Hazards and Their Impacts

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

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World Meteorological Organization
Organisation météorologique mondiale

Outline

- Hazards: What are they?
- Challenges to quantify and understand hazard impacts
- How are countries strengthening their resilience?
- Disasters and their Impacts: Atlas of Mortality
  - Global statistics
  - European statistics

“Access to information is critical to successful disaster risk management.

You cannot manage what you cannot measure.”

Margareta Wahlström, Former Special Representative of the Secretary-General for Disaster Risk Reduction and Chief of UNISDR (UNISDR, 2012).

The Netherlands is the most vulnerable country in Europe to a natural disaster, but still only ranks 69th in a new UN ranking because it is well positioned to cope with floods and rising sea levels.

DuchNews.nl (2011)
https://www.dutchnews.nl/news/2011/09/the_netherlands_most_vulnerabl/

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Hazards: What are they?

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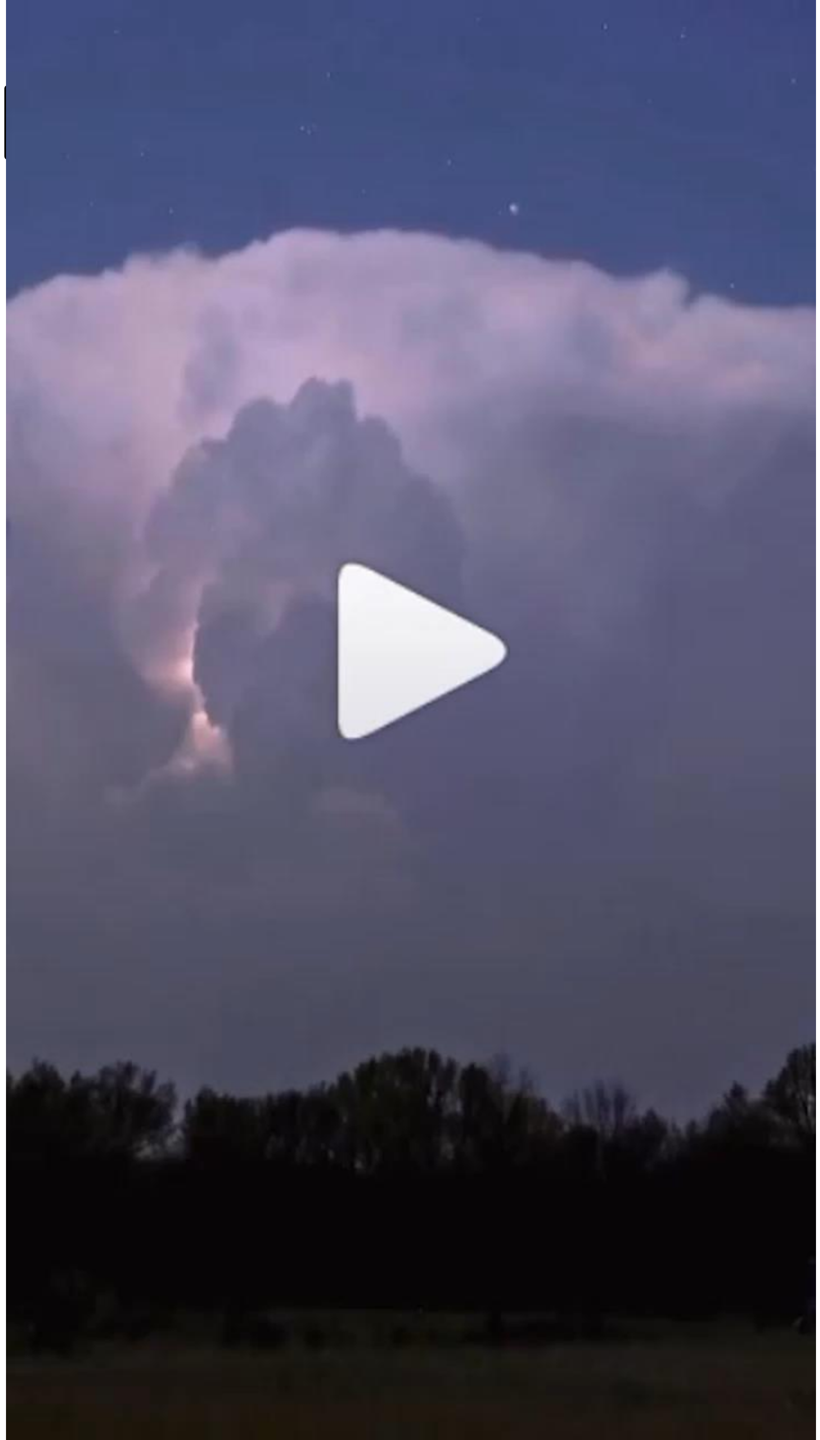

What is a hazard?

Key definitions

- ***Hazard***: A dangerous phenomenon, substance, human activity, or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.
- ***Disaster***: a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.

Source: UNDRR open-ended intergovernmental expert working group on indicators and terminology. https://www.undrr.org/terminology

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Building consensus around multi-hazard risk terminology and concepts 1/2

From the MYRIAD-EU Handbook MYRIAD-EU consortium is working to develop a consensus on hazard how hazards interrelate. They have developed a

Key definitions:

Triggering Relationship - One hazard causing another hazard to occur. Any natural hazard might trigger zero, one, or more secondary natural hazards, with these being either the same or different from the primary hazard.

Complexity - A causal chain with many intervening variables and feedback loops that do not allow the understanding or prediction of the system's behaviour on the basis of each component's behaviour.

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Building consensus around multi-hazard risk terminology and concepts 2/2

Consecutive Disasters - Two or more disasters that occur in succession, and whose direct impacts overlap spatially before recovery from a previous event is completed.

Disaster Risk Drivers - Processes or conditions, often development-related, that influence the level of disaster risk by increasing levels of exposure and vulnerability or reducing capacity.

For more information on the MYRIAD-EU project please go to their website: https://www.myriadproject.eu/

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Challenges to quantify and understand hazard impacts

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Typhoon Haiyan / Yolanda 2013

Characteristics

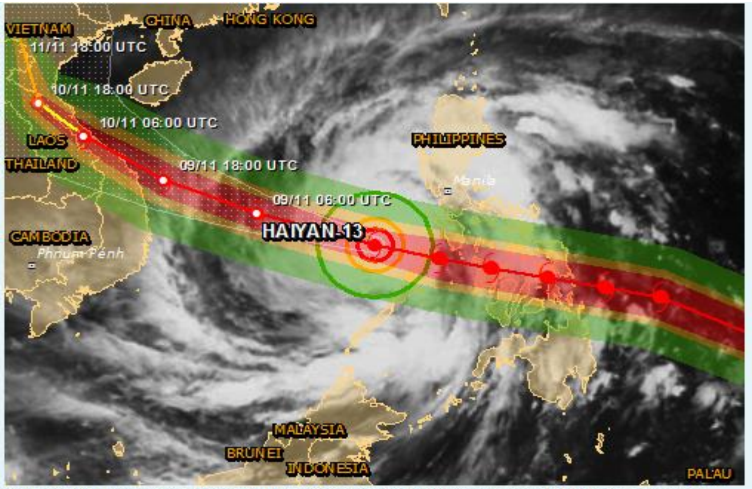
- Max wind: 230 km/h
- Costal surges: up to 5 meters

Reported loss and damage

- More than 6352 deaths with 1071 missing
- 14 millions people affected
- 850 million USD damage

How are impacts attributed to the each causal hazard systematically and authoritatively? (Wind, storm surge, rain, flooding, disease outbreak, loss of power…etc)?

How can losses and damages be recorded and aggregated for the lifespan of the hazard (e.g., impacts from all countries Philippines, Vietnam, SIDS) .



Cloud map. The map shows the areas affected by tropical storm strength winds (green), 58mph winds (orange) and cyclone wind strengths (red). (*Source: JRC*)

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El Nino 2015

Characteristics

- Prolonged drought in vast area, Asia, etc.
- Heavy rain in South America.

Example of reported losses and damages

- Severe impact on sectors: agriculture, forestry, transport, trade, industry, tourism, …
- Estimated economic impact 25Bn US$ for Indonesia (2% of GDP).

How are losses and damages attributed?

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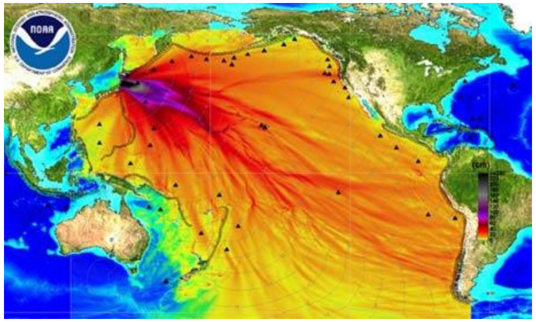
Cascading, Complex Disaster
Earthquake/Tsunami/Nuclear Accident

11 March 2011 - Japan



How are countries strengthening their resilience?

