Maryam Golnaraghi *Editor*

Institutional Partnerships in Multi-Hazard Early Warning Systems

A Compilation of Seven National Good Practices and Guiding Principles

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Foreword

Michel Jarraud

Michel Jarraud,
Secretary-General World Meteorological Organization

In terms of disasters directly or in-directly caused by natural hazards, 2010 was one of the deadliest and most costly years on record. Among the most noteworthy events included, the deadly January earthquake in Haiti, with an estimated 220,000 lives lost, the unprecedented summer heat wave in Russia, with estimated 11,000 lives lost in Moscow alone, the extensive flooding in Pakistan, during which at one point nearly one-fifth of the country's total land area was underwater, with a death toll of close to 2,000, about 20 million people affected, and with massive destruction of property, infrastructure, and livelihoods. In 2011, a number of disasters such as floods in Australia, the complex earthquake, tsunami and nuclear disaster in Japan have showed that even the wealthiest and most prepared countries are not immune to disaster risks.

Every year natural hazards cause significant loss of life and set back economic and social development by years, if not decades. As expressed in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, which WMO co-sponsors, there is increasing evidence of greater vulnerability to the risks associated with hydrometeorological hazards, due to climate variability and change. On a global scale, as revealed by statistics for the past five decades, the economic losses attributable to hydrometeorological hazards have increased significantly over the last decade; however, the reported loss of life has decreased dramatically during the same period as a consequence of the development of early warning systems (EWS) in a number of high-risk countries, thanks in particular to advances in meteorological hazard monitoring and forecasting, as well as more effective and coordinated emergency preparedness and planning at national to local levels.

Disaster risk reduction has always been at the core of the mission and among the highest priorities of the World Meteorological Organization (WMO) and the National Meteorological and Hydrological Services (NMHSs) of its 189 Members. Moreover, in referring to the Hyogo Framework for Action, in 2011, the sixteen World Meteorological Congress highlighted the importance of Multi-Hazard Early Warning Systems (MHEWS) as a proven tool for saving lives while also stressing the value of appropriate documentation and the sharing of good practices and lessons learned.

Accordingly, this book includes a key collection of good practices developed over a period of four years through the collective and systematic efforts of WMO and its Members and the International Strategy for Disaster Reduction (ISDR) System partners. In particular, the book documents seven such practices developed in Bangladesh, mega city of Shanghai in China, Cuba, France, Germany, Japan, and the United States of America (USA), while also providing a set of common principles for MHEWS institutional coordination, based on a synthesis of lessons learnt, including the role of NMHS in the planning, coordination and operational cooperation with other agencies. Indeed, much of the material contained in this volume is already being used globally in supporting a number of MHEWS capacity development initiatives.

I am therefore indeed confident that this book will serve as a key source of information for all concerned WMO Members and partners to support their efforts in strengthening their multi-hazard early warning systems.

Michel Jarraud, Secretary-General of the World Meteorological Organization

Foreword

Margareta Wahlström

Margareta Wahlström,
Assistant Secretary-General for Disaster Risk Reduction

In 2007, cyclone Favio caused great damage in central Mozambique, but only ten were killed. A few years earlier, cyclones of similar intensity killed over 800 people. Experts attributed this to training conducted on evacuation procedures and a simple yet effective warning system which involved the communities in the measurement of the precipitation levels and river gauges to the spreading of warnings using megaphones or radio announcements.

Early warning systems, which ensure people are prepared and ready to act, are one of the most effective measures that Governments can undertake to achieve the goals they set themselves in the Hyogo Framework for Action, namely "the substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries".

We have collectively come a long way from the time when an effective early warning system consisted of a timely forecast. Today, it is good practice for an early warning system to be part of a broader disaster risk management approach, using available information on the location of vulnerable groups and the different types of hazards that can affect them, and actively preparing communities to react and respond when a warning is issued and potential disaster strikes.

The World Meteorological Organization (WMO), one of the most active partners of the International Strategy for Disaster Reduction (ISDR), and the National Hydrological and Meteorological Services (NHMS) have been at the forefront of this change and have championed the early warning cause on many occasions and in international fora.

I am therefore particularly pleased with this interesting publication, as it presents seven cases of development of national early warning systems, documented in a systematic manner. It is my hope that these success stories provide incentives and inspiration for Governments the world over to aim for similar standards in the development of their own early warning systems.

Margareta Wahlström, Assistant Secretary General for Disaster Risk Reduction, United Nations International Strategy for Disaster Reduction

Preface

Over the past decade, the international community has paid significant attention to the topic of early warning systems (EWS). Ten years after the adoption of the Yokohama Strategy,[1] in January 2005, just a few weeks after the tragic December-2004 Indian Ocean Tsunami, the United Nations International Strategy for Disaster Reduction (UN-ISDR) convened the Second World Conference on Disaster Reduction in Kobe, Japan. During this conference, 168 countries negotiated and adopted the "Hyogo Framework for Action 2005–2015" (HFA), shifting the paradigm for disaster risk reduction from post disaster response to a more comprehensive approach, also including prevention and preparedness measures.[2]

The second high-priority area of the HFA stresses the need for, "identifying, assessing and monitoring disaster risks and enhancing early warning." The HFA further stresses that EWS must be an integral component of any nation's disaster risk management strategy, enabling governments at national to local levels and the communities to take appropriate measures toward building resilience in anticipation of disasters.

