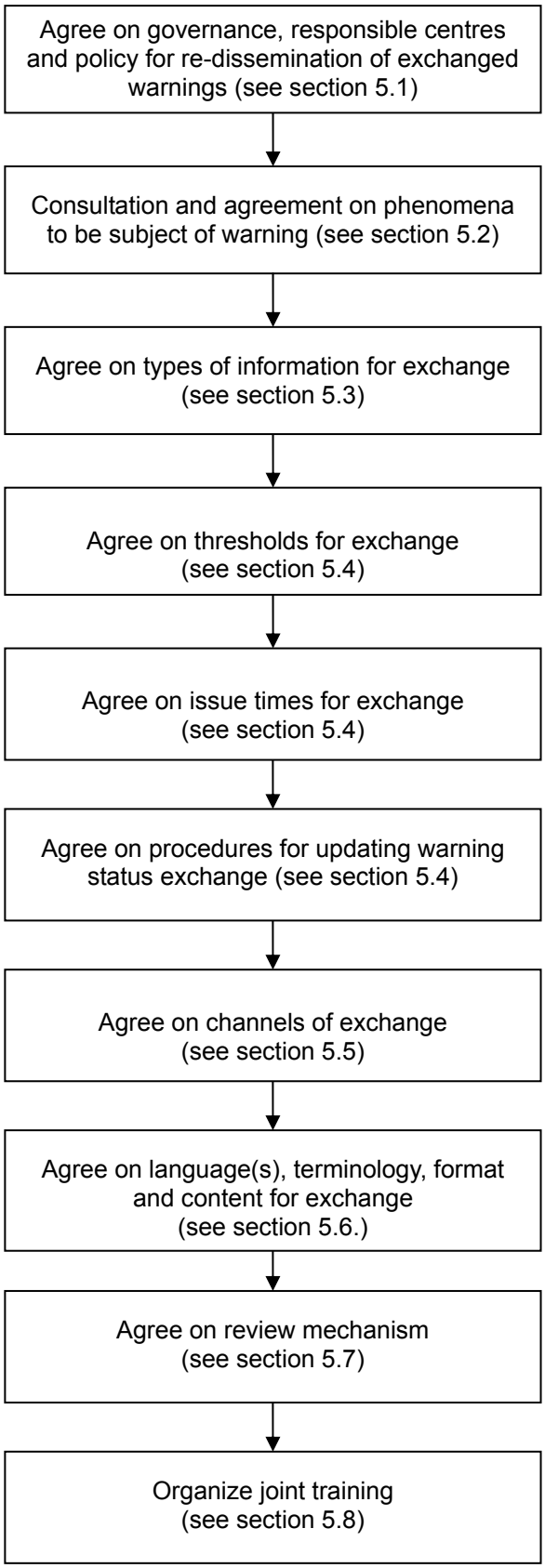
### 5.9 SUMMARY

A general process for setting up international and cross-border collaboration in warning processes is illustrated in Figure 10.

**Table 5 - An example of a standard format for exchange of warnings by NMHSs in a bilateral or regional agreement**

| | |
|---|---|
| ORIGINATOR: | |
| WARNING SERIAL NUMBER: | |
| DATE/TIME OF ISSUE (UTC): | |
| CONTENTS: | |
| TYPE OF HAZARD: | |
| FORECAST ELEMENTS: | |
| EXPECTED TIME OF ONSET: | |
| EXPECTED DURATION: | |
| AFFECTED AREA: | |
| MOVEMENT: | |
| EXPECTED IMPACT: | |
| RECOMMENDED ACTION: | |
| NEXT BULLETIN: | |

**Figure 10. A general process for setting up international and cross-border collaboration in warning processes**



## ANNEX

## EMMA METHODOLOGY FOR METEOROLOGICAL THRESHOLDS

Whereas the warning level and behavioural advice have to be generalized across Europe, the meteorological conditions that cause hazardous phenomena change from one climate region to the other.

To set thresholds for each weather parameter, climatologically determined return periods for each colour were used as a starting point. Based on typical damage/impact relationships of each region the foreseeable average frequency of usage for each parameter has been be determined in each climate region. This frequency has been set in relationship to typical area sizes of approximately 300,000 $km^2$ to avoid small countries using higher alert levels more often than larger ones.

The tentative relationship between the four determining components has been put together in a matrix called the “Redagno Table” (see Table 6) which shows the connection between the four different criteria which have to be considered when warnings are issued:

- What to do?
- Damage/Impact
- Used how often?
- Meteorological thresholds

Primary importance has the “What to Do” criteria – warning and alert level systems are effective if people react to the warnings or alert levels. In an effective system the Damage/Impact criteria is well met for each warning so that people understand the warnings as a realistic description of meteorological features causing damages

Some situations might be meteorologically extreme, but they should not cause warnings if they do not cause any damage. On the other hand some scenarios might result in higher warning or alert levels due to a combination of different parameters or increased vulnerability of the infrastructure.

**Table 6 – Redagno Table**

| **Colour** | **One phrase** | **What to do?** | **Damage/Impact** | **Used how often? (Area approx. 300,000 $km^2$)** | **Meteorological Thresholds e.g., Rain (area + impact related)** |
|---|---|---|---|---|---|
| Green | Weather report | usual phenomena | - - - | usual phenomena | (Examples) |
| Yellow | Be aware! | caution with exposed activities | exposed objects (avoidable) | > 30 per year | > 54 mm/12h |
| Orange | Be prepared! | keep informed in detail, follow advice of authorities | general damages (not avoidable) | 1 to 30 per year | > 80 mm/12h |
| Red | Take action! | follow order of authorities under all circumstances be prepared for extraordinary measures | extreme damage and/or casualties *extreme damage (mostly) on large areas, threatening life and properties* (not avoidable, even in otherwise safe places) | less then 1 per year + *large (5,000$km^2$) scale phenomena* | > 140 mm/12h |