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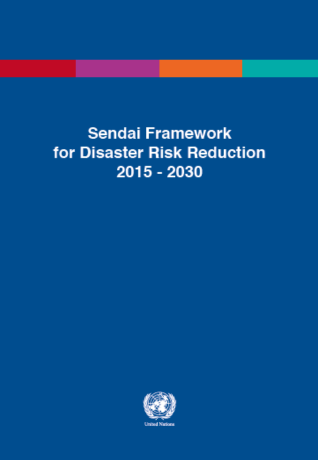

Sendai Framework for Disaster Risk Reduction 2015-2030

- **To strengthen technical and scientific capacity** to capitalize on and consolidate existing knowledge and to develop and apply methodologies and models **to assess disaster risks, vulnerabilities and exposure to all hazards**; *(paragraph 24 j)*

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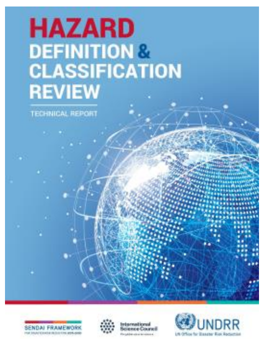
UNDRR/ISC Technical Working Group on the Hazard Terminology Review and Classification

Project Aim: To provide a review of Sendai Framework hazard terminology and classification for partners addressing the all hazards paradigm



UNDRR / ISC Sendai Hazard Definition and Classification Review Technical Report July 2020

https://www.undrr.org/publication/hazard-definition-and-classification-review

Hazard Information Profiles: Supplement to UNDRR-ISC Hazard Definition & Classification Review - Technical Report – October 2021

https://www.undrr.org/publication/hazard-information-profiles-supplement-undrr-isc-hazard-definition-classification

UNDRR UN Office for Disaster Risk Reduction

International Science Council

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Hazard Information Profiles

- 302 Hazards divided into eight hazard types
  - **Meteorological and Hydrological** (60 specific hazards)
  - **Extraterrestrial hazards (**9 specific hazards)
  - **Geohazards:** (35 specific hazards)
  - **Environmental hazards:** (24 specific hazards)
  - **Chemical hazards:** (25 specific hazards)
  - **Biological hazards** (88 specific hazards)
  - **Technological hazards** (53 specific hazards)
  - **Societal hazards** (8 specific hazards)

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Hazard Information Profiles Content

- Hazard name and reference
- Definition
- Annotations (synonyms, additional description elements, UN conventions/treaties, drivers, outcomes and risk management practices)
- Coordination Agency or Organization

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Hazard Information Profiles Examples

MH0006 / METEOROLOGICAL AND HYDROLOGICAL / Flood

Flash Flood

Definition

A flash flood is a flood of short duration with a relatively high peak discharge in which the time interval between the observable causative event and the flood is less than four to six hours (WMO, 2006).

Reference

WMO, 2006. Technical Regulations. Volume III: Hydrology, WMO-No. 49. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/technical_regulations/49_III_E_supplement1.pdf Accessed 20 November 2019.

Annotations

Synonyms

Storm-driven flood, Freshet, Huayco.

Additional scientific description

A flash flood is generally characterised by raging torrents after heavy rains, a dam or levee failure or a sudden release of water in a previously stopped passage (i.e., by debris or ice) that rips through riverbeds, urban streets, or mountain canyons sweeping away everything in its path. Steep terrain tends to concentrate runoff into streams very quickly and is often a contributory factor. Changes in soil properties (e.g., burn areas from wildfires), hydrophobic or impervious soils, removal of surface vegetation, and excess runoff from warm rainfall on significant snowpack can also be important contributors (NOAA, no date a; AMS, 2017).

Metrics and numeric limits

A flash flood is a flood that begins within 6 hours, and often within 3 hours, of a heavy rainfall (NOAA, no date b).

Flash floods are highly localised in space: they are restricted to basins of a few hundred square kilometres or less. They are also restricted in time: response times not exceeding a few hours or even less. This means very little time for warning (NOAA, no date b).

Flash flood hazard measurement and modelling requires a complex approach as more environmental factors must be considered and regularly monitored: topographic parameters (average slope, slope range and valley density for the catchment), soil and surface parameters (surface runoff, infiltration and interception: soil depth, physical soil type, the ratio of barren/vegetation-covered surfaces), and hydrological parameters (precipitation, consecutive rainy days, etc.) (Liu and Smedt, 2005).

Key relevant UN convention / multilateral treaty

Not identified.

Examples of drivers, outcomes and risk management

Drivers of flash flood: The intensity of the rainfall, the location and distribution of the rainfall, the land use and topography, vegetation types and growth/density, soil type, and soil water-content all determine how quickly flash flooding may occur, and influence where it may occur (NOAA, no date b).

Outcomes and impacts of flash flood: Flash floods account for approximately 85% of flooding cases and have the highest mortality rate (defined as the number of deaths per number of people affected) among different classes of flooding (e.g., riverine, coastal). With more than 5000 lives lost to flash flooding each year, flash floods are among the world's deadliest natural hazards and have significant social, economic and environmental impacts (WMO, 2019).

Hazard Information Profiles - Supplement to UNDRR-ISC Hazard Definition & Classification Review - September 2021

MH0060 / METEOROLOGICAL AND HYDROLOGICAL / Wind-Related

Wind

Definition

Wind is air motion relative to the Earth's surface. Unless otherwise specified, only the horizontal component is considered (WMO, 1992).

Reference

WMO, 1992. International Meteorological Vocabulary. WMO-No. 182. World Meteorological Organization (WMO). https://library.wmo.int/doc_num.php?explnum_id=4712 Accessed 25 November 2019.

Annotations

Synonyms

Not identified.

Additional scientific description

Wind velocity is an important consideration in relation to, for example, airborne pollution and the landing of aircraft (WMO, 2018). Surface wind is considered mainly as a two-dimensional vector quantity specified by two numbers representing direction and speed (WMO, 2018).

The extent to which wind is characterised by rapid fluctuations is referred to as gustiness, and single fluctuations are called gusts (WMO, 2018).

Metrics and numeric limits

An internationally recognised scale for measuring wind is the Beaufort Scale, which is an empirical measure that relates wind speed to observed conditions at sea or on land. Its full name is the Beaufort wind force scale (Royal Meteorological Society, 2018).

The Beaufort wind force scale has 13 levels including: calm, light air, light breeze, gentle breeze, moderate breeze, fresh breeze, strong breeze, near gale, gale, strong gale, storm, violent storm, and hurricane. Of note, the quoted wind speed is that measured at 10 m above ground, not at the surface (which, at 2 m, may be only 50–70% of these values (Royal Meteorological Society, 2018).

Key relevant UN convention / multilateral treaty

Not identified.

Examples of drivers, outcomes and risk management

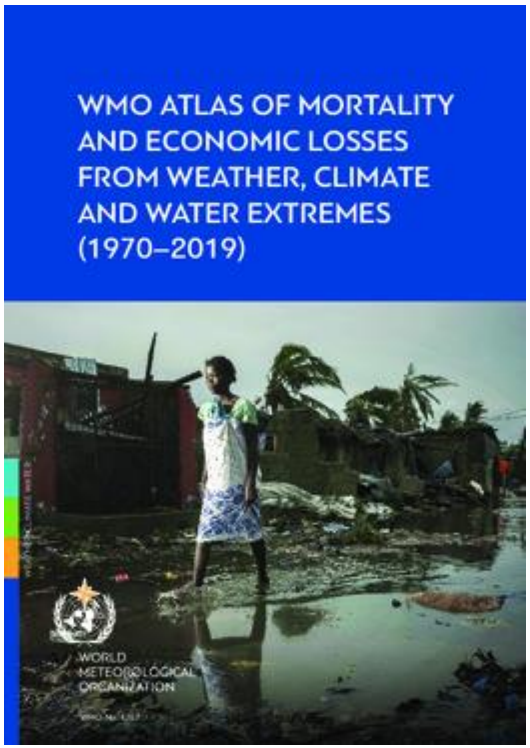
Wind is a main or contributing component to a number of hazards such as derecho, tropical cyclone, blizzard, sub-tropical cyclone, subtropical storm, tornado, and tropical storm. Wind is also associated with the dispersal of dust storms, volcanic ash and coastal floods (WMO, 2019).

Human health can be severely affected by windstorms (Goldman et al., 2014). Effects include direct effects, which occur during the impact phase of a storm, causing death and injury due to the force of the wind. Becoming airborne, being struck by flying debris or falling trees and road traffic accidents are the main dangers. Indirect effects, occurring during the pre- and post-impact phases of the storm, include falls, lacerations and puncture wounds, and occur when preparing for, or cleaning up after a storm. Power outages are a key issue and can lead to electrocution, fires and burns, and carbon monoxide poisoning from gasoline powered electrical generators. Worsening of chronic illnesses due to lack of access to medical care or medication can also occur. Other health impacts include infections and insect bites.

