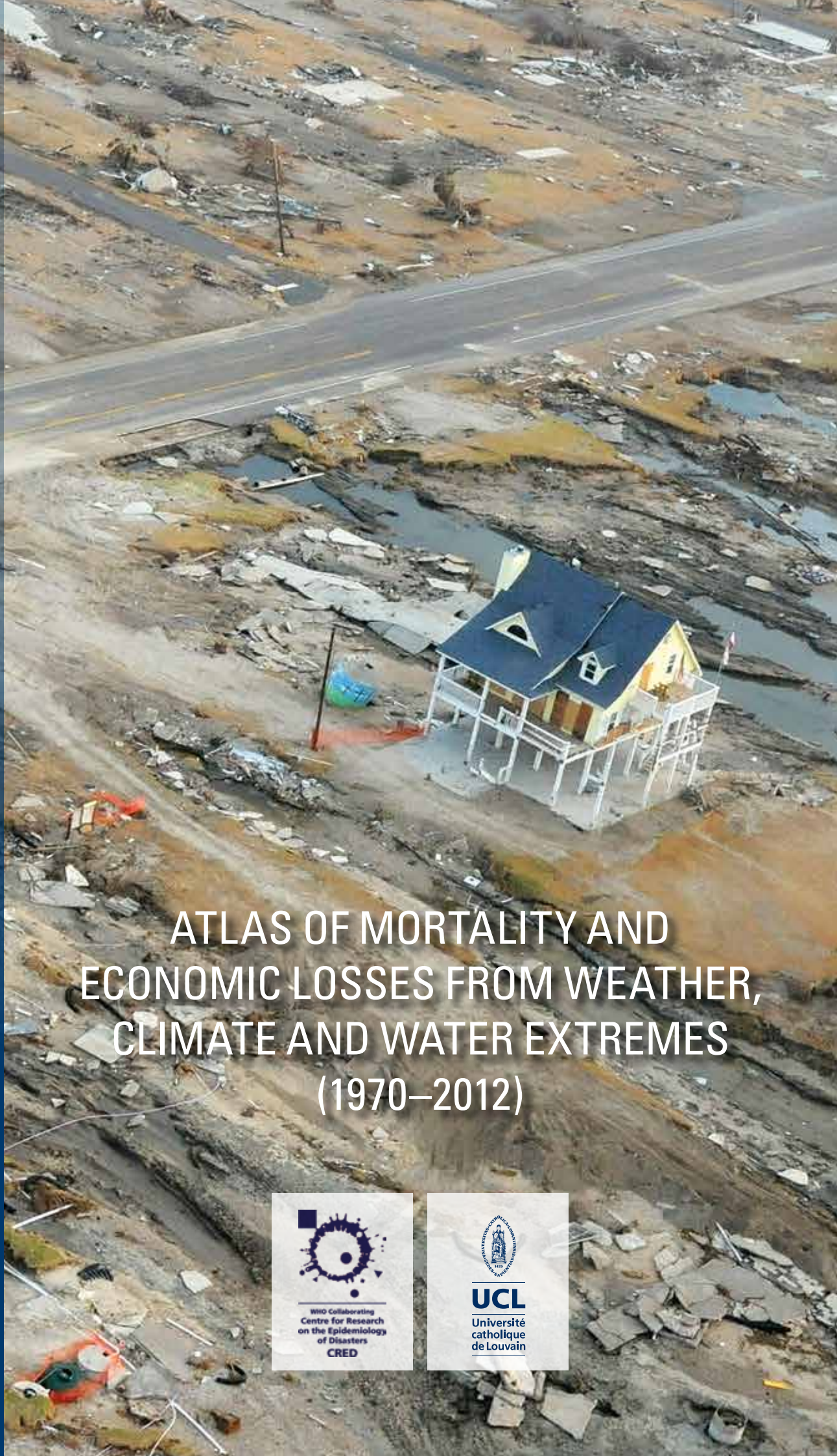

ATLAS OF MORTALITY AND ECONOMIC LOSSES FROM WEATHER, CLIMATE AND WATER EXTREMES (1970–2012)

World Meteorological Organization
Weather · Climate · Water

WMO-No. 1123

WHO Collaborating Centre for Research on the Epidemiology of Disasters CRED

UCL Université catholique de Louvain

Cover: A lone house remains standing after Hurricane *Ike* (2008) devastated Gilchrist and Galveston, Texas, United States of America. The house was rebuilt taking advantage of lessons learned from Hurricane *Rita*, which struck the area in 2005. It was built on elevated ground and the pitch of the roof and the windows were designed to withstand winds of up to 209 km per hour, thus surviving Hurricane *Ike* and its winds of 177 km per hour.

Photo by Jocelyn Augustino/FEMA

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Chairperson, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0) 22 730 84 03
Fax: +41 (0) 22 730 80 40
E-mail: publications@wmo.int

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FOREWORD

Disasters caused by weather-, climate- and water-related hazards are on the rise worldwide. Both industrialized and non-industrialized countries are bearing the burden of repeated floods, droughts, temperature extremes and storms. The escalating impact of disasters is due not only to their increasing frequency and severity but also to the growing vulnerability of human societies, especially those surviving on the margins of development.

To appreciate fully the global effects of weather, climate and water extremes, we need to monitor the number of lives lost or affected and the impact on economies and livelihoods. Historical, geo-referenced information about deaths and damages can be used to estimate risks before the next disaster occurs. It can support practical measures to reduce potential impacts, such as investing in early warning systems, retrofitting critical infrastructure or enforcing new building codes. Information about past impacts can also be used to assess the resilience of a society.

Gathering loss and damage data, however, is a major challenge. Data from different countries are not always comparable or even accessible, and smaller disasters are often not recorded in official records. As a result, the United Nations *Global Assessment Report on Disaster Risk Reduction 2013* concluded that direct and indirect losses from natural hazards of all kinds have been underestimated by at least 50 per cent. Better reporting of disaster impacts is vital for strengthening disaster risk reduction. This is why the international community should help vulnerable countries improve their capacity for developing and maintaining high-quality damage and loss databases.

The full value of damage and loss data is best realized when such information is combined with meteorological, hydrological and other environmental data. By describing the location, severity or frequency of hazards, these data make it possible to analyse the historical and geographical patterns of cause and effect. They can also be used to improve the analysis of risks: some hazards are quite complex, such as when a tropical cyclone results in storm surges, flooding, landslides and wind damage, which can lead to confusion and double counting if damages are attributed both to the coastal storm and the inland flood.

Another challenge for users of risk information has to do with the changing characteristics (frequency, location, severity) of weather-, climate- and water-related hazards. Natural climate variability is now exacerbated by long-term, human-induced climate change, so that yesterday's norms will not be the same as tomorrow's. The Working Group I contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change *Climate Change 2013: The Physical Science Basis*, released in September 2013, confirmed that rising atmospheric concentrations of greenhouse gases have already changed weather patterns and the global water cycle. The climate will continue to change throughout the twenty-first century and beyond.

The *Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2012)* seeks to raise awareness of these and other challenges to collecting and analysing disaster risk information. It presents a worldwide analysis of extreme weather, climate and water events, drawing on the Emergency Events Database (EM-DAT), compiled by the Centre for Research on the Epidemiology of Disasters (CRED). The Atlas compares the reported impacts of meteorological, climatic and hydrological extremes (as categorized by CRED) on people and economies at both global and regional levels.

We hope that by highlighting the value of risk information, this Atlas will help to inspire stronger national and international efforts to report, collect, standardize and analyse data on weather-, climate- and water-related hazards and on how the resulting disasters affect people and their livelihoods. We also view the Atlas as a tool for promoting greater collaboration between the agencies that collect loss and damage data and information and the National Meteorological and Hydrological Services (NMHSs) of

each Member. By working together, these organizations can produce geo-referenced information products that combine data on weather, climate and water with data on human and economic losses due to disasters.

Such products are invaluable because they can provide decision-makers with actionable information for protecting life and property. They can be delivered through the WMO-led Global Framework for Climate Services (GFCS), which is mobilizing the United Nations system and other partners to assist countries in developing their own climate services. These information products can also support activities and services inspired by the post-2015 United Nations Sustainable Development Goals, the second phase of the Hyogo Framework for Action, the United Nations Framework Convention on Climate Change and the United Nations Convention to Combat Desertification.

We invite your feedback and comments on the Atlas, and we hope you find it useful.

Michel Jarraud
Secretary-General of the World Meteorological Organization

Debarati Guha Sapir
Director of the Centre for Research on the Epidemiology of Disasters
Professor at the University of Louvain School of Public Health

BACKGROUND AND METHODOLOGY

Background

Every year, disasters related to weather, climate and water hazards cause significant loss of life and set back economic and social development by years, if not decades. From 1970 to 2012, 8 835 disasters, 1.94 million deaths and US$ 2.4 trillion of economic losses were reported globally[1] as a result of droughts, floods, windstorms, tropical cyclones, storm surges, extreme temperatures, landslides and wildfires, or by health epidemics and insect infestations directly linked to meteorological and hydrological conditions. This Atlas, a joint publication of the World Meteorological Organization (WMO) and the Centre for Research on the Epidemiology of Disasters (CRED) of the Catholic University of Louvain in Belgium (see Annex I), describes the distribution and impacts of weather-, climate- and water-related disasters from 1970 to 2012. It also highlights the actions and programmes led or coordinated by WMO to reduce the impacts of such disasters.

Under the cross-cutting framework of its Disaster Risk Reduction Programme, WMO has launched an initiative to develop guidelines, recommended practices and standards for hazard definition and classification to support the geo-referencing of loss and damage data and risk analysis. As part of the activities of this Programme, WMO is working in cooperation with its technical commissions and programmes and the NMHSs of its 191 Members to develop statistical hazard mapping as well as forecasting and forward-looking modelling tools and methodologies for meteorological, hydrological and climate-related hazards to support loss and damage data collection and analysis and probabilistic risk modelling. This initiative, combined with national capacity development projects, will enable countries to collect and develop hazard databases and metadata, carry out systematic geo-referencing of related loss and damage data and support risk modelling at local, national, regional and global scales.

Underpinning this initiative is the significant capacity that WMO and its 191 Members have developed for gathering and disseminating data through two globally coordinated operational systems – the WMO Integrated Global Observing System and the WMO Information System. In addition, World Meteorological Centres, Regional Specialized Meteorological Centres (including Regional Climate Centres) and NMHSs provide weather and climate analyses, warnings, forecasts and other information services through the WMO Global Data-processing and Forecasting System on a 24/7 basis. These various centres are also involved in other vital programmes and activities to support meteorological, hydrological and climate services for disaster risk reduction, such as the Tropical Cyclone Programme, which facilitates the development of operational tropical cyclone bulletins and information.

WMO projects such as the Severe Weather Forecasting Demonstration Project use the resources and modelling capabilities of NMHSs to assist the severe weather forecasting and warning services of less developed NMHSs, in particular in least developed countries and small island developing States. Other relevant WMO contributions include activities for the monitoring and integrated management of floods and droughts, the forecasting of storm surges and coastal inundation, climate prediction organized by Regional Climate Centres (RCCs), coordination of El Niño-Southern Oscillation reports, and the annual statements on the status of the global climate. All of these activities ensure delivery of reliable and timely meteorological, climate and other related environmental services and information on hazards to decision-makers building on the WMO Strategy for Service Delivery.

The *Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970–2012)* is a first step by the new partnership of WMO and CRED to engage their respective national and global networks in improving national disaster loss and damage databases by linking them to the hazard information collected by WMO and its Members.

Disaster database used for the analysis

The analysis provided in this Atlas is based on the CRED EM-DAT database[2], which contains data on disasters caused by several types of natural hazards – geophysical, meteorological, climatological, hydrological and biological – and

[1] CRED (EM-DAT); US$ prices are adjusted to 2012.

[2] http://www.emdat.be/database

technological disasters dating back to the year 1900. Of the over 20 700 reported disasters listed in the database, 62 per cent were caused by natural hazards and 38 per cent were technological. The objective of developing and maintaining this database is to provide evidence to support humanitarian actions and the development of national and international programmes.

The disasters included in this report are classified as meteorological (storms), climatological (droughts, extreme temperatures and wildfires) and hydrological (floods and mass movement wet, which includes subsidence, rock-falls, avalanches and landslides). These categories were developed by CRED along with a number of its partners engaged in collecting loss and damage data associated with natural hazards (see Annex II, Table 1).

Through the long experience of CRED in data collection and management, EM-DAT has provided a unique, public and global reference database of reported disasters. It ensures transparency through normative rules, clearly stated definitions and methodologies and selective validation methods and tools. Information sources were selected to describe disasters and their related losses as accurately as possible in EM-DAT (Annex II, Table 2). All events reported in EM-DAT should, moreover, meet the defined selection criteria (Annex II, Table 5).

Over the years, data entry and delivery have become automated, making it easier to compare EM-DAT data across time and space. Thus, the quality and amount of loss and damage data from reported disasters have increased over time.

Methodology

This publication provides statistical analyses of reported disasters in the CRED EM-DAT database spanning the 43-year period from 1970 to 2012, inclusive. The analyses have been carried out at the global scale and for each of the six WMO Regions (see Annex III, Table 8). The reported number of disasters, related deaths and economic losses are assessed for the 43-year period as well as by decade (1971–1980, 1981–1990, 1991–2000, 2001–2010) to indicate significant disasters and trends over time. Lists of the 10 worst reported disasters in terms of human deaths and economic losses during the 43-year period are provided for each Region. According to EM-DAT, in some regions multiple disasters could be listed under one event; however, for the top 10 lists provided in this report, these cases have been excluded and only disasters related to a single event are included.

Outline

The statistics for reported disasters related to meteorological, hydrological and climatological hazard categories, as defined by CRED (see Annex II, Table 1), are presented globally, followed by statistics for each of the six WMO Regions. The final section provides a comparison of these reported disasters among the six WMO Regions.

Note: The depiction and use of boundaries, geographic names and related data shown on maps and included in lists, tables, documents and databases are not warranted to be error free nor do they necessarily imply official endorsement or acceptance by WMO.

GLOBAL

From 1970 to 2012, 8 835 weather-, climate- and water-related disasters were reported globally. Together they caused the loss of 1.94 million lives and economic damages of US$ 2.4 trillion. The 10 worst reported disasters in terms of human lives lost represented only 0.1 per cent of the total number of events, but accounted for 69 per cent (1.34 million) of the total deaths. The 10 most costly disasters accounted for 19 per cent (US$ 443.6 billion) of overall economic losses. Storms, droughts, floods and extreme temperatures all figure on both lists of the worst disasters.

Storms and floods accounted for 79 per cent of the total number of disasters due to weather, water and climate extremes and caused 54 per cent of deaths and 84 per cent of economic losses. Droughts caused 35 per cent of deaths, mainly due to the severe African droughts of 1975, 1983 and 1984.

The 10 worst reported disasters in terms of lives lost occurred primarily in least developed and developing countries, whereas the economic losses occurred primarily in developed countries and in countries with economies in transition.

STRINGER RUSSIA / REUTERS

A security guard walks near grass lit on fire by severe heat in Moscow, 2010.

Map highlighting major reported disasters linked to weather, climate and water extremes

Note:

Non-WMO Member States and non-self-governing Territories are indicated in grey, as are States for which CRED did not have data during the 1970–2012 period.

RICK WILKING / REUTERS

A police car is submerged in New Orleans, United States, after Hurricane Katrina *hit in 2005.*

MSF

Victims of the East Africa drought, Sudan, 1984

Disasters ranked according to reported (a) deaths and (b) economic losses, globally (1970–2012). TC indicates disasters caused by tropical cyclones.

(a)	Disaster type	Year	Country	Number of deaths
1	Drought	1983	Ethiopia	300 000
2	Storm (TC[a])	1970	Bangladesh	300 000
3	Drought	1984	Sudan	150 000
4	Storm (TC[b])	1991	Bangladesh	138 866
5	Storm (*Nargis*)	2008	Myanmar	138 366
6	Drought	1975	Ethiopia	100 000
7	Drought	1983	Mozambique	100 000
8	Extreme temperature	2010	Russian Federation	55 736
9	Flood	1999	Venezuela, Bolivarian Republic of	30 000
10	Flood	1974	Bangladesh	28 700

(b)	Disaster type	Year	Country	Economic losses (in US$ billion)
1	Storm (*Katrina*)	2005	United States	146.89
2	Storm (*Sandy*)	2012	United States	50.00
3	Storm (*Andrew*)	1992	United States	43.37
4	Flood	1998	China	42.25
5	Flood	2011	Thailand	40.82
6	Storm (*Ike*)	2008	United States	31.98
7	Flood	1995	Democratic People's Republic of Korea	22.59
8	Extreme temperature	2008	China	22.49
9	Storm (*Ivan*)	2004	United States	21.87
10	Drought	1994	China	21.33

[a] Otherwise known as Bhola; however, the name was given prior to 2004 when a recognized tropical cyclone naming system was introduced in the region.

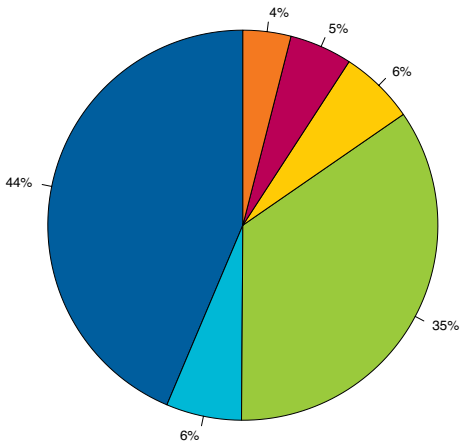
[b] Otherwise known as Gorky; however, the name was given prior to 2004 when a recognized tropical cyclone naming system was introduced in the region.

