

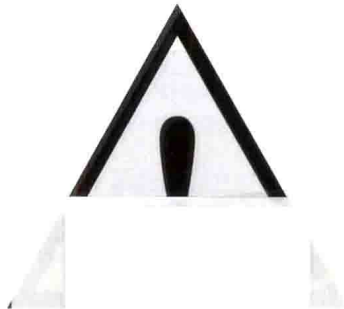


HEADS UP!

**Early Warning Systems for
Climate, Water and Weather**

Michael H. Glantz, Editor

TSINGHUA UNIVERSITY PRESS
BEIJING, CHINA



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2007

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in cooperation with the National Center for Atmospheric Research*

NCAR

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Boulder, CO USA 80307

and the Chinese Academy of Meteorological Science

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Beijing, P.R. China

*The National Center for Atmospheric Research (NCAR) is sponsored by the US National Science Foundation. The views expressed herein are those of the authors and do not necessarily reflect the views of NCAR or CAMS, NSF, or any of their subagencies.

图书在版编目(CIP)数据

当心! 气候、水以及天气预警系统=Heads Up! Early Warning Systems for Climate, Water and Weather: 英文/(美)格兰茨(Glantz, M. H.)主编. —北京: 清华大学出版社, 2007. 2
ISBN 978-7-302-14633-9

I. 当… II. 格… III. 天气预报 – 预警系统 – 英文 IV. P45

中国版本图书馆 CIP 数据核字(2007)第 017039 号

出版发行: 清华大学出版社 地 址: 北京清华大学学研大厦 A 座

<http://www.tup.com.cn> 邮 编: 100084

c-service@tup.tsinghua.edu.cn

印 装 者: 北京佳信达艺术印刷有限公司

开 本: 153 × 140 印张: 5.75 字数: 183 千字

版 次: 2007 年 2 月第 1 版 印 次: 2007 年 2 月第 1 次印刷

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Acknowledgments

The results of an Internet search for early warning systems underscore the universal interest in early warning systems for a wide range of threats, and especially for climate, water, and weather related hazards. So many early warning systems, so much interest, and yet there is so much continued damage to life, limb and property. The idea emerged to present different warning processes for a subset of hazards.

As I discovered, the easy part was identifying specific hazards to present here. The hard part was preparing the collection of warning systems in brief form. It was the endless effort of D. Jan Stewart, CCB administrator and editor, who turned an idea conceived in a coffee shop into this publication. Clearly, she deserves the lion's share of thanks from the editor, the contributors, and from NCAR. Anne Blondeel-Oman, former administrative assistant at NCAR, deserves praise for her effort to paste together (literally) the pages of the first prototype. Qian Ye, CCB, has supported the idea for this publication and arranged for the publisher. Special thanks go to the contributors to this publication. Last but not least in importance is the constant support from NCAR's Imaging and Design Group, Erick Halvorson and Mike Shiba.

A final acknowledgment must be made of the sincere efforts of scores, if not hundreds, of organizations in just about every country involved in formal and informal early warning activities. Their overriding missions are to protect at-risk populations from harm, especially harm that might result from climate, water, and weather related hazards.

Michael H. Glantz
January 2007

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Section 1

Introduction

Interest in Early Warning

Most likely, all governments, corporations, groups and individuals are interested in early warning in one form or another. They are concerned about impending or likely threats and problems they may have to face. The more advanced the warning they can get the better they would be, at least in theory, because they would have ample time to, at the least, prepare for and hopefully cope with the natural or human-induced threat or to prepare for its potential impacts.

Many early warning systems (EWSs) are in operation today to warn the general public, governments and businesses, such as insurance companies or grain producers, about impending climate, water, and weather-related hazards, along with other natural or human-made threats. The experiences and insights identified in the use around the globe of early warning systems can help to inform officials and other decision makers in various governmental and non-governmental organizations about how to prepare and communicate effective warnings. Sharing experiences also helps to educate the media and the general public about how to interpret warnings and apply them to their own local needs: in other words, empower the people by helping them to understand the value and use of warnings of foreseeable hazards. Information is power. Sharing information is empowering. In sum, the purpose of this publication is to identify ways to make early warnings of potential “threats” to society and the environment more useful, usable, credible, and reliable.

