WORLD METEOROLOGICAL ORGANIZATION

GUIDE TO PUBLIC WEATHER SERVICES PRACTICES

SECOND EDITION

WMO-No. 834

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Second Edition

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Secretariat of the World Meteorological Organization–Geneva–Switzerland
1999

Cover: *Press briefing at the Bureau of Meteorology in Australia*
(Bureau of Meteorology, Australia)

ISBN No. 92-63-12834-X

NOTE

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WORLD METEOROLOGICAL ORGANIZATION
ORGANISATION MÉTÉOROLOGIQUE MONDIALE
ВСЕМИРНАЯ МЕТЕОРОЛОГИЧЕСКАЯ ОРГАНИЗАЦИЯ
ORGANIZACIÓN METEOROLÓGICA MUNDIAL

Guide to Public Weather Services Practices

Second Edition

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CORRIGENDUM

Please amend by hand "Bracknell" to read "Moscow" in the fifth line of the text on page 26.

Guide des pratiques concernant les services météorologiques destinés au public

Deuxième édition

OMM-N° 834

CORRIGENDUM

Veuillez lire page 30, section 3.3, 3ème paragraphe, 6ème ligne "Moscou, Melbourne et Washington" au lieu de "Bracknell, Melbourne et Washington".

Руководство по практике метеорологического обслуживания населения

Второе издание

ВМО-№ 834

ИСПРАВЛЕНИЕ

Просьба исправить ошибку в параграфе 3.3, третий абзац сверху на с. 34 издания на русском языке, заменив слово «Бракнелл» на «Москва» в предложении, начинающемся со слов «Три ММЦ... ».

Guía de prácticas de Servicios Meteorológicos para el Público

Segunda edición

OMM-Nº 834

FE DE ERRATAS

En la página 26, en la quinta línea del tercer párrafo del punto 3.3, en vez de (Bracknell, Melbourne,Washington) debe leerse (Moscú, Melbourne y Washington).

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PREFACE

As weather and climate play such a significant role in the cultures and lifestyles of people around the world, national Meteorological or Hydrometeorological Services (NMSs) have no greater responsibility than ensuring the safety of life, protection of property and the well-being of their nations' citizens. Consequently, the warnings and forecasts that they provide should be timely, reliable and comprehensive. In addition, these forecasts and other information on weather- and climate-related events are vital for disaster management and the decision-making processes of many weather-sensitive sectors. Indeed, the visibility and credibility of an NMS are derived from its ability to provide demonstrably useful and reliable public weather services, tailored to the needs of its national community.

To help NMSs fulfil this task, the Eleventh World Meteorological Congress (1991) established the Public Weather Services (PWS) Programme as a component of the Applications of Meteorology Programme of the World Meteorological Organization (WMO). The implementation of the Programme got under way in 1994. The main purpose of PWS Programme is to assist WMO Members to provide comprehensive weather services to the community, with particular emphasis on public safety and welfare, and give guidance to the public on how best to use those services.

In 1996, WMO published a preliminary *Guide to Public Weather Services Practices* to assist WMO Members with the development of their public weather services. The present publication is a revised edition of that *Guide*, prepared at the request of Congress and expanded to include chapters specifically on warnings, forecasts, the dissemination of these products and their verification. Special emphasis has been placed on the concept of providing service in a more user-focused manner. The role of warnings and their contribution to disaster management have been particularly highlighted. Accompanying this *Guide* is a CD-ROM which contains a large number of examples of the various types of warnings, forecasts and weather information, and of ways of graphically displaying them on television and in newspapers.

The Secretariat was assisted in the preparation of this *Guide* by a number of experts, in particular Mr D. Wernly (USA), Dr A. Liakhov (Russian Federation), Mr M. Sanchez H. (Costa Rica), Mr K. O'Loughlin (Australia), Dr N. Gordon (New Zealand), Mr W. Kusch (Germany) and Mr F. Otieno (Kenya), who contributed greatly by way of ideas and examples towards the completion of the initial draft prepared by Mr E. Gross (USA). In addition, in order to ensure that the *Guide* adequately addresses areas that are of special importance in the development and maintenance of national public weather services, several Permanent Representatives from each WMO Region and the Presidents of WMO Regional Associations were invited to provide comments on the substance of the *Guide*. A final editing of the publication was undertaken by Mr D. Linforth (Australia).

On behalf of WMO, I wish to express my sincere thanks to all those who have contributed to the writing and editing of this *Guide*.

(G.O.P. Obasi)
Secretary-General

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE *GUIDE*

Weather and extreme hydrometeorological events are not only a vital component in the decision processes for disaster management and weather-sensitive economic sectors, but affect the everyday life of the general public. While the impacts of disasters heighten and focus public support for improvements in hydrometeorological prediction and warning programmes, the ongoing socio-economic value of such programmes is now increasingly recognized. National Meteorological or Hydrometeorological Services (NMSs) have to provide warnings, forecasts and information on weather and climate-related events in a timely, reliable and comprehensive manner as part of their responsibility for the safety of life, protection of property and the well-being of their nations' citizens.

To assist the NMSs to fulfil this task, WMO's Public Weather Services Programme has prepared this second edition of the *Guide to Public Weather Services Practices* (WMO-No. 834). Its main purpose is to assist WMO Members with the development and improvement of weather services to the general public. It contains information about those practices and procedures which are of greatest importance for providing meteorological services to the public and, therefore, presents an overview of established principles, techniques, methodologies and related material along with ideas and recommendations from various individuals and groups with expertise in the field. The intended audience is mainly the NMS staff, but the *Guide* may also be useful to NMSs in discussions with external audiences and other governmental agencies.

This *Guide to Public Weather Services Practices* is based on the first edition which was published in 1996. In preparation of the present *Guide*, a comprehensive survey was carried out in 1997 of the NMSs to assess the current state of national public weather services programmes, their strengths and shortcomings, and to facilitate the implementation of well-targeted capacity-building initiatives. The results of the survey have been incorporated in the *Guide*. Both Guides reflect the very high priority which WMO places on the development and improvement of public weather services.

This expanded *Guide* consists of two parts. Chapters 1–4 and 11 are descriptive in nature, providing background information related to public weather services practices and management. Chapters 5–10 may be used as the basis for training programmes related to the various components of a public weather services programme. A "how to" approach has been employed in preparation of most chapters, providing examples of the steps to be followed by the NMS staff leading to the preparation and issuance of warnings, forecasts, informational products, and their presentation on radio and television, in newspapers, etc. Examples of current products and methods employed by NMSs are also incorporated into some chapters. An electronic version of the *Guide* will allow even greater access to the latest practices, techniques and public weather service products, by making these available as soon as they are introduced. It will also include a larger number of examples in each of the chapters, as relevant. Both the electronic and paper versions of the *Guide* should provide NMSs with a continuous source of the latest practices and information on the rapidly changing and evolving technologies which can be used in the improvement and advancement of Members' public weather services programmes. The *Guide to Public Weather Services Practices* is by nature evolutionary and will be therefore continuously updated. The electronic version will especially strongly support that concept.

Throughout the *Guide*, emphasis is placed on the importance of providing services which users require. To have a successful public weather services programme, it is essential for NMSs and their staffs to develop products based on the understanding of user requirements. Therefore, how to ascertain user requirements, how to respond to these requirements and the need to continuously assess and review the level of user satisfaction with those products have been addressed in the *Guide*. It is important to remember that further development of public weather services should only be undertaken in response to actual and real needs and requirements expressed by the user community and not as an end in itself. By their very nature public weather service programmes must be clearly seen to be of service to the public if they are to retain validity, credibility, and public and political support. To help the NMSs to identify the users' needs, samples of questionnaires will be provided in the electronic version of the *Guide*.

National practices vary on the placement of responsibility for hydrological services. Some countries place the responsibility with the meteorological service, others place it with a separate organization. In some cases the responsibility is divided, e.g. the meteorological service being responsible for flood warnings, a separate organization being responsible for routine monitoring of river flow and control of irrigation. In this *Guide* the term national Meteorological or Hydrometeorological Service (NMS) has been used.

1.2 WMO PUBLIC WEATHER SERVICES PROGRAMME

Within the WMO system, the PWS Programme falls under the general responsibility and leadership of the Commission for Basic Systems (CBS). Because of the programme's strong interrelationships with basic systems, as well as with virtually all other WMO Programmes, its functioning must be coordinated very broadly both with other WMO constituent bodies and with external international organizations.

The purpose of the WMO PWS Programme is to assist WMO Members to provide reliable and effective weather and related services for the benefit of the public.

> ".......... in establishing the Public Weather Services Programme, WMO took into consideration current global environmental concerns, the requirements of Members and the rapid advances in science and technology. Accordingly, the purpose of this programme is to assist Members to improve weather services to the general public and give guidance on how best to use them. These services support the safety and welfare of the community, both directly and indirectly.".......... Professor G.O.P. Obasi

The main long-term objectives of the PWS Programme are:

(1) To strengthen Members' capabilities to meet the needs of the community through the provision of comprehensive weather and related services, with particular emphasis on public safety and welfare;

(2) To foster a better understanding by the public of the capabilities of national Meteorological Services and how best to use their services.

1.3 SCOPE OF THE PUBLIC WEATHER SERVICES PROGRAMME

The PWS Programme includes a core component common to all NMSs, which centres on ensuring the safety of life and property, one of the primary responsibilities of a government. Other components focus on enhancing the economic well-being of the nations and these will vary considerably depending on national practices and cultures.

Considering the above, the public weather services activities of WMO Members belong to one of the most diversified fields of meteorological applications.

Requirements for real-time services span a very broad spectrum ranging from the critical needs of disaster prevention and emergency management agencies to those of the city dweller who listens to the weather forecast to decide whether or not to carry an umbrella. They include the needs of the farmer who must make a critical decision on harvesting a crop or the highway manager who must decide whether or not to place snow plough crews on standby in advance of an anticipated snowfall. Then there are the special needs of national governments, state councils and local governments at various levels. Governments require information to assist them in preparing development strategies, organizing economic activities including agricultural and industrial production, urban construction, disaster reduction and preparedness and in conducting large-scale scientific experiments. This information is often of a climatological nature. Needs for public weather services, in addition, encompass other significant climatological and hydrological requirements for drought monitoring information, data on winter snowpack accumulation, spring and summer water supply outlooks and climatic normals and other statistics. As a consequence, a variety of national and regional practices and procedures have evolved in the delivery of public weather services. These national and regional variations are to be expected and usually reflect real differences in climate, in culture, or in economic circumstances.

Basic services funded by governments commonly take the form of weather warnings, forecasts and other information products which are distributed to the public at large through broadcast and print media. In many countries, computer networks, recorded telephone messages, weather radio broadcasts, emergency or civil defence public alert systems and other technologies are also used to disseminate products to the general public or large segments of it.

In addition to the services provided to the population in general, many national public weather services programmes also include more specialized products and services which, though funded by governments and provided for the public good, are not necessarily made directly available to all citizens. Specialized warnings and messages for emergency, civil defence or public security agencies are examples as are, in some cases, tailored products for a dominant sector of the economy such as agriculture, water resource management or tourism.

A significant meteorological private sector now exists in a growing number of countries and some private companies engage in international operations. Private companies generally seek to earn revenue by the provision of specialized, client-specific, hydrometeorological services. They have often been notably innovative in the development of products and product formats which meet the requirements of particular clients. Private sector initiatives may either complement or compete with the public weather services programmes of national Meteorological Services, depending on national policies, circumstances and capabilities. In addition, several major international television broadcast networks now cover huge geographic areas with their meteorological programming, via communications satellites. Some of these networks broadcast meteorological products generated by their own meteorological staff or by the private sector. These new realities highlight the need for coordination of weather warnings and forecasts not only between national Meteorological Services but, increasingly, between all providers or disseminators of such products. This latter issue is of special concern if public confusion is to be avoided in severe weather and emergency situations.

1.4 DEVELOPMENT OF A NATIONAL PUBLIC WEATHER SERVICES PROGRAMME

When developing and implementing any programme, it is important to have a clearly-stated objective, or set of objectives, towards which all efforts are directed. It has, in addition, been found useful to articulate a set of guiding principles at the earliest stage of programme development. These guiding principles largely determine and underpin the strategies to be applied in order to achieve the overall objective(s). Objectives along with guiding principles, strategies, a coordination and accountability regime and individual action plans (to achieve specific goals or implement specific initiatives), when combined together, form an overall management framework for the programme. A well-developed management framework is useful in providing direction and coherence to a programme and in managing its implementation. Equally important, it is useful in explaining or "selling" the programme both to internal staff and to important external groups such as major clients, funding authorities and partner agencies.

The essential first step is to achieve consensus on programme objectives such as:

- to meet the needs of the community through the provision of comprehensive weather and related services with particular emphasis on public safety and welfare;
- to foster public understanding of the capabilities of the NMS and how best to use its services.

A consensus is unlikely to be very difficult in a context where ensuring good public weather services is concerned.

The second step — collective agreement on guiding principles appropriate to the economic, cultural and political realities of the country — will likely require extensive discussions. Such discussions can, however, greatly assist the national Meteorological Service by ensuring national relevance and sensitivity in its public weather services programme and by building broadly-based support for overall programme directions. An example of a set of guiding principles is provided in 1.5 below.

The third step — the development of strategies to achieve the agreed objective(s) — should flow naturally from the guiding principles. The existing management structures and systems of the national Meteorological Service provide a ready-made coordination and accountability regime, thereby adding the fourth component. Finally, the development of action plans for individual initiatives which will contribute to the achievement of the overall objective(s) is a clear responsibility of the national Meteorological Service itself — a responsibility which would have to be addressed even in the absence of a formal management framework.

Examples of initiatives for which action plans have to be developed range from the modernization of technologies (e.g. installation of a new telecommunications system, a weather radar or a satellite receiving system) to broader thrusts such as improving the training of staff or the coordination with broadcast media and other major clients. Planning, obtaining approval and funding, and implementing such initiatives are, of course, part of the ongoing business of all national Meteorological Services. The successful completion of these essential steps, however, will usually be facilitated by the existence of a solid management framework for the overall programme.

INVOLVEMENT OF EXTERNAL INTERESTS

Substantial benefits may result when a national Meteorological Service involves significant external interests in the development of a management framework for its public weather services programme. Participants in the development may, for example, include representatives of major clients or economic sectors, public safety and emergency agencies, and the media. Operational meteorological staff and representatives from the funding authority which provides the resources for the national Meteorological Service should also be included.

The collective commitment to programme objectives and strategies on the part of influential clients and partners who were involved in their development may be built upon to gain valuable support for specific action plans and initiatives. This broadened support can greatly assist the national Meteorological Service in obtaining authority and funding to implement specific initiatives and in gaining the cooperation, or even the direct participation, of other agencies in their actual implementation. The exercise of developing a formal management framework is one mechanism by which to gain or strengthen such involvement. At the same time, a management framework, once developed, provides an overall context, a clear rationale and coherent direction to the national Meteorological Service's internal planning and management of specific improvements to its public weather services.

1.5 GUIDING PRINCIPLES OF THE PUBLIC WEATHER SERVICES PROGRAMME

The following set of generic guiding principles may be modified, expanded or rewritten to form a more appropriate component of a management framework for the development of a particular national public weather services programme. It may, however, provide a useful starting point for discussions leading to the definition of a set of guiding principles appropriate to specific national circumstances.

GUIDING PRINCIPLES

(1) The population has a right to a basic level of weather, climate and related services for its safety, security, convenience and economic benefit and to contribute to sustainable development. This basic level of services includes (*specifics appropriate to the particular national circumstances may be added here by the national Meteorological Service*).

(2) All publicly disseminated severe weather warnings will be provided by the (*national Meteorological Service*) as the single official source for such warnings. Domestic and

international broadcast and print media and other external disseminators of weather warnings will clearly identify the (*national Meteorological Service*) as the originating authority for such warnings.

(3) Public weather services provided by the (*national Meteorological Service*) contribute to the global World Weather Watch system of WMO. Coordination with other national Meteorological Services and major players such as broadcast media will be pursued to minimize conflicts and ensure that the public receives accurate, timely and consistent information, particularly during severe events.

(4) Forecasts, warnings and bulletins for the general public will focus on weather, climate and related phenomena which are meaningful to and have significant impacts on the safety and well-being of the population. These phenomena include (*specifics relevant to the country may be added here by the national Meteorological Service*).

(5) Forecasts and warnings will be issued in a timely manner so as to provide sufficient advance warning of significant events to enable the public to take action to minimize adverse impacts.

(6) Weather forecasts, warnings and related bulletins will be expressed in clear, concise and unambiguous language which is readily understandable to the public (*in multilingual countries, it may be useful to clarify which language(s) will be used in products*).

(7) Appropriate distribution methods will be chosen to ensure the widest possible dissemination of timely and accurate public weather warnings, forecasts and related bulletins (*these methods could be described or listed here by the national Meteorological Service*).

(8) Ongoing emphasis will be placed on educating the public to understand the role of the national Meteorological Service, the products and services it provides and how to use these services.

(9) Input will be regularly solicited from the public and from major economic sectors (*these could be identified by the national Meteorological Service*) concerning ways in which services can be improved or made more meaningful.

(10) The accuracy and timeliness of weather forecasts and warnings will be continuously monitored through an ongoing verification and evaluation programme. The information obtained will be used in determining and implementing needed improvements.

(11) Arrangements will be developed with the media and other organizations as appropriate (*these agencies could be identified here by the national Meteorological Service*) to ensure that public weather services are delivered in the most efficient and cost-effective manner.

As noted earlier, the above generic guiding principles may require substantial modification to make them more meaningful to an individual national Meteorological Service and its clients. They do, however, include elements which are directly relevant in the context of the WMO PWS Programme and which reflect some experience.

1.6 BIBLIOGRAPHY

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WMO:
http://www.wmo.ch

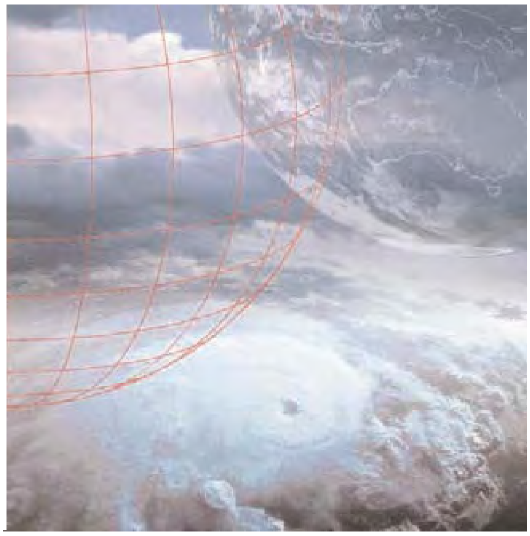
APPENDIX

EXAMPLES OF SERVICE CHARTERS

AUSTRALIA

EXTRACT FROM THE SERVICE CHARTER FOR THE COMMUNITY

- Introduction
- Who we are
- What we do
- Our services to you
- What you can expect from us
- How we will be accountable
- How you can help us
- Contact Information



INTRODUCTION

The Bureau of Meteorology is the National Meteorological Service for Australia. It was established by an Act of the Commonwealth Parliament in 1906 to provide essential meteorological services to all sectors of the Australian community. Its operation as a single integrated Commonwealth science agency reflects the pervasive influence of weather and climate on all our lives and the fact that the atmosphere recognises neither State nor national boundaries.

This Service Charter has been prepared in response to the Government's requirement that all government bodies which provide services to the public will develop individual charters. It is based on the Bureau's current official charter which elaborates its statutory responsibilities under the Meteorology Act 1955 in the light of Australia's contemporary national needs and international obligations. The following pages set down what the Bureau is and what it does, and record the commitment of the Bureau and its staff to provide the Australian community with the highest quality services that modern meteorological science and technology and available resources will permit.

This first issue of the Bureau Service Charter was published in June 1998. It has been developed by Bureau staff and management through consultation with a wide cross-section of those in the community who use its services. We in the Bureau want to make sure that the services we provide are what you need, that we are able to provide them to your satisfaction and that all our staff will take pride in the contribution that their work makes to your safety, security and general well being, and to the economic, social and environmental benefit of Australia.

WHO WE ARE

- A Commonwealth statutory agency with offices in every State and Territory;
- The provider of essential weather, climate and related environmental services to the Australian community;
- The custodian of the official records of Australian weather and climate;
- The authority responsible for meeting Australia's international obligations under the Convention of the World Meteorological Organization and other multilateral treaty obligations to provide meteorological support for the safety of international shipping and aviation and the protection of the global atmosphere.

WHAT WE DO

The Bureau contributes to the safety, security and general convenience and well being of the Australian community by:

- continuously monitoring the weather and climate of the Australian region;
- providing meteorological and related forecasts and warnings to weather- and climate-sensitive sectors of the community;
- collecting and safeguarding reliable long-term data on the climate of Australia and surrounding regions, including the Australian Antarctic Territory;
- carrying out research to improve our services and increase our understanding of the global atmosphere and oceans, in the long-term interests of the community; and
- cooperating in all aspects of meteorology and related sciences with the other 184 Members of the World Meteorological Organization, for the benefit of the Australian and international community.

Our services are aimed at helping people make better-informed decisions affecting their lives and their community and business activities, on a daily basis and in their long-term planning, and especially in dangerous or life-threatening weather situations. Our weather surveillance and forecasting and warning services operate 24 hours a day, every day of the year.

We interact regularly with major community groups who have particular needs for meteorological and related information, including emergency services, aviation, shipping, primary production, industry, trade, commerce, education and defence.

We support our services with:

- specialist training of our staff to internationally recognised standards;
- major Regional Offices in each State capital and Darwin, and smaller Field Offices at another 59 locations throughout Australia and its Territories;
- advanced technology for collection and communication of data around Australia and between Australia and other countries; and
- powerful computing facilities for data processing and running computer prediction models of the atmosphere and ocean.

The cost of operating the Bureau is about two cents a day for every person in Australia. In addition to its contribution to the safety of life and property, studies suggest this cost is repaid at least twenty-fold in overall economic benefit to the nation.

OUR SERVICES TO YOU

We provide the community with:

- warnings of dangerous weather such as severe thunderstorms and tropical cyclones, and weather conditions leading to floods or bush fires;
- weather forecasts for the land areas and for the coasts and oceans around Australia;
- seasonal outlooks of Australia's climate;
- data and information services on the weather and climate of Australia and surrounding areas; and
- scientific advisory and consultancy services in meteorology, hydrology and oceanography.

You can access our services through:

- weather segments on radio and TV and in the print media;
- our staff at the Bureau's Regional and Field Offices listed below;
- Weathercall 24-hour telephone weather services — call Freecall 1800 687 999 for a directory;
- Weather By Fax 24-hour poll fax weather services — call Freefax 1800 630 100 for a directory;
- the Internet — the Bureau has an extensive World Wide Web site at http://www.bom.gov.au/
- marine radio and radio fax broadcasts — see our Web site at http://www.bom.gov.au/marine/ or call Weather By Fax 1902 935 046 (60¢ per minute, more from mobile phones) for broadcast schedules; and
- a number of other electronic access and delivery systems — call one of our major offices for more information.

Most of our services are provided for the benefit of the general community, and are fully funded by government in the public interest. Some, including those to the aviation industry and the defence forces, carry a charge to cover the costs of their preparation and delivery. You can find information on service charges on our Web site, or by contacting staff at one of our offices. We also have a separate commercial Special Services Unit which provides a range of tailored services to Australian and international customers.

WHAT YOU CAN EXPECT FROM US

Quality — we will:

- treat you with respect and courtesy, maintaining confidentiality where required;
- identify ourselves when we speak to you;
- be clear and helpful in our dealings with you, giving reasons for our decisions;
- refer enquiries we cannot answer to an appropriate source;
- present our information, including forecasts and warnings, clearly, using plain English, understandable graphics, or other means relevant to your needs;
- ensure that our recorded telephone, fax and Web services are kept up-to-date with the latest information and products;
- ensure that our recorded telephone and fax services use concise wording and compact graphics;
- ensure that our Web site is easy to use and well set out; and
- ensure that all our services have a sound scientific basis.

Responsiveness — we will endeavour to:

- deal with your enquiries and complaints quickly and effectively;
- answer your phone calls promptly, and ensure that unattended phones in operational service areas are re-directed or provided with an answering service; and
- reply to your letters, faxes and e-mails within two weeks — on more complex issues, our initial reply will give you an estimate of the time a full response will take, and the cost, if any.

Accessibility — we will be available:

- for emergency concerns about forecasts and warnings, and aviation briefing, 24 hours a day at our major offices; and
- for other enquiries, from 9am to 4pm (minimum) Monday to Friday at our major offices, and as often as possible at our smaller offices, where staff have a range of duties including operating and maintaining complex meteorological equipment to precise time schedules.

Service improvements — we aim to:

- ensure that the accuracy and quality of our services remain world-class by incorporating relevant advances in science and technology into our ongoing operations;
- further improve procedures for monitoring the accuracy of our forecasts and warnings and reporting the results;
- upgrade the ways in which we deliver our services, in line with improvements in technology and the changing needs of the community;
- make access to our services easier and more convenient, particularly for people with special needs; and
- develop a more streamlined system of handling your enquiries and feedback on our services.

HOW WE WILL BE ACCOUNTABLE

We undertake to:

- publish information showing the accuracy of our forecasts and warnings;
- provide explanations when our services do not meet acceptable standards of quality, timeliness or accuracy; and
- monitor our performance against the standards set in this Charter, and publish the results in our Annual Report and other publications which are available on request from the Bureau Head Office and Regional Offices. Performance information will also be provided on our Web site.

HOW YOU CAN HELP US

We welcome your views and comments as a vital ingredient in helping us to monitor and improve the relevance and quality of our service to the community. We will consider all suggestions fully and promptly in our planning for service improvement and, wherever possible, we will respond immediately. We may occasionally seek your input to random surveys of how the community perceives our services and what services they need, including assessments of our performance after severe weather events.

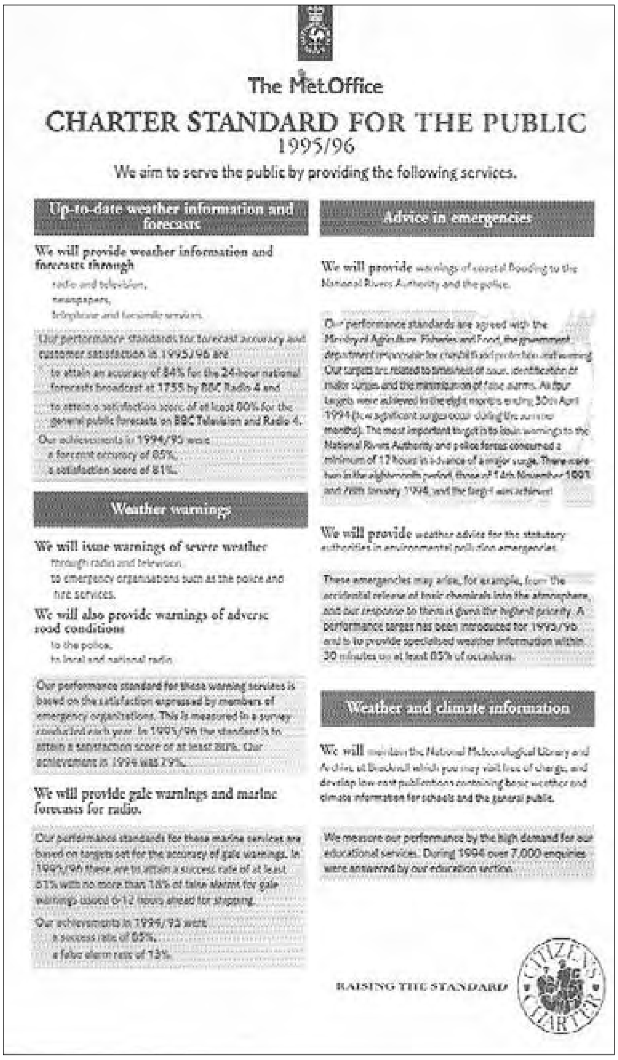
To help us to give you the best possible service, we ask that, if you are not satisfied with our services, you:

- advise us of your needs; and
- tell us about the difficulties you are experiencing, understanding that at crucial times such as during dangerous weather, our staff, services and systems may be under great pressure.

We also ask that you understand that weather forecasting is a highly complex scientific problem and that the services you receive depend on the smooth operation of an integrated national and international meteorological services system. Although steady progress is being made, occasional significant forecast errors will still occur, as a result of inadequate data or the limitations that still exist in the international state of the art in meteorological science and technology.

HOW YOU CAN CONTACT US

If you want help with....	***Contact...***
Emergencies — forecasts and warnings	Regional Offices (24 hrs) — see list below, Systems Help Desk (24 hrs) — (03) 9662 2182
General enquiries — forecasts & warnings	Regional Offices (9am-4pm) — see list below, Field Offices (as available) — see list below [Note: The list has been omitted from this *Guide*.]
Climate data & information	Regional Offices (9am-4pm) — see list below, Field Offices (as available) — see list below National Climate Centre (9am-4pm) — (03) 9669 4082 (ph), (03) 9669 4515 (fax), webclim@bom.gov.au
Urban & building design, climate & health	National Climate Centre (9am-4pm) — (03) 9669 4589 (ph), (03) 9669 4515 (fax), webclim@bom.gov.au
Seasonal outlooks, El Niño, current climate	National Climate Centre (9am-4pm) — (03) 9669 4655 (ph), (03) 9669 4678 (fax), webclim@bom.gov.au
Complaints and general feedback	Head Office (9am-4pm), (03) 9669 4000, Regional Offices (9am-4pm) — see list below
General information about the Bureau	Public Affairs Unit (9am-4pm), (03) 9669 4552, Regional Offices (9am-4pm) — see list below Field Offices (as available) — see list below
Administrative enquiries	Head Office (9am-4pm) — (03) 9669 4000, Regional Offices (9am-4pm) — Admin. Officers — see list below
Freedom of Information enquiries	Legal Services Unit — (03) 9669 4669
Aviation briefing	Regional Offices (24 hrs) — see list below
Technical problems with:	
Weather By Fax	Systems Help Desk (24 hrs) — (03) 9662 2182
Web	Systems Help Desk (24 hrs) — (03) 9662 2182, webops@bom.gov.au
Weathercall	Systems Help Desk (24 hrs) — (03) 9662 2182
Radio facsimile AXI/AXM	Systems Help Desk (24 hrs) — (03) 9662 2182
Inmarsat satellite broadcast	Systems Help Desk (24 hrs) — (03) 9662 2182
Weather By Fax — feedback on services	Freefax (24 hrs) — 1800 630 101
Web — feedback on services	Bureau Webmaster e-mail — webmaster@bom.gov.au
Weathercall — feedback on services	Regional Offices (9am-4pm) — see list below


The Met Office

CHARTER STANDARD FOR THE PUBLIC

1995/96

We aim to serve the public by providing the following services.

Up-to-date weather information and forecasts

Advice in emergencies

Weather warnings

Weather and climate information

RAISING THE STANDARD

Charter Standard for the Public 1995/96

We aim to serve the public by providing the following services.

Up-to-date weather information and forecasts

We will provide weather information and forecasts through
radio and television,
newspapers,
telephone and facsimile services.

Our performance standards for forecast accuracy and customer satisfaction in 1995/96 are
to obtain an accuracy of 84% for the 24-hour national forecasts broadcast at 1755 by BBC Radio 4 and
to attain a satisfaction score of at least 80% for the general public forecasts on BBC Television and Radio 4.

Our achievements in 1994/95 were
a forecast accuracy of 85%
a satisfaction score of 81%.

Weather warnings

We will issue warnings of severe weather
through radio and television,
to emergency organizations such as the police and fire services.

We will also provide warnings of adverse road conditions
to the police,
to local and national radio.

Our performance standard for these warning services is based on the satisfaction expressed by members of emergency organizations. This is measured in a survey conducted each year. In 1995/96 the standard is to attain a satisfaction score of at least 80%. Our achievement in 1994 was 79%.

We will provide gale warnings and marine forecasts for radio.

Our performance standard for these marine services are based on targets set for the accuracy of gale warnings. In 1995/96

UNITED KINGDOM

EXTRACT FROM THE MET. OFFICE'S CHARTER STANDARD FOR THE PUBLIC these are to attain a success rate of at least 81% with no more than 18% of false alarms for gale warnings issued 6-12 hours ahead for shipping.

Our achievements in 1994/95 were

a success rate of 85%,
a false alarm rate of 13%.

Advice in emergencies

We will provide warnings of coastal flooding to the National Rivers Authority and the police.

Our performance standards are agreed with the Ministry of Agriculture, Fisheries and Food, the government department responsible for coastal flood protection and warning. Our targets are related to timeliness of issue, identification of major surges and the minimization of false alarms. All four targets were achieved in the eight months ending 30th April 1994 (few significant surges occur during the summer months). The most important target is to issue warnings to the National Rivers Authority and police forces concerned a minimum of 12 hours in advance of a major surge. There were two in the eight-month period, those of 14th November 1993 and 28th January 1994, and the target was achieved.

We will provide weather advice for the statutory authorities in environmental pollution emergencies.

These emergencies may arise, for example from the accidental release of toxic chemicals into the atmosphere, and our response is to proved specialized weather information within 30 minutes on at least 85% of occasions.

Weather and climate information

We will maintain the National Meteorological Library and Archive at Bracknell which you may visit free of charge, and develop low-cost publications containing basic weather and climate information for schools and the general public.

We measure our performance by the high demand for our educational services. During 1994 over 7,000 enquiries were answered by our education section.

Measuring how we are doing

Monitoring our forecasts

We continually monitor our performance. For instance we compare the forecast with what is observed and measure its accuracy. Forecasts have been steadily improving over the years and this is reflected in the performance targets set for our forecasts on radio and television and for our gale warnings.

Public surveys

We use independent consultants to make regular surveys. We welcome your comments and will react positively to them. Satisfaction scores are calculated using a scale of 1 (very dissatisfied) to 5 (very satisfied). The average value, scaled to lie between 0 and 100, is the percentage of satisfaction score.

Performance targets

We have a number of performance targets in addition to those set out here. We review our targets each year and set standards for quality of service, accuracy and increases in efficiency. Further information on these targets, and our performance against them, may be found in our Annual Report and Accounts.

Finding out more

You can contact your nearest weather centre, or the Enquiries Office at Bracknell.

We will be pleased to answer any questions you may have on our services, and you can ask for a brochure describing them at the Met. Office. You can also find out about our services from programme magazines, newspapers, and in telephone directories under ‘weather’. We want to hear your views and learn if you are satisfied with our services.

Should you have a complaint

Please telephone the Enquiries Office or, better still, write in. We aim to respond to a complaint within five working days of its receipt, or at least provide you with an acknowledgement and an estimate of when a full reply may be expected.

CHAPTER 2

BENEFITS OF PUBLIC WEATHER SERVICES

2.1 THREAT TO LIFE AND PROPERTY BY HYDROMETEOROLOGICAL HAZARDS

Natural hazards, particularly hydrometeorological hazards, are taking an ever-increasing toll on people's lives and property. The increase of population in general, and in highly exposed areas such as coastal and flood-prone areas in particular, as well as the conglomeration of people in (mega)cities are placing ever more people at risk to extreme hydrometeorological events such as tropical cyclones, floods and severe storms. At the same time, greater attention has to be focused on the increasing loss of life due to extremes in heat and cold, desertification, reduced air quality, and dense fog episodes. Although loss of life in well-developed countries may have been reduced by establishing warning systems, in developing countries it continues to be unacceptably high. Meanwhile, the continued economic development is creating interdependent infrastructures where a disaster in one location can affect the delivery of services and quality of life across an entire region. Very often, the damage due to natural disasters in developing countries not only has an immediate and high impact on the present population but also seriously sets back economic and social development for many years to come (see Tables 1 and 2).

Table 1. The three greatest natural catastrophies in recent years in terms of loss of lives (source: Munich Reinsurance)

Event	*Year*	*Place*	*Loss of lives*
Cyclone	1970	Bangladesh	300 000
Earthquake	1976	China	270 500
Cyclone	1991	Bangladesh	140 000

Table 2. The seven greatest natural catastrophies in recent years in terms of economic loss (source: Munich Reinsurance)

Event	*Year*	*Place*	*Loss (million US$)*
Earthquake	1995	Kobe, Japan	100 000
Earthquake	1994	Northridge, USA	44 000
Hurricane Andrew	1992	Florida, USA	30 000
Flooding	1998	China	30 000
Flooding	1996	China	24 000
Flooding	1993	Mississippi, USA	16 000
Winter storms	1990	Europe	15 000
Flooding	1991	China	15 000

Property loss, according to Munich Reinsurance, is escalating at an exponential rate. For many years, Munich Reinsurance scientists have been observing a trend towards ever-increasing numbers of natural catastrophes with ever-increasing losses. In 1998 natural catastrophes caused worldwide economic losses totalling US$93 billion. This was almost three times the previous record set in 1994, which would have been passed even without the earthquake in Kobe (US$100 billion) (more information can be found at the Munich Reinsurance Internet site at http://www.munichre.com).

Taking its detailed analysis of the wide-ranging losses as a basis, the company draws important conclusions with regard to the vulnerability of our modern industrial society, e.g. the susceptibility of the infrastructure in large cities, the time that is required to restore it, and the indirect effects on industry caused by losses of production and supply problems.

A comparison of the most recent ten-year period from 1986 to 1995 with the 1960s reveals that the number of natural catastrophes classified as "great" increased by a factor of 4.4. In this context, a 'great' natural catastrophe is defined by:

- the number of deaths reaches thousands;
- the number of homeless reaches hundred of thousands; or
- the economic losses are substantial for a country.

Even after allowing for inflation, economic losses were eight times as high, while insured losses soared dramatically by a factor of no less than 15.

According to Munich Reinsurance, the trend towards ever-increasing economic losses is primarily due to the rapid increase in the concentration of property values in the regions exposed to catastrophes and to the growing vulnerability of modern industrial societies. Also, the suspicion that climatic conditions are changing must now be regarded as a definite assumption. The mean global temperature in the 1990s was higher than in any other decade since worldwide meteorological records began about halfway through the 19th century. In eight of the last fifteen years the mean temperatures were far higher than ever observed before. The consequences of global warming may include an increase in extreme meteorological situations in many regions and an increase in the number of catastrophes and the devastation they cause.*

A rapidly increasing awareness of the impact that human activities are having on the environment and, in turn, a wider appreciation of the relationships that exist between the environment, humanity and ecosystems, are giving rise to new demands that often can only be met through cooperation between atmospheric and other scientists. For example, the relationships between human health and radiation reaching Earth from the sun, especially variations of ultraviolet radiation resulting from stratospheric ozone depletion, have been addressed, in part, by atmospheric and medical science and operational weather forecasting units providing relevant public services. It is quite obvious that collaboration between NMSs, the scientific community, government officials, the media and the private sector is a necessity in the evolution of improved public weather service activities.

Dramatic industrial accidents or pollution episodes involving toxic chemicals or radioactive substance have occurred in recent years. Furthermore, industrialization and demographic growth mean that all countries must be prepared for national emergencies related to hazardous substances, and that many countries must plan for possible transboundary air or water pollution arising from industrial accidents. The meteorologist has a critical role to play with respect to the movement and dispersion of hazardous substances released in the atmosphere, whilst the hydrologist has a similar important role in relation to water.

To reduce economic loss, physical plants and facilities must be designed to survive the natural hazards they can be expected to experience through their lifetimes. New technologies and urban and rural developments must be examined with an eye to the new vulnerabilities that they may create with respect to natural hazards. The burden of natural disasters falls disproportionately on poor populations. Loss of life from storms, floods, extreme temperatures and other hazardous events in developing nations far exceeds that in developed nations. Even in developed nations it is often the disadvantaged who live in areas prone to floods or other natural hazards and suffer the most in disasters. The economies of most of the countries which are predominantly dependent on rain-fed agriculture depend on the weather. Either delayed or early onset of a rainfall season can cause significant losses to the farmers and threaten the countries' food security. Furthermore, there is a concern among governments of developing countries that major disasters can have such catastrophic effects on food and water supplies, the general economy and the social fabric that they can constitute a threat to national security.

2.2 HYDROMETEOROLOGICAL HAZARDS AND EARLY WARNING

Hydrometeorological hazards including drought: For the purposes of this *Guide*, the term "hydrometeorological hazards" is taken to include the wide variety of meteorological, hydrological and climate phenomena which can pose a threat to life, property and the environment. Table 3 lists hazards for which warnings

* For further reading on climate matters, see the Intergovernmental Panel on Climate Change (IPCC) reports, 1995.

are issued by NMSs illustrating the broad range of potentially dangerous hydrometeorological phenomena which are experienced in various regions of the globe.

Table 3. An illustrative list of hydrometeorological hazards for which warnings are issued by NMSs

Storms and consequent phenomena	*Precipitation and fog*
Tropical cyclones, typhoons, hurricanes	Heavy rainfall, heavy snowfalls
Winter storms	Freezing rain, freezing drizzle, sleet
Thunderstorms, thundersqualls	Hail
Tornadoes	Blowing snow
Strong winds, gales	Freeze, frost, glazed frost
Lightning	Icy roads
Blizzards, snow squalls	High humidity
Waves, storm surges, storm tide	Dense fog
Waterspouts	
Sand storms, dust storms	

Heat and cold	*Other weather-related hazards*
Intense cold, cold wave, sudden temperature decrease	Drought
Wind chill	Floods, Flash floods
Excessive heat, heatwave	Avalanches, landslides

To achieve the greatest reduction in economic losses and loss of life in natural disasters, the earliest possible warning needs to be given. Hydrometeorological hazards have several distinguishing characteristics which are particularly significant in the context of early warning. Hydrometeorological phenomena often can move fast and cross national boundaries and, in some instances, are regional or even global in their impacts. They are probably the most frequently occurring hazards and also the most extensively observed due to the geographical coverage and round-the-clock capability of the observing networks and systems which have been established to support the ongoing daily requirements of operational meteorology and hydrology. These hazards are, therefore, particularly appropriate targets for early warning enhancement efforts due to the frequency and scale of their impacts and to the fact that a solid global and regional framework of observational and predictive capacity is already in existence which can be upgraded where necessary or appropriate.

The spatial and temporal scales of hydrometeorological hazards vary from short-lived, violent, phenomena of limited extent (e.g. tornadoes and severe thunderstorms) to widespread droughts which may affect huge subcontinental areas for months to years causing loss of animal populations, increased risk of forest and bush fires, desertification, famine and mass migration. Between these extremes are large systems (e.g. tropical and extratropical cyclones) which can subject whole countries or regions to strong winds, heavy, flood-producing rains, storm surges and coastal flooding or heavy snowfalls, blizzard conditions, freezing rain and extreme hot or cold temperatures for periods of several days. Meteorological and hydrological forecasting requirements for effective early warnings of these hazards span a very broad continuum ranging from less than one hour in the case of tornadoes, severe thunderstorms and flash floods, through short- and medium-forecast ranges (hours through days) where tropical and extratropical cyclones, heavy rains, extreme temperatures, high winds and some other phenomena are concerned, to seasonal and interannual time scales in the context of drought.

Short-lived phenomena, while they are sometimes locally catastrophic, are primarily of domestic concern and it is usually left to national and local governments to respond to their impacts. In contrast, large weather systems and widespread droughts may cause impacts which overwhelm the capacities of national governments, requiring international disaster relief efforts. An overview of the spatial and temporal ranges of weather and climate phenomena is illustrated in Figure 1.

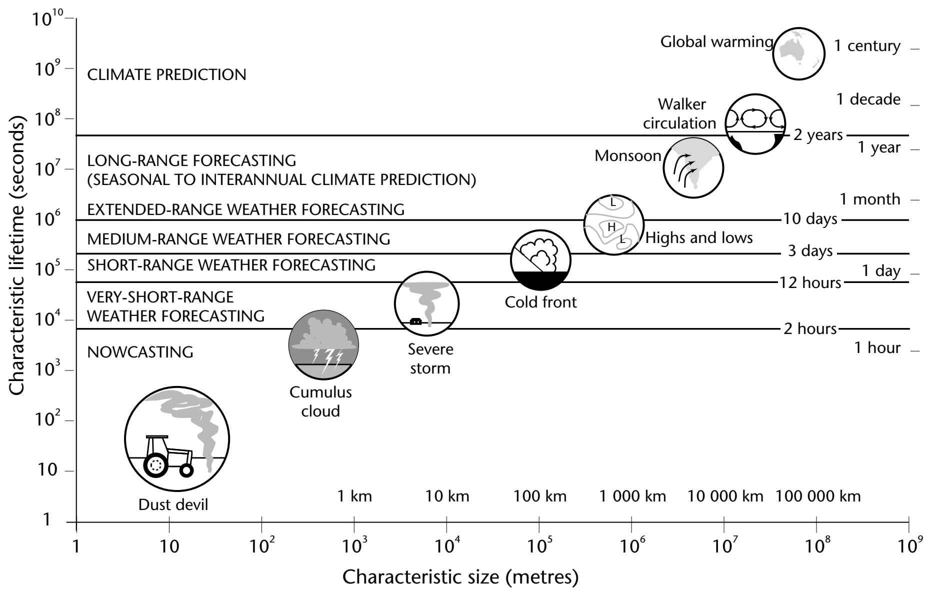


Figure 1. Spatial and temporal scales of meteorological phenomena (Bureau of Meteorology, Australia)

Non-hydrometeorological hazards

Natural hydrometeorological hazards such as floods, extreme temperatures, high winds and droughts may cause or exacerbate other disasters such as bush and forest fires, infestations of desert locusts and army worms, spread of diseases such as typhoid, malaria or cholera and even toxic gas releases, oil spills and nuclear accidents (see Table 4). Many developing countries, for example, are heavily dependent on agriculture and/or pastoral agriculture. Consequently, those regions are vulnerable to severe attacks by migratory pests which may be significantly influenced by weather conditions. Therefore, the provision of meteorological products such as trajectory forecasts or advice based on dispersion modelling, to cite two examples, can represent a valuable contribution to combating some non-hydrometeorological hazards.

Table 4. An illustrative list of non-hydrometeorological hazards

Caused/worsened by hydrometeorological hazards
Forest fires, bush fires
Smoke, dust, volcanic ash
Infestations of desert locusts and army worms, migratory pests
Desertification
Mass migration
Toxic gas releases, oil spills
Nuclear accidents

2.3 THE BENEFITS

A revolution in weather forecasting has been under way for many years. The investments that have been made in atmospheric and related sciences have paid off in the form of more accurate and useful forecasts and warnings, with the result that NMSs are much more credible to the general public and to decision makers. In order to further increase the credibility of NMSs around the world, the maturing of NMSs' predictive capabilities must be communicated through the provision of public weather services, to a wider spectrum of users. The level of understanding and appreciation of what the NMS capabilities and limitations are must be enhanced and extended to decision makers in weather-vulnerable economic sectors.

The importance of the contribution of public weather services to the safety and well-being of the world's peoples is illustrated not only by economic gains, but especially in the major reductions in loss of life and property damage due to natural disasters in vulnerable regions of the globe following implementation of effective warning systems for severe weather. At the macroeconomic level, cost-benefit studies invariably demonstrate very high rates of return to national economies from the investments made in hydrometeorological services. On a smaller scale, the same holds true for many individual enterprises in weather-sensitive sectors such as agriculture, fishing, forestry, construction, transportation and power generation. At the level of the ordinary citizen, the value of public weather forecast and warning programmes is reflected in very high listening and viewing audiences for weather broadcasts and in the great popularity of telephone and computer access to these products. Clearly, well-targeted initiatives directed towards improving the quality, timeliness and utility of public weather services, their coordination and their infrastructure can yield significant dividends by preventing loss of life, reducing damage to property and the natural environment, increasing economic efficiency and improving the overall quality of life for individual citizens.

2.3.1 THE BENEFITS OF WARNING SERVICES

The provision of meteorological and hydrological support to early warning is perhaps the most fundamental aspect of the public weather services supplied by NMSs and, as such, is a high priority of the World Meteorological Organization.

Timely warnings for rapid onset hazards such as tornadoes, severe thunderstorms, flash floods, extreme winds, storm surges and blizzards have a dramatic payoff in saving lives by providing the information necessary to move people out of harm's way or to assist individuals in taking quick response measures. They enable businesses, local government officials and the general populace to modify their operations and protect their property. For example, advance knowledge of a landfalling tropical cyclone can enable refineries and other industrial installations to close down operations in an orderly way. Similarly, foreknowledge of an impending winter storm can enable airlines to move their aircraft out of the affected area and to restructure their routes before their planes are trapped on the ground. At the same time, it is important not to overwarn. Warning of hazards which do not eventuate can destroy the credibility of the warning service. The area covered by a warning should be the smallest allowed by meteorological capability.

The advantages of early warning also apply to longer lead time hazards such as droughts. Accurate prediction of drought can allow farmers to reduce stock on pasture and avoid wastage of seed unlikely to grow. Droughts develop from a complex interaction of factors and, in many instances, can no longer be considered to be purely climatically driven. Other factors include economic conditions; poor farming, land use and water management practices; long-term soil degradation, and human influences due to population expansion beyond the natural system's carrying capacity. In the case of drought, meteorology, through provision of climatological data, and hydrology can assist in identifying vulnerable regions and in assessing the probability of recurring droughts, considering such anthropogenic factors as land and water use practices. This contributes to planning and to the design of mitigation measures. Ongoing monitoring of the components of the hydrological cycle, along with developing seasonal and interannual predictive capability, assist in preparedness by providing an indication of the development or likely persistence of drought situations. The development and application of indices of drought can contribute to both preparedness and response by assisting in the detection of emerging drought conditions and by providing an indication of their likely impacts. This latter linkage to impacts is particularly important as a trigger for response and mitigation activities. Meteorological and hydrological monitoring and prediction programmes and related scientific advice can also be of value during actual drought occurrences and in the recovery phase. Accurate prediction of the break of a drought allows farmers to plant with confidence. Governments need continually updated information on the progress of a drought to arrange assistance and relief, if necessary by importing food and appealing to donors for assistance. Ideally, food relief should arrive before people begin to starve.

2.3.2 THE BENEFITS OF WEATHER FORECAST AND INFORMATION SERVICES

Generalized public weather services intended for the population at large can also be of significant value to weather-sensitive sectors of the economy such as agriculture, forestry, fishing and marine transportation, tourism and recreation. This is particularly the case where the NMS has involved representatives of such

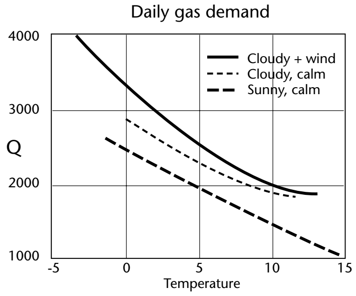


Figure 2. Correlation between gas demand and weather conditions
(The Met. Office, UK)

economic sectors in the planning of its public weather services programme. Suggestions from these representatives concerning, for example, broad product content and format, optimum times for scheduled issues and the most appropriate boundaries for forecast regions, can often be incorporated and may improve the utility of basic public weather services products. This approach is particularly appropriate in regions where the population is heavily dependent on one or two weather-sensitive economic activities, such as agriculture.

Agriculture, fishery and forestry, energy and water resources management, land, marine and aviation transports, commerce and trade, banking and insurance, construction and urban design as well as recreation and tourism can all directly benefit from weather services. The examples below help to illustrate this point:

Agriculture

Agriculture, a dominant activity in many countries, is very much subject to the weather. Consequently, the provision of services to agriculture to provide day-to-day guidance in scheduling farming operations such as planting, irrigation, spraying and harvesting as well as other activities such as food storage and transportation can avoid waste and spoilage.

Water resource management

Water resource management is required to provide a continuous and sufficient supply of water for farming, industry and households. Weather forecasts serve as a basis for decisions on storage and withdrawal, avoiding unnecessary waste or withholding water from users, as they can provide advance knowledge of the water supply and demand depending on rainfall and temperature.

Energy supply

The use of energy varies with the daily weather, as heating and cooling requirements strongly depend on cool or hot weather conditions. Forecasts assist in operational planning to meet the expected demand for electric power and heating fuel.

Perishable food

The demand for some perishable foods, such as cakes, meat pies and ice cream fluctuates considerably according to the weather. Forecasts help match production to demand and avoid waste.

Transport

The travelling public and the land transportation industry are two distinct client groups relying on weather forecasts and information. Most people obtain information on hazardous weather conditions from public forecasts which in turn helps them to plan their trip and decide on the modes of transport. Road and rail traffic operations require information on ice, snow, winds, temperature and floods.

Building construction

Building construction is a very weather-sensitive sector as the short- and long-term planning depend heavily on the weather conditions. Warnings of strong winds allow safe operations of cranes and lifting of large modules. Frost or heavy rain might make it necessary to postpone a scheduled stage in the building process, while a longer period of dry weather helps to save costs in drying concrete.

Recreation and tourism

As recreation and tourism are becoming an increasingly important economic sector around the globe, weather forecasts are not only used by visitors to schedule their activities, but also by the tourism industry to contribute to the safety and security of tourists. Climatological data may be used to promote specific countries and regions as attractive destinations.

2.3.3 THE BENEFITS OF LONG-TERM (SEASONAL AND CLIMATE) FORECASTS AND INFORMATION

Many of the public and socio-economic benefits of warning and weather services, as mentioned above, not only apply to short-term, but also to long-term, i.e. seasonal and climate, information. Consequently, public weather services programmes increasingly display a trend towards the treatment of weather and climate as a single continuum. Many NMSs have gained experience in preparing various climate products and broadening their range of services for use in socio-economic activities and decision-making.* These services include the provision of historical data and derivations from these, short period climate-based predictions, monthly and seasonal forecasts, climate change forecasts and impact assessments.

Accurate seasonal forecasts are of great value in:

- farming decisions on the choice of pesticide or antibiotic, crop types and livestock types, irrigation systems and land usage;
- management of water storages according to whether the coming season will be wetter or drier than normal;
- handling natural disasters, including awareness, education and preparedness. For example, prediction of a larger number of tropical cyclones than usual can lead to greater preparedness. Prediction of drought allows timely implementation of measures to mitigate its effects;
- prediction of demand for water supply, energy, food and medical supplies, road salt or tourist accommodation.

The results of large-scale atmospheric experiments have revealed the role played by such phenomena as El Niño and North Atlantic Oscillation in the weather. More intensive monitoring of areas such as the central eastern Pacific Ocean has allowed early warning of El Niño episodes to be given. With these developments, seasonal forecasts have moved from a totally statistical approach based on previous experience to one that includes some dynamic input.

The periods of long-term forecasts range from about several months to a few seasons and they are issued about the same time periods in advance. They indicate areas in which there is an increased likelihood of a particular deviation from the climatic mean, eliciting regions where dry/wet or warm/cold conditions may occur. So the statement is usually limited to a probability of temperature or rainfall (on average over a specified time period) being above, near or below normal without indicating the specific amount of the deviation. As the long-term atmospheric changes are mainly influenced by the enormous heat capacities of the oceans, any seasonal forecast depends crucially on the quality of (observed or predicted) sea-surface temperature fields.

The benefits of long-term forecasts apply to the overall environment, sustainable development and quality of life in general. The social benefits are to be especially emphasized as, due to lack of measures, they are not strongly enough accounted for. They include the stability and improvement of environmental, living, travelling and working conditions, the sustainability of employment, and improved leisure facilities. The realized social benefits vary greatly according to the type of beneficiary and to whether and how benefits are applied within the relevant industry, organization or society.

Beyond the range of seasonal forecasts provision of climatological data is of great value to many sectors of the economy. The data must have been gathered over a period of many years, preferably at least 30, and need to be analysed by statistical distribution and calculation of means, medians, decile values, frequency distributions, bivariate analysis, etc. Detailed information on the analysis and presentation of climatological data can be found in the *Guide to Climatological Practices* (WMO-No. 100).

Examples of the use of climatological data are:

- decisions whether to extend areas of agriculture or to plant new crops;
- siting of industrial plants to minimize pollution;
- the design of structures to withstand extreme weather conditions;
- design of buildings, transport systems and urban areas;
- the siting of new airports;
- the location and design of reservoirs;
- the location of wind and solar energy plants;
- utilization of renewable energy, reducing consumption of fossil fuel and concentration of pollutants.

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* The WMO Climate Information and Prediction Services (CLIPS) project focuses on sharing this experience among NMSs.

In most cases climatological data are used for commercial gain and there is no reason why charges should not be made, at least to cover the cost of retrieval and provision of the data.

The field of climatological forecasting is a developing one, and still the subject of research. There are many long-term projects where information on whether the climate in 20 or 30 years time will be wetter or drier would be of great value.

2.3.4 OTHER BENEFITS

The worldwide prominence of environmental concerns presents a great opportunity for NMSs to highlight the significant contributions which public weather services programmes make to sustainable development and to the resolution or abatement of environmental challenges. Many meteorological, climatological and hydrological products and services contribute in a substantive way to the minimization of environmental damage, to reducing pollutant loading on vulnerable ecosystems and to effective responses to environmental disasters. More conscious consideration of the environmental benefits of public weather services along with much more explicit articulation of these benefits to governments, environmental interests, major clients and the general public should be important components of the future direction for both national and international meteorological programmes.

Air pollution and environmental quality

Inclusion of air quality information in public weather bulletins can assist the public to take action with respect to smog and air pollution from traffic and industries. Forecasting the movement of pollutants such as oil spills, toxic gas releases or radioactive material from nuclear accidents can help relevant authorities to take action to protect against harmful effects. Weather forecasts also predict wind, temperature, humidity and rain, helping authorities contain bush and forest fires.

Health

There is a growing awareness of the linkages between human health and the weather and climate. Public weather forecasts can contribute to improved human health by providing information on risks caused by changing weather and climate conditions. Such changes put added stress on sensitive, elderly or sick people, and on young children. People with cardiovascular or respiratory diseases may specially be overtaxed during certain atmospheric events. Direct impacts such as heat and cold stress, UV radiation (with consequences ranging from sunburn and sunstroke to skin cancer and cataracts), spread of pollens, dust (causing allergies, attacks of bronchial asthma and other respiratory problems) or effects of high ozone concentrations can be avoided, thus improving physical comfort and ensuring sustained health. Public weather forecasts can also warn people of conditions favouring the spread of diseases such as typhoid, malaria or cholera and assist in the reduction of disease and death as well as in the improvement of health and health care.

2.3.5 ASSESSING THE BENEFITS

The focus on needs and benefits assessment has become increasingly necessary in order to:

- justify public investment by demonstrating the value of public weather services;
- support commercial marketing activities;
- verify the utility of the rendered services to the users of public weather services;
- serve as a basis for improvement of the services.

To assess the value of a warning, an assessment of the avoidable damage (if any) which occurred is compared with that which might have occurred in the absence of a warning. After a disaster figures are often published in the media giving the monetary value of the total damage; these need to be treated with caution as they are first estimates, given in answer to media questions by personnel dealing with the emergency.

Later figures are often based on the value of claims made on insurance companies. On the one hand, these are underestimates of total damage as they do not include damage to public infrastructure such as roads, and many people find they are not insured against flood damage. On the other hand, they do not differentiate between avoidable and unavoidable damage. Buildings, roads and power lines cannot be moved out of the way of tropical cyclones, tornados, hailstorms or floods. It is difficult to assess the value of damage and economic loss which might have occurred if the warning had not been given.

The value of a warning service in the reduction of loss of life is not usually put into financial terms. The value is often assessed by the reduction in loss of life over time in comparable disasters as the warning service improves, making allowance for changes in population density.

To assess the value of a forecast, the results of a decision based on the forecast are compared to those of a decision ignoring the forecast. As a basis for a proper assessment, a benefit can generally be defined as: A change in the outcome for a user which is welcomed by the user and ascribed to the application of the meteorological or climatological input.

Benefits may be expressed as improvements in quality, in quantitative but non-financial terms, or in economic terms. The nature of the assessments may therefore range from evaluating the financial impact of weather forecasts or an improved observational database on a specific economic activity to determining the public's behavioural response to a new or improved weather warning or advisory service.

The easiest benefits to assess are those which can be put into economic terms:

- Reduction in damage and dislocation in extreme weather;
- Improved earnings or reduced losses: improvements or loss reduction in yields in tonnage of crops, volume of livestock products, surplus of reservoir water, overall profit;
- Net financial savings: improvements in production efficiency and reduction of wasted operational effort such as the reduced number of crop sprayings, fertilizer and pesticide applications, frequency of irrigation;
- Improved prediction of demand for water supply, energy, food, medical supplies and others;
- Significant contribution to the tourist industry, particularly in developing countries.

Quantitative benefits not put in financial terms include:

- reduction in death and disease;
- increase in the standard of living, health and general welfare;
- improvements in the design of buildings;
- improvement in ecological and agricultural management.

Examples of qualitative benefits are:

- improvements in the quality of life;
- greater satisfaction in participation in weather-sensitive recreational activities.

These improvements may be due to a number of factors and it can be difficult to separate and quantify those due to public weather services.

The economic and social benefits of meteorological and hydrological services have been extensively examined. The bibliography lists many papers from a variety of countries which illustrate many specific meteorological and hydrological applications and provide assessments of their social and economic value. These studies generally show very substantial benefit-to-cost ratios arising from the application of hydrometeorological information and services to specific sectors and to national economies. They contain much useful and detailed information on methodologies available for the assessment of benefits.

Surveys of users are an important method of assessing the benefits of public weather services (surveys of users to ascertain satisfaction and perception are discussed in Chapter 10). Many respondents are able to place a value on a particular service. However, responses may need to be treated with caution. If a respondent thinks a free service will continue he or she will amplify its value. If it is thought that charges may be introduced or increased, the value will be minimized.

Other factors to be borne in mind are:

- The user might have institutional constraints, and resource or technical problems that do not allow him or her to fully use the given information.
- The costs of information and response activities may inhibit the use of the forecasts.

User surveys are especially necessary to find out about the non-assessable benefits, and the acceptance and confidence of the public in the value of the public weather services.

An important longer-term objective for NMSs would be to build meaningful utility measures into routine assessment schemes for all products disseminated to the public. For example, the UK Meteorological Office has developed "user satisfaction" scores and publishes annual user satisfaction targets.

The assessment of benefits by a NMS should be carried out within a small interdisciplinary unit which can also identify user requirements and needs, market services/product, provide two-way links with users, conduct benefits-of-services studies, serve as a national focal point for relevant value-of-information work, and assess the quality of its forecasts. The development and application of methodology to assess the benefits of services should be encouraged and supported on a continuing basis.

