

DISASTER RISK MANAGEMENT

Universita di Roma Tor Vergata
B.A. Global Governance

Spring 2022

Session 2 – April 25, 2022

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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.

Fast-onset or slow onset

Natural or human-induced

Talk in terms of frequency and intensity

Geological (Land based)

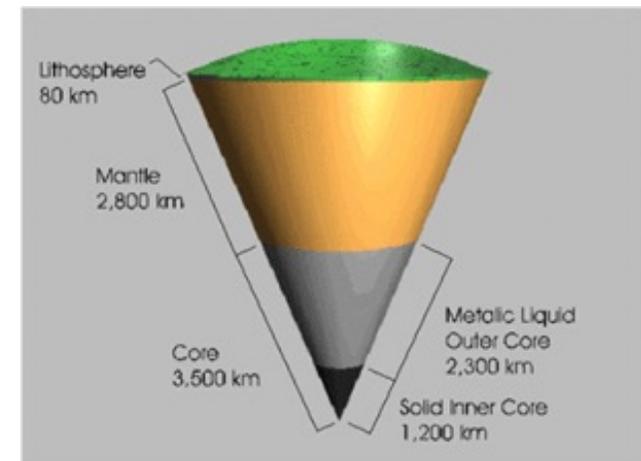
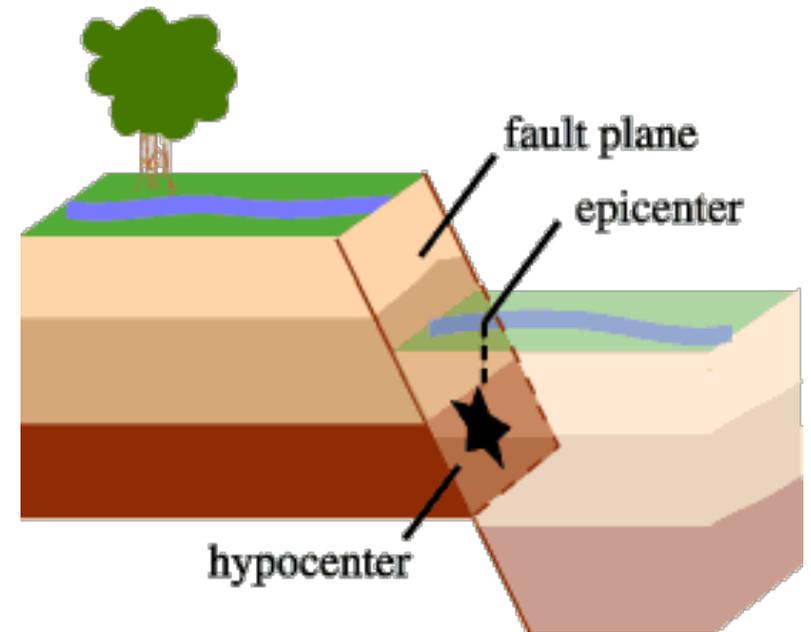
Earthquake

An *earthquake* is what happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the *fault* or *fault plane*. The location below the earth's surface where the earthquake starts is called the *hypocenter*, and the location directly above it on the surface of the earth is called the *epicenter*.

Foreshocks – Smaller earthquakes that happen in the same place as the larger earthquake that follows.

Mainshock – Largest, main earthquake is called the *mainshock*.

Aftershocks – Smaller earthquakes that occur afterwards in the same place as the mainshock. Aftershocks can continue for weeks, months, and even years after the mainshock!



Source: USGS

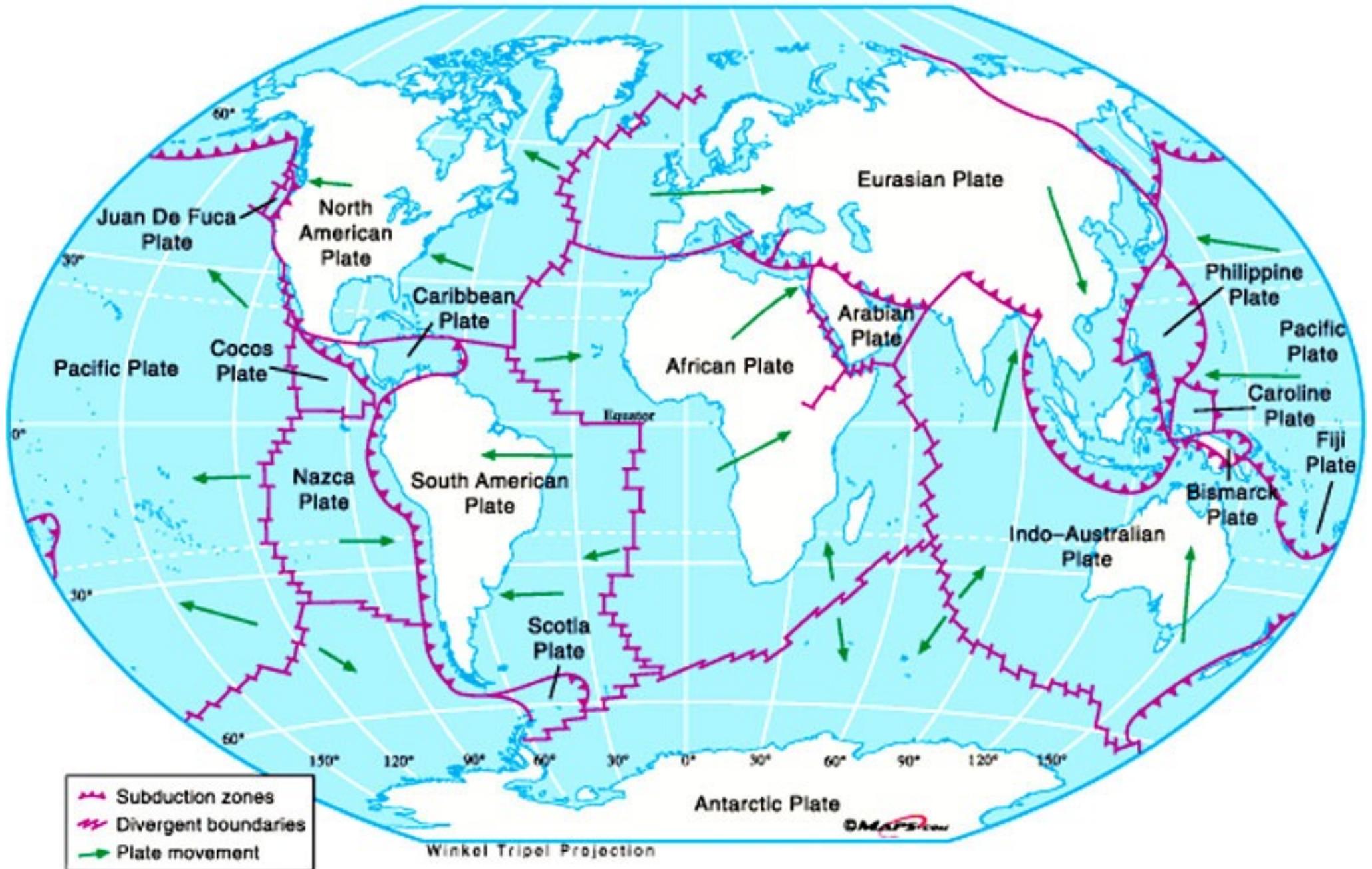
Earthquake

Magnitude	Description	Earthquake effects	Frequency of occurrence
Less than 2.0	Micro	Micro earthquakes, not felt. ^[14]	Continual
2.0–2.9	Minor	Generally not felt, but recorded.	1,300,000 per year (est.)
3.0–3.9		Often felt, but rarely causes damage.	130,000 per year (est.)
4.0–4.9	Light	Noticeable shaking of indoor items, rattling noises. Significant damage unlikely.	13,000 per year (est.)
5.0–5.9	Moderate	Can cause major damage to poorly constructed buildings over small regions. At most slight damage to well-designed buildings.	1,319 per year
6.0–6.9	Strong	Can be destructive in areas up to about 160 kilometres (99 mi) across in populated areas.	134 per year
7.0–7.9	Major	Can cause serious damage over larger areas.	15 per year
8.0–8.9	Great	Can cause serious damage in areas several hundred kilometres across.	1 per year
9.0–9.9		Devastating in areas several thousand kilometres across.	1 per 10 years (est.)
10.0+	Massive	Never recorded, widespread devastation across very large areas; see below for equivalent seismic energy yield.	Extremely rare (Unknown/May not be possible)

(Based on U.S. Geological Survey documents.)^[15]