Aside from being the right thing for governments to do — that is, to protect their citizens from harm — it is imperative for governments to protect its principles and its institutions. An adage that must exist in many, if not all, cultures is the following: “To be forewarned is to be forearmed.”

There are many organizations, from local to global, with responsibility for early warning of impending threats to life, limb, and property. The UN system has been charged by governments to foster awareness and progress in the development and effective use of EWSs. Organizations like the WMO, WHO, UNEP, UNDP, UNESCO, IOC, ISDR, WFP, FEWS-Net and FAO/GIEWS, among others, are deeply involved in some aspects of early warning that pertain to their institutional jurisdictions. Many humanitarian organizations are also dependent on EWS output for their effective operations. Keep in mind that there is likely to be a mix of several formal and informal warning systems operating at the same time in a given country focused on similar climate, water and weather related hazards.

The Precautionary Principle as an Early Warning

In the 1980s, the notion of the “precautionary principle” began to take hold in international environmental discussions. The principle is based on the view that scientific uncertainties that surround an environmental stress should not be used as an excuse for inaction to address that stress. It is “better to be safe now rather than sorry later,” if the environmental stress were to become critical and cause irreversible and costly consequences in time or space. The European Environment Agency published a collection of case studies in which the precautionary principle was not applied. The publication was titled “Late Lessons from Early Warnings” (EEA, 2002) and is about gathering information on the hazards raised by human economic activities and its use in taking action to better protect the environment and of the health of species and

ecosystems that are dependent on it. The study aims to contribute to better and more accessible science-based information and more effective stakeholder participation in the governance of economic activity so as to help minimize environmental and health costs and maximize innovation (EEA, 2002).

Human influence on global climate appears to be the latest global environmental stress (some say “insult”) that seems destined to be yet another case of early warnings accompanied by late lessons, though there may still be time to prevent, mitigate, or adapt to some of global warming’s worst impacts.

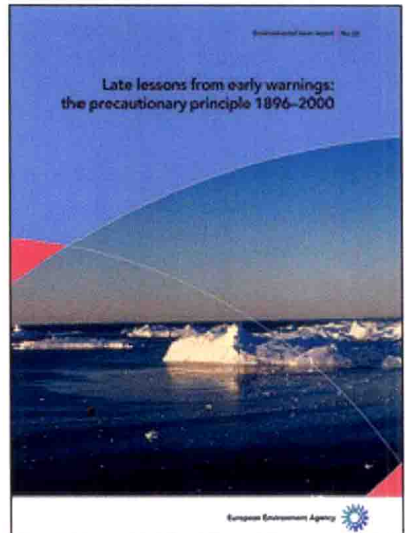
The Future Has Arrived Earlier Than Predicted... Take Global Warming, For Example

It seems that, as each decade since the 1970s has progressed, we witness some of the signs that scientists had been warning us about related to the gradual warming of the Earth’s atmosphere. For example, sea level continues to rise; 96% of the world’s glaciers are receding; warm climate ecosystems are moving upslope to higher altitudes into previously cooler climates and latitudes; exotic species and disease vectors are appearing in new locations poleward, adjusting to warmer winters and hotter summers. Droughts seem to be recurring with greater frequency and intensity in some drought-prone locations, and floods seem to be doing the same in flood-prone locations. Arctic sea ice has been disappearing at an increased rate and is now at its smallest surface area in a century.

Many of these changes are taking place earlier than expected, at rates faster than expected, and in places where they were often unexpected. We are starting to see stronger storms, some of which are called “superstorms.” In fact, we are watching the development of “seasons of superstorms.”