Many NMSs have already established dedicated units and are placing ongoing emphasis on the target areas identified above to assess the benefits of their services. During the past decade, several NMSs have totally reoriented their operating philosophy in a marketing direction. This involves designing products and services which respond to client needs, developing a user service orientation among staff and maintaining ongoing emphasis on quality, value and responsiveness.

The assessment of benefits in developing countries may need to be approached differently than in more developed economies. A number of WMO Members have difficulty in obtaining resources to implement and maintain adequate observing networks, communications systems and other essential infrastructure and may need to justify the introduction of public weather services products rather than improving existing products.

Most methods of assessment relate to economically ascertainable benefits and especially to agriculture and other production processes only. Benefit assessments generally lack emphasis on social aspects or on longer-term environmental issues such as were addressed in Agenda 21 of the United Nations Conference on Environment and Development (UNCED). It is important to recognize that the economic benefits are in addition to the enormous, but not easily quantifiable, social benefits related to community safety and convenience which, in most countries, provide the primary rationale for the operations of the NMS. Clearly, these two considerations should be kept in mind by national Meteorological Services during the planning and implementation of studies intended to assess the national benefits of meteorological and hydrological services. The value of the public weather services to ensure life, health and welfare of the public cannot be emphasized enough.

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CHAPTER 3

ROLE OF PUBLIC WEATHER SERVICES

3.1 NECESSITY OF PUBLIC WEATHER SERVICES

The prime responsibility of governments is the safety and well-being of their nation's citizens. Their NMSs have the responsibility to warn the citizens of meteorological and hydrological hazards and to assist emergency management agencies in keeping hazards from becoming disasters. The issuance of meteorological and hydrological warnings and forecasts for the safety of life and protection of property and for the general welfare and convenience of the people are therefore seen in almost every country as a basic community right and necessity, and as one of the primary roles of all NMSs. Consequently, it is not only the role in which Services are most visible, but also the role which represents the communities' most visible pay-off for public investment in NMSs' infrastructures of observational networks, computer and communications systems, offices and specialist staff.

Once an infrastructure is put in place to fulfil the safety of life and property mandate, and to fulfil obligations to provide service to aviation and shipping, the resources and expertise thus provided can be used for issuing forecasts to the general public. Furthermore, the infrastructure provides the foundation for more specialized hydrometeorological and environmental programmes and for national climate information systems which are of critical importance in view of growing concerns about climatic variability and the threat of global warming.

The operations of external interests such as national and international broadcast and print media and other partners of NMSs are greatly enhanced by access to the existing infrastructure which provides observational data (including satellite and radar imagery), outputs from numerical weather prediction models and various forecasts and other products provided by NMSs.

PUBLIC GOOD ASPECTS OF PUBLIC WEATHER SERVICES

Because meteorological services in support of the safety of life and property and the general well-being of all citizens have long been seen in most countries as a basic community necessity and right, and because they possess the intrinsic properties of "public goods" (Harris, 1995), their provision has always been accepted as a responsibility of government.

The timely and reliable meteorological information, forecasts and warnings which communities need to help ensure their safety and security and contribute to their general day-by-day convenience and well-being constitute what, in economic terms, are referred to as pure public goods. The defining characteristic of pure public goods (Self, 1993) is that they are both:

- non-depletable, in that their use by one member of society does not reduce their availability or value to everyone else; and
- non-excludable, in that once they have been made available to some members of society, it is not possible, or at least not realistically practicable, to exclude others from benefiting from them.

Economic analysis further elaborates some essential conditions which apply to the provision of pure public goods as follows (Bailey, 1995):

- because they are collectively owned and no property rights can be vested in them, markets will fail to exist for their provision;
- the decision on whether they should be provided, and at what level, must be taken by government;
- the costs of their provision must be fully met by taxation; and
- the beneficiaries are the whole of society and the total benefit to society is greater the more widely they are consumed.

Historically there have been two powerful reasons why governments have assumed responsibility for the provision of an official national meteorological service:

- First, the need for a high level of standardization and long-term continuity in the observational network;

- Second, the need to ensure the highest levels of professional integrity in the preparation of the forecasts and warnings which bear on safety of life and property, based on full cooperation from all possible providers of data and avoiding the competition that would lead inevitably to the withholding of vital data and the provision of dangerously confusing information to the public, especially in life-threatening situations.

While the provision of warnings, forecasts and information, through the mass media, widely and free of charge to the public, by an official source, is a key feature of effective public weather services, cost pressures on governments, technology that allows increased direct access to weather information by electronic means, and the clear identification of specialized users who can make commercial gain from weather information, have led to an increased focus in some NMSs on cost recovery or commercial charges for some specialized weather services. Arrangements for this vary from country to country and guidance on these aspects is given in other WMO material (see WMO-No. 837 — *Exchanging Meteorological Data — Guidelines on Relationships in Commercial Meteorological Activities — WMO Policy and Practice* (1996).

In making charges for services, WMO policy on the free exchange of data and products among Members must be kept in mind. The Twelfth Congress of WMO in 1995 recognized that it is essential to obtain meteorological data from a wide area to provide weather services, and that there should be no restriction on the flow of such data, regardless of the cost-recovery policies of individual NMSs. Congress unanimously passed Resolution 40 (Cg-XII): "Members shall provide on a free and unrestricted basis essential data and products which are necessary for the provision of services in support of the protection of life and property and the well-being of all nations...".

3.2 PROVIDING COMPREHENSIVE PUBLIC WEATHER SERVICES

In order to achieve its final goal, i.e. to deliver comprehensive warning, forecast and information services to the public in a timely and comprehensible fashion, the NMS has to consider the entire service process from beginning to end. This "end-to-end" service process not only ensures that the NMS's mandate to support safety of life and property is fulfilled, but also shows the technical and scientific requirements to create the infrastructure for an effective warning and forecast system.

The end-to-end service process provides an outline for the NMSs' entire hydrometeorological warning and forecast system. It begins with observations, progresses through the analysis and numerical models run at the World Meteorological Centres (WMCs), Regional Specialized Meteorological Centres (RSMCs) and National Meteorological Centres (NMCs), includes guidance products and expertise of the RSMCs and NMCs, internal and external coordination on the hydrometeorological situation, the creation of products and services from NMS service delivery points, the communication and dissemination of the information, and ends with the ultimate response from the public. Figure 3 illustrates the conceptual nature of the end-to-end service process. The last step is extremely important. A highly accurate forecast or warning is of no value unless it is received, understood and acted upon by its intended audience.

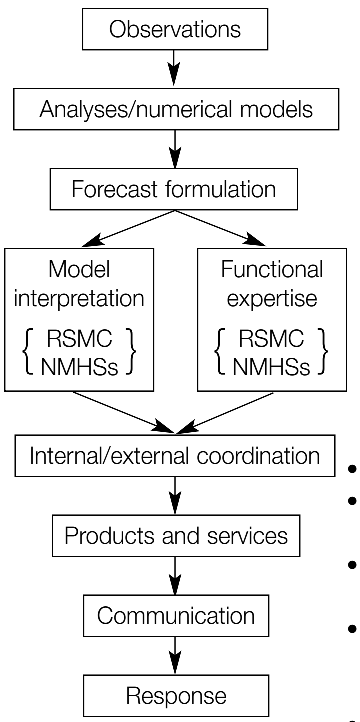


Figure 3. End-to-end forecast process (NWS/NOAA)

Each aspect of the end-to-end process is critical to the ultimate delivery of service. To complete the end-to-end service process, each NMS must consider:

- How it is going to obtain observations.
- Whether it will develop numerical models of its own or rely on the WMCs and RSMCs.
- Whether it will centralize the warning and forecast process, or rely on a decentralized local hydrometeorological service structure.
- How it will establish coordination mechanisms both for internal warning and forecast coordination and externally between nations, its RSMC, and its partners in the warning process.
- What types of products and services it will develop to support its mission.
- How it will disseminate and communicate its information to the ultimate decision makers and the public.

- How it will ensure that receivers of its information, including the public, make the best use of its products and services.

Each part of the end-to-end service process creates products that not only build the process but are end products in themselves:

OBSERVATIONS

Observations are not only the starting point and continuous input for the forecast process but provide invaluable information to pilots attempting flight operations, ship captains determining their best course of action, water resource managers in planning usage, and the media for communicating the hydrometeorological situation to the public. They are also the foundation of climatological data used, *inter alia*, for hazard risk analyses, vulnerability analyses, land use planning, and for the formulation of building codes and construction guidelines.

NUMERICAL WEATHER AND CLIMATE ANALYSES AND DATA

Numerical weather and climate analyses and model data from the WMCs, RSMCs and NMCs can be obtained from the NMS and used by other government agencies, private hydrometeorological service providers and the media for direct integration into their decision-making methodologies, to assist them in their operations, and to support planning efforts.

GUIDANCE PRODUCTS

Similarly, guidance products from RSMCs and NMSs can also serve as guidance products to other agencies, emergency managers, local decision makers, private hydrometeorological services, media and businesses.

FORECAST COORDINATION

Internal and external forecast coordination ensures that all individuals and organizations involved in the warning process both within the NMSs, with other NMSs, as well as emergency managers and the media are fully apprised of the situation and can speak literally with one consistent message to the public (see Chapter 8).

The methods of financing public weather services vary considerably among NMSs according to the policies of national governments. They range from a fully government-funded service to the provision of a very basic service and other services at a charge. Even a fully funded service needs some control on costs, e.g.:

- how many forecast issues a day will be sent to a medium;
- to what extent are weather presentations in the press provided;
- to what extent are NMS staff to be employed on radio broadcasts.

Many NMSs provide some services free of charge and charge for others, e.g. warnings and general forecasts and information may be free, but specific forecasts and information for specific recipients are chargeable. Some NMSs charge the media for forecasts and information, though it needs to be remembered that the cooperation of the media is essential if the NMS message is to reach the general public.

In general, warnings of severe weather should be freely provided in carrying out a government's responsibility for the welfare of its citizens, and WMO Congress Resolution 40 (Cg-XII) should be observed (see Appendix to Chapter 8).

3.3 LINKS TO THE WORLD WEATHER WATCH

By helping Members communicate weather warnings and forecasts to users, the Public Weather Services Programme provides the final step in the firmly established World Weather Watch (WWW) system of WMO. Through its components — the Global Observing System (GOS), the Global Telecommunication System (GTS) and the Global Data-processing System (GDPS) — the WWW concentrates the effort of all nations in observing, monitoring and predicting the weather.

To fulfil data requirements for producing warnings and forecasts each country takes part in collection of weather observations and the pooling of the gathered data to make all data available for other countries. The measurements and observations of a wide range of meteorological and related environmental parameters are achieved by facilities on the land surface of the Earth, aircraft, ships and satellites. Over the vast ocean areas merchant ships and special buoys as well as commercial aircraft and satellites help to fill the gaps of the data network. The observing systems are coordinated under the GOS, while the GTS ensures that the observations are distributed rapidly to WMCs, RSMCs and NMSs.

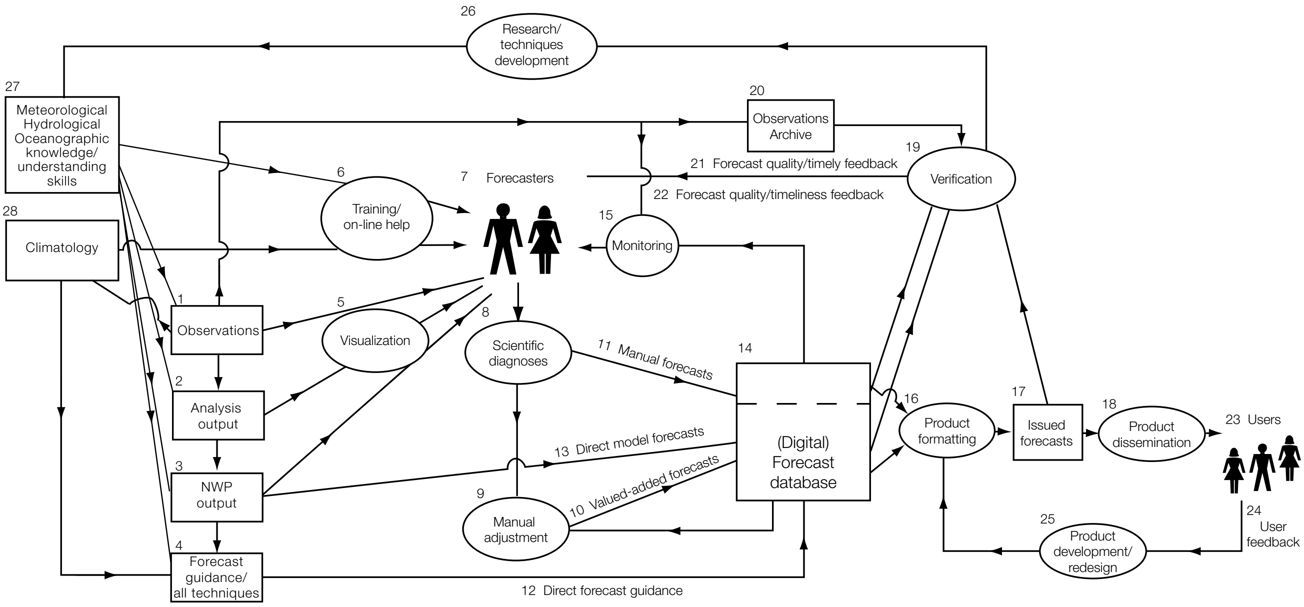


Figure 4. Links between partners in the forecast process
(Bureau of Meteorology, Australia)

All types of weather observation are complementary and can be imagined as part of a giant and ever-changing jigsaw puzzle. Under the GDPS the pieces of the puzzle are put together in a few locations such as the WMCs, RSMCs and NMCs and predictions are made of the global and regional development of weather patterns. The three WMCs (Moscow, Melbourne, Washington) run global models for short-, medium- and long-range forecasting of large-scale weather systems and for climate monitoring. RSMCs use the WMC products in preparing regional and specialized products (RSMCs are specialized in geographical, tropical cyclone, and/or transport model products for environmental emergency response). The analyses and predictions of WMCs and RSMCs are made available to all countries contributing the observations and thus make it possible for the NMCs to obtain a view of the continuous global weather system and to provide forecasts and climate-variation predictions as well as more detailed, tailored products for national users.

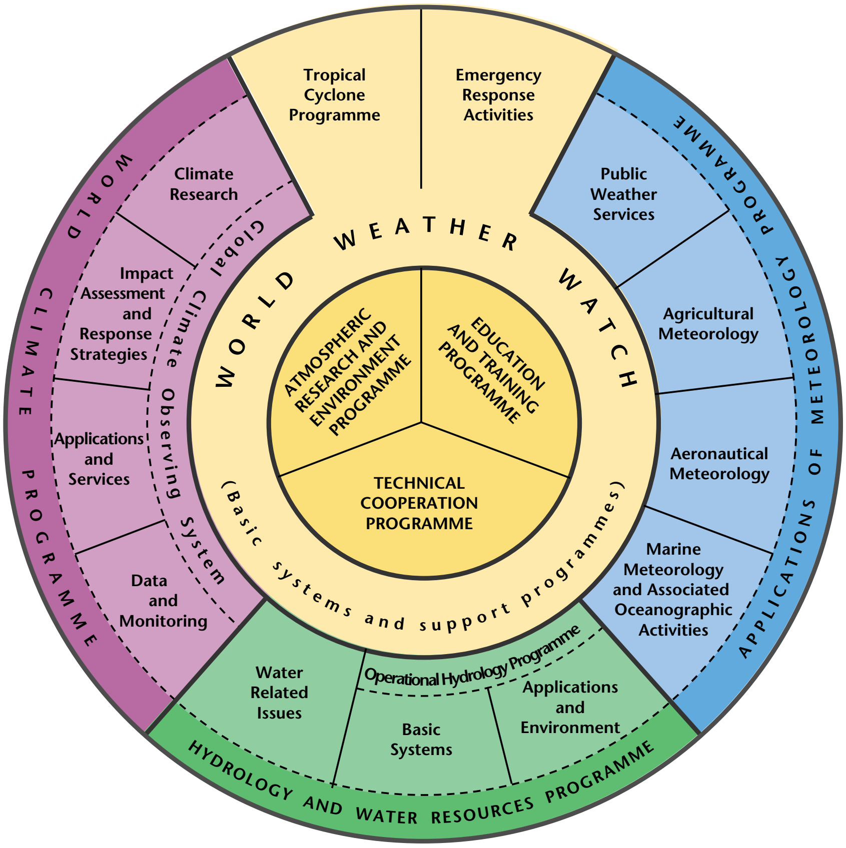
A big advantage in assembling the picture and predicting its development at more than one centre is that, apart from the obvious benefits to be gained from having a backup available in case of failure, similar efforts to produce better analyses and better overall forecasts introduce an element of healthy and beneficial competition. Moreover, collaboration in the exchange of ideas and the results of experiments has resulted in considerable improvements in the accuracy of predictions and in the diversity of output available.

Although the WWW provides many common-base products to which local detailed information and knowledge are added to provide a number of public weather services, the use of the information by each country varies considerably according to the economic, social and climatological conditions in which people live and work.

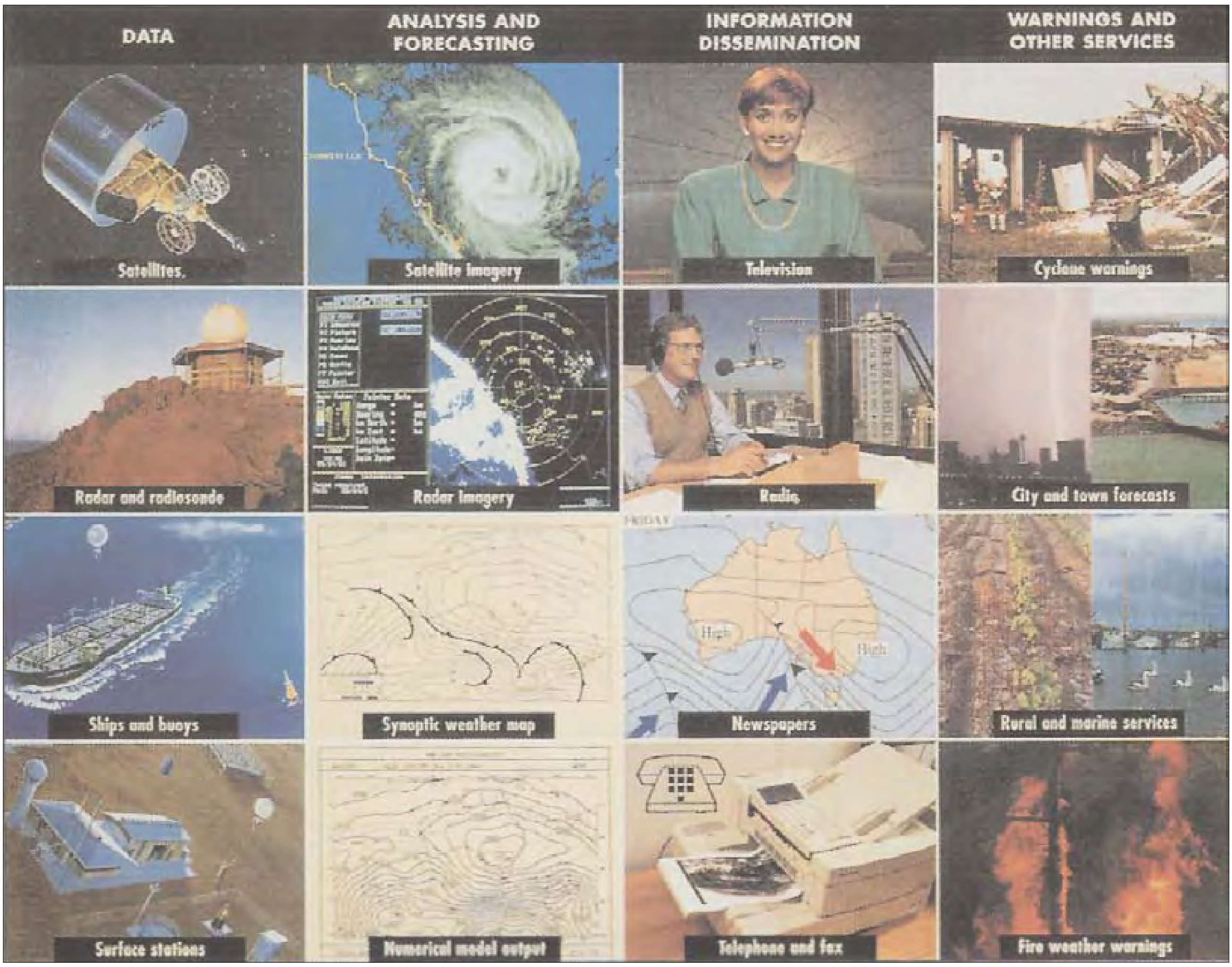
In all cases there is a complex system linking the WWW, NMSs, local meteorological offices, the meteorologist, and the mass media to the individual or group receiving and reacting to the information. But the information flow is not all one way. The meteorologist can respond to meet only known needs and, like all others providing a service, he or she sets out to improve the service in response to feedback from users. Meteorologists should not simply wait passively for responses; they should actively seek

Figure 5 (opposite, top). The World Weather Watch provides the international framework for the free and unrestricted exchange of basic meteorological data and products. It ensures the international flow of information which is essential to the delivery of public weather services and most other operational meteorological and hydrological programmes of national Meteorological Services and the private sector

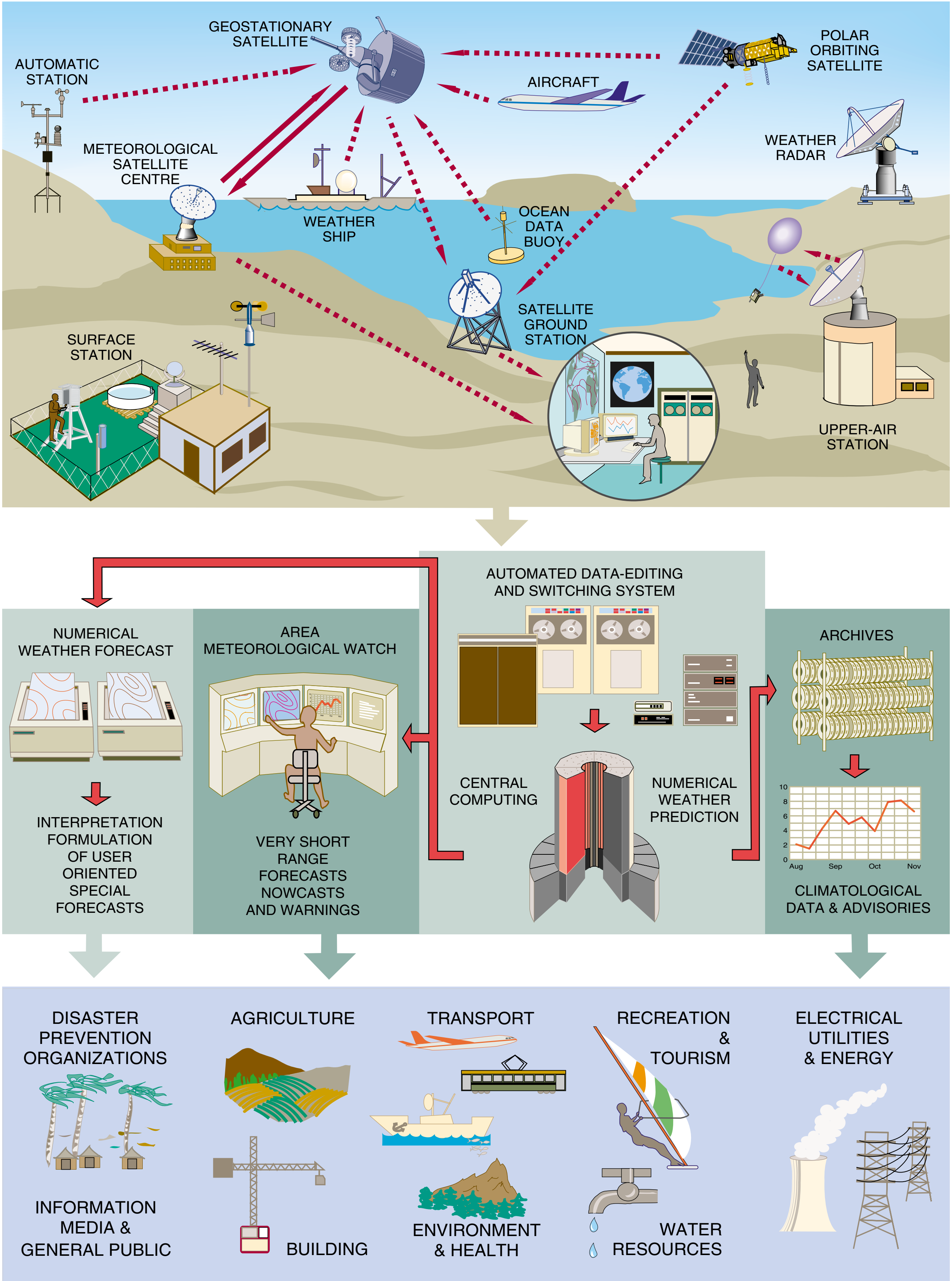
Figure 6 (opposite, bottom). The essential building blocks for a public weather services programme are effectively illustrated in this example from the Bureau of Meteorology, Australia



Tropical Cyclone Programme
Emergency Response Activities
Public Weather Services
Agricultural Meteorology
Aeronautical Meteorology
Marine Meteorology and Associated Oceanographic Activities
APPLICATIONS OF METEOROLOGY PROGRAMME
WORLD WEATHER WATCH
(Basic systems and support programmes)
ATMOSPHERIC RESEARCH AND ENVIRONMENT PROGRAMME
EDUCATION AND TRAINING PROGRAMME
TECHNICAL COOPERATION PROGRAMME
Operational Hydrology Programme
Water Related Issues
Basic Systems
Applications and Environment
HYDROLOGY AND WATER RESOURCES PROGRAMME
WORLD CLIMATE PROGRAMME
Climate Research
Impact Assessment and Response Strategies
Applications and Services
Data and Monitoring
Global Climate Observing System



DATA
ANALYSIS AND FORECASTING
INFORMATION DISSEMINATION
WARNINGS AND OTHER SERVICES
Satellites
Satellite imagery
Television
Cyclone warnings
Radar and radiosonde
Radar imagery
Radio
City and town forecasts
Ships and buoys
Synoptic weather map
Newspapers
Rural and marine services
Surface stations
Numerical model output
Telephone and fax
Fire weather warnings


GEOSTATIONARY SATELLITE
POLAR ORBITING SATELLITE
AUTOMATIC STATION
AIRCRAFT
METEOROLOGICAL SATELLITE CENTRE
WEATHER RADAR
WEATHER SHIP
OCEAN DATA BUOY
SATELLITE GROUND STATION
SURFACE STATION
UPPER-AIR STATION
AUTOMATED DATA-EDITING AND SWITCHING SYSTEM
NUMERICAL WEATHER FORECAST
AREA METEOROLOGICAL WATCH
ARCHIVES
INTERPRETATION FORMULATION OF USER ORIENTED SPECIAL FORECASTS
VERY SHORT RANGE FORECASTS NOWCASTS AND WARNINGS
CENTRAL COMPUTING
NUMERICAL WEATHER PREDICTION
CLIMATOLOGICAL DATA & ADVISORIES
DISASTER PREVENTION ORGANIZATIONS
AGRICULTURE
TRANSPORT
RECREATION & TOURISM
ELECTRICAL UTILITIES & ENERGY
INFORMATION MEDIA & GENERAL PUBLIC
BUILDING
ENVIRONMENT & HEALTH
WATER RESOURCES

out that feedback from users and play a major role in helping to unravel the intricate ways in which daily weather and climate variability influence all aspects of life. Every enquiry for weather information — whether the information can be provided or not — helps to build the dialogue between provider and user, to the advantage of both. If any link is broken, weak or missing in the chain of events and activities in the process of providing weather services, then the service to the public is inadequate, or it fails completely. Chapter 4 deals with the importance of focusing on the needs of users.

3.4 SUPPORT TO DISASTER REDUCTION

No country is immune from natural hazards. But while natural hazards cannot be avoided, most natural disasters can be mitigated and the effects of an extreme event reduced. The link from hazards to disasters is given by the vulnerability, the degree to which an individual, family, community or region is at risk of experiencing misfortune following extreme events. So hazards become natural disasters only when human habitation and activities are located in affected areas. A tropical cyclone crossing a barren, uninhabited coast may not cause much damage. A tropical cyclone crossing a densely inhabited coast may cause a disaster. To summarize it:

VULNERABILITY + HAZARD = DISASTER

It is important to realize that an NMS or an emergency agency cannot prevent a hazardous event itself, but only support the efforts to prepare for and mitigate its impacts, so that a hazard does not eventually become a disaster.

All groups involved in disaster reduction are joined together in the hazards community. This includes the NMS, national and local government authorities/officials, emergency managers, non-governmental and volunteer organizations and the media. They all, knowing their roles and functions, have detailed action plans, and work in a complementary manner before, during and after an event.

Those organizations charged with response to natural hazards, including other government agencies, emergency management officials, local government officials and the media are known as the hazards community. All members of the hazards community contribute in activities in which they are expert and most effective. The media is most effective in dissemination of the messages. The authority of officials and emergency managers helps give warnings validity, and local decision makers take action to protect people and their property. Other government agencies provide technical and environmental information to help determine critical thresholds for action. All members need to know their primary function and how they relate and work with other members. The NMS must meet with other members of the hazards community to assess their needs and the NMS representative must explain the capabilities of the NMS technologies and operational aspects in meeting those needs.

The goal is to make sure that the entire hazards community has critical information to ensure timely and effective response. The hazards community must speak in one voice during threatening events; conflicting messages lead only to confusion among the public. The NMS must work with other members to get the message out and to get people to respond. The structure of governments varies considerably, but a primary focus of NMS activities must be with those agencies directly responsible for detecting and/or responding to hazardous hydrometeorological and technological events. The NMS role, as the expert in warning and detection, is one of a resource contact and motivator. NMSs must be prepared to take a leadership role in the whole process of disaster reduction, but this must be done with diplomacy and tact.

A complete Action Plan for Disaster Reduction consists of detailed plans for Mitigation, Preparedness, Response and Recovery. An excellent discussion of this topic is provided in *The Roles of Meteorologists and Hydrologists in Disaster Preparedness* (WMO/TD-No. 598).

Figure 7 (opposite). The operation of a national Meteorological Service: observations and data collection (top), data processing and preparation of forecasts, warnings and climatological advisories (centre), dissemination of forecasts and other specialized information through the media to users (bottom)

MITIGATION *Long-term activities undertaken prior to an impact aimed at reducing the occurrence of a disaster or reducing its impact*

This includes the use of climatological records for the definition of potential hazards and a vulnerability analysis and the provision of advice to planners on the probability of occurrence, frequency, duration and speed of onset of severe phenomena. A major aspect of vulnerability analysis is the mapping of the effects and impacts a hazard can have on a city or an area. It also includes the indication of areas at risk of flooding and inundation from tropical cyclones, as well as the investigation of susceptibility of buildings to storm surges. Computer models are becoming more and more helpful to estimate both the strength of a hydrometeorological phenomenon and its effects. NMSs often have to keep reminding the public and other members of the hazards community of vulnerability to events which occur infrequently, perhaps only every 10–20 years. There is often pressure to build on fertile flood plains, or on waterside locations subject to storm surge.

The databases of NMSs are the basis for risk assessments and vulnerability analyses that support proper land use planning and building code development. NMSs must be included in all mitigation planning efforts and should be referred to for their expertise on the impacts of natural and technological hazards. Long-term forecasts and climatological data should be used to suggest changes in vulnerability.

PREPAREDNESS *Long-term activities to increase the effectiveness of emergency response during the disaster*

NMSs support the development of detailed action plans, the preparation of response planning efforts and the establishment of a real-time coordination infrastructure to sustain a consistent delivery of service. Plans must also be put in place to ensure that critical hydrometeorological information will be available even if the NMS is severely impacted by the disaster or cannot function at all. Together with a comprehensive education of the general public this will not only ensure an effective warning programme, it will also heighten the visibility of NMSs both within the government infrastructure and with its users.

Key aspects of preparedness are that citizens understand the hazards that may affect them and know how to respond in a predetermined or learned manner and that decision makers are trained to make the best use of meteorological information to minimize the potential for misinterpretation or misinformation. Consequently, the conduct of public awareness campaigns, hazard awareness drills and training programmes represent significant contributions to warning and response.

When working with the hazards community to develop preparedness plans and warning systems, meteorologists and hydrologists *must* realize that emergency planning is a process that has application to all natural and technological hazards. Dissemination systems, use of aural alarms, etc. can be used for warnings of non-meteorological events. For example, in the USA, weather radio systems initially implemented for severe weather and flood warnings have become a conduit for the release of emergency messages from health departments to the public as well as a major complement of nuclear power plant emergency warning procedures. Preparedness plans and warning systems that embrace the all-hazards concept enable governments to effectively deal with all threats in a highly efficient, effective and well coordinated manner.

RESPONSE *Activities undertaken to protect lives and property prior and during the event*

Response activities consist of the actual warning process, including detection of a hazard, dissemination of warnings and forecasts and communication of essential information to make each individual respond to the hazard by taking sufficient precautions. The goal of any warning system is to maximize the number of people who take appropriate actions for the safety of life and property. All warning systems start with detection of the event and end with people getting out of harm's way. Studies of response have shown that warnings in themselves are not sufficient to motivate the population into response action. People in a threatened area will normally first assess their personal risk before acting, taking into account the content and clarity of the warning and the credibility of the issuing organization. Individuals are more likely to act appropriately if they are provided with more information to define their risk and which advises them what actions to take to protect life and property.

It cannot be emphasized enough that for an NMS to fulfil its safety of life and property mandate, it must be sure that its warnings and forecasts are disseminated in a timely and comprehensive fashion, received by the public and other members of the hazards community, and finally responded to properly.

In order to avoid public confusion in times of severe weather, the NMSs should be recognized as the sole authority for preparing and issuing warnings of severe weather. In this connection, the need for coordination of weather warnings and forecasts between all providers and disseminators of such products, including the international television broadcast networks, is vital.

NMSs must work as effectively as possible, not only in constantly updating the meteorological situation, but also in coordinating and supporting other emergency agencies. The coordination with the media must be given a high priority to ensure timely, complete and unambiguous information.

NMSs should plan for emergencies where they are not fully functioning themselves or cannot be contacted, so that backup support from appropriate RSMCs could be arranged.

RECOVERY *Post-impact activities performed to return impacted communities to a more normal condition*

The NMS's responsibility does not end once a significant event has occurred. Following a disaster, the NMS has two major responsibilities:

(1) Provision of forecasts and post-disaster support to the public and emergency managers on weather events which could hamper recovery efforts: The days following a weather disaster can be very hazardous due to swollen rivers, weakened structures, downed power lines and threat of disease. Inclement weather can frustrate or delay recovery efforts while severe weather can pose a major threat where adequate shelter, food, water and communications are lacking. During this period, NMSs should be particularly responsive to the needs of recovery officials and can sometimes assist by communicating emergency messages.

(2) Conducting post-disaster assessments of the warning system to assist in future preparedness and mitigation actions: This is where the cycle of disaster mitigation activities restarts. Post-disaster assessments include the definition of the strength and intensity of the event, provision of input to hazard and vulnerability analysis, and the definition of requirements in building codes, and land use planning. Following a disaster, there is further intense pressure to seek solutions to ensure that events of that magnitude cannot happen again. During these times, hydrometeorological agencies have the opportunity to brief government officials on what initiatives should be implemented to support mitigation efforts.

An international combined effort to coordinate and organize disaster reduction got underway in the 1990s in the form of the International Decade for Natural Disaster Reduction (IDNDR). The IDNDR Early Warning Programme addresses the complete spectrum of hazards through its emphasis on capacity building at local and national levels and on improving international coordination and effectiveness in warning and response. An important element of the latter thrust is to ensure that warnings of large-scale hazards such as droughts, floods and tropical cyclones are relayed in a timely fashion to international humanitarian and relief agencies to assist these bodies in maintaining their operational readiness.

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WEB SITES

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http://hoshi.cic.sfu.ca/epix

HazardNet (a project of International Decade of Natural Disaster Reduction; real-time hazard alerts, warnings, forecasts, etc.)
http://hoshi.cic.sfu.ca/hazard

International Federation of Red Cross and Red Crescent Societies (IFRC):
http://www.ifrc.org

Natural Hazards Center (operated by University of Colorado, Boulder; information on natural hazards):
http://www.colorado.edu/hazards

Project SAFESIDE:
http://www.weather.com/safeside

ReliefWeb (a project of the United Nations Office for the Coordination of Humanitarian Affairs; information on prevention, preparedness and disaster response):
http://www.reliefweb.int

United States Federal Emergency Management Agency (FEMA) (information on natural hazards, mitigation and preparedness):
http://www.fema.gov

CHAPTER 4

USER FOCUS AND SERVICE DELIVERY

4.1 IMPORTANCE OF FOCUSING ON THE NEEDS OF THE USER

It is important that the products and services provided by an NMS are those actually required by the users and not those the NMS thinks they require. It is a waste of resources to provide things that no-one wants. This means communication and consultation with users to ascertain the products and services required. This is an ongoing task, as user requirements and expectations change over time, as does the meteorological capability of meeting them. Knowledge of user requirements allows the NMS to properly plan the end-to-end forecast process, from organization of observations, through development of analyses, guidance and numerical models to production of the forecasts and warnings.

There are four main groups of users:

The hazards community

These organizations, whose mission is to ensure the safety of life and protection of property, are known and should be in continuous close consultation with the NMS, thus their requirements should be readily known and should be given priority;

Governmental authorities (other than those dealing with hazards)

These will often make an approach to the NMS, and their requirements should also be readily ascertained;

Weather-sensitive economic sectors

These include agriculture, transport, tourism, energy production, sport and outdoor entertainment. In a diverse sector such as agriculture it will be necessary to consult with government agricultural departments and farmers' organizations, as well as going out to talk to villagers and farmers;

The public

As well as being warned of dangerous weather, their requirements often relate to travel, outdoor leisure activities and weather-sensitive medical problems. Their requirements are often less clear and it is usually by means of surveys of a sample of the public that they can be ascertained.

Effective user liaison is a key objective of any national public weather services programme. In addition to the staff and other resources required for the delivery of operational, round the clock services, resources need to be allocated to:

- assessing user needs;
- developing and improving relevant products and services;
- educating users on how to make the most of the information and services provided.

Other important activities that ensure the continuous improvement in quality and relevance of public weather services are:

- evaluation of products and services;
- measuring user satisfaction by measures such as surveys;
- taking advantage of technology to improve timeliness and presentation;
- documentation and other systems to ensure consistency of products and services; and
- effective mechanisms to deal with complaints.

In addition to the activities of dedicated public weather services staff, effective focus on user needs requires an organization-wide commitment to, and alignment with, a corporate goal or priority of providing high-quality public weather services. In other words, success in delivering effective public weather services requires not only the commitment of those directly involved in the service delivery but strong support from the NMS's leadership, technical systems, research and management.

4.2 DETERMINATION AND ASSESSMENT OF USER REQUIREMENTS

It is necessary to find out what products and services users require and also the means by which the user would receive these products and services.

A number of techniques are at hand to ascertain user requirements:

- surveys, questionnaires, interviews and in-depth case studies to identify in a broad overview the users' needs and expectations;
- fora and workshops with user participation in order to learn in direct exchange with the users their requirements, to detect potential changes in those requirements and to apprise them of the NMS's capabilities;
- pilot projects in concert with the users to develop products and services on a longer term to meet the stated requirements.

Means of ascertaining the requirements of the public and the weather-sensitive economic sector are discussed in Chapter 10.

In determining and assessing the users' requirements with a view to developing specific products, the NMS must take into account significant impediments that might hinder the user to make (full) use of current or future product(s):

- the user's flexibility to respond to (improved) information might be limited due to economic or decision-making aspects or due to operational systems and practices;
- the user ignores the (improved) information due to little belief in the accuracy of information, from past experience;
- the information provided is too general, too non-specific to an area or particular application, and too difficult to interpret and apply; and/or
- the user's access to dissemination channels does not allow reception of specific types of information.

One of the most important activities in building a warning system is to determine the critical hydrometeorological information requirements of all members of the hazards community. The hazards community comprises all those organizations which deal with natural hazards which may threaten life and/or property, such as national and local government authorities/officials, emergency managers, non-governmental and volunteer organizations, the media and the NMS. The actual composition of the hazards community may vary with the type of hazard, e.g. flood, drought or forest fire.

Besides a thorough analysis of possible hazards, personal contacts through visits to the offices of all groups involved in preparing emergency plans will help identify the needs of the hazards community, and will clarify their operational constraints. Of equal importance is to determine their critical thresholds for action and the lead times required for effective action. In order to reduce the deadly and destructive impacts of hydrometeorological hazards on communities, effective communication of environmental information critical for timely decision-making to protect lives and property is required.

A key responsibility of the NMS representative is to ensure that all members of the hazards community understand their roles in the warning process and how all will work together to support the warning programme. In this process, all members of the hazards community should have access to all of the available information. Above all, a consistent message must be communicated to the public or response actions will be compromised. Different messages issued by the NMS and other government authorities will lead to confusion and disaster. In addition to effective communication systems, it is important to develop a public education programme (see Chapter 9).

No matter how good the information, if it is not available at the time that critical decisions need to be made, then it is of no use. It is, therefore, vital for meteorologists and hydrologists to understand what critical information is needed and when it is needed. This must be taken into account in the development of future products and services. Frequently, emergency managers and local decision makers require information in time frames that cannot be met with the current skill level of the hydrometeorological products. In other words, there will be occasions when lead time is more critical than forecast accuracy; e.g. though it might not be possible to forecast the extent of a flood or the track of a hurricane until a few hours before the impact, preparations must start long before that. This suggests that a forecast be given along with a quantification of the uncertainty inherent in the forecast.

An important aspect in the process of determining the requirements — especially those of the hazards community — is the understanding of the hazards that threaten an NMS's area of responsibility. Therefore, hydrometeorological studies should be conducted to identify the events that can occur, the potential magnitude of the events, their onset conditions, development and decay, and the areas affected. This information may come from research institutes, universities, former studies and observations including storm data analysis, historical records, disaster survey reports, climatological studies, output from computer-generated models, and experienced emergency managers and local NMS staff. This knowledge will assist NMS operational staff to provide more specific information in warnings, advisories and statements. For example, an NMS office aware of critical flood water levels requiring evacuation could issue vital information well in advance for local decision makers to take appropriate action when expecting heavy or long-lasting rainfall. Once the hazard risks and areas at risk have been identified, plans can be developed and implemented as a joint effort between the NMS and local emergency management officials.

4.3 TYPES OF SERVICES

Once user requirements are known, products and service programmes can be developed that will meet those requests as far as possible within the limits of resources and meteorological capability.

The first question to be addressed is "What is required to produce the required products and services?" This will be dealt with by the technical departments of the NMS, involving consideration of the observation network, communication of observations, analysis and prognosis programme, and staffing of the operational area.

The staff responsible for the national public weather services programme have to decide on:

- Which services will be offered? When? How often?
- How will they be disseminated?
- How will they be presented?

Close consultation with the technical department is necessary to ensure that the proposed services can be provided within available resources.

There are three broad types of services in a Public Weather Services Programme:

Warnings — Warnings of hydrometeorological and related events which endanger life and/or property.

Forecasts — Forecasts of the weather over time scales from an hour to a season or longer.

Information — Information on current and past weather and on the climate.

Warnings are discussed in detail in Chapter 5; forecasts and information are discussed in detail in Chapter 6.

The services can also be classed as real-time and non-real-time.

Real-time products — Real-time products are perishable and lose their value after a short period of time from an hour to a day. They include warnings of phenomena expected in the next few hours or days, forecasts for periods up to several days and information on current and immediate past weather (last 24 hours or so). Although forecasts may be issued for several days ahead, it is usual for these to be updated each day. Warnings are also updated frequently.

A suite of products can be developed to provide an escalating level of information from everyday weather forecasts to warnings of critical hydrometeorological situations. Such a coherent suite of products progressing from routine weather to critical situations could include: weather summaries, forecasts, short-term forecasts/statements, discussions, outlooks, watches, warnings.

Different products should not be mixed or used for the same purpose. For example, to avoid confusion, a warning should be clearly distinguished from a general forecast.

Many NMSs presently provide a product suite in a multi-tiered manner as above to heighten concern as the possibility of a severe hydrometeorological event becomes more certain. The suite may include:

Weather summaries — Highlight significant events that have occurred over the last 12 to 24 hours and suggest what is to be expected over the next 12 to 24 hours. These act as a baseline and set the stage for more detailed information on what is expected in the future.

Explanatory notes — Give an explanation of recent and/or forecast events in simple synoptic terms for the benefit of television weather presenters, and members of the public with a great interest such as farmers and fishermen.

Forecasts — A set of products that describe future expectations of hydrometeorological parameters. Some elements, such as temperature, may be quantified. The area covered by a forecast can vary from several thousand square kilometres to a small town. The period of the forecast can extend to several days depending on meteorological capability and local climatology. Uncertainties in the forecast may be included in the form of probabilities for such things as occurrence of precipitation, precipitation amounts and tropical cyclone landfall. Current warnings, watches and advisories should be highlighted.

Short-term forecasts/Statements — These are forecasts highlighting what is expected to happen in the next six hours or so during relatively benign weather and what is anticipated in the next one to two hours during rapidly changing or severe conditions. They are intended to maximize the potential offered by new technologies aimed at observing and predicting mesoscale hydrometeorological phenomena. During active hydrometeorological situations, they are issued more frequently to highlight existing conditions and how they might change in time.

Statements are issued at frequent intervals to amplify warnings, watches and advisories by reinforcing the message, indicating what is expected and outlining appropriate response actions.

Discussions — Discussions state the reasoning behind the forecast process to support coordination both within the hydrometeorological agencies and the entire hazards community. They should not be issued to the pubic as they can contain considerable technical jargon and indication of uncertainties that is intended to enhance local decision makers' understanding of the evolving situation.

Outlooks — The forecast for some days ahead may be called an outlook to indicate a lower level of confidence than the shorter-term forecast. Outlooks may also be used to indicate to the hazards community that a hazardous hydrometeorological event may develop. They are intended to provide information to those who need considerable lead time to prepare for the event.

Watches — Watches are issued when the risk of a hazardous event has increased significantly, but its occurrence, location and/or timing is still uncertain. These are intended to provide enough lead time so that those who need to set their response plans in motion can do so.

Warnings/Advisories — These products are issued when a hydrometeorological event is occurring, is imminent or has a very high probability of occurrence. A warning is used for conditions posing a serious threat to life and property. Advisories are for less serious conditions that cause significant inconvenience and, if caution is not exercised, could lead to situations that may threaten life and/or property.

The actual products included in the suite will depend on the requirements of users which have been ascertained. The entire suite is not disseminated as one message, but contains the products which may be disseminated at different times and with different frequency. In particular, most warnings are issued as separate messages, as required, and given prominence in forecasts so that the public will be aware of them.

Normally, the above suggested products should be applicable for the every-day situation and most natural hazards whether they have relatively long lead times or are of a rapid on-set nature, such as flash floods and tornadoes. Lead times obviously should be long enough to maximize response actions. Ultimately they will be a balance between defined user requirements and an NMS's technical capability.*

Non-real-time products

Non-real-time products retain their value for some time, and slower means of dissemination can be used. Products include:

- seasonal forecasts;
- warnings of drought;
- information on the weather over the past week or longer;
- climatological information.

4.4 PRODUCT CONSISTENCY

In any public forecast programme, there must be consistency between warnings, forecasts and other bulletins if confusion is to be avoided. There must, moreover, be a reasonable degree of consistency between products issued for use by the general public and those for specialized clients such as the aviation industry or marine interests. For the same reason, consistency is highly desirable between products issued by an NMS and those disseminated publicly by private meteorological companies, international broadcast media or neighbouring Meteorological Services. This re-emphasizes the vital importance of coordination between all issuers and disseminators of services in a region. Because of their critical bearing on safety of life and property, weather warnings should be disseminated as issued by the responsible NMS or Regional Specialized Meteorological Centre (RSMC) and clearly identified as originating from these NMSs or RSMCs. For the same reason, it is vital that there is a single official issuer of weather warnings in each jurisdiction and that this is the national Meteorological Service. Coordination within an NMS, and externally with other organizations including the media, is discussed in Chapter 8.

4.5 COMMUNICATION WITH THE PUBLIC

Timely and effective communication with the public is a key success factor in the delivery of high-quality public weather services, with the NMS being seen as the official, authoritative source of public warnings and forecasts.

Because the main channel to the public is via the mass media, the NMS needs strong working arrangements and robust technical systems in place to support this partnership (see Chapter 8, 8.5).

In addition to linking with the public via the mass media, access to public weather information can be via telephone, facsimile and the Internet. Some countries are also able to operate their own direct communication systems such as special radio networks.

Descriptions of these systems, and their advantages and disadvantages, are discussed in Chapter 7.

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* Wernley, D., 1994: *The Roles of Meteorologists and Hydrologists in Disaster Preparedness*, WMO/TD-598, WMO, Geneva, pp. 18-22.

CHAPTER 5
WEATHER WARNING SERVICES

5.1 THE NEED TO WARN

The public expects to be warned of any natural phenomena which endangers life and property. Warning in good time allows action to be taken, depending on the type and severity of the warning, such as people to be evacuated, goods to be moved to higher ground, closing down of operations and securing of property, or avoidance of unnecessary travel.

Weather warnings, the most vital component of all public weather services programmes from a public safety perspective, incorporate a higher degree of urgency and severity of expected conditions than other products. They are intended to alert the public, in dramatic or attention-grabbing fashion, to hazardous conditions which may endanger their lives or property. Warnings are usually issued when conditions are forecast to exceed predetermined criteria, are amended or updated as required, and given priority in dissemination over other routinely scheduled products. In some countries, warnings include probabilities of occurrence of forecast phenomena such as precipitation or strong winds.

> It should be noted that NMSs handle hydrometeorological hazards in different ways. The purpose of this chapter is not to delineate how each NMS operates, but to present the "how to" information and examples of the warning preparation process using examples from a number of NMSs from around the world.

Meteorologists and hydrologists have a crucial role to play in the entire process of dealing with natural disasters due to meteorological or hydrological events. Scientific knowledge alone, however, will not solve the problem. Meteorological and hydrological agencies must become involved with other governmental organizations, local and national officials, emergency managers, local decision makers, the media, voluntary organizations, and weather-sensitive businesses (known collectively as the hazards community) to create effective preparedness plans, warning systems, mitigation strategies and public education programmes.

As the nations grapple with the issues surrounding disaster preparedness and public response, meteorologists and hydrologists must work to develop systems and strategies that can be used for all natural and technological hazards.

5.2 DETECTION OF AN IMPENDING HAZARD

Many impending meteorological and hydrological hazards are detected in the course of routine meteorological analysis and prognosis. Analyses are made of data received from basic observation networks which are documented in other WMO publications. Prognoses in many NMSs are now done by computer using mathematical models of the atmosphere, and these are proving their worth in a longer time frame of reliable prognosis and in the prediction of development of weather systems which may lead to severe weather.

5.2.1 COOPERATIVE OBSERVERS

In observation networks, reports received from people on the ground play a significant part in detecting impending hazards. Most NMSs rely on volunteer or part-time observers, often known as cooperative observers, from a variety of lifestyles — farmers, local officials, schools, prisons, tourist resorts, monasteries, etc. In addition to their routine reports, these observers can be asked to make special reports whenever specified events occur, such as more than a specified amount of rain or snow in a specified time, a rise in a river level above a specified level, or the occurrence of strong winds or hail. These reports alert the forecasting office, or confirm its view, that something hazardous is about to happen. Automatic stations can also fulfil the same purpose, say in a remote uninhabited river valley, to report whenever rain over a specified amount has fallen.

Secure communications are vital when warnings may depend on these reports. Special systems installed in remote areas must have very high reliability — 90 per cent is not good enough. The 10 per cent unreliability will occur during bad weather.

5.2.2 DETECTING A RAPIDLY DEVELOPING EVENT

In some instances, an event occurs so rapidly after the initial cause that the process of detection and warning, communication and response is so truncated as to be unworkable. Hazard and vulnerability analyses should point out these situations. An example is a flash flood in hilly or mountainous terrain.

These situations are candidates for automated flash flood alarm systems. This system consists of a water level sensor connected to an audible or visible alarm device located either in the affected community or in a community emergency operations centre with a 24-hour operation. Water levels exceeding one or more preset levels can trigger the alarm.

More sophisticated systems exist that consist of automated event reporting river and precipitation gauges, automated data collection and processing equipment, processing software, and communications and display software. Some of these systems may also be implemented that include a simple hydrologic model as well as some form of hydrometeorological analysis.

The simple form of flash flood alarm systems offers the potential to allow persons time for quick action if a warning is issued. A more complex system, the Automated Local Evaluation in Real Time (ALERT), used to help forecast crests, has been implemented in many countries, such as China, Taiwan, Australia, Argentina, Mexico, Italy and the United States of America. In the Tuscany region of Italy, the Tuscany Regional Administration in 1990 set up a new flood forecasting system in cooperation with the National Hydrological Service in Pisa. The system includes 45 rain gauges and eight stage gauges connected to a central control system containing an improved flood model (Mauro, 1993).

5.2.3 SPOTTER NETWORKS

In the case of some hazards, especially severe thunderstorms and tornados, a denser network is required than that of cooperative observers. These are trained volunteers or spotters, who report only in severe weather. They provide the ground truth necessary for interpreting data available from remote sensing systems, such as conventional and Doppler radars. No matter how sophisticated the new observing systems, trained spotters will be required to enable forecasters to better interpret the data and to improve the science. They can provide such information as the occurrence of tornadoes, downbursts, extreme winds, hail size, rain and snowfall rates, river stages, tide levels, and visibility in major obscuring phenomena.

Potential sources for volunteer spotters include amateur and citizen band radio groups; law enforcement and fire prevention personnel; highway, railroad, telephone and power company maintenance crews; bus drivers and delivery services with two-way radio systems; and port authorities. A goal should be to have a spotter network in each community with supplemental spotters in rural or open country. Control of the spotter groups would depend on the makeup of the organization. It is impossible to expect the hydrometeorological service agency to directly support each spotter or group of spotters by telephone.

In most cases, spotters should report directly to a communications centre or emergency operations centre in their community with a relay to the appropriate hydrometeorological service agency. This would enable local communities to sound sirens or other warning devices while contacting the local weather service office as soon as possible. An excellent option is to have an amateur radio base station at the local weather service office operated by a local amateur radio organization. This would allow for relay of information to the local weather service while meteorologists or hydrologists could direct spotters to the most critical areas.

A key element in developing effective spotter networks is training. The level of training is directly related to the events to be reported. Instruction would be minimal for rainfall, snow depth and tide level observations. However, for severe convective storms, knowledge of thunderstorm types (single cell, multicell, multicell line and supercell), storm structure and tornado look-alike is necessary if the observations are to be credible. Training for convective storms should be done in increments to allow for a base level of knowledge followed by advanced training. Tools in the training process should include slide presentations aimed at the participant level as well as materials to take into the field to assist in spotting efforts. Meetings should be held with all spotter groups at least yearly to maintain both interest and proficiency in the programme. Newsletters on a quarterly basis also heighten interest and support an exchange of ideas between spotter groups.

5.3 DECISION TO WARN

The issuance of timely warnings is a high-priority challenge facing an NMS and its staff. This is especially critical for rapid onset hydrometeorological hazards (tornadoes, thunderstorms with large hail and/or damaging winds, and flash floods, among others) where lead time is short and immediate action must be taken. Responding to the challenge requires a thorough understanding of the many factors influencing a successful decision to warn. Such factors include (but are not limited to) knowledge of conceptual models of the large-scale and mesoscale conditions favourable for hazardous events to occur, expertise in interpreting data sets from weather radar, satellite imagery and numerical weather prediction models, and advance planning to ensure that office conditions (equipment layout, staff responsibilities, etc.) support the mission at hand.

A methodology for effective decision-making, as also applied in a variety of other occupations as aviation, medicine or nuclear power management, is provided by the concept of situation awareness. Its essence is the anticipation of how events are likely to develop, combined with sensitivity for the range of developments possible if conditions change. In large offices this especially demands a link between the staff monitoring and forecasting the atmospheric conditions and those issuing rapid-onset warnings. It consequently allows the warning decision makers to anticipate how the severe weather situation will evolve, rather than react to current events.

A successful warning decision begins with a plan with which all operational staff must be familiar, which serves as a basis for training and periodic drills, and can be used for reference during a severe weather situation to ensure an appropriate response to the event regardless of the personnel on duty. In addition, information on how to contact key officials and media and knowledge of local effects (particularly flash flood-prone areas, etc.) must be readily available. The components of a successful warning message, including information content, frequency of issuance and means of dissemination, have to be understood by the operational staff. Pro-forma should be prepared for each type of warning, setting out the form of the message and giving details of its distribution. Where operations are automated the pro-forma can be called to the computer screen and the computer pre-programmed to make the required dissemination.

Rapid-onset hazards

Ideally, the potential for rapid-onset severe weather conditions, such as severe thunderstorms, tornados, hail and flash flooding, should be anticipated through a routine weather watch. A knowledge of the large-scale atmospheric conditions that are favourable for such conditions should be learnt from analysis of past events and climatological studies. Early information on the threat for hazardous weather to develop should be shared with office staff, civil defence authorities, the media and the public, in order to sensitize everyone to the potential. It is important to focus on the range of severe weather scenarios that are possible, rather than simply on the event that seems most likely. Forecasters must avoid falling into the trap of anticipating the most likely outcome, looking for signs of that particular event developing and failing to see signs of other hazardous phenomena.

Once a range of possible severe weather conditions is anticipated, operational staff should upgrade monitoring in intensity and frequency in relation to the threat to determine if those conditions are materializing. Surface and upper-air observations, satellite imagery and short-range numerical model forecasts can be used to identify regions where parameters are coming together to support severe weather occurrence. Weather radar and satellites are vital for monitoring hazards and providing information on their location, intensity and intensity trend. In addition, real-time ground truth information from trained spotters is extremely useful in assessing the danger to those affected. This has especially proven to be useful for fast-moving events such as severe thunderstorms and tornadoes. The operational staff should communicate frequently during this stage, sharing all information and suggesting alternative explanations for what is observed and for what is likely to develop. Such actions are designed to prevent the biases and actions of one individual (the one charged with final warning decision authority) from possibly adversely affecting the warning process. These adverse effects are most likely when fatigue, stress or some other factor influences decision-making processes.

Warning decisions must be made with sufficient time for those in danger to prepare, based on the intensity (which affects the level of response) and the development of the hazard. Warning messages should contain specific detail concerning the magnitude of the hazardous weather (wind speed, hail size, rainfall amounts) in order to motivate those in danger to take protective action.

As the threat of severe weather evolves, follow-up information should be sent at frequent intervals to update storm location, current intensity and recent reports of damage or severe weather occurrence. The follow-up statements provide additional proof to the public that the danger still exists, and gives a sense of urgency to those in immediate danger to take appropriate action.

There is a certain danger for forecasters who face a decision (especially inexperienced ones) to be biased towards a sense of normality when recent ground-truth information is lacking, or when weather radar (or other) information is ambiguous with regard to the hazard's intensity. There may be a tendency to cancel public severe weather warnings, or to let existing warnings expire without re-issuance. Under certain conditions, this can develop into a dangerous situation. The lack of ground truth reports can result from sparse population, from storm spotters not located in areas experiencing the worst weather, or from communications problems that prevent timely reporting. Nevertheless, warning decision makers must develop a level of confidence in their interpretative and predictive skills to make correct decisions in the face of information that is ambiguous or lacking.

Slower onset hazards

Many hazards, such as hurricanes, typhoons and floods, develop more slowly, allowing a bit more time for decision-making. Nevertheless, it is still necessary to maintain a routine weather watch for likely developments. Additional observations may need to be arranged on a pre-determined plan. Weather radar and satellites are vital for monitoring developments. Warnings must be issued with sufficient time for those in danger to prepare, and re-issued at frequent intervals to keep the public informed on the latest position.

Accuracy versus lead time

Hazards, whether they occur rapidly, such as tornadoes or flash floods, or whether they develop slowly, demand as much preparation as possible to prevent them from becoming a disaster. In issuing warnings, a major difficulty is the fine balance between lead time and accuracy. In such cases, the lead time of issuance is often given precedence to the accuracy of the warning. Local decision makers would like as much lead time as possible, especially where evacuations are required. Frequently, they are willing to sacrifice some accuracy in order to maximize lead time. For example, hurricane evacuation experiences have shown that many areas along the Gulf and Atlantic coasts of the United States require more than 40 hours to evacuate. The City of New Orleans, Louisiana, located below sea level, requires up to 72 hours to evacuate for a category 5 hurricane. In these situations, emergency managers and local government officials must make preparations and begin evacuations well before a warning or even a watch is issued.

Workload

The workload in a forecasting office during severe weather is very much greater than during benign weather. The synoptic situation is more difficult to analyse, the decisions are more difficult, there are more messages to issue and the phones never seem to stop ringing. More staff are required to cope, and arranging this can be difficult on weekends or at night, when many severe weather situations develop. The warnings plan must include provision for additional staff to be called in. Some members of staff may be trained in the specifics of a particular type of severe weather relevant to the NMS, e.g. severe thunderstorms or tropical cyclones or floods, and can be called in as specialists when warnings of these events are likely to be required.

5.4 DEFINITION OF A WARNING SYSTEM

The goal of any warning system is to maximize the number of people who take appropriate and timely actions for the safety of life and protection of property. Basically, all warning systems start with detection of the event and end with people getting out of harm's way.

Social scientists (Mileti, 1990) after studying warning systems and response actions for both natural and technological hazards, have defined a paradigm for successful warning systems. Such warning systems encompass three equally important elements, namely: detection and warning; communication; and response. If any of these fail, the entire warning system fails. Even excellent warnings that are not received and acted upon in a predetermined manner become useless.

Detection and warning

This element includes the traditional scientific role of meteorologists and hydrologists of examining data and predicting, or warning of, a natural hazard. Detection considers data from remote sensing devices such as radar and satellite; on-site observing devices such as traditional instrument shelters, river and rain gauges, automated flood warning systems; and eyewitness reports. Correct decisions depend upon understanding and analysing these data sources.

Communication

An effective communications system is a vital component of any effective warning system. Relevant authorities and the public must be made aware of the approaching hazard by receiving the warning information in time to respond. This implies more than simply dissemination of a warning. Communication is complete only after the information is fully received and understood.