Earthquake

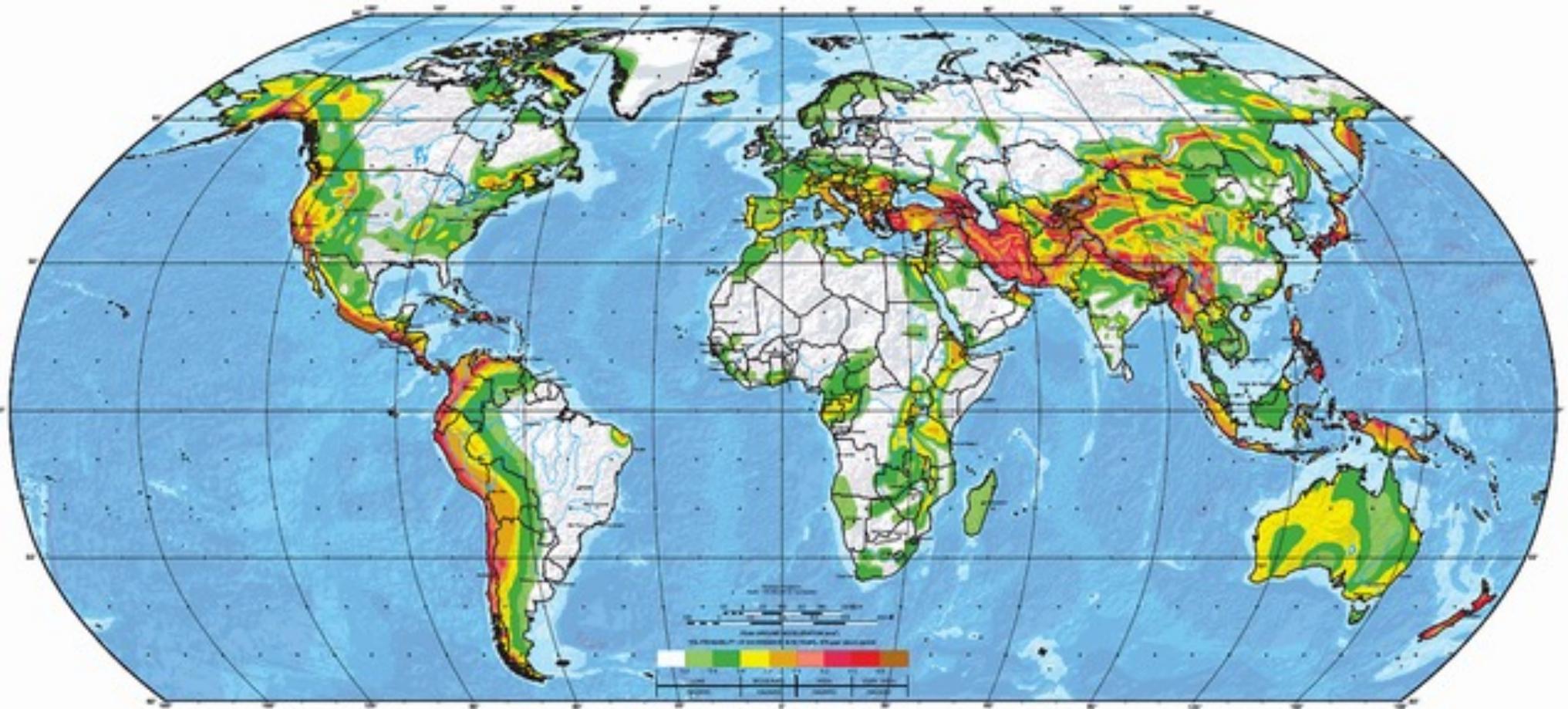
Earth's Tectonic Plates



Earthquake

GLOBAL SEISMIC HAZARD MAP

Produced by the Global Seismic Hazard Assessment Program (GSHAP),
a demonstration project of the UN/International Decade of Natural Disaster Reduction, conducted by the International Lithosphere Program.
Global map assembled by G. Giardini, G. Grünthal, K. Shedlock, and F. Zhang
1999



Earthquake

Type of Margin	Divergent	Convergent	Transform
Motion	Spreading	Subduction	Lateral sliding
Effect	Constructive (oceanic lithosphere created)	Destructive (oceanic lithosphere destroyed)	Conservative (lithosphere neither created or destroyed)
Topography	Ridge/Rift	Trench	No major effect
Volcanic activity?	Yes	Yes	No

The diagrams illustrate three types of plate tectonic margins:

- (a) Divergent Margin:** Shows two plates moving apart. A ridge forms at the center where magma rises from the asthenosphere through the lithosphere. Labels include "Ridge", "Lithosphere", and "Asthenosphere".
- (b) Convergent Margin:** Shows one plate moving under another. This process creates a trench, volcanic arcs, and earthquakes. Labels include "Volcanoes (volcanic arc)", "Trench", and "Earthquakes".
- (c) Transform Margin:** Shows two plates sliding past each other horizontally. Earthquakes occur within the crust. Label includes "Earthquakes within crust".

Landslide

Landslides occur when masses of rock, earth, or debris move down a slope. They may be very small or very large, and they can move at slow to very high speeds. Many occur at the same place since prehistoric times. New ones may be triggered by:

Natural causes such as:

- Groundwater pressure acting to destabilize the slope
- Loss or absence of vertical vegetative structure, soil nutrients, etc.
- Erosion of a slope
- Earthquake, or liquefaction due to earthquake
- Volcanic eruptions

Human activities such as:

- Deforestation, cultivation and construction which destabilize a slope
- Vibration from machinery or traffic
- Blasting
- Earthwork which brings new loads on existing slope or change the amount of water that gets into the soil