Disasters and their Impacts

- Global statistics
- European statistics

WMO Atlas of Mortality and Economic Losses (1970 – 2021)



- An overview of impacts from weather, climate and water extremes globally from 1970 to 2019 based on disaster data from the Emergency Events Database (EM-DAT)
- Disaster statistics are conducted for the 50-year and decadal periods at the national, regional and global scales
- A special section on the disproportionate impacts that tropical cyclones have on disaster statistics as well as on developing countries
- Contributions from UNDRR and WHO discussing relevant sectoral loss and damage statistics, challenges and opportunities in recording and analysis of loss and damage data considering implementation of the Sendai Framework agreement and the 2030 global agenda

Global perspective

Highlights

- 44% of disasters have been associated with floods (riverine floods 24%, general floods 14%) and
- 17% have been associated with tropical cyclones.
- 38% of deaths have been attributed to Tropical Cyclones
- 34% of deaths have been attributed to drought

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Global top 10 disasters ranked according to reported deaths and (1970–2019)

(a)	Disaster type	Year	Country	Deaths
1	Drought	1983	Ethiopia	300 000
2	Storm (*Bhola*)	1970	Bangladesh	300 000
3	Drought	1983	Sudan	150 000
4	Storm (*Gorky*)	1991	Bangladesh	138 866
5	Storm (*Nargis*)	2008	Myanmar	138 366
6	Drought	1973	Ethiopia	100 000
7	Drought	1981	Mozambique	100 000
8	Extreme temperature	2010	Russian Federation	55 736
9	Flood	1999	Bolivarian Republic of Venezuela	30 000
10	Flood	1974	Bangladesh	28 700

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Global top 10 disasters ranked according to reported economic losses (1970–2019)

(b)	Disaster type	Year	Country	Economic losses (in US$ billion)
1	Storm (*Katrina*)	2005	United States	163.61
2	Storm (*Harvey*)	2017	United States	96.94
3	Storm (*Maria*)	2017	United States	69.39
4	Storm (*Irma*)	2017	United States	58.16
5	Storm (*Sandy*)	2012	United States	54.47
6	Storm (*Andrew*)	1992	United States	48.27
7	Flood	1998	China	47.02
8	Flood	2011	Thailand	45.46
9	Storm (*Ike*)	2008	United States	35.63
10	Flood	1995	Democratic People's Republic of Korea	25.17

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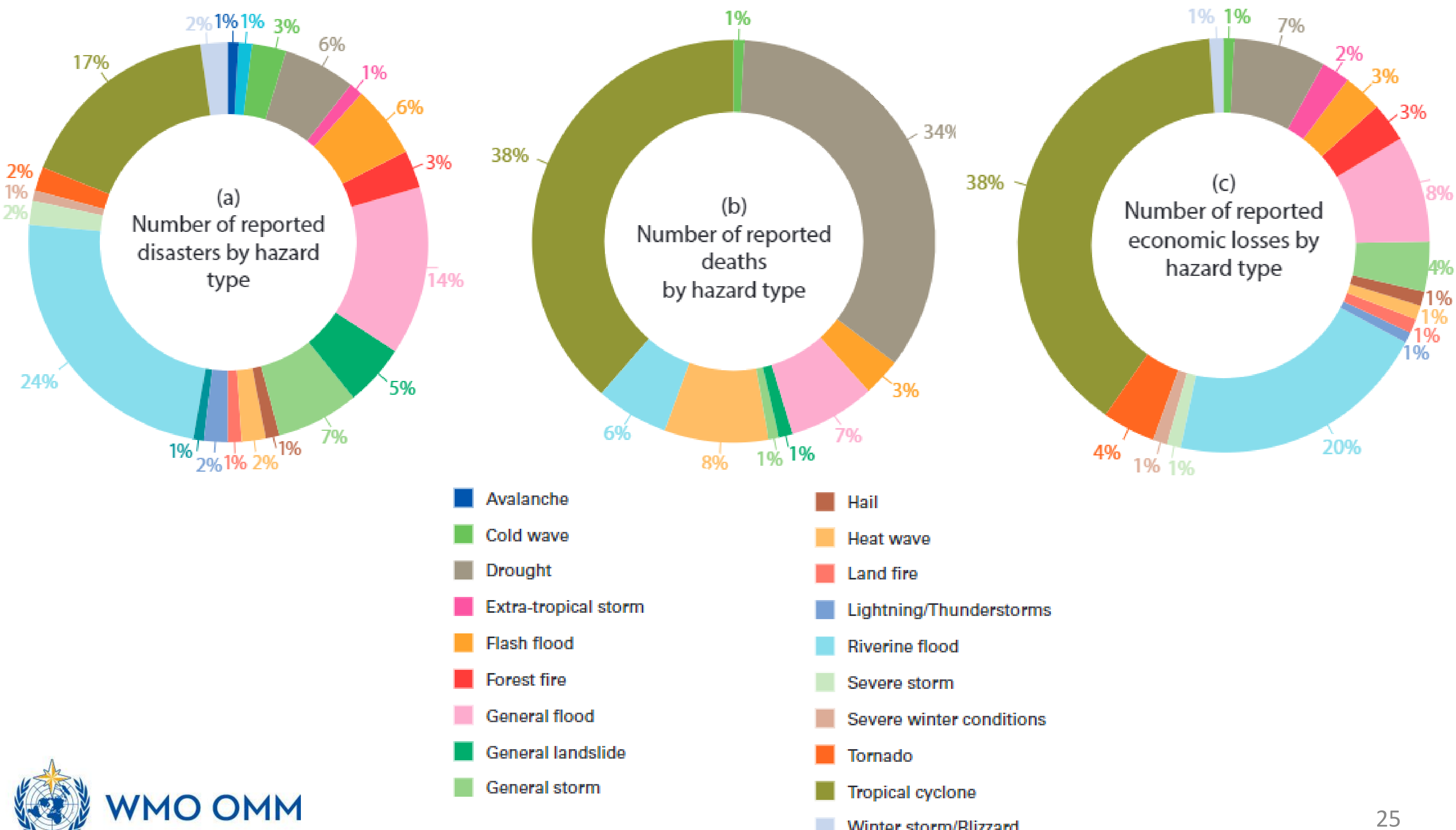
Number of disasters, deaths and economic losses by hazard



Impacts based on country economic groupings globally

- According to the United Nations country classification, 91% of recorded deaths occurred in developing economies while 59% of economic losses were recorded in developed economies

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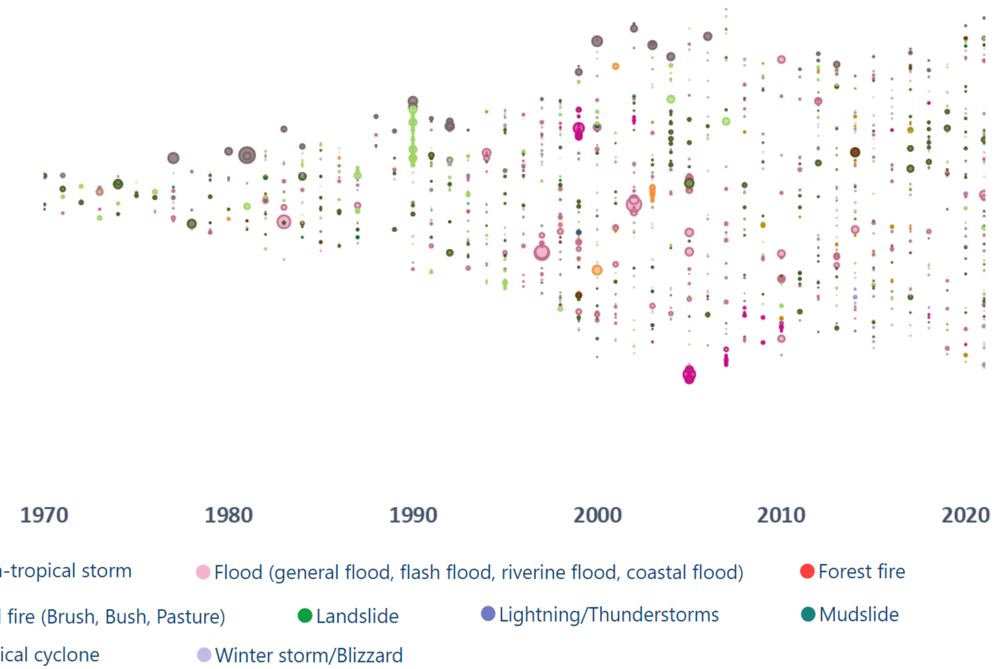
Reported economic losses as a % of developed economies' Gross Domestic Products (1970-2021)

2 824 disasters were reported in developed economies, yet economic losses were reported for **51%** (1438 disasters) only.

In developed economies, 84% of disasters with reported economic losses had an impact equivalent to less than 0.1% of the gross domestic products (GDP) of the respective economies.