Response

Through extensive studies of human response to disasters, it has been shown that warnings by themselves are not a stimulus to response action. Normally, people in a threatened area will first assess their personal risk. Action in response depends on:

- the content and clarity of the initial message;
- the credibility of the issuing organization; and
- the state of preparedness of receiving authorities or agencies.

The potential for individuals to act will be markedly increased if they are provided with information to:

(1) define their risk; and
(2) highlight what life- or property-saving actions to take.

Response also depends on:

(1) the length of time since the last serious event; and
(2) whether there have been recent false alarms.

Special attention in building a warning system has to be paid to fast-moving, slow onset and concurrent hazardous events:

Fast-moving hazards

Fast-moving hazards pose an even more intense threat to the public as the time for warning and response is very short. A tornado, for example, that can evolve within minutes and moves at great speeds does not allow for much preparation. A smooth running warning system, within both the NMS and the hazards community, is the indispensable basis for any immediate and successful warning of fast-moving hazards. Special warning equipment and communication technology (sirens, flags, balls, flashing lights) or predefined automatic processes such as the automatic stoppage of trains and closure of gas facilities in the affected areas may also be arranged to increase the effectiveness.

Slow onset events

Slow onset events, such as droughts, present special warning needs because they can take months to reach a critical level. In this situation the people of an area or region, slowly with time, lose the ability to support themselves and maintain their livelihood. Ecological, economic, social and political conditions often aggravate the situation.

Concurrent hazards

With the vulnerability of modern society and occurrence of hazards increasing at the same time, dealing with concurrent hazards is expected to require more concerted actions by the hazards community. These include compound hazards where one event like a flood causes another like the spread of a hazardous chemical or the outbreak of diseases as well as independent hazards occurring coincidentally at the same time.

5.5 PARTNERS IN THE WARNING PROCESS

As described in 3.4 above, meteorologists and hydrologists are not the sole members of the warning process. Rather they are part of the larger hazards community made up of all organizations charged with response to natural hazards, including other government agencies from the national to local level, emergency management officials, local government officials, the media, decision makers and weather-sensitive businesses.

An effective warning system requires that different organizations and people with expertise work cooperatively in order to deliver effective and timely public warnings when they are needed. The overall aim is always to maximize the number of people who take appropriate and timely action to protect themselves from natural disasters. Over the last four decades, research on community warning capabilities for disasters has revealed that effective public warnings are the product of managed teamwork of a combination of organizations.

All members of the hazards community must understand their roles in the warning process so that a consistent flow of critical information and advice is provided to the public.

Meteorological and geophysical services are responsible for the detection of hazards and their scientific prediction.

Governmental agencies and emergency management must be aware of their strong influence on the public's decisions as the public mainly responds to advice and orders from credible local public officials.

Relief and governmental agencies are mostly in charge of the coordination and monitoring of public response and mitigation actions.

Communication within the hazards community must be set up to facilitate maximum exchange of critical hazard-related information prior to and during impact. Warnings and other information on hazardous events can be distributed rapidly via a shallow cascade system whereby recipients of a warning pass it on to others, e.g. the NMS sends the warning to the headquarters of an emergency organization which in turn passes it on to its other offices. It should not consist of too many levels as information might get more and more lost on the way down. An example of such arrangements from Mauritius is shown in Figure 8.

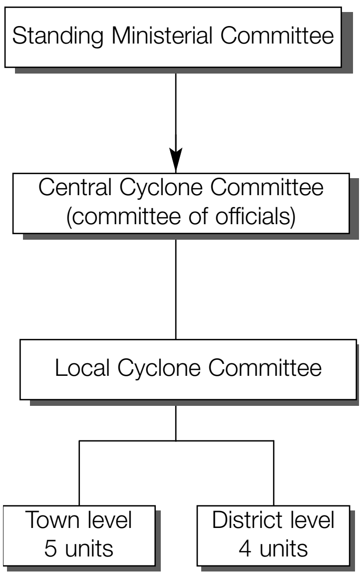

Figure 8. Reporting channel — cyclone and other natural disasters (Membership (38) of the central cyclone and other natural disasters committee shown at right)
(Meteorological Services, Mauritius)

Secretary for Home Affairs, Prime Minister's Office (*Chairman*)
The Representatives of the:
- Ministry of Foreign Affairs and International Trade
- Ministry of External Communications and Outer Islands
- Ministry of Finance
- Ministry of Public Utilities
- Ministry of Urban and Rural Development
- Ministry of Land, Transport, Shipping and Port Development
- Ministry of Education and Scientific Research
- Ministry of Women, Family Welfare and Child Development
- Ministry of Fisheries and Cooperatives
- Ministry of Social Security and National Solidarity
- Ministry of Youth and Sports
- Ministry of Agriculture, Food Technology and Natural Resources
- Ministry for Rodrigues
- Ministry of Health and Quality of Life
- Ministry of Public Infrastructure and Public Safety
- Ministry of Industry and Commerce
- Ministry of Telecommunications and Information Technology
- Ministry of Local Government
- Ministry of Housing and Lands
- Ministry of Environment, Human Resource Development and Employment
- Ministry of Tourism and Leisure
- Ministry of Civil Service Affairs and Administrative Reforms

P.A.S, Government Information Service
The Representatives of the:
- Police
- Special Mobile Force
- Meteorological Services
- National Transport Authority
- Mauritius Marine Authority
- Central Water Authority
- Central Electricity Board
- Mauritius Broadcasting Corporation
- University of Mauritius

Representatives of the Municipalities and District Councils
The Representative of the:
- Government Fire Services
- Mauritius Telecom
- Sugar Industry Labour Welfare Fund
- Mauritius Red Cross Society

Key decisions should be based on accurate and timely information. Similarly, communication of risk to the public must be consistent from all members of the hazards community. If it is not, delayed or inappropriate public response is liable to be the outcome. Specific warning tasks should be coordinated across organizations to reduce duplication of efforts and omission of critical tasks. Management of multi-organizational efforts will promote the integration of complex individual agency tasks into a cohesive warning effort.

Emergency management and the concept of the professional emergency manager are becoming much more widespread and where the hazards community is well organized, it is fairly straightforward for meteorologists and hydrologists to support the warning process. In cases where the hazards community has not developed a viable working partnership, someone must take the lead to organize the community and develop a warning system. Due to their crucial role in the whole warning process, NMSs are often in the position to take over that role.

To ensure an effective warning system, and avoid public confusion, a single official voice for the issuance of all warnings and advisories to the public should be established. This single official voice should be the NMS as the originator of warnings of hydrometeorological hazards. This will help to minimize the possibility of conflicting information being broadcast to the public via radio and television broadcast, either internationally or domestically. For the distribution and access of severe weather warnings agreement should be made with the electronic media that:

- Warnings and advisories should not be modified except for format.
- Warnings and advisories should be issued directly to the general public as soon as possible after receipt, and as close to verbatim as possible (or in graphical presentation).
- Warnings and advisories should not be disseminated after expiration time.
- Warnings and advisories should be attributed to the issuing NMS.
- Viewers and listeners should be urged to monitor their own NMS information services for further information on local or regional weather conditions.

The electronic media includes not only national radio and television but also international broadcasters such as satellite television. Dissemination is further discussed in Chapter 7, 7.1.1 and relations with the media in Chapter 8, 8.5 and 8.6.

5.6 AN EFFECTIVE WARNING MESSAGE

To be successful, a warning programme strives to ensure that everyone at risk must:

- Receive the warning;
- Understand the information presented;
- Believe the information;
- Personalize the risk;
- Make correct decisions;
- Respond in a timely manner (Mileti, 1990).

The ideal warning process has to take into account each of the above components to be successful. People's reactions to warnings cannot be meaningfully described as anything other than how they experience the situation in which they find themselves. Different groups of people and different individuals at risk have different interpretations of the situation, different perceptions of risk and different reactions to warnings. This interpretation always incorporates the person's identity and previous history. For example, previous experience with disaster makes people more receptive to warnings and to the need for protective action. The meaning of the warning messages that they hear is shaped by this personal history, and also by what they observe other people doing in response to hearing warnings. Many people try to evaluate warnings heard by seeking information and confirmation of the warning through observing changes in their surroundings, and by inquiring how others perceive the risk. Similarly, people have difficulty believing the warning message when they cannot see or hear the hazard. The more important aspects of this process in an ideal scenario can be summarized as follows: People hear a warning, understand its contents, believe that the warning is accurate and credible, personalize its message about risk to the their own situation, confirm the fact that others are responding to the warning, and respond by taking protective action.

Public response to warnings is an outcome of this process. It ranges from inertia, i.e. the explicit or implicit refusal or denial to grant validity to the announcement of the risk and the need for protective action, to the complete, conscious acceptance of the risk and the need for protection. Between these two extremes are many stages, in which people attempt evaluation of the risk and assessment of their options. The important thing to keep in mind is that such reactions are products of social circumstances, impacted not only by the person's subjective interpretation of the situation at hand but also by the qualities of the warning message. These qualities can alter the perceptions that people form. The specific character of the warnings issued to the public can direct most people at risk to form sound risk perceptions and guide them to appropriate actions. The basic problem that all warning systems seek to solve is to disseminate warnings that bring diverse members of a population to similar and appropriate perceptions of danger and action.

5.6.1 TYPES OF WARNINGS

The meteorological and related hazards which usually require the issue of warnings are listed in Table 5. The criteria or thresholds for issue of the various types of warnings are discussed in 5.7 below.

Table 5. An illustrative list of hydrometeorological hazards for which warnings are issued by NMSs

Storms and consequent phenomena	*Heat and Cold*
Tropical cyclones, typhoons, hurricanes	Intense cold, cold wave, sudden temperature decrease
Winter storms	Wind chill
Thunderstorms, thundersqualls	Excessive heat, heatwave
Tornadoes	
Strong winds, gales	
Lightning	
Blizzards, snow squalls	
Waves, storm surges, storm tide	
Waterspouts	
Sand storms, dust storms	

Precipitation and fog	*Other weather-related hazards*
Heavy rainfall, heavy snowfalls	Drought
Freezing rain, freezing drizzle, sleet	Floods, flash floods
Hail	Avalanches, landslides
Blowing snow	Forest and grass fires
Freeze, frost, glazed frost	Agricultural plant diseases
Icy roads	Increased ozone levels
High humidity	High pollen count
Fog, dense fog	

The results of a survey of NMSs in 1999 showed that the most commonly issued warnings are those for severe thunderstorms, strong winds and gales, and heavy rain; understandably, as these phenomena affect most countries. Warnings of frost and hail are issued by over half of NMSs. Flood warnings are issued by less than half and this may be because, in some countries, such warnings are issued by hydrological authorities. Warnings of cold phenomena, such as heavy snow, freezing rain or ice on roads are issued by 35–40 per cent of NMSs. Only 14 per cent issue tornado warnings.

Warnings for 'other weather-related hazards' are often issued in consultation with other authorities. In some countries the particular warning service may be the responsibility of another authority. An agricultural department may be responsible for warnings of drought or of plant diseases, in consultation with the NMS. An NMS may be responsible for warning river authorities of impending heavy rain and while river authorities have responsibility of warning the public of a flood. On controlled rivers, flood warnings can only be issued in consultation with those responsible for the operation of dams and reservoirs. Authorities with responsibility for fighting forest and grass fires may have the responsibility for warning the public and for imposing legal penalties for lighting fires in the open. Environmental or health authorities may have the responsibility for warnings of pollen, ozone or air pollution.

National arrangements vary considerably. The important things are that:

- there be complete consultation and cooperation between the NMS and other relevant authorities; and
- the public receive one clear, unambiguous message, from one source, in good time to take action.

To increase public awareness and encourage a proper response to critical weather information, it has been found useful to have a graduated level of warnings as the threat becomes more certain and imminent. The following example illustrates the concept as used by the National Weather Service (NWS), USA:

Outlooks — Are used to indicate that a hazardous weather or hydrological event may develop. These are intended to provide information to those who need considerable lead time to prepare for the event.

Weather Watches — Are issued to alert the public and heighten its awareness that severe weather, such as tornadoes, severe thunderstorms or flash floods, is developing or is expected to develop and to advise citizens to remain alert for possible later issue of Weather Warnings. The occurrence, location and/or timing of the event are still uncertain. They further enable emergency managers and decision makers to prepare for the coming event. In this way, once a warning is issued, response time can be reduced dramatically. Watches either evolve into Warnings or Advisories or are cancelled.

Weather Warnings — Are issued when a severe weather event is occurring or if there is an extremely high probability of occurrence. Conditions pose a threat to life and/or property. They inform the public of the threat posed by the situation and give advice on how to react.

Weather Advisories — Are issued for events that pose more of an inconvenience rather than a true threat to life or property. Conditions are less severe, but may nevertheless cause operational problems, particularly for road transportation.

Not all of the listed products have necessarily to be used, nor do they have to be termed exactly as above. Other graduated levels might consist of "Early Warning", "Advanced Warning", "Flash Warning" and "Emergency Flash Warning" as used by the UK Met. Office, stating the increasing importance of the situation. A further specification can be applied by adding terms such as 'major', 'moderate' or 'minor' to the warning title. The terms used can be chosen according to national preference to ensure the communication of the meaning of:

- there may be a threat;
- a threat is likely and keep listening for further advice;
- a threat is definite and imminent.

The German Weather Service (Deutscher Wetterdienst (DWD)) defines three stages of warnings as follows:

Pre-warnings: — Issued under certain conditions before primary warnings if they are required by the customers or considered suitable by the Regional Centre in order to make the relevant safety measures well in advance. After the issue of a pre-warning, a primary warning or an amendment must follow. They are valid for 24 hours. If the event is weaker than expected or finished earlier, the primary warning has to be cancelled.

Primary warnings: — Warnings of meteorological events that might cause extreme damage. Under certain circumstances, it can be necessary to declare a state of emergency. Primary warnings are disseminated to governmental authorities, private customers (if agreed upon by contract), media and others. They are given to public radio and TV stations, newspaper agencies and if possible to private radio and TV stations (that must not be customers of the DWD) free of charge to ensure the safety of life and property. They are valid up to 24 hours after issuance. If the event is weaker than expected or finished earlier, the primary warning has to be cancelled.

Secondary warnings: All other warnings. They are issued for customers according to their requirements and for internal use. They should normally be restricted to 24 hours (for frost, longer time period is possible). In contrary to primary and pre-warnings, the secondary warning will not be cancelled if the event is weaker than expected or finished earlier.

In another approach, a colour code can be devised that indicates in a very simple way how severe the situation is. The following example from the South African Weather Bureau shows how a colour code works:

Green	No severe weather conditions are expected
Yellow	Severe weather conditions are expected
Orange	Severe weather development is in progress
Red	Severe weather is in progress. Its path and time of onslaught can be determined. The areas concerned are notified.

In every case, it has to be ensured that people receive critical information in a timely and comprehensive manner to be able to take appropriate action.

Further information about the developing weather situation can be disseminated by means of Statements to amplify watches, warnings and advisories by reinforcing the message, indicating what is expected, and outlining appropriate response actions.

The lead time of issuing warnings depends on the rapidity of onset. In the USA, for example, for rapid-onset hazards (usually from convective events) such as tornadoes, severe thunderstorms or flash floods, an outlook is issued 12–24 hours in advance of the potential severe weather. Watches are valid up to six hours after issuance. Warnings are valid up to one hour after issuance. For slow-onset hazards (usually from synoptic events) such as tropical storms, frost, fog, dust or river/coastal floods, outlooks are issued three days in advance. Watches are issued 12–36 hours in advance and warnings are valid up to 24 hours after issuance.

Finally, End of Warning or Warning Cancellation messages have to be issued to indicate that a warning issued earlier has been cancelled and is no longer in effect, e.g.: "The high wind watch has been cancelled." or "The excessive heat watch has been discontinued.". These messages are usually included within routine forecast issues. Ending and cancelling warnings is just as important as the issuance of the warning. Warnings that are old or dated hamper credibility and could negatively affect public perception.

5.6.2 DISSEMINATION OF WARNINGS TO THE PUBLIC

Speed is essential in disseminating rapid-onset warnings to the public. Even in slower-onset situations such as floods and tropical cyclones the latest position must be communicated quickly. In these situations, radio has a major advantage in being able to reach a wide audience very rapidly. Furthermore, radios will operate on batteries when the electricity fails. Television, with its visual display capability and a large number of viewers in most countries, is a highly effective means of disseminating forecasts and warnings. Sirens are used to warn communities of the approach of severe weather. While newspapers are useful for providing detailed and graphic information about the weather and are a powerful medium in public awareness campaigns on hazards, their drawback is the time between issue of the warning to the newspaper and the distribution of the newspaper to the public, especially with morning newspapers. This may be several hours during which the weather may change dramatically. Newspapers, however, are valuable in bringing the attention of the public to an impending drought. Other means of communication concentrate on specific groups or individuals. For instance, the Internet, dial-in facsimile and recorded telephone services provide information on demand, although here the recipient has to initiate the request for information. This is of value in obtaining updated information once an initial warning has been issued. NMSs should use, to the greatest extent possible, the latest technological advances in communication and dissemination systems, especially in situations of severe weather.

Some segments of a population require special warnings simply by virtue of their unique character. Special populations can be defined in many ways, and they vary according to their level of risk, their particular characteristics or the amount of time they need to respond. These population segments include those in special facilities such as schools, prisons, old-age homes, hospitals and other institutions. The warnings required by such institutions are probably not different from the sort provided to the general public. However, it is likely that such facilities would require more time for warning response than would be required by members of the general public. Consequently, it would be useful if means were provided to specially communicate warnings to such facilities, as for example, over tone-alert radios or dedicated phone lines.

Special populations with unique warning needs can also exist in non-institutionalized settings. For example, the elderly may occupy a particular geographical region of town. Since it often requires a larger effort to convince older people to engage in protective actions such as evacuation, special warnings should be provided for their neighbourhood, for example, through the frequent repetition of media warnings. Additionally, people who are hearing or sight impaired may require special alert and notification devices for the delivery of effective warnings; also, people who have mobility disabilities or who do not read or understand the local language have special warning needs.

Dissemination is discussed more fully in Chapter 7.

5.6.3 CONTENT OF A WARNING

The actual content of a warning message that is delivered to members of an at-risk public is of critical importance in guiding what people think and in leading them to take appropriate action to protect themselves before disaster strikes. The wording of warnings is crucial to the effectiveness of the service.

Experience has shown that, when composing a warning, it is important that:

- the heading stand alone and stand out;
- the components of the message are clearly defined;
- the message be simple;
- it personalize the event, the consequences and the actions required (“People are warned that...”);
- information which allows people to confirm an impending event for themselves be included;
- special care be taken with warnings for extraordinary events;
- the most important information be placed first;
- allowance be made for shortening the message by broadcasters;
- location references be made relative to well-known places;
- plain language be used (e.g. am and pm, not the 24-hour clock);
- a statement of recommended action be included; and
- a sympathetic but arresting tone be used.

Source

It is important that a warning message clearly states its source of information and date and time of issue such as “Issued by the Meteorological Office of (*country*)” or “National Meteorological Service, (*country, city*), (*time*), (*date*)”. This serves to enhance the credibility of the information by identifying the professional basis of its generation. In some countries, call-to-action statements and warnings from, for example, a mayor or civil defence director, or technical sources, such as scientists who work for agencies that monitor the natural environment, are included in the warnings issued by the NMS. In nations with populations of various cultures and ethnic groups, each culture or group may place different importance on the types and sources of information they rely upon. There needs to be consultation with the various groups to ascertain their preferred sources of credible information. Warning messages can then be prepared in such a way as to address these specific requirements.

Description of the threat The warning must inform the public of:

What hazard? Description of the endangering event and how it poses a threat to humans.

When? Timing of the event (beginning and ending, times of worst conditions and duration).

Where? Affected area, geographic indications.

How severe? Expected impact and significant past effects of the event. The type of impact should be outlined, such as the amount of rain/snowfall, wind speed or size of hail. The connection between the meteorological phenomenon (wind speed > 60 km/h) and the impact (old trees can be blown over) should also be clearly stated.

In longer messages the most important information on what, when and where should be given first in succinct form, with amplification later in the message, bearing in mind the tendency of radio and television presenters to avoid long statements and read out only the first part of a message.

Recommended action An effective warning message should recommend ways that the public can achieve protection, including e.g. safety rules or guidelines for appropriate action. These recommended actions should be worked out in agreement with disaster managers, following established regulations. A message that effectively describes a danger, but offers no suggestions for protection, simply tends to be denied or reinterpreted by recipients. At worst, individuals could generate protective actions for themselves based on misinterpreted folk wisdom or an incorrect understanding of the threat that would increase their level of likely injury.

Protective action recommendations differ for different threats and should reflect the strategy of warning authorities for managing the consequences of the threat. The description of protective measures should be as creative, specific and simple as possible for the public to follow. For example, if the protection is to evacuate the area, the message should indicate recommended routes and destinations, e.g. "for residents in area X, road Y is the only open road; roads A–C are washed out/closed by falling trees". Or, if the timing of a flood's impact requires immediate movement to high ground, reference should be made to exactly what constitutes high ground: "move immediately to ground higher than the top of city hall". A statement in a tornado warning could read: "If you are in the path of this tornado, go to the basement shelter or a central interior room on the lowest floor. Abandon vehicles and mobile homes for a reinforced building". Advice for excessive cold could include "leave water taps running a little bit to prevent pipes from freezing".

Language Language and vocabulary used should be appropriate for the country or region and to the user needs. Most importantly, it should easily be understood by the intended recipients.

Warnings should not only be issued in the official language, but also in the most common one(s). For example the Malaysian Meteorological Service issues warnings in Bahasa Malaysia, which is the national language, and in English as well (for an example from Malaysia, see 5.8.7 below). The choice of technical terminology is dependent on the user. The use of meteorological jargon as well as abbreviations and codes should be avoided for the general public, whereas in communicating with disaster management authorities, it can be assumed that they are familiar with meteorological terms. Clear, concise, simple words are usually most effective in conveying the desired meaning and in minimizing potential confusion.

The public may often hear or see critical information only once. This consideration heightens the importance of clarity and simplicity, and that this information be as complete as possible. A warning issued by an RSMC for the use of NMSs is in general not suitable for dissemination to the public.

Style The message should be concise, specific and clear. All warning messages should be stated with certainty, e.g. "Any travel tonight is strongly discouraged. If you leave the safety of being indoors, you are putting your life at risk." (US NWS Blizzard Warning). If necessary, because of the kind of information available, the message should refer to ambiguities in timing of impact or nature of the threat, but still be authoritative. For example, in the case of a tornado one might say: "there is no way to know if the tornado will hit your house, but the advice from your local civil defence is that everyone in your neighbourhood should take shelter now."

Use of geographical terms

Locations and geographical features should be widely known. During hazardous weather, the assessment of personal risk is dependent on a clear understanding of the location of the hazard with respect to the individual making decisions to respond to the warning. Use of site-specific terminology tied to well-known locations will generally result in clear understanding and a more effective public response to warnings. The names of cities, towns or well-known geographical locations directly affected, e.g. in the path of the storm, should be highlighted for greater public awareness and response. For example "around the Town Hall" is more specific and easier to understand than "SW of the City Centre".

Graphics

Graphical products should be uncluttered and include map backgrounds which depict well-known locations for ease of reference and comprehension.

The following example from the South African Weather Bureau serves to illustrate the above principle in preparation of warnings:

Example of warning from the South African Weather Bureau

1. SOURCE SOUTH AFRICAN WEATHER BUREAU

2. CONTENTS

Type of hazard	Intense thunderstorm
Stage of development, observed features	Heavy rain of over 50 mm in the last hour; golf ball size hail
Expected time of onset	Is expected to reach ... in the next half an hour
Expected duration	Is expected to last about 30 min
Affected area	The SW suburbs of Johannesburg and Soweto
Expected impact	Flooding is expected in low-lying areas
Level of threat	Red day
Further information	Further bulletin will be issued in the next 30 min.

3. RECOMMENDED ACTION —

The warning issued by the South African Weather Bureau corresponding to the above situation was formulated as follows:

Intense thunderstorm has been radar observed south-west of Johannesburg and Soweto, with ground observed reports of heavy rain of over 50 mm in the last hour and golf ball size hail. The line squall is expected to reach the south-western suburbs of Johannesburg and Soweto in the next half an hour to one hour and last about 30 minutes. We are therefore declaring a red day for the area. The public is advised that flooding is expected in low-lying areas. Movement will then be to central and eastern parts of Johannesburg and Soweto, but further bulletin will be issued in the next 30 minutes to one hour.

An advice for recommended action could be added, e.g. "Stay indoors while the storms lasts and move to higher grounds in areas where flooding is expected". The warning could be issued in other common languages spoken in the affected area.

Table 6. Table of effects from the UK Met. Office

Phenomena		Effects
50 mph gusts	a)	Difficult driving conditions for high-sided vehicles, especially on exposed roads or bridges
60 mph gusts	a)	Difficult driving conditions: unladen high-sided vehicles at risk of being overturned
	b)	Some damage to trees (e.g. falling branches)
70 mph gusts	a)	Hazardous driving conditions: unladen high-sided vehicles at risk of being overturned and motorists advised to drive with particular care
	b)	Damage to trees (e.g. falling branches with some trees being uprooted)
	c)	Minor damage to some buildings, particularly to tiles, slates and chimneys
80 mph gusts	a)	Dangerous driving conditions: high-sided vehicles at risk of being overturned and motorists advised to avoid driving if possible
	b)	Considerable damage to trees with significant tree uprooting
	c)	Extensive minor damage, particularly to tiles, slates and chimneys, and structural damage to some buildings
90 mph gusts	a)	Driving extremely dangerous
	b)	Widespread uprooting of trees
	c)	Widespread damage to buildings with potential for severe structural damage
	d)	Public advised not to venture out of doors unless really necessary
Snow	a)	Difficult driving conditions
Heavy snow	a)	Dangerous driving conditions
	b)	Motorists advised to avoid driving if possible
Blizzards or severe drifting	a)	Driving extremely dangerous
	b)	Some roads likely to become impassable
	c)	Public advised not to venture out of doors unless really necessary
Heavy rain, fog, icy roads	a)	Difficult driving conditions
Heavy rain, dense fog, widespread icy roads, glazed frost, freezing rain	b)	Dangerous driving conditions
	c)	Motorists advised to use extra care
	d)	Localized flooding (in association with heavy rain)

5.7 CRITERIA FOR ISSUE OF WARNINGS

Tables 6 and 7 give examples of the effects of hydrometeorological phenomena such as wind, rain and snow on their environment. They are used to set up the thresholds for the dissemination of warnings, products.

Criteria and thresholds are defined which, when exceeded, will automatically lead to the issuance of a warning. Criteria and thresholds might differ very much from region to region and even within a country, because the severity of effects of meteorological phenomena differs in each area. For example, wind, rain or snow conditions which may occur frequently in one area (and where structures are built accordingly) may be rare in other areas and require warning of their occurrence. When selecting thresholds the NMS should also take into account how frequently these thresholds are exceeded. For example, a coast where the sea breeze reaches 25 knots on most afternoons does not require warnings of this; another coast where this is rare may require them. In Ireland, the criteria for severe weather alerts are based on return periods — about five years for wind in the windier parts of the country, in excess of two years for rain in low-lying areas, and about one to two years for inland snow.

Examples of criteria/thresholds for various types of weather from various parts of the world can be found in Tables 8 to 11.

EUROPEAN COUNTRIES

Table 8 illustrates thresholds for the issuance of weather warnings in a number of European countries. The table lists a selection of those thresholds used for the issue of warnings of strong winds and heavy rain. This demonstrates that thresholds chosen to issue a warning might even vary significantly within the same region.

Table 7. The Saffir-Simpson Hurricane Scale

Category	*Definition*	*Effects*
One	Winds 74–95 mph	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery and trees. Also, some coastal road flooding and minor pier damage.
Two	Winds 96–100 mph	Some roofing material, door and window damage to buildings. Considerable damage to vegetation, mobile homes and piers. Coastal and low-lying escape routes flood 2–4 hours before arrival of centre. Small craft in unprotected anchorages break moorings.
Three	Winds 111–130 mph	Some structural damage to small residences and utility buildings with a minor amount of curtain wall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain continuously lower than 5 feet above sea level (ASL) may be flooded inland 8 miles or more.
Four	Winds 131–155 mph	More extensive curtain wall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Major damage to lower floors of structures near the shore. Terrain continuously lower than 10 feet ASL may be flooded requiring massive evacuation of residential areas inland as far as 6 miles.
Five	Winds greater than 155 mph	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Major damage to lower floors of all structures located less than 15 feet ASL and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within 5 to 10 miles of the shoreline may be required.

Table 8. Thresholds for the issuance of wind and rain warnings in some European countries (Although the thresholds for the United Kingdom have been updated, much of the remaining information in the table may be out of date and should, consequently, be regarded as illustrative only. Despite this caveat, the table is useful in illustrating the wide range of thresholds in use within the European region.)

Country	*Wind*	*Rain*
Austria	—	30 mm/24 hours or for 3 days
Bulgaria	20 m/s	30 mm/6 hours
Denmark	15 m/s	—
Finland	10 and 17 m/s	—
Hungary	10–30 m/s	—
Netherlands	14 and 21 m/s	—
Poland	15 m/s	—
Russian Federation	25 m/s	20 mm/12 hours
Switzerland	8 m/s	—
United Kingdom	31 m/s	15 mm/3 hours

CANADA

Table 9. Representative criteria and thresholds used for warning products issued by the Canadian Atmospheric Environment Service

Table 9 lists thresholds used by the Atmospheric Environment Service of Environment Canada for the issue of Weather Advisories, Weather Watches and Weather Warnings. Due to the significant geographic variations in hazardous weather conditions experienced across Canada, warning elements and specific thresholds are established at the regional level. The examples shown are a representative cross-section of regional practices.

Phenomenon	*Advisories*	*Watches*	*Warning*
Heavy rainfall			50 mm in 24 hours
Freezing rain	Likely to cause general inconvenience		4 hours' duration
Freezing drizzle	Likely to cause general inconvenience		7 hours' duration
Heavy snowfall	Likely to cause general inconvenience		15 cm in 12 hours
Wind			Mean wind 65 km/h or gusts to 90 km/h
Blizzard			Temperature –3°C or less and visibility 1 km or less and wind of 40 km/h or more and duration 3 hours or more
Wind chill			2000 Watts/sq metre
Frost			Grass minimum temperature ≤ 0°C; growing season only
Severe thunderstorm		Severe thunderstorm possible/probable	Thunderstorm with gusts > 90 km/h; hail > 15 mm diameter; rain > 25 mm/h
Tornado		Tornado possible	Tornado observed or expected
Cold wave			Temperature fall within 24 hours from near normal to minimum < –30°C and maximum < –20°C
Winter storm	Supervisors' discretion		When two or more criteria met for warning of rain, snow, freezing rain, blizzard, wind, cold wave, snow squall
Snow squall	Likely to cause inconvenience		10 cm/6 hours or less
Dust storm	Visibility < 1 km		Visibility near zero
Blowing snow	Sufficient to affect safety or cause concern		
Thick or extensive fog	Visibility < 1 km		
High humidex	When humidex forecast > 40 for 3 or more days		
Waterspout	Waterspouts reported/ expected over Great Lakes		
Funnel cloud	Cold air funnel or funnel clouds expected but not a tornado		

MALAYSIA

Table 10. Criteria for strong wind and moderate to heavy rainfall warnings — Malaysia

Warning stages	*Criteria*	*Possible impact*
First category	— Possibility of monsoonal surge in the next 24 to 48 hours	
Second category	— Moderate monsoon rain is currently occurring or expected to occur in the next 24 hours — Low-pressure system/tropical depression with sustained wind speed of 50–60 km/h accompanied by moderate to heavy rain	Flooding over low-lying areas and areas by river banks
	— Strong wind with sustained wind speed of 50–60 km/h (whole tree in motion; inconvenience felt when walking against wind) with slight to moderate rain and has lasted for the last 2 hours	Thatched/zinc roofs can be blown off by the wind
Third category	— Heavy widespread monsoon rain is currently occurring or expected to occur in the next few hours	Flooding over low-lying areas and areas by the river banks
	— Tropical storm/typhoon with sustained wind speed of at least 60 km/h accompanied by moderate to heavy rain	Swift water currents can be dangerous to children playing beside monsoon drains and river banks
	— Strong wind with sustained wind speed of at least 60 km/h (breaks twigs off trees; generally impedes progress when walking against the wind; structural damage occurs) with moderate to heavy rain and has lasted for the last 2 hours	Thatched/zinc roofs can be blown off by the wind

MONGOLIA

Table 11. List of hazardous and severe atmospheric phenomena used in weather warning by Mongolia

Phenomenon	*Criteria*	
	Severe hazardous phenomenon	*Hazardous phenomenon*
1. Strong wind	30 m/s	(1) Wind speed: 15–20 m/s, duration ≥ 3 hours (2) Wind speed: 21–28 m/s, duration ≥ 1 hour
2. Snow storm	Snowfall, wind speed ≥ 16 m/s, duration ≥ 9 hours	Snowfall, wind speed 10–16 m/s, duration ≥ 6 hours
3. Dust storm	Dust, wind speed ≥ 16 m/s duration ≥ 12 hours	Dust, wind speed ≥ 16 m/s, duration 6-12 hours
4. Snow, wet snow	Fall of amount ≥ 10 mm in a time period ≤ 12 hours	Fall of amount ≥ 5 mm in a time period ≤ 12 hours
5. Rain	Fall of amount ≥ 30 mm in a time period ≤ 12 hours	Fall of amount ≥ 15–49 mm in a time period ≤ 12 hours
6. Shower	Fall of amount ≥ 30 mm in a time period ≤ 3 hours	Fall of amount ≥ 15–30 mm in a time period ≤ 3 hours
7. Cold rain	—	Continuous rain with wind speed ≥ 6 m/s, duration ≥ 6 hours and temperature 8°C (during wool shearing)
8. Frost	Drop of soil surface temperature below –2.5°C	Drop of soil surface temperature below 0.0 – (–2.5°C) (during plant growing)
9. River flood	The overflowing by water of the confines of a stream	Water level reaches flood level
10. Flash flood	—	Flash flood in settlements

5.8 EXAMPLES OF WARNING PRODUCTS ISSUED BY NMSs

The following examples illustrate the format and style of various types of warnings. Many more examples can be seen on the accompanying CD-ROM. For real-time access to weather warnings from NMSs with Web or Gopher Servers, visit the Internet site at: http://www.wmo.ch/web-en/member.html.

5.8.1 TROPICAL CYCLONES, TYPHOONS, HURRICANES

India Meteorological Department

The India Meteorological Department uses a two-stage approach to issuing cyclone warnings when adverse weather is expected to occur in association with an approaching cyclonic storm. A "Cyclone Alert" is issued 48 hours in advance of the expected occurrence of adverse weather. A "Cyclone Warning" is issued approximately 24 hours in advance of the arrival of severe weather. The following are examples of a cyclone alert and a cyclone warning issued by the Cyclone Warning Centre at Madras. Note that the Alert includes advice to the public to keep tuned to All India Radio for updated warnings and a request to radio stations to be prepared to extend their hours of broadcasting in order to carry subsequent warnings during the night.

Kindly broadcast the following cyclone alert message number one.

Cyclone Alert number one issued by Area Cyclone Warning Centre, Madras at 1230 hours IST on 29 October 1994.

Depression lies over Southwest Bay centred at 0830 hours IST of 29 October about 500 km east-south-east of Nagapattinam. System likely to intensify further and move in a west-north-westerly direction.

Under its influence rainfall likely at most places over Madras, Chengalpattu MGR, South Arcot, Thanjavur, Nagapattinam Quaid-e-Milleth, Pudukottai, Ramanathapuram, Tirunelveli, Chidambaranar and Kanyakumari districts and Pondicherry during the next 48 hours. Heavy rainfall also likely at a few places over Madras, Chengalpattu MGR, South Arcot, Thanjavur, Nagapattinam Quaid-e-Milleth and Pudukottai districts and in Pondicherry during the same period. Rainfall at many places likely over interior districts during next 48 hours. Heavy rain at one or two places is also likely over Ramanathapuram, Tirunelveli, Chidambaranar and Kanyakumari districts and all the interior districts of Tamilnadu during next 48 hours. Strong winds from north-easterly direction speed reaching occasionally 55–60 km/h likely along off the districts of Madras, Chengalpattu MGR, South Arcot, Nagapattinam Quaid-e-Milleth, Thanjavur and Pudukottai and in Pondicherry during the next 48 hours. Fishermen advised not to venture into sea off above districts' coasts. Strong winds speed reaching 50–55 km/h likely along off Ramanathapuram, Tirunelveli, Chidambaranar and Kanyakumari districts during the same period.

Subsequent warnings on this system will be broadcast by AIR stations.
Please keep listening to AIR broadcast for subsequent warnings.
Message ends.

FOR AIR STATIONS ONLY

Kindly make arrangements for extending night transmission at short notice.

METCENTRE

** Cyclone Warning Bulletin Number FIFTEEN issued by Area Cyclone Warning Centre Madras at 0700 hours IST on 31 October 1994 for repeated broadcasts at hourly/half-hourly intervals.

* Cyclone Warning for Madras, Chengalpattu MGR, South Arcot, Thanjavur, Nagapattinam Quaid-e-Milleth, Pudukottai, Ramanathapuram districts and Pondicherry.

* Severe cyclonic storm crossed north Tamilnadu coast near Madras and now lies centred at 0630 hours IST of 31 October over land about 30 km north of Madras.

* Under its influence heavy to very heavy rain is still likely at a few places over Madras, Chengalpattu MGR, South Arcot, Thanjavar, Nagapattinam Quaid-e-Milleth and Pudukottai districts and in Pondicherry during the next 48 hours. Heavy to very heavy rain at one or two places is also likely over Ramanathapuram, Tirunelveli, Chidambaranar and Kanyakumari districts during next 48 hours.

* Gales wind speed reaching 100–120 km/h likely uprooting trees, damaging pucca houses and disrupting communications in Madras, Chengalpattu MGR, South Arcot districts and Pondicherry coasts during next 6 hours. Gales wind speed reaching 60–90 km/h likely breaking tree branches causing damages to kutcha houses in Thanjavur, Nagapattinam Quaid-e-Milleth and Pudukottai districts during same period. Sea high to very high off north Tamilnadu coast. Fishermen advised not to venture into sea off above districts' coast and Pondicherry.

Strong winds speed reaching 50 to 55 km/h likely along off Ramanathapuram, Tirunelveli, Chidambaranar and Kanyakumari districts during next 24 hours.

Great Danger signal number Ten kept hoisted at Madras Ports. Great Danger signal number Eight kept hoisted at Pondicherry, Cuddalore and Nagapattinam Ports.

Above warning is for Madras, Chengalpattu MGR, South Arcot, Thanjavur, Nagapattinam Quaid-e-Milleth, Pudukottai and Ramanathapuram districts and Pondicherry.

METCENTRE

5.8.2 WINTER STORMS

These examples from the United States National Weather Service illustrate the graduated level of warnings described in 5.6.1.

SPECIAL WEATHER STATEMENT...WINTER WEATHER OUTLOOK
NATIONAL WEATHER SERVICE RENO NV
1200 NOON PST WED FEB 14 1990

...A storm with heavy snow appears headed toward northern Nevada and the Lake Tahoe area this holiday weekend...

Another Pacific storm in the Gulf of Alaska will dive South along the Pacific Northwest coast Thursday. This storm system will bring a chance of snow to northern Nevada and the Lake Tahoe area by late Thursday. Snow will continue Friday and into the holiday weekend. Depending on the track of the slow moving storm...there is the potential for very heavy snowfall during the holiday weekend...particularly along the west slopes of the Sierra around Lake Tahoe.

Anyone planning travel or outdoor activities should keep informed on the progress of this storm. Be ready for winter driving and dangerous highway conditions.

WINTER STORM WATCH
NATIONAL WEATHER SERVICE LITTLE ROCK AR
430 AM CST WED JAN 24 1990

...A winter storm watch has been issued for northwest Arkansas for tonight and Thursday...

This watch means that hazardous winter weather could develop over northwest Arkansas tonight and Thursday. Strong low pressure in south Texas will move to Mississippi by Thursday. This low dumped heavy snow on north central Texas and southwest Oklahoma during the night. It was gaining strength as it moved east.

Rain will spread across most of the State tonight and Thursday. However...Temperatures will be cold enough over northwest Arkansas for heavy snow or a mixture of rain and snow. The higher elevations of northwest Arkansas including the cities of FT Smith and Fayetteville could get a half foot of snow tonight and Thursday.

If you are in or plan to travel through northwest Arkansas tonight and Thursday...prepare now for the impact of this storm.

WINTER STORM WARNING
NATIONAL WEATHER SERVICE ANN ARBOR MI
400 AM CST MON MAR 5 1991

...A winter storm warning is in effect for south and east Michigan today...
This warning means that a winter storm is imminent. A mixture of snow and sleet is falling over southwest Michigan this morning. The sleet and snow will spread east and become heavier during the morning. Most of southern lower Michigan will be covered by snow except for the southeast corner of the state where a mixture of snow...sleet...and freezing rain will make driving treacherous. The storm will end early this evening with total snowfall of 6 to 10 inches. Low temperatures and strong winds will continue to make both walking and driving hazardous.

Increasing north winds will cause blowing and drifting snow and low visibilities. If you must travel in south and east Michigan this afternoon...be ready for difficult driving conditions. Carry extra supplies in case your car becomes disabled or you are stranded.

5.8.3 THUNDERSTORMS

In this example from the United States National Weather Service, the US Emergency Broadcast System (EBS) is activated to ensure urgent and widespread dissemination of the weather warning, showing highly developed coordination with emergency agencies and the media.

BULLETIN — EBS ACTIVATION REQUESTED
FLASH FLOOD AND SEVERE THUNDERSTORM WARNING
NATIONAL WEATHER SERVICE DES MOINES IA
755 PM CDT MON JUN 20 1994

The National Weather Service in Des Moines has issued a severe thunderstorm warning effective until 845 pm CDT and a flash flood warning effective until 1000 pm CDT for people in the following locations...
In south-central Iowa
Marion county

A severe thunderstorm 9 miles west of Knoxville at 753 pm will move slowly east across Marion county. Radar indicates hail the size of nickels and torrential rainfall with this storm. People in Knoxville and Flagler are in the path of this storm and should prepare for extensive street flooding and large hail.

If you are in a severe thunderstorm’s path, move inside a strong building. Do not stand by windows. Don’t use telephones or electrical appliances unless in an emergency until the storm has passed. Heavy rains may quickly flood roads so don’t drive into areas where water covers the road.

The following examples from the Australian Bureau of Meteorology are of a severe thunderstorm advice and a brief cancellation message.

WARNING
PRIORITY FOR IMMEDIATE BROADCAST
SEVERE THUNDERSTORM ADVICE
BUREAU OF METEOROLOGY PERTH
ISSUED AT 5.45PM FRIDAY 24/02/1995

People in eastern parts of the Central Wheatbelt are advised that there is a risk of severe thunderstorms this evening. Storms may be accompanied by hail and strong winds that could result in damage to property. Localised flooding may occur. Thunderstorms are expected to ease after 8pm, and this is the last advice to be issued.

BUREAU OF METEOROLOGY, MELBOURNE 22:22 19/01/1995
*** NEWS FLASH *** FOR IMMEDIATE BROADCAST
CANCEL SEVERE THUNDERSTORM WARNING FOR THE METROPOLITAN AREA.

TEXT:
Thunderstorms on the northern and eastern hills have decayed and present no further threat.

5.8.4 TORNADOES

This example of a tornado warning from the United States National Weather Service indicates the value of storm spotters. As with thunderstorm warnings, the US Emergency Broadcast System (EBS) is activated to ensure urgent and widespread dissemination of the weather warning.

BULLETIN — EBS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE PITTSBURGH PA
532 PM EDT MON JUN 20 1994

The National Weather Service in Pittsburgh has issued a tornado warning effective until 615 pm EDT for people in the following locations...
In southwestern Pennsylvania
northern Washington county

A tornado is expected to move across the Buffalo and Westland area by 615 pm EDT. At 531 pm EDT, storm spotters reported a tornado 11 miles northwest of Washington near Buffalo. The tornado was moving northeast at 30 miles an hour. People in Buffalo and Westland are in the path of this storm and should take cover immediately.

If you are in a home or apartment, get to a basement if one is available. Get under a workbench or sturdy table. If a basement is not available, seek shelter in the innermost portion of the building on the lowest floor. Protect your body from flying debris with cushions or blankets. Avoid windows and mobile homes.

5.8.5 STRONG WINDS AND GALES

It should be remembered that it is the repeated occurrence of high gusts that may cause structural damage and consequently endanger life. Over inland urban areas, in many cases, the ratio of gust speed to mean wind speed can exceed 2.5. Care should be taken, however, not to be overly influenced by observations from exposed coastal or hill sites which may not be representative of the surrounding area. Warnings of strong winds and gales in coastal waters are discussed in the *Guide to Marine Meteorological Services* (WMO-No. 471).

The following examples are from the United States National Weather Service and the German Weather Service (Deutscher Wetterdienst (DWD)).

HIGH WIND WARNING
NATIONAL WEATHER SERVICE OMAHA NE
830 PM CDT SUN JUN 2 1991

...A high wind warning has been issued for extreme southeast Nebraska until 930 pm...

A high wind warning is in effect until 930 pm for extreme southeast Nebraska along and south of a line from Nebraska city...30 miles south of Omaha...To Fairbury...About 50 miles southwest of Lincoln.

The warning includes the cities of Beatrice...Tecumseh...Auburn...and Falls City.

At 825 pm winds gusting to 75 miles an hour knocked down power lines and tree limbs in Sterling...About 25 miles southeast of Lincoln...and Dewitt...About 30 miles south of Lincoln.

High winds will sweep across the rest of southeast Nebraska until about 930 pm. The high winds are caused by severe thunderstorms that have moved out of the area.

People in the warned area should go to shelter away from windows and quickly secure any loose items...such as lawn furniture...that could become flying debris.

Wind and gust warning for the area of Hamburg

Valid from 06.05.1998, 12.00 h until 07.05.1998, 12.00 h

Issued by the Deutscher Wetterdienst, Regionalzentrale Hamburg, 06.05.1998, 09.00 h

From noon today until noon tomorrow, risk of gusts force 7 from south-westerly direction.

5.8.6 BLIZZARDS AND SNOW SQUALLS

The following is an example of a blizzard warning from the United States National Weather Service.

BLIZZARD WARNING
NATIONAL WEATHER SERVICE BISMARCK ND
500 PM CST SUN DEC 9 1990

...A BLIZZARD WARNING IS IN EFFECT FOR THE EASTERN THIRD OF NORTH DAKOTA TONIGHT...

DANGEROUS BLIZZARD CONDITIONS WILL CONTINUE OVER THE EASTERN THIRD OF NORTH DAKOTA TONIGHT. HEAVY SNOW...WINDS GUSTING TO MORE THAN 50 MILES AN HOUR...AND TEMPERATURES IN THE SINGLE DIGITS WILL PRODUCE A LIFE-THREATENING SITUATION. A SNOWFALL OF 8 TO 10 INCHES IS POSSIBLE WITH THE WIND WHIPPING THE SNOW INTO 3 TO 4 FOOT DRIFTS. VISIBILITIES WILL BE NEAR ZERO AND WIND CHILLS WILL APPROACH 60 DEGREES BELOW ZERO.

TOWNS WITHIN THE WARNING AREA INCLUDE FARGO...GRAND FORKS...JAMESTOWN...DEVILS LAKE AND VALLEY CITY.

ANY TRAVEL TONIGHT IS STRONGLY DISCOURAGED. IF YOU LEAVE THE SAFETY OF BEING INDOORS...YOU ARE PUTTING YOUR LIFE AT RISK.

5.8.7 WAVES, STORM SURGES AND STORM TIDES

Waves and rough seas are marine phenomena and are dealt with in the *Guide to Marine Meteorological Services* (WMO-No. 471), however, they have an effect on people living in exposed coastal areas. Storm surges and storm tides are potential causes of loss of life in tropical cyclones. They can also occur in extratropical areas where sustained strong winds push water along a narrowing gulf or estuary.

The following example of a warning of rough seas from Malaysia is issued in a bilingual format.

AMARAN ANGIN KENCANG DAN LAUT BERGELORA

Angin timur laut yang kini adalah kencang selaju 50–60 kmsj di perairan pantai timur Semenanjung Malaysia, perairan pantai Sarawak dan juga pantai barat Sabah di jangka berterusan sehingga pukul 6.00 pentang 7hb Feb 1995.

Dalam tempoh ini, keadaan laut adalah bergelora laitu setinggi 2.0–4.0 meter dikawasan perairan pantai timur Semenanjung Malaysia dan perairan pantai Sarawak akan berterusan. Keadaan laut ini adalah merbahaya kepada bot-bot kecil dan juga aktiviti-aktiviti di perairan tersebut.

> STRONG WIND AND ROUGH SEA WARNING
>
> The current strong north-easterly wind 50–60 km/h over the coastal water of east coast of Peninsular Malaysia, coastal water of Sarawak and west coast of Sabah is expected to continue until 6.00 p.m. 7th Feb 1995.
>
> During this period, the rough sea condition of heights 2.0–4.0 in the coastal water of east coast of Peninsular Malaysia and coastal water of Sarawak will continue. This sea condition is dangerous to small boats and coastal activities.

Warning of a surge from a tropical cyclone may be incorporated within the warning of the cyclone itself. The following example from Australia is the relevant paragraph from a tropical cyclone warning issued at 6 pm EST on Thursday, 11 February 1999:

> Coastal residents between Port Douglas and Cardwell are specifically warned of the dangerous storm surge as the cyclone approaches the coast. The sea is likely to rise steadily up to 2 metres above the normal tide with damaging waves and flooding of some low-lying areas close to the shoreline.

5.8.8 SAND STORMS AND DUST STORMS

Following is an example of a dust storm warning from the United States National Weather Service.

> DUST STORM WARNING
> NATIONAL WEATHER SERVICE ALBUQUERQUE NM
> 230 PM MDT SUN AUG 2 1991
>
> ...A dust storm warning has been issued for extreme southeast New Mexico until 730 pm...
>
> The warning covers an area to the south and east of Clovis to Roswell to Carlsbad. Visibilities in the area were 1/4 mile or less in blowing dust and sand as of 2 pm MDT. West winds will increase in speed this afternoon into early evening.
>
> Visibilities could drop to near zero creating a dangerous condition for people traveling and those with respiratory aliments. The fine dust and sand could be especially hard on machinery. Conditions will not improve until late this evening as the wind weakens and temperatures decrease.

5.8.9 HEAVY RAINFALL, HEAVY SNOWFALL

When soil moisture deficits are zero or nearly so, heavy rain may lead to local flooding, which should be distinguished from river or coastal flooding. In urban areas rain may be sufficiently heavy to overwhelm the drainage system, flooding streets and shops for a period.

The following is an example of a heavy rain warning from Costa Rica.

> WARNING
> NATIONAL METEOROLOGICAL INSTITUTE
> MINISTRY OF THE ENVIRONMENT AND ENERGY
> TUESDAY, 4 AUGUST 1998
> 6.30 p.m.
>
> In the latest satellite image received, heavy cloud cover can be seen, stretching from the Pacific Ocean to the South Pacific region of Costa Rica and causing strong precipitation.
>
> In the past hour, rains have increased considerably in the South Pacific region. Moderate to heavy showers accompanied by electrical storms could be expected to last until the early morning hours, causing overflows and flooding.
>
> For this reason, the National Meteorological Institute recommends vigilance in areas liable to overflow, flooding and landslides.

5.8.10 FREEZING RAIN, FREEZING DRIZZLE, ICE STORM, FREEZE, FROST, GLAZED FROST, ICY ROADS

Freezing rain or drizzle, or frost sufficient to freeze a wet road, can cause dangerous driving conditions. The following example is a warning from Germany.

> Freezing rain and frost warning for the area of Hamburg
> Valid from 27.01.1998, 18.00 h until 28.01.1998, 16.00 h
> Issued by the Deutscher Wetterdienst, Regionalzentrale Hamburg, 27.01.1998, 16.00 h.
>
> Minimum temperatures during the night around minus 2 degrees. After midnight approaching snowfall from the North with high risk of slippery roads.

A sufficient duration of freezing rain can cause dangerous accumulations of ice on trees and power lines sufficient to bring them down — a phenomenon known as an ice storm. Following is an example of an ice storm warning from the United States National Weather Service.

> ICE STORM WARNING
> NATIONAL WEATHER SERVICE RALEIGH NC
> 500 AM EST WED DEC 20 1990
>
> ...An ice storm warning has been issued for the Piedmont region of central North Carolina today...
>
> This ice storm warning means that dangerous accumulations of ice will develop over the Piedmont area. Freezing rain will cover the area this morning and continue through the day resulting in an inch of ice.
>
> This much ice can break trees and power lines and lead to dangerous driving and walking conditions.
>
> The cities most at risk from this ice storm include Charlotte... Greensboro...Winston-Salem...High Point...and Raleigh/Durham. The mountains and eastern third of the State will escape the ice storm. Temperatures will be warm enough for the precipitation to fall as rain in the east and cold enough to fall as light snow in the western mountains.
>
> Moist air riding up over a dome of cold air is responsible for this dangerous weather. The freezing rain will diminish after dark ending the buildup of ice.
>
> Travel will become dangerous once the freezing rain begins. Travel is discouraged unless it is an emergency. Avoid downed power lines and be ready in case of a loss of power.

Frost can damage crops and fruit at critical stages of their development, therefore warnings are needed so that farmers can take preventive measures.

5.8.11 DENSE FOG

The following is an example of a dense fog advisory from the United States National Weather Service.

> DENSE FOG ADVISORY
> NATIONAL WEATHER SERVICE BRISTOL TN
> 400 AM EDT THU JUN 1 1991
>
> ...A dense fog advisory is in effect for upper east Tennessee and southwest Virginia this morning...
>
> Dense fog has developed over much of northeast Tennessee and southwest Virginia this morning. Visibilities are near zero in many places...Especially low lying areas.
>
> The fog will burn off later this morning. However...Motorists in the dense fog should drive carefully early this morning.

5.8.12 WIND CHILL

Increased wind speeds accelerate heat loss from exposed skin. When the temperature is well below freezing, wind can be dangerous to life. Tables have been developed for determining an 'effective temperature' for various air temperatures and wind speeds. Following is an example of a wind chill advisory from the United States National Weather Service.

WIND CHILL ADVISORY
NATIONAL WEATHER SERVICE PITTSBURGH PA
500 AM EST MON JAN 21 1991

...An advisory for dangerous wind chill is in effect for western Pennsylvania today...

Extremely cold temperatures and strong winds will produce dangerous wind chills across western Pennsylvania today. Arctic air stormed into the region last night and temperatures will continue falling through the day. Temperatures in the teens this afternoon with winds gusting to around 40 miles an hour will cause wind chills near 40 degrees below zero.

This is a potentially dangerous situation for anyone outside and not prepared. If you must be outdoors...be careful to cover all exposed skin.

5.8.13 HEATWAVE

The following example of an excessive heat warning is from the United States National Weather Service, which has devised a Heat Index as a measure of the combined effect of temperature and humidity on the human body.

EXCESSIVE HEAT WARNING
NATIONAL WEATHER SERVICE FORT WORTH TX
430 AM CDT WED AUG 22 1990

...An excessive heat warning is in effect for north central...central and northeast Texas through Thursday...

The Heat Index will reach at least 115 degrees today and Thursday and could go as high as 125 degrees. Nighttime lows will only fall into the lower 80s making this a much more hazardous situation. This warning includes the cities of Fort Worth...Dallas...Waco...Tyler...Longview...Sherman and Paris.

The heat index is a measure of how hot it feels when the effects of humidity are combined with the temperature. A heat index of 105 degrees is considered the level where many people begin to experience extreme discomfort or physical stress. Remember...The heat index is measured under shady conditions...and direct exposure to sunshine can increase the heat index as much as 15 degrees.

Heat index values yesterday climbed to 108 degrees in Dallas/Fort Worth...Tyler and Longview and near 120 degrees in Sherman and Paris. These conditions are caused by an unusual combination of weather systems resulting in lots of sunshine...very high temperatures...and way above normal humidity for this time of year.

Children...the elderly and people with chronic ailments are usually the first to suffer from the heat. Heat exhaustion...cramps or...in extreme cases...heat stroke can result from prolonged exposure to these conditions. Friends...relatives or neighbors should check on people at risk.

Reduce outdoor activities...Drink lots of water or other non-alcoholic beverages...Wear light-colored/light-weight clothes and...if possible...spend more time in air conditioned or well ventilated places.

5.8.14
FIRE WEATHER

The combination of high temperature, low humidity and strong wind with dry forest or grass can lead to the extremely rapid spread of fire. The following is an example of a fire weather warning from the Australian Bureau of Meteorology.

FIRE WEATHER WARNING
BUREAU OF METEOROLOGY, SYDNEY
Issued at 1630 hours on Wednesday, 31/12/97
FOR THURSDAY 1 JANUARY 1998

Hot, dry and windy conditions are expected to cause VERY HIGH TO EXTREME FIRE DANGER in the following weather forecast districts on Thursday:
SOUTHWEST SLOPES
RIVERINA
SOUTH COAST
SOUTHERN TABLELANDS
UPPER WESTERN
LOWER WESTERN

The NSW Minister for Emergency Services will TOTALLY BAN THE LIGHTING OF FIRES in ALL OF THESE DISTRICTS and the CENTRAL WEST PLAINS from MIDNIGHT TONIGHT until MIDNIGHT THURSDAY NIGHT 1/01/1998.

5.8.15
FLOODS

The following is an example of a flash flood warning from the United States National Weather Service. Doppler radar is used to detect thunderstorms with heavy rain.

BULLETIN — EAS ACTIVATION REQUESTED
FLASH FLOOD WARNING
NATIONAL WEATHER SERVICE ALBUQUERQUE NM
650 PM MDT SAT AUG 9 1997

The National Weather Service in Albuquerque has issued a:

* Flash Flood Warning for...Bernalillo county in central New Mexico. This includes the city of Albuquerque.

* until 830 pm MDT

* at 645 pm MDT...National Weather Service Doppler radar indicated a thunderstorm with very heavy rain over Petroglyph National Monument...moving slowly to the east.

* Thunderstorms with excessive rainfall will be near western metropolitan Albuquerque at 700 pm MDT. An inch or more of rainfall is expected in downtown sections of Albuquerque from this thunderstorm.

During the next two hours...Flash flooding is expected in normally dry arroyos that drain into the Rio Grande from Albuquerque. Persons in low-lying or normally flood-prone areas should go to higher ground immediately.

5.8.16
AVALANCHES AND LANDSLIDES

The following example of an avalanche warning is from Switzerland.

National Avalanche Bulletin Nr. 25
Issued Sunday, 13 December 1998, 17:00 h
Extended danger of snow-slides

General information

Saturday night, snow fell above about 2200 m, accompanied by strong northwesterly winds. The centre of the precipitation activity was found with 10–30 cm at the westerly northern slope of the Alps and in the western part of the Wallis.

Towards the South and the East, the amount of fresh snow decreased. Below 2200 m, rain fell. Because of this, the snow cover rapidly lost firmness, resulting in numerous crevices and wet snow avalanches.

Short-range development:
Following a mostly cloudy night, it will be sunny in the whole of the Swiss alpine region. Temperatures will rise again by about 4 degrees, so that the freezing level will be at about 3000 m. The snow cover will not significantly stabilize during a cloudy Sunday night.

Forecast of the danger of avalanches for Monday:
Northern slope of the Alps, Wallis, Nord- and Mittelbünden and Unterengadin:
Severe danger of avalanches

Danger spots for dry snow-slides are mainly situated on steep slopes above about 2200 m, especially in exposed locations. Even individual skiers or snowboarders are able to release snow-slide avalanches. Self-releasing snow-slide avalanches have still to be reckoned with. During the second part of the day, small and intermediate avalanches are to be expected. These are especially endangering exposed roads situated under steep slopes facing the sun.

Southern slope of the Alps and Oberengadin:
Moderate danger of avalanches
Tendency for Tuesday and Wednesday:
In the Swiss part of the Alps, sunny and unusually mild weather. During clear nights, the snow cover will stabilize and the danger of avalanches decreases.

Eidgenössisches Institut für Schnee- und Lawinenforschung, Flüelastrasse 11, CH-7260 Davos Dorf

Fax: +41-81-417-0110, Tel: +41-81-417-0111 lang

CHAPTER 5

5.8.17 SMOKE AND VOLCANIC ASH

Smoke from forest and grass fires can cause significant problems for people with respiratory ailments, and can cause significant reduction in visibility, endangering road traffic. The chemical composition and abrasive characteristics of the particles in volcanic ash can seriously affect people and machinery on the ground.

The following are examples of volcanic ash and smoke advisories from the United States National Weather Service.

VOLCANIC ASH ADVISORY
NATIONAL WEATHER SERVICE ANCHORAGE AK
1100 AM AST THU NOV 1 1990

...VOLCANIC ASH FROM MT REDOUBT COVERS THE NORTHERN KENAI PENINSULA AND IS APPROACHING ANCHORAGE...

MT REDOUBT ERUPTED AGAIN THIS MORNING ABOUT 830 AM. SOUTHWEST WINDS ARE CARRYING THE ASH CLOUD NORTHEAST. ASH BEGAN FALLING OVER LAND AREAS ABOUT 150 MILES SOUTH OF ANCHORAGE...ESPECIALLY THE KENAI/SOLDOTNA AREA ABOUT 10 AM. THE ASH CLOUD SHOULD REACH ANCHORAGE BETWEEN 2 AND 4 PM.

LOCAL OFFICIALS RECOMMEND THAT YOU SHOULD NOT VENTURE OUTSIDE UNLESS IT IS ABSOLUTELY NECESSARY. THE ABRASIVENESS OF THE ASH COULD BE HARMFUL TO ANYONE WITH RESPIRATORY PROBLEMS. THE ASH PARTICLES ARE VERY FINE AND MAY SLIP THROUGH MACHINE OR MOTOR VEHICLE FILTER SYSTEMS AND CAUSE DAMAGE. TAKE PRECAUTIONS TO AVOID SUCH CIRCUMSTANCES.

SMOKE ADVISORY
NATIONAL WEATHER SERVICE MIAMI FL
300 PM EST WED MAR 14 1990

...A SMOKE ADVISORY HAS BEEN ISSUED FOR FORT LAUDERDALE/POMPANO BEACH AND NORTHERN BROWARD COUNTY FOR THIS AFTERNOON AND EVENING...