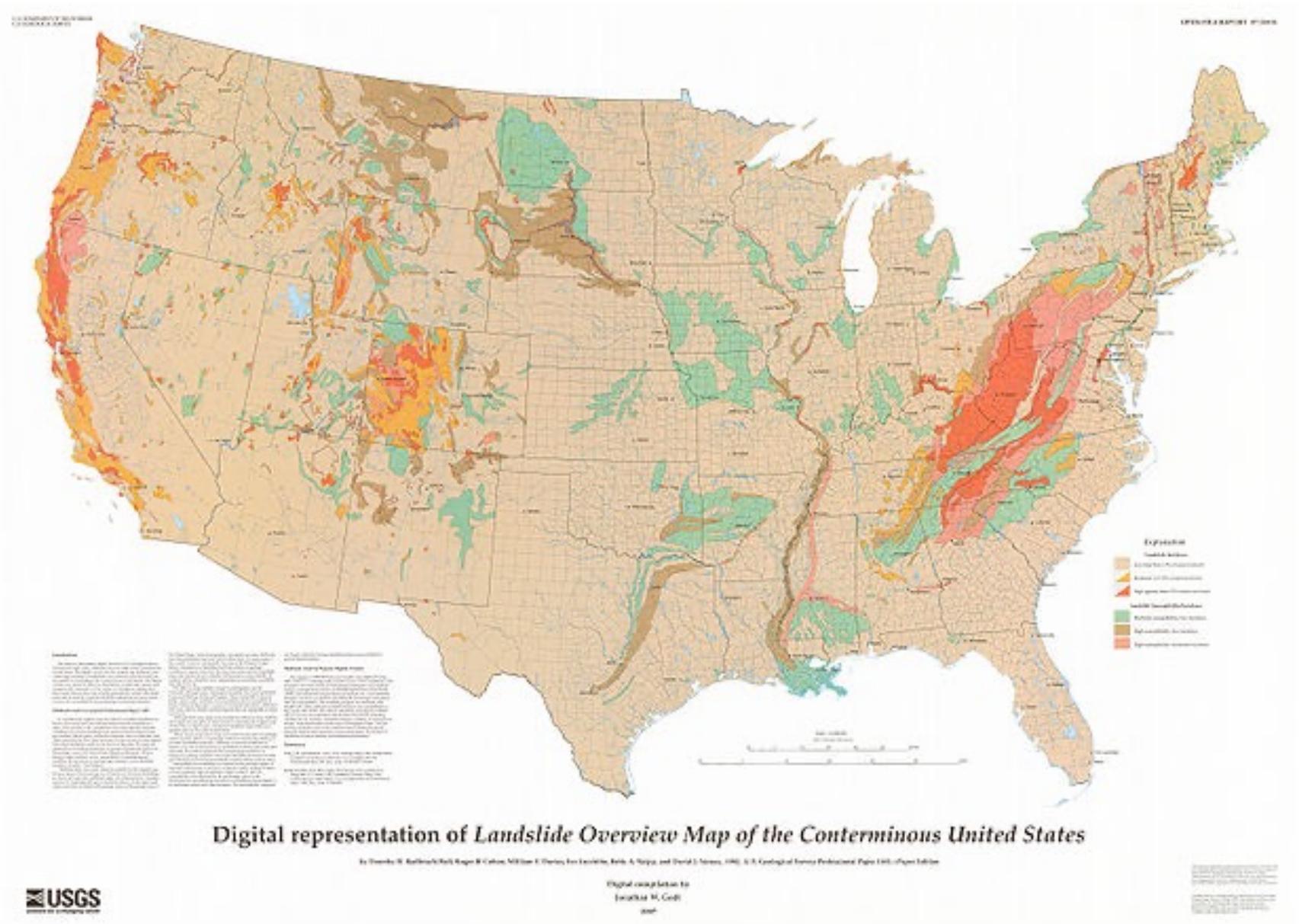
Landslide



Landslide



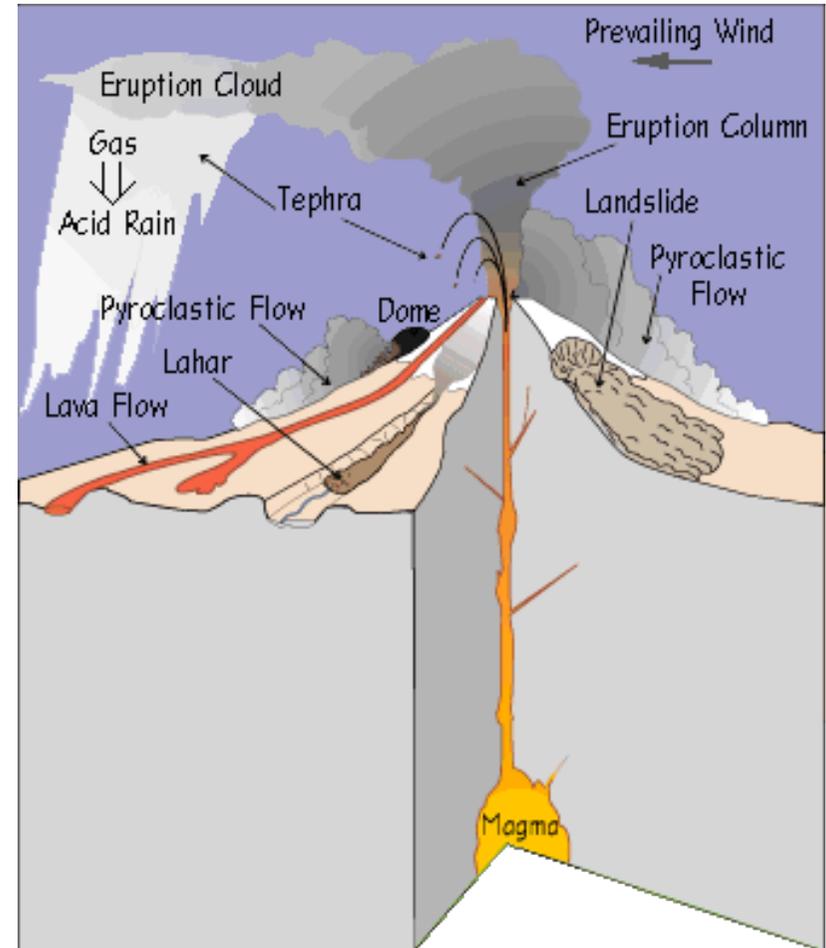
Landslide



Volcanic Eruption

A volcano is a mountain that opens downward to a reservoir of molten rock below the surface of the earth. Unlike most mountains, which are pushed from below, volcanoes are built up by an accumulation of their own eruptive products – lava, ash flows, and airborne ash and dust.

Volcanic eruptions are one of Earth's most dramatic and violent agents of change. Not only can powerful explosive eruptions drastically alter land and water for tens of kilometers around a volcano, but tiny liquid droplets of sulfuric acid erupted into the stratosphere can change our planet's climate temporarily.



Volcanic Eruption – Ring of fire



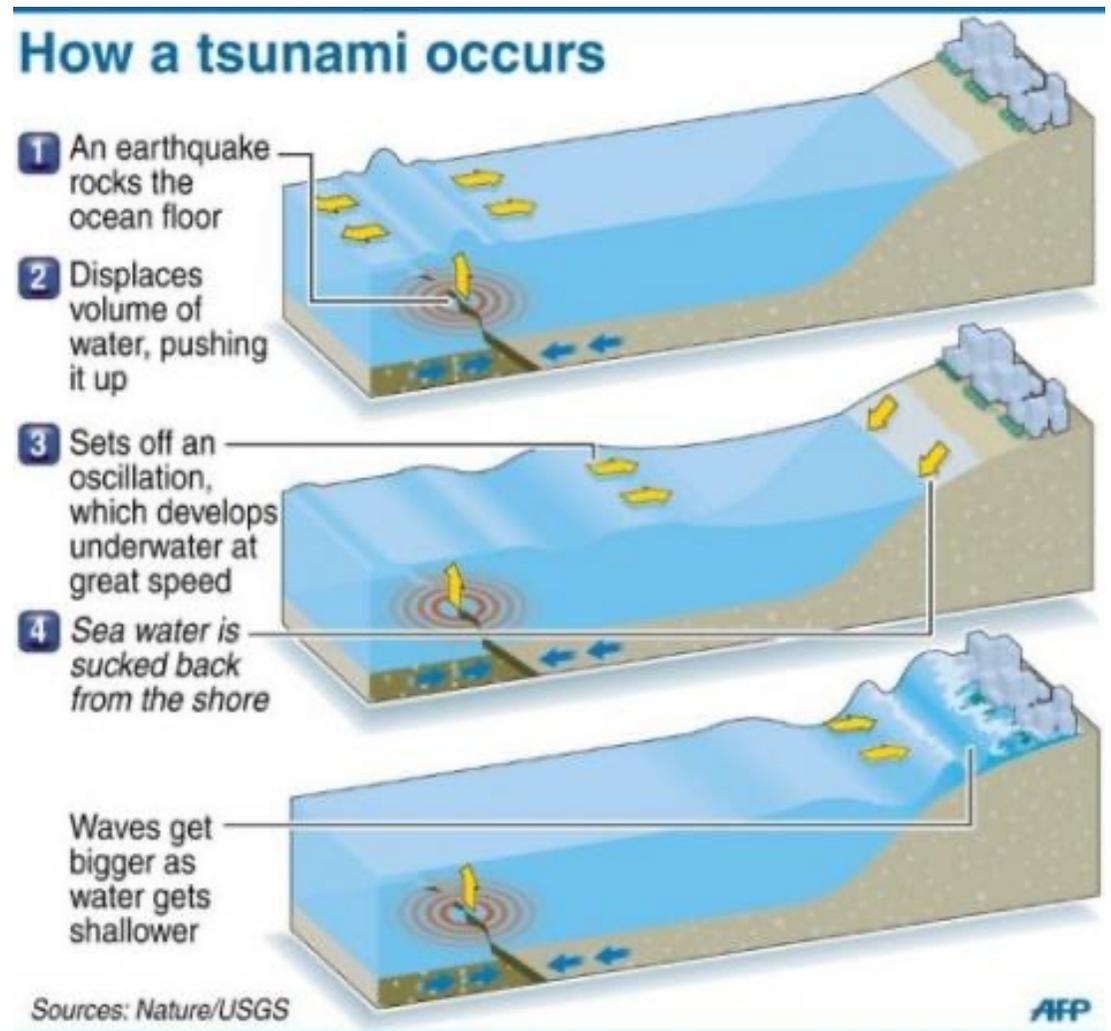
Volcanic Eruption – Iceland April 2010



Tsunami

A Tsunami (Harbor Wave), also known as tidal wave, is a series of waves in a body of water caused by the displacement of a large volume of water, generally in an ocean or a large lake.

Earthquakes, volcanic eruptions, and other underwater explosions, landslides, glacier calvings, meteorite impacts, and other disturbances above or below water all have the potential to generate a tsunami



**Hydrological
(Water based)**

Coastal Erosion

Coastal erosion is the wearing away of land and the removal of beach or dune sediments by wave action, tidal currents, wave currents, drainage or high winds. Waves, generated by storms, wind, or fast moving motor craft, cause coastal erosion, which may take the form of long-term losses of sediment and rocks, or simply the temporary redistribution of coastal sediments

Coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time.

West Africa Coastline – 10/20m per year

Picture from UK: 40m in 9 years



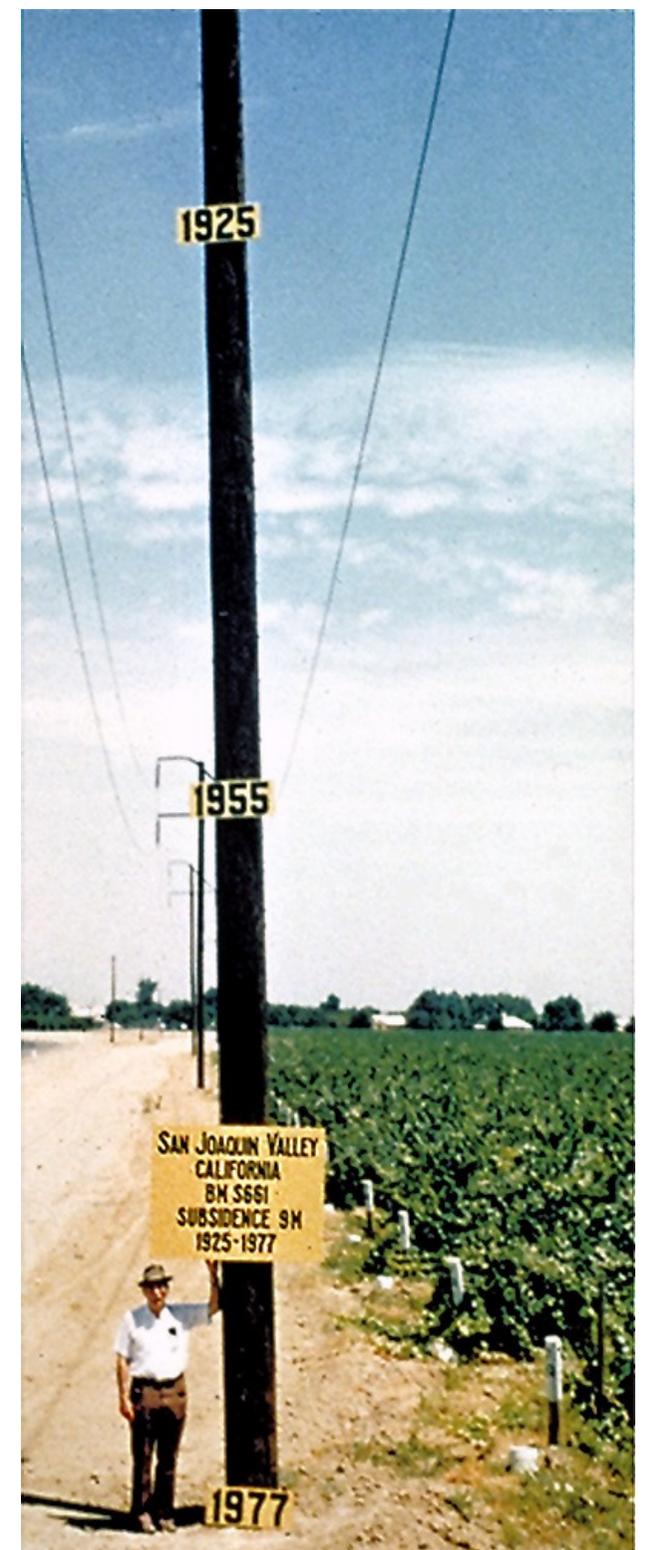
Land Subsidence

Land subsidence occurs when large amounts of groundwater have been withdrawn from certain types of rocks, such as fine-grained sediments.