No disasters were reported with economic losses greater than 3.5% of GDP.



Sources:

Centre for Research on the Epidemiology of Disasters, 2023: EM-DAT: The International Disaster Database, https://emdat.be.

The World Bank, 2023: Data, GDP (current US$), https://data.worldbank.org/indicator/NY.GDP.MKTP.CD.

Note: the hazard classification is based on EM-DAT hazard type; the bubbles are event-specific; the size of a bubble relates reported economic losses from weather-, climate- and water-related extremes to countries' annual Gross Domestic Products.

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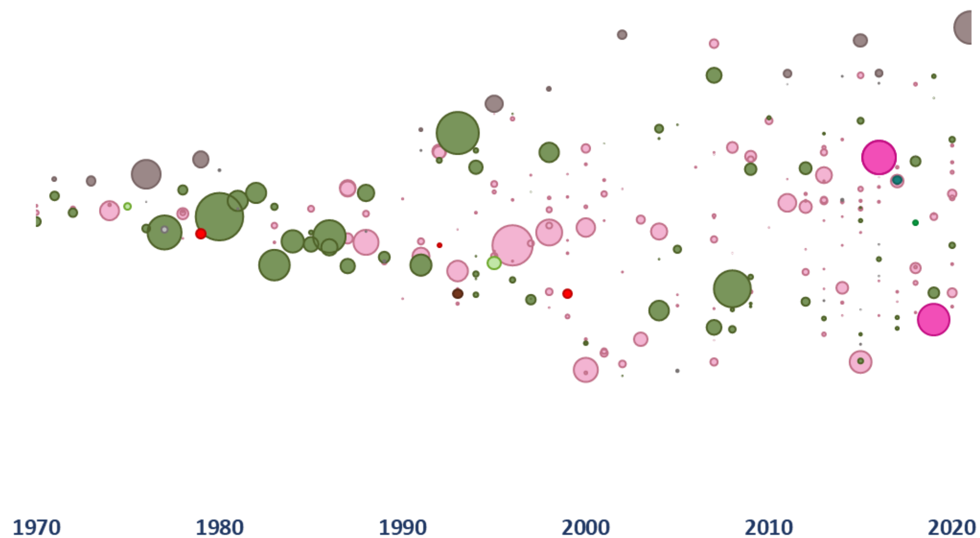
Reported economic losses as a % of Least Developed Countries' Gross Domestic Products (1970-2021)

2 086 disasters were reported in Least Developed Countries, yet economic losses were reported for **13%** (280 disasters) only.

In LDCs, 38% of disasters with reported economic losses had an impact equivalent to less than 0.1% of the respective GDPs.

7% of disasters for which economic losses were reported had an impact equivalent to more than 5% of the respective GDPs, with several disasters causing economic losses up to nearly **30%**.



Sources:

Centre for Research on the Epidemiology of Disasters, 2023: EM-DAT: The International Disaster Database, https://emdat.be.

The World Bank, 2023: Data, GDP (current US$), https://data.worldbank.org/indicator/NY.GDP.MKTP.CD.

Note: the hazard classification is based on EM-DAT hazard type; the bubbles are event-specific; the size of a bubble relates reported economic losses from weather-, climate- and water-related extremes to countries' annual Gross Domestic Products.

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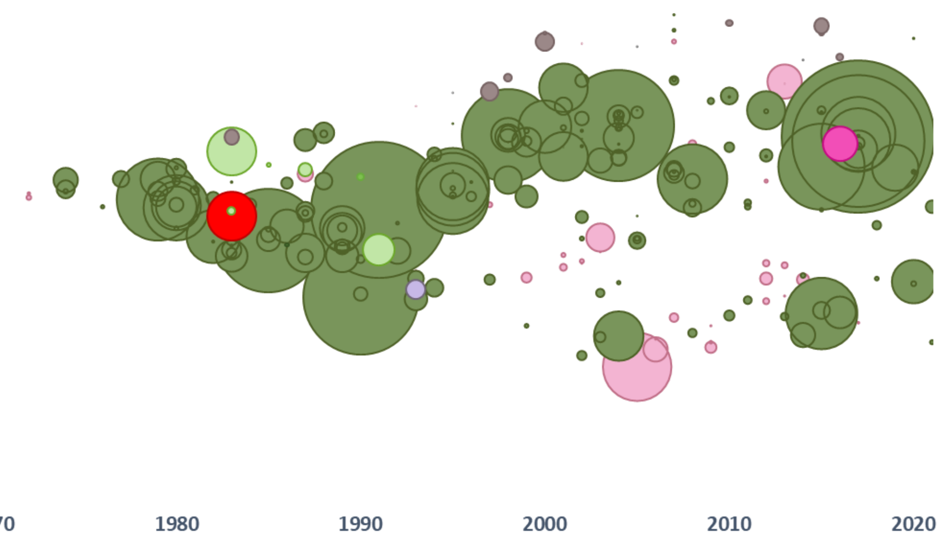
Reported economic losses as a % of Small Island Developing States’ Gross Domestic Products (1970-2021)

840 disasters were reported in Small Island Developing States between 1970 and 2021, yet economic losses were reported for **38%** (319 disasters) only.

20% of disasters with reported economic losses led to an impact equivalent to more than 5% of the respective GDPs, with some disasters causing economic losses above 100%.



Avalanche · Cold wave · Drought · Extra-tropical storm · Flood (general flood, flash flood, riverine flood, coastal flood) · Forest fire

General storm · Hail · Heat wave · Land fire (Brush, Bush, Pasture) · Landslide · Lightning/Thunderstorms · Mudslide

Severe winter conditions · Tornado · Tropical cyclone · Winter storm/Blizzard

Sources:

Centre for Research on the Epidemiology of Disasters, 2023: EM-DAT: The International Disaster Database, https://emdat.be.

The World Bank, 2023: Data, GDP (current US$), https://data.worldbank.org/indicator/NY.GDP.MKTP.CD.

Note: the hazard classification is based on EM-DAT hazard type; the bubbles are event-specific; the size of a bubble relates reported economic losses from weather-, climate- and water-related extremes to countries’ annual Gross Domestic Products.

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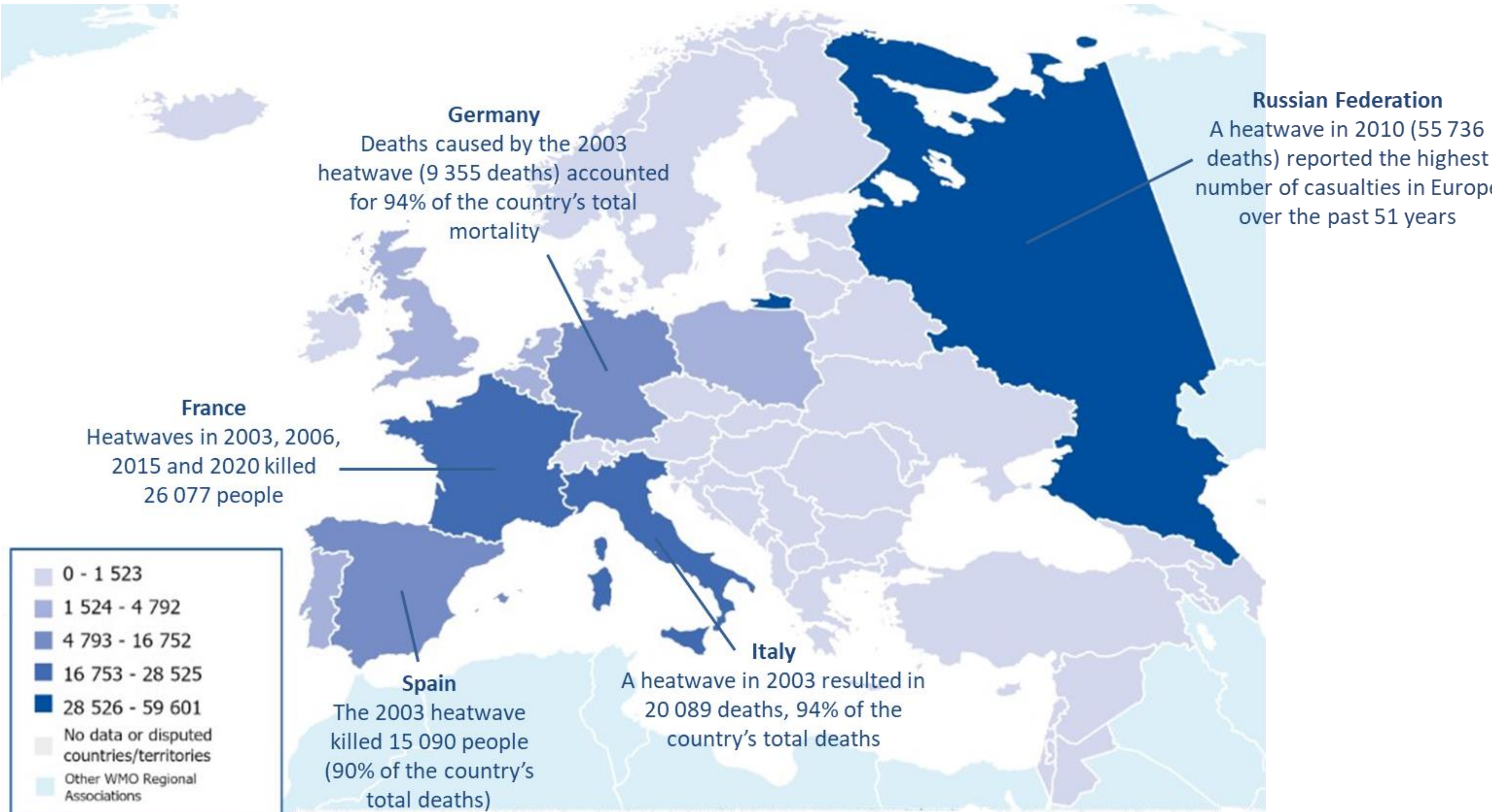
European Statistics