Many good practices around the world have demonstrated that EWS should be developed with a multi-hazard, multi-sectoral and multi-level (national to local) approach. Effective EWS are comprised of four operational components, to ensure that,

- Hazards are detected, monitored, forecasted, and hazard warnings are developed;
- Risks are analyzed and this information is incorporated in the warning messages;
- Warnings are issued (by a designated authoritative source) and disseminated in a timely fashion to authorities and public at-risk;
- Community-based emergency plans are activated in response to warnings, to reduce potential impacts on lives and livelihoods.

These four components need to be coordinated across many agencies at national to local levels for the system to work. Failure in one component or lack of coordination across them could lead to the failure of the whole system. The issuance of warnings is a national responsibility; thus, roles and responsibilities of various public and private sector stakeholders for implementation of the EWS should be clarified and reflected in the national to local regulatory frameworks, planning, budgetary, coordination, and operational mechanisms.

In 2006, the Global Survey of Early Warning Systems[3] and the outcomes of the Third International Early Warning Conference (EWC-III)[4] concluded that though progress has been made, many gaps remained to be addressed to ensure that EWS are implemented in all countries, particularly those with least resources. The 2006 Global Early Warning Survey Report cited challenges on legislative, financial, organizational, technical, operational, training and capacity building fronts.

Throughout these international events and assessments, it has become clear that governments and various agencies could benefit from experiences of other governments, with good practices in EWS that had been demonstrated to reduce loss of lives and livelihoods. It also has been voiced in many international and regional forums that there is a need for systematic documentation of such good practices, lessons learned, and synthesizing the factors that have contributed to their successes.

To this end, the 15th World Meteorological Congress in 2007 requested that such an initiative be undertaken by the WMO in partnership with its Member States and UN partners, particularly, related to institutional and operational aspects of EWS for weather, water and climate-extremes.

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[1] Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation (1994).

[2] Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters (2005).

[3] Following the tragic 2004 Indian Ocean Tsunami, former Un Secretary General, Kofi Annan requested The Global Early Warning Survey. The Survey was implemented by an interagency task Team, Chaired by the World Meteorological Organization and the United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA), coordinated by the United Nations International Strategy for Disaster Reduction (UN-ISDR) (2006)
(www.reliefweb.int/rw/lib.nsf/db900sid/AMMF6VKH6Z/$file/UNISDR-Sep2006.pdf?openelement)

[4] Third International Early Warning Conference was sponsored by the Government of Germany and was held in Bonn, Germany, 27–29 March 2006.

The compilation of this book is the result of nearly four years of consultations and efforts, including, (1) two international Multi-Hazard Early Warning Systems Symposia to establish the criteria for good practice identification, documentation and synthesis processes, (2) a documentation process engaging many national agencies and ministries from each of the seven countries presented in this book; and, (3) a detailed synthesis process involving consultations with a large cadre of experts and practitioners in EWS, from around the world.

This book features cases from Bangladesh, megacity of Shanghai in China, Cuba, France, Germany, Japan and the United States of America, building on the expertise of WMO Members and relevant national ministries, UN and international partners. The book makes the case for greater integration of EWS in development, preparedness and planning at all levels of society. It provides the basis for a holistic and systematic approach to the mapping and evaluation of early warning systems including improvement and sustainability. It offers government officials, heads of agencies and their operational staff as well as other stakeholders in EWS with detailed information on policy and legal frameworks, institutional coordination and collaboration and operational aspects of EWS.

This work has clearly revealed that even though the specific design and implementation of EWS in each of the seven cases vary according to their governance mechanisms, specific history, culture, socio-economic conditions, institutional structure, capacities and resources for sustainability of their respective systems, there are principles common to all them that have led to the reduction of the impacts of hazards, particularly through saving of lives. This synthesis is provided in Chapter 10. It is noteworthy to highlight that while these cases are treated as good practices, no system is ever perfect. A critical commonality to the cases presented in this book is that there are feedback mechanisms and investments for continuous evaluation and improvement of as various aspects of these systems, over time.

As the editor of this book, it is my hope that this book will provide the motivation for the continuation of a systematic and holistic approach to the study and strengthening of EWS, with engagement of the public and private sectors, NGOs and the academic community.

I would like to thank the WMO Members, and in particular their National Meteorological and Hydrological Services and Disaster Risk Management Agencies for their commitment and contributions to this work. I also would like to thank the team within the WMO Secretariat that have supported this work. I am also grateful to the Secretary-General of WMO for his continuous support, encouragement and deep commitment.