UNHCR

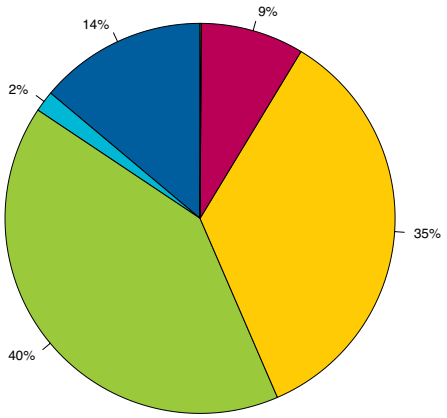
Cyclone Nargis *survivors in the ruins of their destroyed home in Mya Ba Go village, Bogale township, Myanmar*

Distribution of the reported (a) number of disasters, (b) deaths and (c) total economic losses by hazard type, globally (1970–2012)

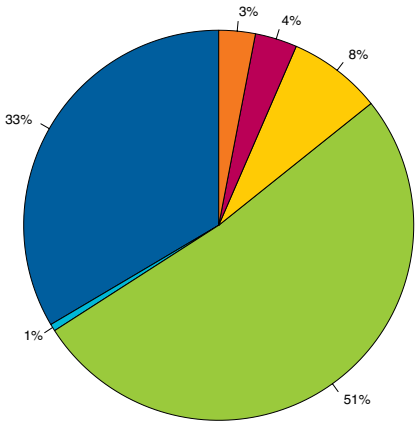
Total = 8 835 disasters (1970–2012)



Total = 1 944 653 deaths (1970–2012)

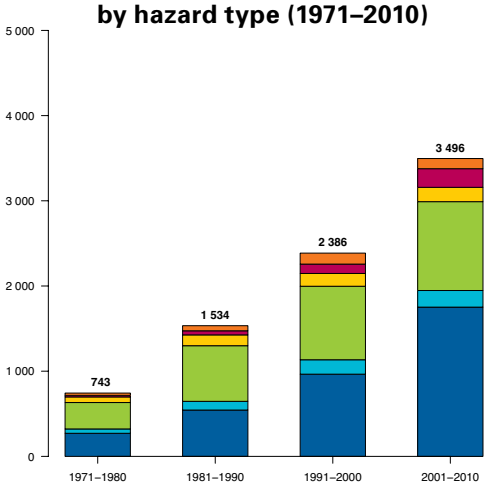


Total = US$ 2 390.7 billion (1970–2012)

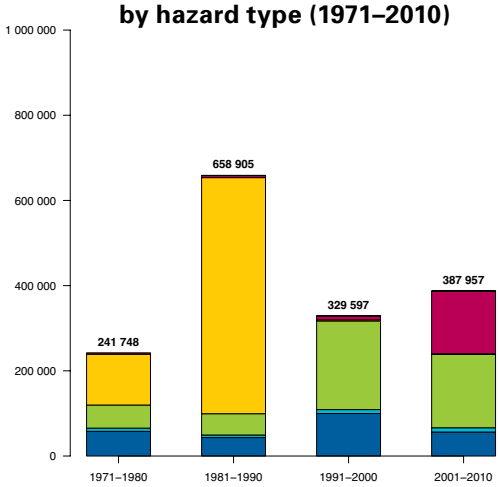


(in US$ billion, adjusted to 2012)

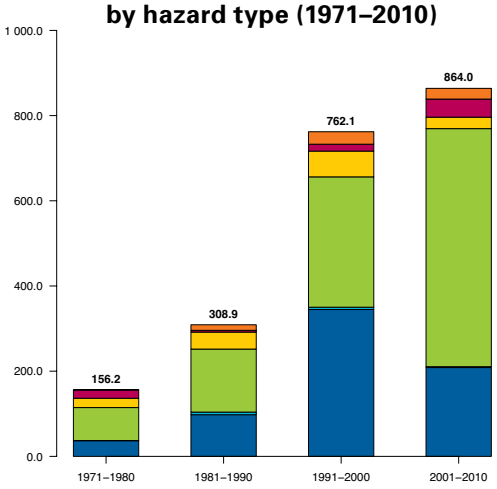
Number of reported disasters by decade by hazard type (1971–2010)



Number of reported deaths by decade by hazard type (1971–2010)



Reported economic losses by decade by hazard type (1971–2010)



(in US$ billion, adjusted to 2012)

Floods | Mass movement wet | Storms | Droughts | Extreme temperature | Wildfires

AFRICA

In Africa, from 1970 to 2012, 1 319 reported disasters caused the loss of 698 380 lives and economic damages of US$ 26.6 billion. Although floods were the most prevalent type of disaster (61 per cent), droughts led to the highest number of deaths, accounting for some 96 per cent of all lives lost to weather-, climate- and water-related disasters in the region. The severe droughts in Ethiopia in 1975 and 1983 and in Mozambique and Sudan in 1983 and 1984 caused the majority of deaths. Storms and floods, however, caused the highest economic losses (78 per cent).

The 10 worst reported disasters in terms of human deaths accounted for 97 per cent (674 362) of the total number of lives lost. The 10 biggest reported events in terms of economic losses accounted for 42 per cent (US$ 11.3 billion) of all losses.

FEISAL OMAR / REUTERS

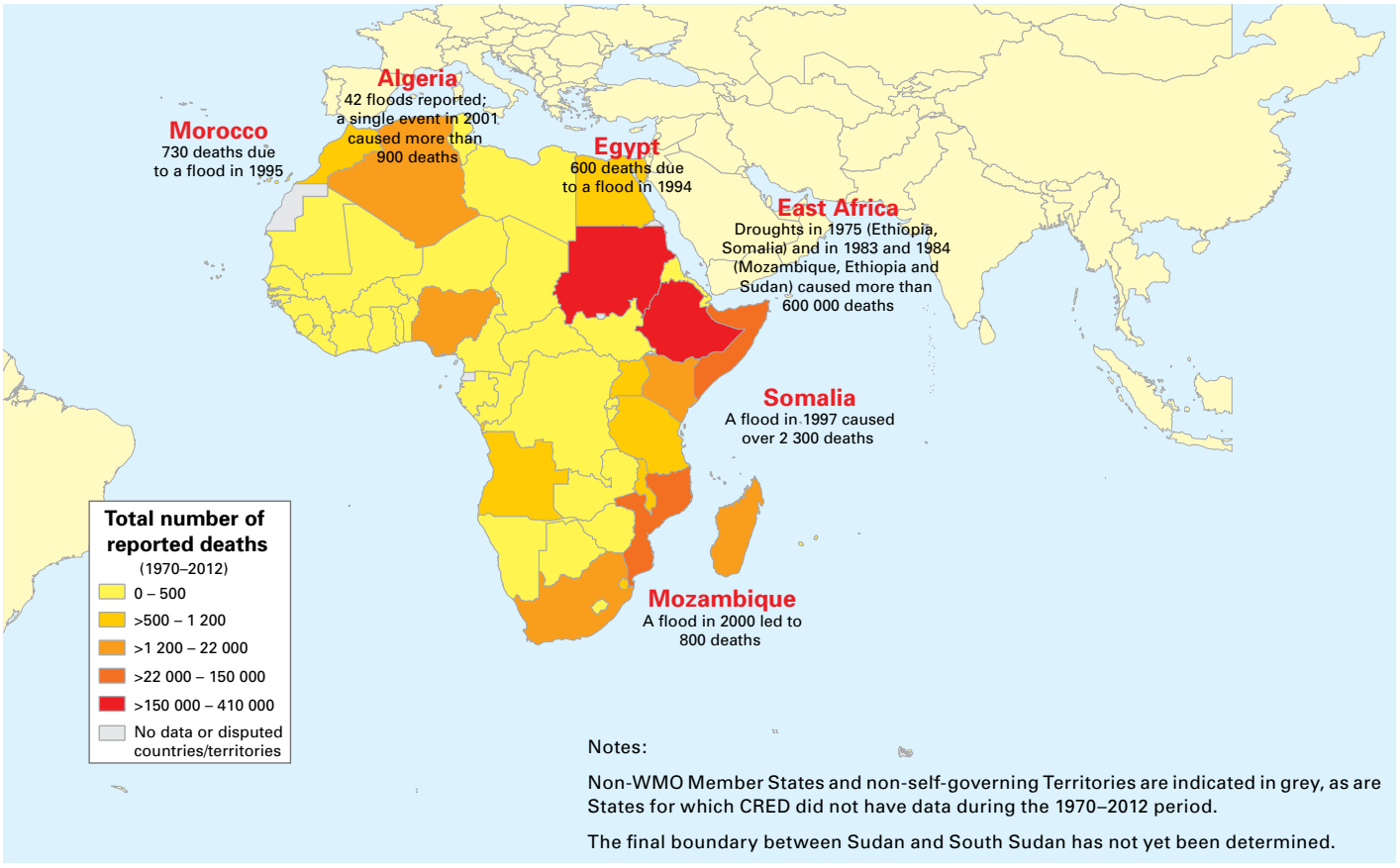
A displaced woman repairs her makeshift shelter after heavy rains flooded the region in Middle Shabelle, Somalia.

Disasters ranked according to reported (a) deaths and (b) economic losses (1970–2012). TC indicates disasters caused by tropical cyclones.

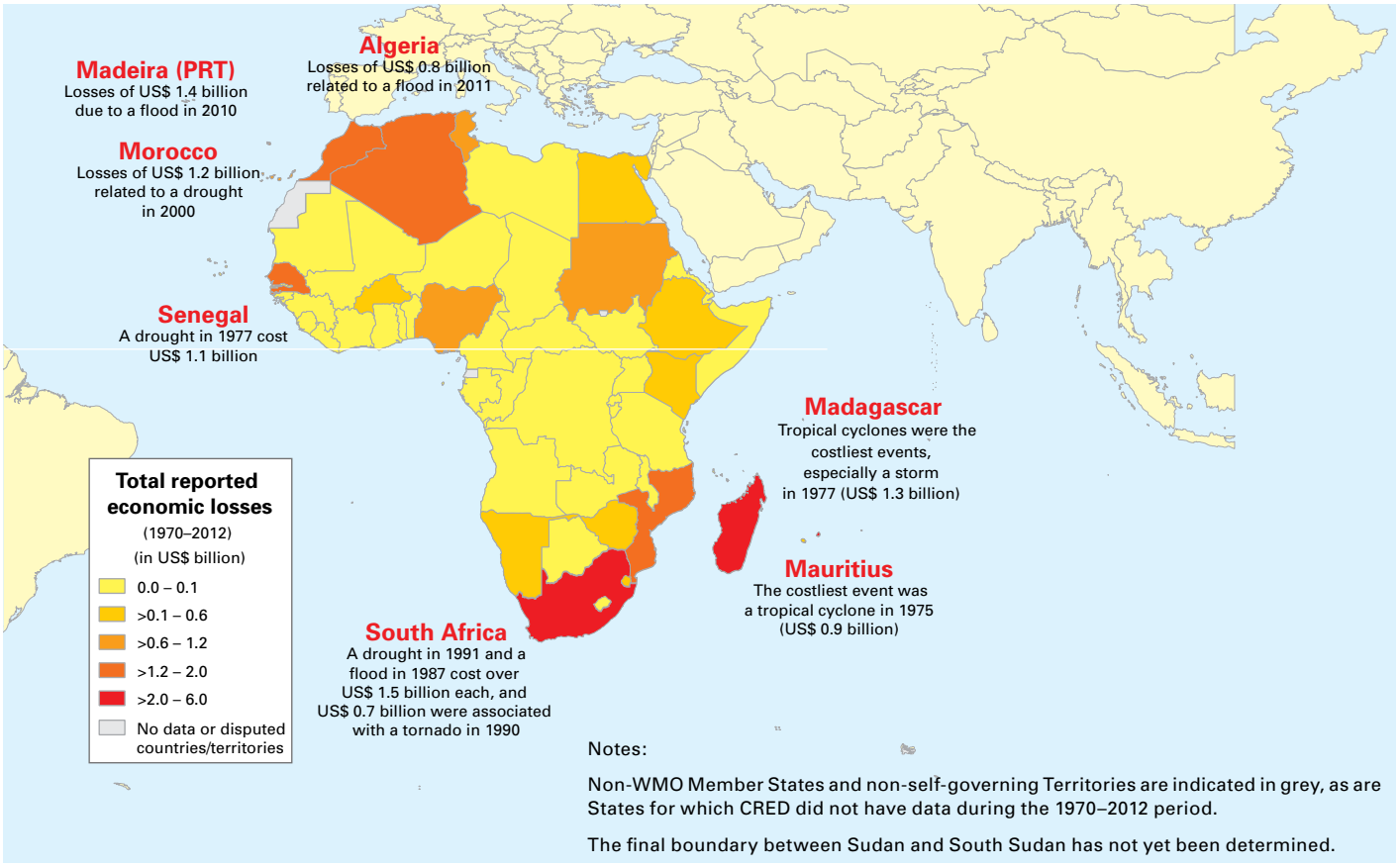
(a)	Disaster type	Year	Country	Number of deaths
1	Drought	1983	Ethiopia	300 000
2	Drought	1984	Sudan	150 000
3	Drought	1975	Ethiopia	100 000
4	Drought	1983	Mozambique	100 000
5	Drought	1975	Somalia	19 000
6	Flood	1997	Somalia	2 311
7	Flood	2001	Algeria	921
8	Flood	2000	Mozambique	800
9	Flood	1995	Morocco	730
10	Flood	1994	Egypt	600

(b)	Disaster type	Year	Country	Economic losses (in US$ billion)
1	Drought	1991	South Africa	1.69
2	Flood	1987	South Africa	1.55
3	Flood	2010	Madeira (PRT)	1.42
4	Storm (*Emilie*)	1977	Madagascar	1.33
5	Drought	2000	Morocco	1.20
6	Drought	1977	Senegal	1.14
7	Storm (*Gervaise*)	1975	Mauritius	0.85
8	Flood	2011	Algeria	0.79
9	Storm	1990	South Africa	0.69
10	Storm (*Benedicte*)	1981	Madagascar	0.63

Map of reported disasters and their related deaths (1970–2012)



Map of reported disasters and their related economic losses (in US$ billion, 1970–2012)



Supporting drought risk management in Africa

For more than 10 years, an innovative forum known as the Regional Climate Outlook Forum (RCOF), initiated by NMHSs and Regional Specialized Meteorological Centres (RSMCs) with the support of the WMO Secretariat, has been providing consensus-based early warning seasonal climate information to help reduce climate-related risks. Recognizing its vulnerability to extreme hydrometeorological events and climatic variability, Africa has been a pioneer in the RCOF process. RCOFs have played a significant role in capacity development for seasonal climate prediction in many parts of the globe[a]. Recent advances in (sub-) seasonal forecasting of droughts, combined with the WMO Integrated Drought Management Programme[b], are critical contributions that are helping Members improve monitoring, warning and mitigation of the impacts of droughts. This is accomplished by sharing information, knowledge and good practices as the basis for providing policy and management advice on the development of short- and long-term drought management plans and actions. Improving drought management is one of the priorities of the GFCS[c].

[a] For more information on RCOFs, see http://www.wmo.int/pages/publications/bulletin_en/archive/57_2_en/ogallo_en.html.

[b] For more information on this Programme, see http://www.wmo.int/pages/prog/wcp/drought/idmp/.

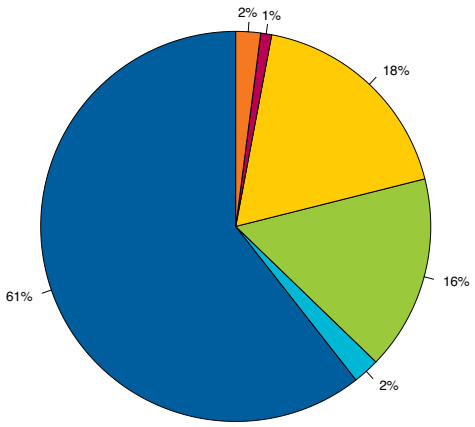
[c] For more information on the GFCS, see http://www.gfcs-climate.org/.

MOHAMED ABD EL GHANY / REUTERS

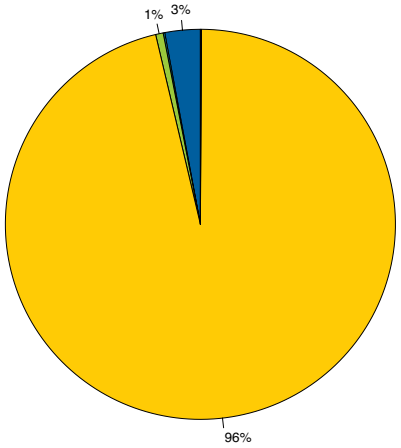
An Egyptian farmer squats down on cracked soil to show the dryness of the land due to drought in a farm formerly irrigated by the river Nile.

Distribution of the reported (a) number of disasters, (b) deaths and (c) total economic losses by hazard type in Africa (1970–2012)

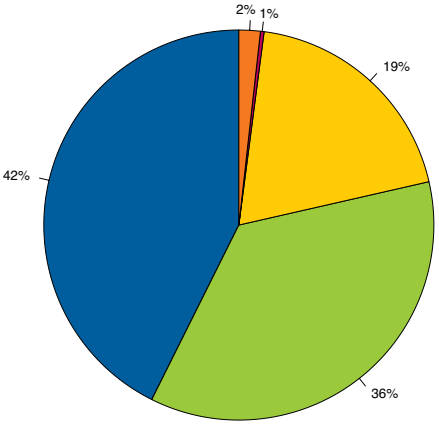
Total = 1 319 disasters (1970–2012)



Total = 698 380 deaths (1970–2012)

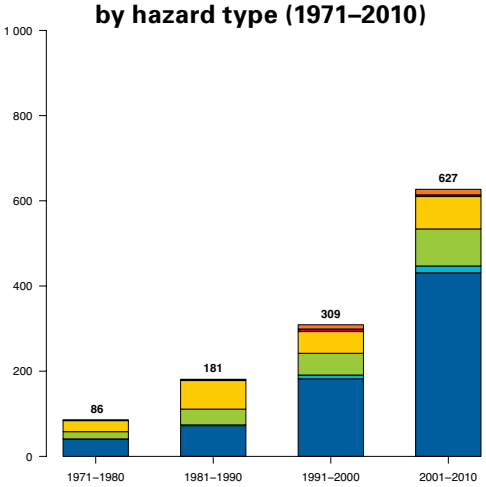


Total = US$ 26.6 billion (1970–2012)

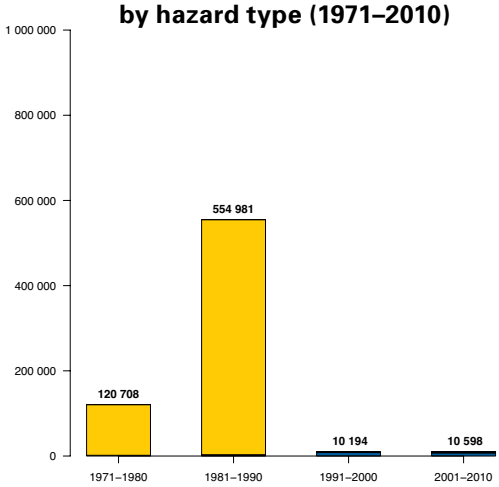


(in US$ billion, adjusted to 2012)

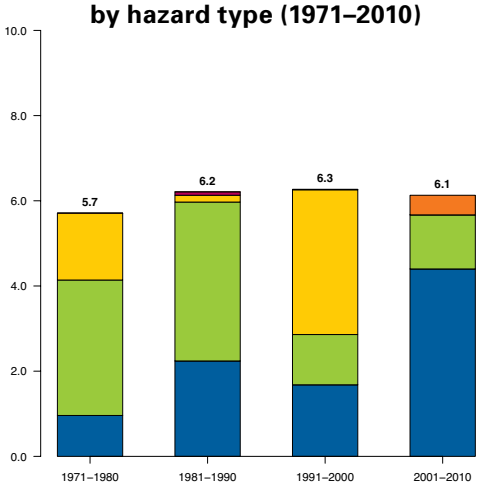
Number of reported disasters by decade by hazard type (1971–2010)



Number of reported deaths by decade by hazard type (1971–2010)



Reported economic losses by decade by hazard type (1971–2010)



(in US$ billion, adjusted to 2012)

Floods | Mass movement wet | Storms | Droughts | Extreme temperature | Wildfires

ASIA

In Asia, 2 681 disasters were reported in the 1970–2012 period, resulting in the loss of 915 389 lives and economic damages of US$ 789.8 billion. Most of these disasters were attributed to floods (45 per cent) and storms (35 per cent). Storms had the highest impact on the number of deaths, causing 76 per cent of the fatalities, while floods caused the greatest economic loss (60 per cent). Three tropical cyclones were the most significant events, striking Bangladesh and Myanmar and leading to over 500 000 deaths. Economic losses were caused primarily by disasters in China, most notably by the 1998 floods.