- 1,672 recorded disasters cumulated 159,438 deaths and US$ 476.5 billion in economic damages from 1970–2019
- Extreme temperatures accounted for the highest number of deaths (93%), with 148,109 lives lost over the 50 years
- Floods (36%) and storms (44%) incurred the most economic losses in the Europe

Reported deaths in Europe (1970-2021)



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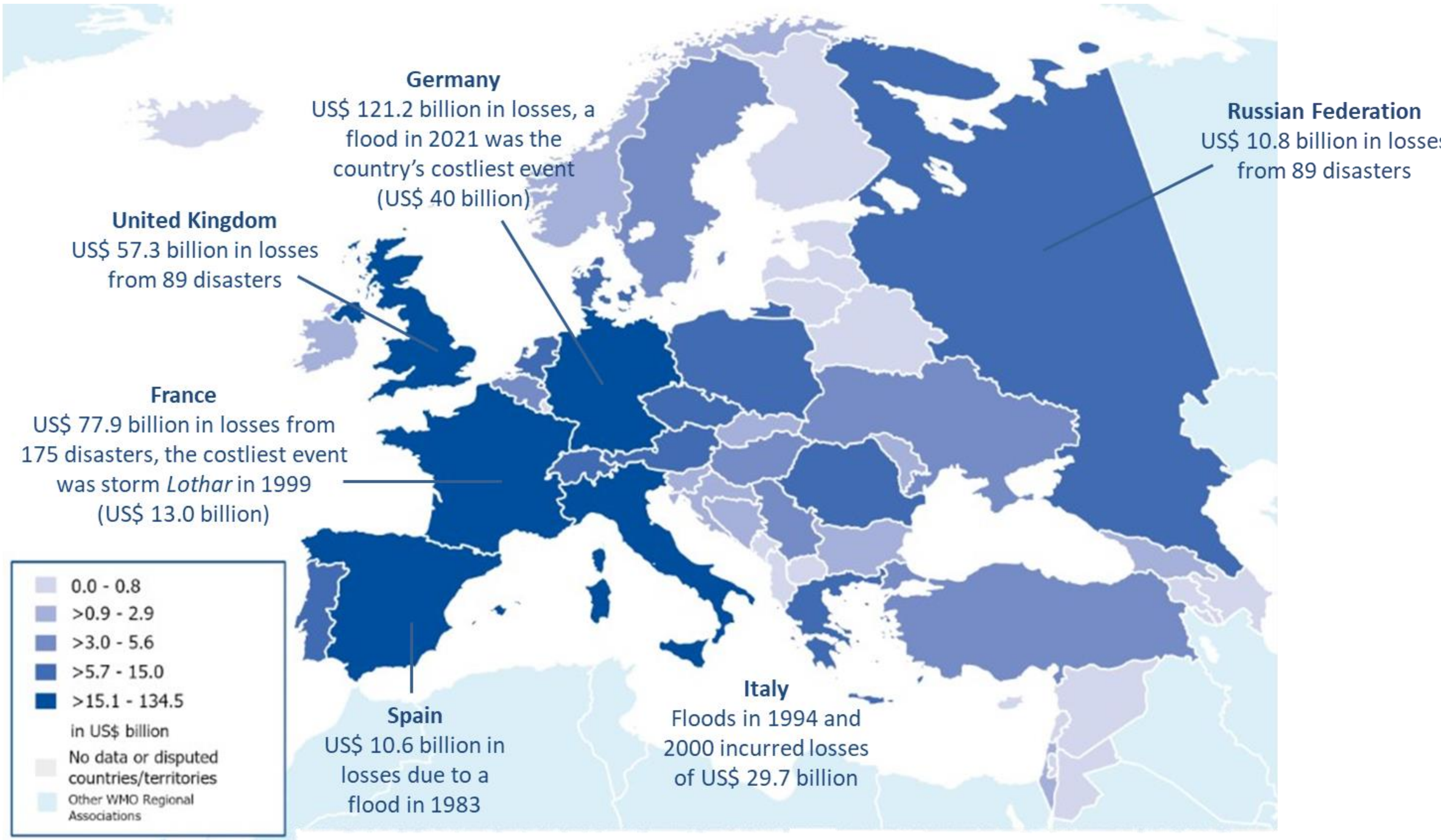
Reported economic losses in Europe (1970-2021)



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Top 10 disasters in Europe ranked according to reported deaths (1970–2019)

(a)	Disaster type	Year	Country	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	2015	France	3 275
7	Extreme temperature	2003	Portugal	2 696
8	Extreme temperature	2006	France	1 388
9	Extreme temperature	2003	Belgium	1 175
10	Extreme temperature	2003	Switzerland	1 039