THICK SMOKE FROM GRASS FIRES IN SOUTHEAST FLORIDA JUST WEST OF POMPANO BEACH IS REDUCING VISIBILITIES TO LESS THAN A QUARTER MILE AT TIMES. WEST WINDS ARE PUSHING THE SMOKE ACROSS THE SAWGRASS EXPRESSWAY AND THE FLORIDA TURNPIKE AS WELL AS NUMEROUS CITY STREETS.

SLOW DOWN AND DRIVE CAUTIOUSLY THROUGH THE SMOKE. THE FLORIDA HIGHWAY PATROL HAS REPORTED MANY TRAFFIC ACCIDENTS AS A RESULT OF THE SMOKE. THE LOW VISIBILITIES WILL CONTINUE THROUGH THE AFTERNOON AND INTO THE EVENING AND SLOWLY IMPROVE BY MIDNIGHT AS THE FIRE IS BROUGHT UNDER CONTROL.

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[Chapters 41-46 on hydrological forecasting]

A number of NMSs maintain Internet sites with current forecasts. Access to these can be obtained by hot links from WMO at:

http://www.wmo.ch

NOAA

NOAA/National Weather Service/Weather Operations Manual:
WSOM Chapter C-40, *Severe Local Storm Warnings*. Department of Commerce, 1986.
WSOM Chapter C-41, *Hurricane Warnings*. Department of Commerce, 1991.
WSOM Chapter C-42, *Winter Storm Warnings*. Department of Commerce, 1985.
WSOM Chapter C-43, *Coastal Flood Warnings*. Department of Commerce, 1986.
WSOM Chapter C-47, *Country Warning Areas*. Department of Commerce, 1990.

Photos on opposite page: Shown are some examples of natural disasters affecting hundreds of millions of people all over the world every year — forest fire [FAO/P. Johnson]*; lightning* [NOAA Photo Library]*; flood* [Munich Reinsurance]*; tornado* [NOAA Photo Library]*; and Hurricane Mitch* [Paul Jeffrey/CCD]. *Education and training activities for (bottom left) professional meteorologists* [WMO/H. Kootval] *and (bottom right) the general public including schools* [Thailand Meteorological Department] *are essential elements in a public weather services programme.*

Photos overleaf (page 68, clockwise from top left): Public weather services can be of significant value to weather-sensitive sectors of the economy, such as construction [Jacques Mallard, ILO]*; transport* [WMO/C. Reynolds]*; public awareness* [SES Australia]*; recreational activities and tourism* [WMO/H. Kootval]*; public health* [Tero Pajukallio]*; fishing and agriculture* [WMO/H. Kootval].







How to stay safe during storms

CHAPTER 6

WEATHER FORECAST AND INFORMATION SERVICES

6.1 WEATHER FORECAST SERVICES

Public weather forecasts and warnings, being broadcast regularly over radio and television and published in newspapers, form the public face of the NMS. People judge the NMS by the quality of the service. It is therefore a major opportunity for NMSs to strengthen their visibility through the regular issuance of high-quality products. While it is sometimes difficult to get the media to acknowledge the NMS as the source of the forecast, this is doubly important where some media obtain forecasts from a private meteorological organization.

The differences between warnings and forecasts can be summarized as follows:

Warnings	*Forecasts*
For safety of life and property	Serve socio-economic needs and convenience
Issued irregularly as the need arises	Issued routinely to a schedule
Of an urgent nature, given priority	Of a routine nature

The schedule of times of issue of forecasts has to take into account:

- Major news broadcasts by television and radio;
- Newspaper deadlines;
- Times of receipt of synoptic data;
- Operational workloads in forecasting offices;
- Communications if these do not operate at all hours.

It has been found valuable to survey particular communities, such as farmers and fishermen, to ascertain their means of receipt of forecasts and preferred times of receipt. A forecast issued after a fisherman has left harbour is of little value; a forecast broadcast while a farmer is out in the fields may not be heard.

In many countries the major times when the public is receptive to forecasts are around the times of breakfast and the evening meal. Many television stations broadcast a weather segment after the evening news. Forecasts need to be issued to television stations an hour or more before broadcast to allow time for preparation of graphics and for the presenter to become familiar with the weather situation.

There is a trend for the electronic media to broadcast weather information regularly through the 24 hours. It becomes necessary to issue updates of forecasts between the major issue times if the weather changes in an unforeseen manner, or if forecast weather has already eventuated, e.g. morning fog.

The temporal and spatial scales and the contents of forecasts must be adapted according to the intended users of the forecast. For the public more general information is required, while forecasts for sports activities might be more detailed in area (e.g. for the mountains or the sea) or be issued only in a specific season (e.g. snow cover for skiers in winter). Weather-sensitive economic sectors such as agriculture need more detailed information on, for example, rain and temperatures. Means of ascertaining user requirements are discussed in Chapter 9.

Generalized public weather services intended for the population at large can also be of significant value to weather-sensitive sectors of the economy such as agriculture, forestry, fishing and marine transportation, tourism and recreation (see Figure 9). This is particularly the case where the NMS has involved representatives of economic sectors in the planning of its public weather services programme. Suggestions from these representatives, concerning, for example, broad product content and format, optimum times for scheduled issues and the most appropriate boundaries for forecast regions, can often be incorporated and may improve the utility of basic public weather services products. This approach is particularly appropriate in regions where the population is heavily dependent on one or two weather-sensitive economic activities such as agriculture. Forecasts for such particular sections of the economy are discussed in 6.4 below.

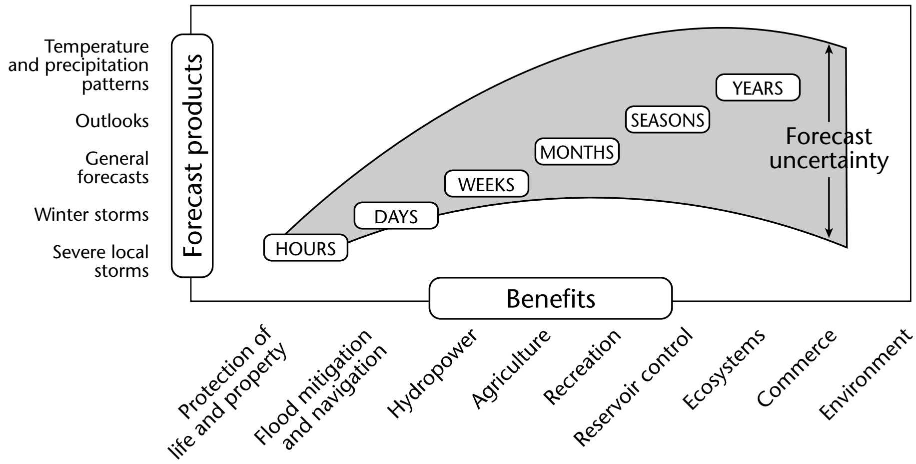


Figure 9. Integrated suite of forecasts (after NOAA)

6.1.1 COMMON VARIABLES/PHENOMENA IN PUBLIC FORECASTS

There are a number of meteorological variables and phenomena which commonly appear in public weather services products. These are discussed in detail in the following sections. It should be noted that the order in which the variables and phenomena are addressed is not intended to reflect their priority within individual regions or countries.

Precipitation

The likelihood of occurrence of precipitation is of great interest, if not of vital importance to people in most regions of the globe. For this reason, forecasts of occurrence or non-occurrence of precipitation are a universal feature of public weather services programmes. The forecast precipitation type (rain, snow, hail, etc.) is normally indicated along with an indication of its expected intensity and its temporal and spatial characteristics, e.g. slight/heavy rain, drizzle, shower or "heavy rain in the late afternoon" or "showers in the east clearing during the day".

Regardless of specific practice, it is important that the terminology used to describe precipitation (and other elements) in forecasts is readily understandable to the public, that descriptors are concise and meaningful and that great effort is made to avoid ambiguity. In some countries, for example, public forecasts include predictions of the Probability of Precipitation (POP). [A probability of precipitation of 80 per cent means that it was raining in 80 out of 100 similar weather situations. For verification purposes (see also Chapter 10), this forecast is always carried out for single locations.] Where such an approach is taken, the POP values cited must be consistent with other references to precipitation in the forecast. POP forecasts should be issued only for small areas such as cities and towns. It is the chance of rain falling at any one location at some time during the forecast period, e.g. an afternoon. This is not the same as the chance of rain falling somewhere in a large metropolitan area, or the chance of rain falling in a particular half-hour.

Wind

Wind is a very important meteorological element which is frequently included in public forecasts since it affects many human activities. The wind speed is usually given in descriptive terms such as light, moderate, etc. Descriptors or qualifiers used in forecasts of wind conditions must be well understood by the public and must relate to their local environment and their daily activities. In cold winter climates, for example, "wind chill" is well understood by residents while in hot and humid coastal regions, the forecast development of a "sea breeze" may offer the promise of welcome relief to the population.

Very strong winds are usually the occasion for the issue of a warning as they are a major hazard to people, property, crops, transportation systems, public utilities and other vulnerable sectors. In some countries, climatic or topographic factors result in regional-scale or localized strong wind phenomena (e.g. tropical cyclones, tornadoes, the monsoon, katabatic winds such as the Foehn or Chinook) which are well-known to the population. Warnings and forecasts of these phenomena form an essential component of public weather services in the affected regions.

Temperature

Temperature forecasts for the general public are normally issued for geographic regions or groups of regions or for significant locations such as cities. Descriptive terms may be used, e.g. cold, mild, hot, or they may take the form of predictions of daily maximum and minimum temperatures except in some stable climatic regimes where expected changes from preceding temperature conditions are indicated. Where strong temperature gradients occur, such as along coastlines or on the slopes of mountains, special reference may be made to these variations in regional forecasts or, alternatively, separate forecasts may be issued to address the phenomena. Explicit reference is also sometimes made to temperature trends expected to occur during the forecast period, particularly when an abnormal or unseasonable temperature regime is either expected to occur or is forecast to continue.

Temperature information can be issued in a variety of different measures: air temperature, ground temperature (especially if temperatures below 0°C are expected), probability of frost, perceived temperature (see Appendix 1 to this chapter).

Humidity

In some climatic regimes, the humidity of the air has a significant impact on human comfort (see Appendix 1 to this chapter) and capacity to do physical work. High humidity in combination with high temperatures can be a hazard to human life by diminishing the body's ability to dissipate heat through sweating and evaporation. Atmospheric humidity can also directly affect socio-economic activities in other ways. Some farming operations, such as irrigation and crop drying, are strongly influenced by the humidity of the air as is the spread of diseases and blights which may reduce agricultural productivity or increase the costs of production. During periods of high humidity in warmer climates, an upsurge in demand for electricity for air conditioning of buildings can stress power-generating facilities. Conversely, an extended period of low atmospheric humidity will significantly increase the flammability of forests, bush and savannah, thereby heightening the risk of disastrous fires in vulnerable regions.

As a result of the above impacts, some NMSs include information on atmospheric humidity in their public weather services products. The form which this information takes shows considerable variation. Some NMSs routinely provide observed values of relative humidity to the public. Others disseminate a Heat Index or a Humidity Index which provides a simplified indication of human comfort (or discomfort!), either in numerical terms or as a short descriptive phrase. References to significant trends and/or changes in humidity are also often included in public forecasts in the form of brief statements such as "humidity will remain high" or "becoming less humid".

A number of specialized products (most notably agricultural bulletins and fire weather forecasts) routinely include information on observed and predicted atmospheric humidity conditions, but dissemination practices for these specialized products vary considerably. Some NMSs restrict them to special clients such as major agricultural and forestry companies or government departments and may charge these clients for them. In other countries, it is the policy to disseminate such products widely by radio, television and newspapers as a component of the national public weather services.

Visibility

References to visibility in public forecasts are usually limited to situations where restrictions to visibility may present a hazard to public safety, most particularly to travellers by road, air and sea, but also to skiers and mountain climbers. Weather situations which may cause dangerously restricted visibility include fog, snow or blowing snow, blizzards, sandstorms or dust storms, smoke from forest or bush fires, heavy rains and photochemical smog. A number of WMO Members include reduced visibility hazards among their national criteria for the issue of weather warnings or advisories to the population. Visibility conditions are also included in forecasts for recreation and tourism, for example to point out the possible view from a mountain area.

Sky condition

It is a common practice for public forecasts to include a description of the expected sky condition during the forecast period since the state of the sky or amount of cloud cover is of interest to the population in most climatic regimes. References to this element are generally concise (e.g. sunny, cloudy, bright periods) with appropriate temporal and spatial modifiers added where necessary. There is heightened public interest in the sky condition during recreational seasons, public holidays and for special outdoor events. At such times, provision of additional detail on sky cover may be appropriate in public forecasts and this approach is followed in a number of countries.

6.1.2 TIME SCALE OF FORECASTS

Time scale definitions

Forecasts may be classified in accordance with the following WMO definitions of forecasting ranges. However, some NMSs follow variations of the WMO definitions.

Nowcasting	a description of current weather parameters and a zero to 0–2 hour forecast description of forecasted weather parameters
Very short-range weather forecasting	to 12 hours description of weather parameters
Short-range weather forecasting	beyond 12 hours and up to 72 hours description of weather parameters
Medium-range weather forecasting	beyond 72 hours and up to 240 hours description of weather parameters
Extended-range weather forecasting	beyond 10 days and up to 30 days description of weather parameters, usually averaged and expressed as a departure from climate values for that period
Long-range forecasting (from 30 days up to two years)	
— monthly outlook	description of averaged weather parameters expressed as a departure (deviation, variation, anomaly) from climate values for that month (not necessarily the coming month)
— three month or 90 day outlook	description of averaged weather parameters expressed as departure from climate values for that 90-day period (not necessarily the coming 90-day period)
— seasonal outlook	description of averaged weather parameters expressed as departure from climate values for that season
Climate forecasting (beyond two years)	
— Climate variability prediction	description of the expected climate parameters associated with the variation of interannual, decadal and multi-decadal climate anomalies
— Climate prediction	description of expected future climate including the effects of both natural and human influence

Nowcasts and very short-range forecasts can be regarded as explicit, physically-based predictions of the expected occurrence of the forecast elements or phenomena. As the forecast period lengthens through medium- to long-range time scales, however, forecasts must increasingly be regarded as spatially and temporally averaged conditions thought most likely to occur, based on current knowledge. Since our current understanding of the behaviour of the atmosphere on longer time scales is imperfect, the accuracy and detail of longer-range predictions is considerably less than that to which users of short-range forecasts have become accustomed. In 1999, over 90 per cent of NMSs were issuing short-range forecasts, over half medium-range forecasts, and about one-third long-range forecasts.

As the skill of medium- and long-range forecasts improves, however, they do offer great potential for economic and social benefits (see Chapter 2). Many developing countries, especially those in tropical regions, would benefit from predictions on seasonal time scales due to the importance to them of seasonal events such as the beginning or ending of the rainy season and the nature of seasonal rainfall. This interest arises from the dominant importance of agriculture in many developing countries and the sensitivity of that sector to prolonged droughts or unusually heavy rainfalls. Long-range forecasting is further discussed in 6.4.1 below.

6.1.3 SPATIAL SCALE OF FORECASTS

Forecasts may be issued for areas of various sizes from a town to an area of several thousand square kilometres. As the area becomes larger the forecast becomes more general. As it becomes smaller the forecast can be more specific. Countries of relatively small area issue forecasts for the country as a whole. Countries of relatively large area are usually divided into States or provinces, and forecasts are issued for these. In some countries these may be subdivided into counties. In countries where States or provinces are large in area, they may be subdivided into districts or zones for forecast purposes. These are often delineated by mountain ranges or river valleys or deltas. Forecasts may also be issued for the larger cities and towns. Most NMSs have their own spatial scale definitions.

The important points are that:

- the name and boundaries of an area must be well-known to the public so that there is no confusion as to where the forecast applies; and
- the forecast areas should be meteorologically consistent, i.e. have similar weather on most occasions.

The desirable size of these areas will depend on the local meteorological variability. In static weather situations smaller areas can be combined with one forecast.

There is often pressure from local communities for a separate forecast for their area, on the grounds that their weather is different. Whether the request is acceded to depends on whether the claim is real and whether the NMS has the resources to undertake the additional work. Sometimes the request is made to obtain publicity for the community on the television weather presentation rather than any real difference in the weather.

Figure 10 is an example of the division of a country into forecast districts. The smaller the district the more variable the weather, the more reliable the rainfall and the higher the population density.

Figure 10. Weather forecast districts in Australia (Australian weather forecast districts, showing also the locations for which daily temperature forecasts are provided through the media)
(Bureau of Meteorology, Australia)

6.1.4 FREQUENCY OF ISSUE

Short-range forecasts are often issued to meet major media news times, usually early in the morning for news around breakfast time, and in the late afternoon for evening news broadcasts. Some NMSs have a third issue around midday.

No matter how many routine issues are made per day, it is important to keep a check on the current forecast and issue an amendment if required. It is not good for the image of an NMS if a radio or television station continues to broadcast a forecast at variance with weather developments during the day. As forecasting accuracy improves, such amendments should become less necessary.

6.1.5 CONTENTS OF FORECASTS

An effective forecast provides sufficient detail to enable the user to make effective decisions. So when producing a forecast, several points should be taken into account.

General information

Public forecasts must include essential background information such as the name of the issuing NMS or Weather Office, the time of issuance of the product, the period covered by the forecast and the region to which it applies.

Current warnings

It is useful to include in the forecast reference to current warnings applicable to the forecast area.

Variables

Variables are described in 6.1.1 above.

Layout

Layout (text, charts, maps, tables): see Chapter 7.

Language

Forecasts must be written in an easy to understand manner, using clear and common language. It is important that the terminology used to describe the weather in general and also every variable such as precipitation or temperature is readily understandable by the public; that descriptors such as POP are concise and meaningful and that great efforts are made to avoid ambiguity and technical jargon. On the other hand, in specialized products such as forecasts for the agricultural section or water management, more technical and detailed terminology could be used to state the information more precisely.

Uncertainty

If there is uncertainty in the forecast, it should be highlighted either in a qualitative or quantitative sense to assist the user in the decision-making process. In the context of uncertainty, terms such as “possible”, “may” or “expect” should be used with discretion as they could be seen by users as lack of confidence on the part of the forecaster. On the other hand, they are useful to state that there is always a certain degree of uncertainty in any forecast. The nature of some significant events is such that it would be a disservice to not indicate the uncertainty in the forecasts.

Style

Forecast styling is an important tool in effective communication with the public. Too often, the forecast is structured in a repetitive or routine formula regardless of the weather situation. This can be detrimental for unusual, dangerous or fast-breaking events where a sense of immediacy or urgency is required. Appropriately, the occasional use of more descriptive phrasing or more definitive timing of events should be used as long as the forecast remains clear and easily understood. For greater public understanding, forecast wording should be as concise as practicable. This may mean occasionally eliminating one or more less important elements, especially when they are implied by other elements in the forecast, i.e. sky cover when precipitation is occurring.

The issuance of warnings and forecasts at the same time needs special attention to ensure that the warnings are not underestimated. Their differences in nature should be reflected in style and language.

Before releasing the forecast, if time permits, the forecaster should read through the forecast and perceive it from the public’s point of view. This should help ensure that the forecast states (or implies) exactly what is intended.

6.1.6 AUTOMATIC FORECAST GENERATION

The use of computer technology in the generation of public weather forecasts and warnings is proving to be of great assistance to many NMSs.

The US National Weather Service has developed the Interactive Computer Worded Forecast (ICWF) that enables forecasters to prepare digital forecasts of weather elements from which routinely-issued forecast products can be automatically composed and formatted. This allows NWS forecasters to concentrate on making important forecast and warning decisions, rather than on the preparation of products. The common digital database used to generate these products also allows for more consistent forecasts over time and among products, and makes it easier to monitor and maintain those forecasts. A first-guess forecast for sensible weather elements is generated from forecast guidance. Guidance sources include Model Output Statistics (MOS), the Local Automated Weather Interactive Processing System (AWIPS), and forecast gridfields produced at NWS National Centres. The previous official forecast may also be selected for initialization.

6.1.7 EXAMPLES OF FORECAST PRODUCTS

The examples below are from Argentina, Australia and the United Kingdom. Examples from other countries are in the accompanying CD-ROM.

This example from Argentina give the forecast for one city (Buenos Aires) for four days.

Weather Forecast for Federal Capital and Surrounding Areas
Buenos Aires, 10 February 1998
Official forecast for 05.00 hrs, for federal capital and surrounding areas

TUESDAY
Slightly or partially cloudy. Temperatures falling.
MINIMUM: 13
MAXIMUM: 25
Sky slightly or partially overcast. Morning mists in suburban area. Temperature falling. Weak southerly winds.
Forecast Intensity of Solar Ultraviolet Radiation (ISUV): Very high

WEDNESDAY
Little cloud. Pleasant.
Sky slightly overcast. Cool during the morning, thereafter pleasant. Weak south-easterly winds, backing easterly.

OUTLOOK FOR THURSDAY AND FRIDAY

THURSDAY: Clear or slightly overcast. Cool during the morning, later on slight rise in temperature.

FRIDAY: Partly overcast. Slight rise in temperature.

This example from Australia is a group of forecasts for a State (Victoria), its capital city (Melbourne) and local waters near Melbourne. It starts with a summary of current warnings. It ends with a headline for the benefit of television captions and front pages of newspapers.

FORECAST FOR VICTORIA
Bureau of Meteorology, Melbourne 05:29 13/12/1994
for today and tonight.

WARNINGS:
A Fire Weather Warning is current for the Mallee, Northern Country and North Central districts where Fire Danger will be extreme in forest areas.

VICTORIA:
Cooler west to south-westerly winds in the south-west gradually extending to all districts by tonight. Warm to hot with northerly winds ahead of the change. Isolated showers and thunderstorms developing in most areas.

Fire Danger: Extreme in northern, western and central areas of the State and high to very high elsewhere at first but decreasing from the west.

ALPINE AREAS: (ABOVE 1200 METRES)
Isolated showers and thunderstorms developing during the day. Fresh and gusty northerly winds, easing later.

PORT PHILLIP BAY and WESTERN PORT:
Variable winds to 10 knots at first becoming north westerly to 15 knots in some parts before shifting west to south-westerly at 10 to 15 knots by the afternoon. Waves to 1 metre.

MELBOURNE and METROPOLITAN area:
Cloudy at times and mostly fine but the chance of a thunderstorm developing during the day. Cooler west to south-westerly winds developing by the afternoon. MAX = 28

OUTLOOK WEDNESDAY	Fine. MAX = Low 20s
OUTLOOK THURSDAY	Fine. MAX = Mid 20s
OUTLOOK FRIDAY	Fine. MAX = Low 30s

HEADLINES:
Headline City: Mostly dry. Becoming cooler.

This example from the United Kingdom is of a brief forecast for the whole country issued several times a day for national radio broadcast. It also includes a headline.

BBC 30 WORD FORECAST
FOR BROADCAST BETWEEN 1000 AND 1400 07-DEC-94

Here is the forecast for the United Kingdom until dawn tomorrow.
Blustery showers, most frequent and heavy in the west and north, scattered in the east with the best of any sunshine there. Rain again tonight, with gales in the south.

HEADLINE:
Showers or longer periods of rain. Very windy. Gales in south tonight.

6.2 WEATHER INFORMATION SERVICES

REAL-TIME INFORMATION

The provision of weather information to the public can take a variety of forms, and the names given to the various products can be chosen by the NMS. As with other products, only those with user demand need to be provided.

Information provided in real-time (i.e. for immediate use by the media) includes:

- A description of the weather over the past 6 to 24 hours, including the highest and lowest temperatures and highest rainfalls in the period over the area of responsibility of the forecasting office. Interesting or significant events in neighbouring areas could also be included. Possible titles include “weather summary”, “recent events”, “today’s weather”, etc.;
- Tables of rainfall and/or temperature for the past 6 to 24 hours;
- A simple explanation of what has been causing the recent weather and what will bring about the forecast weather. A possible title is “explanatory notes”;
- Maps showing isobars and positions of high, lows and fronts, from the latest analysis and from prognoses for the next day, and for some further days. In tropical areas where pressure gradients are weak streamline analyses may be useful. Other maps can be developed which show, for example, the direction of air mass movement instead of isobars;
- Technical discussions stating the reasons behind the forecast in more technical terms. These are not for the general public but for specific agencies, particularly the hazards community, to help the decision makers understand the meteorological situation and any uncertainties in the forecast. They may be exchanged between forecasting offices;
- More extended information on unusual weather, such as a hot, cold, wet or dry spell, and any records which may have been reached, issued only when there is something of this nature to report. This may be issued as a press release. A regular issue may be made at the end of each month briefly summarizing the month as a whole for rainfall, etc. for the benefit of the media. Issuance would be according to demand and climatology — for example, there would probably be little point during a tropical dry season.

Other information: Although not meteorological, it is common practice for the media to include with the weather presentation information about the rising and setting of sun and moon, sea temperature, high and low tide. Such information may originate from astronomical or tidal authorities or may be issued by the NMS according to national arrangements.

NON-REAL-TIME INFORMATION

Information provided in non-real-time includes:

- Summaries and tables of total rainfall, mean temperature, etc. at various places for a week or a calendar month;
- Maps of rainfall for a calendar month or a year;
- Hydrological information such as water supply, levels of irrigation storages, river flows, soil moisture content and snowpack status;

- Summaries of growing degree-days (for agriculture) or heating degree-days (for fuel supply).

There is less urgency with these products, and they can be sent by post as well as by facsimile, e-mail, Internet etc.

6.2.1 EXAMPLES OF INFORMATIONAL PRODUCTS

The following examples are from Colombia and the United States.

This example from Colombia describes the current synoptic situation.

SYNOPTIC SITUATION IN COLOMBIA AND SURROUNDING AREAS FOR WEDNESDAY 31 DECEMBER 1997

Preparation date : Wednesday 31 December at 12.00 noon

Synoptic situation:
A high-pressure system continues to prevail over the Central and Western Atlantic. This system covers the Eastern parts of the Caribbean, with between moderate and heavy air subsidence. This is favouring the presence of clear or only slightly overcast skies in Colombia in the north of the Caribbean Region and the north of the Andean Region.

The Intertropical Convergence Zone is not very active over the national area, only a few isolated convectional nuclei are to be seen in the south of the Andean Region and the central and southern sectors of the Pacific Region.

In addition, advection of air masses from the north of Brazil towards the Amazonian interior and the southern Orinoco can be perceived.

This example from the United States describes the recent weather over the State of North Dakota.

NORTH DAKOTA STATE WEATHER SUMMARY
NATIONAL WEATHER SERVICE BISMARCK ND
735 AM CDT FRI JUL 11 1997

Thunderstorms with heavy rain and hail rumbled across North Dakota last night. One to two inch hail was reported in west central North Dakota...A tornado was spotted near the Minot Airbase...And over four inches of rain fell across east central North Dakota...In Lamoure.

For the major reporting points...Jamestown received /0.86/ And Bismarck /0.41/. Minot reported /0.29/ Williston /0.19/ Fargo /0.10/ And Grand Forks had /0.08/. Lows ranged from 62 in Dickinson to 71 at Grand Forks.

At 7 am CDT...Skies were partly cloudy to cloudy with temperatures in the 60s to around 70. Winds were southerly at 10 to 25 mph except in the far west where the wind was northwest at 5 to 10 mph.

6.3 APPLIED FORECAST PRODUCTS

Many national Meteorological Services also provide special applied meteorological, climatological and hydrological information to support weather-sensitive sectors of the economy. Considerable variation in national practices exists where these applied services are concerned with some NMSs producing them on an exclusively user-pay basis and others supplying them at no cost. In addition, distinctions are frequently made between free and chargeable services to economic sectors on the basis of detail, specificity and targeting with tailored products being charged for while generalized products are made freely available. Provision of detailed information on applied national products and services is beyond the scope of this *Guide* and readers are referred to the relevant WMO Guides referenced throughout this publication.

6.3.1 AGRICULTURE

Public forecasts can provide much useful guidance to agricultural communities by informing them of expected weather conditions in time to schedule farming operations such as ploughing, irrigation, spraying and harvesting or to take action to reduce losses in the face of, for example, drought or flood conditions or severe weather phenomena. They can also assist in scheduling the transport to market of vulnerable produce so that potentially damaging weather conditions are avoided en route (e.g. freezing temperatures which can damage potatoes and other vulnerable crops).

Agriculture is a dominant activity in many developing countries and in some developed ones. Consequently, the provision of services to agriculture is a very high priority for many NMSs. Though much of the information of value to the agricultural community is somewhat specialized, NMSs in highly agriculture-dependent countries commonly treat applications of meteorology to this sector as part of their public weather services programmes and often supply very detailed and specialized products freely to the agricultural or rural community. Conversely, in a number of developed countries, specialized services to strong and prosperous agricultural interests are either provided by private meteorologists or by the NMS on a cost-recovered basis.

In countries which are prone to recurring, often disastrous, drought conditions, drought monitoring programmes are usually considered to be a vital part of the national public weather services programme. As an example, severe droughts in Africa in recent decades have led to the establishment of Drought Monitoring Centres in Nairobi, Kenya and Harare, Zimbabwe. These centres produce drought monitoring products which are widely used by NMSs throughout that region.

This example from Zambia is of a seasonal forecast followed by the implications for agriculture.

SEASONAL RAINFALL FORECAST FOR 1995/96 SEASON

Introduction:
The onset of the rains is expected to be normal over the whole country. As the season progresses, near normal rainfall is anticipated to continue, with Western Province and adjoining parts of North-Western Province receiving slightly above normal rainfall whereas Lusaka Province will have marginally below normal rainfall.

Details:

However, some short dry spells particularly during the months of December and January could occur. But the rest of the rainy season will return to normal.

This high probability of near normal rainfall is supported by:
The current absence of the El Niño in the South Pacific Ocean; the Southern Oscillation Index (SOI) values having an upward trend between May and September, 1995; the normalization of the sea surface temperatures in the equatorial Pacific, Indian and Atlantic Oceans; the likelihood of the Intertropical Convergence Zone (ITCZ) having a maximum southward shift due to the absence of anomalously warm water over Central Indian Ocean.

The implications of this Forecast from an agricultural point of view are:

Plant early (before 2nd week of December) especially critical in the Southern half of the country (Regions I & II). Early planted crops stand better chance of attaining full crop cycle.

Plant seeds appropriately suited. Successful cultivation markedly depends on right choice of varieties in the drier areas, drought-resistant crops give better yield per unit of land.

Apply moisture-conserving tillage practices. Appropriate tillage practices help crop to withstand dry spells. Careful weeding improves soil-moisture status in crop stands.

Take keen interest in weather forecasts. Regular weather updates available on TV and radio. Ten-day weather updates presented in Crop-Weather Bulletins.

However, this forecast should be used cautiously because other local and regional factors, as well as inherent climate variability, may influence the rainfall pattern.

This example from India is a farmers' weather bulletin issued twice daily.

FROM MET. SAFDARJUNG
TO A.I.R. NEW DELHI THURSDAY 16-8-94
FARMERS WEATHER BULLETIN FOR U.P., HARYANA, CHANDIGARH AND DELHI,

VALID UNTIL THE MORNING OF 18-8-94
Monsoon has been vigorous in Haryana and West Uttar Pradesh and active in East Uttar Pradesh.

Moderate to rather heavy rain will occur at many places in all the districts of Uttar Pradesh, Haryana, Chandigarh and in Delhi.

HEAVY RAINFALL WARNING:
Heavy rain is likely at a few places in all the districts of Garwhal, Kumaon, Meerut, Moradabad, Bareilly divisions and in all the districts of Haryana and at one or two places in Lucknow, Allahabad, Faizabad, Gorakhpur and Varanasi divisions during the next 48 hours.

OUTLOOK FOR THE SUBSEQUENT TWO DAYS:
Decrease of rainfall.

Bulletins like the above example are issued twice daily for farming districts.

This example from Australia is targetted to a particular agricultural sector, in this case the dried fruits industry.

SUNRAYSIA FORECAST
BUREAU OF METEOROLOGY, MELBOURNE
16:51 18/04/1994

FORECAST: SUNRAYSIA AREA:
A high pressure system over the Bight extends a ridge to northern Victoria and will remain west of Victoria until Thursday then be slow moving over western Victoria. Conditions will be fine and cool to mild throughout the forecast period up to Friday. Some cloud is expected in the west of the Mallee tomorrow and Wednesday but clear skies are likely Thursday and Friday. Maximum temperatures are expected to be about 20 tomorrow and Wednesday and in the low 20s Thursday and Friday. Relative humidity is expected to range from 75–85 per cent in the early mornings to 40–50 per cent in the afternoons. Light to moderate southwest to southerlies are expected until Friday.

6.3.2 FORESTRY

Public weather services in forested regions should be sensitive to the requirements and constraints of the local population and the forestry sector. Ongoing consultation should be undertaken with the population and industry in these regions to ensure that public weather services highlight elements and conditions which are most relevant and meaningful to those who live and work in the forests.

One concern of forest workers in some parts of the world is forest fire, and forecasts of the relevant elements (temperature, humidity and wind) may be required during the season for fires. The NMS may also need to monitor the dryness of the forest as well, so as to inform the public of the degree of danger of fires each day. When the danger is extreme a warning will be required. Another requirement may be forecasts of calm conditions for aerial spraying of insect pests.

6.3.3 ENERGY

In many countries, the public is highly dependent on power and energy supplied by public utilities and other elements of the energy sector. Residential and commercial heating and cooling systems, for example, are essential to human comfort and even survival in some climates. Severe weather events can cause major disruptions to these systems. Public weather services can assist the population to prepare for and minimize the impact of such disruptions. They can also assist energy utilities and companies to efficiently deploy repair crews and other essential staff so that inconvenience or risk to the population is minimized. Many energy utilities also contract with national Meteorological Services or the meteorological private sector for specialized forecasts and climatological services to assist them in operational planning to meet expected demands for electrical power, heating fuel and gasoline. Forecasts for offshore oil and gas exploration and extraction are marine services and are discussed in the *Guide to Marine Meteorological Services* (WMO-No. 471).

The following example from Australia is a forecast for public utilities (gas and electricity supply) with particular attention to the time of peak load (6 pm).

BUREAU OF METEOROLOGY
VICTORIAN REGIONAL OFFICE

Public Utilities Forecast for Melbourne
Issued at 0830 on Monday 19/04/99

Monday: Fine. A sunny morning then cloudy periods this afternoon. Freshening north to northwesterly wind. Max Temp 21

Tuesday: Cooler moderate to fresh west to southwesterly winds will develop during the day with a few showers. Min Temp 13 Max Temp 18

Mean wind speed (knots) for Melbourne over 12-hour periods

	0900–2100	2100–0900
19/04/99	15	15
20/04/99	20	15/20

Outlook:

Wednesday	Shower or two	Min 11	Max 17
Thursday	Becoming fine	Min 9	Max 18

Conditions for peak load 1800

Temp:	18
Cloud:	Broken
Wind (knots):	10/15
Weather:	Fine

6.3.4 WATER RESOURCES

Water resources are essential to all societies and populations whether for the supply of drinking water, irrigation for agricultural production, inland water transport or cooling of power stations. Water resource projects, involving as they do the construction of dams, aqueducts, wells, pumps, water and sewage treatment plants and drainage works, are designed on the basis of knowledge of a region's climate. Once built, their efficient operation relies on up-to-date information on temperature, precipitation, humidity and wind speeds and forecasts of these variables. Predictions of dry weather require conservation of existing water supplies; predictions of excess, particularly if they could lead to flooding, demand a prompt response on the part of all who are responsible for the safety of lives and property in the areas at risk from inundation. This vital flow of information depends on close links being maintained between public weather services and the national and state authorities which operate water resource projects and provide flood forecasting and flood control services.

This example from the United States shows a tabular format for forecasts of river heights for the following three days.

RIVER SUMMARY
NATIONAL WEATHER SERVICE TWIN CITIES/CHANHASSEN MN
1015 AM CDT WED JUL 2 1997

ALL STAGES ARE RECORDED IN FEET
R.....INDICATES A RISE M...INDICATES MISSING DATA
F.....INDICATES A FALL E...INDICATES ESTIMATED DATA
N/C...INDICATES NO CHANGE

	FLOOD STAGE	7 AM STAGE	24-HOUR CHANGE	7/3	7/4	7/5
MISSISSIPPI RIVER..						
MINNEAPOLIS	16	6.9	1.1R	7.4	8.1	8.7
ST PAUL	14	7.3	2.1R	7.1	7.0	7.8
HASTINGS	15	8.5	1.8R	9.8	9.4	9.5
RED WING	14	5.0	0.5R	7.6	9.3	9.4

6.3.5 WEATHER AND HEALTH

Changing atmospheric conditions can place added stresses on sensitive, elderly, or sick people, on young children and on pregnant women. People with cardiovascular or respiratory diseases may be overtaxed during certain atmospheric events while in some countries a significant percentage of the population has been shown to be sensitive to pollen during certain seasons of the year. There is a growing awareness of the linkages between human health and the weather and climate which should be kept in mind when the content of public weather services programmes is being reviewed. This growing awareness is reflected in initiatives such as the completion of a comprehensive monograph on Climate and Human Health, produced by WMO in collaboration with the World Health Organization (WHO) and the United Nations Environment Programme (UNEP), and WMO sponsorship of an expert meeting on the issue of Climate, Tourism and Human Health, held in 1995. In addition, a growing number of national Meteorological Services now include expanded environmental information in their public bulletins. Their broad goals are to improve public understanding of environmental issues and to enable people to take actions to reduce adverse environmental effects or stresses. At the international level, this trend is endorsed by WMO which is placing increased emphasis on the role of national Meteorological Services in contributing to sustainable development. The following "environmental" elements form part of some national public weather services programmes.

Air quality

Inclusion of air quality information in public weather bulletins can assist the public to take action with respect to air pollution and photochemical smog. Examples of pollutants which cause problems for many urban and some rural populations include ground-level ozone, sulphur dioxide and nitrous oxide. Timely information enables members of the public to take action to reduce air pollution levels, to avoid polluted areas or to alleviate adverse effects on health. Real-time measurements of air pollution levels are of great interest to urban populations and are sometimes included in air quality advisories issued to the public. Frequently, however, air quality advisories are issued on the basis of forecasts that pollution levels will exceed predetermined air quality guidelines due, for example, to the development or persistence of a low-level atmospheric inversion with poor atmospheric ventilation. In many countries the measurements of air pollution are taken by another authority and the service to the public is a cooperative one between that authority and the NMS.

Examples of actions which people can take in response to an air quality advisory include using public transportation, pursuing staggered work hours or simply staying indoors. Industries and regulatory authorities in some jurisdictions also take actions such as temporary shutdowns of pollution-emitting industries or thermal power plants, banning private automobiles from city centres and closing government offices.

In many countries the service is a cooperative one where the measurements and other information are provided by the relevant government authority, e.g. an environment protection agency, and the NMS incorporates these with its forecast in a specific air quality product for dissemination with its other products. Similar cooperative arrangements may be made in the provision of services for pollen and ozone discussed below.

The following are examples of environmental products which are issued by NMSs.

Air pollution

The following is an example of an air pollution forecast from the United States, where a pollution standards index (PSI) has been developed as a ready measure of the degree of air pollution. The PSI forecasts and pollen count have been provided by other government organizations.

Example of an air pollution forecast from the United States

OMAHA POLLUTION INDEX
NATIONAL WEATHER SERVICE OMAHA/VALLEY NE
910 AM CDT WED JUL 2 1997

The Omaha metropolitan area Pollutant Standards Index/PSI/forecast for today is 58 with particulates the primary pollutant and ozone a secondary pollutant. This is considered moderate air quality. The forecast PSI for Thursday is 52...Again mainly from particulates. This is also considered moderate air quality.

The Douglas county pollen count was 32...a low count...with grasses and pine the primary pollens.

PSI forecasts are provided by the Omaha air quality control department.
The pollen count is provided by the Douglas county health department.
Burning in wood stoves and fireplaces is allowed in King, Pierce, Snohomish and Kitsap counties subject to normal rules.

Pollen

In Central Europe, every tenth person suffers from allergic reactions to pollen. The time of ripening and release of pollen, as well as the flight of the pollen, all depend on the day-to-day weather. The mean values from pollen calendars do not provide any practical help for allergy sufferers. For this reason, in many European countries, measuring networks have been established during the last 10 years as a basis for forecasting the prevalence of airborne pollen for the following 2–3 days, in connection with the weather forecast.

Example of a pollen forecast from Germany

Deutscher Wetterdienst
Pollen count forecast for Nordrhein-Westfalen, issued by the department of medical meteorology Essen, in cooperation with the foundation German Pollen Information Service
Monday, 27.07.98, 14 h
Valid until Tuesday, 28.07.98, evening

Forecast:
This afternoon, mainly moderate pollen count of grass and mugwort is expected. On Tuesday morning, the count of grass and mugwort pollen will be first limited due to showers. In the afternoon, it will increase again to a mainly moderate level.

Next updating
Tuesday, 28.07.98 about 15 h
Department of medical meteorology (E)

Ultraviolet radiation

Increased levels of ultraviolet (UV) radiation have been observed at the Earth's surface in recent years, most particularly in middle and high latitudes. These increases are associated with the thinning of the stratospheric ozone layer which has resulted from the release to the atmosphere of man-made, ozone-depleting substances such as chlorofluorocarbons (CFCs). Increased UV radiation has been shown to increase the occurrence of skin cancers and eye cataracts in humans and may also adversely affect plants, aquatic organisms and other natural systems. In response, several national Meteorological Services (in 1999, about 20 per cent of NMSs worldwide), now include information on the expected or measured intensity of UV radiation in their public weather services products. To facilitate public understanding, this information is sometimes presented in the form of a simplified "UV Index". The forecast can be even more broadly expressed as 'moderate', 'high', 'very high', etc. UV information can assist people in protecting themselves from over-exposure during periods of high UV intensity by alerting them to avoid outdoor activities, wear protective clothing or use chemical sunblocks.

A meeting was held in Switzerland in July 1997 with the aim of standardizing UV Indices (see WMO/TD-No. 921, Report of the WMO-WHO

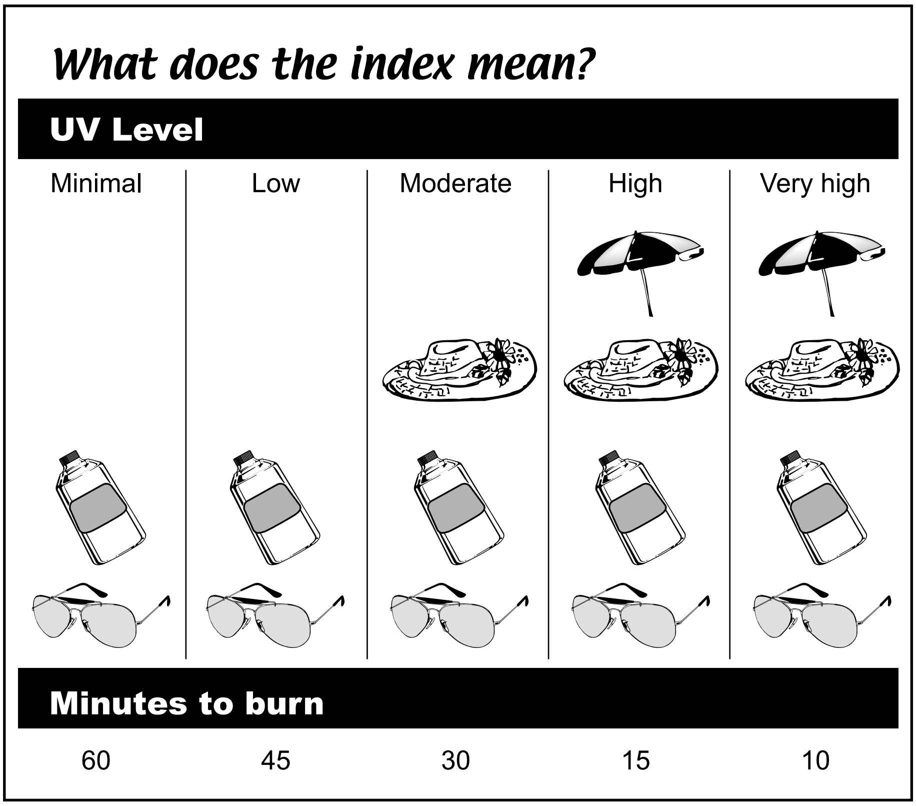
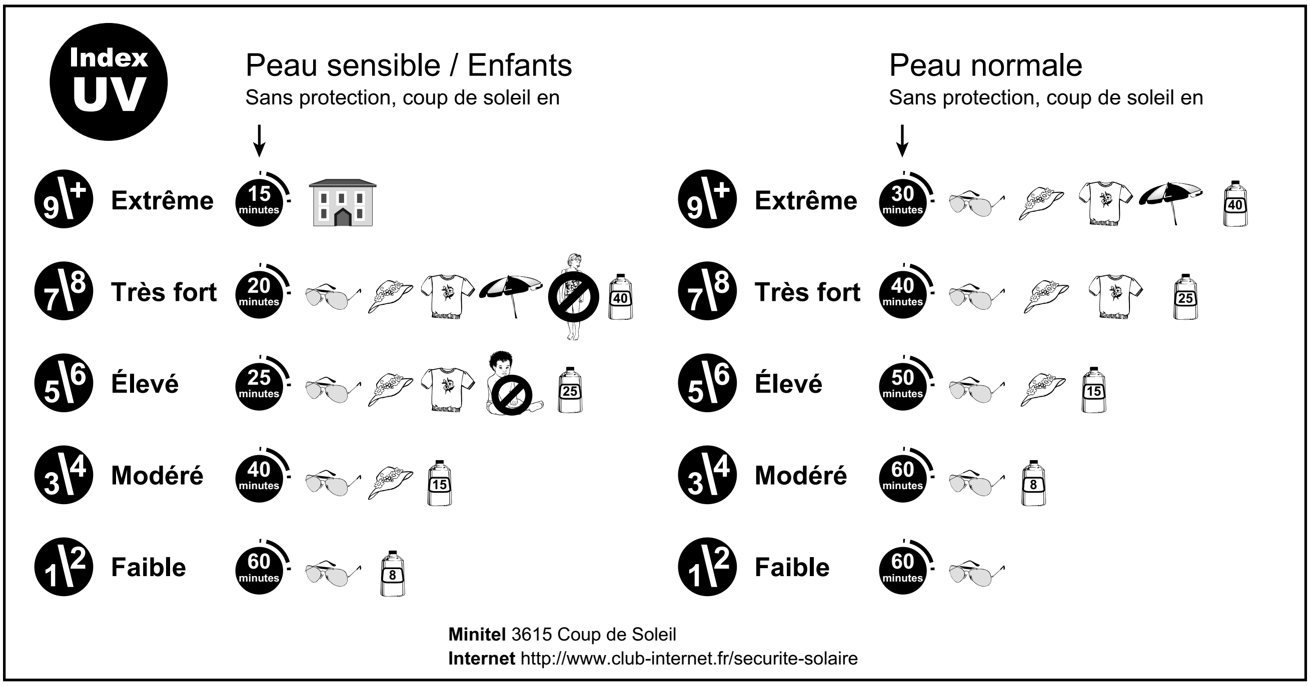


Figure 11. Provision of UV information through public weather services
(adapted from: above: Partners for Sun Protection Awareness, Washington, DC; below: Securité solaire, France)



Meeting of Experts on Standardization of UV Indices and their Dissemination to the Public, Les Diablerets, Switzerland, 21–24 July, 1997). Several NMSs have developed models which forecast the UV Index taking into account the forecast ozone concentration and cloud cover. The Index issued to the public refers to radiation on a horizontal surface, usually an average over 30 minutes, and is usually the maximum expected, which may not be at noon but when cloud cover is less.

The radiation varies elevation above sea level, and will vary greatly during a day of variable cloud cover. Public education is required to tell the people of the variations — particularly that the radiation will be greater on mountain tops.

Example of a UV forecast from the United States

NOAA/EPA ULTRAVIOLET INDEX /UVI/ FORECAST
CLIMATE PREDICTION CENTER NCEP
NATIONAL WEATHER SERVICE WASHINGTON DC
204 PM EDT MON JUN 30 1997
Valid Jul 1 1997 at solar noon/approximately noon
local standard time or 100 pm local daylight time/

The UV index is categorized by EPA as follows

UVI	EXPOSURE LEVEL
0 1 2	MINIMAL
3 4	LOW
5 6	MODERATE
7 8 9	HIGH
10 AND GREATER	VERY HIGH

For health related issues...Contact EPA at 1-800-296-1996 or
CDC 404-488-4347. For technical information on how UV values are
generated...Contact the National Weather Service at 301-713-0622.

CITY	STATE	UVI	CITY	STATE	UVI
ALBUQUERQUE	NM	12	LITTLE ROCK	AR	10
ANCHORAGE	AK	4	LOS ANGELES	CA	10
ATLANTA	GA	7	LOUISVILLE	KY	7
ATLANTIC CITY	NJ	6	MEMPHIS	TN	9
BALTIMORE	MD	4	MIAMI	FL	9
BILLINGS	MT	4	MILWAUKEE	WI	8
BISMARCK	ND	6	MINNEAPOLIS	MN	7

Biometeorological forecasts

Some NMSs issue forecasts for the benefit of people whose health is sensitive to the weather.

Example from Germany

Deutscher Wetterdienst
Forecast for weather-sensitive persons
In Nordrhein-Westfalen und im südwestlichen Niedersachsen, issued by the department of medical meteorology Essen,
Monday, 27.07.98, 11 h
Valid until Tuesday, 28.07.98

Forecast
Early in the day, no adverse weather effects can be expected. In the course of the afternoon, however, due to a low pressure system approaching from the west, there is an increased likelihood that persons sensitive to or suffering from cardiac and circulatory problems can be affected. There is the possibility of hypotensive reactions during the day, and higher blood pressure in the evening. The possibility of suffering from migraines, headaches and rheumatism also increases. At night, the tendency for asthmatic trouble and cramps or colic increases. Accordingly, those likely to be affected by weather conditions should take the necessary precautions as required. Difficulties can still be encountered Tuesday morning, but subside during the course of the day. In the afternoon, weather-related difficulties are in general no longer expected.

This advice is useful only if you have been informed by your medical practitioner of the possible influences of weather on your state of health. In the event of unknown or unusual symptoms, a medical practitioner should be consulted.

Next update
Tuesday, 28.07.98 about 12 h
Department of Medical Meteorology (E)

6.3.6 TRANSPORTATION

Public weather services serve two distinct client groups inside the transportation sector: the travelling public and the industry. The travelling public requires information to facilitate trip planning, decide on modes of transport, plan for accommodation requirements and to avoid hazardous weather conditions and generally obtains this information from publicly available products. The transportation industry requires weather information to plan its operations, to adjust its schedules and to establish or activate backup or contingency measures and in many countries is willing to pay for tailored weather services. Ongoing input from knowledgeable representatives of the transportation sector is clearly an important factor in the planning and development of responsive public weather services which are well-tuned to the needs of the travelling population and those who serve it.

The following is an example of a road weather forecast from Canada. The format was developed in consultation with the Nova Scotia Department of Highways to assist that agency in the operational planning and management of its snow clearing, road salting and other highway maintenance operations.

Example of a road weather forecast from Canada

SITE SPECIFIC FORECAST
......................................PICTOU.......................................
From 02/19 2 AM AST
To 02/20 2 AM AST

HR Local time	TT Temperature	MM Precipitation amount	PP Precipitation type	Wind direction and speed (km/h)
02	-6	Nil	Nil	E13
05	-8	Nil	Nil	SE20
08	-10	Nil	Nil	SE24
11	2	Nil	Nil	S30
14	3	Nil	Nil	S40
17	2	Nil	Nil	S45
20	-2	Nil	Nil	SW44
23	-1	Nil	Nil	SW35
02	-3	Nil	Nil	W24

Total Rain . . . . 0 mm
Total Snow . . . . 0 cm
Black Ice . . . . yes
Blowing Snow . . . . no
Fall to 0°C . . . . 7 p.m. Sunday
Rise to 0°C . . . . 2 p.m. Sunday
END

6.3.7 RECREATION, TOURISM AND SPORT EVENTS

Recreation and tourism are of rapidly increasing importance around the globe and contribute in a major way to the national economies of many countries in both the developing and developed world. Public weather services provide direct support to outdoor recreational activities in their many forms. They assist both citizens and visitors to make choices as to locations and recreational activities for the day. They also contribute to the safety and security of visitors and assist in ensuring that specific countries or regions become or remain attractive destinations. At the most basic level, the availability of weather observations, climatic information and forecasts from specific locations increases their visibility as tourism destinations. In consequence, many national Meteorological Services now produce public weather products which are tailored to the needs of the recreation and tourism sector. These include, for example, skiing and recreational boating forecasts and forecasts for special events such as outdoor concerts, festivals and cultural events.

Weather information is also important for the holding of sport events. Track and field athletes can earn glory, but no records, if wind assistance is 2 m/s or higher in the 100 m, 200 m and several others. Cricket, softball, baseball and tennis are halted by rain. Many outdoor sports have rules to balance fairness and safety when weather intrudes. Sailing is an obvious example: no wind, no start; winds of 25 knots and more lead to cancellation. A cricket stadium manager tracking an approaching storm on a weather radar screen will warn the groundkeepers to get ready to cover the pitch, and may also alert umpires, team rooms, the media, security, the spectators, and even bars and restaurants. Other sports, such as ballooning, make use of the natural variability of the weather elements. Pilots can control up-and-down movement, but their horizontal movement depends entirely on the wind, which they use to fly to a specific target.

The following are examples of recreational forecasts.

Sailing and boating

This example from Australia is on a recorded telephone service.

UPDATED WEATHERCALL YACHTLINE PORT PHILLIP BAY
BUREAU OF METEOROLOGY, MELBOURNE 16:53 23/01/1995

FORECAST:
This is the Bureau of Meteorology yachtline report for Monday night and Tuesday.

WARNINGS: Nil

The forecast is for a variable wind to 10 knots, tending 10 to 15 knot northerly overnight shifting 15 to 20 knots tomorrow afternoon.
Fine tonight. Cloud increasing tomorrow with a little rain developing later.

HIGH TIDE AT PPF HEADS 5.38AM 6.11PM

LOW TIDE 11.01PM 11.38AM 11.44PM

OUTLOOK:
Wed Mod S/SE and a shower or two.

Parks

This example is for the Grand Canyon in the United States.

GRAND CANYON RECREATIONAL FORECAST
NATIONAL WEATHER SERVICE FLAGSTAFF AZ
430 AM MST MON JUN 30 1997...
DO NOT USE AFTER 430 PM TODAY

TODAY...Windy and sunny. Southwest winds 20-30 mph with gusts to near 40 mph this afternoon. Highs from the lower 80s on the south rim to near 103 at the river.

TONIGHT...Clear. Winds decreasing this evening. Lows from the upper 30s on the south rim to near 70 at the river.

TUESDAY...Sunny. Breezy in the afternoon. Highs from the mid 80s on the south rim to near 105 at the river.

Rafting and canoeing

The United States provides observations and short-range predictions for various rivers. The code opposite is used to summarize conditions.

1. Minimum water available for floating. Some portaging or lining through shallows is necessary.
2. Satisfactory water conditions. No lining necessary.
3. Ideal water conditions for floating.
4. Water level approaching hazardous conditions.
5. Maximum water flows for experts only.

F. River in flood.
NA. Not available due to insufficient information on river conditions.

Skiing and hiking

This example of a winter sport report is from Germany.

Deutscher Wetterdienst
Winter sport report for Allgäuer and Bayerische Alpen
Issued by the Deutscher Wetterdienst
Regional Centre Munich
Wednesday, 13.03.1996, 12 h
Valid until Saturday, 16.03.1996
WEATHER AND SNOW SITUATION:

Between a strong high pressure system over north-east Europe and a low pressure system over Great Britain, mild air masses are brought along slowly by a south-easterly turning current.

In the Bavarian Alps and the Allgäu, no changes to the excellent winter sport conditions. Descents are, partly after avalanche forcing, possible everywhere without restriction. Only the descent from the Nebelhorn is limited to the middle station. All mountain railways and lifts are operating. Well-prepared and recently laid tracks for cross-country skiing are as well available. With powder snow and sunshine, all sports enthusiasts will have an excellent day.

Forecast for winter sport conditions until Saturday, 16.03.1996
Thursday and Friday, mainly sunny, with temperatures in the valleys increasing to 4 to 7 degrees. The freezing level raises to about 1500 m, causing the snow conditions in low and moderate locations and especially on southern slopes to worsen for the weekend. For Saturday, increasing cloud cover and later an occasional rainfall is expected, which will turn into snow down to 1000 m.

Snow level in cm:

West – und Oberallgäu	30-70	bis 190
i.d. Hochtälern	70-130	
Ostallgäu	bis 25	bis 110
Werdenfelser Land	bis 40	bis 270
Mittleren Lagen	bis 170	
Gebiet Tegernsee	10-30	bis 60
Gebiet Schliersee	20-40	bis 60
Wendelstein/Sudelfeld	20-40	bis 70
Chiemgau	bis 60	bis 90
Steinplatte		bis 160
Berchtesgadener Land	bis 30	bis 100

The avalanche warning centre of the Bayrisches Landsamt for Wasserwirtschaft announces:

Local dangerous spots are above the tree line on steep slopes close to ridges and facing north or east as well as in shady gaps. In these areas, the release of snow-slide avalanches is possible, especially under large additional loads. Taking into account local dangerous spots and choosing the route accordingly, conditions for tours are favourable at the moment. The avalanche situation will not change significantly during the next days.

Next updating, Thursday, 14.03.1996, about 13 h.

6.3.8 MARINE ACTIVITIES

Commercial and recreational marine activities are highly weather sensitive and accurate and timely marine forecasts and warnings can be a matter of life and death. Weather information intended for the general public can also, however, assist significantly in ensuring the safety and convenience of recreational and other marine users, particularly on rivers and lakes which are of insufficient size to warrant special marine weather forecasts. Consultation with representatives of these marine interests will often enable national Meteorological Services to make modest adjustments to their public weather forecast and warning programmes which will significantly increase their usefulness to this special target group while maintaining their overall value to the larger public. For example, adjustments to the issue times for public forecasts may be possible and useful to mariners and recreational interests as may be inclusion of greater detail with respect to forecast wind speed and direction. For further information, refer to the *Guide to Marine Meteorological Services* (WMO-No. 471).

6.4 SEASONAL AND CLIMATE SERVICES

The provision of weather information to the public can take a variety of forms, and the names given to the various products can be chosen by the NMS. As with other products, only those with user demand need to be provided.

6.4.1 FORECAST SERVICES

The time scale of forecasts prepared routinely each day has been increasing as larger and faster computers allow the running of more complex atmospheric models. Routine forecasts extending to five to seven days are becoming more common, at least in temperate latitudes. It can be expected that the time scale will extend further, perhaps to 10 days, in the next few years. That is, medium-range forecasting will provide specific forecasts of weather elements for each day of this period.

Extended-range forecasts from 10 to 30 days, and long-range forecasts for the next one to six months, are issued by some 30 per cent of NMSs worldwide. The latter may be referred to as seasonal forecasts where, in temperate latitudes, a season is a three-month period of winter, spring, summer or autumn. In tropical areas it may refer to the rainy or dry season. With increasing knowledge of the El Niño effect some success is being made with seasonal forecasts in countries surrounding the Pacific Ocean.

Forecasts beyond 10 days to several months are expressed as departures from average rainfall and/or temperature over the period as a whole. The departures are given in general, rather than numerical, terms. Textual messages are usually accompanied by graphical products and climate reference material. Successful forecasts of impending drought are of great benefit to agriculture, and to governments which may have to cope with a food crisis.

National practices vary considerably where medium- and long-range forecasts are concerned. Some NMSs restrict the issue of such products to selected, well-informed clients such as government agencies. Others disseminate them freely to media outlets and the public at large.

Climate forecasting for two years and beyond is still a research field. Predictions are made on the basis of improved climate models, but by no means on a routine basis.

6.4.2 INFORMATION SERVICES

Information on rainfall, temperature, weather, etc. can be provided for the past month, quarter or year as described in 6.2 above. These may be provided as a publication for a subscription charge, or the information can be disseminated by facsimile, or placed on the Internet for access by anyone. According to the local climate and agriculture, information can be provided on growing degree-days, snow cover, water storages, etc. Such information need only be provided where there is a user requirement for it. In drought-prone countries a monthly statement on the rainfall over the past several months, highlighting areas where there has been a serious deficiency, has proven to be of value.

Climatological information, distilled from a data bank of many years of records, can be provided in a variety of forms, including statistics such as means, medians, decile values, bivariate analyses (e.g. of wind speed and direction). Information on this can be found in the *Guide to Climatological Practices* (WMO-No. 100).

6.4.3 EXAMPLES OF SEASONAL AND CLIMATE SERVICES

The following examples of a six to 10 day outlook and a monthly outlook are from the United States. Textual messages are usually accompanied by graphical products and climate reference material.

> For more information on US climate products, see the Internet site at:
>
> http://nic.fb4.noaa.gov

6–TO–10–DAY OUTLOOK FOR JUL 06–JUL 10 1997
CLIMATE PREDICTION CENTER NCEP
NATIONAL WEATHER SERVICE WASHINGTON DC
3 PM EDT MON JUNE 30 1997

THE NATIONAL WEATHER SERVICE 6 TO 10 DAY OUTLOOK FOR SUNDAY JULY 06 1997 TO THURSDAY JULY 10 1997 calls for below normal temperatures over much of the eastern half of the country from the eastern Great Plains to the Appalachians and from the Canadian border to near the Gulf coast. Small areas of below normal temperatures are also indicated for most of the Rio Grande valley and adjacent parts of southwest Texas and also over a small part of the southern California central valley around Bakersfield.

Above normal average temperatures are expected for most of the California coast...Southeastern interior California... And much of the southern and central intermountain region... With an extension east-northeastward across south-eastern Idaho ... Wyoming... And the southeastern half of Montana to southwestern North Dakota and northwestern South Dakota... As well as over the southern and central Florida peninsula. In unspecified areas near normal average temperatures are indicated.

Little or no precipitation is expected for most of the west and northwest except for near median over parts of the Olympic Peninsula of Washington and above median over northeastern sections of both Washington and Idaho. The area where little or no precipitation is expected extends eastward across Utah and the central Rockies and then southeastward across eastern New Mexico and the central two-thirds of Texas. Below median precipitation totals are indicated for a portion of the Middle Atlantic coastal plain from New Jersey southward to the Virginia Capes and as far west as central Maryland and southeastern Pennsylvania.