Geneva, Switzerland, 20 May 2011 Maryam Golnaraghi

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This work was motivated by the outcomes of three International Early Warning Conferences hosted by the Government of Germany,[5] and the 2006 "Global Survey of Early Warning Systems Report".[6] The methodology for the systematic identification and documentation of the national good practices in Multi-Hazard EWS (MHEWS) presented in this book, was established through two International Experts' Symposia on Multi-Hazard Early Warning Systems (MHEWS Symposia), organized by the WMO in cooperation with a number of United Nations and International agencies and Member States.[7] Specifically, the following national and international experts provided advice and feedback through their participation in the working groups and review teams associated with the two MHEWS Symposia: Shadekul Alam, Rosario Alfaro O, André Bachoc, P.M. Jayatilaka Banda, Curtis B. Barrett, Francoise Bénichou, Ariane de Billy, Michael Bittner, Catherine Borretti, Fredrick Branski, David S. Burridge, Ezio Bussoletti, Jean-Marie Carrière, Tanja Cegnar, Carlos Costa-Posada, Hilda Aguilar Cressent, Philippe Dandin, Keiji Doi, Alan Douglas, Charles Dupuy, Philippe Estiez, Victor M. Fallas Chinchilla, René Feunteun, Kazuhiko Fukami, Hussein Gadain, Luis Garcia, Pierre-Alexandre Genillon, Francois Gérard, David S. Green, Xavier Junior Gulele, Mu Haizhen, Sri Woro B. Harijono, Paulus Joseph Prih Harjadi, Chris Hill, Cyrille Honoré, Branka Ivancan-Picek, François Jacq, Michel Legrand Jean, Yves Le Bars, Magda Little, Lynn Maximuk, Mireille Mayoka-Massengo, Olivier Moch, Eunice Mucache, Mussa Mustafa, Sergio Pasquini, Andreas Pfaffernoschke, Eugene Poolman, Miguel A. Puig González, Sophie Purdey, Paolo Reggiani, David Robinson, Daniel Roux, José Rubiera, Michel Legrand Saah, Michael D. Selves, Pierluigi Soddu, Alain Soulan, Vesna Stajcic, Bruce Stewart, Bernard Strauss, Jean-Michel Tanguy, Akira Terakawa, Elda Vásquez de Godoy, Fazlul Wahab, Caroline Wittwer, Zou Yongjie, Steve Zebiak, Karl-Otto Zentel, Shameza Abdulla, Keith Alverson, Gabriel Arduino, Liliana Balbi, Reid Basher, Patricio Bernal, Joanne Burke, Stefanie Dannenmann, Melissa Arditto Delgado, Maxx Dilley, Glenn Dolcemascolo, William Effah, Norberto Fernandez, Simão Ferraz de Campos Neto, Brad Garanganga, Menghestab Haile, John Harding, Terry Jeggle, Esteban Leon, Horst Letz, Alexia Massacand, Paolo Mattei, Ricardo Mena, Michèle Meunier, Sujit Mohanty, Ian O'Donnell, Paul Paredes-Portella, Pascal Peduzzi, Heidi Peugeot, Francesco Pisano, Everett Ressler, Alain Retière, Magali Salazar, Johan Schaar, Rahul Sengupta, Gurpreet Singhota, Michael Staudinger, Yvette Stevens, Tang Xu, Akihiro Teranishi, Giacomo Teruggi, Katharina Thywissen, Bhupinder Tomar, Zoe Trohanis, Olivier Van Damme, Juan Carlos Villagran de Leon, Masahiro Yamamoto, Hong Yan, Yuichi Ono, Cosmas L. Zavazava.

[5] Three International Early Warning Conferences are as follows: i) First International Conference on Early Warning in 1998 (http://www.geomuseum.com/ewc98/); ii) Second International Conference on Early Warning in 2003 (http://www.ewc2.org/pg000001.htm); (iii)Third International Conference on Early Warning in 2006

[6] Global Early Warning Survey, commissioned by the Former UN Secretary General, Kofi Annan in 2005, following the Indian Ocean tsunami, coordinated by ISDR Secretariat with support by a multi-agency task team, co-chaired by WMO and OCHA. The report of this survey can be accessed at: http://www.reliefweb.int/rw/lib.nsf/db900sid/AMMF-6VKH6Z/$file/UNISDR-Sep2006.pdf? openelement.

[7] The two MHEWS experts symposia included: i) Symposium on Multi-Hazard Early Warning Systems for Integrated Disaster Risk Management Geneva, Switzerland, 23–24 May, 2006: http://www.wmo.int/pages/prog/drr/events/ews_symposium_2006/index_en.html ii) Second Experts' Symposium on Multi-Hazard Early Warning Systems with focus on the Role of National Meteorological and Hydrological Services, Toulouse, France, 5–7 May 2009:
http://www.wmo.int/pages/prog/drr/events/MHEWS-II/index_en.html

The seven good practices documented in this book were presented in a series of training workshops on "Multi-Hazard Early Warning Systems with Focus on Institutional Coordination and Cooperation,"[8] in Southeast Europe, Central America, the Caribbean, and South America. These Workshops engaged directors and senior staff of Disaster Risk Management Agencies, National Meteorological and Hydrological Services, Red Cross and Red Crescent Societies and other EWS stakeholders at national and regional levels. Through this process, we solicited valuable inputs, ideas and feedback on the themes covered by this book. We are thankful to all the participants.

