



# Indian Institute of Technology, Kanpur

## Department of Earth Sciences

ESO213A: Fundamentals of Earth Sciences

### Lecture 31. Natural Hazards - Introduction

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## Aims of this lecture



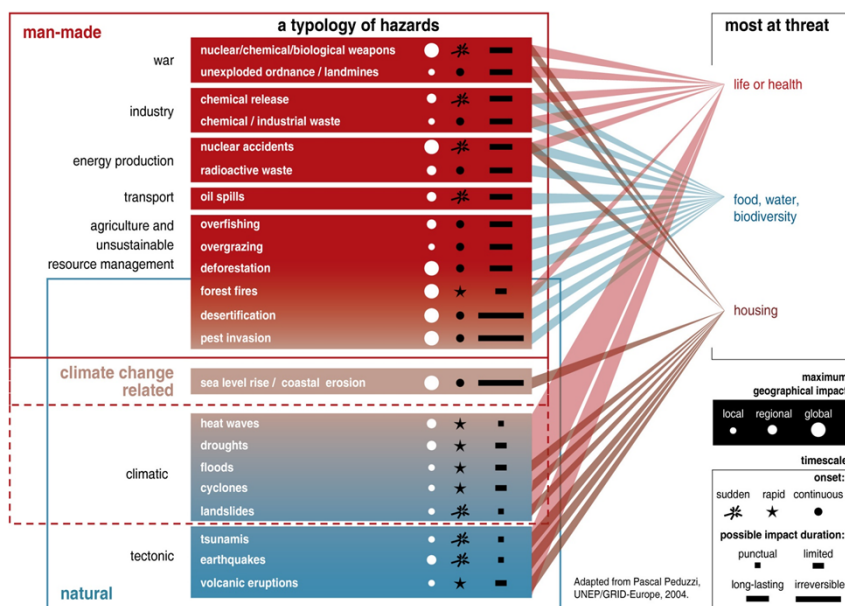
- What is Natural Hazard?
- Some data and Statistics

## The concept of Natural Hazards

- “Events associated with normal geological or biological processes and widespread technological accidents that cause death, injury or loss of home, property or income”.

The intensity of the hazard may be influenced by human modifications of the landscape (e.g., *deforestation and urbanization influence flood frequency and magnitudes*) or climate (e.g., *heat waves in urban areas*).

## The concept of Natural Hazards



Source: Emmanuelle Bournay, UNEP/GRID-Arendal

## Classification of Hazards



Natural and anthropogenic accidents may be classified by the inducing factors

- Atmospheric factors
- Hydrologic factors
- Geological factors
- Biological factors
- Technological Factors
- Social violence
- Complicated danger factors

## The concept of Risk



**RISK = HAZARD X VULNERABILITY**

**Hazard:** Natural processes capable of causing death and/or destruction;

**Vulnerability:** Social or economic sensitivity to the effects of hazards

## The concept of Risk



### Example 1: same hazard; contrasting vulnerabilities

Magnitude 6.5 earthquake in south-central California, on Dec. 22, 2003: 7 dead, ~50 injured because the event occurred in a thinly inhabited area (low risk event).



Magnitude 6.5 earthquake in city of Bam (Iran) on Dec. 26, 2003: ~40,000 dead, ~30,000 injured; much of the city destroyed (very high risk event).



## The concept of Risk



### Example 2: contrasting hazards; same risk

#### Severe snowfall in the Lower Mainland, British Columbia

$$\begin{aligned} \text{Annual risk (\$)} &= P_{\text{blizzard}} \times \text{Cost}^* \\ &= 0.1 \times \$10 \text{ M?} = \$1 \text{ M} \end{aligned}$$



#### "Tunguska" asteroid impact in the Lower Mainland, British Columbia (1908)

$$\begin{aligned} \text{Annual risk (\$)} &= P_{\text{impact}} \times \text{Cost}^* \\ &= 0.000001 \times \$100 \text{ M?} = \$1 \text{ M} \end{aligned}$$



\*Costs = deaths, injuries, building collapse, rescue, cleanup, lost production, rebuilding, etc.  
(often very difficult to assign a dollar value).