The 10 worst reported disasters accounted for 73 per cent (665 071) of the total deaths and 29 per cent (US$ 227.5 billion) of economic losses. The increase in mortality during the periods 1991–2000 and 2001–2010 was mainly due to two major tropical cyclones that caused significant loss of life in Bangladesh in 1991 and Myanmar in 2008 (Cyclone *Nargis*).

NASA

Storm Nargis *in 2008*

Disasters ranked according to reported (a) deaths and (b) economic losses (1970–2012). TC indicates disasters caused by tropical cyclones.

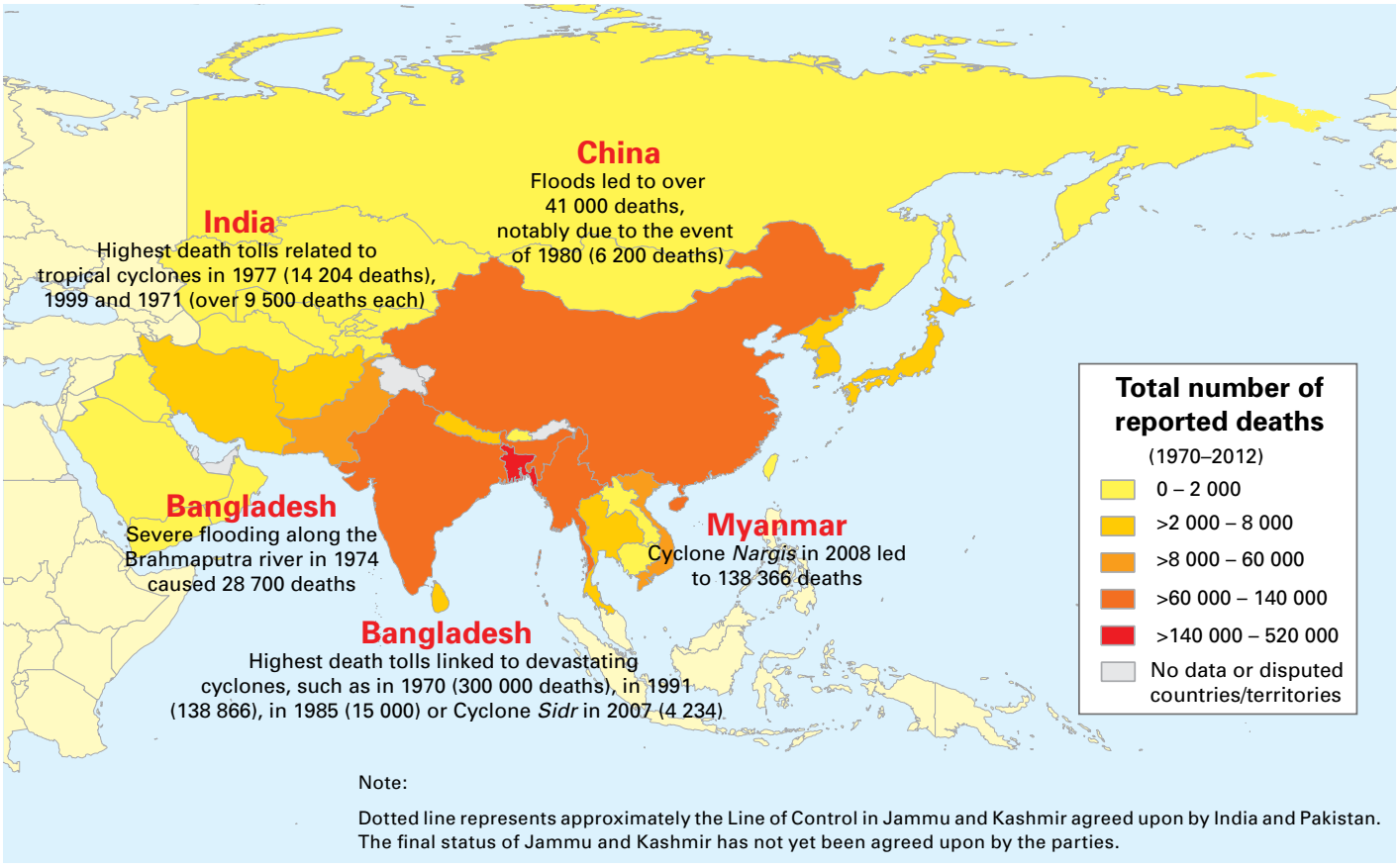
(a)	Disaster type	Year	Country	Number of deaths
1	Storm (TC[a])	1970	Bangladesh	300 000
2	Storm (TC[b])	1991	Bangladesh	138 866
3	Storm (*Nargis*)	2008	Myanmar	138 366
4	Flood	1974	Bangladesh	28 700
5	Storm (TC)	1985	Bangladesh	15 000
6	Storm (TC)	1977	India	14 204
7	Storm (TC)	1999	India	9 843
8	Storm (TC)	1971	India	9 658
9	Flood	1980	China	6 200
10	Storm (*Sidr*)	2007	Bangladesh	4 234

(b)	Disaster type	Year	Country	Economic losses (in US$ billion)
1	Flood	1998	China	42.25
2	Flood	2011	Thailand	40.82
3	Flood	1995	Democratic People's Republic of Korea	22.59
4	Extreme temperature	2008	China	22.49
5	Drought	1994	China	21.33
6	Flood	2010	China	18.95
7	Flood	1996	China	18.45
8	Storm (*Mireille*)	1991	Japan	16.86
9	Flood	1991	China	12.65
10	Flood	1999	China	11.16

[a] Otherwise known as Bhola; however, the name was given prior to 2004 when a recognized tropical cyclone naming system was introduced in the region.

[b] Otherwise known as Gorky; however, the name was given prior to 2004 when a recognized tropical cyclone naming system was introduced in the region.

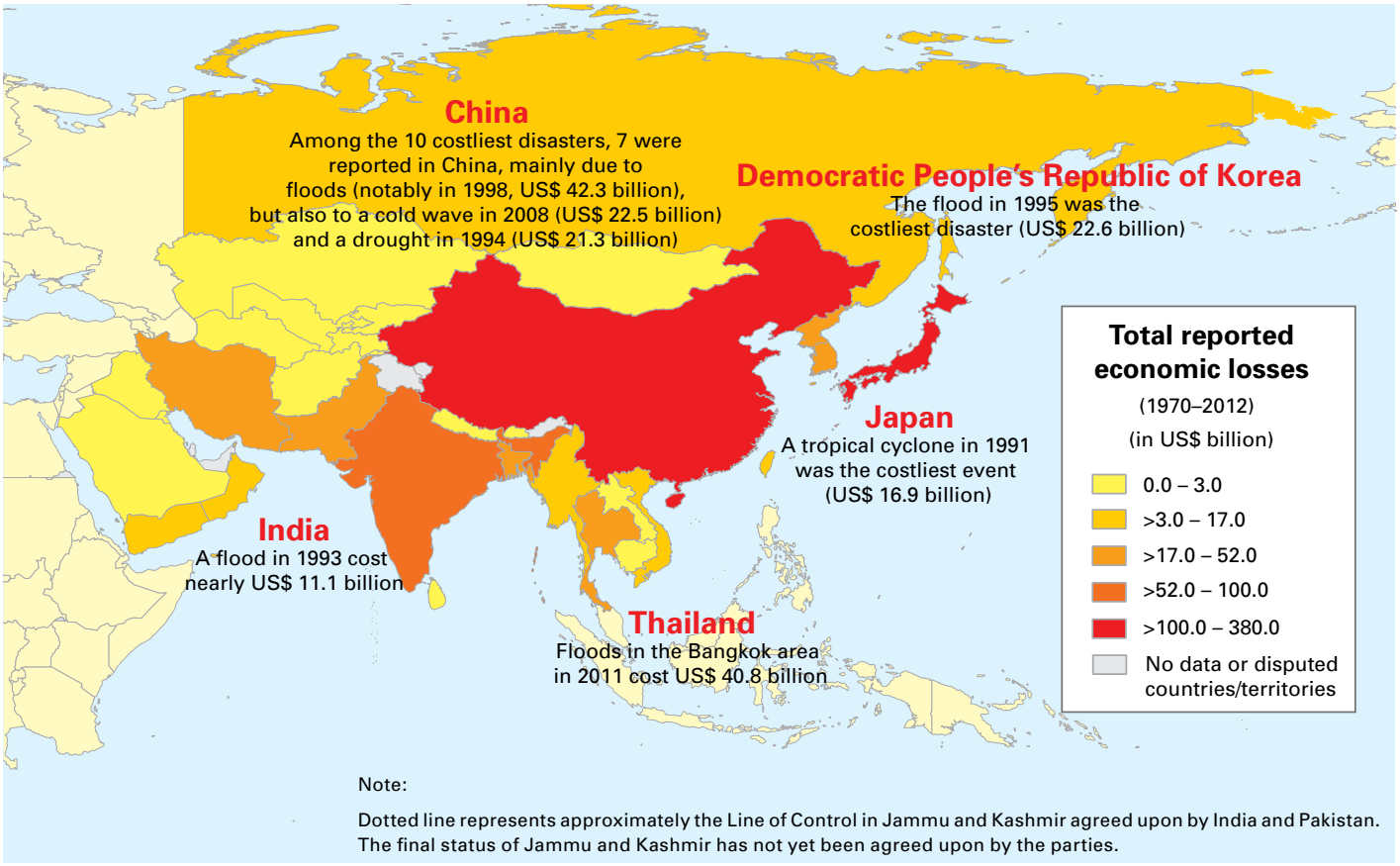
Map of reported disasters and their related deaths (1970–2012)



Note:

Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Map of reported disasters and their related economic losses (in US$ billion, 1970–2012)



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Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

The Bangladesh Cyclone Preparedness Programme: saving lives through an early warning system for tropical cyclones

In Bangladesh, following the tropical cyclones and storm surges in 1970 and 1991 that led to nearly 300 000 and 140 000 casualties, respectively, the Government worked together with the Bangladesh Red Crescent Society to implement the Cyclone Preparedness Programme. The programme's effectiveness was well demonstrated by the much-reduced death toll – less than 3 500 lives lost – during the similar November 2007 Super Cyclone *Sidr*. The Cyclone Preparedness Programme uses a network of over 42 000 volunteers, along with a transceiver telecommunications system, to ensure rapid and timely delivery of tropical cyclone warnings produced by the Bangladesh Meteorological Department to the authorities and the public at risk in coastal regions. Over the last 30 years, WMO has been working with its Members, through its Tropical Cyclone Programme, to establish RSMCs with expertise in tropical cyclone analysis and forecasting to support NMHSs. The RSMC New Delhi works closely with countries at risk from tropical cyclones in South Asia to provide bulletins and forecasts to help NMHSs develop their respective warnings.

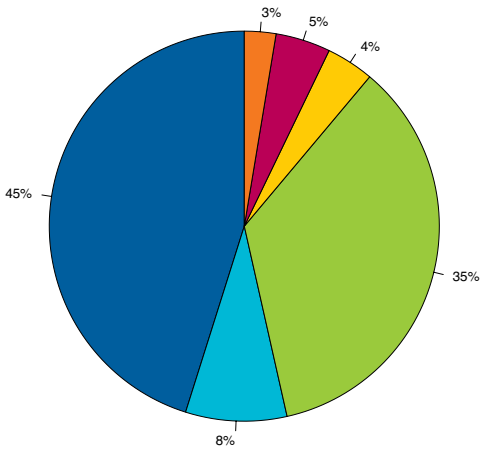
Source: Arjumand, H., M. Shahidullah and A. Dilder, 2012: The Bangladesh Cyclone Preparedness Programme. A Vital Component of the Nation's Multi-Hazard Early Warning System. In: *Institutional Partnerships in Multi-Hazard Early Warning Systems* (M. Golnaraghi, ed.), doi 10.1007/978-3-64225373-7, Berlin, Heidelberg, Springer-Verlag.

U.S. AIR FORCE

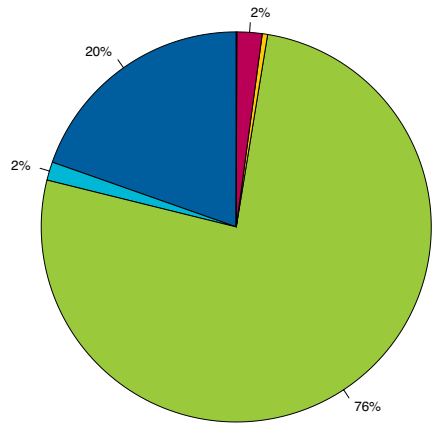
Flooded village in Bangladesh after the 1991 storm

Distribution of the reported (a) number of disasters, (b) deaths and (c) total economic losses by hazard type in Asia (1970–2012)

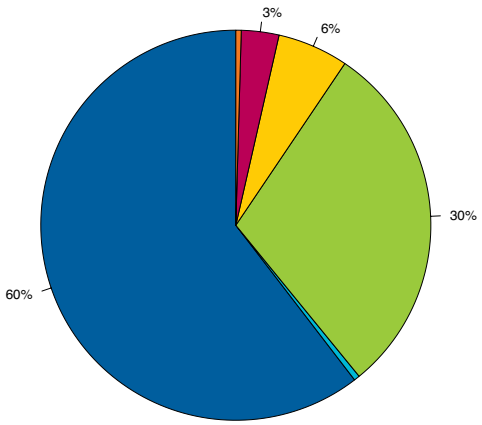
Total = 2 681 disasters (1970–2012)



Total = 915 389 deaths (1970–2012)

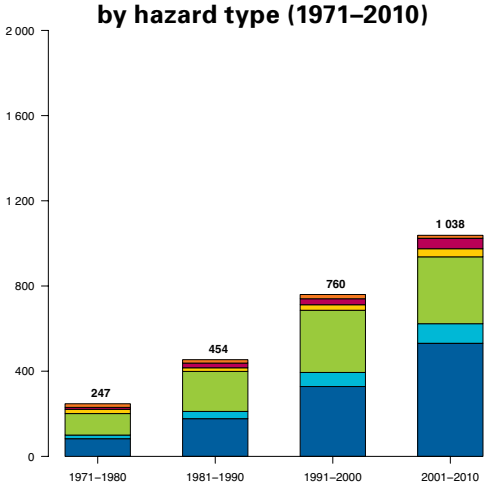


Total = US$ 789.8 billion (1970–2012)

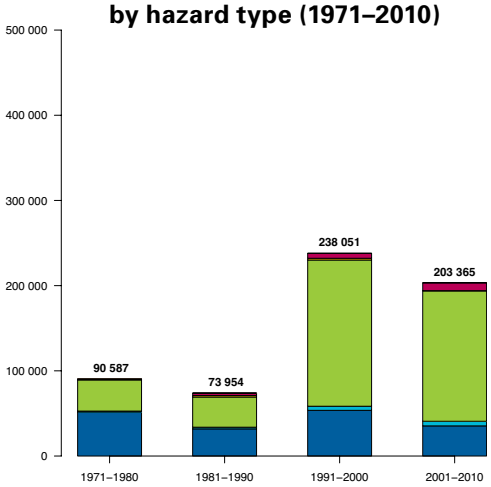


(in US$ billion, adjusted to 2012)

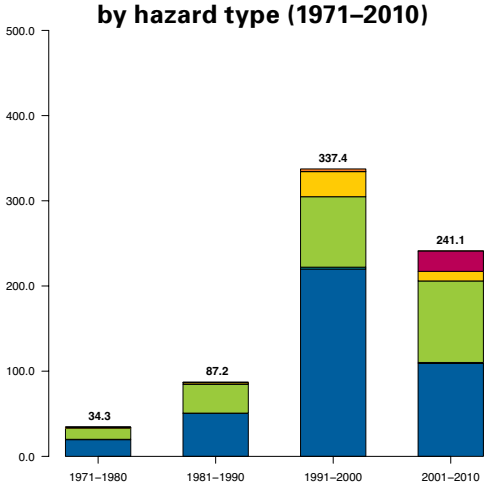
Number of reported disasters by decade by hazard type (1971–2010)



Number of reported deaths by decade by hazard type (1971–2010)



Reported economic losses by decade by hazard type (1971–2010)



(in US$ billion, adjusted to 2012)

Floods **Mass movement wet** **Storms** **Droughts** **Extreme temperature** **Wildfires**

SOUTH AMERICA

During the 43-year period of 1970–2012, South America experienced 696 reported disasters that resulted in 54 995 lives lost and US$ 71.8 billion in economic damages.

Most of the reported disasters related to weather, climate and water extremes involved floods (57 per cent) and mass movement wet (16 per cent). With regard to impacts, floods caused the greatest number of casualties (80 per cent) and the most economic loss (63 per cent). The most significant event during the period was a flood and wet mass movement that occurred in the Bolivarian Republic of Venezuela in late 1999 and caused 30 000 deaths. This single event skews the loss of life statistics significantly for the entire region.

The 10 worst reported disasters accounted for 63 per cent (34 688) of total deaths and 43 per cent (US$ 30.7 billion) of economic losses.