Above median precipitation totals are forecast for the northern border states from northeastern Washington to the upper Mississippi valley... Extending southward to northern Wyoming and South Dakota over the western Great Plains and as far as northeastern Oklahoma over the eastern Great Plains. This area of predicted above median rainfall also includes all but the extreme southern Mississippi valley... Most of the Ohio valley and Tennessee... And much of the southeastern States as far south as the Florida panhandle and as far east as the eastern Piedmont of the southern Appalachians. Above median precipitation is also indicated for northeastern New York and much of northern New England. Elsewhere near median precipitation totals are indicated.

STATE	TEMP	PCPN	STATE	TEMP	PCPN	STATE	TEMP	PCPN
WASHINGTON	N	NP	OREGON	N	NP	NRN CAL	N	NP
SRN CALIF	A	NP	IDAHO	A	NP	NEVADA	A	NP
W MONTANA	N	A	E MONTANA	A	A	WYOMING	A	N
UTAH	A	NP	ARIZONA	A	NP	COLORADO	N	N
NEW MEXICO	N	NP	N DAKOTA	N	A	S DAKOTA	N	A
NEBRASKA	N	N	KANSAS	B	A	OKLAHOMA	N	N
N TEXAS	N	NP	S TEXAS	N	N	W TEXAS	N	NP
MINNESOTA	B	A	IOWA	B	A	MISSOURI	B	A
ARKANSAS	B	A	LOUISIANA	N	N	WISCONSIN	B	A
ILLINOIS	B	A	MISSISSIPPI	B	N	MICHIGAN	B	N
INDIANA	B	A	OHIO	B	N	KENTUCKY	B	A
TENNESSEE	B	A	ALABAMA	B	A	NEW YORK	B	N
VERMONT	B	A	NEW HAMP	N	N	MAINE	N	A
MASS	N	N	CONN	N	N	RHODE ISL	N	N
PENN	N	N	NEW JERSEY	N	B	W VIRGINIA	B	N
MARYLAND	N	B	DELAWARE	N	B	VIRGINIA	N	N
N CAROLINA	N	N	S CAROLINA	N	A	GEORGIA	B	A
FL PNHDL	N	A	FL PENIN	A	N			

LEGEND

Temps with respect to normal PCPN with respect to median

MA – much above A – above A – above N – near median N – near normal B – below B – below NP– no PCPN MB – much below

The forecast classes represent averages for each state. Normal values — which may vary widely across some states — are available from your local weather service forecast office.

MONTHLY OUTLOOK
CLIMATE PREDICTION CENTER NCEP
NATIONAL WEATHER SERVICE WASHINGTON DC
3 PM EDT THURSDAY JUNE 19 1997
30–DAY OUTLOOK DISCUSSION — JULY 1997

The outlook for July 1997 favors above normal temperatures along the eastern seaboard from Florida northward to Maryland extending into West Virginia and Pennsylvania.

Warmer than normal temperatures are also favored over most of California as well as in southern Texas and in western and interior portions of Alaska.

Below normal temperatures are most likely from the northeastern plateau region and northern and central Rocky Mountains to the high plains from Kansas northward.

Above median precipitation is indicated only in southern Minnesota–Montana and Wyoming. Climatological probabilities are forecast for the remainder of the US and for Alaska.

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A number of NMSs maintain Internet sites with current forecasts. Access to these can be obtained by hot links from WMO at:

http://www.wmo.ch

APPENDIX

PERCEIVED TEMPERATURE

DEUTSCHER WETTERDIENST
GESCHÄFTSFELD MEDIZIN-METEOROLOGIE

GERMAN WEATHER SERVICE

Everybody knows: the temperature that appears on a thermometer is not necessarily identical with one's feeling for that same temperature, i.e. the perceived temperature. If in winter a strong wind is blowing, a temperature of –5°C is perceived to be much colder than if there were no wind; a skier might take a sunbath in the lee with no shirt and, in spite of air temperatures about the freezing point, is not cold. If one is hiking, +12°C is a comfortable temperature and it is easy to adapt to wind, sun or shade by wearing different clothes. In contrast, one can break out in perspiration in a 23°C temperature with sunshine and only a very gentle breeze. A temperature of 30°C with sunshine can very easily make outside activities stressful.

The factors influencing the thermal state of humans are air temperature, humidity, wind velocity and short- and long-wave radiation fluxes. In addition, the human metabolic rate according to the degree of activity, and the insulation properties of clothing play a major role. Under equal meteorological conditions, a person's perception of temperature, depending on whether the body is at rest or engaging in physical activity, can be quite a different.

The Deutscher Wetterdienst rates the perception of temperature physiologically correct by means of the perceived temperature. The perceived temperature compares the real conditions to the temperature in a standardized environment, that would cause a similar perception of heat, cold or comfort. The standardized environment is defined to be a deep shadow such as a forest where the temperature of the surrounding surfaces, e.g. the canopy of leaves, is identical to air temperature and where only a gentle breeze of 0.1 m/s is blowing. To assess the meteorological conditions due to the aspects of customary outdoor activities a person is assumed walking at a speed of 4 km/h. Furthermore, it is assumed that the clothing is adapted to the situation so that the person feels quite comfortable. The clothing can range between summer clothes, for example T-shirts and long lightweight pants, and winter clothes, such as a warm coat and hat. Under these standardized conditions the perceived temperature defines the thermal perception based on a 35-year-old male, who is 1.75 m tall and weighs 75 kg.

The "Klima-Michel" model of the Deutscher Wetterdienst is used in order to calculate the perceived temperature. The model computes the thermal energy balance of a person staying outside using the P.O. Fanger equation of thermal comfort. The parameters needed are a complete meteorological observation or rather an appropriate numerical weather forecast, the date and the geographical coordinates. The perceived temperature increases much faster than air temperature, if it is warm and sunny and there is only a gentle breeze. In extreme cases, it is possible that the perceived temperature is up to 15°C higher than the air temperature in Central Europe. Moreover, it also can be slightly lower than air temperature, in spite of generally comfortable conditions due to an increased wind speed or a cloudy sky. Under cold and especially under very windy weather conditions the perceived temperature is up to 15°C lower than air temperature. However, the sun and the absence of wind under cold conditions can make the perceived temperature higher than the temperature of the air, as the above example of the skier shows.

In comparison to other parameters, the perceived temperature displays the perception of heat and cold physiologically correct. The Windchill Equivalent Temperature is used in the USA to classify cold conditions. It is defined to be a measure of chilling effects depending on wind velocity and air temperature that is needed to freeze a quart of water in a plastic cylinder. The Windchill Equivalent Temperature is related to a constant skin temperature of 33°C, a very improbable assumption for cold environments. The sun or the adaptation of insulation properties of clothing is not taken into account at all. Although not as striking, similar disadvantages are true for the Discomfort Index that classifies warm conditions. There is a close relationship between the perceived temperature and the outdoor apparent temperature, according to Steadman, which also accounts for air temperature, wind velocity, humidity and sunshine. This relation is valid only for outdoor apparent temperature and not for the shade apparent temperature which is often used and which does not account to sunshine.

The perceived temperature can be assessed in a physiologically correct manner according to the VD1-Guideline 3787. Heat load or cold stress is a strain for the cardiovascular system. In hot conditions the heart has to work much harder. A lot of blood, which is cooled down by sweat evaporation on the skin, must circulate to keep the body core at the optimum temperature of 37°C for effective organ function.

Thermophysiological assessing of perceived temperature

Perceived temperature (°C)	*Therm. perception*	*Level of stress*	*Physiological stress*
< –39	very cold	extreme	cold-stress
–39 to –26	cold	great	
–26 to –13	cool	medium	
–13 to +5	slightly cool	light	
+5 to +17	comfortable	none	comfort
+17 to +26	slightly warm	light	heat load
+26 to +32	warm	medium	
+3 to +38	hot	great	
> +38	very hot	extreme	

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CHAPTER 7

DISSEMINATION AND PRESENTATION

7.1 EFFECTIVE DISSEMINATION/COMMUNICATION AND INFORMATION EXCHANGE

There is no point in producing warnings, forecasts and information unless they can be disseminated rapidly to the public. Forecasts and warnings are highly perishable products. With modern technologies developing rapidly, the issue is no longer how to simply spread information, but how to disseminate it in the most efficient way to the intended audience.

The most common means of dissemination, the mass media, include television, radio and newspapers. The Internet is gaining increasing importance, and there are many other means such as telephone, fax or pagers, which can be used to convey information very specifically to certain user groups. These different means of dissemination can be separated into two main groups:

(a) point-to-multipoint, mainly the mass media, which present information from one source to a large number of receivers who can access it easily, but without addressing any in particular; and

(b) point-to-point dissemination where the information is available at the source and sent out to a single user at a time on demand only. If the single user is the news media, however, the message is eventually disseminated to a larger audience. The Internet is found in-between these two approaches.

In most cases, point-to-point dissemination requires the user to initiate action to obtain the information. A problem here is that a user may not become aware of an urgent warning issued at a non-routine time. Of course such warnings broadcast by the media will be received by users only if they have their radios or televisions turned on for other purposes.

Another way to group the available means of dissemination is the form of presentation used: visual or audio, employing text, graphic, voice or tone (see 7.2 below). For maximum distribution and impact on the user community, the same information may, of course, be disseminated and presented in more than one format. As an example, a forecast or warning may be disseminated by radio, television, automatic telephone, facsimile service and the Internet.

Each means of dissemination has its advantages and shortcomings: television, radio and newspaper are all effective means of informing the public, as they reach the population at large. Through them, meteorological services attain the greatest visibility amongst the public. Newspapers are particularly useful for providing detailed and graphic information about the weather and are a powerful medium in public awareness campaigns on hazards. However, newspapers are not feasible for the distribution of time-critical information, especially warnings; radio and television are more efficient. Television, with its visual display capability and large number of viewers in most countries, is a highly effective means of disseminating forecasts and warnings. In an emergency situation, radio has a major advantage in being able to reach a wide audience very rapidly; it is also often the only means of communication available at all. But while radio is restricted to audible information, newspapers, television and the Internet can present information in graphical format; television and the Internet can even present animated graphics and pictures. Presentations on radio and television are not limited to pre-produced texts and graphics; live broadcasts and interviews between presenter (moderator) and forecaster can be added. For information that addresses only small user groups other means of dissemination can be used. Point-to-point techniques such as telephone or fax make it possible to give attention to individual issues and problems and to offer a wide range of more specific and detailed services. Telephone hotlines even enable the user to interact with the forecaster.

The information available to the public from all sources through the media and other means is large and becoming ever larger. It is essential that weather information be presented in a way that will attract the intended audience. The information must also be presented in such a way that the important elements stand out and users are not burdened with an unnecessarily large amount of data. Public weather forecasts and warnings are of no use unless they reach and are understood by the public.

In its approach to planning and implementing improvements to dissemination systems and methods, considerations include the mission of the NMS with respect to the provision of public weather services, the users of the services, staffing and funding limitations, and the communications infrastructure.

An effective dissemination system must provide appropriate information to emergency management officials and the general public in a reliable and timely manner during all hours of the day and night. Warnings, forecasts and information have to be disseminated from a forecasting office to a variety of users, which may include:

- the media;
- the hazards community;
- other government organizations;
- non-governmental organizations, such as fishermen's or farmer's cooperatives;
- tourist organizations;
- private companies in weather-sensitive industries such as transport or construction (these will be prepared to pay for the service).

To send products to a large number of recipients, each requiring a different set of products, in a short space of time can present a problem if dial-up facsimile is used. Time can be saved if telecommunications facilities permit broadcast calls, where a number of recipients can be connected to the one facsimile call, although the same material must be sent to all and recipients get more than they need. If a computer has been installed the dissemination can be automated, whereby the computer is programmed to call each number and send only the products each requires. A number of telephone lines are required, however, so that the task is completed in a reasonable time. Another problem can arise at certain times when all the incoming lines of a medium may be busy receiving other news. Consultation with the medium concerned is required to ascertain the best time for an immediate connection. Where traffic to a recipient is large a direct computer-to-computer link may be worth the cost; e.g. to a news agency which can then distribute the products to individual media. It needs to be ensured that this does not involve unacceptable delay.

All communications facilities are liable to break down from time to time, and backup methods need to be available so that the most urgent messages, such as urgent warnings, can be distributed.

Especially in the case of warnings, in order to avoid confusion and elicit proper response, the NMS, public safety officials and the media must work cooperatively to ensure that a clear and consistent message is provided to the public. This requires not only effective communications and dissemination systems but also an extensive and ongoing public education programme.

Not infrequently, the challenge facing an NMS is to provide the most cost-effective dissemination system within severe funding constraints. It is often found that use of proven, "off-the-shelf" technologies is the most cost-effective and efficient approach to the implementation of systems for the preparation and dissemination of meteorological products. Forging partnerships with the media and with public safety and emergency agencies is an approach which will often result in a more effective dissemination system through pooling of resources and capabilities. It is, needless to say, vitally important that backup capability exists when primary dissemination systems fail, particularly during severe or hazardous events. Partnership arrangements can, once again, be helpful in supplying a back-up dissemination capability in such circumstances.

Satellite communication provides the capability to disseminate (and access) extensive meteorological data sets in a wide range of forms and formats. It is now widely used for many purposes including the international relay of information between WMO Members, transmission of weather information to ships at sea and aircraft in flight and to major commercial clients. It is also extensively used for the relay of television weather programmes including those of dedicated television weather networks.

7.1.1 ROLE OF THE MEDIA

Public weather forecasts and warnings are of no use unless they reach the public, and the media are the prime means of achieving this. Broadcast and print media are important partners of NMSs where public weather services are concerned. To ensure that people will read or listen they have a keen interest in the quality, format, content and timing of public weather services products. They can, furthermore, be an effective ally of the national Meteorological Service in highlighting the importance of public weather services to the community, in supporting the need for an adequate hydrometeorological infrastructure of observing networks, communications systems and forecast offices, and in increasing the visibility of the national Meteorological Service.

Cooperative efforts with local or national media outlets can greatly expand an NMS's ability to reach the public-at-large with its forecasts, warnings and other bulletins. Cooperative arrangements can also facilitate the direct provision of weather information via live or taped radio or television broadcasts. They can enable the NMS to carry out its responsibility to warn and inform the public more effectively while, at the same time, providing media outlets with highly desirable programme content. During emergencies and major events such as winter storms, hurricanes or tropical cyclones and tornadoes, information presented by experts from the NMS through live broadcasts is often highly newsworthy from the media viewpoint. At the same time, these presentations are an extremely effective way for the NMS to capture public attention and relay critical weather information and advice.

The broadcast of different and conflicting messages relating to an impending weather event leads to public confusion. It is thus important that the NMS is the "single official voice" in the issuance of weather warnings. This means that the media should only broadcast warnings and advisories issued by the NMS and not modify them except for format. Warnings and advisories should be broadcast verbatim (or in a faithful graphical presentation) and always as soon as possible after receipt. The media should be encouraged to regularly provide attribution to the NMS for making weather information available.

While all warnings are important, some are more urgent than others. For example, the first warning of an imminent threat of a severe thunderstorm or flash flood is more urgent than the renewal of a strong wind advisory for small craft. A priority system may be agreed with the broadcast media whereby some warnings are labelled as top priority — to be broadcast immediately — or priority — to be broadcast at the next station break within half an hour.

The development of television networks that now provide weather services to the public over vast regions of the globe has added a new dimension to the issues faced by WMO. In those countries where international television weather broadcasts originate, the NMS can make a special contribution by working with the television networks to ensure consistency between their weather broadcasts and the official public weather services products issued by responsible NMSs in the listening or viewing areas. This is particularly critical during severe events such as tropical cyclones or hurricanes.

Coordination with national and international media is discussed in Chapter 8, 8.5 and 8.6 respectively.

The Internet is a rapidly developing medium whereby forecasts and warnings can be made available to a very large and widespread number of people. The information and format is under the control of the NMS without any distortion or abbreviation by intervening parties.

7.2 EFFECTIVE PRESENTATION

The effective presentation of weather warnings, forecasts and other public weather services products is essential if they are to influence the behaviour and decisions of their intended audiences.

7.2.1 PREPARATION

The needs of the user must be determined prior to deciding upon product content and format. There may be special considerations which will influence product organization, the language and style used (i.e. technical or non-technical, monolingual or multilingual, formal or informal) and the choice of format (i.e. for effective use of voice or for maximum visual impact). The needs of the users also determine the means and schedule of dissemination.

Forecasts, warnings, data and other information may be presented in voice, text, graphics, animations or gridded data fields according to the possibilities provided by the means of dissemination (newspaper, television, radio, etc.). To optimize the efficiency of a forecast, the presentation techniques have to be fitted to the chosen means of dissemination and to the intended audience (general public, travellers, farmers, teachers, etc.). Reading a well formulated text on radio will reach a large number of people, while displaying the same text on TV will not be appreciated by the users. Furthermore, information can be reinforced not only by using different means of dissemination at the same time, but also by employing different presentation techniques. For example, a warning that was disseminated and explained in length by a TV weather presenter during the main programme can be repeated as shortened text-version using a TV crawler. When preparing a forecast template, the NMS/forecaster should be aware of competitive dissemination channels and products, and adapt its own presentation of information accordingly (e.g. pick the best ideas from different presentations, see what can be improved, see where unique features can be built in by the NMS: a coloured product might be more successful if all other products are in black and white; if other products are very general, a more detailed product might be more successful). The NMS/forecaster should especially take advantages of features that are relevant to the chosen dissemination channel (e.g. do not try to imitate television presentation in a newspaper, but use the advantages of the newspaper for the product).

7.2.2 CONTENTS

The content of products disseminated to the public will depend on the climatology and culture of the country. In some countries the public's interest lies in the forecast weather, in others there is great interest in the weather which has just occurred, e.g. how hot/cold was it today? In countries with long spells of benign weather the interest will be in notification of adverse weather; in countries with changeable weather there is interest in the forecast every day.

In general, the content should include:

- a summary of yesterday's/overnight/today's weather (depending on the time of issue);
- a list of current warnings;
- a forecast of the weather for today/tomorrow (depending on the time of issue) and extending as far ahead as meteorological capability allow with regard to the local climate;
- a brief explanation of immediate past and forecast weather (there is great interest in this if unusual weather has occurred, e.g. hot or cold spells, heavy rain, widespread thunderstorms);
- special forecasts such as for holiday weekends, national sporting events, mountain weather, etc.

Information on times of tides, and of sun and moon rise and set, water temperatures, etc. is often included in weather presentations. The media may obtain this information from the NMS or from another institution such as an astronomical observatory or maritime authority according to national arrangements.

The length of the presentation in the media will depend on the time allocated by the radio or television station, or the space allocated by a newspaper. It is common for the electronic media to broadcast one or two major weather presentations per day and several abbreviated ones.

The source of the information, the time of issue and the validity period of the forecasts should be clearly stated: e.g. Forecasts for (*today/tomorrow*) issued by..........at ......am/pm on (*day, date*). Inclusion of the NMS logo in each (visual) product will advertise the NMS and improve its public image. When the users see the image every day, or several times a day, it becomes ingrained in their memories. After a while the logo becomes familiar. Logo stands for quality of services, for safety of life and property, for a caring NMS. It is also another method to distinguish the NMS from private weather service providers.

If a product is composed primarily of meteorological data then the level of detail will be determined by the nature of the data set. Text products which are intended for the general public should get quickly to the point and information contained in them should be presented in a logical sequence, beginning with the most important details. This is particularly critical in short-fuse, severe-weather warning messages (e.g. tornado warnings) where time is of the essence. Graphical products should be uncluttered and include map backgrounds which depict well-known locations for ease of reference and comprehension.

7.2.3 STYLE AND FORMAT

There are several attributes which all meteorological information presented to the public should share in common. The information should be concise to maintain the interest of the customer and to convey effectively what may be critical advice. It should be easily interpreted to avoid confusion and elicit the correct user response. To the same ends, it should also emphasize the most important meteorological elements or phenomena and highlight the potential impacts of these phenomena (see also 5.6.3 and 6.1.5).

Language

If all the main languages in a country are not covered by radio or television programmes, it should be ensured that the public can understand the weather information by broadcasting such information during a certain time period on the same channel in all the main languages spoken within the country or by ensuring the dissemination on a separate channel in those languages. Graphical displays on television or in newspapers can help overcome language problems.

Appropriate terminology

Terminology used should be appropriate to the country or region and to user needs. Non-technical terminology should be used for the general public. Clear, concise, simple words are usually most effective in conveying the desired meaning and in minimizing potential confusion. The public may often hear or see critical information only once, a consideration which heightens the importance of clarity and simplicity.

Use of descriptive geographic or geopolitical terms

The use of obscure locations, or geographic features known only to relatively few people, should be avoided. During hazardous weather, the assessment of personal risk is dependent on a clear understanding of location of the hazard with respect to the individual making the assessment. Use of site-specific terminology tied to well-known locations will generally result in clear understanding and a more effective public response to warnings.

Required user action

"Call to Action" statements, either in the text or in graphic format, are highly recommended as useful components of warnings of hazardous weather. These statements may include safety rules or guidelines informing the user about appropriate actions which may be taken to reduce risk. As arrangements in this regard differ from country to country, "call to action" statements should be agreed upon by the responsible emergency managers, government authorities and the NMS.

Besides those features that all presentation techniques have in common, there are also significant differences in style and format among them.

Text products

Written (newspaper, bulletins, TV crawlers, facsimile): mostly supported by graphics.

Audio products

Pure audio products that are not supported by visual products are typically found in radio and telephone services. Special care should be taken that the text is clear and concise. Short sentences help the user to follow the information easily. For radio, and also for television, the text is generally written in a relaxed, easily-read style and often restricted in length to a relatively modest number of words. For audio-visual products, the images should underline the spoken/written text. On the Internet audio products are additional features to pure text or graphics.

Visual products Visual products such as graphics, charts or images are used for television, Internet, newspaper or facsimile. Pictograms can underline those products in legends and explanations. Just as text products, visual products should be clear, concise and comprehensive. Too much detail can confuse the user instead of conveying the intended message. Depending on the capabilities, visual products can be two- or three-dimensional, supported by text or voice, and in black and white or in colour.

Animations Animations are mostly possible for television and the Internet. In general, the same requirements as for visual products (see above) apply. In addition, care should be taken over the speed of the animation and the frequency in which the pictures are shown. Well-known examples are animations of satellite pictures or the development of an El Niño event.

Tabulated data Tabulated data are mostly used in newspapers or on the Internet for lists of weather at certain locations in the region or around the world. Bulletins of rainfall, temperature, etc. issued to subscribers by an NMS use this format.

Others For other means of dissemination such as sirens, balls or flags, it is most important that the signals be clearly distinguished by tone series or colour.

7.3 POINT-TO-MULTIPOINT DISSEMINATION AND PRESENTATION

The point-to-multipoint approach to dissemination provides simultaneous and widespread distribution of information to the public and other users, a significant advantage in the context of public weather services whose target audiences are typically very broad.

An important aspect of the point-to-multipoint delivery is the ability to disseminate products to site-specific areas. This is vital with respect to warning messages as it has to be insured that the message reaches the citizens, emergency management officials and the media in a timely fashion.

While new communications technologies are increasingly being used to deliver public weather services, it is important to remember that national and international press networks (Wire Services) continue to play a fundamental role in the dissemination of weather information, forecasts and warnings to the general public in all regions of the globe. Within many countries, national press networks are the primary means for delivery of weather information to newspapers and radio and television broadcast outlets. At the international level, major wire services such as Reuters, Associated Press, United Press International, Agence France Presse and others provide for regional and worldwide dissemination of weather information through the media. This regional and global information is of great interest to a broad spectrum of people such as travellers, export and import brokers, commodity traders and many others. NMSs must, in consequence, continue to place significant emphasis on ensuring reliable and timely delivery of their public weather services products to their press networks. In general, Wire Services tend to relay weather and related information to the media and their other customers in fairly standardized formats, either directly "as received" from NMSs or with only relatively minor editing.

7.3.1 PRINT MEDIA

The print media can contribute very significantly to public weather services by publishing products and by providing valuable means to educate the community about hydrometeorological phenomena, the risks associated with severe events, and ways to mitigate adverse impacts. Catering to the needs of the print media is consequently an important task for NMSs.

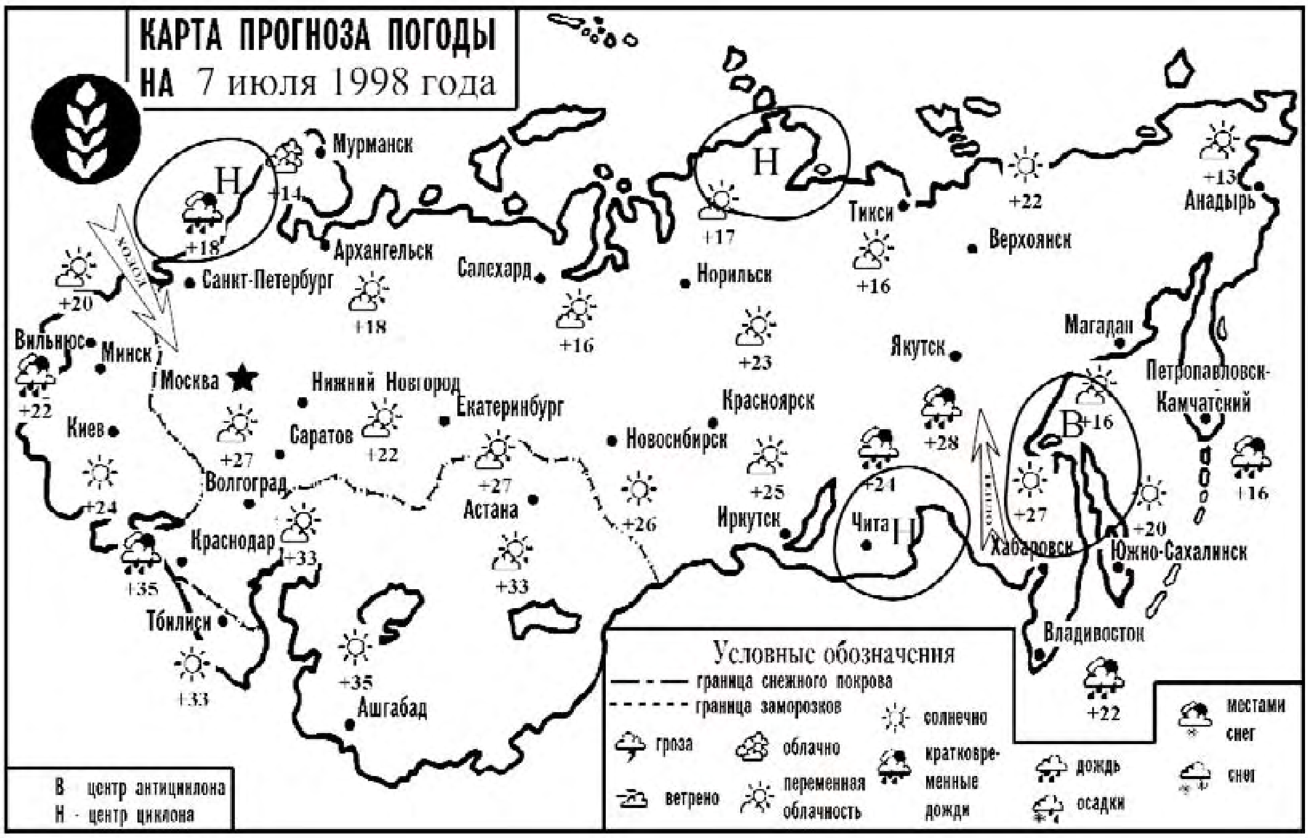
7.3.1.1 Newspapers and magazines

Daily newspapers can effectively disseminate routine weather forecasts and related information to the public at large. Being a print medium, they provide the possibility to combine text and (coloured) graphics and photographs. They are, however, less useful in advising of fast-breaking events which present an immediate threat to local populations, such as tornadoes or severe convective storms. The rapid development of modern media such as television and the Internet induces more and more newspapers to go on-line and to provide a wider range of products. Nevertheless, the role of the print media to disseminate information is not decreasing. Weekly and monthly magazines for specific communities such as farmers or fishermen will often include a weather segment with graphics. The content tends more to the weather over the past week or month but usually includes an outlook for the immediate future.

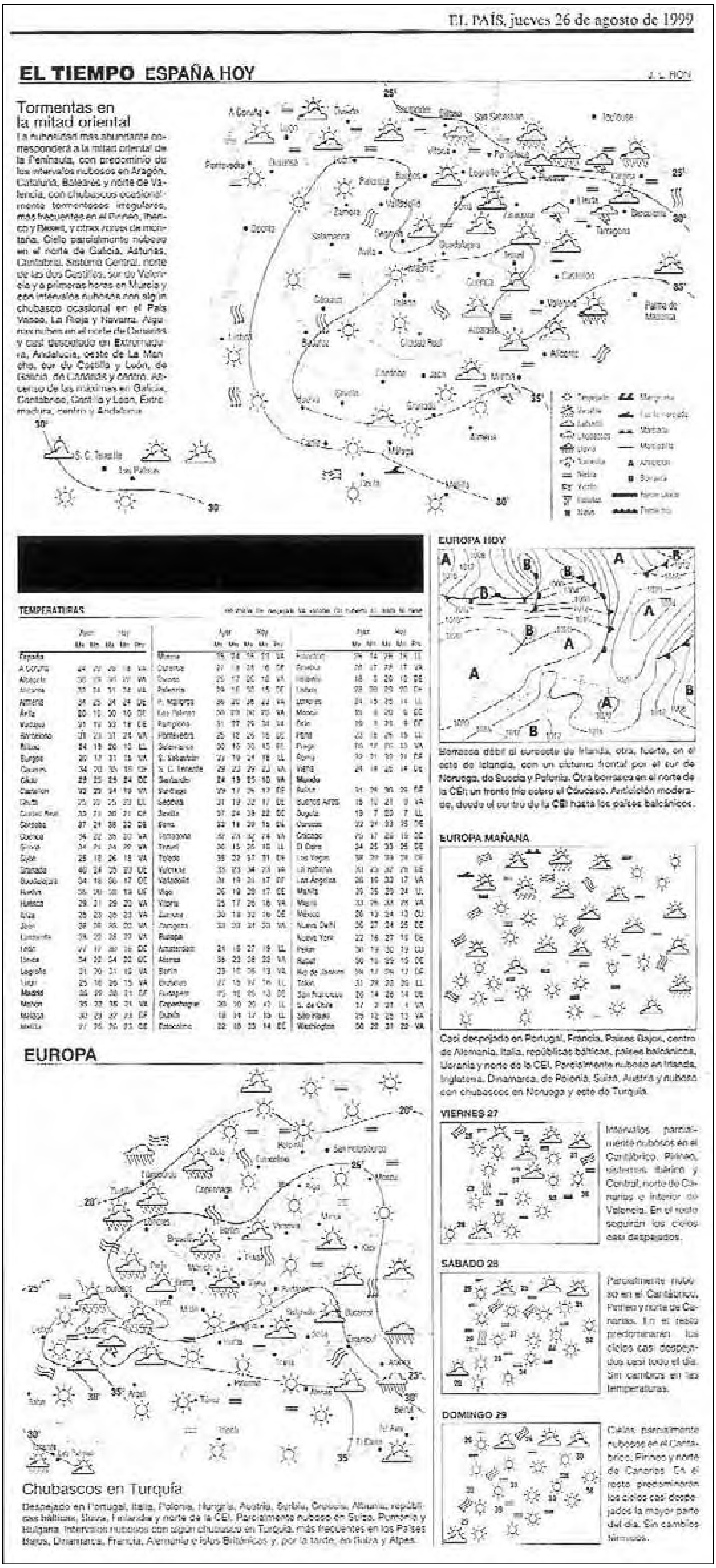
The fact that, each day, newspaper editors devote valuable space to public weather services products provides solid evidence that a major interest exists for this information. Newspapers have adopted a range of approaches to the challenge of effectively presenting weather information to their readers. In some instances (particularly where smaller newspapers with limited circulation are concerned) the forecasts and other products of the NMS are published verbatim as received from the NMS or the wire services. In others, a great deal of effort is devoted by newspaper staff to packaging NMS or private sector weather products in attractive, easily digestible formats. Some newspapers and magazines also rely on private meteorological companies who specialize in the design and preparation of weather information packages for newspaper publication. Many NMSs produce and sell ready-to-print weather page presentations directly to newspapers (see 7.3.1.3 below for details on how to create a weather page for a newspaper). Newspapers will usually pay for this as it saves them preparing it in-house. Though outsourcing the production of the newspaper page saves the NMS a lot of time and work, there is the danger that the content of the forecast will be — willingly or unwillingly — changed. It is therefore important that the NMS clearly identifies its demands and requirements for an accurate and effective forecast in a newspaper.

Newspaper weather pages sometimes display a considerable degree of innovation in design, layout and the use of colour, all intended to attract the reader's attention and to make it easy for him or her to understand, absorb and digest the information provided. The following examples are some extracts from a selection of newspapers which illustrate several approaches to the presentation of weather forecasts and related information from a small to a large newspaper.

CHAPTER 7



Examples on this and the following pages include: Russian Federation, above; El País *(Spain), p. 100;* USA Today *(United States), p. 101;* Tribune de Genève *(Switzerland), p. 102 (top); Russian Federation*, p. 102 (bottom); *New Zealand*, p. 103 (top) and *Germany*, p. 103 (bottom)



EL PAÍS, jueves 26 de agosto de 1999

EL TIEMPO ESPAÑA HOY

Tormentas en la mitad oriental

La nubosidad más abundante corresponderá a la mitad oriental de la Península, con predominio de los intervalos nubosos en Aragón, Cataluña, Baleares y norte de Valencia, con chubascos ocasionalmente tormentosos irregulares, más frecuentes en el Pirineo, Ibérico y Beseit, y otras zonas de montaña. Cielo parcialmente nuboso en el norte de Galicia, Asturias, Cantabria, Sistema Central, norte de las dos Castillas, sur de Valencia y a primeras horas en Murcia y con intervalos nubosos con algún chubasco ocasional en el País Vasco, La Rioja y Navarra. Algunas nubes en el norte de Canarias y casi despejado en Extremadura, Andalucía, oeste de La Mancha, sur de Castilla y León, de Galicia, de Canarias y centro. Ascenso de las máximas en Galicia, Cantabrico, Castilla y León, Extremadura, centro y Andalucía.

[redacted]

TEMPERATURAS

EUROPA HOY

Borrasca débil al suroeste de Irlanda, otra, fuerte, en el este de Islandia, con un sistema frontal por el sur de Noruega, de Suecia y Polonia. Otra borrasca en el norte de la CEI; un frente frío sobre el Cáucaso. Anticiclón moderado, desde el centro de la CEI hasta los países balcánicos.

EUROPA MAÑANA

Casi despejado en Portugal, Francia, Países Bajos, centro de Alemania, Italia, repúblicas bálticas, países balcánicos, Ucrania y norte de la CEI. Parcialmente nuboso en Irlanda, Inglaterra, Dinamarca, de Polonia, Suiza, Austria y nuboso con chubascos en Noruega y este de Turquía.

VIERNES 27

Intervalos parcialmente nubosos en el Cantábrico, Pirineo, sistemas Ibérico y Central, norte de Canarias e interior de Valencia. En el resto seguirán los cielos casi despejados.

SÁBADO 28

Parcialmente nuboso en el Cantábrico, Pirineo y norte de Canarias. En el resto predominarán los cielos casi despejados casi todo el día. Sin cambios en las temperaturas.

DOMINGO 29

Cielos parcialmente nubosos en el Cantábrico, Pirineo y norte de Canarias. En el resto predominarán los cielos casi despejados la mayor parte del día. Sin cambios térmicos.

EUROPA

Chubascos en Turquía

Despejado en Portugal, Italia, Polonia, Hungría, Austria, Serbia, Croacia, Albania, repúblicas bálticas, Suecia, Finlandia y norte de la CEI. Parcialmente nuboso en Suiza. Rumania y Bulgaria. Intervalos nubosos con algún chubasco en Turquía, más frecuentes en los Países Bajos, Dinamarca, Francia, Alemania e Islas Británicas y, por la tarde, en Suiza y Alpes.

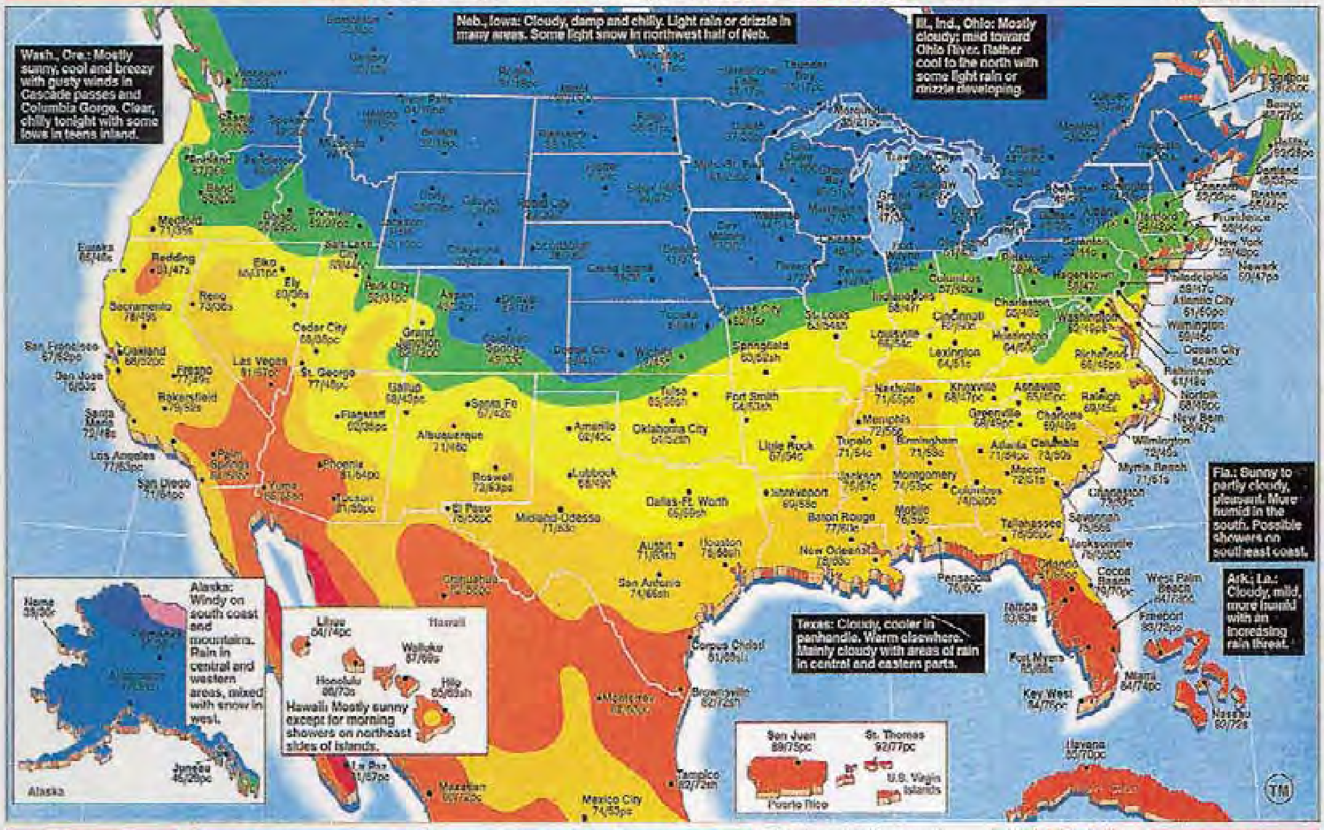
THE WEATHER PAGE

How to use this page
Colors on the map show today's high temperatures in degrees Fahrenheit. Numbers: today's forecast high, tomorrow morning's low. Legend: C (cloudy), PC (partly cloudy), R (rain), S (sun), SH (showers), SN (snow), SF (snow flurries), T (thunderstorms).

Temperature legend
Temperature color bands apply to the large weather map and to the city forecasts below.
10 | 10s | 20s | 30s | 40s | 50s | 60s | 70s | 80s | 90s

Credits
Meteorologist: Wayne Barnes, WSC
Editor: Jack Williams, USA TODAY

Information provided by: Weather Services Corp.



Two-day highlights

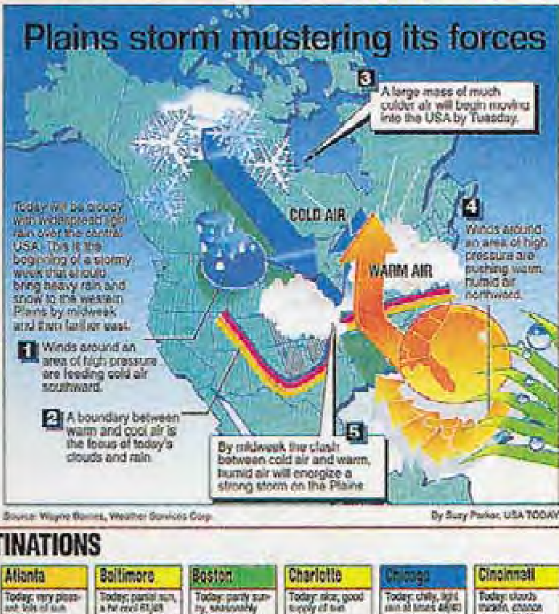
City	Tomorrow	Wednesday
Albany, N.Y.	[illegible]	[illegible]
Atlantic City	[illegible]	[illegible]
Austin, Texas	[illegible]	[illegible]
Birmingham, Ala.	[illegible]	[illegible]
Bismarck, N.D.	[illegible]	[illegible]
Boise, Idaho	[illegible]	[illegible]
Buffalo	[illegible]	[illegible]
Burlington, Vt.	[illegible]	[illegible]
Casper, Wyo.	[illegible]	[illegible]
Charleston, S.C.	[illegible]	[illegible]
Charleston, W.Va.	[illegible]	[illegible]
Davenport, Iowa	[illegible]	[illegible]
Des Moines	[illegible]	[illegible]
El Paso, Texas	[illegible]	[illegible]
Fairbanks, Alaska	[illegible]	[illegible]
Great Falls, Mont.	[illegible]	[illegible]
Greenville, S.C.	[illegible]	[illegible]
Jackson, Miss.	[illegible]	[illegible]
Jacksonville, Fla.	[illegible]	[illegible]
Little Rock	[illegible]	[illegible]
Louisville	[illegible]	[illegible]
Milwaukee	[illegible]	[illegible]
Oklahoma City	[illegible]	[illegible]
Omaha	[illegible]	[illegible]
Peoria, Ill.	[illegible]	[illegible]
Portland, Maine	[illegible]	[illegible]
Reno	[illegible]	[illegible]
Richmond, Va.	[illegible]	[illegible]
Sioux Falls, S.D.	[illegible]	[illegible]
Spokane, Wash.	[illegible]	[illegible]
Topeka, Kan.	[illegible]	[illegible]
Tucson, Ariz.	[illegible]	[illegible]
Wichita, Kan.	[illegible]	[illegible]
Wilmington, Del.	[illegible]	[illegible]

Sunday's extremes

Low temperature: 10 at Williston, N.D.; Soda Springs, Idaho; Stanley, Idaho (8 at Fort Yukon, Alaska)

High temperature: 93 at Coolidge, Ariz. (88 at Honolulu)

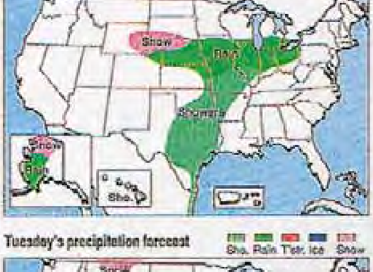
Plains storm mustering its forces



Source: Wayne Barnes, Weather Services Corp.

By Suzy Parker, USA TODAY

Today's precipitation forecast



Tuesday's precipitation forecast

World forecasts

City	Today	Tomorrow
Acapulco	[illegible]	[illegible]
Amsterdam	[illegible]	[illegible]
Auckland	[illegible]	[illegible]
Baghdad	[illegible]	[illegible]
Bangkok	[illegible]	[illegible]
Barbados	[illegible]	[illegible]
Beijing	[illegible]	[illegible]
Berlin	[illegible]	[illegible]
Bermuda	[illegible]	[illegible]
Budapest	[illegible]	[illegible]
Buenos Aires	[illegible]	[illegible]
Cairo	[illegible]	[illegible]
Dublin	[illegible]	[illegible]
Frankfurt	[illegible]	[illegible]
Hong Kong	[illegible]	[illegible]
Jerusalem	[illegible]	[illegible]
Johannesburg	[illegible]	[illegible]
Kingston	[illegible]	[illegible]
Lima	[illegible]	[illegible]
London	[illegible]	[illegible]
Madrid	[illegible]	[illegible]
Manila	[illegible]	[illegible]
Mexico City	[illegible]	[illegible]
Moscow	[illegible]	[illegible]
Nairobi, Kenya	[illegible]	[illegible]
Nassau	[illegible]	[illegible]
New Delhi	[illegible]	[illegible]
Oslo	[illegible]	[illegible]
Panama City	[illegible]	[illegible]
Paris	[illegible]	[illegible]
Rio	[illegible]	[illegible]
Rome	[illegible]	[illegible]
Seoul	[illegible]	[illegible]
Shanghai	[illegible]	[illegible]
Singapore	[illegible]	[illegible]
Stockholm	[illegible]	[illegible]
St. Petersburg	[illegible]	[illegible]
Sydney	[illegible]	[illegible]
Tokyo	[illegible]	[illegible]
Vienna	[illegible]	[illegible]
Warsaw	[illegible]	[illegible]
Zurich	[illegible]	[illegible]

Legend: C (cloudy), PC (partly cloudy), R (rain), S (sun), SH (showers), SN (snow), SF (snow flurries), T (thunderstorms), I (ice)

TOP TRAVEL DESTINATIONS

Forecasts for the world on USA TODAY's free online service: http://www.usatoday.com

Albuquerque — Today: some clouds, maybe a sprinkle 71/48. Tuesday: limited sun 72/46. Wednesday: brighter skies 69/45

Anchorage — Today: cloudy, shower, breezy, windy 42/38. Tuesday: windy with periods of rain 44/37. Wednesday: rain ends 43/37

Atlanta — Today: very pleasant, lots of sun 71/54. Tuesday: turning cloudy, risk showers 69/57. Wednesday: showers 68/56

Baltimore — Today: partial sun, a bit cool 61/48. Tuesday: mostly cloudy, a little sun 65/49. Wednesday: mostly cloudy 63/50

Boston — Today: partly sunny, seasonably cool 55/44. Tuesday: cloudy, damp, some drizzle 55/45. Wednesday: cloudy 54/47

Charlotte — Today: nice, good supply of sun 69/49. Tuesday: clouds increase, looks dry 71/56. Wednesday: cloudy, cool 68/55

Chicago — Today: chilly, light rain at times 48/40. Tuesday: periodic rain and drizzle 47/44. Wednesday: showers likely 51/47

Cincinnati — Today: clouds thicken, chance shower 62/50. Tuesday: overcast with showers around 60/51. Wednesday: showers 65/56

Cleveland — Today: gray skies, a bit of rain 51/43. Tuesday: cool with occasional rain 49/44. Wednesday: rain or showers 53/49

Columbus, O. — Today: cloudy, damp, rain showers 57/46. Tuesday: staying cool, rain more likely 55/48. Wednesday: showers 64/53

Dallas-Ft. W. — Today: rain at times through tonight 65/58. Tuesday: warmer with a few showers 72/63. Wednesday: some sun 78/58

Denver — Today: clouds, could be a flurry 48/34. Tuesday: peeks of sun, briefly milder 61/35. Wednesday: turning colder 42/20

Detroit — Today: cloudy, risk of rain later 49/41. Tuesday: light rain or drizzle at times 45/42. Wednesday: rain probable 50/45

Hartford — Today: a mixture of sun and clouds 54/42. Tuesday: gray, bit of rain or drizzle 55/42. Wednesday: cloudy 52/46

Honolulu — Today: sun and a few passing clouds 86/73. Tuesday: lots of sun, fine weather 86/73. Wednesday: fair skies 86/74

Houston — Today: rain at times 76/68. Tuesday: warm, humid, a few showers 79/69. Wednesday: mostly cloudy 80/66

Indianapolis — Today: light rain 58/47. Tuesday: cool with periods of rain 56/51. Wednesday: showers, milder 64/53

Kansas City — Today: cloudy, cool, threat of rain 52/45. Tuesday: rain or drizzle on occasion 49/47. Wednesday: showers 63/46

Las Vegas — Today: more sun, comfortable 81/57. Tuesday: very nice under plenty of sun 78/52. Wednesday: fair, breezy 75/54

Los Angeles — Today: patchy fog then hazy sun 77/63. Tuesday: filtered sun, just a bit cool 75/60. Wednesday: fair, warmer 78/59

Memphis — Today: partial sun, clouds increase 72/56. Tuesday: cloudy, mild with showers 67/59. Wednesday: a little sun 74/63

Miami — Today: warm sun and a few clouds 84/74. Tuesday: partly sunny, maybe a shower 86/76. Wednesday: showers 87/76

Mpls.-St. P. — Today: partial sun, brisk and cool 41/29. Tuesday: clouds thicken 40/30. Wednesday: chance of rain 45/35

Nashville — Today: partly sunny, mild and dry 71/55. Tuesday: more humid, threat of showers 67/56. Wednesday: shower 72/58

New Orleans — Today: clouds increase, late shower 78/63. Tuesday: couple showers, risk thunder 79/66. Wednesday: showers 80/68

New York — Today: sun at times, continued cool 58/48. Tuesday: cloudy, cool, drizzle possible 61/47. Wednesday: cloudy 61/51

Norfolk, Va. — Today: partly sunny, a cool one 68/48. Tuesday: warmer, mixed clouds and sun 71/54. Wednesday: cloudy 68/60

Orlando — Today: mainly sunny, terrific day 81/56. Tuesday: a blend of clouds and sunshine 84/66. Wednesday: partly sunny 86/70

Philadelphia — Today: clouding up, should be dry 60/47. Tuesday: many clouds, perhaps a shower 62/47. Wednesday: clouds 61/53

Phoenix — Today: clouds and sun 81/64. Tuesday: brighter sky, a bit warmer 83/63. Wednesday: mostly sunny 79/57

Pittsburgh — Today: cloudy, risk shower late 52/43. Tuesday: cool, light rain or drizzle 51/47. Wednesday: chance of rain 61/51

Portland, Ore. — Today: sunny and cool, a brisk breeze 57/36. Tuesday: sunshine 58/39. Wednesday: mostly sunny 60/41

Raleigh-Dur. — Today: sun and high clouds, cool 68/45. Tuesday: clouds tend to increase 70/52. Wednesday: gray and cool 64/53

St. Louis — Today: cloudy, rain threat increases 63/54. Tuesday: cooler with rain at times 60/54. Wednesday: showers 65/56

Sacramento — Today: bright sunshine, mild and dry 78/49. Tuesday: sunny skies, a bit cooler 73/47. Wednesday: sunny 75/45

Salt Lake City — Today: mild, mixed clouds and sun 63/44. Tuesday: variably cloudy, breezy 61/38. Wednesday: snow shower 45/27

San Antonio — Today: cloudy, more humid, showery 74/66. Tuesday: clouds mix with a little sun 80/61. Wednesday: partly cloudy 80/62

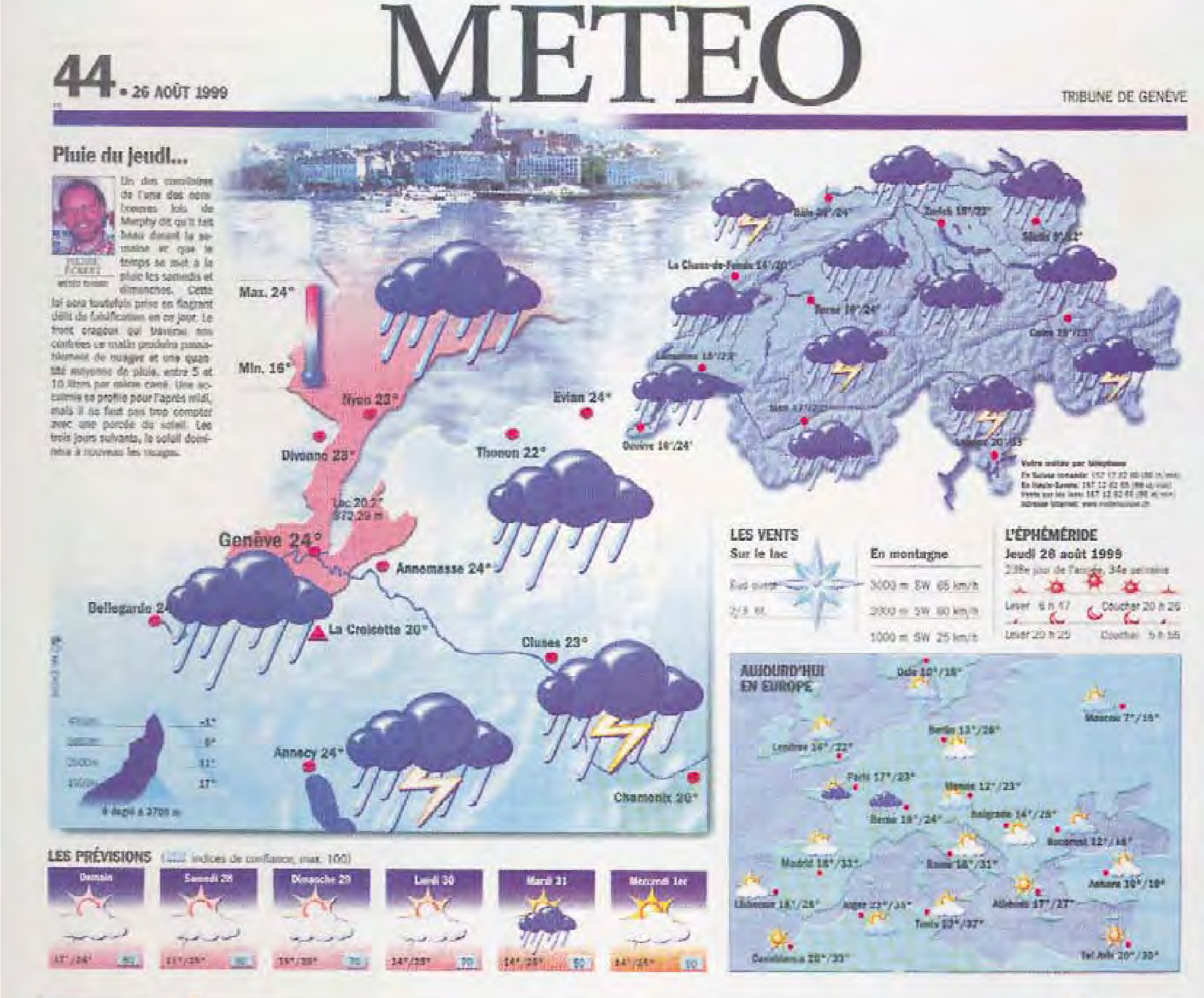
San Diego — Today: clouds then sun, staying cool 71/64. Tuesday: developing sun, not bad 71/63. Wednesday: sunny 74/63

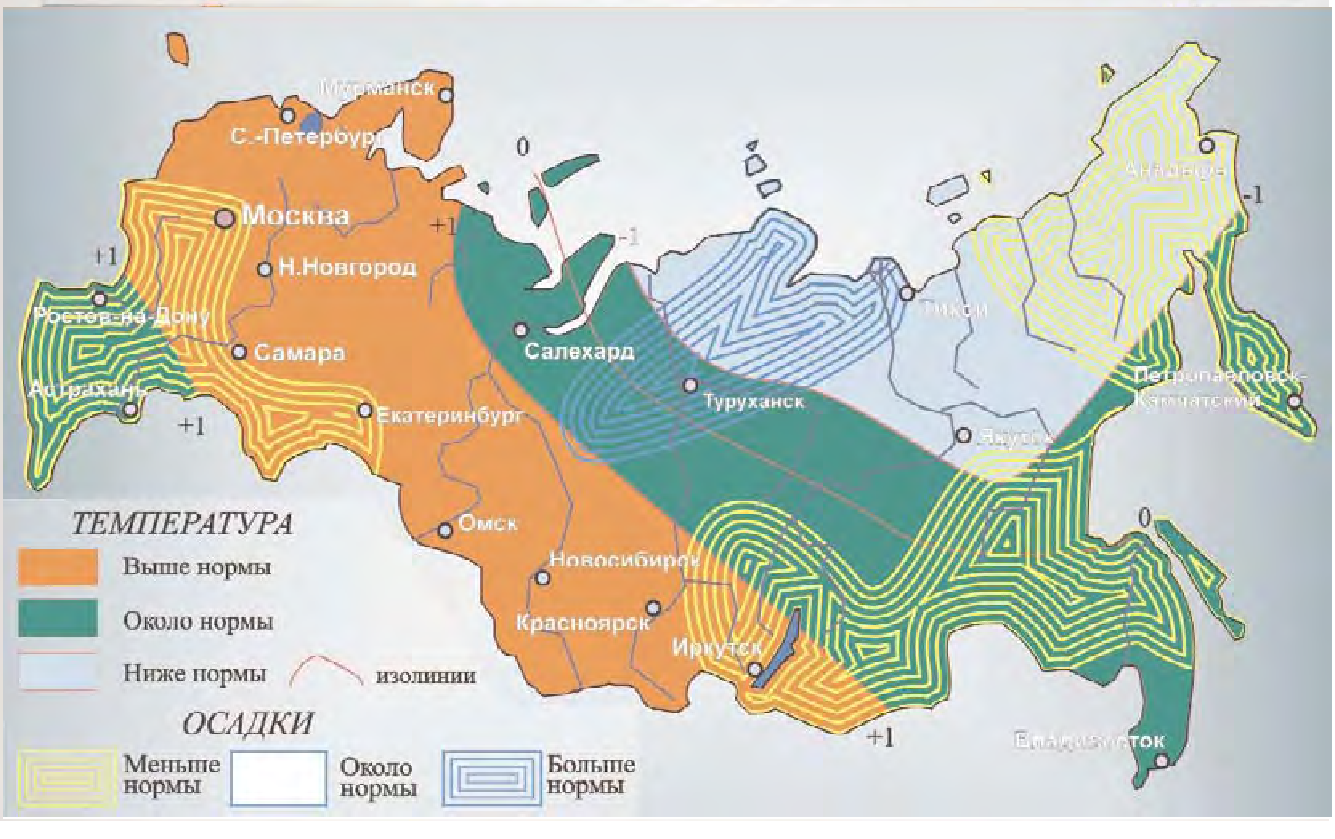
San Francisco — Today: becoming sunny, rather cool 67/52. Tuesday: sun and patchy cloudiness 65/46. Wednesday: sunny, warmer 73/52

Seattle — Today: sun sparkles, crisp and cool 55/36. Tuesday: more sun and fine weather 57/40. Wednesday: sunny 59/39

Tampa-St. P. — Today: warm under abundant sunshine 82/64. Tuesday: sun and a few clouds, nice 85/68. Wednesday: partly cloudy 87/71

Wash., D.C. — Today: intervals of clouds and sun 62/49. Tuesday: limited sun, risk shower 64/50. Wednesday: cloudy, cool 62/53


METEO
44 • 26 AOÛT 1999
TRIBUNE DE GENÈVE
Pluie du jeudi...
Max. 24°
Min. 16°
Nyon 23°
Evian 24°
Divonne 23°
Thonon 22°
Genève 24°
Annemasse 24°
Bellegarde 24°
La Croisette 20°
Cluses 23°
Annecy 24°
Chamonix 20°
LES VENTS
Sur le lac
En montagne
3000 m SW 65 km/h
2000 m SW 60 km/h
1000 m SW 25 km/h
L'ÉPHÉMÉRIDE
Jeudi 26 août 1999
AUJOURD'HUI EN EUROPE
Oslo 10°/18°
Moscou 7°/16°
Berlin 13°/26°
Londres 14°/22°
Paris 17°/23°
Vienne 12°/23°
Berne 16°/24°
Madrid 18°/33°
Rome 18°/31°
Tunis 23°/37°
Casablanca 20°/33°
Tel Aviv 20°/30°
LES PRÉVISIONS
Demain
Samedi 28
Dimanche 29
Lundi 30
Mardi 31
Mercredi 1er


Мурманск
С.-Петербург
Москва
Н.Новгород
Ростов-на-Дону
Самара
Астрахань
Екатеринбург
Салехард
Туруханск
Тикси
Анадырь
Петропавловск-Камчатский
Якутск
Омск
Новосибирск
Красноярск
Иркутск
Владивосток
0
+1
-1
ТЕМПЕРАТУРА
Выше нормы
Около нормы
Ниже нормы
изолинии
ОСАДКИ
Меньше нормы
Около нормы
Больше нормы

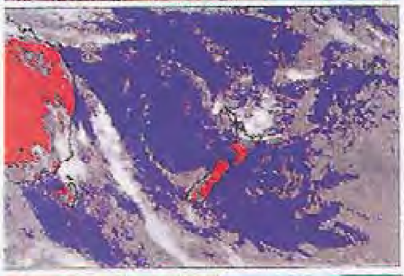
Waikato WEATHER

MetService

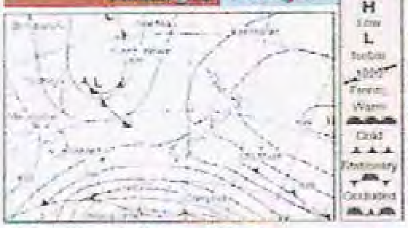
Compiled by the Meteorological Service of New Zealand Ltd.

Midnight Yesterday

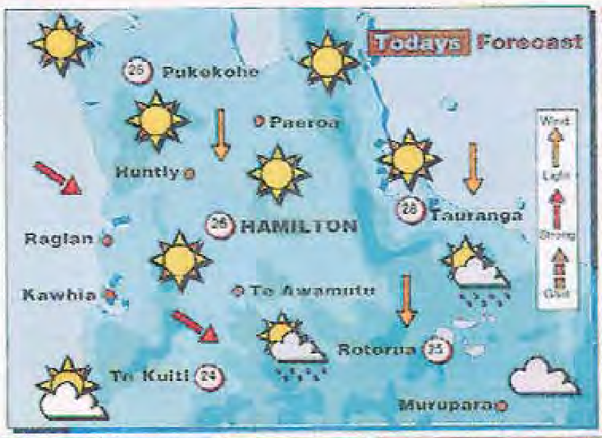
Picture taken from the GMS satellite



Midnight Tonight



Todays Forecast



Tides

Raglan

January 10
L 3:32 am 0.8
H 9:46 am 2.9
L 4:01 pm 0.8
H 10:11 pm 2.8

January 11
L 3:32 am 0.8
H 9:46 am 2.9
L 4:01 pm 0.8
H 10:11 pm 2.8

Tauranga

January 10
L 3:32 am 0.8
H 9:46 am 2.9
L 4:01 pm 0.8
H 10:11 pm 2.8

January 11
L 3:32 am 0.8
H 9:46 am 2.9
L 4:01 pm 0.8
H 10:11 pm 2.8

Regional Forecasts

Waikato

Tuesday:	Mostly cloudy with occasional rain. Moderate northwesterlies dying out.
Wednesday:	Cloudy periods, with isolated showers. Light winds.
Thursday:	Fine apart from isolated afternoon showers. Light winds.