The rock compacts because the water is partly responsible for holding the ground up. When the water is withdrawn, the rocks fall in on itself.

You may not notice land subsidence too much because it can occur over large areas rather than in a small spot.

Picture: 9m in 50 years (18cm/year)



Source: USGS

Sinking cities



Chris Earle

Jakarta among fastest sinking cities

13cm/year

Manila (10 cm/year)

Ho Chi Minh City (8cm/year)

Shanghai: 2.8 m

Tokyo: 5 m

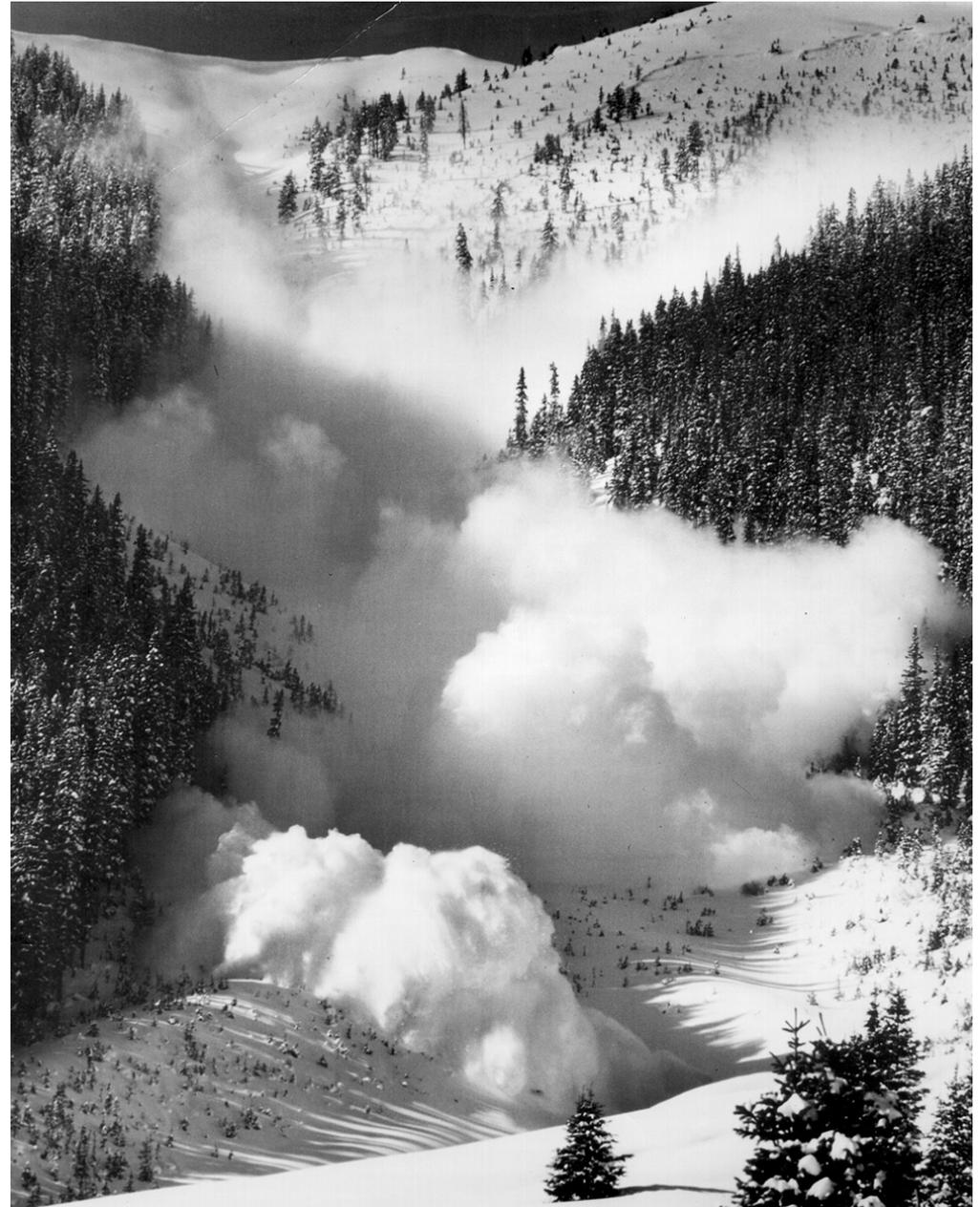
LA/Long Beach: 9 m

Bangkok: 1.6 m

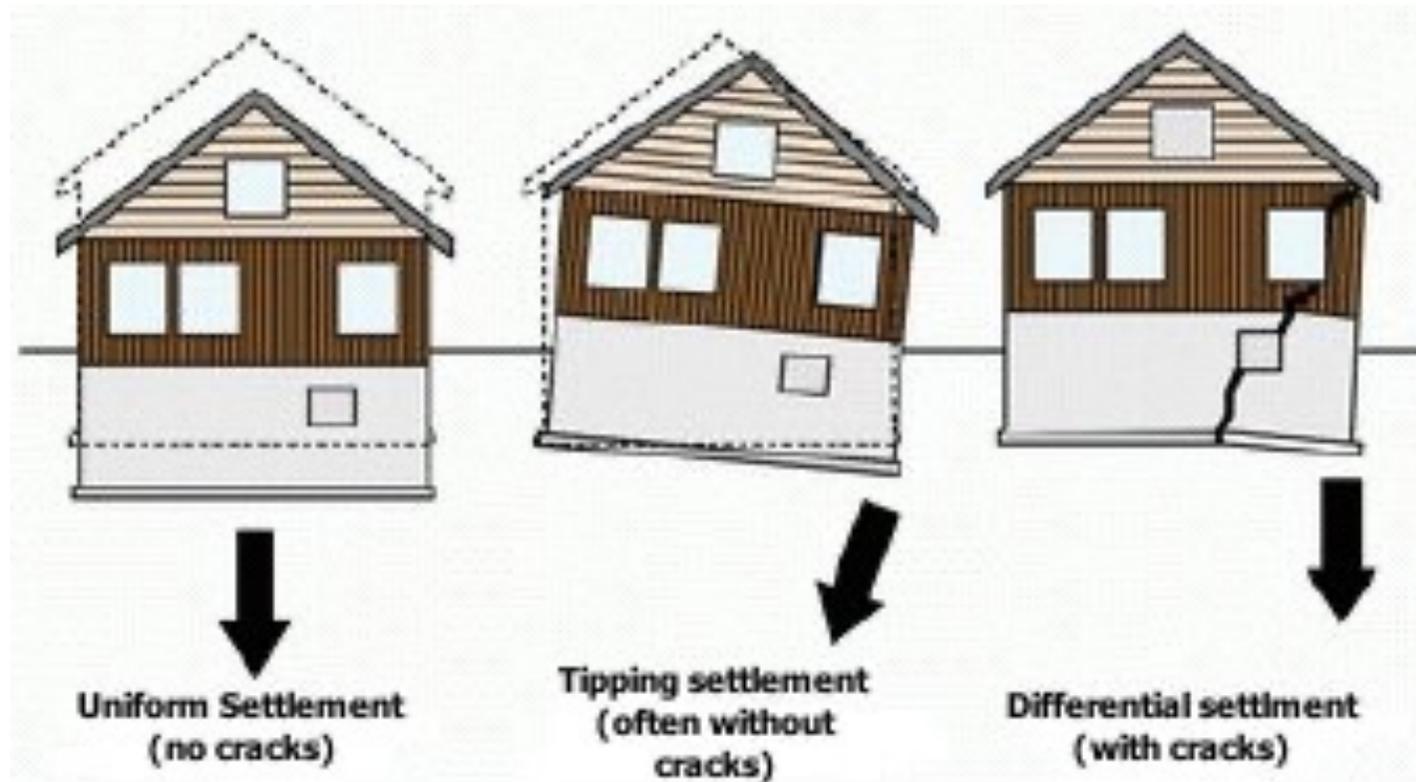
Tianjin: 2.63 m

Snow Avalanche

A snow avalanche is sliding snow or an ice mass that moves at high velocities. Natural and human induced snow avalanches most often result from structural weaknesses within the snow pack. The potential for a snow avalanche increases with significant temperature influences.



Expansive soil



Soils and soft rock that tend to swell or shrink because of changes in moisture content are commonly known as expansive soils.