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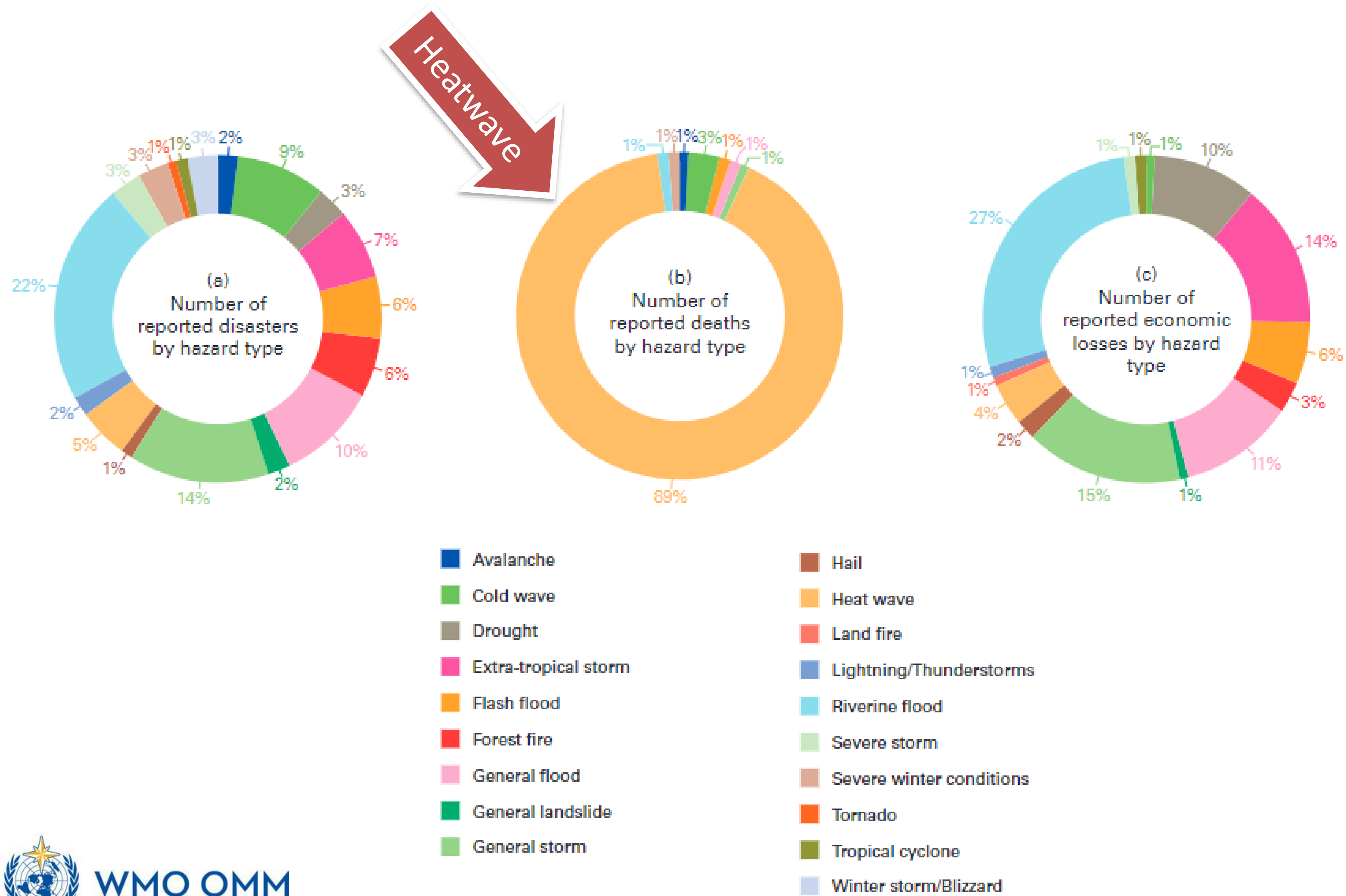
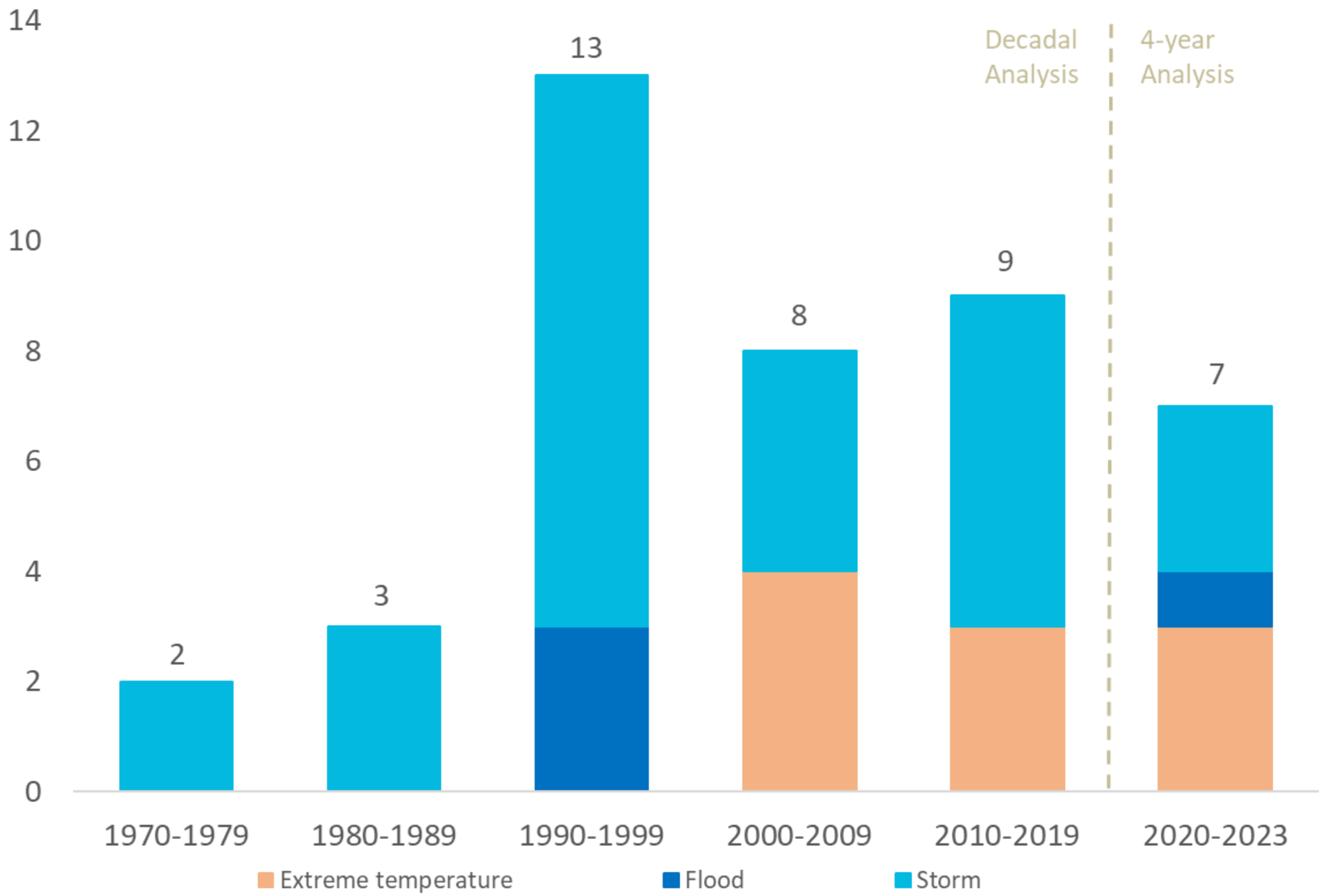
Top 10 disasters in Europe ranked according to reported economic losses (1970–2019)

(b)	Disaster type	Year	Country	Economic losses (in US$ billion)
1	Flood	2002	Germany	16.48
2	Flood	1994	Italy	16.03
3	Flood	2013	Germany	13.86
4	Storm	1999	France	12.27
5	Flood	2000	Italy	11.87
6	Flood	1983	Spain	10.0
7	Drought	1990	Spain	8.81
8	Flood	2000	United Kingdom	8.75
9	Storm	2007	Germany	6.78
10	Storm	1990	United Kingdom	6.65

Distribution of (a) number of disasters, (b) number of deaths and (c) economic losses by hazard in Europe (1970–2019)



Reported disasters in the Netherlands (1970-2023)



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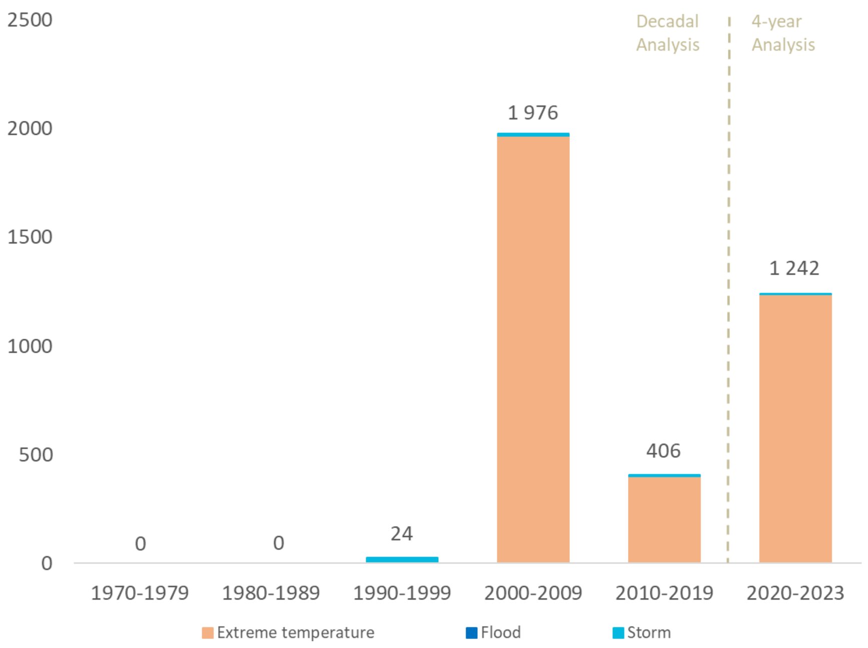
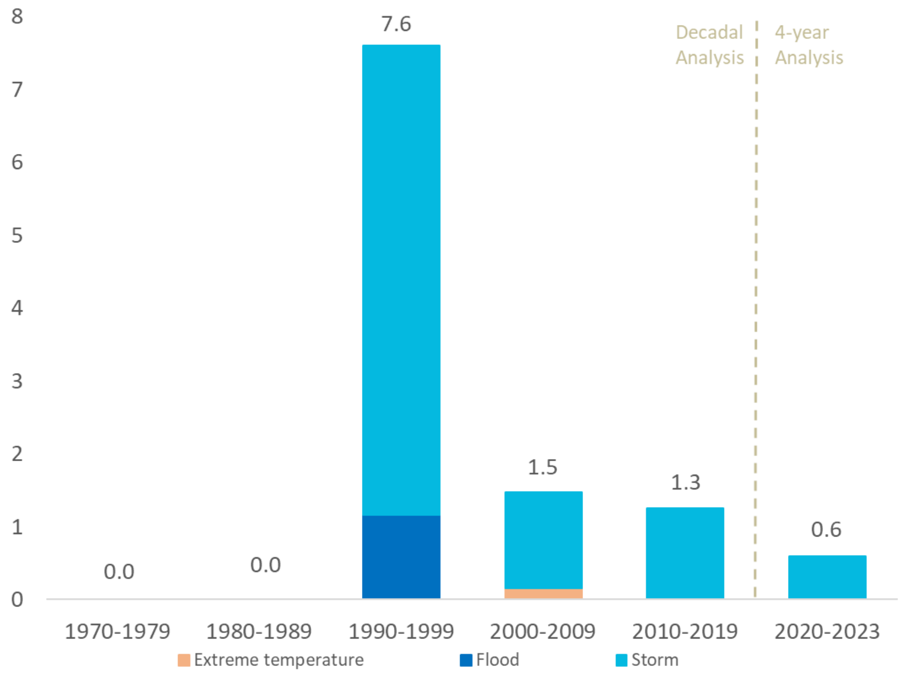
Reported Economic losses and deaths in the Netherlands (1970-2023)





Natural hazards that impact the Netherlands

- Extreme temperature
- Floods
- Storms

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European heatwaves of 2003 & 2010

According to the forthcoming WMO Atlas of Mortality and Economic losses from Weather, Climate and Water Extremes 1970 – 2019.