Waitomo

Tuesday:	Mostly cloudy with occasional rain. Moderate northwesterlies dying out.
Wednesday:	Cloudy periods, with isolated showers. Light winds.
Thursday:	Fine apart from isolated afternoon showers. Light winds.

Bay of Plenty / Rotorua

Tuesday:	Cloudy periods with occasional showers. Moderate northerlies predominating.
Wednesday:	Isolated showers. Light winds.
Thursday:	Fine apart from isolated afternoon showers. Variable winds.

Taupo

Tuesday:	Mostly cloudy with occasional rain. Moderate northwesterlies dying out.
Wednesday:	Cloudy periods, with isolated showers. Light winds.
Thursday:	Fine apart from isolated afternoon showers. Light winds.

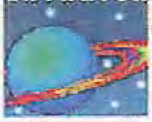
Urban Centres

Auckland:	Occasional rain. Moderate northwest winds. Max 24°
Wellington:	Occasional showers. Moderate southerlies developing. Max 20°
Christchurch:	A few showers. Moderate southerly change. Max 20°
Dunedin:	Showers clearing. Southwesterlies, strong for a time. Max 16°

Around the World

Adelaide	partly cloudy	18°
Apia	thunderstorm	31°
Brisbane	partly cloudy	33°
Cairns	fine	34°
Melbourne	cloudy	16°
Noumea	cloudy	29°
Nuku'Alofa	cloudy	27°
Pago Pago	thunderstorm	29°
Perth	fine	26°
Rarotonga	recent rain	25°
Suva	partly cloudy	30°
Sydney	clear	26°
Vila	cloudy	31°
Amsterdam	cloudy	6°
Athens	cloudy	17°
Bangkok	clear	32°
Beijing	clear	6°
Chicago	cloudy	-3°
Hong Kong	clear	21°
Honolulu	clear	27°
London	cloudy	6°
Los Angeles	clear	24°
Moscow	cloudy	2°
New York	rain	-4°
Rome	cloudy	18°
Tokyo	cloudy	6°
Vancouver	rain	7°

SKYWATCH



Sun rise/set

6:07 am / 8:45pm

Moon rise/set

9:16pm / 5:45am

Moon Phases

Farmers Diary

Observations taken at the meteorological station, Ruakura, yesterday 10 Jan 1994

SUNSHINE:	
On 9 Jan 1994	7.2 (hours)
To date this month	45.2 (hours)
Average for January	229.0 (hours)
WIND:	
Highest Gust (knots / km/hr)	13/24
Gust Direction	280
RAINFALL:	
24 hours to 9am 10 Jan 1994	0.0 (mm)
To date this month	27.4 (mm)
To date this year	27.4 (mm)
Average for January	80.0 (mm)
TEMPERATURE:	
Maximum (to 6pm)	25.0 (°C)
Temperatures for the 24 hours to 9am 10 Jan 1994	
Maximum	28.0 (°C)
Minimum	16.2 (°C)
Grass Minimum	11.1 (°C)
Earth Temperature (30cm)	21.6 (°C)
BAROMETRIC PRESSURE:	
At 9am 10 Jan 1994 (Mean Sea Level)	1018.1/30.06 (hPa)/(inches)
GROWERS' GUIDE	
Soil thermometer reading for Ruakura	
Grass Minimum	11.1 (°C)
Earth Temperature (30cm)	21.6 (°C)

Evapotranspiration

Priestly Taylor Evapotranspiration (mm) run on Tue, 11 Jan 1994

Average percentage evapotranspiration 4.8

Das Wetter

Sonnig und trocken bei Werten um 6 Grad

Wetterlage: Vor Annäherung eines Tiefausläufers herrscht heute Hochdruckeinfluß. Erst morgen wird das Wetter unbeständig. Zu Wochenwechsel dreht der Wind auf südliche Richtungen. Damit gelangt frühlingshaft milde Luft nach Sachsen.

Vorhersage: Heute ist es sonnig und niederschlagsfrei. In der Nacht nimmt die Bewölkung zu und vereinzelt regnet es auch. Morgen bleibt es meist bedeckt, und es regnet gelegentlich. Dabei weht der Wind meist nur schwach und dreht von Süd auf Südwest. Ab Sonnabend lockern die Wolken wieder auf, so daß bis zum Montag hin und wieder die Sonne scheint. Niederschläge treten kaum noch auf.

Höchsttemperaturen am Tage: Die Temperatur steigt auf 6 bis 9, im mittleren Erzgebirge auf 5 Grad. Der Fichtelberg erreicht ein Temperaturmaximum von 1 Grad.

Tiefstwerte in der Nacht: Kommende Nacht wird kaum noch Frost erwartet. Die Temperatur sinkt auf 2 bis 1 Grad, im oberen Erzgebirge bis auf -1 Grad.

Straßenwetter: Bei der milden und trockenen Witterung gibt es keine besonderen, wetterbedingten Einflüsse für den Straßenverkehr. Mit Behinderungen ist also nicht zu rechnen.

Temperaturen gestern 13 Uhr

Chemnitz	3,0 Grad
Plauen	4,3 Grad
Marienberg	2,3 Grad
Fichtelberg	-2,1 Grad
Aue	5,6 Grad
Carlsfeld	1,5 Grad
Dresden	4,2 Grad
Leipzig	5,7 Grad

Vorschau für Chemnitz

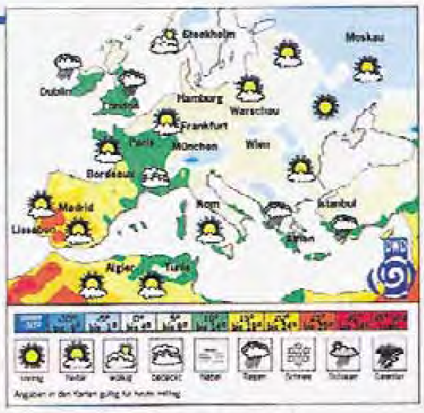
Do	Fr	Sa	So	Mo	
6	12	15	18	19	Höchsttemperaturen
					Wetter
00%	80%	40%	30%	40%	Niederschlagsrisiko
80%	10%	40%	60%	40%	Sonnenscheindauer

SA 5.59 Uhr
SU 18.31 Uhr

MA 5.15 Uhr
MU 16.24 Uhr

Pollenflug

Die Blüte von Hasel- und Erlenpollen ist mit Ausnahme des höheren Berglandes weitgehend beendet. Die zum Beginn der Birkenblüte werden noch weitere Wärmegaben benötigt.



Temperaturen (°C) heute 13.00 Uhr

Algier	heiter	16	Moskau	heiter	-2
Athen	Regen	11	Nizza	wolkenlos	17
Barcelona	heiter	16	Palma d. M.	heiter	18
Basel	heiter	11	Paris	bedeckt	12
Budapest	wolkenlos	9	Prag	wolkenlos	7
Helsinki	bedeckt	0	Rom	heiter	11
Istanbul	Regen	9	Stettin	bedeckt	7
Kairo	wolkig	28	Stockholm	wolkig	6
Kopenhagen	bedeckt	5	Straßburg	heiter	12
Larnaka	Regenschauer	19	Tunis	heiter	15
Lissabon	heiter	24	Varna	heiter	7
London	Regen	12	Wien	wolkenlos	8


předpověď
14.00
N
1010


PARIS
BERN
MADRID
13:00


Mardi
Mercredi
Jeudi
Vendredi
Ennuagement
Beau
MIN MAX
13 23


CONDICIONES METEOROLOGICAS ACTUALES
São Paulo
Porto Alegre
Pelotas
20:15


NEWS 4 WEATHER


Thu
Fri
Sat
Sun
60s

7.3.1.2 Bulletins and newsletters

Most NMSs publish bulletins of weather information on a daily, weekly or monthly basis (see 6.2). They can be printed in-house or given to a printer depending on the relative costs.

7.3.1.3 How to prepare and produce a weather page for a newspaper

Weather pages may be produced for a daily newspaper serving the general public, or for a weekly or monthly magazine for particular groups such as farmers or fishermen.

The process of producing a weather page for a newspaper is shown in Appendix I to this chapter. The process can be divided into two main phases:

(1) Preparation; and
(2) Operational routine.

The preparation phase consists of setting up a (digital) system that allows combination of all the required data more or less automatically for a ready-to-send forecast product. The following are the main requirements:

- The system should be fast, automated and inexpensive;
- The output should be a complete and ready-to-print product;
- Being an operational system, it has to be reliable with a minimum of error sources;
- The system should be easy to use;
- The system has to be compatible with systems within the NMS (access to all products of the NMS) and with systems of the media; and
- To be able to serve different newspapers at the same time, the layout capabilities should be flexible to enhance the creation of individual and ambitious layouts.

Preparation

The development of a particular product is done in close consultation with the newspaper or magazine concerned. The press have a very good idea of the interests of their readership and are experts in layout designed to attract attention and impart information. The NMS has to ensure that its information is presented fairly and completely, and it can contribute its own knowledge of user interests.

The data required to make up the forecast has to be identified and working links established to regularly obtain these data. The data may include output data from the forecasting models, text of manually and automatically created forecasts, synoptic charts, satellite pictures, etc. To complete the layout, maps, graphics, pictograms and images have to be created for inclusion into the page. All these are brought together on a PC for producing the newspaper page.

Operational routine

In the daily operational routine, the necessary data (texts, forecasts, images, charts, etc.) will be automatically fed into the computer and combined to formulate a forecast. After ensuring the relevance of the data used, the layout is revised, saved and printed. The final product is once again checked by a meteorologist for its content and layout to ensure the quality standard. Finally, the forecast is saved as an EPS file and sent to the newspaper by electronic communication or by diskette. For newspapers and magazines not yet produced by computer it may be necessary to provide the product in hard copy.

7.3.2 RADIO

7.3.2.1 General

Radio networks offer an extremely effective and widely used means by which to disseminate weather information. The broadcast of weather warnings, forecasts and related information by national and local AM/FM radio stations therefore continues to be one of the most common and important components of the dissemination system for public weather services in all countries. Radio is not infrequently the only effectively functioning mass dissemination system in catastrophic situations such as severe floods or hurricanes. During more normal

Photos on opposite page: Top — Minitel system [Météo-France]*; TV presenter* [Czech television]*; centre, clockwise from left — four examples of forecast graphics in German* [Deutscher Wetterdienst]*, French* [MétéoMedia/The Weather Network]*, Spanish and English* [Kavouras Inc.]; *inside a weather office* [Weatherwise/T.J. Kierein, WRC-TV]; *and presenter with satellite image and locally-inserted observation crawler* [MétéoMedia/The Weather Network]*; bottom — live radio broadcast watched by participants at training workshop at the Bureau of Meteorology, Australia* [WMO/H. Kootval] *and TV studio* [Weatherwise/T.J. Kierein, WRC-TV].

circumstances, commercial and public radio networks are highly popular sources of news and entertainment. In consequence, they provide an effective means for reaching a large percentage of the general public and are heavily relied upon by most NMSs.

Many radio news programmes include a segment during which the latest weather forecast for the listening area is broadcast. More "serious" radio stations and networks also frequently have a well-advertised schedule of broadcasts of more comprehensive weather information including, for example, descriptions of the synoptic situation, marine and agricultural forecasts, air quality information and the latest observed conditions from key locations. Entertainment-oriented commercial stations often feature frequent interventions between segments of recorded music during which the announcer or disk jockey delivers a very fast-paced and abbreviated summary of current and forecast weather conditions. These music and entertainment stations are an important component of the overall dissemination system since they usually cater to youthful, casual or travelling audiences and frequently are the only source of weather information for this group. Radio stations are often interested in receiving more frequent information and a personalized presentation of the weather report. As a consequence, they deserve attention by NMSs to ensure that the weather information which they broadcast is factual, understandable and current. The partnership between radio stations and the NMS can be strengthened based on the fact that the NMS needs the radio station to convey its information; on the other hand, the radio station needs the weather forecast as an audience-attracting part of its programme.

The fact that radio broadcasts are restricted to voice, and no written text or graphics can support the information process, is easily outweighed by the advantages offered. Information disseminated by radio can by easily updated in rapidly changing situations or emergencies. During severe weather when power outages are common, battery operated or wind-up radios may provide the only means by which the public can access critical weather warning information.

Some radio stations take their programmes for some hours of the day on relay from another station. Some radio stations prerecord several hours of programme for broadcast overnight. During these periods there is no-one in attendance at the radio station. An urgent warning sent to the station late in the evening may only be found on the facsimile machine when staff arrive the next morning. The NMS must keep in regular contact with radio stations it serves and keep informed of such arrangements. The warnings can then be sent to the station from where the relayed programme emanates. It may be possible, in case of extremely urgent warnings, to obtain an emergency contact number for radio staff to travel to the station and interrupt a pre-recorded programme. In times of very severe weather, such as tropical cyclones or major flooding, radio stations will usually maintain staff at the station round the clock to broadcast emergency information.

7.3.2.2 Government operated weather and alert radios

In some countries, the NMS operates a dedicated Weather Radio system which provides continuous weather information to listeners on special VHF frequencies. These radio systems are especially valuable for the dissemination of warnings, forecasts and other hazardous information as weather information is broadcast 24 hours a day; messages are repeated every four to six minutes and are routinely updated every one to three hours or more frequently in rapidly changing local weather if a nearby hazardous condition exists. In emergency situations such as approaching hydrometeorological hazards, but also for other natural and technological catastrophes, the system provides instant warnings for the public. That is especially valuable in places such as hospitals, schools, recreation centres, etc. Widespread use is made of weather radio systems in the USA (NOAA Weather Radio), Canada (WEATHERCOPY) and in China.

Transmission is mostly on special VHF frequencies (rarely on AM or FM). The coverage of the weather radio system is limited to an area within 40 miles (64 km) from the transmitter. During an emergency, forecasters will not only interrupt the routine programming, but also send out a special alarm tone in the listening area that is threatened by a hazard. The special alarm tone can sound an audible or visible alarm or activate the radio itself to ensure that all people receive the warning even when they are not listening to the regular programme or are asleep. By connecting weather radios with alarm tones to other kinds of attention-getting devices like strobe lights, pagers, bed-shakers and text printers, the hearing and visually impaired also receive the warnings. This enables the NMS to distribute its weather warnings rapidly, accurately and effectively. It also enables local officials and emergency managers to quickly send out important area-specific information to the public.

The weather radio system has been constantly improved since its early beginnings: starting out from a 24-hour radio programme that is dedicated to weather information, interruptions of the programme for warnings and alarm tones were introduced. Furthermore, limiting the dissemination of warnings to those areas that are affected avoids a high number of 'false alarms', especially for phenomena such as tornadoes which occur frequently, but very locally only. In the USA, for example, the Weather Radio Specific Area Message Encoding (SAME) digital encoding is employed to activate only those special receivers that are programmed for specific emergency conditions in a specific area, typically a county. The regular broadcasts are specifically tailored to weather information needs of the people within the service area of the transmitter. For example, in addition to general weather information, stations in coastal areas provide information of interest to mariners and those in agricultural areas provided information of interest to farmers. Digital technology now enables broadcasting of text and even graphics.

7.3.2.3 Direct radio broadcasts from the NMS

Direct broadcasts have the advantage that the public image of the NMS can be significantly improved by giving a "voice" to the meteorological service. Naturally, staff making such broadcasts should have clear and fluent articulation.

The forecast can be made from the radio studio, although this involves additional time in travelling to and from the forecasting office. More commonly, the broadcast is made by telephone link from the forecasting office to the radio station. In this case the microphone must be located in a quiet area, in a separate room from the forecasting area, to avoid unwanted sound effects.

The broadcast can take two forms:

(a) the forecaster reads from a prepared script, usually a set of current forecasts; or

(b) the forecaster is interviewed by the radio presenter. This is common with 'talk-back' radio segments. Over time rapport will be built up between presenters and the forecasters, leading to an informal and 'natural' presentation with considerable listener appeal.

In all cases the broadcasts are made at set times as agreed between the NMS and the radio station so that they can be scheduled into the office routine. At times of severe or unusual weather, however, a radio station may request an interview with a forecaster. This provides an excellent opportunity of describing to the public just what is happening, but may be difficult to fit into a very busy period in the office. See 7.3.3.3 below on press conferences.

Although broadcasts are live the radio station may record them for re-broadcast within a limited time, say an hour, to reach more members of a particular section of the public, e.g. farmers.

7.3.2.4 How to prepare and produce a weather radio broadcast

The person undertaking the broadcast must not be suffering from a head cold or cough which may affect the quality of voice. He or she should arrive at the broadcast post in good time — it is difficult to speak clearly and fluently when out of breath.

Forecasts read over radio should not be in a telegram format of short sentences. They should flow smoothly and, as far as possible, follow the cadences of the language. For example, a forecast written as "Showers this evening. Fine tomorrow. Mild to warm. Light winds." should be read as "There will be showers this evening but these will clear to a fine and mild to warm day tomorrow with light winds.".

Scripts need to be prepared with care so that they use simple language, flow smoothly, are attuned to the likely audience, e.g. farmers, and be of the right length to fit the allotted time. Radio stations have their schedules and do not like weather (or any other segment) running over time.

For radio interviews the major requirement is to be fully abreast of the current weather situation, and to be knowledgeable on the relevant meteorology. Confidence comes with practice.

A checklist of things to be considered in making the perfect radio weather forecast is in Appendix 2 to this chapter.

7.3.3 TELEVISION

7.3.3.1 General

Television, with its extensive graphics capabilities, has the power to attract the audience, to personalize information presented and to emphasize risks associated with severe events. The visual nature of television presentation enables viewers to readily assess the impact of an event. This is particularly so when explanatory textual material is included in the presentation or when a TV weather presenter supplies an effective verbal description of the situation. Television is, therefore, very popular in most countries as a dissemination medium for public weather services.

Television news programmes frequently devote a segment of their time to providing weather forecasts and related information to the public. In addition, many television stations routinely interrupt scheduled programming to broadcast severe weather warnings or to report on significant events such as tornadoes or floods. Some television networks carry a regularly scheduled weather programme during which meteorologists from the NMS or the private sector present very complete information covering major weather-sensitive sectors.

Commercial television “weather channels” with both government and the private sector participating exist in some countries (e.g. the United States, Canada). They are specialized in providing “around-the-clock” weather and environmental information to the public. Where these networks exist, they have generally been very successful in attracting large viewing audiences.

Weather broadcasts form a significant component of the regular programme content of national and international television broadcast networks. The weather segment on a network may cover the entire country of the size of the USA or Australia. The broader the area of coverage, the less detail for specific areas can be provided. International television broadcasts are now widely accessible in hotels and on cable television channels around the globe and, in many regions, the weather segments of their programming undoubtedly provide a useful service to vacationers and other travellers and, sometimes, to the local population.

The same problem of stations on relay for part of the day, or running on pre-recorded programmes overnight, as described in 7.3.2.1 above, also apply to television.

7.3.3.2 Television crawler

The use of moving text messages, which move across the top or bottom of television screens, without interrupting the regular programme, has proven to be an effective means for conveying urgent severe weather and flood warning information to viewers. Often, the crawler is combined with a beep signal. A smaller icon of the hazard in a corner of the screen while there is no crawler can further indicate that a warning is currently being issued. This approach is very widely used to alert the public to the hazards presented by tornadoes and other extreme phenomena. Many television stations routinely broadcast severe weather watches and warnings issued by NMSs in crawler form. Studies have found that the late afternoon and early evening hours are a peak viewing period for television. It is also one of the peak periods for severe thunderstorms and tornados. Therefore such a “crawler” warning message would be seen by many viewers who could then take appropriate action to protect themselves.

7.3.3.3 Press conference

In times of severe weather a forecasting office may be inundated with telephone calls from television and radio stations for information and interviews on the situation. This can be overcome by calling a press conference, to be attended by all interested media, including television cameras, when all can be informed at the same time. The best time for such a conference is in the afternoon so that it can be used for the evening television news. Well-briefed non-forecasting staff may be used, alleviating pressure on the forecasting staff. It helps credibility if the most senior person available undertakes the press conference.

Press conferences are also useful in highlighting meteorological events of a non-immediate nature, such as a forecast drought from an El Niño episode, or the prospects for a break in a drought.

7.3.3.4 How to prepare and produce a television weather broadcast

Television broadcasts often incorporate high-quality graphics, enhanced satellite and radar imagery and very polished presentations by on-air personalities. In the case of larger networks and international weather broadcasts, many of the on-air presenters are professional meteorologists. The visual impact of graphics and other imagery combined with clear and concise verbal presentations by professional broadcasters can be highly effective in conveying important weather information to viewers. Television graphics designers and private meteorological companies have been particularly innovative in developing presentations which capture the attention of viewers and convey the key elements of weather forecasts and warnings to them. Several examples of graphics used by television broadcasters in presenting weather information to general public viewing audiences are shown in the accompanying CD-ROM.

Forecast examples range from the highly condensed "punchy" summary (e.g. "Wake up Weather") to a more traditional presentation where an overview of the synoptic situation is provided, followed by a detailed forecast. The former approach is often used in television nowcasts or very short-range forecast presentations for a single city or small region where the objective is to capture the total attention of the viewer for a few seconds and quickly deliver the key element(s) of information in an easily memorable format. Another variant of this approach summarizes the weather conditions expected over a period of several days by means of a single graphics "box" for each day. This heavily synthesized approach is used by many weather presenters on local commercial television stations. More traditional approaches tend to use graphic representations of the main features of the synoptic situation as the backdrop for a discussion of the current and forecast conditions, generally over a fairly large geographic area and for several days ahead. Frequently, these latter also incorporate colour-enhanced satellite and radar imagery, frontal systems and the use of motion to convey the evolution of weather patterns to viewers.

Example from Germany

The Deutscher Wetterdienst developed a weather presentation system to provide an optimal realistic impression of the cloud forecast for the public. Dark clouds with black shadows indicate bad weather, whereas white, fluffy clouds show fair weather. Clouds with lightning give a warning of expected thunderstorms. Different meteorological fields such as isobars associated with pictograms, text and other graphics can also be presented. The pictures can be two- or three-dimensional.

7.3.4 OTHERS

Besides highly sophisticated technological devices to convey information and warnings, there still exist the "old-fashioned", but very effective means, of dissemination of warnings including sirens, speakers, balls, flags and beacons.

Sirens (including speakers)

This method of dissemination is useful for urgent broadcast of warnings and emergency instructions in urban areas with high population density. In the United States, for example, many communities activate sirens for selected severe weather warnings in accordance with procedures jointly developed by weather and emergency management officials. Siren systems, however, may not be heard, especially at night. If they are used for more than one purpose a distinctive call must be used for each, e.g. a series of short sounds, and a series of long sounds. It is important that they be reserved for major emergencies and not overused or the public will begin to ignore them.

Visual warning systems such as coloured balls and flags may be used on high buildings and hilltops. They have the obvious shortcoming, analogous to sirens, in that they must be seen and this is difficult at night. They are mainly used for hazards which occur regularly and to declare a state of situation such as "no danger", "be aware of hazard approaching" and "immediate danger". Beacons of electric lights on high-rise buildings may be used to indicate the forecast weather by a code of colours and flashes. With all these means a public education campaign is necessary to tell people what the various signals mean.

7.4 POINT-TO-POINT DISSEMINATION AND PRESENTATION

Where manual methods are relied upon, the point-to-point approach, e.g. by a series of telephone calls, can be very time consuming and costly, and though useful, its application is usually limited to providing warning or other emergency information to a relatively few key recipients such as broadcast media or public safety agencies. Current and emerging communications technologies, however, make point-to-point dissemination an increasingly viable approach to effective dissemination of public weather information to a growing segment of the population in countries with well-developed communications infrastructure. In particular, such technologies permit the rapid and automatic transmission of critical information to clients or to a central facility for subsequent fan-out by other methods. The specific means discussed below rely on the user initiating the contact rather than the NMS.

7.4.1 TELEPHONE SERVICES

There are a variety of telephone services and systems used by NMSs to provide wider access to their information and services. They can be divided into two broad categories: personal telephone contacts and recorded information. The main advantage of telephone services is that they can be easily adjusted to serve special user groups such as the public, the hazards community or certain economic sectors.

7.4.1.1 Personal telephone services

General weather information for the public

In many countries a popular way of accessing weather information for the general public is through personal telephone contacts. Live answering from listed lines is made available for several hours a day, enabling the user to ask very specific questions. The load on this telephone service will depend on the population of the area of responsibility of the forecasting office, the changeability of the weather, the imminence of local holidays, and the general interest of the public in the weather. In some cases it may be necessary to devote one or two staff members solely to answering this telephone during business hours, and to install a queueing system for callers. In some countries, NMSs have also established specialized telephone services to answer questions from their commercial customers, which enables the NMS to serve its users on an individual basis, building trust and public image.

Telephone hotlines

Hotlines serve the purpose of communicating urgent information without delay. In the context of weather information they apply mostly to communication between the members of the hazards community such as emergency managers, government authorities and the NMS.

To ensure communication in emergency situations, special telephone numbers should be established for the hazards community.

Unlisted numbers for emergency use: Each forecasting office has designated unlisted numbers made available to relevant members of the hazards community, and used ONLY for emergency operations within the office's warning and forecast area. Restricted-use numbers ensure telephone access when needed. These lines would be used by emergency management and other hazards community entities supporting the warning process (e.g. severe weather spotter groups and some other local officials). The numbers are only for incoming calls.

Unlisted numbers for non-emergency use: There may be also unlisted non-emergency use numbers for the hazards community.

7.4.1.2 Recorded weather by telephone

Many NMSs provide the public with telephone access to prerecorded weather forecasts and other information. Automatic telephone answering devices offer an effective means by which to make many routine types of weather information available to the public and reduce the number of telephone calls coming into the office.

The recording equipment used ranges from mass-storage devices with multiple telephone line access capability to low-cost, single-line units such as are increasingly used in private homes. The former are generally used in populous urban areas where there is a high volume of calls from the public while the latter can be quite adequate for locations with more modest levels of demand. The recorded messages must be kept up to date, and the time taken to record the messages should not be underestimated. In some countries, message recording has been automated by using computer-generated voice technology to load the recording devices with forecasts and other products which are fed automatically, in digital form, from the national meteorological telecommunications system. Most of the NMSs offering recorded weather forecasts have a close relationship with the national telecommunication companies.

Recorded weather messages are usually concise in order to minimize cycle time and permit the maximum possible number of callers to access the information. As they are automated services, they are usually available 24 hours a day.

Recorded weather information by phone is generally a popular service since it gives immediate access to up-to-date forecasts and other important information when the user wants it. There is considerable variation in national practices with respect to charging for such access (above any telephone call charge) ranging from no charge to access for a fee. In some countries, access is free but the recorded weather information is preceded by a short advertisement from a commercial sponsor while in others a charge is levied by the telephone company for calls to the recording device and the revenue gained is shared with the NMS.

Example from Germany

In cooperation with the German telecommunication company, the Deutscher Wetterdienst is offering recorded telephone services which consist of more than 400 numbers for weather information and forecasts ranging from general forecasts, aviation weather, bio- and agrometeorological reports. The information is updated up to three times a day. These recorded messages are produced partly manually, the rest being pure computer products.

7.4.1.3 Telephone paging systems

Telephone paging systems are another method of delivering time-critical weather information to both citizens and emergency management officials. In some countries paging services provide immediate notification to an individual's pager of all severe weather information as it happens. The variety of pagers now available allows simple quick messages or alarms drawing attention to the detailed warning issued by the NMSs or other emergency management officials as it relates to a natural or technological hazard.

7.4.1.4 Cellular telephone warning systems

With the advent of the cellular telephone, another important tool is available to the NMS in providing instant access to time-critical weather warnings, advisories and other natural hazard information. In the United States, an association of emergency management professionals, wireless telecommunications companies and equipment vendors have developed the Cellular Emergency Alert Service which broadcasts delivery of site-specific public warnings to cellular phone subscribers.

7.4.2 FACSIMILE

Facsimile can be used to transmit information in a variety of forms and formats including both text and graphics. This capability means that facsimile makes it possible to combine reliable dissemination with enhanced, more effective presentation of information in graphical form. Facsimile products can be relayed by radio, phone lines or communication satellites. In general the NMS can offer two different services: either, it sends the information automatically to all users that subscribed for the fax service or the user can dial in and the fax will be sent on demand. It is an effective means for transmitting specialized information to a limited number of key clients of the NMS. In some countries, it is also used to deliver meteorological products to paying customers and is an important component of their NMSs' revenue earning initiatives.

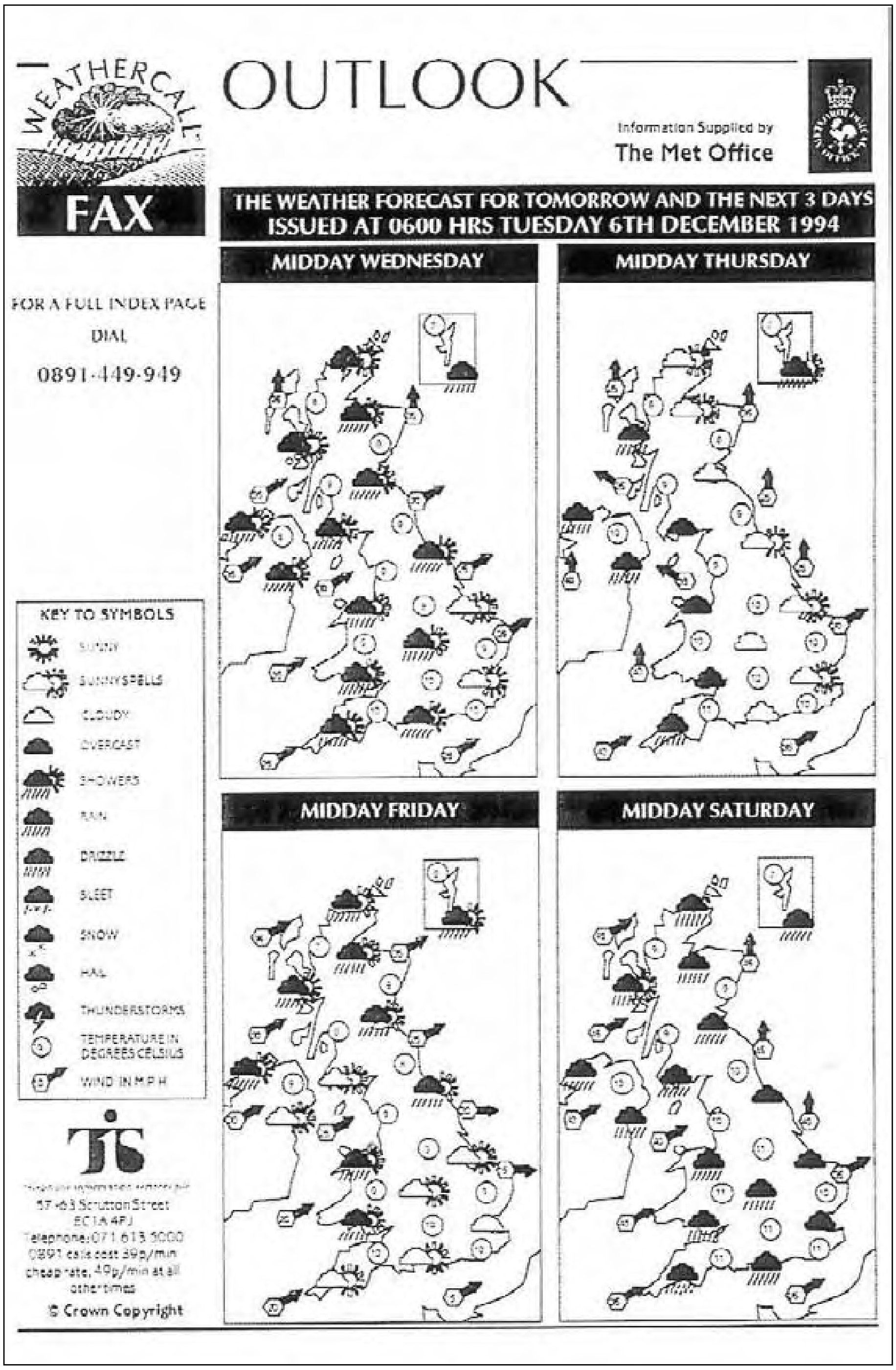


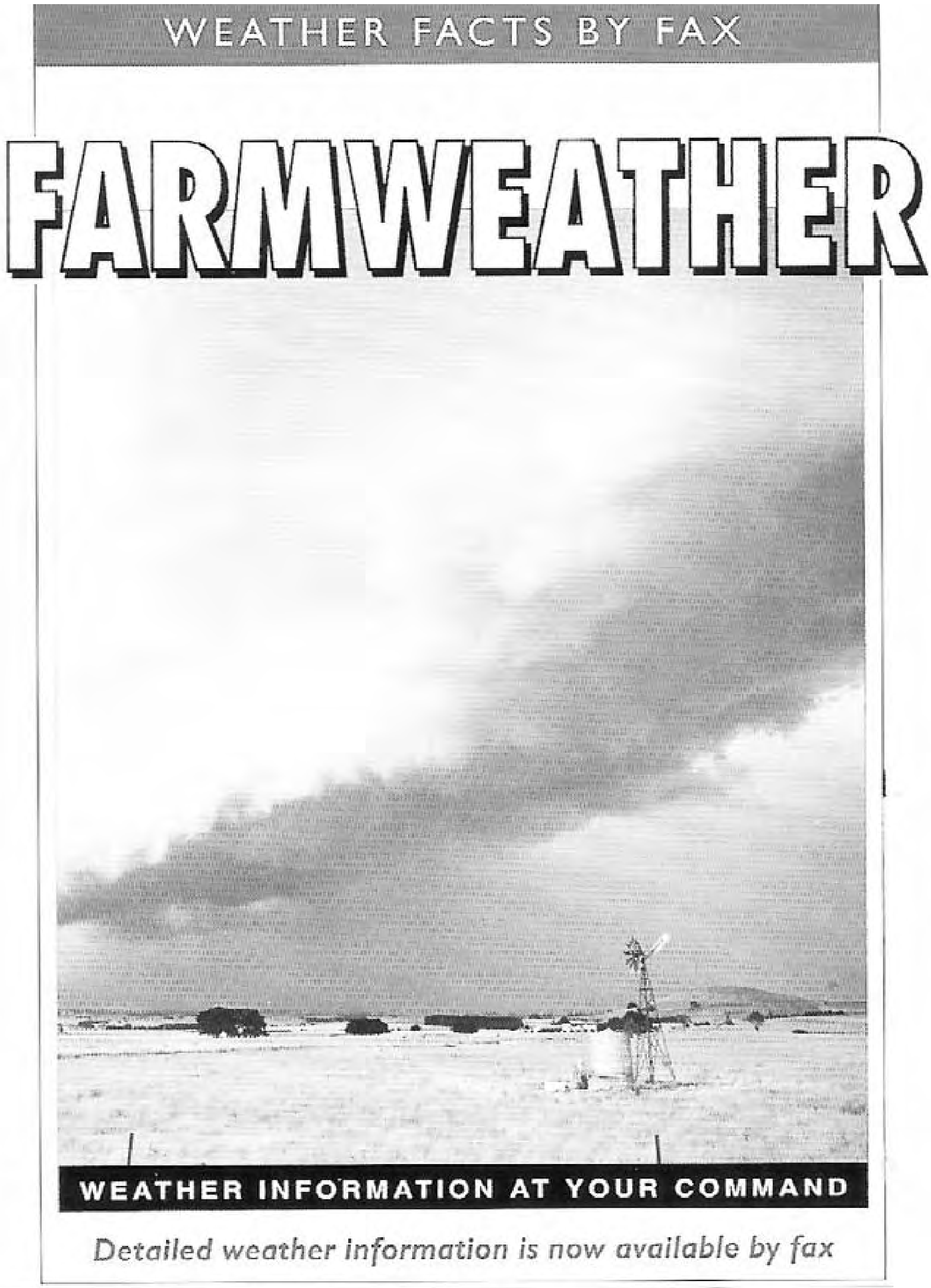
Figure 12. Examples of public forecast information
(this page: the UK Met. Office's Weathercall Service; opposite page: Bureau of Meteorology, Special Services Unit, Australia)

Facsimile is additionally a convenient method of transmitting public weather forecasts to the media. Facsimile-computer interfaces are available so that a computer can be programmed to send particular messages to particular users. The whole process of routine dissemination can be automated in this way (see 7.1 above).

Dial-in facsimile services are easy to set up and to maintain; have relatively low costs; and allow information to be tailored to the very specific needs of different user groups. Information can be provided in greater detail than with many other means of dissemination. As with dial-in telephone services, access can be free, commercially sponsored, or charges may be made and the revenue shared between the telephone company and the NMS.

Examples

Germany: The fax-on-demand programme of the Deutscher Wetterdienst offers 20 phones numbers to provide users with forecasts including weekend weather, bio-weather, winter sport weather conditions, satellite pictures and others. The



forecasts are produced automatically and are delivered to a service provider for selling. In 1998 the fax service was limited to Germany and usage was about 600 times per month and increasing.

Australia: There are more than 200 telephone numbers for fax on demand ranging from general information, weather charts, observations, forecasts, warnings, satellite pictures for all Australia and more specifically for each region within.

7.4.2.1 How to prepare and produce a weather facsimile page

Products received by facsimile by people who have specifically requested them, either by subscribing to a list or by dialling in, do not need the same attention-grabbing display of a newspaper presentation. The transmission of the text of forecasts and warnings, and of unembellished weather charts and satellite pictures may be quite sufficient. Nevertheless it helps the image of the NMS, and the ease of reading by the recipient, and increases patronage, if the information is attractively laid out. Facsimile does not, as yet, have the advantage of colour.

CHAPTER 7

While a newspaper weather page has to be designed to contain a variety of information — forecasts, charts, satellite pictures, yesterday's temperatures, etc. — for dial-in facsimile users it is preferable to have a separate number for each type of information, each product comprising one page. The recipient then receives only the information required, instead of several unwanted pages. This is also of advantage in cases of low transmission speeds. In some cases, however, consultation with users may reveal that many wish to receive two or three products on the one call, instead of making two or three separate phone calls. In this case, some information can be packaged together. The main point is that consultation with users will reveal the best combination of single and packaged products to satisfy the majority of users.

7.4.3 E-MAIL

E-mail is a very efficient way of disseminating weather information to a fixed group of users, who must, of course, have the facilities to receive e-mail. The list of recipients is entered into the sending computer and the send button only has to be pressed once. Charges may be made for the service. It should be remembered, however, that the recipient may have to access his or her mailbox, and it is not a sure method of delivering urgent warnings.

7.4.4 TELETYPE SERVICES

This method of dissemination provides a printed copy of information in text or tabular form. It has traditionally been an effective means of conveying weather information to special clients such as government agencies and to the media. Teletype hardware is now becoming obsolescent and transmission rates are typically rather slow. Consequently, teletype systems have been replaced by faster and more versatile computer communications systems in many countries.

7.4.5 DIRECT COMPUTER CONNECTIONS (VIDEOTAPE)

Direct computer connections provide an effective method for transmission and receipt of a wide range of information and data in the form of text, graphics or gridded data fields. Users may have either dedicated or "dial-in" communications links to a meteorological database at a central computer facility, operated by the NMS or by a cooperating agency. As with recorded telephone and dial-in facsimile services, videotext is not time-dependent and is available at all times of the day or night. A particularly useful feature of this approach is its ability to provide efficient and reliable two-way exchange of information between the user and the NMS.

There are, however, some disadvantages. The production of the displays is time-consuming and operating costs are relatively high especially in relation to only a small number of users. Yet, Météo-France makes extensive use of its system, called MINITEL. It is possibly the most developed application of this approach where telephone subscribers can access videotext pages of weather information through a network of simple terminals supplied by the national telephone company.

The MINITEL system is an on-line, computer-based system established in the early 1980s by the French national telephone company. MINITEL provides dial-up access (for a fee) to a very broad range of information and services by means of simple, inexpensive terminals. The meteorological services available to clients include forecasts, warnings and other meteorological information supplied by Météo-France. The MINITEL system has a modest graphics capability which is progressively being upgraded. As a dissemination/presentation method for public weather services, it offers the advantages of automatic telephone answering systems (i.e. ease of access to a menu of constantly updated information when the customer wishes) along with the potential for increased effectiveness in presentation through its text and graphics capability.

There are about seven million MINITEL terminals located in key locations across France. It is claimed that a high percentage of France's 70 million people have regular access to a MINITEL terminal, either at home or through work. MINITEL is a very effective and well-used system and the very high penetration of the system throughout France makes it an excellent system for the delivery of public weather services with their very broad target audience. As MINITEL is controlled by the national telephone company, an organization with high credibility, security and billing concerns are minimized and customers feel comfortable connecting to it and using their credit cards to pay for services while on-line or in being charged for MINITEL service usage on their phone bills. MINITEL is now accessible from outside France via the Internet by logging on to the World Wide Web (http://www.minitel.fr).

7.5 THE INTERNET

The Internet is at once a worldwide broadcasting capability, a mechanism for information dissemination, and a medium for collaboration and interaction between individuals and their computers without regard for geographic location. The emerging development of the "information highway" provides a new and potentially revolutionary option for the rapid, automatic and global dissemination of meteorological information comparable to the invention of telegraph, telephone, radio, television and computer. A large number of NMSs, university groups, private-sector companies and individuals are already providing weather information on the Internet. This information can be extremely detailed including observations; forecasts; warnings; satellite and radar data and images; numerical weather prediction model outputs; upper air soundings; and climate data.

As with recorded telephone, dial-in facsimile and videotext, the recipient has to initiate access to the information. Many users have to turn their computer on, dial a service provider and access the relevant weather page required. Thus, at present, it is of limited value in disseminating initial urgent warnings.

The advent of the Internet provides both opportunity and challenge to the international meteorological community in determining how best to harness its potential for dissemination of warnings of hazardous weather and for the relay of other weather data and products while minimizing the problems associated with a new and open communications technology.

However, the impacts of this technology on national meteorological infrastructures and on systems such as the World Weather Watch and its components (in particular the Global Telecommunications System (GTS)) are very wide-ranging. An increasing number of NMSs view electronic networks such as the Internet as effective ways to share information by making all data and information available to interested parties. In 1999, about one-third of NMSs were using the Internet as a dissemination medium. However, the delivery of data across the Internet cannot be guaranteed for several reasons such as communications failure along the communications path, routing failure, domain name system failure, circuit or server overloading. Digital data, unlike printed data or analogue information, may be easily altered in a way that cannot be detected, and it is difficult to guarantee the origin, timeliness, authenticity, or accuracy of network information. Therefore, electronic networks should not be considered as an operational system and should not be depended solely upon to support forecast and warning operations or for purposes where data attribution must be guaranteed. It further should be noted that according to WMO's Resolution 40 (Cg-XII) on the policy and practice for the exchange of meteorological and related data and products, certain additional data and products may not be re-exported for commercial use. Therefore, meteorological information available through the Internet can result in distribution of data and products that have restriction on their use by the provider.

7.5.1 HOW TO CREATE AN INTERNET HOME PAGE

7.5.1.1 Design of web pages

There are several options that NMSs can consider for hosting their web pages. One is to put it on their own computers. The basic equipment would consist of a computer (PC plus operating system is sufficient and can be purchased ready to use), a connection to an Internet service provider and an HTML-editor (there are a large number of editors that are used as text processors and will convert the page into HTML format). Problems of security can arise. The computers used as the Internet servers should not be the same ones that are used operationally to store or process data.

The second option is to put the web site on the service provider's computer. Many of these providers rent space on their computers at reasonable rates. The information is updated electronically by the NMS itself from its own computer. Another attractive option for the NMS is to use the web page of a sister agency, such as the tourism agency, environmental ministry, etc. Finally, an NMS can consider placing its web site on servers outside its own country either on a service provider's or on the server of another, larger NMS.

Although with modest resources an NMS can easily establish a highly effective home page, an accompanying problem is that it is very time-consuming to maintain the system if the information must be updated manually and regularly. Automated means of updating are required if anything more than minimal information is provided. Nothing is more frustrating to the Internet user than going to a site and seeing outdated information. This is especially true and could have serious repercussions in the case of severe weather warnings.

The steps in setting up a web page are:

- agree on standards (templates and graphics, programming language (e.g. HTML 2.0)) provided by a single source within the NMS for the editors to ensure a uniform/unified appearance of the home page(s);
- set up a clear structure for the pages: one main page linking to further pages, links back to the home page, table of contents on each page (links);
- take the variety of users' software and hardware into account: different browsers, low-speed modems/telephone links; different screen sizes/resolution; design for any browser to download quickly;
- design pages to be viewed on any web browser (text only/full version; frames/no-frames version);
- make sure the pages can be downloaded quickly: most users have a normal home telephone line only; access to the site should be tested with a home computer using a regular telephone line for design and downloading;
- use graphics sparingly as they slow down downloading; each graphic should serve a purpose and should not be put on merely because the Internet allows graphics; use compressed file formats where possible; and
- investigate the criteria used by search engines to prioritize the sites; then programme the home page to ensure that it is listed among the first.

7.5.1.2 Contents

> Possible content of an NMS's web pages:
>
> Welcome page
> General information about the NMS
> Disclaimer/Copyright
>
> Weather warnings and forecasts
> Current weather
> Weather and climate information
> Products for public and specialized users
>
> Educational information (weather/climate, disaster preparedness, etc.)
>
> Answers to frequently asked questions, background information
> Opportunities for user feedback
>
> Date of last update, reference to the webmaster

Weather sites are some of the most popular sites on the Internet. Weather information is provided by NMSs, universities, private weather companies, on-line newspapers and individuals. A large variety of information is available, including raw data, forecasts and warnings, specialized products, charts, satellite imagery, radar images and educational information. The information is provided in a wide array of formats and it is worth visiting as many pages as possible to emulate the best features of each.

The NMS can use its position as generator and owner of unique regional and local data and information to promote its services. As it is possible for other authors of web sites to capture images and share them with their audiences through hyperlinking, it is important that the NMS places its logo on each of its products to ensure that it receives the recognition it deserves.

If the NMS cannot (yet) provide the information itself, links to other institutions and web sites can be given that might be more specialized. Though the users may not find the information disseminated by the NMS itself, they know that it is possible to find the information via the NMS's web pages. This especially increases the public image of the NMS as a reliable source of information.

Two matters must be borne in mind in the content of weather pages on the Internet:

(a) Though the Internet is a new and fast-changing medium, copyright restrictions have to be respected; normally, an organization using the Internet has a webmaster who is responsible for ensuring that no copyrighted material is available on the server without permission of the author. An example of a copyright and disclaimer statement can be found at Appendix 3 to this chapter.

(b) Restrictions on the exchange of meteorological and related data and products in all matters related to foreign meteorological information, in accordance with WMO Resolution 40 (Cg-XII), have to be respected. Making foreign meteorological information available through the Internet, a method without distribution control, could result in distribution of data and products that have restrictions on their use by the provider.

7.5.2 GLOSSARY FOR THE INTERNET

Term	Description
Domain name	This is an Internet addressing system which identifies a specific organization connected to the Internet.
Download	The process of copying a file from an online service to one's own computer.
E-mail	Electronic mail is comprised of messages delivered via networks, to a specific person or mailbox. Not only messages, but also files, artwork or spreadsheets can be sent. E-mail is used both as a noun and as a verb (i.e. I received her e-mail two days after I e-mailed her).
Home page	This is the first page or welcome page of any web site. It introduces the person or organization to anyone on the Web. It provides links to other pages at the site.
Host computer	The computer on which the home page and web site reside.
HTML	The stands for HyperText Markup Language. This comprises the standardized set of commands that allows the formatting and linking of documents, graphics, etc. on the World Wide Web. Web browsers read this language and encode it so that they may view documents and surf the net.
HTTP	This stands for HyperText Transfer Protocol. This is a set of rules that transfers and processes HTML (hypertext markup language) onto networks. It is what makes the World Wide Web work.
Hypertext	This is specifically text that is encoded enabling the user to link to other documents. Oftentimes hypertext words are highlighted, underlined or in italics. Since they represent links to other documents, the user just clicks on them to retrieve the new information. Jumping from one document to the next is often called "surfing" the net.
Internet	An aggregation of high-speed networks connected to one another, throughout the world. It uses a standardized protocol called TCP/IP to transfer data from one network to another.
Search engines	Search engines are tools which enables the user to research a topic, in an organized and methodical way, on the Internet. Examples of common search engines are Yahoo, Alta Vista.
Web author	One who has developed and taken responsibility for the content of one or more web pages.
Web browser	Software that allows you to retrieve and view hypertext documents, linked graphics, video or audio, from the Web. The browser interprets the hypertext language in order to properly display the document. Examples of common browsers are Mosaic, Netscape, WebCrawler, Microsoft's Internet Explorer.
Web master	One who is responsible for the various WWW presentations housed on a single HTTP server. This person maintains the HTTP server software and oversees access to the server by web authors and WWW clients.
Web page	A single ASCII file containing an HTML document with the in-line images referenced in the document.

Term	Description
Web server	This is the host computer that houses your home page and web site. It "serves" many functions allowing full-time access to the site. For example, it houses software to facilitate E-mail and domain names.
Web site	This is the home page and set of pages that represent who you are to the web community. It can be a combination of text documents, graphics, video, audio and interactive forms.
World Wide Web (WWW)	The World Wide Web is a collection of text documents, graphics, video and audio housed on computer networks all over the world. The documents are written with hypertext, a special code allowing the user to link from one web document to another. This information is accessed via the Internet, through web browsers.
WWW presentation, web presentation	A collection of one or more web pages that coherently addresses a topic.

7.5.3 USEFUL INTERNET SITES

WMO home page (this site has links to the web pages of many NMSs around the world):
http://www.wmo.ch

WMO Members with Web & Gopher Server:
http://www.wmo.ch/web-en/member.html

PWS Programme home page:
http://www.wmo.ch/web/aom/pwsp/pwsp.html

EMWIN — Emergency Managers Weather Information Network:
http://www.nws.noaa.gov/oso/oso1/oso12/document/emwin.htm

NOAA Weather Wire Service (primary telecommunications network for NWS products):
http://www.nws.noaa.gov/wordout.shtml#nwws

ISCS — International Satellite Communication System (ISCS):
http://www.nws.noaa.gov/iscsgen.shtml

GTS — Global Telecommunications System:
http://www.wmo.ch/web/www/gts.html

ECOMET — European Cooperation in Meteorology (The primary objectives of ECOMET are to preserve the free and unrestricted exchange of essential meteorological information between the National Meteorological Services for their operational functions and to ensure the widest availability of basic meteorological data and products for commercial applications by both the private and public sectors.):
http://www.meteo.oma.be/ECOMET

Appendix 4 to this chapter contains a listing of other Internet sites which can be useful to NMSs.

7.5.4 INTRANET

An Intranet is the use of Internet technologies within an organization or a company to facilitate internal communication as well as for access and transfer of data. An Intranet is different from an Internet in the following ways:

(a) Intranet is a network within the organization whereas Internet is a worldwide network;
(b) Intranet has access to Internet but not vice-versa.

For more information about Intranet, see the Internet site at:
http://www.intrack.com/intranet/.

One final word:
The field of communications and computers is changing at a rapid rate. Faster and better means of communication are continually becoming available, and costs are decreasing. It is essential to keep up with developments, and take advantage of new advances in the technology.

7.6 BIBLIOGRAPHY

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WMO, 1987: *Meteorology and the Media*, WMO-No. 688, 56 pp.

NOOA

NOAA/National Weather Service/Weather Operations Manual:
WSOM Chapter C-60, *Radio/TV Dissemination*. Department of Commerce, 1980.
WSOM Chapter C-61, *Telephone Dissemination*. Department of Commerce, 1978.
WSOM Chapter C-62, *Newspaper Dissemination*. Department of Commerce, 1978.
WSOM Chapter C-63, *NOAA Weather Wire Service Dissemination*. Department of Commerce, 1989.
WSOM Chapter C-64, *NOAA Weather Radio (NWR) Programme*. Department of Commerce, 1991.
WSOM Chapter C-66, *Dissemination of Public Warnings*. Department of Commerce, 1979.
WSOM Chapter C-67, *News Wire Dissemination*. Department of Commerce, 1978.

SITES ON HOW TO CREATE A WEB SITE

http://home.netscape.com/home/how-to-create-web-services.html
http://www.yahoo.com.sg/Computers_and_Internet/Communications_and_Net working /Intranet/

WEB SITES

USA TODAY:	http://www.usatoday.com/weather
Weather Alert Canada: (on television crawlers)	http://www.tor.ec.gc.ca/awps/acainfo.htm
Emergency Alert System:	http://www.fcc.gov/cib/eas
Vertical Blanking Interval:	http://www.tor.ec.gc.ca/awps/vbinfo.htm
GTS:	http://www.wmo.ch/web/www/gts.html
NOAA Weather Radio:	http://www.nws.noaa.gov/nwr
Weatheradio Canada:	http://www.tor.ec.gc.ca/awps/wxrdocan.htm
WEATHERCOPY:	http://www.tor.ec.gc.ca/awps/wxcinfo.htm
NOAA Dissemination Systems:	http://www.nws.noaa.gov/wordout
Emergency Managers Weather Information Network (EMWIN):	http://www.nws.noaa.gov/oso/oso1/oso12/document/emwin.htm
Interactive Weather Information Network (IWIN):	http://iwin.nws.noaa.gov/iwin/main.html
International Satellite Communications Systems:	http://www.nws.noaa.gov/iscsgen.shtml
Internet Society:	http://www.isoc.org
Intranet:	http://www.intrack.com/intranet/
Minitel:	http://www.minitel.fr
ECOMET: (most European NMSs are members of ECOMET, to preserve traditional relationships among NMSs)	http://www.meteo.oma.be/ECOMET

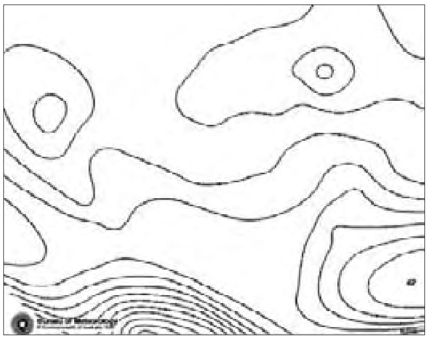
CHAPTER 7

APPENDIX 1
PROCESSES FOR THE CREATION OF A NEWSPAPER WEATHER PAGE

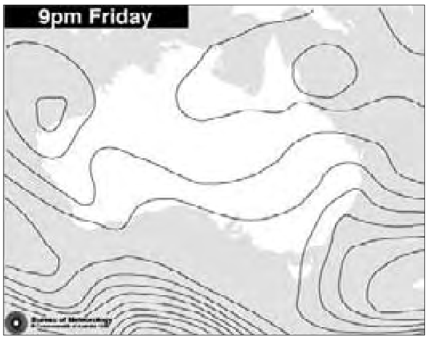
AUSTRALIA
BUREAU OF METEOROLOGY

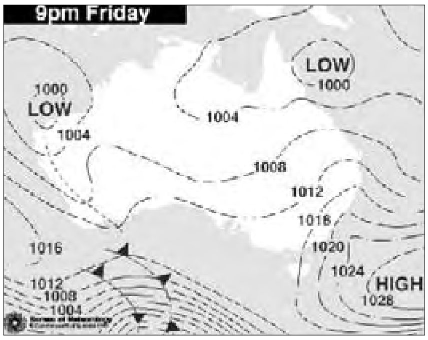
1. PROCESS FOR MAKING A PROGNOSIS

1. Prepare the background image (right).
2. Isobaric lines for the prognosis are initially obtained for the model (far right).



3. The isobaric lines are than placed on a background image (right).
4. The isobaric values and fronts, troughs, warm fronts, highs and low pressure systems are then put on creating the final prognosis as shown at far right.





2. PROCESS FOR CREATING AN ICONMAP

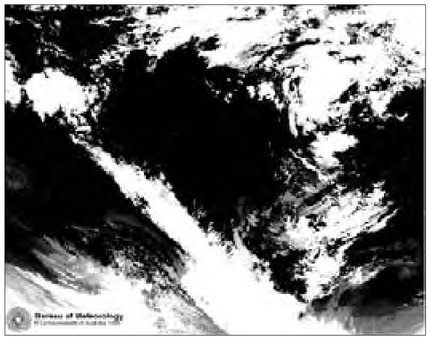
1. Obtain a blank iconmap background with a list icons on the bottom (right).
2. Start placing icons within the iconmap (far right).

3. At right is the finished iconmap.

3. PROCESS FOR CREATING A SATELLITE PICTURE

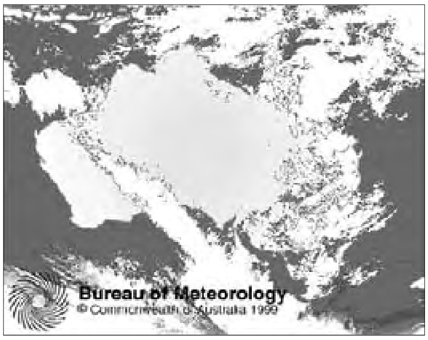
1. Obtain a background image (right).

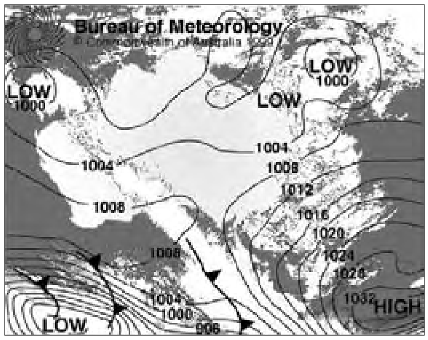
2. Obtain a satellite picture (far right).



3. Remove the clouds from the satellite picture and place them on the background image (right).

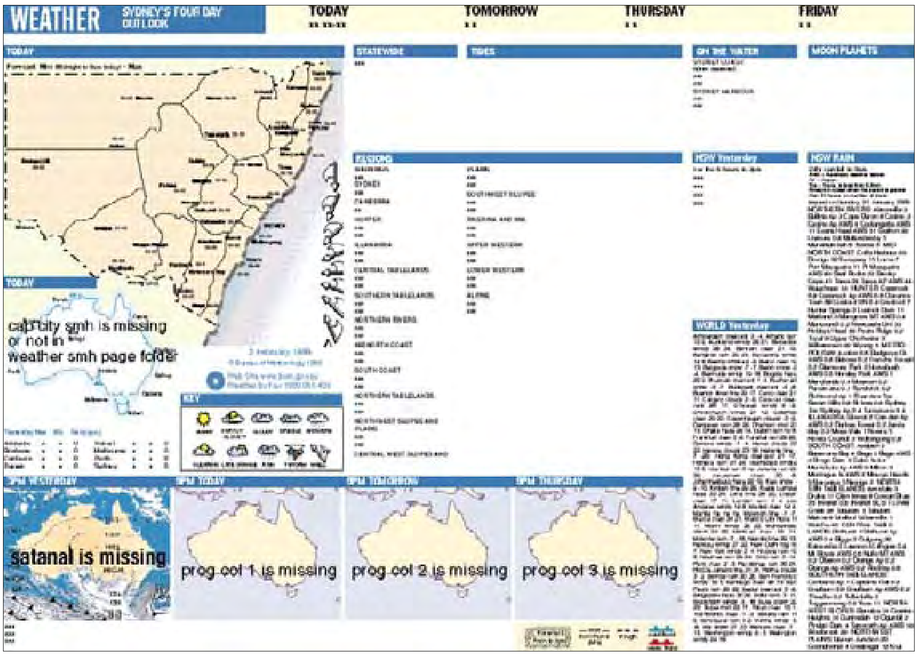
4. In some cases an analysis can also be placed on top of the satellite picture as shown at far right.