CARLOS GARCIA RAWLINS / REUTERS

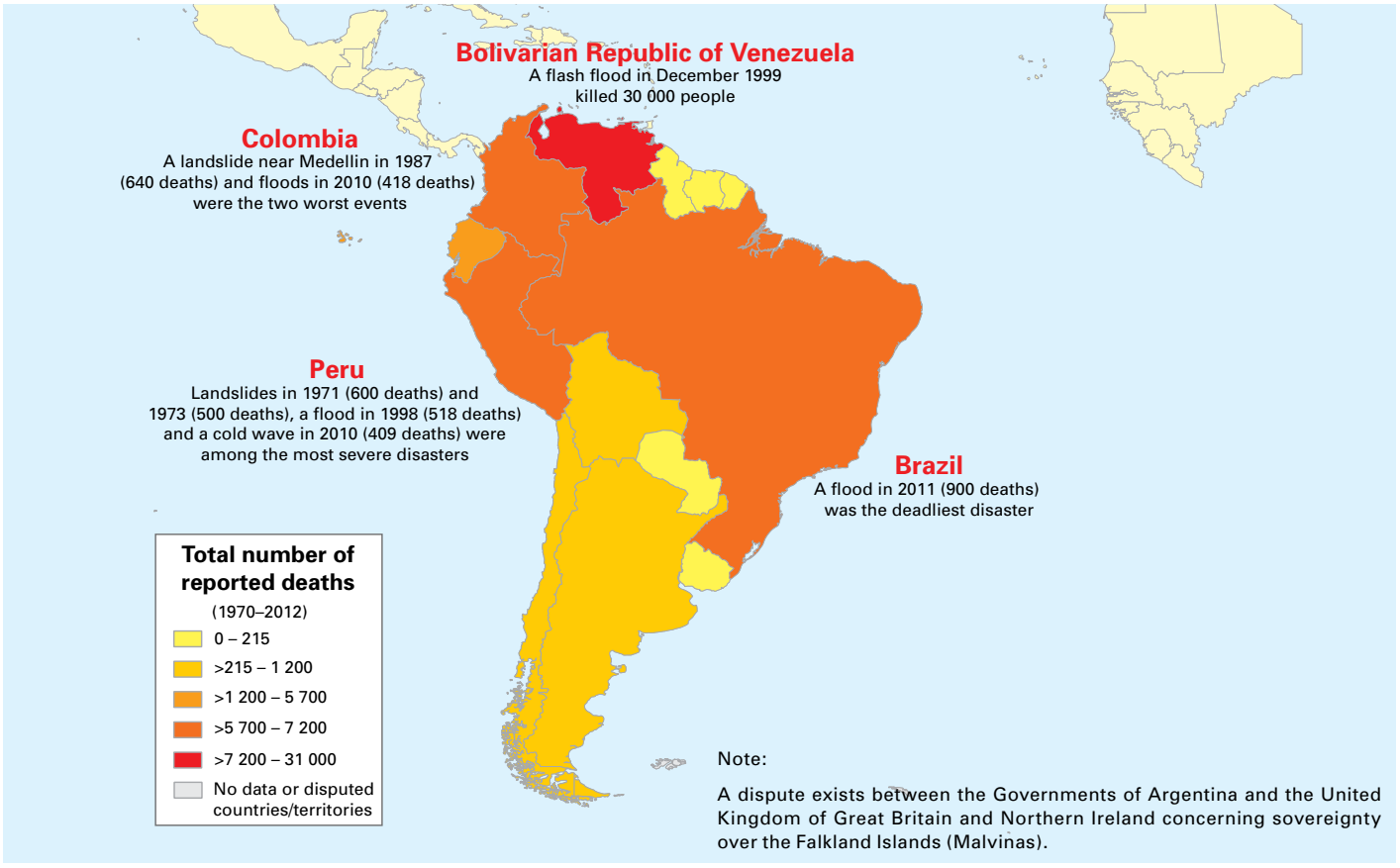
A woman reacts after her home was damaged in a flood in the neighbourhood of Antimano, Caracas.

Disasters ranked according to reported (a) deaths and (b) economic losses (1970–2012)

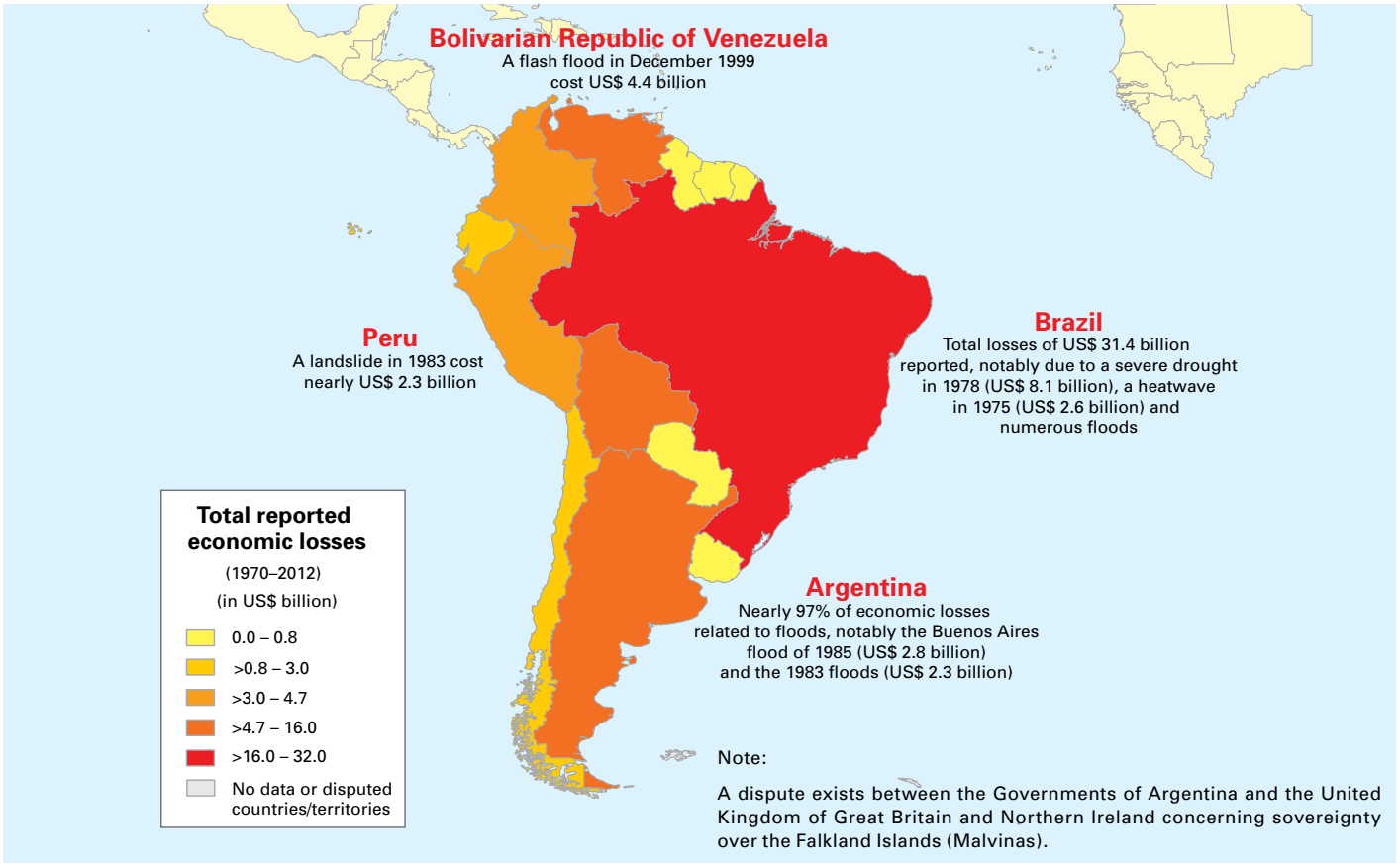
(a)	Disaster type	Year	Country	Number of deaths
1	Flood	1999	Venezuela, Bolivarian Republic of	30 000
2	Flood	2011	Brazil	900
3	Mass movement wet	1987	Colombia	640
4	Mass movement wet	1971	Peru	600
5	Flood	1998	Peru	518
6	Mass movement wet	1973	Peru	500
7	Flood	2010	Colombia	418
8	Extreme temperature	2010	Peru	409
9	Mass movement wet	1983	Peru	364
10	Extreme temperature	2003	Peru	339

(b)	Disaster type	Year	Country	Economic losses (in US$ billion)
1	Drought	1978	Brazil	8.10
2	Flood	1999	Venezuela, Bolivarian Republic of	4.35
3	Flood	1985	Argentina	2.77
4	Extreme temperature	1975	Brazil	2.56
5	Flood	1983	Argentina	2.30
6	Mass movement wet	1983	Peru	2.28
7	Flood	1984	Brazil	2.21
8	Flood	1984	Brazil	2.21
9	Flood	1988	Brazil	1.94
10	Drought	2005	Brazil	1.94

Map of reported disasters and their related deaths (1970–2012)



Map of reported disasters and their related economic losses (in US$ billion, 1970–2012)



Impacts of the El Niño-Southern Oscillation in South America

Research conducted over recent decades has shed light on the role played by interactions between the atmosphere and the ocean in the tropical belt of the Pacific Ocean. This interaction involves changes in the sea-surface temperature and atmospheric pressure (referred to as the El Niño-Southern Oscillation) resulting in alterations in global weather and climate patterns, and particularly in the patterns of weather-, climate- and water-related hazards. El Niño (when sea-surface temperatures in the central and eastern tropical Pacific Ocean are substantially higher than normal) and La Niña (when sea-surface temperatures in these regions are lower than normal) are strongly linked to major climate fluctuations around the globe and, once initiated, can last for 12 months or more, leading to changes in weather patterns. For example, El Niño results in rainfall increases on the coasts of South American countries (Ecuador, Peru and Chile), while droughts are reported in the mountainous and Andean zones, engendering glacier retreat and water availability issues. Precipitation patterns tend to be reduced in northern countries along the Atlantic coast (Colombia, Bolivarian Republic of Venezuela and Guyana), often leading to droughts in the Brazilian north-east. In Argentina, Paraguay and Uruguay, rainfall usually increases. The economic impacts of El Niño can be considerable for fishing. The 1997–1998 event, for instance, caused losses of up to US$ 4.5 billion in Peru[a]. The cessation of upwelling cold water cuts off the supply of nutrients, thus altering the marine environment. This affects the capacity of ecosystems to maintain the marine food chain and fish populations along the western coastline of South America[b]. Since 2003, WMO has facilitated a process to provide El Niño/La Niña consensus-based updates, which are prepared on a quasi-regular basis (approximately once every three months) and are based on contributions from leading centres around the world forecasting this phenomenon[c].

[a] For more information, see http://www.grida.no/publications/vg/lac/page/2753.aspx.

[b] World Meteorological Organization, 1999: *The 1997–1998 El Niño Event: A Scientific and Technical Retrospective* (WMO-No. 905). Geneva. http://library.wmo.int/pmb_ged/wmo_905_en.pdf.

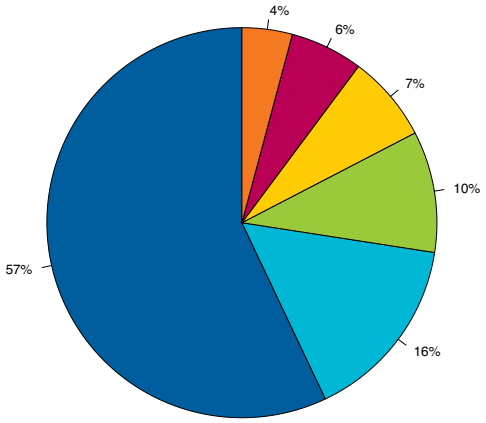
[c] For more information on these updates, see http://www.wmo.int/pages/prog/wcp/wcasp/enso_background.html.

REUTERS

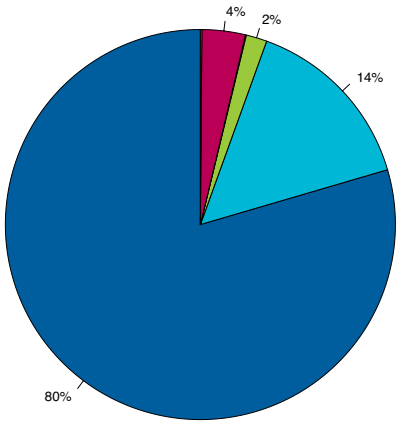
Two trucks are overturned and others are stranded on a road after a mudslide caused by heavy El Niño rains near Lima.

Distribution of the reported (a) number of disasters, (b) deaths and (c) total economic losses by hazard type in South America (1970–2012)

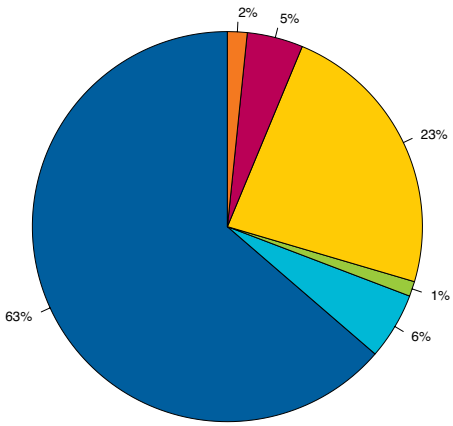
Total = 696 disasters (1970–2012)



Total = 54 995 deaths (1970–2012)

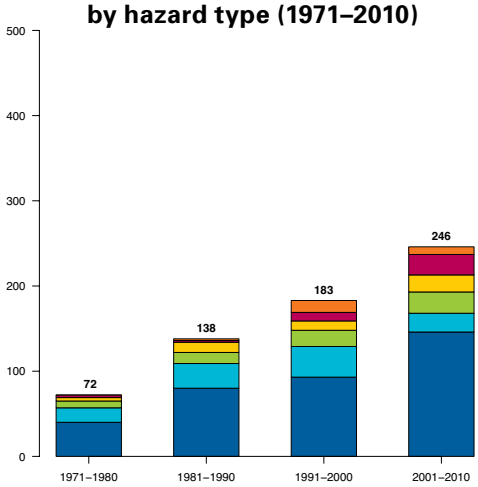


Total = US$ 71.8 billion (1970–2012)

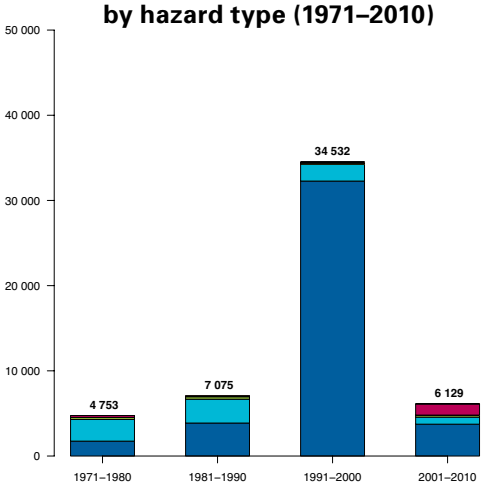


(in US$ billion, adjusted to 2012)

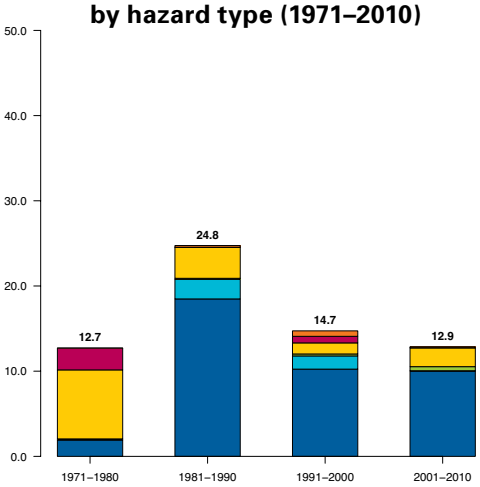
Number of reported disasters by decade by hazard type (1971–2010)



Number of reported deaths by decade by hazard type (1971–2010)



Reported economic losses by decade by hazard type (1971–2010)



(in US$ billion, adjusted to 2012)

Floods **Mass movement wet** **Storms** **Droughts** **Extreme temperature** **Wildfires**

NORTH AMERICA, CENTRAL AMERICA AND THE CARIBBEAN

In North America, Central America and the Caribbean, the period from 1970 to 2012 saw 1 631 reported disasters that caused the loss of 71 246 lives and economic damages of US$ 1 008.5 billion. The majority of the reported hydrometeorological and climate-related disasters in this region were attributed to storms (55 per cent) and floods (30 per cent). Storms were reported to be the greatest cause of casualties (72 per cent) and economic loss (79 per cent). The most significant events in terms of lives lost were Hurricane *Mitch* in 1998 (17 932 deaths), which affected Honduras and Nicaragua, and Hurricane *Fifi* in 1974 (8 000 deaths), which affected Honduras. However, in terms of economic damage, Hurricane *Katrina* in 2005 was the most costly disaster on record, resulting in US$ 146.9 billion in losses.

The 10 worst reported disasters in terms of human deaths accounted for 56 per cent (39 879) of the total reported lives lost, and in terms of economic damages, they accounted for 38 per cent (US$ 388.2 billion) of all losses.