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This book was compiled by Dr. Maryam Golnaraghi, with support from a team of WMO staff and consultants, including, Charles Baubion, Jean-Baptiste Migraine, James Douris, Desmond O'Neal, and Rainer Dombrowsky.

[8] These training workshops included: (i) Training Workshop on Multi-Hazard Early Warning Systems with focus on Institutional Coordination and Cooperation, Pula, Croatia, 1–3 October, 2009 (ii) Training Workshop on Multi-Hazard Early Warning Systems with focus on Institutional Partnerships and Coordination, San Jose, Costa Rica, 22–26 March, 2010, (iii) Technical Conference on Multi-hazard Early Warning Systems during the XVth Session of WMO Regional Association III, Bogota, Colombia, 20–21 Sept 2010, (iv) Technical Cooperation Workshop for the Development of the Caribbean Regional Cooperation Programme in Multi-Hazard Early Warning System Christ Church, Barbados, 2–5 Nov, 2010, (v) National Disaster Coordinators and Meteorologists Dialogue Advancing Multi-Hazards Early Warning Systems in the Caribbean, Montego Bay, Jamaica, 6 Dec. 2010. For more information on these workshops please go to:
http://www.wmo.int/pages/prog/drr/events_en.html.

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Chapter 1
An Overview: Building a Global Knowledge Base of Lessons Learned from Good Practices in Multi-Hazard Early Warning Systems

Maryam Golnaraghi

Every year natural hazards cause significant loss of life, and set back economic and social development by years if not decades in many countries, particularly those with least resources. From 1980 to 2008, weather-, water- and climate-related hazards and conditions accounted for 90% of total number of disasters, 70% of the two million casualties, and 75% of total economic losses.[9]

According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), new scientific evidence has revealed that potential risks associated with weather-related hazards are on the rise, owing to the increasing frequency and severity of droughts, extreme temperatures, severe precipitation and severe storms, linked to climate variability and change. In addition, over the last five years the world has witnessed a number of "unusual" extreme events such as:

i. The severe cyclone storm GONU that affected Oman, Iran and the United Arab Emirates in 2007, noting that it was the second cyclonic storm making landfall in Iran in more than 100 years, since 1898,
ii. Tropical cyclone NARGIS the first such storm to hit Myanmar in 40 years resulted in death of over 140,000 people and estimated losses at nearly 3% of the national GDP for 2008, and;
iii. Tropical cyclone Catarina that affected Brazil in March 2004, was the first hurricane-intensity tropical cyclone ever recorded in the Southern Atlantic Ocean.

Could these become more of the rule than the exception? Are new patterns of risks emerging? If countries are challenged with managing the current level of risk associated with these hazards; how can they address the increasing and changing patterns of risks, in the future?

However, as illustrated in Fig. 1.1, over the last five decades, while economic losses associated with hydro-meteorological hazards have increased, there has been a significant decrease in loss of life. This has been attributed to the development of effective early warning systems, based on advancements in monitoring and forecasting of weather-related hazards (Box 1.1, Box 1.2), combined with effective communication and emergency preparedness at national to local levels in several countries with a history of high-impact weather-related hazards, such as Cuba, Bangladesh, France, and the United States.

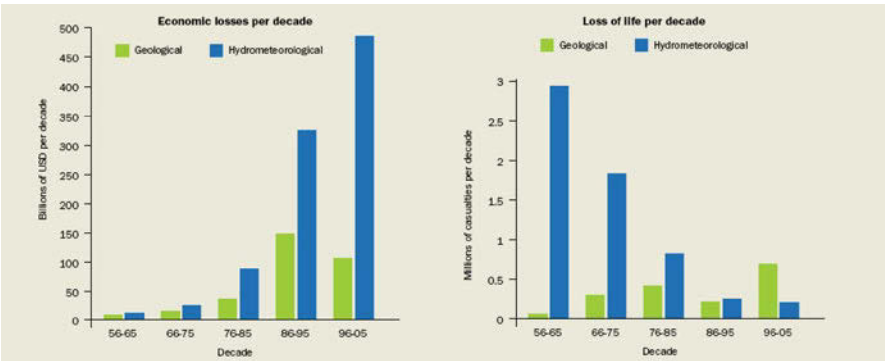

Fig. 1.1 Decadal loss of life and economic losses related to geological versus hydro-meteorological hazards based on data from EM-DAT – The OFDA/CRED International Disaster Database

Maryam Golnaraghi, Chief of Disaster Risk Reduction Programme, World Meteorological Organization

[9] EM-DAT: The OFDA/CRED International Disaster Data-base.

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1.1 International Attention to Early Warning Systems

Over the past decade, the international community has paid significant attention to the topic of early warning systems, including, three international conferences (1998, 2003, 2006, hosted by the government of Germany), two international experts' symposia on Multi-Hazard EWS (2006 and 2009, World Meteorological Organization), the 2006 United nations Global EWS Survey Report, and the World Disaster Report (2009, International Federation of red Cross and Red Crescent Societies) (see references).