Meteorological (Air based)

Extreme Heat

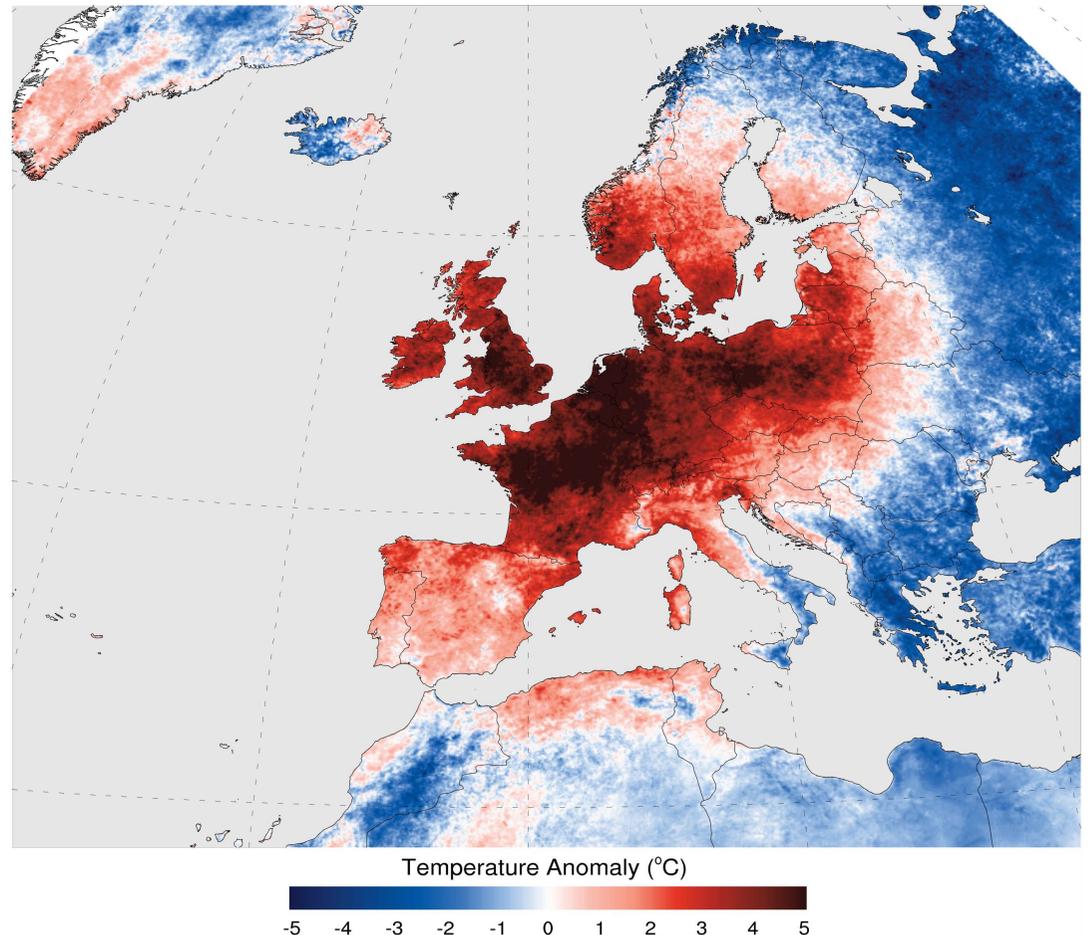
An **Excessive Heat Warning** is issued by the National Weather Service within 12 hours of the heat index reaching one of two criteria levels.

In most areas, a warning will be issued if there is a heat index of

At least 40.5°C for more than 3 hours per day for 2 consecutive days, or

If the heat index is greater than 46°C for any period of time.

Note that local offices, particularly those where excessive heat is less frequent or in areas with deserts or mountainous terrain, often have their own criteria.



*Source: Europe
Heat wave 2006*

Wild Fire

Wildfires are classified into three categories:

- A surface fire is the most common type and burns along the floor of a forest, moving slowly and killing or damaging trees
- A ground fire is usually started by lightning and burns on or below the forest floor
- A crown fire spreads rapidly by wind and moves quickly by jumping along the tops of trees.



Hydrometeorological

Flood

A **flood** is an overflow of water that submerges land which is usually dry

Floods can be slow or fast rising and generally develop over a period of days. They most often occur from large-scale weather systems generating prolonged rainfall and/or onshore winds

Floods are the most frequent and widespread disaster in many countries around the world.



INDEX OF SCENARIOS
EVACUATION SYSTEMS & SHELTER STRATEGIES

attern and the evolving,
quires a combination of
anding the hazard, re-
ducing its risk and dealing with its impact

Convective Storms
Up to 200mm of rainfall in a few hours over very localized areas

Low-lying areas and estuaries are especially exposed to various level of flooding.

Flooding can occur away from known watersheds either through steep slope run off, insufficient drainage capacity (clogging, impervious surface concentration) or else

Cyclones
Up to 600 mm and can affect the entire country

Tropical Waves
Larger disturbances producing up to 400 mm in a 24 hour period

SCENARIO 1 - COASTAL CONDITIONS

SCENARIO 2 - VALLEY CONDITIONS

SCENARIO 3 - MOUNTAINOUS CONDITIONS

Valley of Vulnerability

Coastal Plain (Aval)
Flood Prone | Vertical Strategies

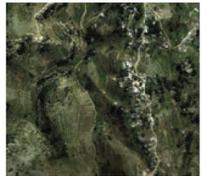
Mid-Slope
Co-location | Distributed Densities | Growing Pheripheries

Uphill (Amont)
Dispersed Density | Rural Farmland

Sources: World Bank, Natural Disaster Ho...ots, A Global Risk Analysis (Washington, DC: Disaster Risk Management Series, 2005), table 1.2, including tropical depression, storms and hurricanes...educing Disaster Risk, a Challenge for Development (UNDP 2004), 4 Report of the PPCR Expert group - Proposal for selection of pilot programs, C...ate Investment Funds, 2009



Village



Village



Village

SCENARIO 3 - MOUNTAINOUS CONDITIONS

Mountainous settlements are characterized as mostly rural and very scattered across vast, varied terrain. Most of these territories have very steep slopes and accessibility in relation to other settlements is hard. This zone is representative of areas like Ivoire, Giulbert, Font Batisse, Leou, Petit Bois and Kenscoff amongst others.

Risks: High Speed Winds, Landslides, Torrential Downpours

1. Co-location: school, church, regional market, mill, bus junction, cooperatives
2. Infrastructure sharing / split program: water, fuel, cash, food.
3. Clear accessibility: Road bridge, lighting, roof, ladder, ditches, gutter clearing
4. Orientation: cluster planting (windward), leeward development
5. Micro-mitigation: Planting, gabions for diversion, canals.





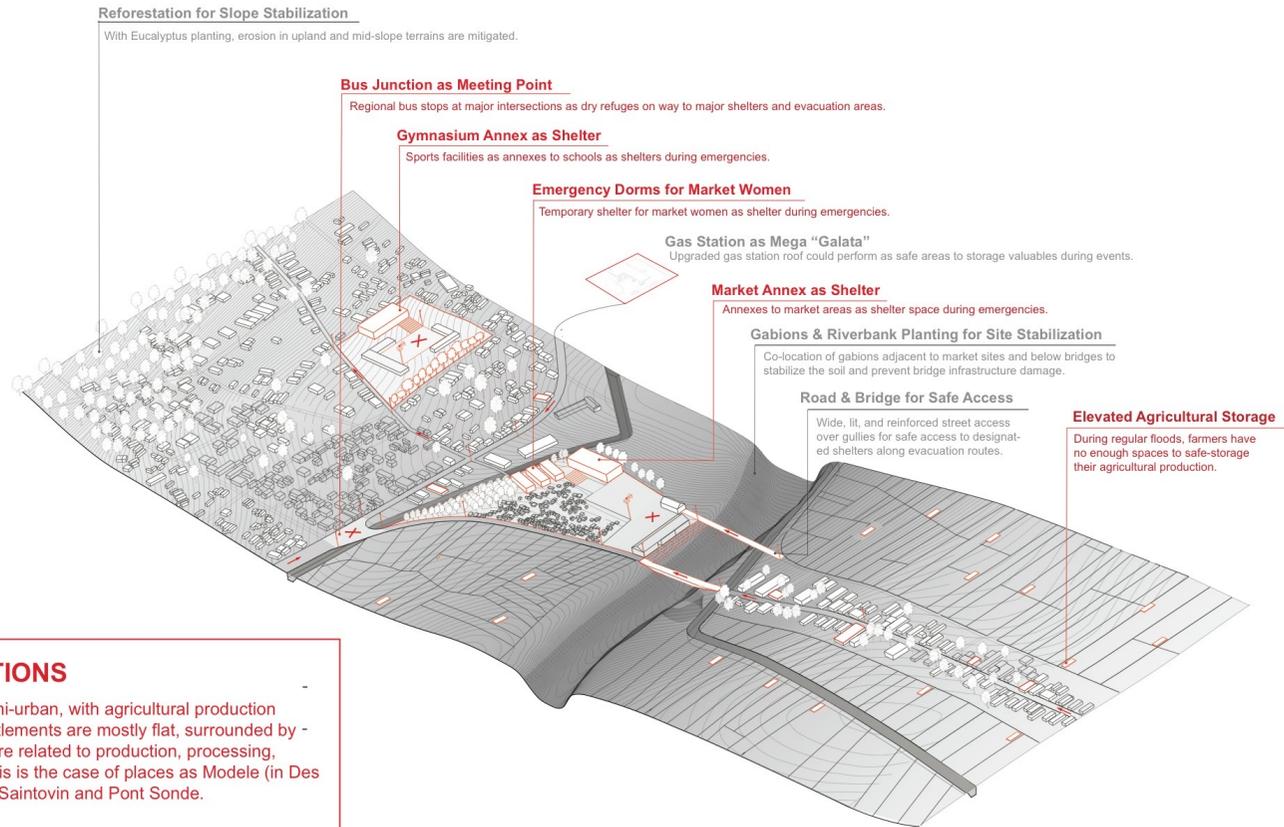
Desdunes



Petite Riviere



Pont Sonde



SCENARIO 2 - VALLEY CONDITIONS

Settlements in valleys are characterized for as semi-urban, with agricultural production regional markets and logistical infrastructures. Settlements are mostly flat, surrounded by regional agriculture and most of its infrastructure are related to production, processing, assembly and distribution of agricultural goods. This is the case of places as Modele (in Desdunes), Desdunes, Rossignol, Belague, Bertrang Saintovin and Pont Sonde.