NOAA

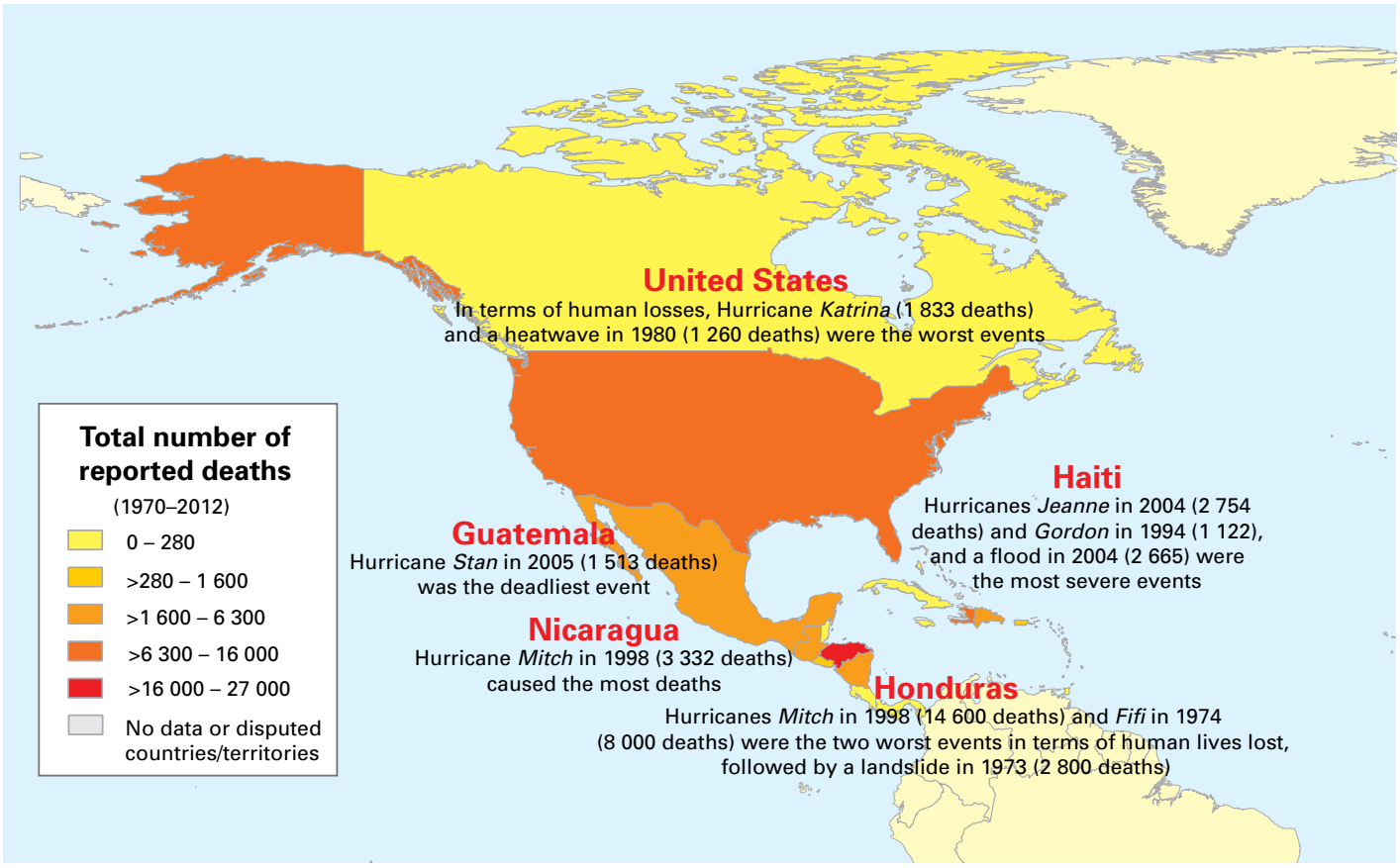
Crew boat upside down after Hurricane Katrina*, Louisiana, United States*

Disasters ranked according to reported (a) deaths and (b) economic losses (1970–2012)

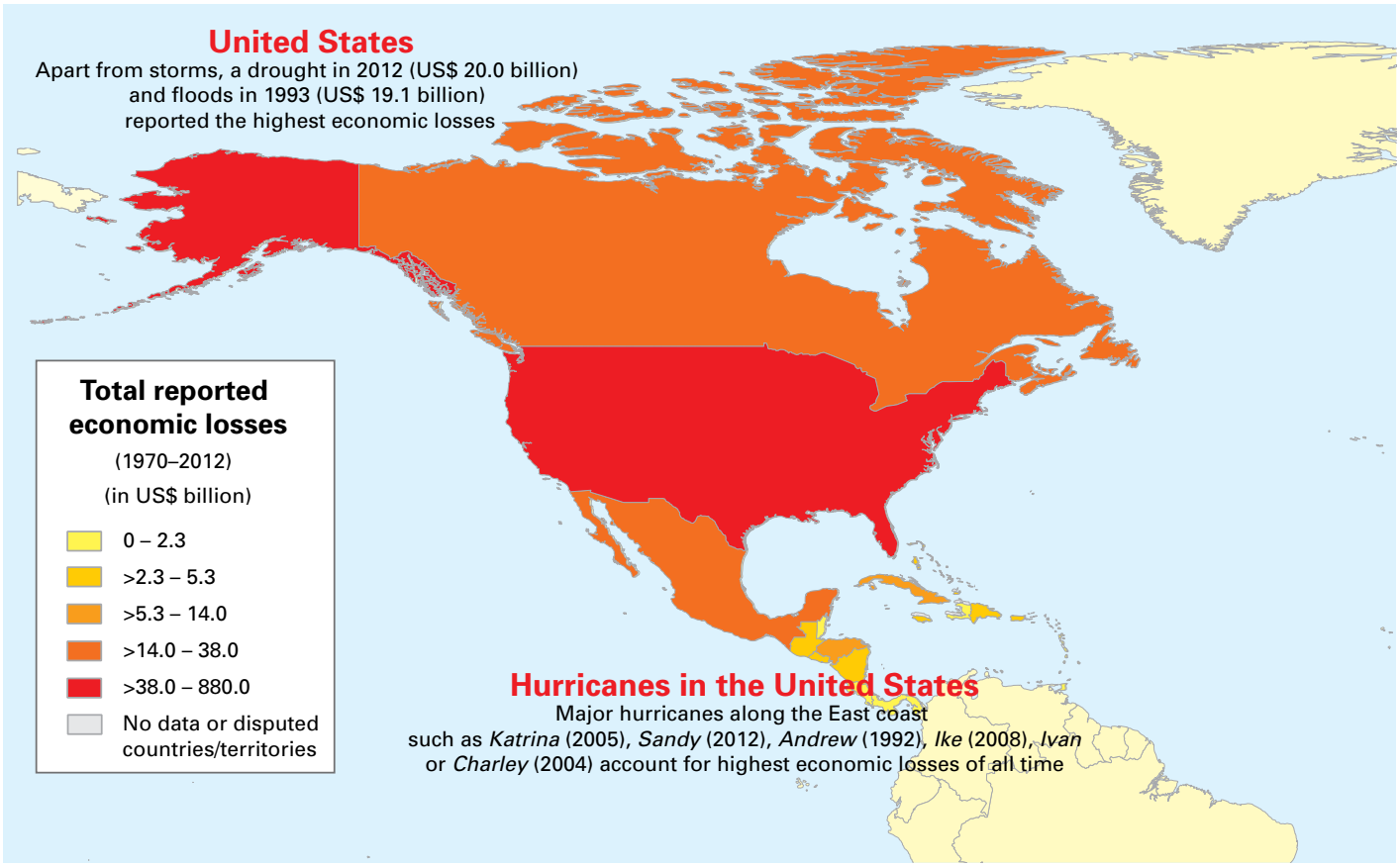
(a)	Disaster type	Year	Country	Number of deaths
1	Storm (*Mitch*)	1998	Honduras	14 600
2	Storm (*Fifi*)	1974	Honduras	8 000
3	Storm (*Mitch*)	1998	Nicaragua	3 332
4	Mass movement wet	1973	Honduras	2 800
5	Storm (*Jeanne*)	2004	Haiti	2 754
6	Flood	2004	Haiti	2 665
7	Storm (*Katrina*)	2005	United States	1 833
8	Storm (*Stan*)	2005	Guatemala	1 513
9	Extreme temperature	1980	United States	1 260
10	Storm (*Gordon*)	1994	Haiti	1 122

(b)	Disaster type	Year	Country	Economic losses (in US$ billion)
1	Storm (*Katrina*)	2005	United States	146.89
2	Storm (*Sandy*)	2012	United States	50.00
3	Storm (*Andrew*)	1992	United States	43.37
4	Storm (*Ike*)	2008	United States	31.98
5	Storm (*Ivan*)	2004	United States	21.87
6	Drought	2012	United States	20.00
7	Storm (*Charley*)	2004	United States	19.44
8	Flood	1993	United States	19.08
9	Storm (*Rita*)	2005	United States	18.80
10	Storm (*Wilma*)	2005	United States	16.80

Map of reported disasters and their related deaths (1970–2012)



Map of reported disasters and their related economic losses (in US$ billion, 1970–2012)



Building on 30 years of regional cooperation in hurricane forecasting to strengthen support for disaster risk management in the Caribbean and Central America[a]

With over 30 years of regional cooperation in tropical cyclone forecasting and warnings, facilitated by WMO, the Central American and Caribbean regions have demonstrated the benefits of regional cooperation to reduce the impacts of tropical cyclones and other related hazards. For example, in the Caribbean region, extensive cooperation in disaster risk management has been developed under the Comprehensive Disaster Management project of the Caribbean Disaster and Emergency Management Agency, underpinned by the Hyogo Framework for Action 2005–2015[b]. Building on this, WMO is collaborating with the Caribbean Disaster and Emergency Management Agency and a number of international and regional partners to:

- Strengthen national and regional institutional capacities and cooperation among NMHSs, disaster risk management agencies and other stakeholders.
- Improve coordination among hydrometeorological systems (for example, by building on the existing regional coordination for tropical cyclones watch and warnings in the Caribbean), and among responsible agencies and early warning networks concerned with other hazards (such as tsunamis and the Caribbean Tsunami Warning Centre, under development by the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions).

[a] For more information, see http://www.wmo.int/disasters/.

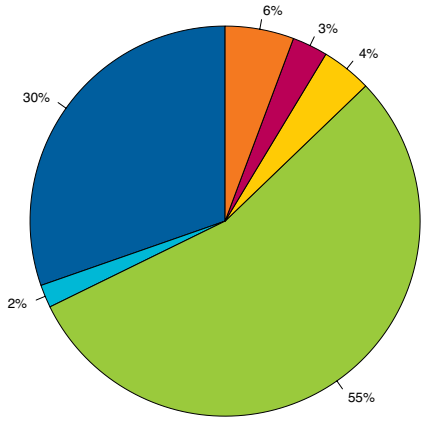
[b] For more information, see http://www.unisdr.org/we/coordinate/hfa.

REUTERS

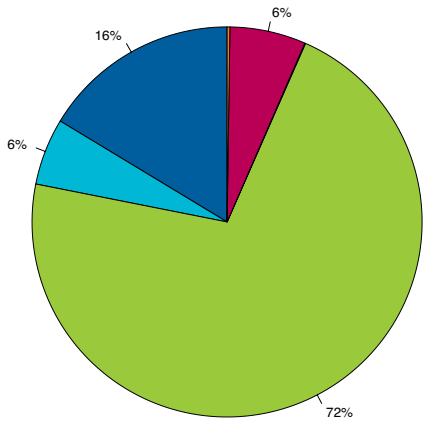
Women walk along a flooded street in Gonaives, Haiti.

Distribution of the reported (a) number of disasters, (b) deaths and (c) total economic losses by hazard type in North America, Central America and the Caribbean (1970–2012)

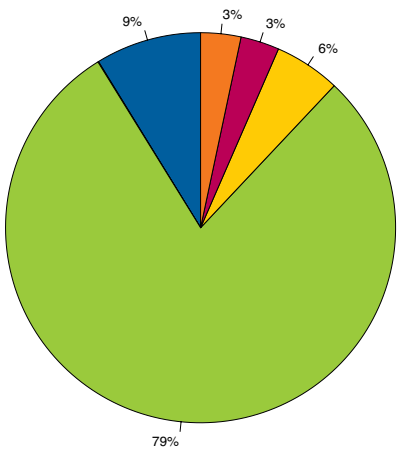
Total = 1 631 disasters (1970–2012)



Total = 71 246 deaths (1970–2012)

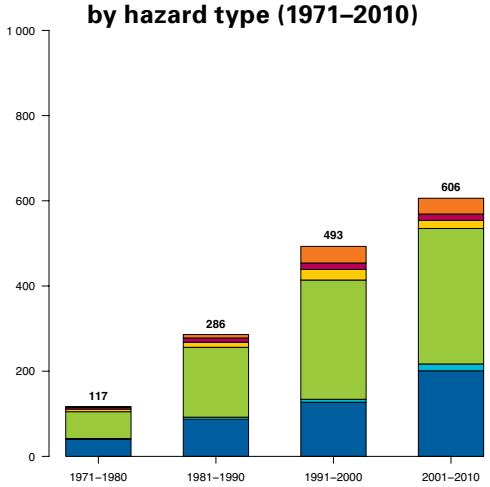


Total = US$ 1 008.5 billion (1970–2012)

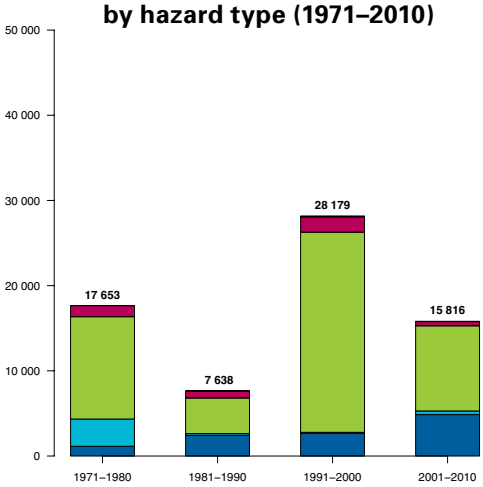


(in US$ billion, adjusted to 2012)

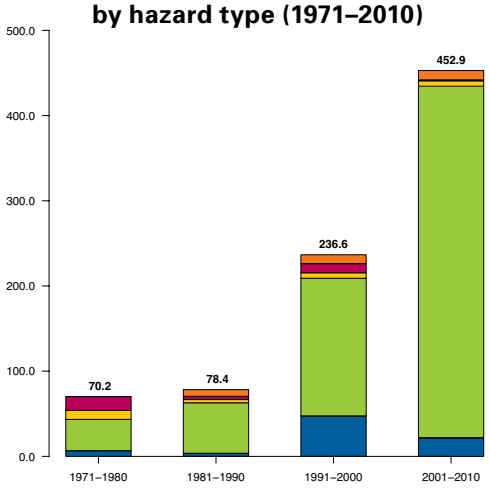
Number of reported disasters by decade by hazard type (1971–2010)



Number of reported deaths by decade by hazard type (1971–2010)



Reported economic losses by decade by hazard type (1971–2010)



(in US$ billion, adjusted to 2012)

Floods **Mass movement wet** **Storms** **Droughts** **Extreme temperature** **Wildfires**

SOUTH-WEST PACIFIC

The South-West Pacific experienced 1 156 reported disasters in 1970–2012 that resulted in 54 684 lives lost and US$ 118.4 billion in economic losses. The majority of these disasters were caused by storms (46 per cent) and floods (38 per cent).

Storms were reported to be the greatest cause of deaths (68 per cent). Economic losses were more evenly distributed amongst the four hazard types: storms (46 per cent), drought (18 per cent), wildfire (14 per cent) and floods (21 per cent). The most significant reported disasters with regard to lives lost were tropical cyclones, mainly in the Philippines, including the event of 1991, which took 5 956 lives. As for economic damages, the 1981 drought in Australia caused US$ 15.2 billion in economic losses and the 1997 wildfires in Indonesia caused US$ 11.4 billion in losses.

The 10 worst reported disasters accounted for 33 per cent (17 933) of the total deaths and 50 per cent (US$ 59.0 billion) of the economic losses.

ERIK DE CASTRO / REUTERS

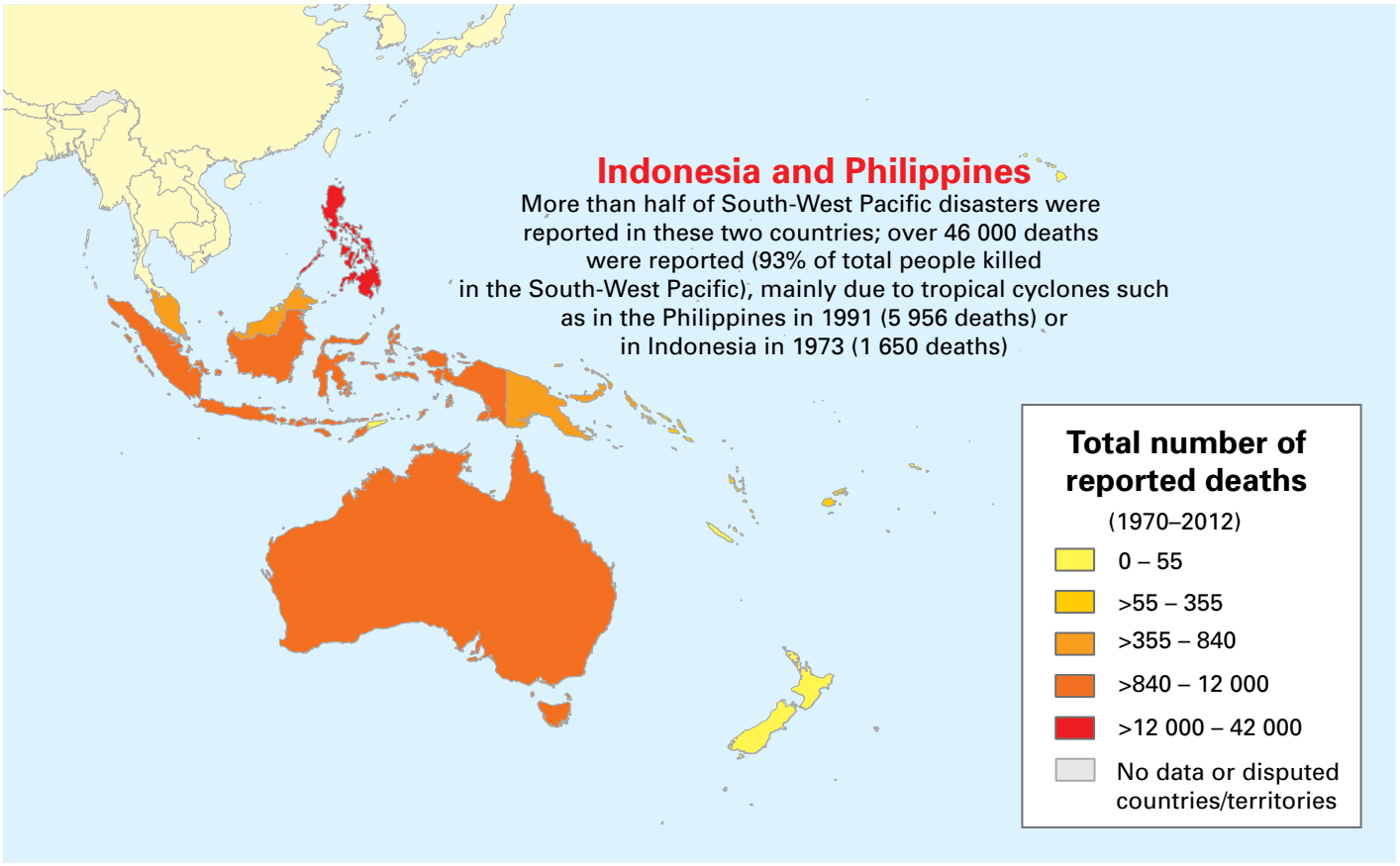
Children look out from a window of a roofless house destroyed at the height of Typhoon Bopha *in the Philippines.*

Disasters ranked according to reported (a) deaths and (b) economic losses (1970–2012). TC indicates disasters caused by tropical cyclones.