Ten years after the adoption of the Yokohama Strategy,[10] in January 2005, during the Second World Conference on Disaster Reduction (Kobe, Japan), 168 countries adopted "Hyogo Framework for Action 2005–2015" (HFA) shifting the paradigm for disaster risk reduction from post disaster response to a more comprehensive approach that would also include prevention and preparedness measures.[11] The HFA outlines five priority areas for action, including:

i. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation;
ii. Identify, assess and monitor disaster risks and enhance early warning;
iii. Use knowledge, innovation and education to build a culture of safety and resilience at all levels;
iv. Reduce the underlying risk factors;
v. Strengthen disaster preparedness for effective response at all levels.

The second high-priority area of the HFA stresses the need for, "identifying, assessing and monitoring disaster risks and enhancing early warning." The HFA further stresses that EWS must be an integral component of any nation's disaster risk management strategy, enabling governments at national to local levels and the communities to take appropriate measures toward building resilience in anticipation of disasters.

The Second International Conference on Early Warnings (2003) concluded that effective EWS are comprised of (Fig. 1.2):

- **Monitoring and warning service:** Hazards are detected, monitored, forecasted, and hazard warnings are developed;
- **Risks knowledge:** Risks are analyzed and this information is incorporated in the warning messages;
- **Dissemination:** Warnings are issued (by a designated authoritative source) and disseminated in a timely fashion to authorities and public at-risk;
- **Response capacity:** Community-based emergency plans are activated in response to warnings, to reduce potential impacts on lives and livelihoods.

Indeed, many good practices around the world have demonstrated that EWS should be developed with a multi-hazard, multi-sectoral and multi-level (national to local) approach.

Fig. 1.2 WMO Schematic of the four operational components of effective EWS developed based on the UN-ISDR definition of EWS)

[10] Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation (1994).
[11] Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters (2005).

Implementation of these components requires coordination across many agencies at national to local levels for the system to work. Failure in one component or lack of coordination across them could lead to the failure of the whole system. The issuance of warnings is a national responsibility; thus, roles and responsibilities of various public and private sector stakeholders for implementation of the EWS should be clarified and reflected in the national to local regulatory frameworks, planning, budgetary, coordination, and operational mechanism.

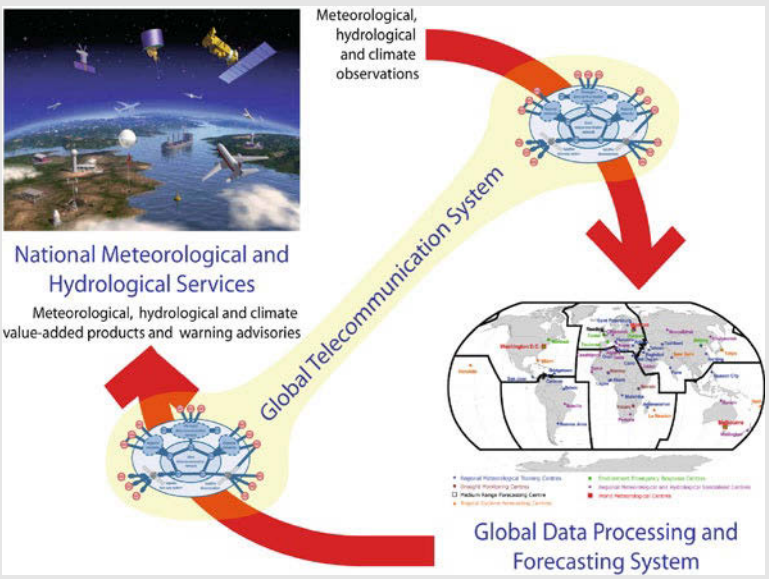
Various assessments and the outcomes of the mid-term HFA review in 2010 have revealed that many nations around the globe operate EWS for various natural and man-made hazards. However, the governmental priority, stage of development and overall effectiveness of the EWS at national to local levels, vary widely. Many countries, especially those with the highest risks and least resources, remain highly challenged in building and sustaining their EWS at national to community levels.

Throughout these international events and assessments, it has become clear that governments and various agencies could benefit from experiences of other governments, with good practices in EWS that had been demonstrated to reduce loss of lives and livelihoods. It also has been voiced in many international and regional forums that there is a need for systematically documentation of such good practices, lessons learned, and synthesizing the factors that had contributed to their successes (Golnaraghi et al. 2007, 2008).

Box 1.1 Sixty Years of International and Regional Cooperation in Meteorology to support National Early Warning Systems

Over the last few decades, meteorological, hydrological and climate forecasts have become increasingly accurate as a result of remarkable international co-operation, facilitated by the World Meteorological Organization (WMO). This involves coordinated research and an operational network, comprised of the WMO Global Observing System, Global Telecommunication System and Global Data Processing and Forecasting System that enable monitoring, detecting, forecasting and exchange of weather, water and climate related information, engaging the National Meteorological and Hydrological Services (NMHS) of 189 Members.