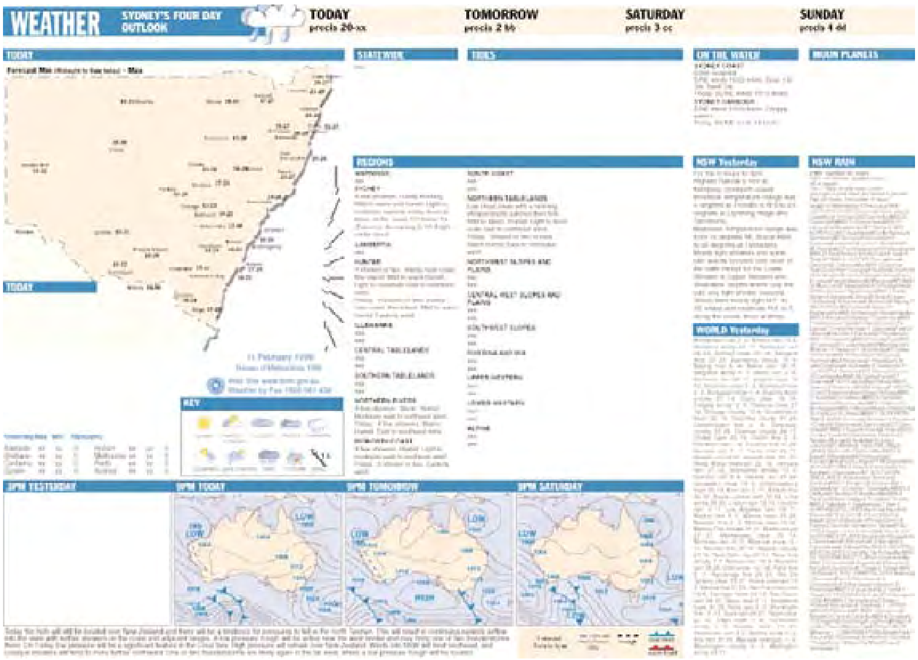


4. PROCESS FOR CREATING A WEATHER PAGE FROM THE DIFFERENT COMPONENTS

1. Obtain all the forecasts and data required for input into weather page.

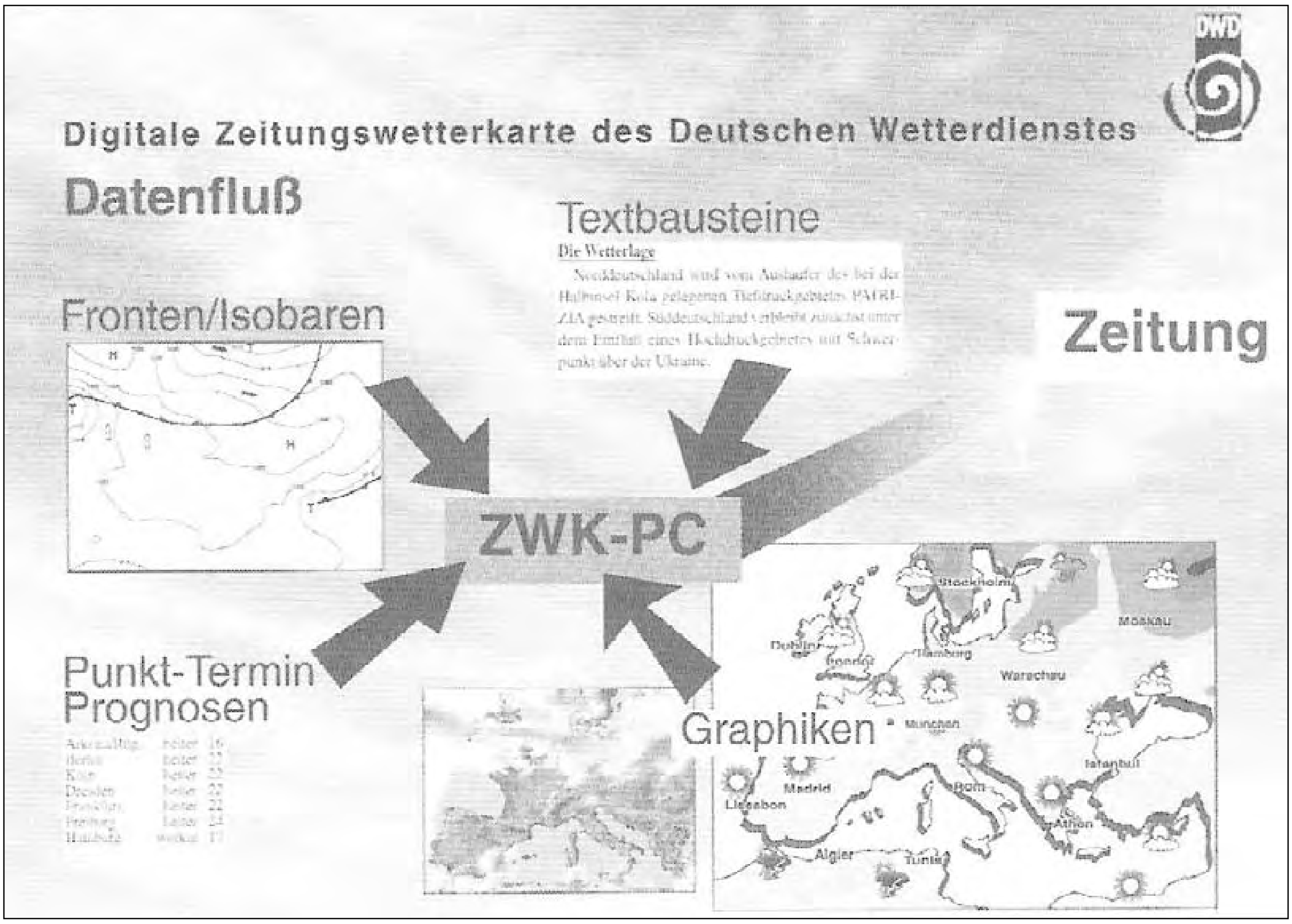


2. Start with a blank page.



3. Put in the charts and all forecasts and warnings.

4. Put in satellite pictures and iconmap and any other relevant data to finish the page. Example at right is the finished page.



GERMANY
DIGITAL NEWSPAPER WEATHER MAP FROM THE DEUTSCHER WETTERDIENST (DWD)

Inputs for a newspaper weather map are as follows:

- Data
- Fronts/isobars
- City forecasts
- Descriptive text
- Graphics

APPENDIX 2
MAKING THE PERFECT RADIO WEATHER FORECAST

The following has been prepared by Andrew Lane of the British Broadcasting Corporation (BBC).

A Perfect Weather Forecast?
Perfectly considered
Perfectly targeted
Perfectly researched
Perfectly prepared
Perfectly produced
Perfectly delivered
(We also require perfection in others!)

Perfectly Considered
What are we trying to do?
Communicate information?
What sort of information?
Warn of danger/disruption?
Pass on facts and figures?
Are they important?
Educate?
Entertain?
Conduct a meteorological briefing?

Perfectly Targeted
Who will we be talking to?
General public?
Farmers/fishermen?
What will they want from the forecast?
What will they be doing?
Will they be wide awake?
Will they be distracted?
Will they have time to listen?

Perfectly Researched
What are the facts?
What's happening?
What is the story?
What am I going to tell people?
Where can I get extra information?
Books/databases/paper records?
Who can I check the details with?
Colleagues/observers/friends?

Perfectly Prepared
"To script, or not to script!"
"Back to square one!"
"The pictures are better on radio!"
"You missed me, am I too late?"
"Talk faster when you get to the Northern Isles!"
"I really must complain!"

Perfectly Produced
How does your contribution fit into the output?
How will you be introduced?
How will you end on time?
Is the studio set up correctly?
Does everything work?
Is the quality satisfactory?

Perfectly Delivered
Is this a speech, a lecture or a conversation?
Remember the 'Ps':
Pace/Pitch/Pause/Pressure.
How much voice?
Where is the listener?
How close to microphone?

Where to get more help:
Other training sessions
Internal Workshops and Reviews
Experienced colleagues
We're also your colleagues!
Books and articles
Listening to others
LISTENING TO YOURSELF!
Recording facilities?

APPENDIX 3
COPYRIGHT AND DISCLAIMER

The following is an example from the Australian Bureau of Meteorology.

Copyright Notice

Bureau of Meteorology materials, including pages, documents and on-line graphics, are protected by copyright law. Copyright of Bureau of Meteorology materials resides with the Commonwealth of Australia. Apart from any fair dealing for purposes of study, research, criticism and review, as permitted under copyright legislation, no part of these services may be reproduced, re-used or redistributed for any commercial purpose whatsoever, or distributed to a third party for such purpose, without written permission from the Director of Meteorology.

When you access the Bureau of Meteorology Web site you agree to:

— retrieve Bureau material for information and decision making only;

— only download a copy or printout of Bureau material for your own organization's own internal use, or to inform potential users about the Bureau services;

— not modify information found in Bureau material without prior written permission of the Director of Meteorology;

— acknowledge the Bureau as the source of information and include the copyright notice in any copy you make.

Disclaimer

The Bureau of Meteorology Web site contains real-time data, loaded automatically with only limited quality control. The Bureau does not warrant, guarantee or make any representations regarding the currency, correctness, accuracy, reliability, or any other aspect regarding characteristics or use of the information presented in the service. The user accepts sole responsibility and risk associated with the use and results of Bureau material on this service, irrespective of the purpose to which such use or results are applied. In no event shall the Bureau of Meteorology be liable for any special, indirect or consequential damages or any damages whatsoever resulting from loss of use, data or profits, whether in an action contract, negligence or tort, rising out of or in connection with the use or performance of Bureau materials on this service.

APPENDIX 4

FURTHER WEB SITES OF INTEREST

The following introduces a few Internet sites which might be of interest to the NMS and which could have application in the NMS operation regarding disaster management.

ReliefWeb

ReliefWeb is a project of the United Nations Office for the Coordination of Humanitarian Affairs. The purpose of this effort is to strengthen the capacity of the humanitarian relief community through the timely dissemination of reliable information on prevention, preparedness and disaster response. The objectives are to provide:

1. wide array of sources;
2. open architecture (upwards and downwards compatible with legacy and future software);
3. easy navigation (well organized);
4. multilanguage support;
5. multi-platform compatibility (Macintosh, Windows, Unix, 386, 486, Pentium, colour, black-white);
6. continuous utility assessment (usage monitoring, feedback, and search success rate);
7. sustainability;
8. management of time-critical information, timely dissemination, text searching, metadata searching, portability, assured 24-hour access, personalization (remembers individual user preferences for language, etc.), immediate acquisition, geo-referencing (place name, latitude/longitude), field level access, 24-hour event monitoring; and
9. springboard for background information.

While recognizing that they are interrelated, the ReliefWeb system distinguishes between emergency/time-critical information and background information. The emergency component is comprised of information acquisition via e-mail, the World Wide Web, telex, etc. If necessary, faxes can be incorporated, but acquiring technical capacity to transmit digitally is strongly encouraged.

The International Telecommunication Union (ITU) been contracted to provide World Wide Web hosting and e-mail listserv services. In addition, ITU is providing 24-hour access to a modem pool which will ensure access to ReliefWeb should the Internet prove unstable or slow. ReliefWeb contains the following information: Situation Reports; Sectoral Reports; Advisories; Field Reports; Project Descriptions; Financial Tracking; Analysis; UN Resolutions and Agreements; Press Releases; News Reports.

> For more information on ReliefWeb, see Internet site at: http://www.reliefweb.int

Emergency Preparedness Information eXchange (EPIX)

The Emergency Preparedness Information eXchange (EPIX) is operated by the Centre for Policy Research on Science and Technology (CPROST), Simon Fraser University, Vancouver, Canada. The purpose of EPIX is to facilitate the exchange of ideas and information among Canadian and international public and private sector organizations about the prevention of, preparation for, recovery from and/or mitigation of risk associated with natural and socio-technological disasters. Continuing development of EPIX is made possible through the generous contributions of many government and non-governmental organizations.

> For more information on EPIX, see Internet site at: http://hoshi.cic.sfu.ca/epix

HazardNet

The HazardNet is a prototype natural and technological hazard information sharing network under development as a collaborative demonstration project of the International Decade for Natural Disaster Reduction (IDNDR). The goal of HazardNet is to enhance the timeliness, quality, quantity, specificity and accessibility of information for persons and organizations worldwide concerned with preventing, mitigating or preparing for large-scale natural and technological emergencies. HazardNet provides access to real-time hazard alerts, warnings and forecasts, situation reports, news accounts, Geographic Information System (GIS) along with country facts, demographics and other relevant information separated by hazard type. This service is to be used in monitoring early warnings and alerts in order to stimulate effective and timely international response. It also provides access to natural and technological information identified/categorized by hazard type. Each general category of hazard is identified by an icon, this being done in an attempt to improve language independence and to accrete similar types of hazards under a common heading.

For more information on HazardNet, see Internet site at: http://hoshi.cic.sfu.ca/hazard

Natural Hazards Center

The Natural Hazards Center, located at the University of Colorado, Boulder, Colorado, USA, is a national and international clearinghouse for information on natural hazards and human adjustments to hazards and disasters. The Natural Hazards Center carries out its mission in four principal areas: information dissemination, an annual workshop, research and library services. The centre's prime goal is to increase communication among hazard/disaster researchers and those individuals, agencies and organizations that are actively working to reduce disaster damage and suffering. The Natural Hazards Center has a variety of resources available on the Internet, including: Information About Who We Are; Introduction to the Hazards Center, its Services and its Staff; What's New on the Hazards Center Web Site?; and Periodicals of the Natural Hazards Center.

For more information on the Natural Hazards Center, see Internet site at: http://www.colorado.edu/hazards

US Federal Emergency Management Agency (FEMA)

The US Federal Emergency Management Agency (FEMA) is an excellent location to obtain information about natural hazards, mitigation and preparedness activities. It contains many safety tips which could be used by national Meteorological Services in the development of their own preparedness and hazard awareness brochures.

For more information on FEMA, see Internet site at: http://www.fema.gov

CHAPTER 7

The Weather Channel and American Red Cross

The Weather Channel and American Red Cross sight provides excellent safety tips for dealing with weather emergencies and can be adapted for other parts of the world with similar hazards. The International Red Cross and Red Crescent Societies (IFRC) also has valuable information on preparedness and other actions needed in dealing with natural hazards and disasters.

Deadly weather disasters kill and injure thousands of people annually and cause property loss and damage that cost billions of dollars every year. A recent survey conducted by The Weather Channel and the American Red Cross indicates an urgent need to make Americans aware of safety and preparedness measures. To address this need for greater awareness and assistance with severe weather preparation, The Weather Channel has teamed with the American Red Cross, the experts in disaster assistance. The two have joined in a national safety and education preparedness and relief initiative — PROJECT SAFESIDE: Keeping You Ahead Of The Storm. PROJECT SAFESIDE's goal is to raise national awareness and the need to plan and prepare for severe weather, and to show American families how to prepare by giving the information needed to remain as safe as possible during a weather emergency. PROJECT SAFESIDE will give you the most critical information you need about the five most deadly weather-related events: floods and flash floods; hurricanes; tornadoes; lightning; and extreme heat. If, as you read this, the sky is blue and the sun is shining, the time to begin preparing is now.

For more information on Project SAFESIDE, see Internet site at: http://www.weather.com/safeside

For more information on the International Federation of Red Cross and Red Crescent Societies (IFRC), see Internet site at: http://www.ifrc.org

Interactive Weather Information Network

The Interactive Weather Information Network (IWIN) is an Internet capability included in the US National Weather Service (NWS) home page. It uses HTTP technology servers, and is one method used by the NWS for disseminating the EMWIN datastream and additional NWS data products. The IWIN page uses

For more information on IWIN, see Internet site at: http://iwin.nws.noaa.gov/iwin/main.html

http://www.nws.noaa.gov/oso/oso1/oso12/document/winnet.htm

HTML format and additional hyperlinks to another server that stores this weather data. Access to this data, as a linked series of clickable screens, is thus provided to users operating World Wide Web browsers such as Netscape or Mosaic. Graphics or text-only access is provided. At present, users must reload screens to see updates or changes in the weather data. FTP access capability is also available. The drawback to this method is that the Internet and the IWIN home page, especially during major weather events, may be difficult or impossible to access because of weather server overloads. The IWIN server has been online since September 1995. IWIN averages 250 000 hits per day and has handled loads of over 450 000 hits per day during several major weather events.

CHAPTER 8

COORDINATION

8.1 COORDINATION FOR EARLY WARNING

The importance of effective, well-coordinated warning systems for natural disasters has been re-emphasized by the United Nations (UN) General Assembly in Resolution 49/22 of December 1994 addressing the capacities of the United Nations system for early warning of natural disasters. The emphasis placed by the General Assembly on improving coordination provides a strengthened rationale for ongoing WMO efforts to ensure effective coordination and exchange of warnings of severe weather, under the umbrella of the World Weather Watch. It also highlights the need to ensure effective linkages between the World Weather Watch with its early warning capacity and UN agencies and external organizations with international disaster relief responsibilities. Timely warnings of potential natural disasters could greatly assist these bodies in planning for and initiating international relief efforts.

Throughout this *Guide*, frequent references have been made to the need for coordination with other agencies and partners and to the value of cooperative arrangements with them. Effective coordination and consultation with a broad spectrum of client groups invariably generates ongoing input and advice which is essential if national Meteorological Services are to ensure that their public weather services are tuned to the needs of the users and responsive to changes in their requirements. In the broadest sense, cooperation and coordination should be pursued with all sectors and institutions who are major users of the meteorological service, who can assist in a substantive way with the production and delivery of public weather services or whose mandate makes coordination with them essential to the effectiveness of those services. This holds true on local, regional, national and international levels.

To ensure effective early warning, coordination is required:

- within the hazards community;
- with neighbouring NMSs; and
- with the media.

A high degree of coordination must exist within the hazards community before, during and after disasters. For maximum effectiveness, early warning systems need to be linked to organizations and humanitarian bodies responsible for response actions. Again, this holds true at all levels from local to international. At local and national levels, coordination is usually achieved through committee structures orchestrated and supported by a municipal agency or lead department and drawing upon the resources and expertise of other organizations and individuals. A key to success here is involvement of the local population and strong support for the coordinator by the local political leadership. At the international level, a particularly important aspect of coordination is to ensure the reliable delivery of relevant early warnings of meteorological and hydrological hazards to United Nations and other relief and humanitarian organizations who must prepare for worst-case scenarios where their resources must be deployed to assist national governments.

The entire early warning system depends on getting the right information to the right people at the right time to enable them to respond appropriately. Maintaining communication and coordination can present a significant challenge because the functions of early warning often cross several levels of government (e.g. national, state, provincial or county and local). Inter-organizational coordination may sometimes be ineffective because of communication problems due to differing (sometimes conflicting) organizational structures, subcultures, and expectations and poor communication can result in weakness in decision-making. It is important that the support provided to disaster response agencies and officials be what they actually need, not what it is believed that they need.

Where meteorological and hydrological hazards are concerned, NMSs must be actively involved in interagency disaster planning to ensure a regular flow of reliable and authoritative warning information to the public, political leaders, responsible officials and affected institutions. It is also essential that effective coordination is established between neighbouring NMSs and with private sector players and the media.

Coordination with the media must always receive a high priority since the distribution of warning messages is, in most countries, largely through media broadcasts. The media can be of great assistance in raising awareness, increasing knowledge of warning procedures and appropriate mitigation and response actions and for dissemination of warnings. NMSs need to eliminate any rivalries concerning the on-air dissemination of warning information between professional media presenters and NMS staff, or between NMS staff and private meteorologists employed by TV and radio stations. In some countries and regions where international television weather broadcasts are received, international coordination is also required to ensure consistency of internationally broadcast information with locally issued warnings and this presents a particular challenge.

Inadequate coordination leading to confusion with respect to flood warnings sometimes occurs between countries, between states within the same country, and even between different agencies within a state due to differing conventions or confused responsibilities. Different jurisdictional arrangements within countries which share the same river system or climatic region can stand in the way of effective coordination. Confusion between countries can be a problem even where there is a long history of cross-border cooperation in flood mitigation and preparedness.

As with other elements of early warning, the relative priority which should be assigned to improving coordination is dependent on the current situation in the country or region in question. Effective early warning requires the closest possible collaboration and partnership between all members of the hazards community, and the maintenance of coordination must be an ongoing concern for all NMSs and emergency agencies. This is an area which requires continuous efforts by all concerned to ensure that early warning systems function as effectively as possible.

The above has been summarized by the 1994 World Conference on Natural Disaster Reduction (Yokohama, Japan) in its Strategy for the Year 2000 and beyond, which emphasized the need for governments to adopt policies of national self-reliance and to increase their emphasis on coordination and cooperation at regional, national and community levels to save lives and protect property. The Conference proposed that:

(1) Planning for mitigation of meteorological and hydrological disasters be given a high priority in order to achieve optimum early warning capability within national territories;

(2) Appropriate mechanisms such as disaster reduction planning committees and emergency response teams be created to facilitate coordination and partnership between domestic agencies including NMSs, officials, political leaders, local communities, the media, private sector representatives and others involved in early warning and response to disasters;

(3) Effective liaison be established between governments and agencies in neighbouring countries to address issues related to cross-border hazards such as the need for timely cross-border relay of warnings and observational data and bilateral or regional coordination of early warning efforts;

(4) Coordination with domestic and, where required, with international media be given high priority to achieve timely and accurate distribution of official meteorological and hydrological warnings and drought advisories and to obtain the assistance of the media in public awareness and education initiatives.

The Conference also drew attention to the need to strengthen international coordination and cooperation in early warning activities, while emphasizing the sovereign responsibility of each country to protect its citizens.

8.2 EXTERNAL EXCHANGE OF FORECASTS AND WARNINGS

Much severe weather requiring warnings is caused by large-scale systems such as tropical cyclones and depressions which cross international boundaries. A flood in a river can move through more than one country. Even short-lived, violent phenomena such as tornadoes and severe thunderstorms with lightning sometimes cross national borders. People living near the border of their country may receive radio or television broadcasts from the neighbouring country. International air travellers like to know the likely weather at their destination. NMSs serving international media need forecasts and warnings from a number of other NMSs. Thus the exchange of forecasts and warnings among NMSs is increasing in importance. In 1999 over half of NMSs were exchanging forecasts and/or warnings with their neighbours and about one third were exchanging further afield internationally.

Under the WMO system, responsibility for the issue of public warnings of hazardous weather rests with the NMS or Regional Specialized Meteorological Centre (RSMC) within whose area of responsibility the event occurs. Consequently, international exchange of information on hazardous conditions should, as a minimum, occur between NMSs or RSMCs. This international exchange of warnings should, ideally, also encompass disaster relief agencies when the magnitude of the event is such as to be likely to require the activation of international relief efforts.

The Twelfth World Meteorological Congress in 1995, in Resolution 40 (Cg-XII), adopted a policy on, and a new practice for, the international exchange of meteorological data and products. In Annex 1 to that Resolution the minimum set of data and products which Members shall exchange without charge and with no conditions on use includes severe weather warnings and advisories for the protection of life and property targeted upon end-users. More details are in the Appendix to this chapter.

8.2.1 GUIDELINES FOR COORDINATION AND EXCHANGE

The following guidelines are directed towards enhancing coordination and exchange at bi-national, regional and global levels.

(1) At the most basic level, simple but effective exchange of information can be achieved by addressing warnings issued by one country, in accordance with its own domestic warning criteria, to the NMS of its neighbour(s). This approach may be enhanced significantly by the establishment of regional thresholds which limit such cross-border warnings exchange to phenomena and events of serious concern to both parties. This should not interfere with the freedom of NMSs to apply national warning criteria within their own areas of responsibility. Information exchange may also be further enhanced by the establishment of more restrictive WMO thresholds for global warnings exchange to support planning for international disaster relief operations or other international activities.

(2) To facilitate such exchanges, NMSs should publish information on their warning criteria and programmes and provide this information to neighbouring national Services. Emergency communications numbers (i.e. telephone, telefax, e-mail, dial-in access) should also be exchanged with neighbouring NMSs. These can be used to request or relay information on hazardous weather conditions, to coordinate the issue of weather warnings and for emergency response purposes. At the world level, a global catalogue of this information should be developed for wide distribution to WMO Members and other interests such as the international media and disaster relief agencies.

(3) WMO and NMSs should continue to coordinate with private sector meteorological companies and the media to ensure that all publicly-disseminated warnings of severe weather originate from the responsible national Meteorological Service, or RSMC, as the single official voice for warnings within their areas of responsibility. A further important objective is to ensure that ongoing, public recognition is given to the essential contribution made by the NMSs to the operations of the private sector and media.

8.2.2 CRITERIA FOR EXCHANGE

The thresholds for the issuance of domestic weather warnings vary from one country to another, usually for reasons of national climatology and vulnerability. It may, however, be useful to standardize thresholds for exchange of warnings between countries within geographic zones and limit the cross-border exchange of warning information to major hazards likely to cause loss of life or serious disruption over a wide area. It would not, however, restrict in any way the criteria used by NMSs for internal warnings within their own areas of responsibility.

This approach has much to commend it, particularly within climatic regions which straddle several countries. It may, furthermore, be expanded to the global scale to incorporate international Global Telecommunication System (GTS) exchange of information on catastrophic events of such magnitude as to require the mobilization of international relief or disaster assistance efforts. Advance warnings of these major catastrophic events could, clearly, be of assistance both to United Nations agencies such as the Office for the Coordination of Humanitarian Affairs and the High Commission for Refugees and to other international bodies such as the International Federation of Red Cross and Red Crescent Societies who must mobilize international relief efforts.

From the above perspective, one may visualize a three-level system for dissemination of warnings comprising: national criteria for domestic issue (determined solely by the responsible NMS); more restrictive, mutually agreed, thresholds beyond which warnings would be exchanged between neighbouring Services or regionally; and still more restrictive WMO criteria for global warnings exchange. In situations where the global exchange criteria were met, warnings and related follow-up information could be distributed internationally on the GTS and could be directed to disaster relief agencies and other interested parties such as major international radio and television networks.

8.2.3 MEANS OF EXCHANGE

The GTS is available for the operational exchange of information on hazardous weather. Other methods of communication are also possible under bilateral arrangements and these may sometimes be more appropriate. This is particularly the case for non-routine warning messages where speed is essential or in parts of the world where deficiencies exist in the GTS. Alternative communications options include telephone, telex, facsimile, e-mail and satellite systems and, in some instances, direct, dial-in computer access. In addition, the ongoing development of a global information superhighway (as currently exemplified by the Internet) offers immense potential for near-instantaneous information access and exchange related to severe weather and other natural and man-made hazards. A number of initiatives have already been undertaken and others, such as HazardNet and ReliefWeb, are under way which are directed towards harnessing the potential of the Internet to assist the global emergency management community in obtaining and sharing emergency-related information including early warnings of potential disasters.

In some regions with a well-established history of regional cooperation, telephone discussions between neighbouring NMSs are standard practice when hazardous weather conditions present a cross-border threat. Provided there are no language barriers, this person-to-person approach has much to commend it as an effective means for coordination of warning messages as well as for urgent relay of information on rapidly changing weather hazards. It should, clearly, continue to be pursued even as more automated information exchange systems are developed since verbal discussion offers a unique capacity to clarify misunderstandings or the rationale behind decisions and to reach agreements.

8.2.4 THE ROLE OF RSMCs

At the international level, WMO is closely involved in emergency planning for disasters which have significant multinational implications such as nuclear accidents, tropical cyclones, volcanic eruptions or major oil spills on the high seas. Any of these events may generate public concern and may involve NMSs in special emergency response activities. In the context of public weather services, however, tropical cyclones and nuclear accidents merit particular comment.

Procedures for the exchange of information on hazardous weather associated with tropical storms are well established under the Tropical Cyclone Programme of the World Weather Watch. These allow for the coordination of forecasts and warnings and their dissemination within each of the areas at risk from tropical cyclones. Centres with activity specialization in the forecasting of tropical cyclones are Regional Specialized Meteorological Centres at New Delhi, Miami, Tokyo and Saint-Denis (Réunion). Comparable arrangements for the coordination and dissemination of forecasts and warnings exist for the high seas and for aviation. Marine and aviation warnings are based on internationally agreed criteria and responsibility for their issue is shared between designated centres.

Major nuclear accidents such as Chernobyl and Three Mile Island have lent added impetus to ongoing international efforts to develop effective responses to nuclear disasters. WMO is involved with other international bodies such as the International Atomic Energy Agency (IAEA) in developing coordinated international response plans. As a contribution to this global effort, WMO has identified RSMCs in Bracknell, Toulouse, Washington and Montreal as specialist Centres for the provision of information on the regional and global transport of airborne pollutants, including radioactive particulates, resulting from nuclear accidents. National Meteorological Services should build upon the availability of trajectory forecasts and other products from these specialist Centres in domestic planning for nuclear emergencies.

8.2.5 OVERCOMING LANGUAGE BARRIERS

Most information on hazardous weather which is currently exchanged is in plain language although this may sometimes be highly structured. An alternative option which might be considered is to convey information in agreed graphical form by facsimile or other graphics transfer method. The graphical approach to information transfer has an obvious advantage in regions where significant language differences exist.

Language translation software can be used to automatically translate warning messages to/from a variety of languages. This software offers dictionaries which can be customized to translate specific words and phrases (such as warning messages) as desired.

8.3 INTERNAL FORECAST AND WARNING COORDINATION

The extent of coordination required within an NMS will depend on the area of responsibility. In countries of small area there may be only one forecasting office and there is need for coordination only by the staff on duty in that office. In countries of large area there may be several forecasting offices with different areas of responsibility, and coordination between these offices is needed to ensure consistency of forecasts and warnings at the boundaries.

The need for coordination within an office is based on the premise that no one meteorologist has a monopoly of meteorological wisdom. The purpose is to ensure that forecast decisions are based on thorough analysis and proper interpretation of all available hydrometeorological information. It can further improve the scientific validity of forecasts as officers share ideas and expertise in meteorological interpretation.

The aim is to achieve a consensus forecast where the contribution of the various individuals results in a better product than before. A compromise forecast should be avoided if at all possible, i.e. one where forecasters agree to some middle ground between two opposing points of view. A compromise forecast is often worse than before 'coordination'. Where consensus cannot be reached it may be necessary for the most senior person, say the shift supervisor, to make a firm decision.

In many offices coordination is achieved by discussion involving all forecasters at routine times, say two or three times per 24-hour period. This may be followed by the formulation of a statement describing in general terms the expected weather over the area of responsibility. The detailed forecasts are then written within this policy.

There needs to be consistency between public weather forecasts and aviation and marine forecasts. It can be disconcerting for an aviator, for example, to hear a public forecast of fine weather and the aerodrome forecast mention thunderstorms. Depending on the size of the office there may be specialists in certain types of severe weather, such as tropical cyclones or severe storms. They should also be involved in coordination discussions

It is a fact of meteorological life that when the weather is benign there is plenty of time for coordination but less need for it. In rapidly changing weather situations with severe weather, decisions have to be taken rapidly and warnings issued. There is then little time for coordination, but as much as possible should be attempted. Verbal coordination can be reduced by the display of graphic representations of current weather, warnings and forecasts for the area of responsibility of the forecasting office. Graphic presentation is more quickly assimilated than reading text forecasts.

Where a country is sufficiently large in area that more than one forecasting office is required there needs to be coordination between the offices. This is most easily done by telephone, although this allows only one person from each office to converse at a time unless a loudspeaker phone is available. Video-conferencing affords the opportunity to involve multiple parties in visual as well as voice communication but, at present, is too expensive to set up for such a routine purpose. Modern communications should allow forecasts and warnings to be routinely exchanged between offices. If the forecasting offices are equipped with computers for forecast preparation, the forecasts and warnings from a neighbouring office will be available at the click of a mouse. Inconsistencies in the forecasts can then be resolved by telephone.

It helps coordination if the forecasters at the different offices have met and know one another personally, rather than just as a voice on the telephone. If the budget permits, interchange of staff for periods of a month or so helps in this regard. An overall environment of mutual trust and respect in the NMS, with forecasters trained in team concepts, will greatly help coordination achieve forecast consistency.

Principles regarding forecast coordination

The following principles regarding coordination have achieved success in several NMSs. They are listed here to provide concepts, all or part of which might have applicability to NMSs either establishing or enhancing their own coordination capabilities.

- Forecast coordination is an increasingly important step in the warning and forecast process.
- There will be an increasing need for both routine (scheduled) and event-driven coordination. Scheduled coordination will be necessary to share forecast ideas and promote consistency somewhat early in a forecaster's duty shift, while event-driven coordination will be needed to provide consistency when warnings or significant forecast changes are contemplated.
- For NMSs that run several numerical models, it will be increasingly more practical to use contemplated changes in the forecast as the baseline from which coordination actions will be taken, rather than receipt of routinely generated guidance products associated with set numerical model forecast cycles.
- When contemplating new communications technologies, any system must allow forecasters to accomplish their coordination tasks expeditiously, as a natural step in the forecast process.
- Offices should be able to generate a suite of coordination products for internal distribution only to facilitate inter-office coordination.
- If at all possible, forecasters should be able to combine verbal coordination with graphical information exchange to enhance effective and efficient consensus building.
- Forecasters must be provided with a confidential means of conducting multi-party/office verbal coordination, so that forecast ideas may be freely exchanged.
- Use of a designated facilitator, not a person acting as a final authority, can further aid the verbal coordination process between multiple entities.
- Forecasters working in an environment of mutual trust and respect, and trained in team concepts, will best be able to carry out procedures to achieve forecast consistency.
- Final coordination responsibility must rest with the person/office issuing the product. The internal coordination process will have failed if a decision must be forced on another forecast entity.

- Persons or entities who continually fail to reach a consensus solution should be dealt with administratively.

8.4 COORDINATION WITH THE HAZARDS COMMUNITY

The development of effective coordination and solid working relationships with public safety, emergency and civil defence agencies is vital to the success of severe weather warning programmes and to effective responses to weather disasters. In 1999 about 85 per cent of NMSs had a working relationship with national emergency managers. NMSs should have a Disaster or Emergency Response Plan which clearly spells out individual and collective responsibilities in the face of catastrophic events. The Plan should identify responsible managers, focal points and/or spokespersons. It should clarify the backup responsibilities of individual offices and describe the procedures for emergency communications. It should define the priorities for emergency issue of products and services. It should, furthermore, identify key contacts in other agencies and include other relevant details. Overall, it should describe in considerable detail how the Service will meet its mandated responsibilities in the face of a natural or man-made catastrophe.

A Service's Emergency Plan should be carefully coordinated with corresponding Plans of agencies with emergency responsibilities. It should be exercised on a regular basis to ensure that all staff are familiar with their responsibilities under the Plan, that the technological components are fully operational and that it meshes smoothly with the overall emergency response effort. Experience in many countries shows that time and effort invested in the development, maintenance and exercise of a good Emergency Plan will invariably yield substantial dividends when a real emergency occurs.

The maintenance of a regular flow of authoritative and factual information can pose a particular challenge during catastrophic events even when a functioning communications system exists. This is generally due to difficulties in obtaining and confirming information or in coordinating the many players involved in emergency response. These constraints can delay the release of official statements and may sometimes create an information vacuum. This vacuum may be filled by media personalities or outside experts who are less constrained in their utterances and who may, inadvertently, contribute to public confusion. It is, therefore, vitally important that national Meteorological Services are actively involved with civil defence and emergency agencies in planning responses to catastrophic events to ensure that adequate provisions are made for the maintenance of essential public weather services.

For slow onset hazards, such as river floods or tropical cyclones, coordination and technical assistance should be directed around explaining the uncertainties involved in the forecasts. This is especially critical for evacuation planning where actions must be taken during time frames that may exceed the skill levels in the forecast. Here, conference calls, including several officials at once, are preferred so that all agencies are part of the process and a consistent message can be formulated.

For rapid onset events, coordination should include what the outlook is for severe convective weather or flash floods so that emergency managers can schedule more personnel and move to a higher level of readiness. During flooding situations, weather service personnel should be prepared to offer scenario-based briefings, highlighting what could be expected given various rainfall amounts. This could be funnelled into flood tables of hydrologic models to suggest the impacts of various rainfall amounts.

Consideration should be given toward having a location at the weather service office for local emergency management officials to send representatives. Similarly, during certain extremely critical situations, the weather service should consider sending an individual to work in the community's Emergency Operations Centre to assist in interpreting warning and forecast products.

8.4.1 COMMUNICATION WITHIN THE HAZARDS COMMUNITY

In coordination with the hazards community communications are vital, not just for communications from the NMS, but also to the NMS from the hazards community, whose members have information which is valuable in the warning process such as observations, spotter reports, and data from hydrologic or dispersion models.

The simplest means of communication within the community would be by telephone. However, this may be vulnerable when it is most needed. This could be the result of the storm or an overloading of the system. Dedicated lines or hotlines are a good option and provide the opportunity for joint communication. Two-way or amateur radio communication between agencies is another possibility for real-time data sharing and coordination of actions. If conference calls are used, one organization should be charged with leading the coordination effort and for scheduling calls so that all interested parties are involved.

The ability to transmit hard copy information throughout the hazards community is extremely beneficial in that it is less likely to be miscommunicated. This can be done by facsimile, but if this uses the telephone system it is vulnerable to failure when it is needed. Again dedicated lines are a good option. Other methods are packet radio systems that use personal computers to communicate by amateur radio and electronic bulletin boards also using personal computers and modems, but with the latter reliance must be placed on the user accessing the information.

The best means of communicating to emergency managers and government officials would be links between agency computer systems. Some countries have connected weather service computer systems to regional or local telecommunications systems. This allows for a two-way flow of information to all organizations on the network. Many of these networks are associated with law enforcement agencies. Unfortunately, not all emergency managers and decision makers will be connected to these systems. In that case, other communications schemes must be found to reach the remainder of the hazards community.

Communications technology is a rapidly developing field and it is necessary to keep abreast of it and make use of advances which ensure reliable, rapid and secure communication.

8.4.2 POST-DISASTER COORDINATION AND SUPPORT

The days immediately after a severe weather or flood disaster can be very hazardous due to swollen rivers, weakened structures, threat of disease and so on. Inclement weather or high water can delay recovery efforts or pose a major threat where adequate shelter, food, water and communications are lacking. In the case of drought, the time frame of the critical post-disaster period is substantially longer and efforts at recovery and re-establishment of affected communities often face even greater challenges.

Useful meteorological and hydrological coordination and support after a disaster include provision of forecasts and related advice to emergency managers and the public on meteorological and hydrological phenomena or, in the case of drought, on expected climatic patterns. Post-disaster assessments of such events are of particular value in improving the performance of early warning systems, providing important lessons regarding the dissemination of warnings, the overall management of preparedness and response and public awareness. These assessments can, furthermore, provide useful inputs to hazard and vulnerability analyses and contribute observational data which may assist in improving observing algorithms. Feedback from post-disaster assessments is an essential component of the learning process through which more effective early warning capability is developed.

It is clearly vital that forecasting/warning/dissemination systems continue to function after a disaster occurs, even when they may have been degraded due to loss of power and telecommunications infrastructure. The importance of effective coordination between all members of the hazards community also comes into sharp focus during the period following a disaster. At this stage, there is a particularly critical need for close coordination within and between levels of government and with communities, private sector interests and the media to ensure that recovery actions are pursued in an efficient and coherent manner.

8.5 COORDINATION WITH THE NATIONAL MEDIA

Maintenance of close coordination with the media is essential in order to ensure timely and accurate dissemination of products. By working with media representatives during the development of public weather services programmes, NMSs can ensure that product formats adapt readily to the operational constraints of media outlets, that issue times facilitate broadcast of these products during optimum viewing or listening periods, that urgent products such as weather warnings are broadcast immediately and that the potential for public confusion is minimized. In 1999, over 80 per cent of NMSs have a working relationship with the media.

As in the case of emergency agencies, formal coordination mechanisms such as standing committees and focal points can facilitate positive working relations with the media. These mechanisms can be effective at both national and local media outlet levels. A useful reinforcing tactic at the broadcast station level has been to involve on-air media personalities in periodic workshops sponsored by the national Meteorological Service. Well-structured media workshops can be highly effective in educating media personalities about meteorological products, the underlying science, the accuracy of predictions and related subjects. They can provide information and insights which are interesting and helpful to these "on-air" disseminators. Information technology continues to develop dramatically as do the demands of the audience with respect to style and the content of written and oral weather reports in radio and television. Workshops are helpful in improving the skills of forecasters in writing clear and concise forecasts to comply with the demands of the media. These workshops make it possible to better understand each other's responsibilities, aims and problems and should be repeated regularly. Workshops also provide natural forums in which personal contacts can be developed between broadcasters and meteorologists, a significant factor in contributing to more effective communications between the two sectors.

The various media are often in competition with one another to get the earliest story, or a new 'angle' on a story. In order to ease this competition and to promote a consistent message, conference calls or hotlines involving the major outlets are of prime importance. Also, a location can be set up in the weather service facility to support live media presentations. A media pool arrangement should then be set up where one camera or microphone can be shared by all stations. At national hydrometeorological centres, a pool should be developed between national, regional and local media. Furthermore, times should be scheduled for national, regional and local media to ensure that media outlets in the affected areas are given priority. An excellent example of overall coordination occurred before Hurricane Hugo struck Puerto Rico. As a result of discussions between emergency management, the media and elected officials, the Governor of Puerto Rico came on the radio announcing the threat of the hurricane. He then introduced the meteorologist in charge of the Weather Service Office to present the forecast track and intensity of the storm. Finally, the Governor introduced the emergency management director who outlined how and when evacuations would be conducted.

Examples of a Memorandum of Understanding between the National Oceanographic and Atmospheric Administration/National Weather Service (NOAA/NWS) and a media organization and of one between the United Kingdom Meteorological Office (UKMO) and their users can be found in 8.8 below.

8.6 COORDINATION WITH THE INTERNATIONAL MEDIA

In 1995, an informal meeting was held between the presidents of WMO Regional Associations, a selected number of representatives from countries which currently engage in production and international broadcasts of weather forecasts, and the representatives of the international broadcast meteorologists, in order to exchange views on issues of concern and to ensure the growing and continued cooperation between NMSs and the international broadcast community. This was an important meeting as the issues that were raised are important to the development of any national public weather services programme.

That meeting and other consultations have made the international broadcasters aware of the need to ensure that the concept of one "single official voice" for the issuance of all warnings and advisories is respected. In all instances, this voice would be that of the NMS. This will help minimize the possibility of conflicting information being communicated to the public via radio and television broadcasts, either internationally or domestically. They also proposed pursuing a policy on global distribution of, and access to, "significant weather warnings and advisories" determined by the NMSs, containing the following conditions:

- Warnings and advisories should not be modified except for format;
- Warning and advisories should be issued directly to the general public as soon as possible after receipt, and as close to verbatim as possible (either translated or in graphical presentation);
- Warnings and advisories should not be disseminated after expiration time;
- Warnings and advisories should be attributed to the issuing NMS; and
- Viewers and listeners should be urged to monitor their own NMS's information services for further information on local or regional weather conditions.

Some international media obtain their weather information from private companies. It is essential that all warnings of severe weather for a given region are issued from a single source — the responsible NMS or RSMC — and are identified as originating from that official source. Otherwise there is a risk of public confusion which could result in needless loss of lives and property.

Consequently, any effective international exchange system for warnings of severe weather must facilitate media and private-sector access to the weather warnings issued by NMSs and RSMCs in order to ensure that these important external interests can disseminate and otherwise use those official warnings in their operations. An equally important challenge is to ensure that public recognition is given to the essential contribution made to these broadcasts, and to other private-sector meteorological activities, by NMSs and the World Weather Watch through the infrastructure of observing networks and systems, the GTS, forecast offices and specialized centres.

8.7 COORDINATION WITH OTHER USERS

Coordination with other users refers to two-way communication between NMS offices/units and users of their products. It does not refer to the external dissemination of products and services. Non-real-time feedback and interaction with customers regarding routine forecasts is usually limited to a small subset of customers. Preparation for major weather events, and developing event-driven products and services, may require considerable interaction with a larger subset of customers. This interaction ensures that the needs of various customers are understood and met, and that customers can quickly obtain and properly utilize NMS services. Questions or comments from the customer community are largely handled via telephone calls to the NMS office that originated the product.

8.8 SAMPLE AGREEMENTS WITH THE MEDIA

8.8.1 AGREEMENT BETWEEN THE UNITED STATES NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION (NOAA) AND A MEDIA ORGANIZATION

I. The Parties

NOAA, created in 1970 as the Nation's civilian Oceans and Atmospheric Science Agency, includes the National Weather Service as one of five line organizations. NOAA/NWS has as its primary mission public safety, the protection of public assets, and the preservation and growth of the national economy. Hence the core functions of NWS are the provision of forecasts and warnings of severe weather, flooding, hurricanes, and tsunami events; the collection, exchange, and distribution of meteorological, hydrologic, climatic, and oceanographic data; and the preparation of hydrometeorological guidance and core forecast information. The NWS is the single "official" voice when issuing warnings for life threatening situations and is the source of a common national hydrometeorological information base.

A. For NOAA and the NWS to carry out its mission most effectively, it must rely upon the support and cooperation of organizations with similar interests and understanding. Improved public understanding and recognition of NOAA services will also lead to increased awareness concerning natural hazards and will help to improve the citizens ability to anticipate rather than just react to daily weather warning and forecasts as well as to potential natural disasters.

B. The ______________ operates a network dedicated to the dissemination of weather data and forecasts and related environmental information. The ______ is also involved in a variety of community outreach activities as well as awareness and educational projects.

Therefore, _______ is a strong and supporting partner with the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) in the timely distribution of weather warnings and forecasts, and its meteorological, hydrologic, and climatic data and information. Also, ______ is a strong and supporting partner with NOAA/NWS in fostering community preparedness, awareness, and education and carries this out in many aspects of its operation.

II. PURPOSE

This MOA is intended to strengthen the existing partnership between NOAA and _____ and to broaden future activities to encompass other cooperative ventures between NOAA and ______. This purpose is to ensure that the Nation receives the full benefit of hydrometeorological, oceanographic, and other NOAA products and services needed to promote safety of life and property and economic prosperity.

III. UNDERTAKING

As a part of its programming, _____ distributes certain unaltered NOAA/NWS products. This distribution is accomplished in a clear and timely manner through various automated systems in conjunction with certain independent companies engaged in the distribution of NOAA/NWS data and products.

Whereas NOAA/NWS recognizes the value of _____ service, distribution, support and cooperation in effectively assisting NOAA/NWS in carrying out its mission and whereas _____ desires to continue to provide this support and cooperation to NOAA/NWS, the parties agree to the following:

A. In local programming segments generated where _____ chooses to use unaltered NOAA/NWS forecast and warning products, appropriate attribution will be given to the NOAA/NWS.

B. Other activities undertaken as part of this public-private partnership will include as part of its joint attribution the inclusion of the NOAA and _____ Logos or appropriate text.

C. The NOAA/NWS will code and format weather data and products to ensure compatibility with the ____ and all other users systems so as to facilitate the distribution of NOAA/NWS products. The goal is to develop a single code and product format which will satisfy the system demands of all users.

D. NOAA/NWS will coordinate with _____ and other users so as to minimize any negative impacts that changes in NOAA/NWS products or services might have on the ability of _____ and other users to distribute those products or services and to communicate as far in advance as possible any changes in weather data products and services provided by NOAA/NWS.

E. ______ and NOAA will cooperate to increase public awareness, preparedness, and understanding of natural hazards. When appropriate ______ and NOAA will:

(i) develop materials and video spots in support of local, regional, and national awareness weeks;

(ii) take part in actual awareness weeks through dissemination of test watch, warning, and call to action information;

(iii) test new NOAA meteorological and hydrological products on ______ in order to obtain public reaction;

(iv) develop educational material in the form of videos, spot announcements and brochures for use on _____ as well as for general public consumption;

(v) develop educational materials on weather hazards and other agreed-to subjects involving either NOAA or ______ initiatives for children in elementary and secondary school.

F. ______ shall advise NOAA/NWS of public/viewer response to its products and services and other issues related to NOAA activities.

G. ______ and NOAA will issue joint, as well as individual, releases announcing this agreement and the planned public-private partnership.

IV. ADDITIONAL UNDERSTANDINGS

A. If _____ furnishes any of its own severe weather information and/or forecasts, it will ensure that the information is clearly differentiated from Government-originated products and is attributed to _____. In particular, it will avoid using the terms "watch" and "warning" in presenting such information.

B. There shall be nothing in any program, announcement or release that constitutes an endorsement express or implied by NOAA of _____ and/or any commercial products it advertises.

C. Nothing in this agreement obligates NOAA or _____ to undertake any specific level of activity or to commit or expend funds.

D. _____ will maintain complete control of its operation. Nothing in this agreement shall be interpreted as affording NOAA any role in content or programming decisions. Furthermore, nothing herein obligates _____ to display any information provided to it by NOAA or through a source which provides access to NOAA products and services.

E. NOAA and _____ recognize that this is a nonexclusive agreement and that NOAA or _____ may enter into similar agreements with other entities without the consent or approval of the other. Nothing herein obligates NOAA/NWS to provide any information to which would not be made available to any other user of NWS' products or services.

F. In order to facilitate accomplishing the goals and objectives set forth in this MOA, _____ and NOAA/NWS agree to meet at least quarterly to discuss issues of mutual concern and interest and assess progress in accomplishing the desired objectives.

G. NOAA and _____ shall review and assess the effectiveness of this agreement annually. Thirty days prior to this annual review, the parties shall provide each other with a status report covering the cooperative activities under this agreement specifying those requiring discussion at the review. Amendments to this MOA may be made at any time by written agreement of the parties.

8.8.2 UNITED KINGDOM ANNUAL AGREEMENT FOR NATIONAL SEVERE WEATHER WARNING SERVICE

Conditions for the receipt by the Company of Flash and Advanced Warnings of Severe Weather

The text of the warning must not be changed.

The Met. Office must be acknowledged within the broadcast message as the originator of the warning.

The period of validity in the warning must be adhered to.

The warnings must only be disseminated in connection with radio, television and teletext services provided by the Company.

In order that the dissemination of warnings can be controlled effectively by The Met. Office, the Company will inform The Met. Office of the relevant media services they provide.

The Company agrees to receive Flash and Advanced Warnings, at no charge, from The Met. Office on the above conditions.

Name of Company ______________________________

Address ____

Signed ____

Position ____

Date ____

APPENDIX

RESOLUTION 40 (Cg-XII) AND CRITICAL WEATHER EXCHANGE

In Resolution 40 (Cg-XII), the Twelfth WMO Congress, in 1995, adopted the following practice:

1. Members shall provide on a free and unrestricted basis essential data and products which are necessary for the provision of services in support of the protection of life and property and the well-being of all nations, particularly those basic data and products required to describe and forecast weather and climate, and to support WMO programmes;
2. Members should also provide the additional data and products required to sustain WMO programmes at the global, regional and national levels and, as agreed, to assist other Members in the provision of meteorological services in their countries. At the same time, it is understood that Members may be justified in placing conditions on the re-export of such data and products for commercial purposes outside the receiving country or group of countries forming a single economic group, for reasons relating to national legislation or costs of production;
3. Members should provide to the research and education communities, for their non-commercial activities, free and unrestricted access to all data and products exchanged under the auspices of WMO, with the understanding that their commercial activities are subject to the same conditions as above.

Congress stressed that all meteorological and related data and products required to fulfil Members' obligations under WMO programmes would be encompassed by the combination of essential and additional data and products exchanged by Members.

CHAPTER 9

PUBLIC AWARENESS, EDUCATION AND TRAINING

9.1 INTRODUCTION

This chapter provides guidance on how NMSs can foster better public understanding of their role in the provision of public weather services, the range of services available, how to obtain them, the terminology used, and how these services can be used to greatest effect. A second aspect shows how NMSs can work with technical users of NMS products and services, and with the education sector to incorporate understanding of public weather services.

As already mentioned in several chapters of this *Guide*, it is not sufficient for a successful warning or forecast to be created and made available; it is equally important that it be disseminated and presented in a way that allows the intended user to actually receive, understand, believe, and make use of the information.

To receive the information the user must be aware of the services available, and the means by which they can be received.

To understand the information the product must be presented in plain, straightforward language and the user must know the meaning of the meteorological terms used.

For the user to believe the information, the NMS must have a public image of credibility, reliability, accuracy and timeliness.

While some of the above requirements for successful services such as accuracy and timeliness of the services can be handled internally, others such as user satisfaction and perception have to be realized by intense and continuous interaction with the different user groups. The following aims are to some degree applicable to all user groups.

General weather literacy

As people are more apt to believe and act on warnings and forecasts when they are weather-literate and well informed, they should be provided with general background information on weather, climate and related issues. Education not only raises the interest in meteorological topics in general, but also ensures that warnings and forecasts provided by the NMS are understood by its intended users.

Awareness

People need to be aware of the magnitude and frequency of occurrence of hazardous events and how to prepare for them. Education helps to build up a high level of awareness of hazards and preparedness in how to deal with them. This includes information related to what types of weather can affect the area, the possible impacts, and what to do if severe weather threatens.

Coordination and cooperation

Educational activities also aim to strengthen the links between members of the hazards community to make natural disaster reduction most effective through preparedness plans for communities and individuals as well as specific actions that individuals can take to cope with weather-related hazards. This aspect will normally be undertaken in partnership with emergency management agencies with specific responsibilities for combating disasters and educating the community about appropriate disaster response actions.

Effective public weather services require an understanding of the above issue among key people in the emergency management community and in the media. NMSs need to work with these important partners to ensure an appropriate level of knowledge and understanding on public weather services to enable emergency management staff to make well-informed decisions and to foster effective communication with the public via mass media channels. Effective training will minimize the potential for misinterpretation of information and communication of misinformation to the public.

Availability

Information should be provided to let the public know of the role of the NMS, what types of products and services are available and how they can obtain these, and show users what they can expect of the NMS and how to make best use of such information for themselves.

Public image

The above educational activities help to enhance the image of the NMS as a concerned, caring, scientific organization. The image is also enhanced by the quality of meteorologists who take part in radio and television broadcasts, the use of modern technology and, above all, by the accuracy and timeliness of the forecasts and warnings issued by the NMS.

Some public education activities can usefully be undertaken in association with the education sector, civil defence and emergency management agencies and other public institutions, with societies interested in science (such as museums) and with other community or special interest groups.

The strategy for public education programmes is basically knowing the audience and its needs, defining the objectives and desired outcomes, developing a programme of activities to meet the objectives, and having some criteria to measure performance against objectives.

9.2 TARGET AUDIENCES

When planning and preparing public education activities, it is important to consider the different types of audiences which will be addressed. Some educational topics, materials and approaches may suit a broad spectrum of audiences. In other instances, educational activities are best tailored to the specific audience. The following sections identify some important target audiences for public education programmes.

9.2.1 PUBLIC AND MEDIA

The general public

Because of the breadth and diversity of this audience, the most effective means of reaching it are the mass media. More specific activities and campaigns are appreciated by interested users. Public interests range across weather forecasts and warnings, current weather, climatology, atmospheric phenomena, technology and environmental issues and concerns.

The media

The role of the media is twofold. On the one hand, they are the main transmitters of weather information to the public and they therefore also play a vital role in the successful implementation of public awareness and education activities. On the other hand, they are also a target audience in that they require education and raised awareness concerning the kinds of information which are available from the NMS and in what situations the Service can assist.

Schools and academic institutions

This audience has a particular interest in scientific aspects of weather and weather services because of their relevance to science and geography curricula. The education of children is an important part of the long-term preparation of a basic weather-literacy among the population. Special programmes for teachers further support that aim. At the university level, the training of students from all kinds of subjects assures basic knowledge for future meteorologists, decision makers and members of the hazards community.

Activities and content to assist schools and academic institutions in the education of pupils and students vary with the level of the institution. Primary school pupils are invariably interested in seeing and hearing about simple weather instruments and concepts. Secondary school pupils and teachers are usually more interested in material related to their curricula. Tertiary students and academic staff are likely to be interested in a variety of more specific and complex topics such as, for example, solar radiation or cyclogenesis.

9.2.2 GOVERNMENT AUTHORITIES

Among the most significant members of this target group are those in key positions of the government and related agencies. They influence issues that directly affect the NMS such as resource allocation or priority afforded by government to the NMS. They are further in need of detailed information to decide about actions to be taken during a hazardous event or measures to ensure air and environmental quality. If decision makers are to make sound decisions on those issues, they must be informed on the products provided by the NMS and how to make best use of them. Effective information transfer to and education of this group will minimize the potential for misinterpretation of information and communication of misinformation to the public.

9.2.3 HAZARDS COMMUNITY

The hazards community consists of the media, government authorities, emergency managers, non-governmental and volunteer organizations and the NMS itself. They all play a special role when hazardous events occur. For these occasions, where immediate and clear response is essential, all of the members need to know what role the NMS can play and how they can make use of the NMS in terms of disaster reduction.

9.2.4 ECONOMIC SECTORS

Educational activities for the various economic sectors such as agriculture, fishing, forestry, energy suppliers, transport, building and construction, and for recreational activities such as skiing and yachting, need to be focused on the particular weather of interest to each sector and how to make the best use of the information available.

9.3 OBJECTIVES AND TOPICS

The formulation of objectives and performance indicators for an education programme for the public or other users can be undertaken once the target audience has been identified and after some assessment has been made of its current understanding.

Objectives might be along the following lines:

- to foster a better understanding by the general public of the capabilities of NMSs and how to use their various services;
- to foster an increased understanding of weather and climate and to assist the community in using that understanding in their own and the national interest;
- to inform the public and specific user groups about the NMS's role and its services;
- to raise awareness of local meteorological and hydrological hazards and how to prepare for them.

A list of possible topics for a public education programme might include some of the following:

- the role of the NMS;
- the range of weather services provided and how to use them;
- the different types of warnings;
- the economic benefits of weather services;
- meteorology and hydrology related to the environment;
- meteorology and sustainable development;
- meteorology, hydrology and natural disasters;
- terminology;
- severe weather;
- climate services;
- hydrological services;
- services to agriculture;
- weather phenomena;
- using weather information.

Other topics can be added to reflect particular national requirement or concerns.

9.4 MEANS OF PUBLIC EDUCATION

9.4.1 PUBLIC EDUCATION "FOCAL POINT"

NMSs can improve their public awareness activities by effective use of their existing staff. For example, a Service can designate and develop a staff member as a public "focal point" or "Service Representative" who is involved in the entire processes of working with the users, to assess their requirements, to develop products and services to meet their expectations and last but not least to educate them on how to make the most of the information and services provided. The Service representative should be provided with suitable training. In selecting a focal point, it is important to identify a staff member who has special aptitude for this kind of work. This individual should work closely with the Service's management to initiate and coordinate public education activities. Related initiatives should include training in presentation skills and in media relations for senior staff and others who have contact with the public. Due to the overlap of some tasks, the public focal point could also be designated as the warning coordination meteorologist.

9.4.2 PUBLIC AWARENESS AND EDUCATION MATERIALS

General materials

An NMS can develop educational materials such as pamphlets, posters, slides and videos which target a specific audience or topic. These materials may be developed in-house or with assistance from other agencies such as government information services, the media or commercial interests. The availability of computers, laser printers and photocopiers now facilitates the production of high-quality materials in-house at modest cost. Educational materials typically include:

- description of the topic (e.g. the role of the NMS, or "What is a tropical cyclone?");
- what products and services are available;
- how to get the products and services; and
- how to use the products and services, including terminology and special actions such as preparedness and safety measures.

The cost of brochure development and distribution can be very high. Partnerships should be formed with other agencies, the media and businesses to develop, print and distribute awareness materials. Multiple logos on a publication indicate that each organization supports and agrees with the message. This tends to heighten credibility of information with the public. It is extremely beneficial to include a respected non-governmental organization, such as the International Federation of Red Cross and Red Crescent Societies. These organizations understand how to communicate positive safety messages to the public while their support enhances public acceptance. Also, many businesses are extremely weather sensitive. As weather services assist them in their preparedness efforts, they may be inclined to support the printing of materials for their employees and the community in which they reside. In that case, materials could contain white space on the front or back of the publication where business logos can be affixed.

Materials that support hazard awareness and preparedness

Many materials that are developed to heighten the public's awareness and to encourage individual preparedness are of use to all segments of the hazards community. Accordingly, representatives from the hydrometeorological agency, emergency management, other government agencies, the media and organizations such as the International Federation of Red Cross and Red Crescent Societies should work toward joint development and distribution strategies. The suites of materials that are developed should be consistent and supportive of each other. For example, small fliers intended for wide distribution could be developed for each hazard that outline safety rules on one side and longer-term preparedness actions on the other side. The flier would indicate who to contact for additional information.

For those wanting more information, including media representatives, school teachers, emergency managers, local officials and local decision makers, more in-depth brochures should exist that outline such things as:

- What the hazard is, how it develops and what its impacts are.
- What products of critical information are available about the hazard (warnings, watches, advisories).
- How critical information can be received.
- Description of appropriate safety rules.
- Individual, family and community preparedness activities.

Posters may also be developed that parallel fliers. These can be hung up in public locations as well as offering a visual aid for those giving preparedness presentations. If more resources are available, slide sets, overhead transparencies, videotapes and media spot announcements can be prepared.

Slide sets should be treated as slide libraries with a number of representative slides per topic. A presenter's guide should accompany the slide set with talking points developed for each topic and for each slide. This is especially important for school teachers who can use the presenter's guide as an aid to merging the information into the curriculum.

When preparing materials for the public, it must be realized that many people tend to deny that disastrous events can affect them. Social scientists have learned that too many images of damage tend to reinforce denial. Messages in awareness and preparedness materials should focus rather on the positive things people can do to protect themselves.

9.4.3 TALKS, SEMINARS AND WORKSHOPS

NMSs can arrange talks, seminars or conferences which focus on specific topics (e.g. droughts and tropical cyclones) or key target audiences (e.g. emergency managers or teachers). The events can range in duration from one hour for a talk to a week for a detailed workshop. Educational materials produced as described in 9.4.2 above can be used during these meetings. Copies of materials such as pamphlets should, where possible, be provided to the participants so that they can share the information and raise awareness in their own environments. On all occasions, feedback should be obtained from the users and interaction with them should be enhanced. Appendix 1 to this chapter gives a checklist for preparation and presentation of a talk.

Seminars can be conducted on particular forecast problems, highlighting what information is available and how it can be used to aid in critical decision-making. When hurricane strike probabilities were introduced, representative emergency managers along the United States Gulf and Atlantic coasts were trained at the National Hurricane Center to ensure that they understood how the probabilities were derived, how they related to the forecast track, and how they were to be used in evacuation decision-making. Similarly, farmers in areas that are affected by El Niño should be informed on how to interpret and make use of climate forecasts.

All members of the hazards community should be invited to the weather service facility to familiarize themselves with the operations and constraints of the meteorologists and hydrologists. Training sessions should be conducted on all products and services of the NMS to ensure that users understand what is available and the significance of the information. Similarly, overviews should be given of the new technologies, especially if data from these technologies are available to the users. They will then appreciate why these technologies are required and will understand to a certain extent what limitations exist so that their expectations are not unrealistic.

Seminars and workshops can also be conducted in concert with professional societies to ensure cross-fertilization of ideas and to reach the largest possible audience. The NMS should also participate in events organized by other agencies, universities, public education organizations, etc. Workshops for local decision makers should be conducted jointly with other organizations in the warning process so that training costs and personnel resources can be shared. An excellent partnership for the hazards community would be joint training activities conducted by the hydrometeorological agencies and those government organizations charged with emergency response actions.

In a similar way, users from utilities and other economic sectors should be invited to take part in workshops to learn about the availability of public weather services and to coordinate their requirements with the NMS.

9.4.4 OPEN DAYS/VISITS

Open days at the NMS's headquarters or local weather offices can be effective in targeting specific audiences. Open house days provide an opportunity to introduce the NMS's staff to its clients and personalize the relationship between the NMS and its users. Visitors see the Service's operations, products and services. Staff can discuss with visitors whether their requirements for weather information are being met. This leads to improved two-way exchange of information and increases understanding. Similarly, visits by school or university groups can help to foster interest and understanding among tomorrow's generation.

9.4.5 SHOWS AND EXHIBITIONS

A stand at a show, fair or exhibition is a good way for an NMS to advertise its services. The stand should focus on the theme of the exhibition, e.g. services to farmers at an agricultural show, services to fishermen and yachtsmen at a boat show. If possible, modern technology in computers, satellite imagery and radar imagery should be on display to enhance the image of the NMS as scientific and up to date.