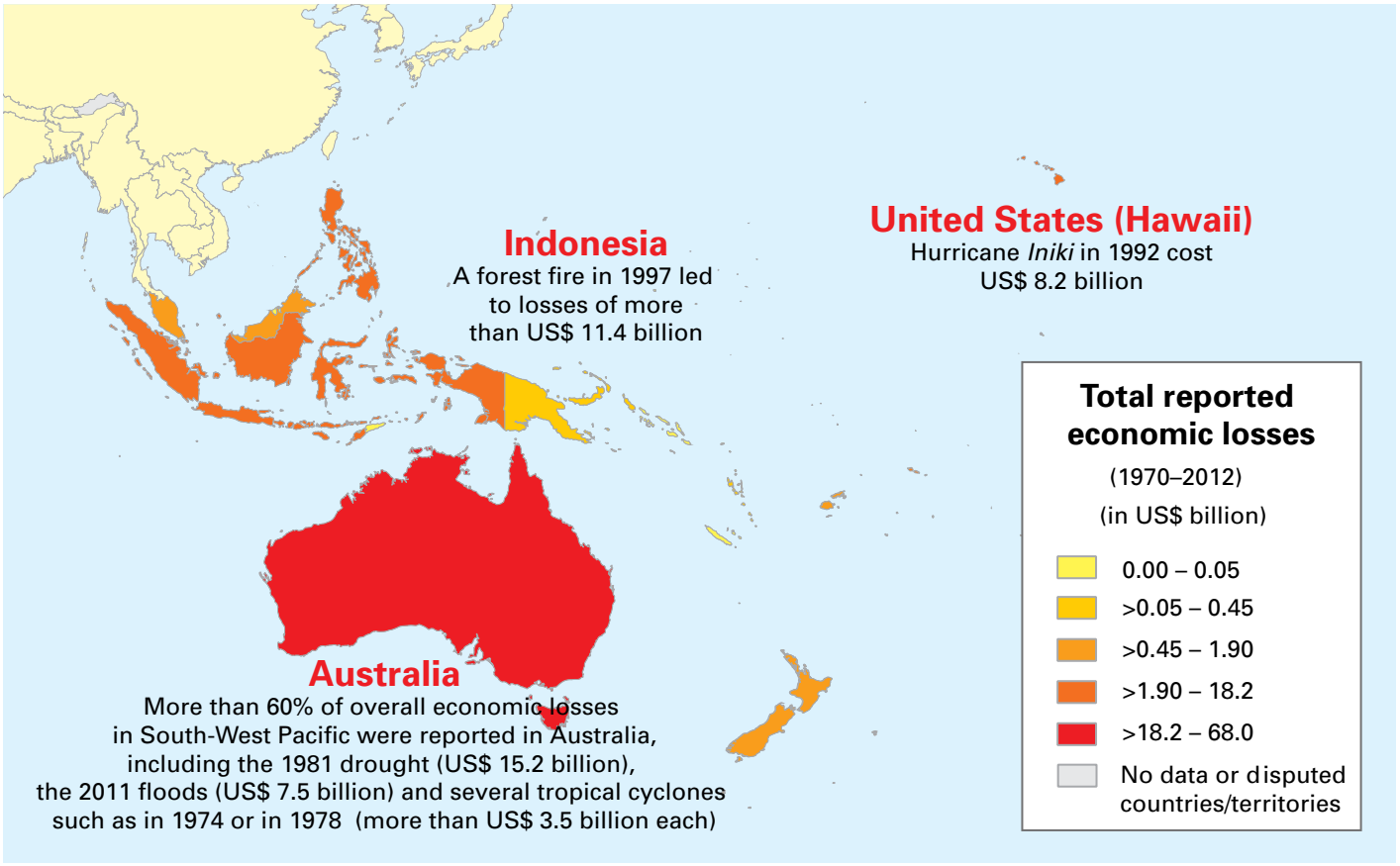
(a)	Disaster type	Year	Country	Number of deaths
1	Storm (*Thelma*)	1991	Philippines	5 956
2	Storm (*Bopha*)	2012	Philippines	1 901
3	Storm (TC)	1973	Indonesia	1 650
4	Storm (*Winnie*)	2004	Philippines	1 619
5	Storm (*Washi*)	2011	Philippines	1 439
6	Storm (*Durian*)	2006	Philippines	1 399
7	Mass movement wet	2006	Philippines	1 126
8	Storm (*Agnes*)	1984	Philippines	1 079
9	Storm (*Angela*)	1995	Philippines	882
10	Storm (*Nina*)	1987	Philippines	882

(b)	Disaster type	Year	Country	Economic losses (in US$ billion)
1	Drought	1981	Australia	15.15
2	Wildfire	1997	Indonesia	11.44
3	Storm (*Iniki*)	1992	United States (Hawaii)	8.18
4	Flood	2011	Australia	7.45
5	Storm (*Tracy*)	1974	Australia	3.72
6	Storm (*Alby*)	1978	Australia	3.52
7	Storm (*Yasi*)	2011	Australia	2.55
8	Drought	2002	Australia	2.55
9	Drought	1994	Australia	2.33
10	Storm	1999	Australia	2.07

Map of reported disasters and their related deaths (1970–2012)



Map of reported disasters and their related economic losses (in US$ billion, 1970–2012)



Managing weather-, climate- and water-related disasters in the South-West Pacific

Building on the Integrated Regional Strategy for Disaster Risk Management and Climate Change in the Pacific[a], WMO is working with a number of international and regional partners to strengthen technical and operational capacities for early warnings of severe weather and other water- and climate-related hazards in the region. The aim is to assist NMHSs in providing effective warnings to disaster risk management authorities.

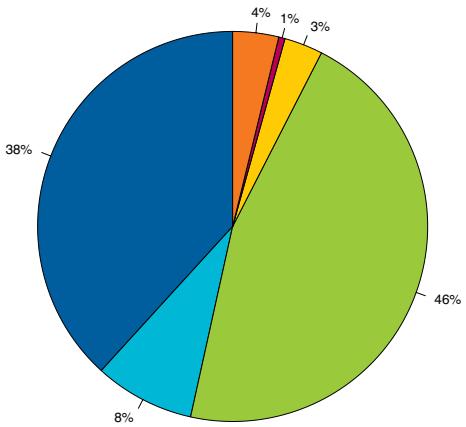
[a] http://reliefweb.int/report/world/roadmap-towards-integrated-regional-strategy-disaster-risk-management-and-climate

NASA

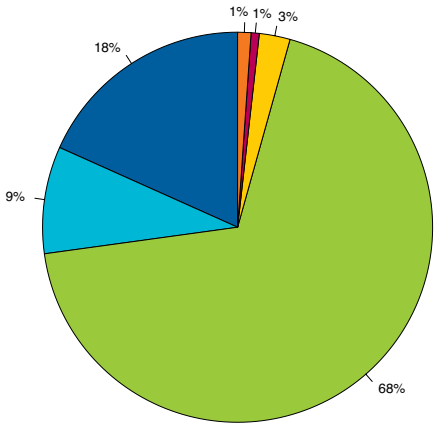
Tropical Cyclone Yasi *in 2011, over the Coral Sea*

Distribution of the reported (a) number of disasters, (b) deaths and (c) total economic losses by hazard type in the South-West Pacific (1970–2012)

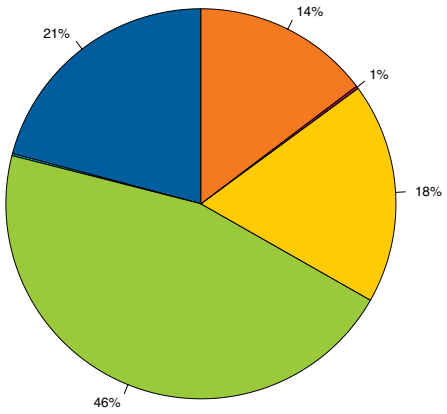
Total = 1 156 disasters (1970–2012)



Total = 54 684 deaths (1970–2012)

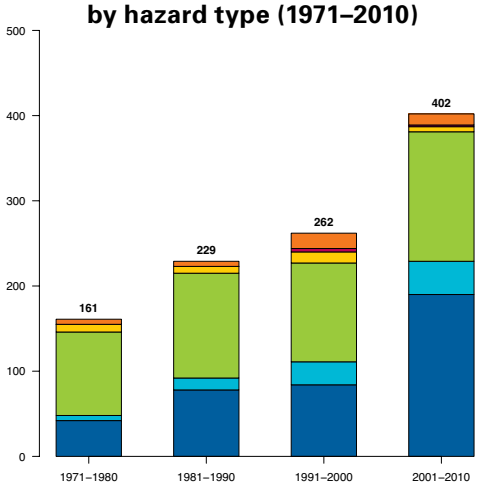


Total = US$ 118.4 billion (1970–2012)

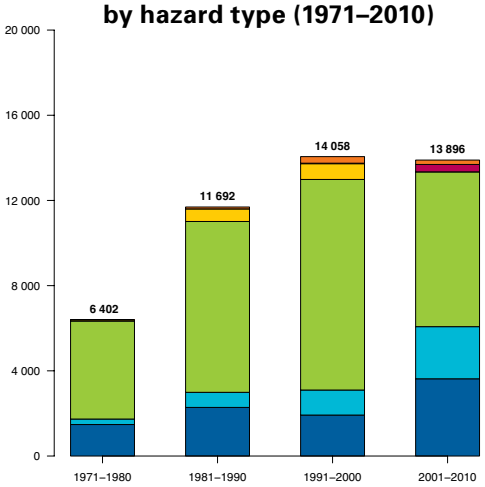


(in US$ billion, adjusted to 2012)

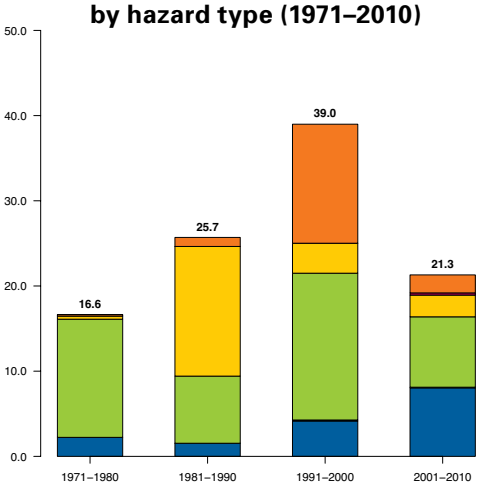
Number of reported disasters by decade by hazard type (1971–2010)



Number of reported deaths by decade by hazard type (1971–2010)



Reported economic losses by decade by hazard type (1971–2010)



(in US$ billion, adjusted to 2012)

Floods **Mass movement wet** **Storms** **Droughts** **Extreme temperature** **Wildfires**

EUROPE

In Europe, 1 352 reported disasters caused 149 959 deaths and US$ 375.7 billion in economic damages during the 1970–2012 period. Although floods (38 per cent) and storms (30 per cent) were the most reported causes of disasters, extreme temperatures led to the highest proportion of deaths (94 per cent), with 72 210 lives lost during the 2003 European heatwave and 55 736 during the 2010 heatwave in the Russian Federation. In contrast, floods and storms accounted for most of the economic losses during the period.

The 10 worst reported disasters accounted for 85 per cent (127 058) of total lives lost and 25 per cent (US$ 92.7 billion) of economic losses associated to weather-, water- and climate-related hazards.

DENIS SINYAKOV / REUTERS

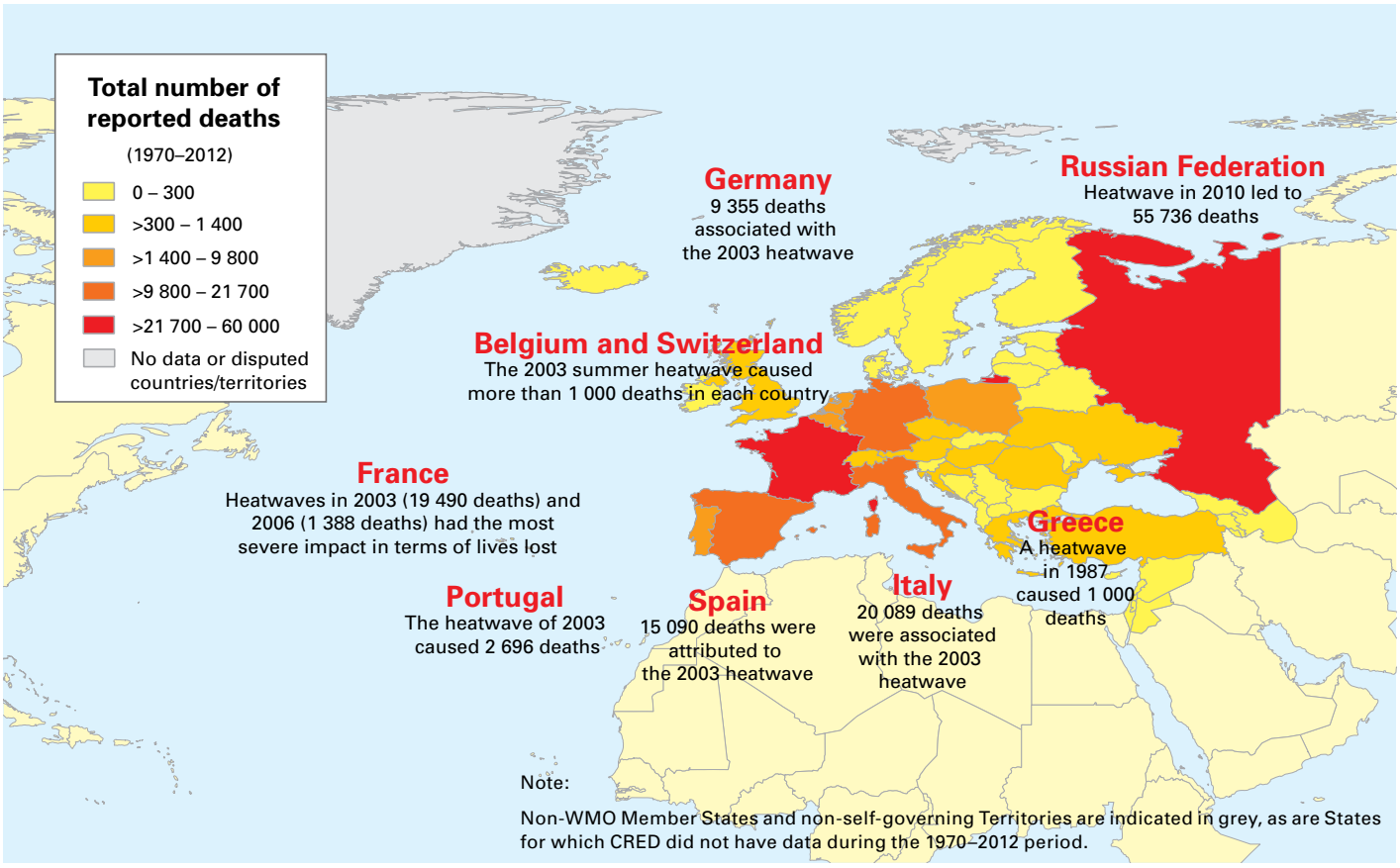
A firefighter works to extinguish a wildfire in the Ryazan region, south-east of Moscow.

Disasters ranked according to reported (a) deaths and (b) economic losses (1970–2012)

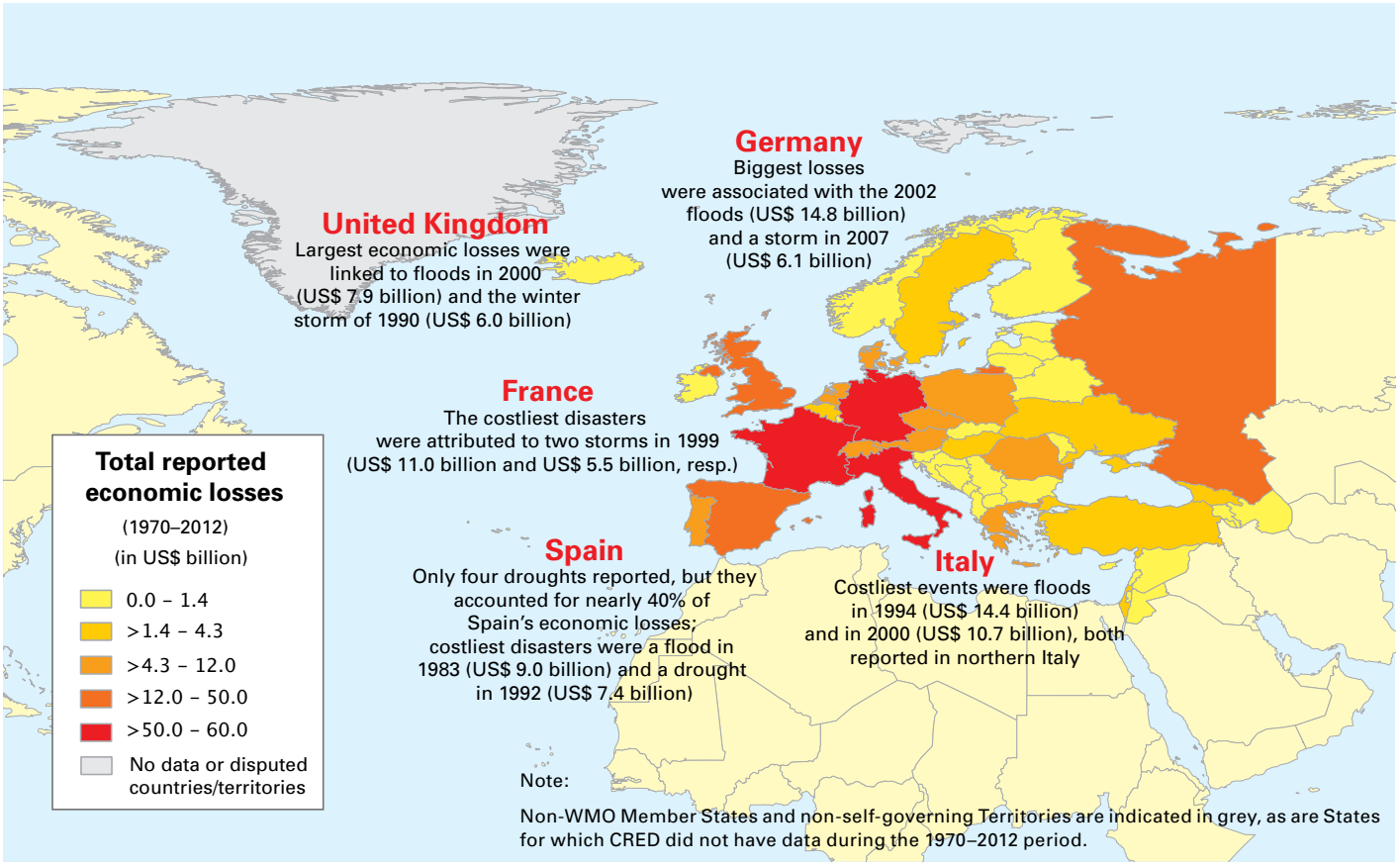
(a)	Disaster type	Year	Country	Number of deaths
1	Extreme temperature	2010	Russian Federation	55 736
2	Extreme temperature	2003	Italy	20 089
3	Extreme temperature	2003	France	19 490
4	Extreme temperature	2003	Spain	15 090
5	Extreme temperature	2003	Germany	9 355
6	Extreme temperature	2003	Portugal	2 696
7	Extreme temperature	2006	France	1 388
8	Extreme temperature	2003	Belgium	1 175
9	Extreme temperature	2003	Switzerland	1 039
10	Extreme temperature	1987	Greece	1 000