- Two extreme heatwave events of 2003 and 2010 in Europe accounted for the highest proportion of deaths (80%), with 127,946 lives lost during the period.
- The 2003 heatwave alone was responsible for half of the deaths in Europe (45%) with a total of 72,210 deaths among 15 affected countries.
- The lessons learnt from these heatwaves led to significant improvements in Multi-hazard Early Warning Systems in the European countries

Why is DRR and Climate Adaptation Important?

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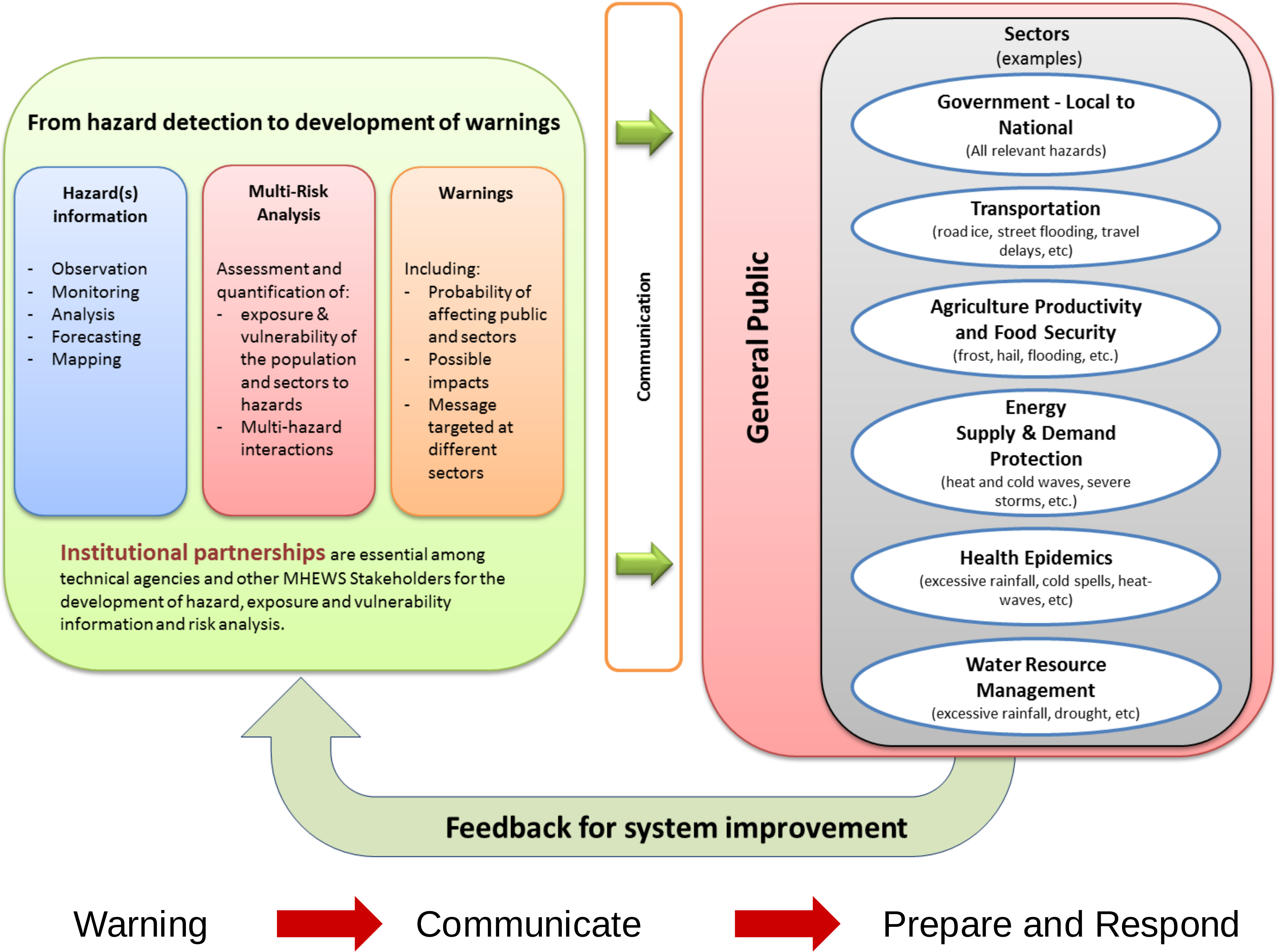
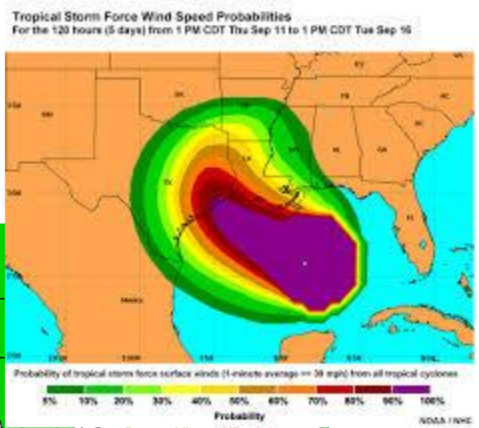
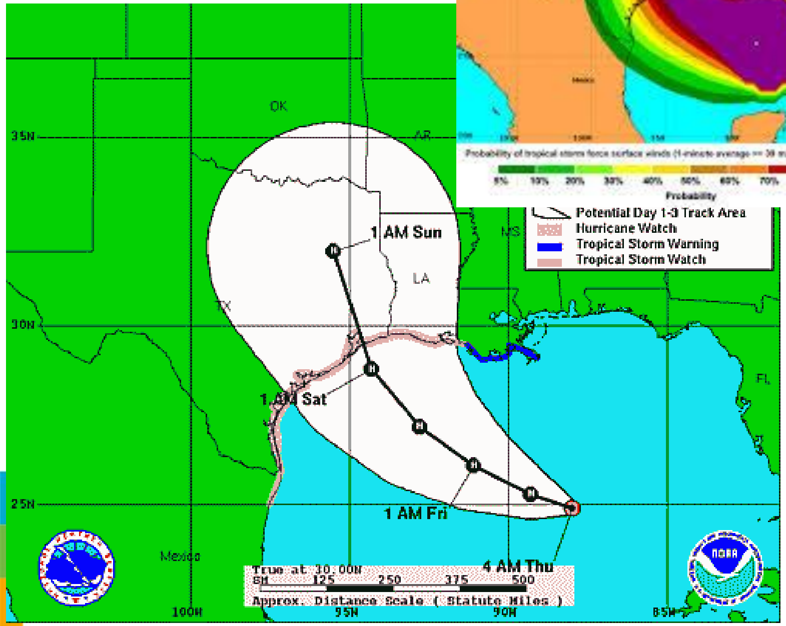
Multi-Hazard Early Warning System

Warnings that Utilizes and Incorporates Impact & Risk information to Identify and Inform Specific At-Risk Groups



Hurricane Rita (Sept 2005)
The most intense tropical cyclone on record in the Gulf of Mexico, stronger than Hurricane Katrina