Risks: Flash Floods, High Speed Winds, Cholera

1. Co-Location: regional market, mill, bus junction, dorms, school, church, cooperatives.
2. Infrastructure sharing / split program: water, fuel, cash, food.
3. Clear accessibility: road bridge, lighting, roof, ladder, ditches, gutter clearing
4. Orientations (interoperativity): cluster planting, wind, localized flooding
5. Micro-mitigation: slope plantings, cluster planting, gabions, canals.



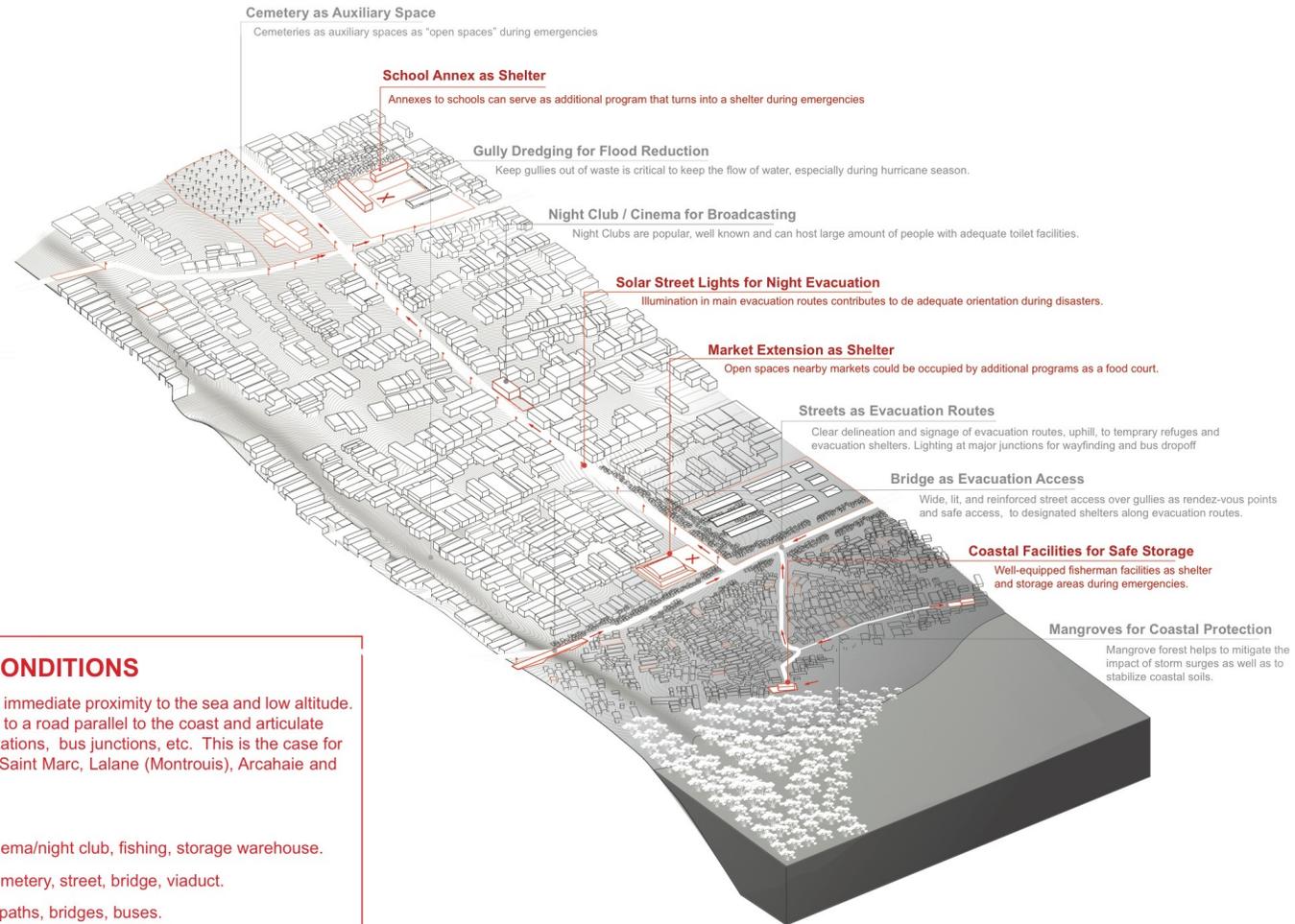
Gonaives



Port-au-Prince



Saint Marc



SCENARIO 1 - COASTAL CONDITIONS

Coastal settlements are characterized by its immediate proximity to the sea and low altitude. These settlements are generally connected to a road parallel to the coast and articulate the major infrastructures as markets, gas stations, bus junctions, etc. This is the case for settlements like Gonaives, Grande Saline, Saint Marc, Lalane (Montrouis), Arcahaie and Royale (Cabaret).

Risks: Flooding, Storm Surge, Congestion

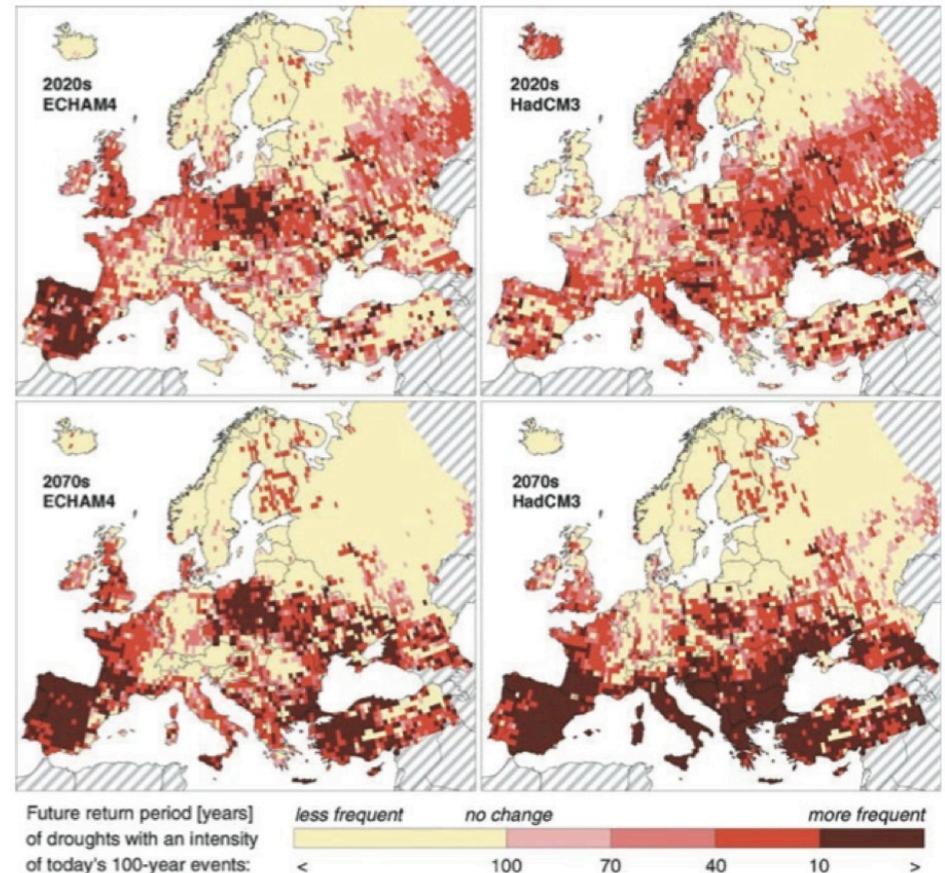
1. Co-location: School, church, market, cinema/night club, fishing, storage warehouse.
2. Infrastructure sharing / split program: cemetery, street, bridge, viaduct.
3. Clear accessibility: lights, street, roads, paths, bridges, buses.
4. Orientation (interoperativity): windward (waterside)
5. Micro-mitigation: gully breaks, gully dredging (waste), coastal mangroves, roofs.

Drought

Drought is an extended period when a region receives a deficiency in its water supply, whether atmospheric, surface or ground water. A drought can last for months or years, or may be declared after as few as 15 days.

Droughts differ from other natural hazards:

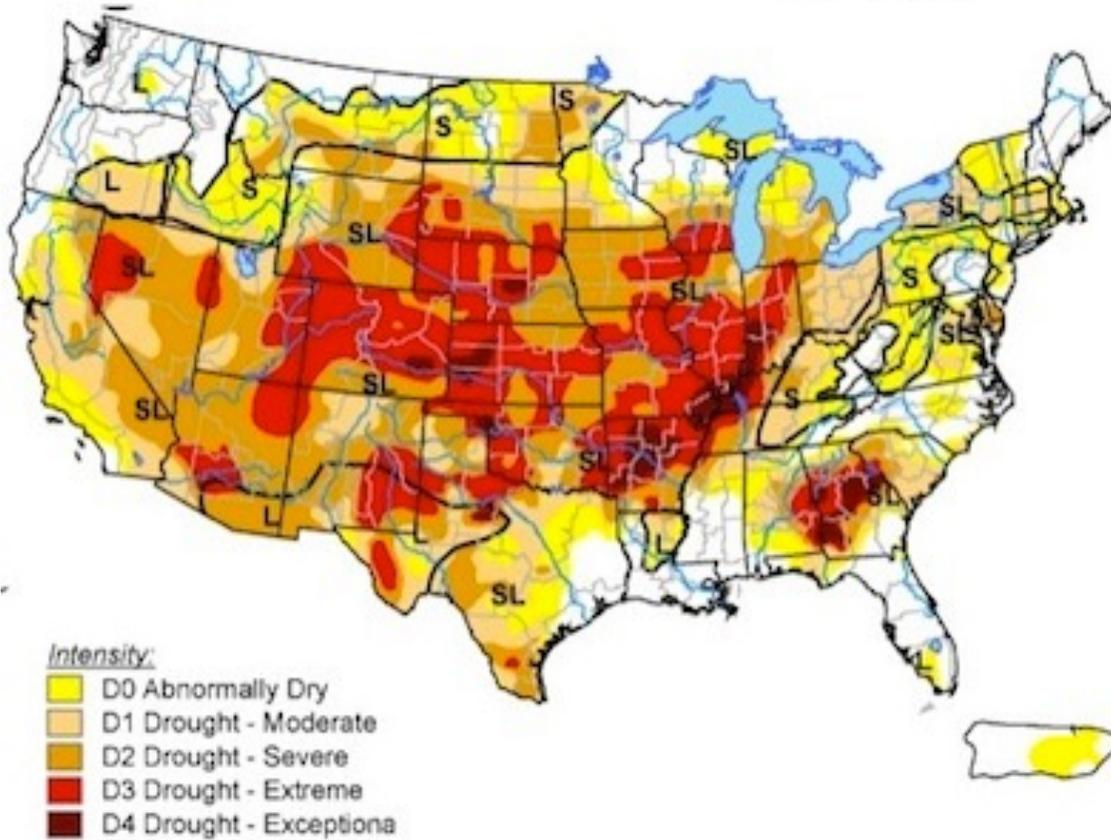
- The onset and the end are difficult to determine because the effects accumulate slowly and may linger after the drought end
- The absence of a precise and universally accepted definition
- The spread of drought effect over a large geographic area



Drought

U.S. Drought Monitor

July 24, 2012
Valid 7 a.m. EDT



<http://droughtmonitor.unl.edu/>

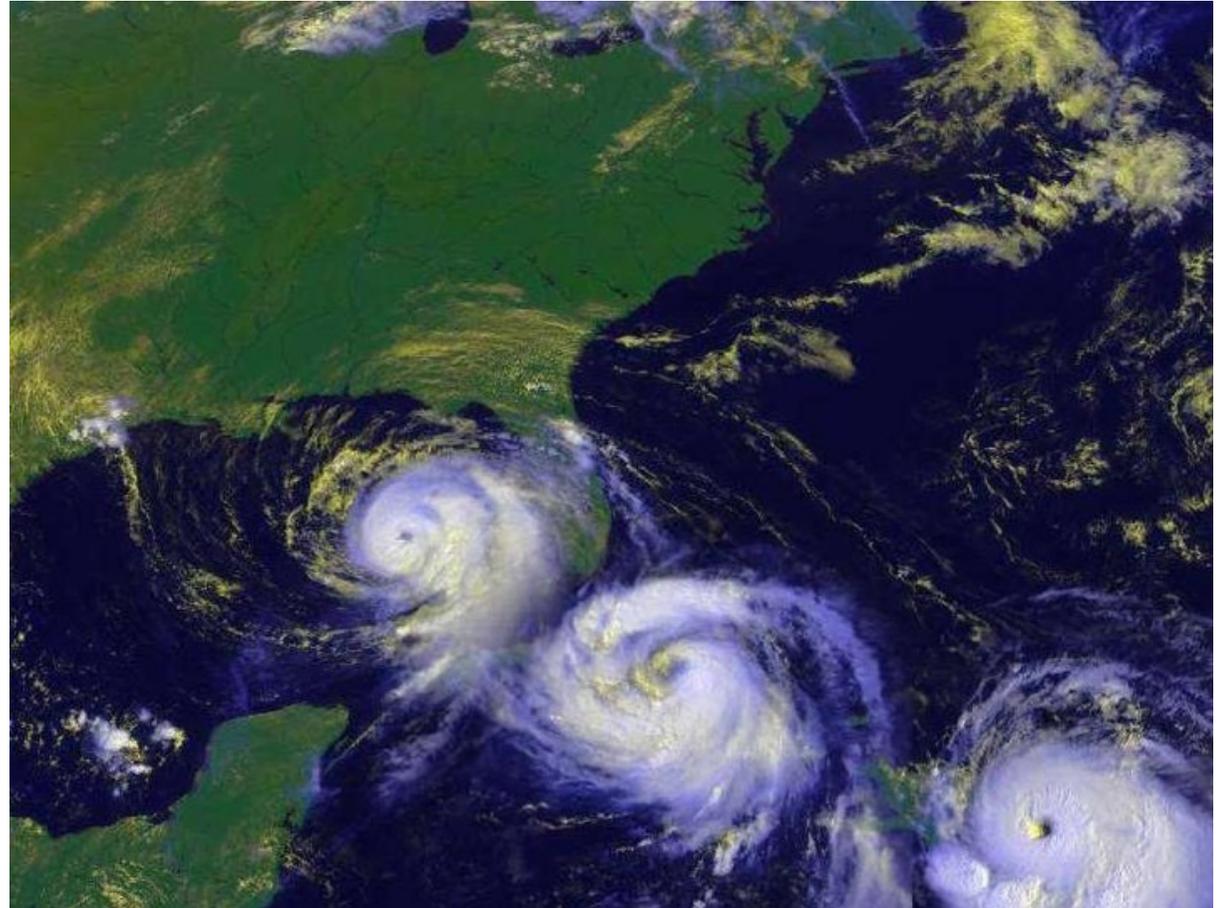
Released Thursday, July 26, 2012
Author: Richard Heim, NOAA/NESDIS/NCDC

Hurricane

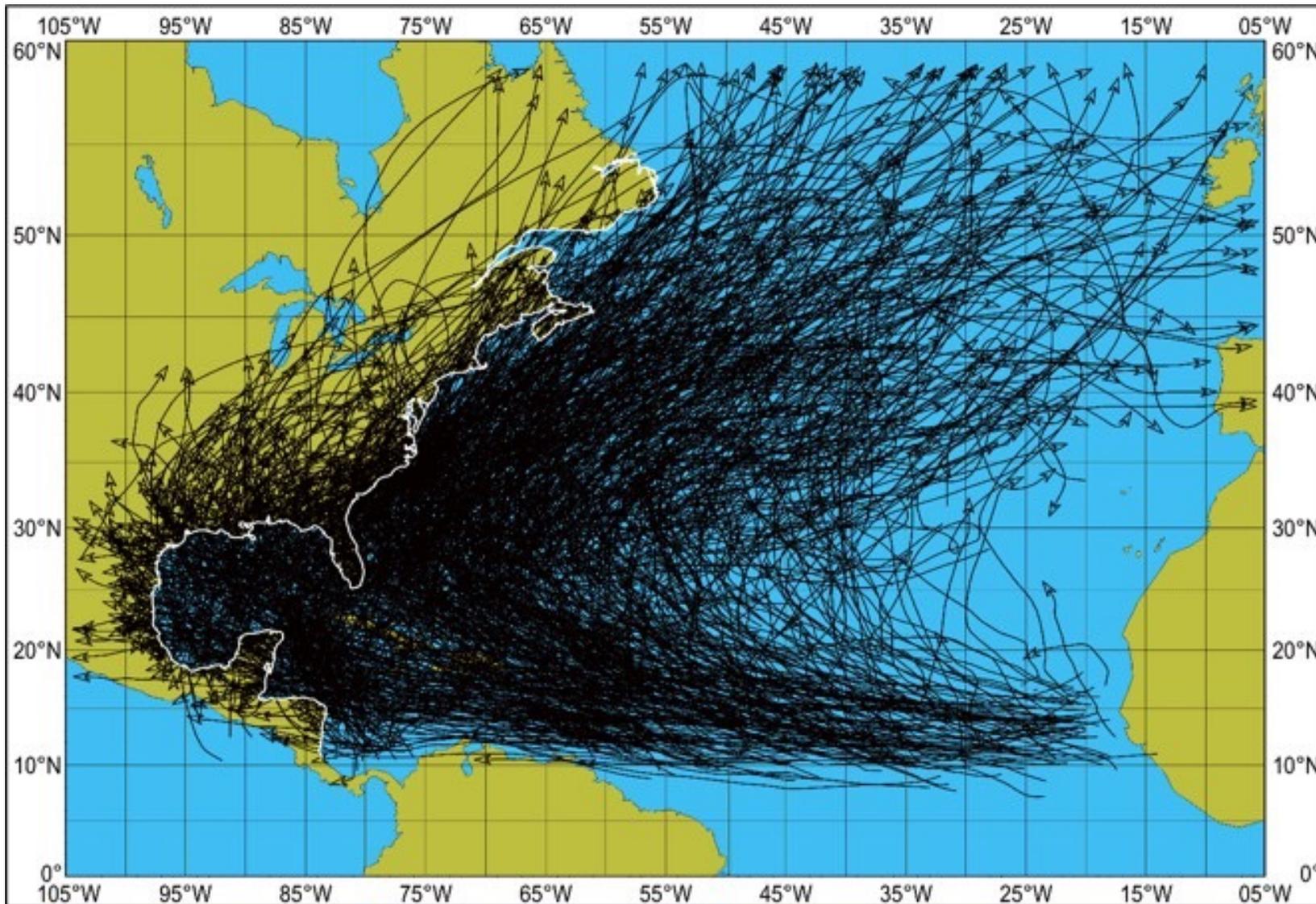
A **tropical cyclone** is a rapidly rotating storm system characterized by a low-pressure center, strong winds and a spiral arrangement of thunderstorms that produce heavy rain.

All hurricanes start as tropical waves that grow in intensity and size to tropical depression, which in turn grow to tropical storm.