While a lot of the computer model-based climate change scenarios yield foreseeable consequences of global warming out to the year 2050, 2070, or even 2100, we are already witnessing some of what scientists expect to take place in the distant future happening now in different parts of the globe. Coral reefs are dying worldwide. Permafrost is melting. Each year seems to be ranked in the hottest ten on record. Tropical storms in the Atlantic and Pacific are increasing in frequency and intensity, and so forth. These are changes that have already been suggested verbally as well as in print for a couple of decades. They are not longer speculative changes. They are real.

Compounding physical and biological changes that are accompanying global warming (all observers admit that the climate has warmed in the 1900s by about 0.7°C) are demographic changes, such as in population growth and migration, land transformation and land-use patterns, heightened exploitation of a wide range of natural resources, and increases in water and food shortages in many parts of the globe. In addition, there is a movement of populations worldwide toward coastal areas, areas that are increasingly going to be at risk to tropical storms, storm surges, and sea level rise.



Cover of EEA publication, "Late Lessons from Early Warnings: The Precautionary Principle 1896 – 2000"

What Constitutes an Early Warning System?

An early warning system (EWS) is made up of several components and is not well represented only by the formulation and issuance of a warning. Components of a holistic EWS includes the formulation of the warning, the issuance of the warning, and the reception of and response to the warning and finally feedback to those who developed and issued the forecast in the first place. Each element has to be considered in evaluating an EWS. A weakness in any part of this chain of steps from warning preparation to responses can render the early warning system less effective, and an early warning system that does not warn will not be taken seriously. Also, an important part of an effective EWS is the feedback loop that must always be in place so that those responsible for the warnings can better determine the value to at-risk people of specific warnings as well as the effectiveness of the system (a hindcasting activity). Basic questions must be addressed before either setting up or evaluating the effectiveness of an EWS. For example, do people agree on what is meant by early? What constitutes a warning? Who is to be warned? What seems obvious may prove to be not so obvious; a warning to one person may not be considered a warning by another. Does everyone (e.g., the government, the media, the public, the military) need to be warned at the same time, in the same way, and by the same warning system?

How is a warning affected by the reliability and credibility of the sources of information on which it is based? Are there levels or degrees of warning? Is the warning to be like a go-no go warning switch (e.g., high alert or no alert), or are there levels of warning such as those we have for traffic lights: green, yellow, and red? Or are the levels of warning like those used for weather phenomena such as tornadoes and hurricanes, i.e., a watch, a warning and an alert?

In fact, there are numerous EWSs in any given society. In addition to those for hydrometeorological hazards, they are designed for famine, flash floods, infectious

disease epidemics, heat, drought, fire, etc. The meteorological and hydrological communities have been using EWSs for a long time to warn about all kinds of extreme hydrometeorological events. Clearly, there is considerable expertise and experience on which to draw on, when constructing a new EWS for the first time.

There is an EWS for just about every conceivable process or event of concern to individuals, societies, corporations, and governments. They exist at the global scale (e.g., for monitoring global warming or stratospheric ozone depletion) at the national level (e.g., regional drought, desertification, famine, or large-scale flooding) and at the local level (e.g., infectious disease outbreak, nutritional changes, or flash floods).

The truth of the matter is that EWSs are constantly being created for newly identified threats (terrorism, West Nile virus, SARS), are being revised for changes in existing threats (food insecurity, invasive species), and critiqued for shortcomings (just about every system). There are many examples of truly successful early warnings that have demonstrably led to the saving of lives, livelihoods, and the protection of properties.

For the most part, EWSs are under constant scrutiny with each half-generation (every 10 years or so) trying to create the perfect EW system. The task is daunting. Existing systems are constantly being challenged by Nature in general and by variations in the climate system specifically. People and societies have forever been in conflict with a varying or changing climate. Making a difficult task of early warning even more difficult is the fact that societies are constantly changing as well as are ambient environmental conditions. Thus, the quick-onset event or the slow onset (creeping) process that is being warned about is always embedded in a set of other confounding events or processes, and this synergy frequently leads to what has been labeled complex humanitarian crises. Complexity, however, must not be used as an excuse for inaction.