Forecast

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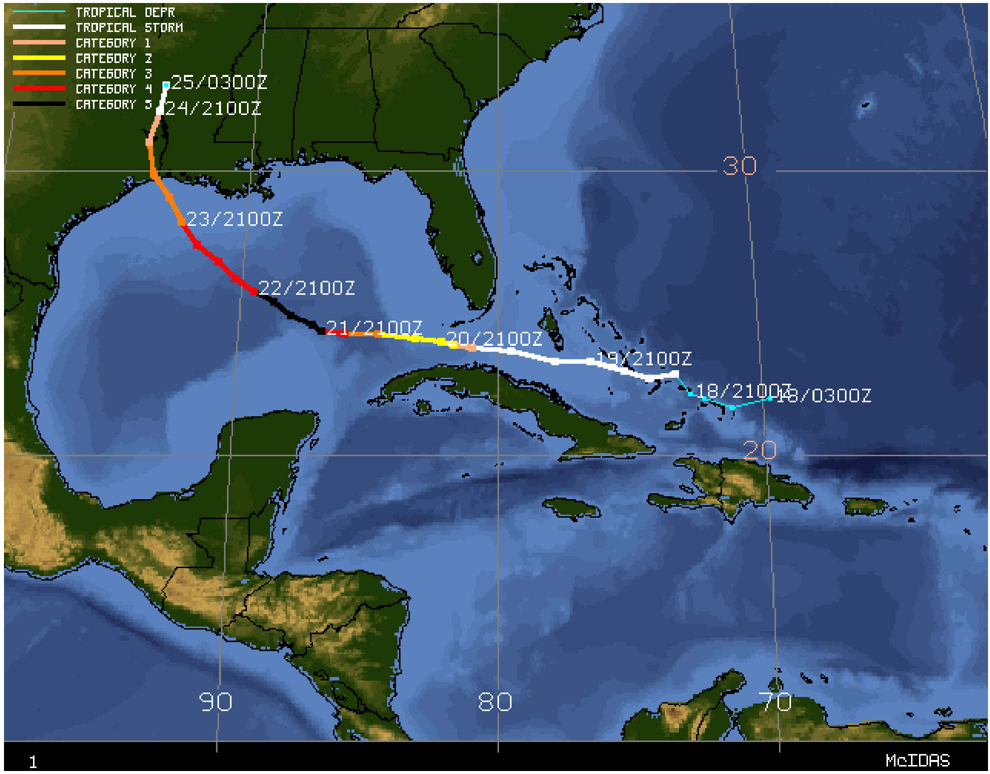
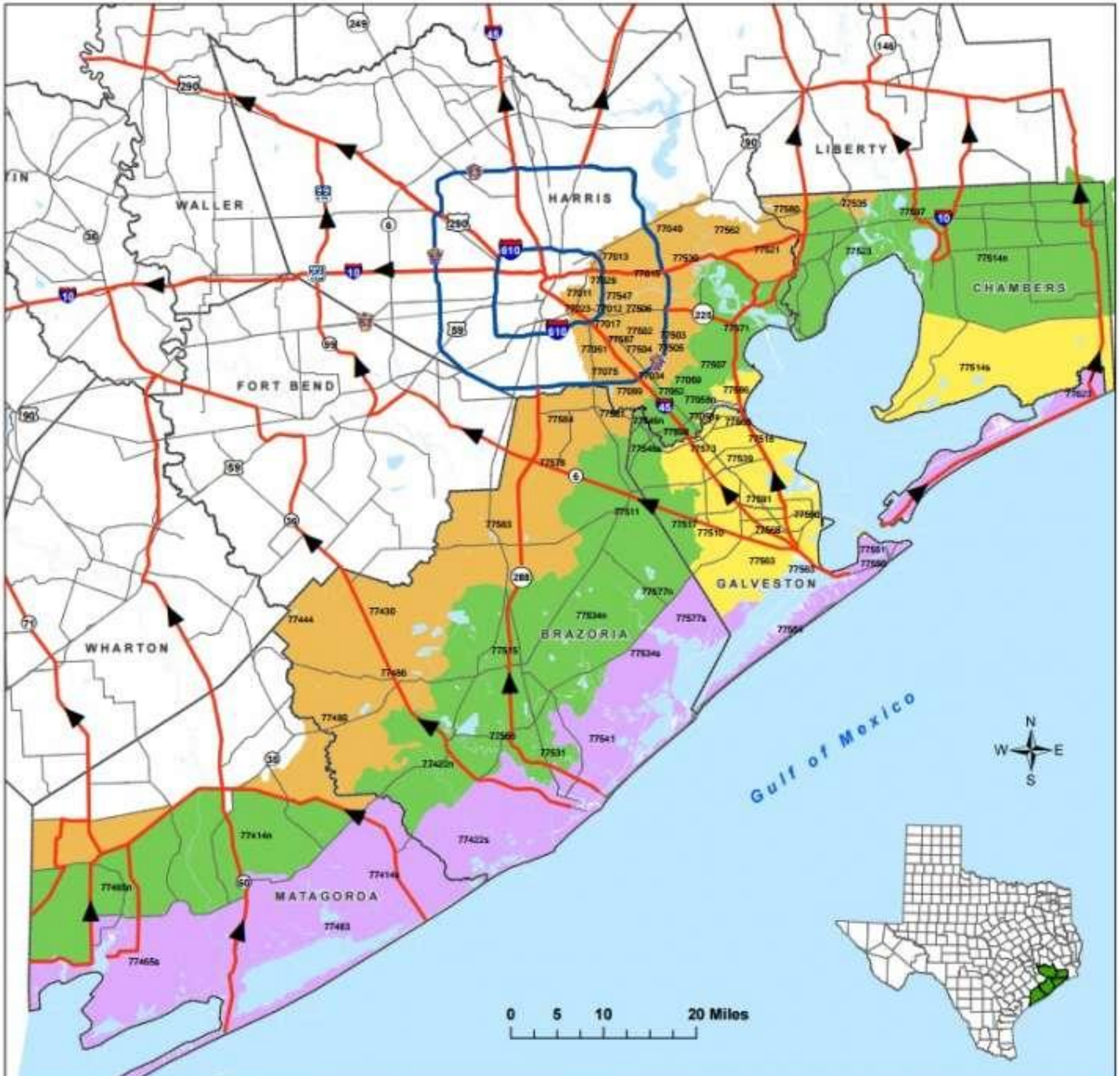
Actual



One of the largest evacuations in United States history: estimated 2.5 – 3.7 million people fled prior to Rita's landfall

The combination of severe gridlock and excessive heat led to between 90 and 118 deaths even before the storm arrived.



Brazoria, Chambers, Galveston, Harris and Matagorda Hurricane Evacuation Zip-Zones Coastal, A, B, C

ZIP ZONE COASTAL				
77414s	77422s	77465s	77483	77534s
77541	77550	77551	77554	77563
77577s	77623			
ZIP ZONE A				
77058s	77510	77514s	77518	77539
77563	77565	77568	77573	77586
77590	77591			
ZIP ZONE B				
77058n	77059	77062	77414n	77422n
77465n	77507	77511	77514n	77515
77517	77523	77531	77534n	77546n
77546s	77566	77571	77577n	77597
77598				
ZIP ZONE C				
77011	77012	77013	77015	77023
77029	77034	77049	77061	77075
77087	77089	77430	77486	77502
77503	77504	77505	77506	77521
77530	77535	77536	77547	77562
77578	77580	77581	77583	77584
77587				

Route Designation

- Evacuation Corridors
- Evacuation Connections
- Other Roads
- County Boundary

Expiration Date: December 31, 2015
Revised: April 21, 2015
Map Created by:
Houston-Galveston Area Council

Strengthening Infrastructure

[Hurricane Michael (2018)
Florida, Mexico Beach, USA]

[Hurricane Ike (2008),
Galveston TX, USA]

Estimates vary but building a house to withstand a category 5 hurricane range to adding 7% to the value of the house to as much as 30,000 USD additional.

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Summary questions:

- Do governments know the risks to their people?
  - Direct risks (Medium- and long-term tropical cyclone, heatwave)
  - Indirect risks (downriver effects of flooding)
  - Complex risks (i.e. Japan earthquake scenario)
- Do governments actively seek to reduce risk?
  - Early warning systems
  - Medium- and long-term planning
  - Financial mechanisms
- Are governments prepared to act when the situation warrants?
  - Save lives before and during the event
  - Protect essential infrastructure during and after the event
- Are governments learning?
  - Post disaster reviews and reports on gaps and needs
  - Feedback from people and industry

Thank you

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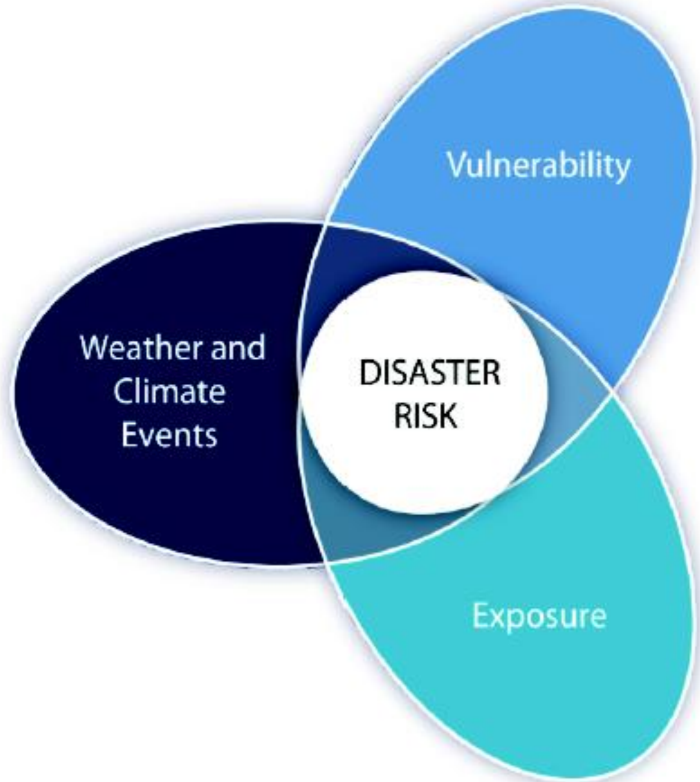
Organisation météorologique mondiale

What is Risk?



- Hazard Events
- Exposure
- Vulnerability