## The concept of Risk



### Combating Risk

Pre-Event

**Assess:** characterize the hazard regime;

**Mitigate:** reduce vulnerability;

**Prepare:** educate; warn; evacuate;

Post-Event

**Respond:** remove bodies, locate and treat survivors, destroy unstable structures;

**Recover:** rebuild communities and infrastructure

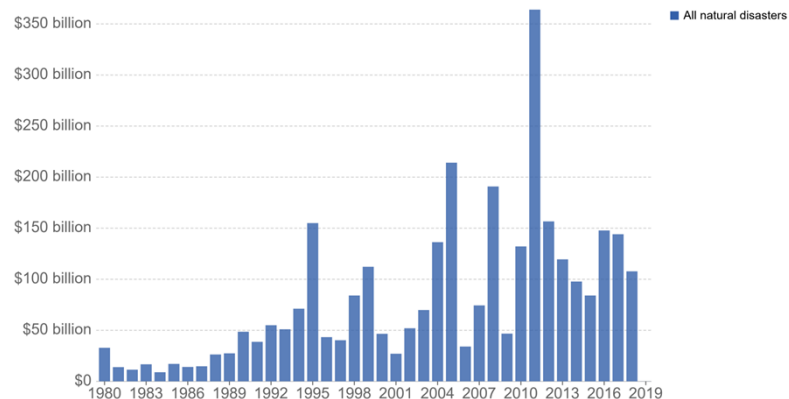
## Some data related to Hazard, Damage and Risk



### Global damage costs from natural disasters, All natural disasters, 1980 to 2019

Our World  
in Data

Total economic cost of damages as a result of global natural disasters in any given year, measured in current US\$. Includes those from drought, floods, extreme weather, extreme temperature, landslides, dry mass movements, wildfires, volcanic activity and earthquakes.



Source: EMDAT: OFDA/CRED International Disaster Database, Université catholique de Louvain – Brussels – Belgium  
OurWorldInData.org/natural-disasters • CC BY



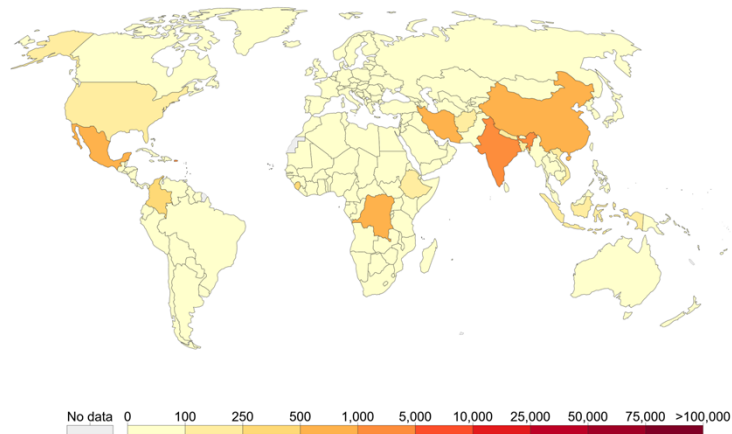
## Some data related to Hazard, Damage and Risk



### Natural disaster deaths by country, 2017

Total number of deaths from natural disasters per year.

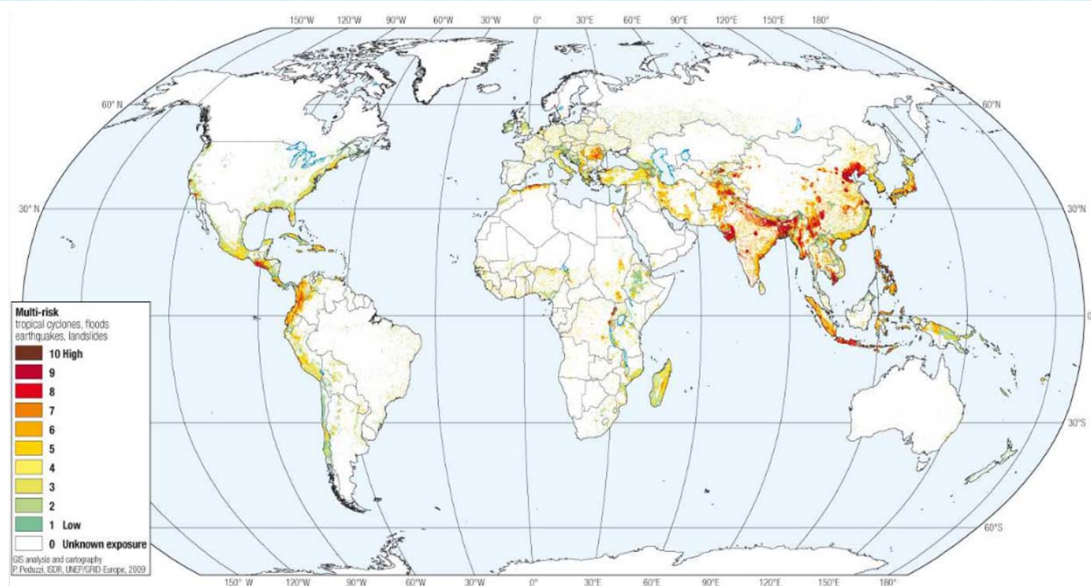
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Source: IHME, Global Burden of Disease (GBD)