Threats

Threats to societies are many, with each society having its own unique set of threats about which to be concerned. Some of those threats are natural while others are directly or indirectly human made. Some can be well prepared for, while others cannot. Threats of one kind or another will always exist. While we cannot necessarily eradicate all of them, we can become better aware of their likelihood and potential impacts. For most of these threats, perceived and real, an early warning apparatus has been set up, however formal or informal. Those warnings related to threats may not be labeled as warnings but are, in essence, warnings based on forecasts, projections, scenarios and trends as a result of tracking a selected explicitly identified set of indicators.

The reality is that there are numerous formal as well as informal early warning mechanisms in any given society, whether rich or poor, industrial or agrarian, democratic or totalitarian, capitalist or socialist. Early warnings are not to be taken lightly. People in most societies are free to issue warnings. However, with every threat warning issued to a society, someone is listening, if not responding, to it. It is up to each society to determine how to decide which ones are credible and are based on reliable indicators (qualitative as well as quantitative) and which ones are based on less reliable factors, such as unsubstantiated rumors. The primary objective is to provide a warning of a potential threat with enough lead time for recipients of the warning to take appropriate evasive action.

The UNDP uses an assessment technique (SWOC, or strengths, weaknesses, opportunities and constraints) to evaluate various programs or activities. Here, we apply SWOC to early warning systems in general with a special emphasis on early warnings related to atmospheric processes, such as droughts, floods, frosts, fires, and infectious disease outbreaks. It is important to keep in mind that each weakness or

constraint can be viewed as an opportunity for improvement and as a challenge to society.

Strengths, Weaknesses, Opportunities and Constraints Assessment

Strengths

People want to know what the future has in store for themselves, their families, and societies. The same is true for every government. A glimpse of the future, no matter how reliable (or unreliable), is viewed as having some value to someone. So, the strength (e.g., value) of an early warning about anything that might impinge on one's routine or livelihood or on the workings of government is seen as having value. Value, however, is a loaded term, because what one person values another might not; what one government values, another might not.

Early warning implies that there will be “ample” time to react to the information conveyed by that warning. Ample time refers to lead time and it is a relative term, depending on the hazard or concern. An early warning several months in advance of the development of an El Niño episode in the tropical Pacific can provide several countries with several months of usable lead time. Tornado warning, on the other hand, may occur only a matter of minutes ahead of a tornado's impacts. Both, however, can provide enough lead time to take protective action. Nevertheless, there are time constraints on warnings. To hear about a flash flood as the water is rushing at one's doorsteps does not provide ample time to act and is too late as a warning. Also not very useful is an early warning that is too early, one that might be given too far in advance of the impact of what is being warned about; for example, if you are living in a region that is prone to flash flooding and you know it, can that knowledge be seen as an early warning? In both of these situations the information provided might be of some

use, but by itself it does not maximize its potential benefits for those being warned. The former example may allow one to save some possessions and even one's life; the latter example enables one to protect against a low probability, worst-case flash flood scenario.

The bottom line about the value (strength) of early warning systems is that governments, the media, and the general public as well as those most at risk to the climate-related or other hazard of concern can be warned to take appropriate action.

Weaknesses

In theory as well as on paper, early warning systems function quite efficiently. In reality, they seldom work as smoothly as one would like. In spite of the best efforts of individuals, agencies, and governments, Nature (the climate) does not follow a set pattern or a government's hopes for its good behavior. As American ecologist Barry Commoner once said, "You can't change just one thing." This is a truism as far as human interactions with their climate systems are concerned. Demographic changes (population shifts as well as increasing affluence, or increasing poverty) alter the impacts on societies and ecosystems of constantly varying and changing atmospheric behavior.

Thus, other factors besides the issuance of a warning itself — such as the ability of those at risk or agencies responsible for those at risk to receive and understand the warning and the phenomenon being warned about, political access of the at-risk populations, vulnerability to hazard impacts of communications and transportation infrastructures, even the desire or capability of the government to take appropriate action — come into play to determine the actual, as opposed to hypothetical, value of an early warning.