Through this coordinated operational network, a wide range of global and regional forecast products and services based on latest technologies and forecasting tools are provided to the support the National Meteorological and Hydrological Services in supporting them with the development of national products and services such as hazard analysis, early warnings and other products and services to support sectoral risk management decision-making. Examples where this coordinated network is supporting the WMO Member States include:



Internationally coordinated network of WMO involving Global Observing System, Global Telecommunication System and Global Data Processing and Forecasting System facilitating sharing of data, analysis and forecasts across 189 WMO Members through their National Meteorological and Hydrological Services.

Box 1.2 Applications of WMO Global Operational Network

Tropical Cyclone Programme

The Tropical Cyclone Programme is an example of cooperation using regionalcapacities to support national warning systems to promote disaster risk reduction strategies. Through the Programme, six Regional Specialized Meteorological Centres (RSMCs) are dedicated to providing tropical cyclone analysis, forecasts and alerts in support of National Meteorological Services' operational warnings. These include: RSMC Nadi-wTropical Cyclone Centre, RSMC La Reunion-Tropical Cyclone Centre, RSMC New Delhi – Tropical Cyclone Centre, RSMC Tokyo – Typhoon Center, RSMC Honolulu, and RSMC Miami – Hurricane Center. The Programme is supported by five regional committees, involving forecasters from the NMHSs, which ensure ongoing improvements in the tropical cyclone forecasting and warning systems. This has enabled availability of tropical cyclone warning capacities to all countries at risk.

Emergency Response Activities

The WMO programme of Emergency Response Activities (ERA) established in 1986 to assist NMHSs, governments and international organizations to respond effectively to environmental emergencies with large-scale dispersion of airborne hazardous substances is another example of regional cooperation. The programme is focussed on nuclear facility accidents, but also provides for meteorological support in emergency response to the dispersion of smoke from large fires, volcanic ash, dust and sand storms and chemical releases from industrial accidents. The WMO operational network of global, regional and national meteorological centres provides the infrastructure for specialized atmospheric dispersion-modelling that play a crucial role in assessing and predicting the spread of air- and water-borne hazardous substances. Some applications include:

Nuclear Accidents

The Chernobyl nuclear accident (April 1986) led to strengthened international cooperation in the event of a nuclear emergency through the Joint Radiation Emergency Management Plan of the International Organizations. The plan is coordinated by the International Atomic Energy Agency in cooperation with international organizations including WMO, the World Health Organization, and the Food and Agriculture Organization. WMO maintains a system of eight Regional Specialized Meteorological Centres which provide highly specialized computer-based simulations of the atmosphere that predict the long-range movement of airborne radioactivity to support environmental emergency response, when needed. These centres, which provide complete global coverage 24 hours a day, every day, are located in Beijing (China), Obninsk (Russian Federation) Tokyo (Japan), Exeter (United Kingdom), Toulouse (France), Melbourne (Australia), Montreal (Canada) and Washington (USA). This response system was activated on 12 March 2011 in the aftermath of the earthquake in Japan.

Volcanic ash

Volcanic ash is a direct safety threat to jet transport aircraft, primarily because the melting point of ash is around 1100°C, while the operating temperatures of jet engines are around 1400°C. The ash melts in the hot section of the engines and then fuses on the turbine blades, eventually leading to engine stall. The International Civil Aviation Organization is responsible for coordinating the efforts of its member states and seven international organizations, including WMO, which comprise the International Airways Volcano Watch (IAVW). Under the IAVW, international ground-based networks, global satellite systems and in-flight air reports detect and observe volcanic eruptions and ash cloud and pass the information quickly to appropriate air traffic services units and Meteorological Watch Offices, which provide the necessary warnings to aircraft before or during flight. The warnings are based on advisory information supplied by nine Volcanic Ash Advisory Centres (VAACs) designated upon advice from WMO. The designated VAACs are located in Anchorage, Buenos Aires, Darwin, London, Montreal, Tokyo, Toulouse, Washington and Wellington.

Wildfires

Following the worst smoke and haze episodes that affected South-East Asia in autumn 1997, which impacted many socio-economic sectors including civil aviation, maritime shipping, agricultural production, tourism and the health of populations, WMO joined with the Association of South-East Asian Nations (ASEAN) to set up the ASEAN Regional Specialized Meteorological Centre in Singapore. This Centre provides smoke/haze information and forecasts to NMHSs to assist in environmental emergency situations. It also displays weather and hot spots using satellite images on its website. Satellite imagery can provide information on the dryness of vegetation, location and size of major fires and smoke plumes, energy released by fires, and air pollutants in the smoke plumes.

1.2 Methodology for Identification and Documentation of Good Practices in Multi-Hazard EWS

The process for systematic identification of good practices might be said to have commenced during the Third International Early Warning Conference (EWC-III). At the EWC-III, a Checklist for Developing Early Warning Systems was distributed, providing a simple list of the main elements and actions to consider when developing or evaluating the EWS.[12] However, while the participants expressed appreciation for this guiding tool, they noted that many countries require more detailed guidance and assistance to implement holistic and effective EWS within a multi-hazard framework. Following the EWS-III, WMO, in cooperation with other UN and international partner organizations held two international experts symposia on multi-hazard EWS to develop a clear methodology for identification and documentation of good practices.