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## Some data related to Hazard, Damage and Risk



According to the probability of death rates

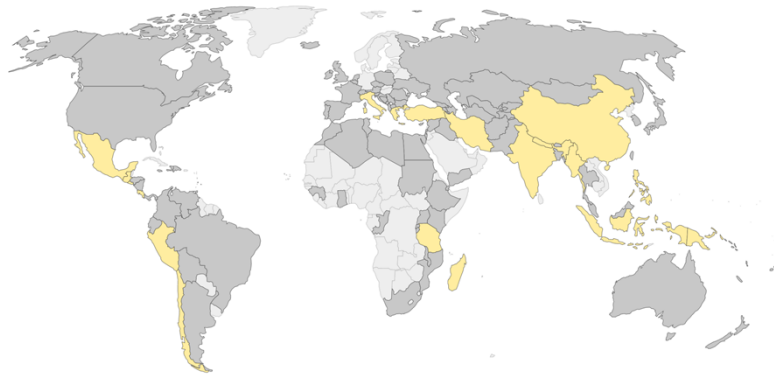
## Some data related to Hazard, Damage and Risk



### Number of deaths from earthquakes, 2017

Deaths from earthquakes includes direct deaths from the event plus those from secondary impacts (such as a tsunami triggered by an earthquake). Due to data availability, reporting and evidence, it's expected that more recent data will be more complete than the long historical record. A trend in reported estimates therefore doesn't necessarily reflect the true change over time.

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in Data



No data None 0 2,500 5,000 10,000 50,000 100,000 500,000 1 million

Source: National Geophysical Data Center (NGDC) of the NOAA

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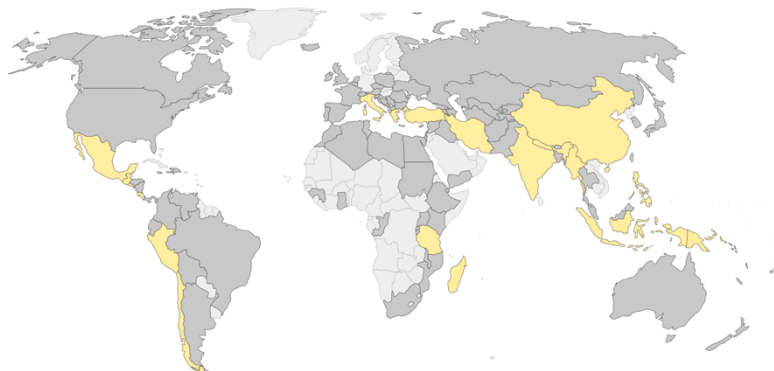
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Our World  
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Source: National Geophysical Data Center (NGDC) of the NOAA

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## Physical Expressions of Hazards



**Direct effects** are effects that appear immediately after the disaster

**Indirect effects** appear later and sometimes can be difficult to identify and link up with a disaster

**Tangible effects** are those for which it is possible to estimate losses in monetary terms, such as the damaged property to restore the necessary resources

**Undetectable effects** are actual effects, but impossible to determine in monetary expression (loss of life can be detectable medically and legally, but economical or financial loss value calculation is very complex)

## Some common Natural Hazards



### Earthquakes

Earthquakes' primary effects are associated with the earth shake, and vertical or horizontal ground movements.

This leads to a strong impact on people and structures.

Secondary effects of earthquakes are associated with rock mass movement, such as **Rock falls** & **Landslides**.

**Tsunami**

**Flood**

**Biological Hazards (pandemics etc.)**



## Some common Natural Hazards



**Volcanoes**

**Fire**

**Infectious diseases**

**Heat Waves**

**Drought**

**Thunderstorms, Hurricanes, Tornados**

## Next Lecture



**Earthquakes**