(b)	Disaster type	Year	Country	Economic losses (in US$ billion)
1	Flood	2002	Germany	14.80
2	Flood	1994	Italy	14.42
3	Storm	1999	France	11.02
4	Flood	2000	Italy	10.67
5	Flood	1983	Spain	8.99
6	Flood	2000	United Kingdom	7.87
7	Drought	1992	Spain	7.36
8	Storm	2007	Germany	6.09
9	Storm	1990	United Kingdom	5.98
10	Storm	1999	France	5.51

Map of reported disasters and their related deaths (1970–2012)



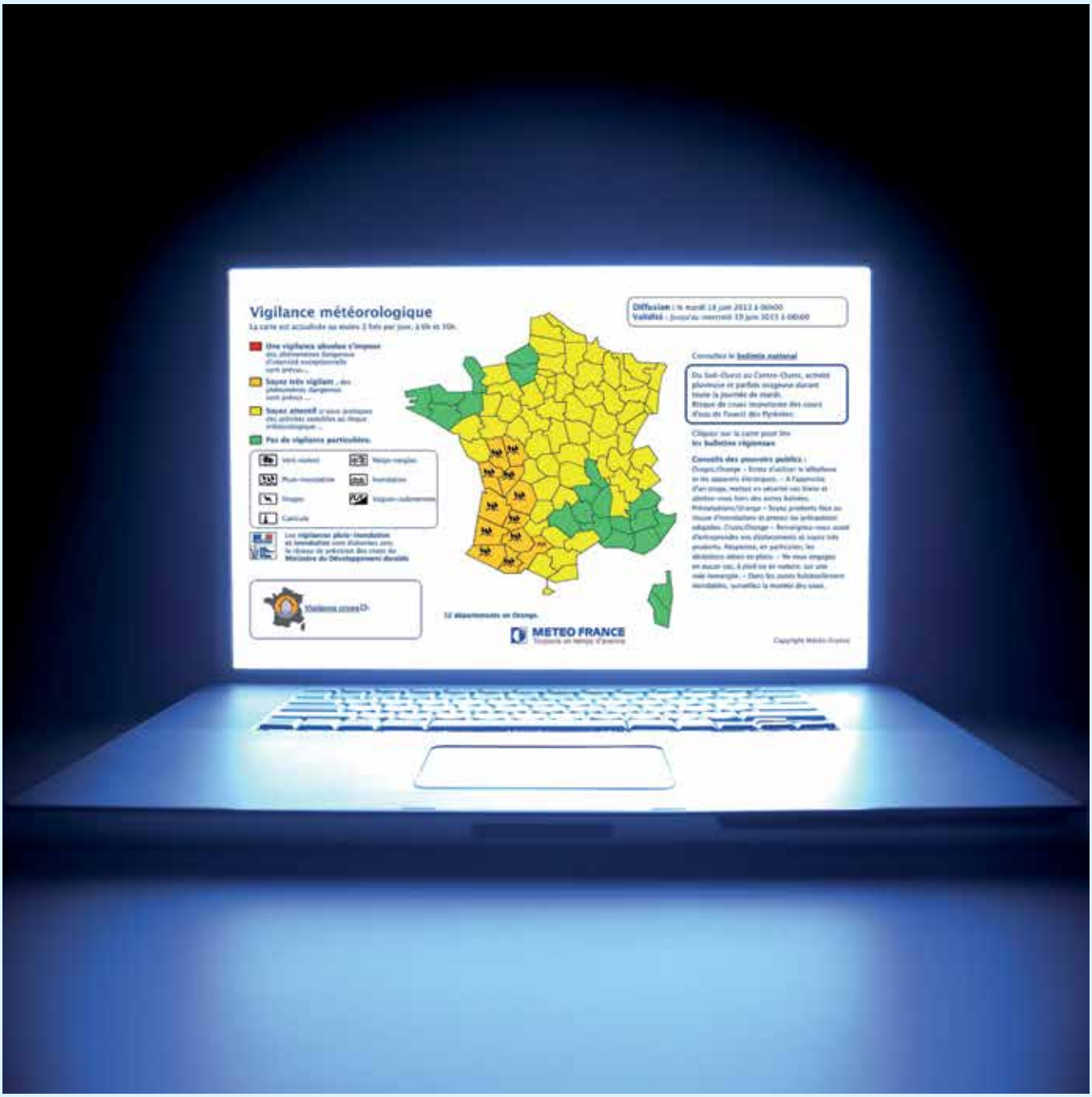
Map of reported disasters and their related economic losses (in US$ billion, 1970–2012)



The French *Vigilance* system and the heat/health warnings

In France, following the devastating December 1999 winter storm, a public warning system named *Vigilance* was developed as part of the country's revised emergency planning and response mechanisms. The *Vigilance* system uses a four-colour scheme reflecting different risk levels. It is used at the scale of the French departments – the administrative division of the national territory best suited to planning and crisis management. A 24-hour time frame combines satisfactory forecasting reliability with sufficient advance warning for action. This system was upgraded to include heat/health warnings following the intense heatwave in 2003, which led to 19 490 deaths in France. It now also includes river flood risk warnings following the major flood in 2007.

Source: Borretti, C., 2012: The French Vigilance System. Contributing to the Reduction of Disaster Risks in France. In: *Institutional Partnerships in Multi-Hazard Early Warning Systems* (M. Golnaraghi, ed.), doi 10.1007/978-3-642-25373-7, Berlin, Heidelberg, Springer-Verlag.

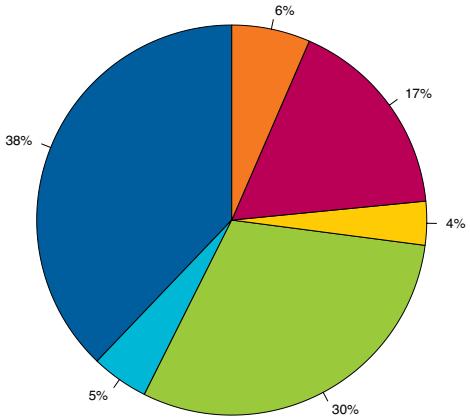


SHUTTERSTOCK.COM / VIGILANCE.METEOFRANCE.COM

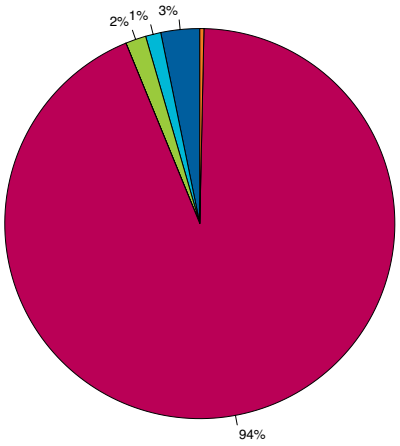
A French Vigilance system map

Distribution of the reported (a) number of disasters, (b) deaths and (c) total economic losses by hazard type in Europe (1970–2012)

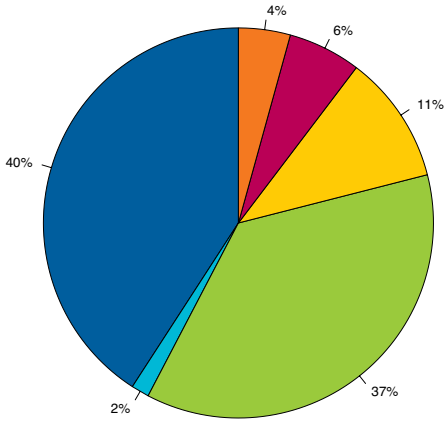
Total = 1 352 disasters (1970–2012)



Total = 149 959 deaths (1970–2012)

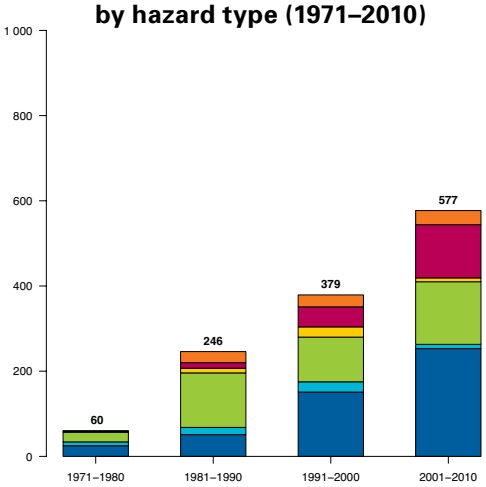


Total = US$ 375.7 billion (1970–2012)

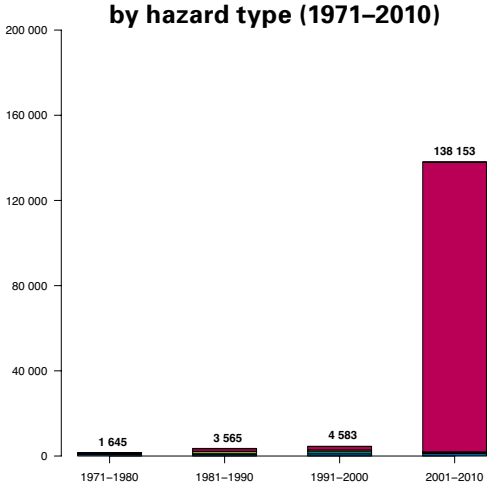


(in US$ billion, adjusted to 2012)

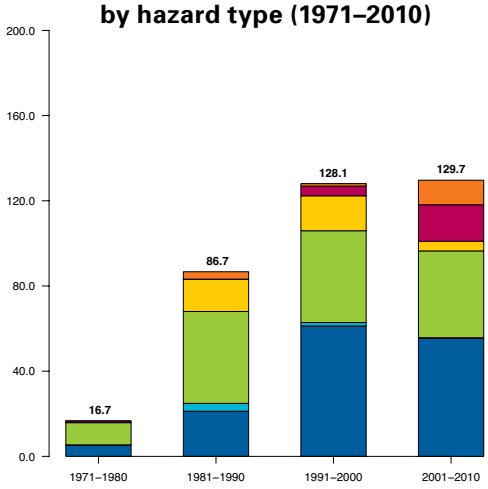
Number of reported disasters by decade by hazard type (1971–2010)



Number of reported deaths by decade by hazard type (1971–2010)



Reported economic losses by decade by hazard type (1971–2010)



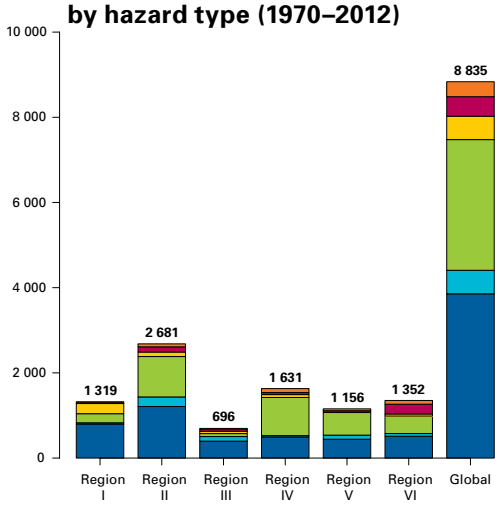
(in US$ billion, adjusted to 2012)

Floods | Mass movement wet | Storms | Droughts | Extreme temperature | Wildfires

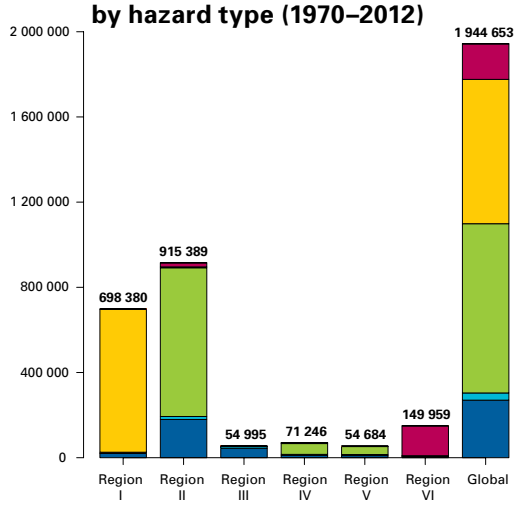
REGIONAL INTERCOMPARISONS

Storms, floods and droughts are among the most recurrent weather-, climate- and water-related hazards around the world. However, the distribution of deaths and economic losses from these hazards varies from Region to Region. For example, the main contributors to the loss of life have been droughts in Africa; storms in Asia, in Central America, North America and the Caribbean, and in the South-West Pacific; floods in South America; and heatwaves in Europe. On the other hand, a large portion of economic losses has been attributed to floods in Africa, Asia, South America and Europe, and to storms in Central America, North America and the Caribbean, and the South-West Pacific.

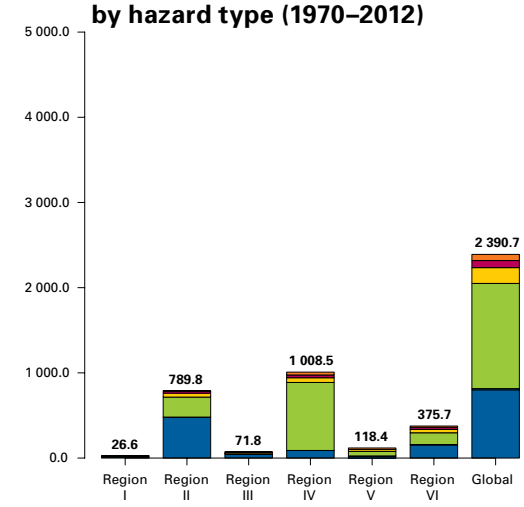
Number of reported disasters by WMO Region by hazard type (1970–2012)



Number of reported deaths by WMO Region by hazard type (1970–2012)



Reported economic losses by WMO Region by hazard type (1970–2012)



(in US$ billion, adjusted to 2012)

Floods | Mass movement wet | Storms | Droughts | Extreme temperature | Wildfires

ANNEXES

ANNEX I

About the World Meteorological Organization[3]

About 90 per cent of disasters are caused by weather-, climate- or water-related hazards, such as droughts, tropical cyclones and floods. These hazards know no national boundaries; so international cooperation at global and regional scales is essential. The WMO – the authoritative voice of the United Nations on weather, climate and water – facilitates this cooperation by working with the NMHSs of its 191 Members via 10 scientific and technical programmes. Through these cooperation and coordination efforts, the following fundamental systems and capacities have been developed and implemented alongside capacity development activities. This is to ensure that all WMO Members can contribute to, and benefit from, these internationally coordinated systems that deliver meteorological, hydrological and climate-related services to support risk-based decision-making in the Member's respective countries.

The WMO Integrated Global Observing System enables data to be collected worldwide from 17 satellites, hundreds of ocean buoys, thousands of aircrafts and ships and nearly 10 000 land-based stations.

The WMO Information System builds on the success of the Global Telecommunication System of the WMO World Weather Watch, which has been the backbone of meteorological information exchange for the past 50 years. The WMO Information System is used for daily weather observations and forecasts, tropical cyclone warnings and tsunami alerts. More than 50 000 weather reports and several thousand charts and digital products are disseminated daily. It is also used to exchange all weather-, climate- and water-related information, enabling users outside the meteorological community, for instance in the disaster risk reduction community, to have access to such information.

The Global Data-processing and Forecasting System produces and disseminates weather and climate analyses and predictions that enable NMHSs to provide high-quality meteorological forecasts, warnings and other information services related to weather, environmental quality and climate. It does this on a 24/7 basis, and its three-level system – World Meteorological Centres; Regional Specialized Meteorological Centres and Regional Climate Centres; and National Meteorological Centres – support NMHSs and their early warning capacities. Improved skill and lead time of forecasts of high-impact weather events have greatly contributed to disaster risk reduction. This has been technically and operationally demonstrated by the WMO Tropical Cyclone Programme, the WMO Severe Weather Forecasting Demonstration Project and the WMO Emergency Response Activities programme.

[3] For more information on WMO, see http://www.wmo.int.

Weather and Disaster Risk Reduction Services Department

To further strengthen its contribution to disaster risk reduction, WMO established the cross-cutting Disaster Risk Reduction Programme[4] in 2003 within its Weather and Disaster Risk Reduction Services Department. The organization is working with a number of United Nations agencies, international and regional organizations, academia and WMO Members to facilitate development of meteorological, hydrological and climate services to support decision-making on disaster risk reduction. The globally coordinated operational network of NMHSs, RSMCs and RCCs forms the core of this capability. To this end, the Disaster Risk Reduction Work Plan (2012–2015)[5], adopted by the WMO Executive Council at its sixty-fourth session, has laid out the priorities and a road map. A number of User-Interface Expert Advisory Groups have been established to guide the implementation of this work plan, with priorities of action centred on developing services to support:

- Risk assessment – Information on the characteristics of weather and climate hazards needs to be complemented with exposure and vulnerability information in order to develop a complete picture of risk. The latest scientific advances in climate modelling and forecasting offer unprecedented opportunities for analysing and providing predictions with longer lead times of the changing patterns of hazard characteristics as input to risk assessment. Armed with such information,

[4] For more information on the Disaster Risk Reduction Programme, see http://www.wmo.int/pages/prog/drr/index_en.html.

[5] For more information on the Disaster Risk Reduction Work Plan (2012–2015), see https://www.wmo.int/pages/prog/drr/documents/DRR-WorkPlan2012-2015.pdf.

individuals, communities, organizations, businesses and governments can make decisions to reduce the risks associated with climate variability and change.