1.2.1 The First International Experts' Symposium on Multi-Hazard EWS

WMO hosted the First International Expert's Symposium on Multi-Hazard EWS (MHEWS-I) in May 2006, which brought together experts from various disciplines and organizations, working at national and international levels. The Symposium had the following main goals:

i. To provide recommendations for an integrated approach to warning systems, building on and linking existing capacities of different stakeholders, including identification of actions at national level to strengthen early warning capabilities and regional and international actions to support these national efforts.
ii. To explore further the concept of a "multi-hazard approach" to EWS, including potential economies and synergies from such approach, and to provide recommendations on additional studies and/or demonstrations that might be required to fully assess all aspects of this approach.
iii. To develop criteria for what constitutes a good practice and identify such cases in the world.

When considering the role of technical agencies, in particular those responsible for monitoring, detecting and forecasting of the hydro-meteorological and climate-related hazards, the symposium stressed that in many countries the National Meteorological Services (NMSs) and the National Hydrological Services (NHSs) are separate agencies, under different line ministries. The operational roles of such technical agencies could be divided into three categories based on their institutional structures and mandates for specific hazards;

- **Type I hazards:** NMS or NHS have sole mandate to monitor, detect and develop warnings for the hazard.
- **Type II hazards:** NMS and NHS have a joint mandate between them and/or with another specialized technical agency to monitor, detect and develop warnings for the hazard.
- **Type III hazards:** NMS and NHS are required to provide data and forecast products or lend their infrastructure (e.g., communication systems) to other agencies that have the official mandate to monitor, detect and develop warnings for the hazard.

Technical and operational cooperation of these agencies would be fundamental to the development of hazard warnings. Furthermore, many other agencies are responsible for managing the risks and ensuring coordination for emergency preparedness within and across many sectors. These agencies would also monitor and document the impacts of hazards on various sectors such as health, agriculture and food security, infrastructure, water resource management, transportation. Development of effective partnership among technical and sectoral agencies is critical for the development of warnings that incorporate risk sectoral information.

The Symposium also provided significant input for the development of a standard template that could be utilized by the national ministries and agencies to document systematically their respective national EWS. A "simplified" outline of this template is provided in Box 1.3.

During MHEWS-I, four examples of good practices were identified using the above criteria, including Bangladesh, Cuba, France and City of Shanghai in China. It was recommended that these cases be documented for further analysis of commonalities and lessons learned.

[12] "Developing Early Warning Systems: A Checklist," UN/ISDR. 2006. Developed as an outcome of the Third International Conference on Early Warning (EWC III), 27–29 March 2006, Bonn, Germany. It was created in order to help governments and communities implement people-centred early warning systems. The checklist was translated into 19 Indian Ocean country languages. Link: http://www.unisdr.org/2006/ppew/info-resources/ewc3/checklist/English.pdf.

Box 1.3 A "Simplified" Outline of the Template Used for Systematic Documentation of Good Practices in EWS

1. ***Overview of the Early Warning Systems (EWS)***
2. ***Background in the establishment of EWS***
3. ***Governance and Institutional Arrangements (national to local levels)***
   a) *Policy, intuitional and legal frameworks to support emergency planning and response*
   b) *National to local emergency planning and related linkages to EWS*
   c) *Organizational structure for implementing the plans*
   d) *Institutional capacities and concept of operations (coordination and operational collaboration)*
   e) *Financial and budgetary aspects*
4. ***Utilization of risk information in emergency contingency planning and warnings***
   a) *Organizational responsibilities and arrangements for the development of risk information*
   b) *Hazard assessment, quantification and mapping (national to local)*
   c) *Assessment of vulnerabilities and exposure (national to local)*
   d) *Storage and accessibility of disaster and national hazard risk information*
   e) *Development and utilization of hazard/risk information to support emergency planning and warnings*
5. ***Hazard Monitoring, forecasting, and mandates for warning development***
   a) *Organizational responsibilities for monitoring, forecasting and development of hazard warnings*
   b) *Organizational collaboration and coordination for development of hazard warnings*
6. ***Development of understandable, authoritative, recognizable and timely warnings***
   a) *Warning message development cycle*
   b) *Warning message improvement cycle*
7. ***Warning dissemination mechanisms (national to local)***
8. ***Emergency preparedness and response activities (national to local)***
   a) *Disaster preparedness and response planning and emergency response activation*
   b) *Community response capacities*
   c) *Public awareness and education*
9. ***Sustainability, resources and budgetary commitments***
10. ***Improvement of overall operational framework of EWS through on-going drills and feedback and evaluations during and after an event***
11. ***Examples of previous events where the operational EWS has led to improvements in emergency preparedness and prevention***
12. ***Overall lessons learned and future steps for improving Meteorological, Hydrological and Climate services contribution in EWS particularly focusing on institutional coordination and cooperation with the disaster risk management agencies and EWS stakeholders (public and private)***

Following the MHEWS-I, in each country, through a formal process, teams of policy and operational experts from the NMHS, Disaster Risk Management Agencies, other key ministries such as health, environment and water, and the Red Cross and Red Crescent Societies (RCRC)[13] were engaged to document their respective EWS.