They can also be called hurricane, typhoon, tropical storm, cyclonic storm, or simply cyclone.



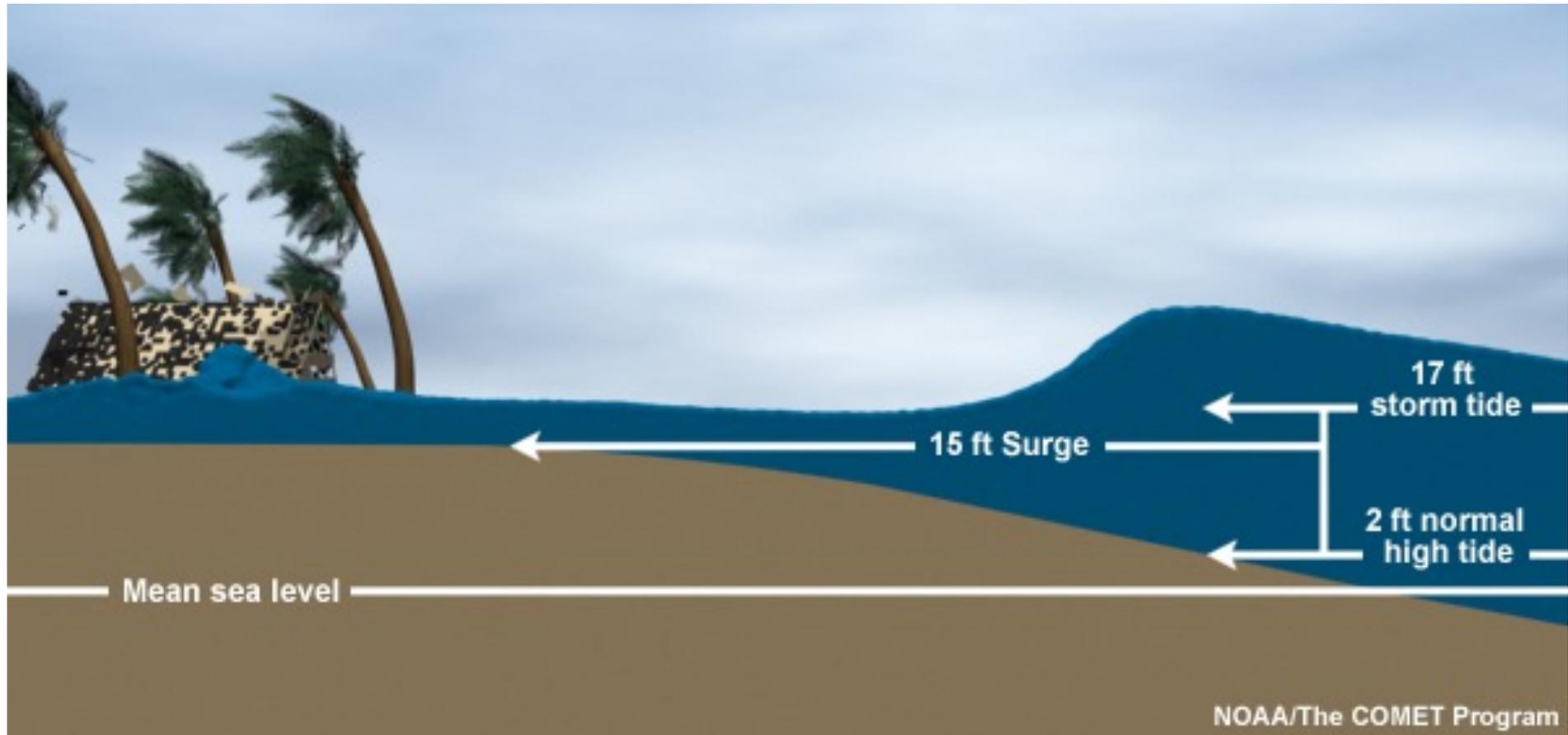
Hurricane



NORTH ATLANTIC TROPICAL STORMS AND HURRICANES, 1851-2004 (1325 STORMS)

Source: USGS

Storm surge



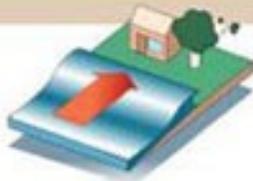
Storm surges are storms that generate large waves on the coast that cause coastal flooding and erosions.

They are generally associated with extra-tropical cyclones, severe winter low pressure systems, etc.

Source: NOAA

Hurricane

	Vents / Winds	Onde de tempête / Storm surge
1	119-153 km/h 74-95 mph	1.2 - 1.5 m 4-5 ft
2	154-177 km/h 96-110 mph	1.8 - 2.4 m 6 - 8 ft
3	178-209 km/h 111-130 mph	2.7 - 3.7 m 9 - 12 ft
4	210-249 km/h 131-155 mph	4.0 - 5.5 m 13 - 18 ft
5	≥ 250 km/h ≥ 156 mph	> 5.5 m ≥ 18 ft



CATEGORY 1
Barometric pressure: 28.94
Winds: 74 to 95 mph
Storm surge: 4 to 5 feet
Damage: Minimal; signs, tree branches, power lines down



CATEGORY 2
Barometric pressure: 28.50 to 28.93
Winds: 96 to 110 mph
Storm surge: 6 to 8 feet
Damage: Moderate; larger signs, tree branches blown down



CATEGORY 3
Barometric pressure: 27.91 to 28.49
Winds: 111 to 129 mph
Storm surge: 9 to 12 feet
Damage: Extensive; minor damage to buildings, trees blown down



CATEGORY 4
Barometric pressure: 27.17 to 27.90
Winds: 130 to 156 mph
Storm surge: 13 to 18 feet
Damage: Extreme; almost total destruction of doors, windows



CATEGORY 5
Barometric pressure: Less than 27.17
Winds: More than 157 mph
Storm surge: More than 18 feet
Damage: Catastrophic; buildings, roofs, structures destroyed

Severe Winter Storm

A **winter storm** is an event in which the varieties of precipitation that are formed only occur at low temperatures, such as snow or sleet, or a rainstorm where ground temperatures are low enough to allow ice to form.

In temperate continental climates, these storms are not necessarily restricted to the winter season, but may occur in the late autumn and early spring as well.



Thunderstorm

A **thunderstorm**, also known as an **electrical storm**, a **lightning storm**, or a **thundershower**, is a type of storm characterized by the presence of lightning and its acoustic effect known as thunder.

Thunderstorms occur in association with a type of cloud known as a cumulonimbus. They are usually accompanied by strong winds, heavy rain and sometimes snow, sleet, hail, or, in contrast, no precipitation at all.

Thunderstorms may line up in a series or rainband.

It is a myth that lightning never strikes twice in the same place. In fact, lightning will strike several times in the same place in the course of one discharge.



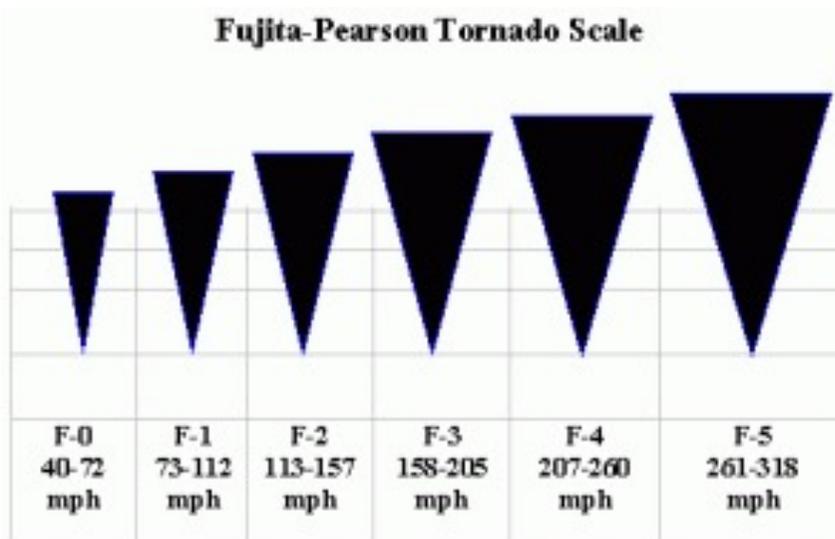
Hailstorm

Hailstorms are an outgrowth of a severe thunderstorm in which balls or irregularly shaped lumps of ice greater than 2cm in diameter fall with rain.



Tornado

A **tornado** is a violently rotating column of air that is in contact with both the surface of the earth and a cumulonimbus cloud or, in rare cases, the base of a cumulus cloud. They are often referred to as **twisters**. Tornadoes come in many shapes and sizes, but they are typically in the form of a visible condensation funnel, whose narrow end touches the earth and is often encircled by a cloud of debris and dust.



Pandemics

Pandemics & Diseases

Flu (Spanish/Avian/Swine)

Covid/SARS

Ebola

Plague

Malaria

Smallpox

Others

Human induced

Fires

Hazardous Materials Incidents

Nuclear Accidents

Terrorism

Biological and Chemical Weapons

Session 2

Hazards – Definition and types

Geological – Earthquakes, Landslides, Volcanic Eruption, Tsunamis

Hydrological – Coastal Erosion, Land Subsidence, Snow Avalanches, Expansive soil

Meteorological – Extreme Heat, Wildfires

Hydro Meteorological – Floods, Drought, Hurricanes, Storm surges, Winter storms, Hail, Thunderstorm, Tornadoes

Pandemics – Flu (Spanish/Avian/Swine), Covid/SARS, Ebola, Plague, Malaria

DISASTER RISK MANAGEMENT

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Session 2 – April 25, 2022

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