9.4.6 THE HUMAN INTEREST STORY

The media are frequently receptive to stories with a human interest aspect. For instance, a story might illustrate the benefits of the NMS to communities demonstrating how its services can help reduce the loss of life and damage to property. Alternatively, the media may be interested in the human side of the NMS itself. Stories such as "A day in the life of a Weather Forecaster" can help improve the image of an NMS from that of a faceless or impersonal organization to one which is staffed by dedicated and concerned real people. This can strengthen both the public's perception and the image of the organization in the eyes of its own staff.

9.4.7 REPORTS

The NMS's annual report, scientific reports or reports on special events or disasters can play a useful role in public awareness and education. Expanded distribution of these reports to selected target groups is an effective way of promoting awareness of the NMS, its role and its activities, and how it contributes to economic and social benefit.

9.4.8 CURRICULA FOR SCHOOLS AND UNIVERSITIES

In many countries, the NMS works with the educational community in the development of meteorological and hydrological lessons and curricula for use in elementary and secondary schools as well as with the university community. This might also include special programmes for the education of teachers. Many NMSs have also close working relationships with the professional meteorological societies in their country. Some examples, such as the US programme DataStreme or the European multimedia project EUROMET, can be found in Appendix 2 to this chapter.

9.4.9 THE INTERNET

The Internet as the latest development in information technology can also be used as a valuable channel to distribute information material. It especially offers the opportunity to link to other sources such as other meteorological and hydrological services, government authorities or research institutions that provide further or more detailed information.

9.4.10 TEAM APPROACHES

Team approaches with other agencies

Some public education and awareness activities are most effective when the NMS combines with other agencies or user groups in a team approach. This team approach works best when the organizations involved have similar goals or target audiences. For example, agricultural cooperatives or power and water utilities may be willing to include information from the NMS with their regular user information material or with monthly accounts which are mailed to customers. Emergency organizations, the International Federation of Red Cross and Red Crescent Societies, or health organizations may also cooperate with the NMS by providing information to the public on safety and preparedness actions and warning services related to hazardous weather.

Partnering with the hazards community

The hazards community has been defined as all organizations involved with warning and response actions to natural or technological hazards. Since all of these groups have a common goal, their cooperation should be fostered wherever possible to do together what each would not have the resources to do alone.

Cooperation with observer groups

Volunteer observers and spotter groups play an important role not only for the collection of data but also for the image of the NMS in the public. Local citizens from all professions and lifestyles sacrifice their time for the recording of daily weather and related information or the detection of signs for severe weather events. These data can form a significant part of a nation's weather and climatological data network and provide vital information for the detection of rapid on-set hazards. Cooperation with these groups also provides a valuable link to the general public and specific user groups. To maintain both interest and quality of data, observer groups should be technically and morally supported. Annual meetings, training events or regular newsletters are a basis to heighten interest and enhance the exchange of ideas between observer groups. A training package, including for example a handbook on storm forecasting techniques as it is used in the NMS, can be developed and distributed to voluntary storm spotters.

9.4.11 AWARENESS CAMPAIGNS

Occasions such as World Meteorological Day or the commencement of the cyclone season provide the opportunity for special awareness campaigns targeting all audiences on that one topic for a day up to a week. Other appropriate occasions for special campaigns might include the anniversary of a disaster, the opening of a weather office, the launch of a new weather service, etc. The NMS can use its own materials, the services of the media (e.g. through special interviews and feature articles), teachers and schools, emergency management and other groups to disseminate information or can otherwise involve these groups directly in the campaign.

Presentations should be made by representatives of the hazards community at schools, critical care facilities, media outlets, fairs, markets and locations where large amounts of people can be reached. The presentations should be enhanced with the use of visual aids. Following the presentations, participants should be provided with fliers they could hang up in their homes. If more information were requested, especially by teachers and media personnel, in-depth brochures could be provided.

Schools are an excellent method of reaching people as presentations can be made to the children who can take materials home and thereby bring the message to the entire family. It is even better to have awareness and preparedness merged into the school curricula. This can be accomplished by seeking out teachers willing to volunteer their time as resource agents to work with the local weather service office to develop instruction plans for schools.

Another very effective outreach effort for hydrometeorological agencies is to work with government officials and the media to designate awareness weeks before the start of the various severe weather or flood seasons. During such weeks, messages developed by weather service personnel and emergency managers could be broadcast over the air while preparedness presentations were held in schools, critical care facilities and businesses.

9.4.12 HAZARD AWARENESS DRILLS

Preparedness is not complete until the hazards community demonstrates that it can function as a unit during a crisis situation. Periodic drills should be conducted to assess readiness and to point out areas of improvement. Some of these drills should afford opportunities for the public to also become involved.

The best way to assess the readiness of the hazards community is to schedule drills during awareness weeks. If the awareness weeks are organized properly, then all members of the hazards community, including government officials, should be involved. At one point during the awareness week, the weather service should issue a test watch and a test warning product. Ideally, these products should be distributed throughout the hazards community and broadcast to the public. This would afford schools, hospitals, emergency operations centres, businesses and the media an opportunity to test their response plans. Follow-up reviews should be conducted to assess weaknesses and areas for improvement.

Similarly, exercises can be conducted with emergency managers, government officials, local decision makers and the media for special hazards. These exercises could last up to a week for tropical cyclone situations where information on a model storm is delivered by the weather service to the hazards community. Each organization would function as if there were a real event to see if it knew how to use the information to make timely decisions.

9.5 PERFORMANCE INDICATORS

Performance indicators are used to measure the effectiveness or degree of success achieved by public awareness initiatives or campaigns. Some examples of performance indicators are:

- rate of use of products and services;
- complaints and compliments received directly or reported in the media (number of press clippings, letters, other feedback);

- change in loss of life and property damage due to adverse weather;
- economic benefits/losses occurring/accruing as a result of the use of the products of the NMS in planning and operations in weather-sensitive economic sectors.

The overall success will also be reflected in greater public recognition of the NMS and its role as well as in the improved understanding and morale among the NMS staff.

9.6 TRAINING OF NMS STAFF

NMS staff need to be trained in the provision of public weather services. Such training needs to be included in courses for staff who will prepare forecasts and warnings for the public, and staff who will have contact with the general public, e.g. by answering telephone enquiries. As appropriate to the activities of the NMS, the training should include:

- how to compose forecasts and warnings so that they are readily understood by recipients;
- how to deal with the media and their questions;
- how to be interviewed successfully on air;
- how to make a radio broadcast (and present weather on television if this is likely to be a requirement);
- how to prepare and give a talk to a group of people;
- how to write a media release;
- how to prepare newspaper graphics;
- how to design a web page on the Internet;
- how to conduct a survey of users to ascertain their requirements or to monitor the value of the existing service;
- how to deal with telephone and face-to-face enquiries, especially the difficult ones;
- how to cooperate with emergency management personnel in severe weather;
- an appreciation of the needs of particular national industries, e.g. agriculture or forestry.

It is valuable to invite specialists from the media and in oral and written communication techniques to assist with such training.

Staff with future management roles should be trained in the organization of public weather services, including:

- development of user focus, identification of users and assessment of their requirements, e.g. what types of products are needed and at what times;
- development of a vision and plan for the service;
- equipment and staffing needed to produce the required level of service;
- monitoring and control of costs;
- monitoring and evaluation of the value of the service;
- the need to make changes to keep pace with changes in national industries, community expectations and meteorological capability.

The first objective of the WMO Public Weather Services Programme is "to strengthen Members' capabilities to meet the needs of the community through the provision of comprehensive weather and related services, with particular emphasis on public safety and welfare". This implies a commitment by WMO to continue a programme of training workshops, seminars and other means of assisting Members with public weather services.

9.7 WEB SITES

Cooperative Program for Operational Meteorology, Education and Training (COMET) Programmes:
http://www.comet.ucar.edu

EUROMET:
http://euromet.meteo.fr

Unidata:
http://www.unidata.ucar.edu/community/community.servers.html

American Meteorological Society (AMS):
http://www.ametsoc.org/ams/amsedu/index.html

DataStreme:
http://www.ametsoc.org/dstreme/extras/overview.html

APPENDIX 1

HOW TO PREPARE A PRESENTATION BEFORE AN AUDIENCE

Careful and thorough preparation and advance attention to details are the key to a successful presentation before an audience. The following is a checklist of things to be done:

One to two weeks before the presentation

- ✓ Review the script and slides carefully. Look over the entire presentation. Become familiar with its contents and how the sections follow one another. Highlight parts of the script that are most important to you.
- ✓ Customize the presentation. Be sure to tailor the presentation to meet the needs of your audience. Farmers, fishermen, pilots, social groups and school groups have different interests.
- ✓ Practice your presentation. The more familiar you are with the presentation, the easier it will be to give it. You can become comfortable in front of an audience by practicing with family, friends or even the mirror.
- ✓ Anticipate questions and try to have responses. Try to anticipate and think through the types of questions the audience may ask, and whenever possible, have answers ready. (If you are asked a question and you do not know the answer, tell that person that you will try to find out the answer and get back to him or her.)
- ✓ Check your supply of materials. Make sure that you have enough copies of any publications you plan to distribute to your audience after the presentation.

On the day of the presentation

- ✓ Check out the equipment. Whenever possible, get to the presentation site ahead of time and check out the facility. Make sure that any equipment you intend to use (e.g. slide projector, overhead projector, video recorder, etc.) is working. Are the chairs arranged so everyone can see the slides?
- ✓ Practice your presentation again. A quick run-through will help you feel confident that your presentation will run smoothly. You may want to bring a watch with you to see if your "running time" is about the same as it was in rehearsal.

During the presentation

- ✓ If there is no chairperson to introduce you, introduce yourself. People are more likely to listen and feel comfortable when they know the name of the person speaking to them.
- ✓ Thank the audience for their interest. You can get your audience immediately engaged by thanking them for taking the time to join you for a discussion of this important topic.
- ✓ If you have literature to distribute, tell your audience that you will distribute it after the presentation. The audience will be ready and more willing to use the information after your talk. This also prevents the audience from becoming distracted during your presentation.
- ✓ If you are using slides or an overhead projector, dim the lights, but do not turn them off. People may want to take notes, and they will need light to do that. A completely darkened room may discourage note taking and make it difficult for audiences to focus their attention on the topic being presented.
- ✓ Maintain eye contact with your audience. Look up as often as you can. Scan the room to "read" the audience's reactions.
- ✓ Involve your audience. Asking questions out loud encourages audience participation and breaks up the repetition of one person doing all of the talking.
- ✓ Open the floor to questions. At the conclusion of your presentation, encourage people to ask questions. You can get this started by having a "friend" ask the first one (arrange this with someone who arrives early).
- ✓ Leave your name. It is always a good idea to leave your name and phone number as well as that of your organization. People can then contact you with follow-up questions.

APPENDIX 2

EXAMPLES FOR CURRICULA FOR SCHOOLS AND UNIVERSITIES

ATMOSPHERE

In the United States, Project ATMOSPHERE is the American Meteorological Society's (AMS) education programme that promotes studies in the atmospheric sciences at elementary and secondary schools. It is designed to encourage teachers to use the science whose data and products are most frequently reported to the public in classroom learning activities. Its main goal is to help teachers utilize atmospheric topics to generate student interest and understanding in science, technology and mathematics. Project ATMOSPHERE emphasizes the following: the operation of a national network of AMS Atmospheric Education Resource Agents (AERAs), the production of instructional resource materials, and the dissemination and implementation of these materials.

AERAs act as regional points of contact for teachers who are seeking information on atmospheric science topics; act as liaison among teachers, schools and teachers' organizations of the atmospheric sciences and related professional communities; represent the Society, as appropriate, at teacher workshops, professional meetings and educational conferences; serve, from time to time, on advisory panels for the Society's precollege educational initiatives; work with Society staff and members to develop and implement instructional resource materials. AERAs are, or have been, master precollege teachers, and they have been carefully chosen for AERA participation. Selection is based on their demonstrated leadership in teaching, curriculum development, and the in-service training of fellow teachers and their special training and interest in the atmospheric environment.

For more information see the American Meteorological Society's Internet site at:
http://www.ametsoc.org/amsedu/aera/index.html
http://www.ametsoc.org/ams/amsedu/index.html

DATASTREME

The American Meteorological Society is also involved with a exciting program called DataStreme. The DataStreme Project is a major precollege teacher enhancement initiative of the AMS. Its main goal is the training of weather education resource teachers who will promote the teaching of weather across the K-12 curriculum in their home school districts.

For more information see the AMS Internet site at:
http://www.ametsoc.org/dstreme/extras/overview.html

EUROMET

EUROMET has been created to establish a multimedia, network-based service to support education and training in the meteorological community within Europe. It addresses the education and training needs of professional meteorologists employed by the NMSs, and students in the tertiary education. This service will provide open and distance learning for this group in a way which can be customized to fit local needs.

The course will be delivered using World Wide Web (WWW) tools and will employ a variety of media including text with mathematics, images, video, sound and animations. The WWW clients will be enhanced to include a high degree of interaction. WWW servers with a high-compute capacity will provide image processing and simulation services more powerful than can be delivered on a standard workstation. In support of this learning environment communication facilities for one-to-one and one-to-many communication are included. These communication facilities support all media elements and both symmetric and asymmetric communication.

For more information see the EUROMET Internet site at:
http://euromet.meteo.fr

CHAPTER 10

VERIFICATION, SERVICE EVALUATION AND IMPROVEMENT

The main purpose of having public weather services is indeed to provide the public with warnings, forecasts and other information to ensure safety of life and property as well as day-to-day convenience, in a timely and reliable fashion. To be able to fulfil that task, the public weather services programme has to be intensely user focused as it was already pointed out in Chapter 4 of this *Guide*. As a consequence, any public weather services programme has to include a system to evaluate whether this task is being fulfilled and to regularly assess the programme's performance. A portion of this activity has to focus on the assessment of services following significant events.

In this context, the aim of programme evaluation can be seen as twofold, namely:

Verification: Ensuring that products such as warnings and forecasts are accurate and skilful from a technical point of view.

Service evaluation: Ensuring that the services and products provided are meeting the users' requirements, that they are well perceived by the users, and that the users are fully satisfied with the products themselves.

The first component, the determination of forecast skill, timeliness and product accuracy, while an essential step, is clearly not in itself sufficient for a meaningful programme evaluation of public weather services. Internally, service evaluation ensures that the NMS is making the best use of science, technology and training in the end-to-end services process. The assessment of the accuracy is necessary to keep track of the quality of the products and to find out where there is room for improvement. Assessment of accuracy can show the effectiveness of new technologies and techniques that have been introduced. Programmes to further improve products can range from forecaster training and new algorithms in the numerical weather prediction (NWP) models to more powerful computers. In all these cases, increases in accuracy can be used to justify expenditure on staff and equipment.

The second component — an assessment of the utility or value of the services to the user(s) — must be added before overall programme evaluation can be said to be complete. A forecast may be very accurate but of no value because the user did not understand it or did not receive it. Externally, service evaluation determines whether products and services are meeting user requirements and ascertains whether users fully understand the products and services provided and are making optimum use of them — the conclusion of the end-to-end services process. Even highly accurate or skilful products will not produce an effective programme if they do not respond to the users' needs. To be effective, a programme must contribute significant social or economic benefits to its clients. Consequently, any meaningful programme evaluation must include an assessment of the value added to clients by the programme.

Though service evaluation is a very important task for the NMS, it does not necessarily need complicated computer programs, sophisticated models and formal user surveys. It is more important to get the evaluation process started and to put it on a regular basis. This should be done in a pragmatic and reasonable fashion, as objectively as possible. Having some results available to use when talking to decision makers and in response to media enquiries is more beneficial for the public image of the NMS than ideal surveys and programmes that become bogged down in the process of being perfected before being used at all.

10.1 EVALUATION: ASSESSING USER NEEDS, SATISFACTION AND PERCEPTION

The acceptance of the national Meteorological Service's products by the public and other users, and therefore its public image almost exclusively depend on the quality of its services. The criteria to check the quality can be said to be composed of three parts:

User requirements Do the products fully meet the needs of the users?

User satisfaction Are the users satisfied with the format of the products, the means of dissemination, etc.?

User perception Does the user understand the content of the services? Does the user have trust in the products of the NMS and see them as credible?

These three components are strongly related to each other. The user will not be satisfied if requirements are not met, or equally if the user does not understand the content of the product. On the other hand, a confusing format or layout can hinder the user's understanding of the product.

10.1.1 WHY ASSESS USER NEEDS, SATISFACTION AND PERCEPTION?

As mentioned above, the main goal for any evaluation programme is to find out about the users' needs and the acceptance of the services provided. It is also important to have some knowledge of current public understanding to help focus the attention on the main issues which need to be addressed in public awareness campaigns.

Once it becomes clear to the users that the NMS is seriously concerned about their needs, support for the NMS and its activities will increase dramatically. When the public is given full and frequent information, the public takes warnings and forecasts seriously, while being more forgiving of the inevitable uncertainties in forecasting. Similarly, the NMS will reap the benefits of knowing that its efforts are taken seriously and that it is indeed providing the type of service that the public and users demand. This is extremely important for all service organizations, and especially government organizations. One way to keep in close touch with the users' needs is to conduct user surveys and workshops to assess user satisfaction and to suggest needed service changes and improvements.

It is also important to stay in close touch with the key users in the hazards community, to know what information they need and how they use it. It also helps to ensure timely cooperation for mitigation and preparedness and maintenance of a dialogue during a severe weather event.

10.1.1.1 User requirements

The importance of focusing on the needs of the users was already emphasized in Chapter 4, 4.1. Knowing the actual requirements of the users will eventually enable the NMS to set up a clearly defined product suite that comprehensively covers the needs of the users. Existing products can be adapted to new standards by adding or dropping features, and new products can be developed. The user requirements are mainly reflected in the following aspects.

Content Is the user satisfied with the content of the products? Are all his/her requirements met? Is any additional information offered? For example, the public might not be interested in exact pressure values for high and low systems, but would like to have the probability of rainfall included instead or as well. If requirements are not met, this might not only make it necessary to change a product, but also to improve the accuracy (quality of the NWP models). For example, an operator of a power plant needs to know the next day's maximum temperature more accurately, within ± 2°C instead of only ± 5°C. Further problems can result from the information provided being too general, or not specific enough for the forecast area or a particular application.

Frequency and timeliness Is the information updated periodically and often enough? Is the information disseminated in a timely manner, so that the user has sufficient time to respond and take appropriate actions? Any information and especially warnings that reach the user too late are of no use at all.

10.1.1.2 User satisfaction

Whether the user is satisfied with the performance of the NMS and the products that the NMS offers depends also on a number of components:

Means of dissemination Does the user have fast and easy access to the information? Which are the means of dissemination preferred by the user?

Format Does the user like the format in which the information is presented such as layout, graphics, colours, duration of a broadcast and length of a text? Does the user like the presenters on TV or radio? Does the user consider the forecasters on the phone to be friendly?, etc.

User satisfaction can be improved through introducing better formats and delivery. In that context, special emphasis has to be put on the further inclusion of user requirements as stated above.

10.1.1.3 User perception

Finally, an overall satisfaction with the offered products is only possible if the user fully understands the content and believes in it: a user who does not know what the forecast means and how to interpret the information will not be able to make use of it and will lose interest in it. In this context, it is also important to be aware of the fact that the way a user perceives the information will most likely differ significantly from the way the forecaster sees or intends it. Furthermore, it is essential that the user believes the given information. Even the most accurate forecast will be of no interest to the user if he or she does not believe it to be reliable. The credibility of the NMS in the public and among its users is highly important.

However, some forecasts, though useful, may not be very accurate. For very severe weather events, for example, some people would like to know that there is a risk of the events occurring so that they can take precautions. In that case, they may be forgiving for an inaccurate forecast as long as the uncertainties are well communicated.

The user perception is therefore a question that is on the one hand concerned with the content of the forecasts and on the other — even more — with the public image and the credibility of the NMS. Problems to be solved here include:

Content Are the phenomena and features presented known and understood by the user? For example, the introduction of isobars in a graphic might confuse many users if they do not understand the physical background. They would not see how that will affect them, and reject the whole forecast as not being intended for them.

Terminology Is the wording easy to understand or very technical and scientific? Does the user know what the expressions such as “a slight chance of rain” mean?

Credibility Does the user believe the information to be true and accurate? Is any legitimate uncertainty communicated so that the information is credible and useful, even if, because of the inherent nature of forecasting, it cannot be guaranteed to be perfectly accurate?

Poor perception of the product will make changes in the product necessary to convey the information more clearly, including improved content and wording. The first two problems, content and terminology, can be solved on the one hand by simply questioning the users and adapting the products according to their requirements, and on the other hand by raising the general weather literacy of the public. The latter will then be part of public education programmes and public education campaigns, which are also meant to build up the credibility and a caring image of the NMS on a long-term basis. Credibility and public image can also be increased by ensuring a constant presence of the NMS in the public eye (see Chapter 9). This can be achieved, for example, through regular radio spots or frequent talks at school and community meetings. Credibility can also be enhanced by communicating uncertainty where necessary, rather than pretending to always be perfectly accurate.

10.1.2 HOW TO ASSESS USER NEEDS, SATISFACTION AND PERCEPTION

Frequently, the starting point of a proper determination and assessment of the user requirements, satisfaction and perception is the evaluation of the current services. A number of techniques at hand to be used are:

- surveys, questionnaires, interviews and in-depth case studies to identify in a broad overview the users' needs and expectations;
- fora and workshops with users' participation in order to learn in direct exchange with the users their requirements, to detect potential changes in those requirements and to apprise them of the capabilities of the NMSs;
- pilot projects in concert with the users to develop products and services on a longer term to meet the stated requirements.

Whatever method is chosen, it is most important to go out and ask the (potential) user for his or her opinion. Often the means to determine and assess the user requirements, satisfaction and perception go hand in hand with user education (see also Chapter 9), one serving the other at the same time. For example, World Meteorological Day can be used to show the interested user how a forecast is made and what information it contains. At the same time, while attracting the user's interest, a survey, even in form of a quiz or a game, could be conducted. If the public receives most of its information from the media, then surveys and workshops with the media might suggest the types of products and services that will be most effective.

10.1.2.1 Surveys

Surveys are one of the most important and efficient means to get into contact with the public and to gather the necessary information for the evaluation process. To conduct a proper survey among the public and other users of the NMS's products is not a difficult job to do, but it should be prepared carefully to avoid wasting resources and to ensure getting as exact information as possible. It therefore involves a lot of work. Considering the time and effort necessary, especially if one has never attempted to conduct a public survey before, it might be worth hiring a private company that specializes in this type of work, though it seems to be more expensive in the beginning. Some universities may be interested in being involved in surveys of this kind as an exercise for their students in marketing or statistics. In some countries, it may be possible to have questions on weather services included in official surveys undertaken by the government statistics office. In addition, information is available on the results of studies and surveys of this type carried out by other countries.

According to Czaja and Blair (1996), there are five general stages in the development and completion of a survey. These stages are briefly explained below.

Preliminary planning

This includes formulating the overall goal of the survey. What exactly is the information expected to be obtained by the survey? Detailed planning includes the following: selecting a sample population, choosing a method or medium for the survey, designing the questionnaire, determining available money and time, and planning for how the data will be analysed and the results reported.

Pre-testing

Before carrying out the actual survey, a pre-testing should be done. This includes drafting the questionnaire, deciding if interviewers will be used, and deciding on pre-test methods. During pre-testing, the researcher tests the questions to ensure that they are not confusing to the respondent and that they do not elicit an unexpected response. The questions should be clear and concise, and there should not be too many questions asked, or questions which demand a lot of text as a response.

Final survey design and planning

In this stage, the results of the pre-tests are used to finalize the questions that will be asked. Also, final changes made to the sampling plan are determined, interviewer training procedures and materials (if needed) are compiled, data-coding plans are made, and data analysis procedures are finalized.

Data collection

At this stage, the survey is actually performed and data are collected.

Evaluation process

The final stage encompasses coding the data in order to make use of the results, analysing the results and writing a final report.

Even for small or local research studies, it is recommended that a good reference book be utilized. By doing a little research prior to the start of a survey project, one may avoid making simple mistakes that can severely compromise the final results of the survey.

Topics for an NMS questionnaire could include the following:

- *General topics:* means of receiving weather information, information of interest (warnings, forecast, climate; area; time span), level of acceptance/confidence/credibility;
- *Forecasts:* terminology, quality, requirements (features, level of detail, accuracy, time of issuance), usefulness to the user, frequency of use; and
- *Disaster mitigation:* surveys are possible in all stages of disaster reduction (mitigation, preparedness, response, recovery.

Surveys among the members of the hazards community are of special importance to evaluate the efficiency of the warning system. They can therefore be the basis for the improvement of the content of warnings, their distribution and their turnaround time.

Some possible questions for a survey of the public can be found at Appendix 1 to this chapter.

10.1.2.2 Workshops

Another approach toward assessing user needs and expectations is through conducting user workshops. Though there are many ways to do this, it has proven very successful when users are invited to a workshop and are involved in the development of the workshop agenda. When assessing the product quality in a workshop, the number of invited users must by necessity be limited. This procedure is therefore especially useful for clearly defined user groups such as farmers from the agricultural sector, or operators of power plants.

Before starting to organize the workshop, the NMS must decide which services it wishes to review. Once this is done, it can notify potential users of its desire to conduct a workshop and to solicit items for discussion. Participation can be further enhanced by letting the users know that the NMS will set as a goal, actually making a change in some products or services as a direct result of the workshop. It can also be useful for staff from the NMS to visit the users in their own environment before a workshop is conducted (on the farm, at the power plant, etc.) to gain a direct understanding of their operations and their needs, as well as to send a clear signal of being interested and caring about the users. This is a more “outward looking” approach rather than being internally focused on what the NMS does. The workshop could also be conducted “on site” rather than at the NMS.

As soon as the agenda is formalized with the users, it should be sent out, well in advance of the meeting date. Included in the agenda should be discussion points that outline the problem and contain one or more potential solutions. This will keep the workshop focused on results rather than on a ‘show and tell’ solely by the NMS. One person with excellent communication and people skills should serve as a moderator to ensure that all users contribute their opinions and to keep the programme solution focused. Another person should be charged with taking action items and noting any pertinent issues that would require research or further work to answer.

Before the attendees leave the workshop, they should be asked if any would like to be considered to form an advisory panel to the NMS. In this capacity, they would agree to have the NMS float opinions on future services by them to get their first opinions. This has proven extremely valuable in some NMSs where routine user feedback translates into evolving service enhancements.

Additionally, when the workshop is over, each participant should be provided with a copy of the action items and the decisions made from the workshop. Periodically, the NMS should provide status reports on the actions to the attendees.

10.1.2.3 Other forms of direct contact

Besides surveys and workshops, there are many other occasions to get into direct contact with the user. Another means of monitoring needs, satisfaction and perception is to review complaints and compliments either received directly or reported in the media. Wherever possible the user should be encouraged to express his or her opinion. Such feedback by telephone, mail or Internet and via press clippings enables the NMS to keep continuously track of its performance as well as to improve its services based on user requirements and respond quickly to issues.

Also, public relations campaigns such as the World Meteorological Day or speeches at school and community meetings should be used to interact with the users. Maintenance of close liaison with the media will also generally provide a good insight into public opinion. It is not enough, however, to provide the media with systems and products. The service provider has to start with information on how the Weather Service works and how the broad spectrum of products such as observations, model data, and satellite and radar data can be used.

On the emergency level regular meetings with government agencies and emergency managers help to strengthen the links to the users. It is important to stay in close touch with these key users of the hazards community, to know which information they need and how they use it. It also helps to ensure timely co-operation for mitigation and preparedness and maintenance of the dialogue during an event. For example, in case of heavy rainfall in an area, the authorities need to know which areas might be affected by floods and at what time the highest water level will be expected.

10.2 VERIFICATION

10.2.1 WHY VERIFY ACCURACY?

Verification programmes enable NMSs to verify and track the accuracy, skill and timeliness of their forecasts and to identify improvements in predictive skill resulting from investments in training, new radars, satellite ground stations or computer capacity. Verification statistics assist in making rational decisions concerning priority target areas for increased emphasis. They provide answers to questions concerning forecast accuracy from the public, the media, major clients and decision makers. They are also increasingly required by funding authorities to justify proposed investments in meteorological infrastructure or as after-the-fact evidence that investments made have indeed produced promised improvements in skill and accuracy. Equally, verification data are essential to the development of improved numerical and statistical forecast techniques whose accuracy must exceed that of earlier or more subjective approaches. All forecasts have some error associated with them. If the error in the forecast can be quantified, then the forecast becomes much more useful. NMSs which do not have an ongoing verification programme in place are strongly encouraged to implement such a programme as a matter of priority.

10.2.2 HOW TO VERIFY ACCURACY

The following sections discuss considerations in the design and implementation of an operational verification system, whether it be largely manual or highly automated. Whether the system is relatively simple or very complex, it should be designed to meet the specific needs of forecasters and managers of an NMS.

To ensure the technical accuracy of the products, objective control mechanisms have to be employed. This is a completely internal process, that ranges from approaches which are easily and readily employed (e.g. simple scoring systems, especially for local weather forecasts) up to highly sophisticated models involving technical equipment and staff (detailed statistics, especially for NWP products). While it is beyond the scope of this *Guide* to elaborate on the various measures of forecast accuracy which exist, it is appropriate to briefly discuss some characteristics of operational verification schemes and to provide a few examples of current practices.

If one is considering designing a verification system, then the need and purpose must have already been identified. It is important that the purpose(s) be explicitly stated, including how the output of the system will be used. A forecast verification system can be designed to evaluate and compare various components of the operational system. Verification results can reveal important information about the overall skill, as well as specific weaknesses, of the forecast system. The ability to build a verification system is, of course, linked to the availability of both forecast and observed data. An operational system must be designed to collect and save the necessary data, verify the forecasts, and distribute the results in a timely manner.

Who is verifying?

The specific needs for a verification system will vary widely from country to country, depending on its size and the organization of its forecast service. A particular NMS might consist solely of a central facility, in which case a centralized verification system is the only option, although the "system" could be a single integrated system or could be a collection of largely unrelated components. Or, an NMS might be concentrated in local offices with, perhaps, strong regional offices. In this case, a local system may meet the service's needs. A large country may have many local offices and also have strong regional and/or central elements.

Careful planning is an important part of a successful verification system. Just as important, but perhaps not as obvious, is the need for people to accept the verification system. Weather forecasters and observers must understand the need for a verification system, the importance of the collection of high-quality data, and the value of verification statistics for improving the entire forecast system. The verification system must not only be "fair" but must be perceived as fair by the people who make the forecasts. All aspects of the verification system should be carefully examined to ensure that the system itself is reasonable: is the added work imposed on personnel at all levels justified and do the verification statistics yield accurate and meaningful information? At the same time, forecasters must feel that verification statistics accurately represent the specific information sought by managers. If a verification system is to be successful, the needs of forecasters must be considered along with the requirements of management and the availability of resources.

What does verification include?

Verification usually means the comparison of one data set against another. To verify forecast accuracy, the forecast disseminated to the user is compared to the actual observations (real-time monitoring; especially for very-short- and short-range forecasts). The forecast skill is checked by comparing the disseminated forecast to a reference forecast. This could be persistence (very-short- to medium-range forecasts) or the climate normal (long-range and probability forecasts), or perhaps objective guidance (e.g. statistical temperature forecasts). More detailed comparisons include the verification of forecast performance for different meteorological elements and events, at different places to detect dependencies on forecasters and local-climatological differences, for different forecast periods ranging from very-short-, short- to medium- and long-range as well as different observation time scales, and for different forecasting techniques, for example, man (subjective forecaster) versus machine (automated forecast).

Special verification systems can provide important information about the performance of a forecast system during specific events. The verification should usually include a comparison of accuracy of the forecast versus its lead time, false alarm ratio, frequency of the hazardous event, and an assessment of the efficiency of the dissemination channels.

Verification results provide information ranging from the overall accuracy of routine daily forecasts to the quality of forecast performance during rare or significant events. In order to be successful, a verification system must meet the needs of all levels of the NMS. The needs of a local verification system, where stress is placed on the improvement of forecast performance, differ from the needs of a central system, where a main goal may be to monitor the long-term improvement of a forecast system.

Which elements will be verified?

A wide variety of weather forecast programmes may exist in order to meet the needs of a similarly wide variety of users. Each forecast programme, such as public, aviation, agriculture, marine, severe weather or fire weather, will provide detailed forecasts for specific weather elements. In all cases, the forecast is that actually disseminated to the user. Elements that could be verified are for example weather, air and ground temperature (maximum/minimum), cloud cover, visibility, wind direction and speed, amount and probability of precipitation, or the duration of sunshine/day. Furthermore, verification of severe weather plays an important role. There, not only the accuracy of the forecast hazard and its features is of importance, but also false alarm rates, number of severely underestimated hazards or the timeliness of the warning. According to the importance of the different element and programmes a spectrum of forecasts and elements is chosen as it is usually not possible to verify everything. While temperature, precipitation, hours of sunshine and related weather elements are important to the agricultural community, the aviation industry needs accurate forecasts of ceiling height, visibility and wind. Any single score cannot provide a complete picture about the skill and accuracy of a particular set of forecasts. However, computing many scores can result in a cumbersome verification system and the results may be too voluminous for individuals to deal with, especially those having little time to devote to, and perhaps relatively little interest in, verification. A practical compromise is to compute a few meaningful scores that address the specific purposes of the verification system.

Several factors determine the selection of forecasts and elements that are appropriate for inclusion in a verification system. First, of course, is the availability of both forecasts and verifying observations of a particular weather element. Such an obvious requirement can easily be oversimplified and there are often limitations on the availability of verifying observations, especially over sparsely populated areas or after a severe weather event. A large element of subjectivity is probably inevitable — certainly in the case where the occurrence of a severe weather event can never be entirely proven because of a lack of observations. But even subjective verification results, provided they are done consistently, are much better than no results at all. And even if observations are available for a particular weather element, the forecasts themselves may not be in a form suitable for inclusion in a verification system. For instance, a forecast may be available in text form, but cannot easily be retrieved and converted into quantitative (numerical) form for use in verification.

When both forecasts and observations are available, they should correspond in space and time. Subtle differences in the characteristics of forecasts and observations can bias the verification results. Therefore, each forecast should be verified against local observations (point verification) and not against any fictitious “area weather”. For example, a minimum temperature forecast issued in an agricultural forecast product might be valid for a particular geographical region rather than a specific point. If several observations are available from different sites within the region, a single observation or some weighted average of the observations can be used for verification, depending on the weather element and event that one is trying to forecast. For instance, to evaluate a forecaster’s ability to predict crop-damaging low temperatures, the lowest observed minimum temperature in the region might be used for verification. In this case, an observation near the level of the crop may be more important than observations at standard levels.

From the verification standpoint, it is easiest to verify forecasts at fixed sites (point verification) and fixed times/intervals. Elements observed at fixed times are for example temperatures, cloud cover or wind speed. Clearly, using observations made at the exact forecast valid time is appropriate. In practice, however, forecasts often are valid for periods of time such as precipitation or total sunshine per day. For some weather elements, e.g. in aviation terminal forecasts, forecasts are valid for periods of fixed duration that begin at the same time each day, e.g. for 12-hour periods that begin at 0000 or 1200 UTC. For other elements, forecast validity periods vary in terms of both starting time and duration. For example, an aviation prediction may specify a certain weather condition for the first eight hours of the period, followed by a different condition during the next four hours. These forecasts may be difficult to fully verify, because observations may be available only for fixed times, which may not fall within the valid period of the forecast. Also, verifying observations taken at a specific time during the forecast valid period provide only an instantaneous measurement of current weather conditions, which may not represent the prevailing weather conditions during the forecast valid period. There may not be a very satisfactory solution to this problem in a particular instance. Special observations could be taken, but this is usually not practical. Whatever the solution arrived at, one must be careful to interpret the results in light of the intended purpose of the forecast, the characteristics of the verifying observation, and how well they correspond to each other.

Data collection and quality control

Before the actual evaluation process can begin, data must be collected from various sources, forecasts must be matched with their verifying observations, and all values must be checked for errors.

Collection

The data collection process depends to a large extent on the availability of resources and the communications capabilities. To collect forecasts and observations, the process may be as simple as recording the data values on a verification form and sending the forms to the data-processing site. If appropriate communications capabilities exist, data can be entered by the forecaster or observer and transmitted to the data-processing site electronically. In a very highly automated data-collection system, the local software can automatically retrieve forecasts and observations from products stored at the local site and transmit these data to the appropriate destinations. While automated collection is obviously reducing the workload, the danger is inherent that the control of the data quality is neglected.

Forecast and observed data should be collected on a regular basis, with reasonable deadlines imposed. Frequency of data collection will again depend on resources and communications capabilities. For a system that uses verification forms, it is reasonable to expect that data would be collected about once or twice a month. In a highly automated system, observations could be entered into the computer and transmitted soon after observation time.

Quality control

All data should be checked for errors prior to calculation of verification statistics. Quality control is easiest and most effective when performed at the data source — at the local level. Forecasters and observers are most familiar with the daily weather at their specific sites and are better able to identify erroneous data. A relatively simple quality control process might consist of a forecaster regularly checking the data and manually correcting bad values. More complex, though not necessarily better, quality control can be accomplished through the use of automated error checking. Usually, automated quality control consists of a series of gross error checks, such as determining whether a data value falls within an allowable range. For example, maximum/minimum temperature observations and forecasts may not be allowed to exceed certain upper and lower limits, which could vary by season and location. Special properties of some weather elements allow even more stringent error checks. For instance, a minimum temperature observation for a particular period may not exceed the maximum temperature observation for the same period. Questionable values should be flagged and, perhaps, automatically set to "missing".

Quality control processes, whether manual or automated, will not be perfect. Automated error checking can catch obviously bad values, but small errors can easily go undetected. On the other hand, if the quality control measures are too strict, an automated procedure may eliminate highly unseasonable or rare values that are correct. Since these data may come from some of the most critical forecast situations, special care should be taken to not eliminate these data from the verification sample. Forecasters and observers have the best knowledge of the local weather and are usually better able to identify the more subtle errors than persons located far from the location. Thus, in order to minimize the occurrence of erroneous values in the data sample, it is highly desirable that personnel at the local level carefully check and correct the data. By requiring forecasters to check the data, the occurrence of erroneous values is minimized. At the same time, having forecasters check their own work demonstrates trust in each individual and allows greater local control over the process. Local quality control can add to forecaster acceptance of verification by instilling confidence in the accuracy of the results.

At the central level, performing additional quality control is advisable for two reasons. First, deficiencies in local data collection can sometimes be identified. Quality control ensures that data were collected, collated, encoded and decoded properly throughout the process. Second, central quality control finds erroneous data values that were missed at the local level, ensuring that such values are removed from the data sample prior to verification. Information from the central quality control system should be passed back to the local sites, since it is likely that the local data sample contains the same erroneous values. In addition, personnel at stations that consistently report data which are flagged as erroneous at the central location may be completely unaware that there is a problem.

10.2.2.1 Scoring systems

Instead of calculating the deviation of the forecast from the actual observations and employing heavy statistics, a scoring system awards points to every feature that was forecasted correctly. That way it is easily possible to see the quality of the forecast as well as the trend in the overall performance. An example of a scoring system can be found in Appendix 2 to this chapter.

10.2.2.2 Statistics

The basic approach for technical verification of weather products is to compare statistics. Statistics might, for example, be calculated by applying statistical tools such as bias, mean absolute error or variances to a number of places in the area of forecast and a number of forecast features such as maximum temperature or probability of precipitation. As long as no changes to the forecasting or verification process such as new technologies or forecasting techniques are introduced, the quality of the products should remain stable. Verification results can be compared to persistence, objective guidance, climatology and to former results. Also, there may be a need to compare the collective results of one station with another or of one forecaster with another.

The ability to distinguish the impact of a new technology is a function of other concurrent activities. Multiple changes introduced during the period in question complicate the task of isolating cause and effect related to one specific change. Also, the quantity and quality of data collected for the verification establishes the level of confidence associated with conclusions drawn from analysis of that data. This includes a continuing need for statistics on warning performance for offices before and after the availability of new technology. Verification statistics will provide an ongoing assessment of long-term trends in forecast accuracy for a wider range of products.

Figure 13 embodies the essential features of the verification system that has been in use in the United States for about 10 years. It shows the flow of data from local National Weather Service (NWS) offices to a central site along with the various processes that occur. Built into this system is the ability to process data at both the local and central levels so that the results cover the scope and time scales required by all levels. At the local level, forecast and observed data are collected, checked for errors and saved in a database. Soon thereafter, all forecast and observed data are sent to a central site for processing. There, data are collected from all local sites, checked for errors and saved in a database. Verification scores are generated both locally and centrally. The central headquarters maintains two long-term databases; one contains forecast and observed data and the other contains verification scores. These databases are used to establish trends in forecast skill and accuracy and to provide information for research purposes.

10.2.3 HOW TO USE THE VERIFICATION RESULTS

The results of the verification programme can serve many purposes. As mentioned above, these purposes should be stated explicitly before developing the programme so that the design of the programme will best meet to the actual requirements, such as the publication of results, internally to forecaster, research department, management, and externally to the public and other users.

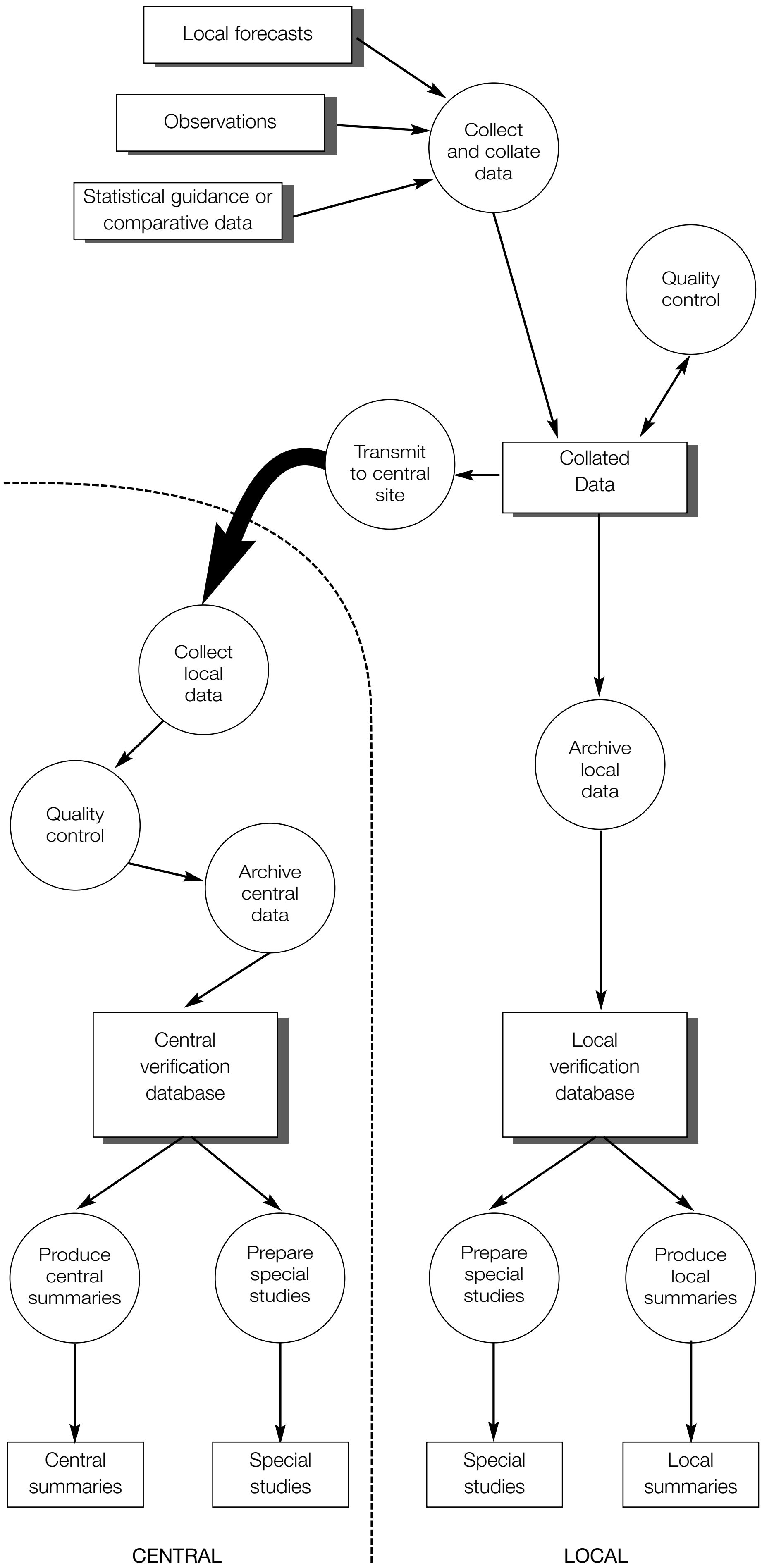


Figure 13. Sample design of a verification system showing the flow of data and the roles of the central and local verification systems (NWS/NOAA)

The following points should be taken into consideration.

Quality improvement

The main goal of the verification process is to constantly improve the quality (skill and accuracy) of the services. This includes:

- establishment of a skill and accuracy reference against which subsequent changes in forecast procedures or the introduction of new technologies can be measured;
- identification of specific strengths and weaknesses in a forecaster's skills and the need for forecaster training and similar identification of a model's skills and the need for model improvement; and
- information to the management about a forecast programme's past and current level of skill to plan future improvements to detect trends in the forecast accuracy and skill; information can be used in making decisions concerning the organizational structure, modernization and restructuring of the NMS.

Public image

Though weather services capabilities have improved considerably in the last 20 years, this has not yet been recognized by most of the public. The demonstration of forecast accuracy and user satisfaction by publishing verification results in a public annual report can significantly improve the public image of the services and products and the NMS in general. It also has real value as a means of educating the public, other clients and funding authorities concerning expectations for forecast accuracy, providing these interests with measures against which to gauge the agency's performance and, not least, in challenging internal staff.

Verification database

Storing the results in a database will also help to provide up-to-date verification data upon request on a real-time basis for all types of warnings and forecasts.

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WEB SITE

US Techniques Development Laboratory (TDL):
http://www.nws.noaa.gov/tdl

APPENDIX 1

POSSIBLE QUESTIONS FOR A SURVEY

The following are some typical questions which could be asked in a survey, carried out by telephone, personal interviews or mail. A full range of possible questions can be found in the accompanying CD-ROM.

QUESTIONS ABOUT SOURCES/USAGE OF WEATHER INFORMATION

Means of receiving forecasts

Which are your primary means for obtaining weather information? (multiple answers possible)

- Newspaper
- Radio/weather radio
- Local TV/pay TV/weather channel
- Telephone (recorded, live)
- Fax
- Internet-weather page
- Teletext/videotext
- Directly from a forecaster at the NMS
- Look/go out to see weather
- Other

→ TV and radio can be further split up by channels

General need of forecasts

When do you mostly need weather information?

- Summer
- Winter
- Weekend
- Weekdays
- Before/during the holidays
- On a normal day
- Never

QUESTIONS ABOUT QUALITY OF SERVICES

Reliability

How reliable do you think the weather information provided by the NMS is?

- Very reliable
- Reliable
- Less reliable
- Not reliable

Type of forecasts

Which period of forecast is most useful to you?

- Today
- Tomorrow
- Following 2 days
- 5–10 days ahead
- General outlook
- Seasonal outlook
- None especially
- Other (please specify)

Questions about the content

The temperature forecast is "A high near 20°C." The high that day turns out to be 17 degrees. In your opinion, how accurate was the temperature forecast?

- Excellent

- Good
- Fair
- Poor

IMPROVEMENTS

Which improvements would you like to see in your weather forecast? (multiple answers possible)

- Forecast should be more/less subdivided regionally
- Quality of forecasts should be improved
- More/less information/detail
- More pictures, graphs/more visual to make you understand
- Simplify presentation
- Presentations are too fast/slow
- Give more/less time/space to weather information
- Improve technology/use of resources for more accuracy
- Presentation of the forecast should be more at ease/relaxed
- Improve personalities/personal presentation of weathercasters
- Longer-range forecasts
- More weather information relevant to specific interests or job
- Extend information via modern means of communication
- More information about the services provided by the NMS

APPENDIX 2
EXAMPLE OF A VERIFICATION PROGRAMME

The following is an example from New Zealand of a simple verification scheme for public forecasts. Other examples of verification schemes can be found in the accompanying CD-ROM.

The following simple verification scheme is applied in New Zealand for public forecasts for a city or region. The forecast as well as its verification are carried out for a 12-hour period. As an example the forecast for "today" (effectively 6 am to 6 pm) which is issued around 4 am in the morning will be verified.

A maximum of eight points can be obtained for each forecast. These consist of four points for precipitation, two for cloud cover, and one each for wind direction and wind speed. This allocation of points reflects the understanding of what the public most cares about — mainly, will it rain or not, then, will it be sunny or not, and finally, what is the wind like. The public also cares about temperatures, but this is treated separately, and simply by counting what percentage of the forecasted maximum temperatures in the region are within 2°C of the actual maximum temperatures.

The scoring is subjective. However, it was found that different people tend to give very similar scores to the same combination of forecast and observed weather.

The individual weather elements are scored as follows:

Precipitation (max of 4)

The scoring takes into account the intensity of rain, and the length of time it rained. The maximum of four points is given if there is close agreement between the forecast and observations. No points are given if there was no agreement (e.g. the forecast was for rain all day and none fell). Numbers in between are given for partial agreement.

Cloud cover (max of 2)

This is taken to be correct (two points) if there is a close match between the forecast and observed cloud cover, or if the cloud cover is not explicitly forecast but rain is forecast and the weather is cloudy (note that a forecast of showers implies variable skies with some sunshine). It is taken to be partly correct (one point) if the forecast implies cloudy weather part of the time, and the weather is mostly cloudy, or mostly clear. Examples of a wrong forecast (zero points) would be a forecast of fine, clear weather, and the observed skies are mostly cloudy (middle or low cloud — thin high cloud of the kind the public would not worry about would be taken as clear).

Wind direction (max of 1)

This is taken to be correct (one point) if generally within one compass point (e.g. northwest winds are forecast and west winds are observed), and partially correct (half a point) if within two compass points. Again, this takes into account any forecast or observed wind changes during the 12-hour verification period.

Wind speed (max of 1)

This is taken to be correct (one point) if the forecast and observed winds are generally within one Beaufort Force over the 12 hours, and partially correct (half a point) if within two categories of Beaufort Force.

These points are all entered into a simple spreadsheet, then added up for the month and divided by the maximum possible (eight points times the number of days in the month) to give an overall "per cent correct" for the month.

For example, Figure 14a shows the results for the forecasts for Wellington, New Zealand, for "today" issued around 4 am of the same day, and "tomorrow" issued around 11 am the previous day. This shows a typical variation from month to month. As would be expected, the accuracy of the forecast for today is also usually slightly better than the forecast for tomorrow.

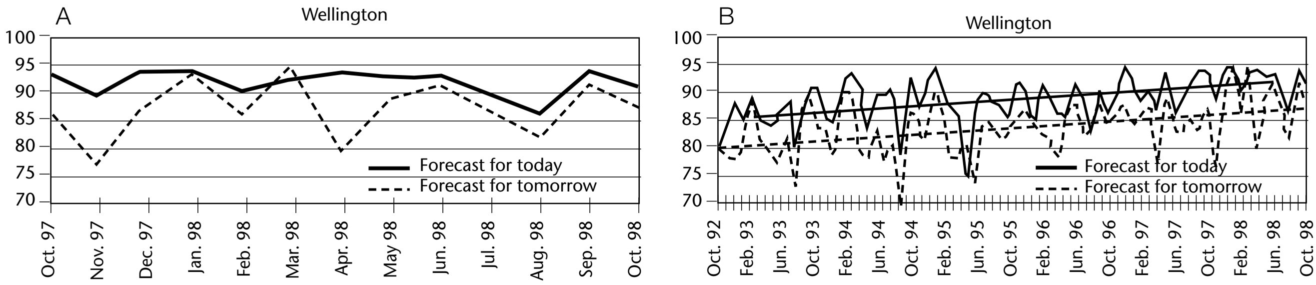

Figure 14. Sample design of a verification system showing the flow of data and the roles of the central and local verification systems (Meteorological Service of New Zealand)

Such verifications have been carried out in New Zealand since 1992. Figure 14b shows the long-term improvements in the assessed accuracy of the forecasts for Wellington. The individual plots are 12-month running averages, and linear trend lines are superimposed.

A simple verification scheme for warnings of severe weather

A simple scheme can be set up for verifying warnings of severe weather. In this case, it is applied to heavy rainfall, but it could also apply to warnings of other severe events such as heavy snow or severe gales.

The first step is to make sure that there are well-defined criteria for issuing such forecasts. In New Zealand, for example, heavy rainfall warnings are issued when 100 mm of rain within 24 hours or 50 mm of rain within 12 hours is expected, over a widespread area (an isolated heavy downpour with a thunderstorm would not count).

The second step is to divide the country up into forecast regions, or zones, for which you will verify the forecast. These would typically correspond to existing forecast regions which are used.

Then, each time a heavy rainfall warning is issued, it has to be decided for each region whether the warning would be counted as correct, or a "hit". There is an element of interpretation, judgement and subjectivity in this. There may not be many observations to decide exactly how much rain fell, and heavy rainfall may not have covered all of the region. However, any experienced meteorologist can usually make a fair assessment of this and decide whether a forecast was a "hit".

If in the judgement of the meteorologist the heavy rain did not occur, then the warnings would be counted as a "false alarm".

For each region for which warning was issued, this is done and the number of "hits" and "false alarms" is totalled up for that particular warning.

		Observed heavy rain	
		Yes	No
Forecast heavy rain	Yes	Hits	False alarms
	No	Misses	

Additionally, a watch has to be kept for times when no warning was issued, but heavy rainfall did occur. Once more, judgement is needed, but an experienced forecaster will be able to count occasions for any particular region when heavy rainfall was observed, but no warning was issued. These events can be called "misses". If the heavy rain covered three forecast regions, then this would count as three "misses".

In summary, for this example of heavy rain, the table opposite depicts the scoring system for severe weather warnings.

If this is done for all the regions and, for example, over a period of three months, some simple summary statistics can be calculated:

Probability of detection (POD)

POD = Hits / (Hits + Misses)

False alarm ratio (FAR)

FAR = (False Alarms) / (Hits + False Alarms)

Critical success index (CSI)

CSI = Hits / (Hits + Misses + False Alarms)

Each of these is normally expressed as a percentage.

APPENDIX 3

POST-EVENT ASSESSMENT

Following significant events, it is extremely important to assess if the NMS's products and services meet the needs of all members of the hazards community as well as the public. Periods following disasters or significant hydrometeorological events can be thought of as learning laboratories where the NMS and its partners in the warning and response process can test their performance under extreme conditions and seek ways to improve the Service.

While an assessment of the NMS's performance is important for continuous improvements, it is essential after a natural disaster to detect shortcomings in order to protect life and property in case of another similar event. The intent of a post-event survey is to find out how well the warning system functioned and to look for areas of possible improvement. It will not only assess the operations of the local weather office and the hydrometeorological agency but also the performance of all members of the hazards community.

The post-event survey should involve interviews with the affected weather service offices, other governmental agencies, emergency managers, governmental officials, the media and local decision makers. The team that conducts the interviews should include programme leaders from the weather service agency, subject matter specialists known for their expertise on such events, social scientists to assess the response by the public and local officials, and someone adept at dealing with the media. It is also advisable to have membership from outside of the agency to ensure an unbiased report. Subject matter specialists should be drawn not only from the agency but also from other agencies and leading academic institutions.

The team should also be dispatched as soon the immediate post-recovery is over. This is to ensure that those interviewed will be able to have sufficient time to devote to the effort. In preparation for the team's arrival, the local weather service office should make copies of appropriate forecasts, data and records for the team's use. The local office should also work to schedule interviews with emergency managers, other agencies and local media outlets.

Information for the post-event survey should come not only from the interviews and offices visited but also from requests for data and information from health officials, other government agencies and the media. Much of the information concerning the magnitude of the event should be drawn from damage surveys conducted immediately following the event and before any of the damage is cleaned up.

In addition, it should be remembered that other organizations as well as academic institutions may also be fielding teams to assess various aspects of the situation. An attempt should be made to coordinate with these other organizations to avoid duplication of effort. Finally, it should be remembered that the victims of the disaster must not become victims of repeated interviews by a barrage of investigators.

For the survey to be of use in improving the warning system as well as supporting constructive changes to preparedness planning efforts, it should be completed as soon as possible after the event. A goal should be to have the survey document ready for publication or distribution within 90 days. The resulting document should receive wide distribution to the government, the hazards community, and be available if requested from the public.

Lessons learnt from the post-event surveys and damage surveys should be folded into the warning systems and preparedness plans to ensure continued improvement. They should also point governments in directions to support future mitigation efforts as well as public awareness and education activities.

Example for the outline of a survey report

The survey report should include specific findings concerning all aspects of the warning system as well as recommendations for improvement. A suggested outline is included below.

Executive summary — A brief narrative summarizing highlights of the entire report.

Findings and recommendations — A list of all findings and recommendations from each chapter.

Chapter 1 — Description of the event and its impact including:
- Type and magnitude of event.
- Fatalities.
- Injuries.
- Damage estimates.
- Economic impact.
- Disruption of services.

Chapter 2 — Hydrometeorological analysis of event.

Chapter 3 — Warning services:
- Assessment of weather service warnings and forecasts.
- Assessment of numerical and subjective guidance.

Chapter 4 — Data acquisition, communications, facilities:
- Types of systems.
- Performance of systems.
- Performance of weather service facilities.

Chapter 5 — Coordination and dissemination:
- Assessment of internal and external coordination during the event.

Chapter 6 — Preparedness:
- Internal actions within weather service.
- External efforts with hazards community.

Chapter 7 — User response:
- Emergency management response.
- Media response.
- Public response.

Conclusion — Brief recap of significant themes.

The above outline works well for relatively large documents. The alternative outline, shown below, is aimed at a brief document that can be completed literally before the survey team leaves the field. This type of document is extremely valid for providing information to the media and to senior government officials who want rapid feedback.

EVENT SUMMARY — This would be about a 5 to 10 page summary of the salient points of the event including:
- Impact to the community.
- Key findings centred around service delivery.
- Outline of how public and emergency managers responded to the event.

SUMMARY OF FACTS, FINDINGS AND RECOMMENDATIONS — This would include significant findings about the event and the proposed recommendations to deal with each finding. Significant information about various aspects of the situation but which do not require any subsequent action to improve would be stated simply as facts. One approach for grouping the facts, findings and recommendations would be to use a modified version of the end-to-end service process which was defined in Chapter 3 of this *Guide*. For example:
- Observations.
- Numerical guidance.
- Role of RSMCs and NMS.
- Local NMS products and services.
- Internal and external forecast coordination.
- Dissemination and communications.
- Technical user and public response.
- NMS facilities and personnel issues.

CHAPTER 11
FUTURE TRENDS

11.1 CHANGES IN NEEDS

Population growth and movement of population to coastal areas, fertile river valleys and steep hillsides around large cities are increasing vulnerability to meteorological and hydrological hazards. Coastal areas are vulnerable to tropical cyclones, gales and flooding from storm surges. River valleys are prone to destructive floods. Steep hillsides suffer landslides from heavy rain.

There is increased potential for catastrophic loss of life and property and greater need for risk analyses, land use planning and early warning. Risk analyses and land use planning require the use of climatological data; early warning depends on meteorological forecasting capability.

Increasing leisure time in many parts of the world, with the consequent increase in weather-sensitive leisure activities such as surfing, hang-gliding, hiking, skiing, snowboarding, etc. will lead to an increase in demand for relevant forecasts. There will be increasing interest in, and demand for, forecasts related to air quality, pollen and UV radiation.

The increasing pressure on water resources, with the prospect of shortages in some parts of the world, will lead to more sparing use of irrigation and consequent demand for more specific forecasts of rainfall. Increasing use of solar and wind power will require climatological data to find the best sites for generators.

On the other hand, technological change makes the public less susceptible to the weather. The spread of air-conditioning and central heating in hospitals and other buildings, and of refrigeration, makes people less susceptible to extremes of heat and cold. The folding umbrella makes the commuter less interested in forecasts of rain.

11.2 CHANGES IN METEOROLOGICAL CAPABILITY

The last 30 years have seen enormous increases in the accuracy and lead time of forecasts and warnings due to the introduction of computers and satellites. This trend can be expected to continue as more sophisticated numerical models of the atmosphere/ocean are developed. Improved mesoscale models, run on smaller computers, provided they have a sufficiently dense network of observations as input, will increase the accuracy and resolution of forecasts for limited areas of high economic value.

Greater understanding of El Niño and similar phenomena in other oceans, together with improved computer models, should also lead to more reliable seasonal forecasts and prediction of drought some months ahead.

The trend away from labour-intensive activities to automation will continue. There will be continuing pressure on NMSs to reassess their observation programmes. The automation of surface observations, loss of dedicated human observers, costs associated with traditional upper-air observing systems, the potential for new satellite-based sensors and other remote sensing systems, including Doppler radar, all suggest that a unified approach toward using systems in a complementary way must be established.

Increasingly sophisticated workstations will enable forecasters to integrate observational and numerical model data to view the atmosphere in four dimensions. Combining this with the ability to quantify forecast uncertainty will require methods of communicating these uncertainties to users in such a way as to make their decision processes more definitive. For the ultimate goal of NMSs is to use new technologies, combined with the ability to understand atmospheric and hydrologic processes, to provide information to users in such a way as to enable them to make response decisions according to the amount of risk that is acceptable to their operations.

11.3 CHANGES IN COMMUNICATIONS TECHNOLOGY

Communications technology is advancing at a rapid rate as speed and volume increase and costs come down. As telex replaced telegrams and facsimile replaced telex, so e-mail and computer-to-computer transfer are replacing facsimile. The volume of information which can be found on the Internet is huge. Further advances can be expected and must be closely monitored to take advantage of the latest technology at, usually, lower cost.

Dissemination of forecasts and warnings will be done more rapidly to greater numbers of recipients. There will be further improvements in graphic display capabilities in television and newspapers, improving understanding of the weather in the community. The trend to international satellite television broadcasts can be expected to continue.

NMSs need to take advantage of these developments. They need to place emphasis on ensuring that their staff are well-trained, on accessing the best available guidance, on developing relevant, high-quality products, and on implementing systems and technologies which ensure timely distribution of their products and services to their public.

As we move into the 21st century, the vision lies before us of accurate forecasts and warnings issued in good time, received promptly and readily understood and acted on by the people.