1.2.2 The Second International Experts' Symposium on Multi-Hazard EWS: with focus on the Role of NMHS

In 2009, WMO convened the Second International Experts' Symposium on Multi-Hazard EWS, (MHEWS-II) in 2009.[14]

MHEWS-II reviewed the outcomes of the first four documented good practices, discussed lessons learned, and identified additional good practices in MNEWS including Japan, United States of America, Italy and Germany, for further expansion of this initiative.

[13] RCRC was specifically involved in the documentation of the Bangladesh Cyclone Preparedness Programme.

[14] MHEWS-II was organized by WMO with a number of partners and was hosted by Météo-France, in Toulouse, France on May 5–7, 2009. MHEWS-II brought together nearly 100 experts from the NMHS, disaster risk management agencies, various ministries and the international and regional partners.

1.3 Documentation of Good Practices

This book provides detailed analysis of seven of these good practices with particular focus on multi-hazard EWS for meteorological and hydrological hazards. These include, (i) Bangladesh Cyclone Preparedness Programme; (ii) Cuba Tropical Cyclone Early Warning System; (iii) The French "Vigilance" System; (iv) The Warning Management of The Deutscher Wetterdienst in Germany, (v) Multi-Hazard Early Warning System in Japan, (vi) Multi-Hazard Early Warning System of The United States' National Weather Service; and, (vii) Shanghai Multi-Hazard Emergency Preparedness Programme.

This work has clearly revealed that the specific design and implementation of EWS in each of the seven cases vary according to their governance mechanisms, specific history, culture, socio-economic conditions, institutional structure, capacities and resources for sustainability of their respective systems. However, there are principles common to all them that have led to the reduction of the impacts of hazards, particularly through saving of lives. These 10 common principles are provided with more details in Chap. 9 of this book. They include:

1. There is a strong political recognition of the benefits of EWS reflected in harmonized national to local disaster risk management policies, planning, legislation and budgeting;
2. Effective EWS are built upon four components: (i) hazard detection, monitoring and forecasting; (ii) analyzing risks and incorporation of risk information in emergency planning and warnings: (iii) disseminating timely and "authoritative" warnings, and, (iv) community planning and preparedness and the ability to activate emergency plans to prepare and respond, with coordination across agencies involved in EWS, at national to local levels;
3. EWS stakeholders are identified and their roles and responsibilities and coordination mechanisms clearly defined and documented within national to local plans, legislation, directives, MOUs, etc, including those of the technical agencies such as the NMHS;
4. EWS capacities are supported by adequate resources (e.g., human, financial, equipment, etc.) across national to local levels and the system is designed and implemented accounting for long-term sustainability factors;
5. Hazard, exposure and vulnerability information are used to carry-out risk assessments at different levels, as critical input into emergency planning and development of warning messages;
6. Warning messages are; (i) clear, consistent and include risk information, (ii) designed with consideration for linking threat levels to emergency preparedness and response actions (e.g., using colour, flags, etc) and understood by authorities and the population, (iii) issued from a single (or unified), recognized and "authoritative" source;
7. Warning dissemination mechanisms are able to reach the authorities, other EWS stakeholders and the population at risk in a timely and reliable fashion;
8. Emergency response plans are developed with consideration for hazard/risk levels, characteristics of the exposed communities (e.g., urban, rural, ethnic populations, tourists, and particularly vulnerable groups such as women, children, the elderly and the hospitalized), coordination mechanisms and various EWS stakeholders;
9. Training on risk awareness, hazard recognition and related emergency response actions is integrated in various formal and informal educational programmes and linked to regularly conducted drills and tests across the system to ensure operational readiness at any time;
10. Effective feedback and improvement mechanisms are in place at all levels of EWS to provide systematic evaluation and ensure system improvement over time.

It is noteworthy to highlight that while these cases are treated as good practices, no system is ever perfect. A critical commonality to the cases presented in this book is that there are feedback mechanisms and investments for continuous evaluation and improvement of as various aspects of these systems, over time.

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List of Acronyms

DRR	Disaster Risk Reduction
EWC-III	Third International Early Warning Conference
EWS	Early Warning Systems
HFA	Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters
IPCC	Intergovernmental Panel on Climate Change
MHEWS	Multi hazard Early Warning Systems
MHEWS-I	First International Experts' Symposium on Multi-Hazard EWS
MHEWS-II	Second International Experts' Symposium on Multi-Hazard EWS
MOU	Memorandum of Understanding
NMHS	National Meteorological and Hydrological Organization
RCRC	Red Cross and Red Crescent Societies
UN	United Nations
UN-ISDR	UN – International Strategy for Disaster Reduction
WMO	World Meteorological Organization