- Early warning systems – Effective early warning systems include risk knowledge, monitoring and warning service, dissemination and communication, and response capacity. Climate services that focus on the characteristics of hazards and understanding their underlying risks are critical for decisions about investing in and strengthening early warning systems, as well as for developing emergency preparedness plans. Warnings of expected events are critical for activating emergency plans on the ground.

- Risk reduction in climate-sensitive sectors – Multisectoral planning to reduce disaster risk and adapt to changing patterns of hazards linked to climate variability and change require information from historical, current and forward-looking risk analyses. Relevant multisectoral planning and investment decisions concern areas such as financial planning, land zoning, infrastructure and urban development, agricultural practices and food security measures, water management, health service provision, education planning and social protection programmes, among others.

- Risk financing and transfer – This involves structured sharing of the potential financial impacts of disasters caused by natural hazards. This occurs often, but not only, through insurance mechanisms. A suite of risk financing and risk transfer approaches can be used at different levels to guarantee the availability of immediate post-disaster and longer-term recovery funds, for which historical and forward-looking assessments of hazard characteristics are fundamental.

Global Framework for Climate Services[6]

The Global Framework for Climate Services was launched in 2009 by the World Climate Conference-3 as a global partnership of governments and organizations that produce and use climate services. This United Nations initiative seeks to facilitate global access to continuously improved climate services in the four priority sectors of agriculture and food security, health, water, and disaster risk reduction by the end of 2017. The objective for end-2021 is to facilitate access to improved climate services across all climate-sensitive sectors.

Climate services have taken advantage of the significant improvements in climate prediction and climate change scenarios. Seasonal to multi-year climate forecasts and predictions can now be used to generate actionable information for decision-making in all climate-sensitive sectors. A growing number of countries are building on their experience in weather forecasting to customize climate information and target it to specific users. These climate services make it possible to incorporate science-based climate information and prediction into planning, policy and practice to achieve real benefits for society.

Disaster risk reduction is one of the main priorities of the GFCS. An essential starting point for reducing disaster risks is to make a quantitative assessment that combines information on hazards with information on exposures and vulnerabilities of populations or assets (such as agricultural production, infrastructure and homes). The hazard side of the equation uses historical data and forward-looking modelling and forecasting of environmental conditions, such as tropical cyclones, rainfall, soil moisture and river basin hydrology. This must be augmented with socio-economic data that quantify exposure and vulnerability, such as potential casualties, construction damages, crop yield reduction and water shortages.

About the Centre for Research on the Epidemiology of Disasters[7]

The CRED has been active for more than 35 years in the fields of international disaster and conflict health studies, with research and training activities linking relief, rehabilitation and development. It was established in Brussels in 1973 at the School of Public Health of the Catholic University of Louvain as a non-profit institution with international status under Belgian law. In 1980, CRED became a World Health Organization (WHO) collaborating centre as part of the WHO global programme for emergency preparedness and response. Since then, CRED has increased its international network substantially and collaborates closely with numerous United Nations agencies, intergovernmental and governmental institutions, non-governmental organizations, research institutes and universities.

Objective

The Centre promotes research and provides an evidence base to the international community on the burden of disease and related health issues due to disasters and conflicts, in order to improve preparedness and responses to these humanitarian emergencies. The Centre trains field managers, students, relief personnel and health professionals in the management of short- and long-term humanitarian emergencies.

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6 For more information on GFCS, see http://www.wmo.int/pages/governance/ec/global-framework-for-climate-services_en.html.

7 For more information about CRED, see http://www.cred.be/.

Focus

CRED focuses its research on all humanitarian and emergency situations that have a major impact on human health. These include all types of natural and human-made disasters, such as earthquakes, floods and storms, longer-term disasters such as famines and droughts, and situations creating mass displacement of people, such as civil strife and conflicts.

The Centre focuses on health aspects and the burden of disease arising from disasters and complex emergencies. It also promotes research on broader aspects of humanitarian crises, such as human rights and humanitarian law, socio-economic and environmental issues, early warning systems, the special needs of women and children, and mental health care.

The Centre is actively involved in stimulating debate on the effectiveness of various humanitarian interventions.

It encourages scientific and policy discussions on existing and potential interventions and their impacts on acute and chronic malnutrition, human survival, morbidity, infectious diseases and mental health.

The CRED team works in four main areas:

- Natural disasters and their impacts
- Civil strife and conflict epidemiology
- Database and information support
- Capacity-building and training

ANNEX II

Disaster loss and damage data sources and the CRED EM-DAT database

EM-DAT hazard classification

The hazards listed in EM-DAT are classified as shown in Table 1.

Table 1. Hazard classification as defined in EM-DAT[a]

Disaster sub-group	Disaster main type	Disaster sub-type	Disaster sub-sub-type
Hydrological	Flood	General river flood, flash flood, storm surge/coastal flood	
	Mass movement wet	Rockfall	
		Landslide	Debris flow, debris avalanche
		Avalanche	Snow avalanche, debris avalanche
		Subsidence	Sudden subsidence, long-lasting subsidence
Meteorological	Storm	Tropical storm	
		Extra-tropical cyclone (winter storm)	
		Local/convective storm	Thunderstorm/lightning, snowstorm/blizzard, sandstorm/duststorm, generic (severe) storm, tornado, orographic storm (strong winds)
Climatological	Extreme temperature	Heatwave	
		Cold wave	Frost
		Extreme winter conditions	Snow pressure, icing, freezing rain/debris avalanche
	Drought	Drought	
	Wildfire	Forest fire	
		Land fires (grass, scrub, bush, etc.)	

[a] For more information, see http://www.emdat.be/classification.

The EM-DAT database depends on a number of sources of information, as highlighted in Table 2.

Table 2. List of sources commonly used by CRED to gather the necessary information for the disasters likely to be included in EM-DAT

Sources	Examples
United Nations	Office for the Coordination of Humanitarian Affairs, Integrated Regional Information Network, World Health Organization, Food and Agriculture Organization of the United Nations
National figures	Official country figures (for example, the National Disaster Risk Reduction and Management Council in the Philippines)
United States technical agencies	Office of Foreign Disaster Assistance (of the US Agency for International Development), National Oceanic and Atmospheric Administration, US Geological Survey, Federal Emergency Management Agency
Non-governmental organizations	International Federation of Red Cross and Red Crescent Societies and/or National Red Cross and Red Crescent Societies
Intergovernmental organizations	World Bank, European Union
Reinsurance companies	Munich Re, Swiss Re
Insurance magazines	Lloyd's Casualty Week
Research centres	Universities/academic institutions (for example, the Hazards and Vulnerability Research Institute of the University of South Carolina and its Sheldus database), Asian Disaster Preparedness Centre, Dartmouth Flood Observatory and/or any scientific paper/ working document
Press/media	Agence France-Presse, Reuters

A list of institutions that collect damage and loss data concerning natural hazards is provided in Table 3. These institutions also produce reports and publications that analyse the disasters occurring worldwide, providing information about their magnitude, socio-economic impacts and geographic distribution.

Table 3. List of the main publications focusing on major natural or man-made disasters and their related socio-economic impacts

Institution	Examples	Frequency	Keywords
CRED	*Annual Disaster Statistical Review: the numbers and trends*	Yearly	Victims – economic losses – natural disasters
WMO	Statements on the status of the global climate	Yearly	Climate variables – climate anomalies
Swiss Re	Sigma reports on natural catastrophes and man-made disasters	Yearly	Natural disasters – economic losses – victims
Munich Re	*Topics Geo*	Yearly	Natural disasters – economic losses – victims
UNISDR	*Global Assessment Report*	Biennial	Economic risk – disaster risk reduction

EM-DAT event template

The EM-DAT database provides a number of data fields related to disasters as defined in Table 4.

Table 4. EM-DAT definitions describing the social and economic impacts of disasters

Field	Definition
Killed	Persons confirmed as dead and persons missing and presumed dead
Injured	People suffering from physical injuries, trauma or an illness requiring medical treatment as a direct result of a disaster
Homeless	People needing immediate assistance for shelter
Affected	People requiring immediate assistance during a period of emergency, including displaced or evacuated people
Total affected	Sum of injured, homeless and affected
Total estimated damages	The value of all damages and economic losses directly or indirectly related to the disaster
Reconstruction cost	Costs of replacing lost assets
Insured losses	Economic damages covered by the insurance industry

Each disaster event is recorded in the EM-DAT database with the following variables (Table 5):

Table 5. Disaster event variables in EM-DAT

Variable	Details
Disaster information	• Disaster number (DISNO – a unique ID of eight digits: four digits for the year and four for the disaster number, e.g. 19950324) • Disaster group/type/sub-type/sub-sub-type • Name • Entry criteria – for a disaster to be entered into the database, at least one of the following criteria must be fulfilled: - Ten or more people reported killed - One hundred or more people reported affected - Declaration of a state of emergency - Call for international assistance
Temporal information	• Year • Start and end dates • Local time
Geographical information	• Country/continent/region • Location • Latitude/longitude
Characteristics	• Origin • Associated disasters • Magnitude/scale
International appeal	• Response from the Office of Foreign Disaster Assistance • Request for international assistance • Declaration of state of emergency • Aid contribution
Economic impact	• Estimated damages (direct/indirect; by sector) • Insured losses • Reconstruction cost(s)

Human impact	• Deaths • Injured • Homeless • Affected • Total affected (injured + homeless + affected)
Sector impact	• Impact on infrastructure: houses, bridges, hospitals, crops, roads damaged/ destroyed • Sectors affected: industry, sanitation, communication

Country name changes

A number of country names have changed over the years for various political reasons. These are listed in Table 6.

Table 6. List of country name changes in the EM-DAT database

Country/territory name as listed in EM-DAT	Corresponding WMO Region	Explanation
Czechoslovakia	VI	Split into Czech Republic (CZE) and Slovakia (SVK) in January 1993
Eritrea	I	Separated from Ethiopia in 1993
German Democratic Republic	VI	Germany (DEU) since 1990
Federal Republic of Germany	VI	Germany (DEU) since 1990
Serbia Montenegro	VI	Split into Serbia (SRB) and Montenegro (MNE) in 2006
Soviet Union	II	Split into 15 countries in 1991
Timor-Leste	V	Separated from Indonesia in 2002
Yemen Arab Republic	II	Yemen (YEM) since 1990
People's Democratic Republic of Yemen	II	Yemen (YEM) since 1990
South Sudan	I	Separated from Sudan in 2011
Yugoslavia	VI	Split into five countries in 1991/1992 (Slovenia, Croatia, Bosnia and Herzegovina, Serbia Montenegro and the former Yugoslav Republic of Macedonia)

All data records for Yugoslavia, Serbia Montenegro and Czechoslovakia were included in the global statistics and global maps. For the regional map of Europe however, data from these former countries could not be shown and were therefore excluded (see Table 7), unless one of these data records could be specifically attributed to another existing country from the metadata.

Table 7. Disaster statistics from three former countries that were excluded from the map of Europe

Country	Statistics		
	Number of disasters	Number of deaths	Economic losses (in US$ billion)
Czechoslovakia	7	0	0.03
Serbia Montenegro	8	8	None
Yugoslavia	4	70	3.10

ANNEX III

List of WMO Regions and corresponding countries and territories as listed in EM-DAT

The countries and territories that were included in EM-DAT are matched to each of the six WMO Regions according to their geographical location (Table 8). The mainland of all countries is contained within one single WMO Region, with the exception of the Russian Federation (formerly referred to as the Union of Soviet Socialist Republics) and Kazakhstan (formerly part of the Union of Soviet Socialist Republics), which stretch across WMO Region II (Asia) and WMO Region VI (Europe). The entries in the EM-DAT database for the Russian Federation and Kazakhstan were therefore carefully considered according to location (based on the information available in EM-DAT) to ensure that the reported events and their associated socio-economic losses were properly attributed to the corresponding WMO Region. Overseas territories (such as La Reunion) and federal states (such as Hawaii) are included in the WMO Region in which they are located, with an indication of which country they are associated with.

Table 8. List of WMO Regions and their Member countries (names according to WMO standard) as well as non-Member countries and territories (names according to United Nations standard) as listed in EM-DAT

WMO Region I (Africa)	
Country/territory	**No. of disasters**
Algeria	52
Angola	36
Benin	22
Botswana	13
Burkina Faso	24
Burundi	32
Cabo Verde	7
Cameroon	17
Canary Islands (ESP)	6
Central African Republic	24
Chad	26
Comoros	8
Congo	10
Côte d'Ivoire	8
Democratic Republic of the Congo	32
Djibouti	17
Egypt	19
Eritrea	6
Ethiopia	65
Gabon	4
Gambia	17
Ghana	19
Guinea	14
Guinea-Bissau	10
Kenya	57
Lesotho	16
Liberia	9
Libya	1
Madagascar	58
Madeira (PRT)	2
Malawi	38
Mali	26
Mauritania	24
Mauritius	17
Morocco	32
Mozambique	63
Namibia	18
Niger	27
Nigeria	51
La Reunion (FRA)	8
Rwanda	20
Saint Helena (GBR)	1
Sao Tome and Principe	1
Senegal	26
Seychelles	2
Sierra Leone	11
Somalia	46
South Africa	73
South Sudan	4
Sudan	42
Swaziland	11
Togo	14
Tunisia	13
Uganda	33
United Republic of Tanzania	48
Zambia	22
Zimbabwe	17

WMO Region II (Asia)	
Country/territory	**No. of disasters**
Afghanistan	101
Bangladesh	241
Bhutan	6
Cambodia	24
China	525
Democratic People's Republic of Korea	31
Hong Kong, China	104
India	432
Iran, Islamic Republic of	81
Iraq	8
Japan	150
Kazakhstan	15
Kuwait	1
Kyrgyzstan	16
Lao People's Democratic Republic	27
Macao, China	4
Maldives	3
Mongolia	20
Myanmar	32
Nepal	74
Oman	8
Pakistan	120
Republic of Korea	86
Russian Federation	61

Union of the Soviet Socialist Republics (until 1991)	12
Saudi Arabia	13
Sri Lanka	69
Taiwan Province of China (CHN)	63
Tajikistan	40
Thailand	107
Turkmenistan	1
Uzbekistan	3
Viet Nam	165
Yemen prior to 1990 (Yemen Arab Republic)	4
Yemen prior to 1990 (People's Democratic Republic of Yemen)	7
Yemen	27

WMO Region III (South America)

Country/territory	No. of disasters
Argentina	80
Bolivia, Plurinational State of	57
Brazil	160
Chile	57
Colombia	112
Ecuador	39
French Guiana (FRA)	1
Guyana	10
Paraguay	30
Peru	90
Suriname	2
Uruguay	22
Venezuela, Bolivarian Republic of	36

WMO Region IV (North America, Central America and the Caribbean)

Country/territory	No. of disasters
Anguilla[a] (GBR)	5
Antigua and Barbuda	9
Bahamas	15
Barbados	9
Belize	16
Bermuda (GBR)	5
Canada	93
Cayman Islands (GBR)[a]	7
Costa Rica	41
Cuba	60
Curaçao and Sint Maarten[b]	2
Dominica	11
Dominican Republic	50
El Salvador	35
Grenada	7
Guadeloupe (FRA)	9
Guatemala	50
Haiti	84
Honduras	57
Jamaica	31
Martinique (FRA)	11
Mexico	166
Montserrat (GBR)[a]	3
Nicaragua	44
Panama	39
Puerto Rico (USA)	25
Saint Kitts and Nevis	7
Saint Lucia	14
Saint Vincent and the Grenadines	12
Trinidad and Tobago	9
Turks and Caicos Islands (GBR)[a]	6
United States	691
British Virgin Islands (GBR)[a]	2
United States Virgin Islands (USA)	6

[a] Group membership of the British Caribbean Territories

[b] Group membership of the Dutch Caribbean territories; since 2010, Curaçao and Sint Maarten are constituent countries of the Netherlands.

WMO Region V (South-West Pacific)

Country/territory	No. of disasters
American Samoa (USA)	4
Australia	199
Brunei Darussalam	1
Cook Islands	7
Fiji	43
French Polynesia (FRA)	6
Guam (USA)	8
Indonesia	218
Kiribati	3
Malaysia	49
Marshall Islands	2
Micronesia, Federated States of	7
New Caledonia (FRA)	9
New Zealand	47
Niue	2
Northern Mariana Islands	2
Papua New Guinea	30
Philippines	434
Samoa	9
Solomon Islands	17
Timor-Leste	7
Tokelau (NZL)	3
Tonga	11
Tuvalu	6
United States (Hawaii)	5
Vanuatu	25
Wallis and Futuna (FRA)	2

WMO Region VI (Europe)

Country/territory	No. of disasters
Albania	18
Armenia	4
Austria	42
Azerbaijan	10
Azores (PRT)	2
Belarus	8
Belgium	44
Bosnia and Herzegovina	18
Bulgaria	34
Croatia	22
Cyprus	9
Czech Republic	23
Czechoslovakia	7
Denmark	14
Estonia	3
Finland	3
France	123
Georgia	18
Germany prior to 1990 (German Dem. Rep.)	3
Germany prior to 1990 (Fed. Rep. of Germany)	11
Germany	61
Greece	48
Hungary	27
Iceland	5
Ireland	19
Israel	12
Italy	75
Jordan	10
Latvia	7
Lebanon	5
Lithuania	12
Luxembourg	11
Montenegro	9
Netherlands	28
Norway	10
Poland	42
Portugal	30
Republic of Moldova	14
Romania	71
Russian Federation	66
Union of the Soviet Socialist Republics (until 1991)	7
Serbia	15
Serbia Montenegro	8
Slovakia	20
Slovenia	5
Spain	70
Sweden	10
Switzerland	48
Syrian Arab Republic	7
The former Yugoslav Republic of Macedonia	15
Turkey	67
Ukraine	29
United Kingdom	69
Yugoslavia	4
State of Palestine	3

Acknowledgements

Project team:
Maryam Golnaraghi (WMO)
Christophe Etienne (WMO)
James Douris (WMO)
Jochen Luther (WMO)
Debarati Guha Sapir (CRED)
Regina Below (CRED)
David Hargitt (CRED)

Map production:
Christophe Etienne (WMO)

Editors:
Michael Williams and Sylvie Castonguay (WMO)

Authors:
Maryam Golnaraghi (WMO)
Christophe Etienne (WMO)
Debarati Guha Sapir (CRED)
Regina Below (CRED)

For more information, please contact:

World Meteorological Organization

7 bis, avenue de la Paix – P.O. Box 2300 – CH 1211 Geneva 2 – Switzerland

Communications and Public Affairs Office

Tel.: +41 (0) 22 730 83 14 – Fax: +41 (0) 22 730 80 27

E-mail: cpa@wmo.int

www.wmo.int

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