1 **Introduction to**
Environmental Geology, 5e
Chapter 5
Introduction to Natural Hazards

2 **Natural Disasters: summary in haiku form**
"natural" disasters?
just nature doing her thing
'til you add people...

3 **Case History: Hurricane Katrina (1)**
- Made Landfall in August 29, 2005 to the east of New Orleans
- Storm Surge: 3 to 6 m (9 to 20 ft)
- Diameter of serious damage path: About 160 km (100 mi)
- 80 percent of New Orleans under water
- Official number of deaths: 1,836
- Property damages: Tens of billions
- Estimated costs for recovering and rebuilding: hundreds of billions

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5 **Case History: Hurricane Katrina (2)**
- Regional subsidence: 1 to 4 m (3 to 12 ft) per 100 yrs
- Sea level rise: 20 cm (8 in.) last 100 yrs due to global warming and extraction of GW, oil and gas
- Geographic location: Vulnerable to hurricanes, storms, and inland floods
- Aware of risks and warnings in place
- Insufficient funds for monitoring and maintaining the levee and floodwalls
- Poor coordination in initial emergency response efforts
- Rebuild: Better design and planning, better technology and knowledge, broader awareness

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9 **Natural Disaster, Hazards (1)**
- Criteria: A particular event in which 10 or more people are killed; one hundred or more people are affected; a declaration of emergency is issued, or there is a request for international assistance
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- Dangerous natural processes, including earthquakes, floods, volcanic activities, landslides, and storms

10 **Natural Disaster, Hazards (2)**
- The occurrences of natural disasters on a world scale are increasing
- Natural disaster causing great loss of life and/or property damage
- Earthquakes, floods, cyclones (hurricanes) killed several million people, with an average worldwide annual loss of life of about 150,000 people
- Annual average property damage exceeds $50 billion
- Impact risks, depending on the nature of hazards, spatial and temporal relations to human environment

11 **Types of Natural Hazards**

12 **Why Natural Processes Become Hazards**
- Natural processes become hazardous: When people live or work in areas where they occur
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- Land-use changes, such as urbanization or deforestation
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- Better environmental planning:Simply not to build on floodplains, earthquake prone areas
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- Consumption of energy resources and climate changes

13 **Hazard Magnitude and Frequency**

- Magnitude: Intensity of a natural hazard in terms of the amount of energy released
- Frequency: Recurrence interval of a disastrous event
- Magnitude and Frequency: Generally an inverse relation between them
- More damages associated with hazards of moderate frequency and magnitudes

14 **Magnitude, Frequency, and Impact Risk**

- Magnitude and Frequency: Largely controlled by natural factors
- Impact risk: Controlled by both natural and human factors
- Low-magnitude and high-frequency hazards not always destructive, a high magnitude one almost certainly catastrophic
- Commonly, most impact risks from natural processes of moderate magnitude and moderate frequency

15 **Mixed Blessings of Natural Hazards**

- Not all hazardous processes exert harmful or deadly consequences
- Benefits: Creating new land, supplying nutrients to soil, flushing away pollutants, changing local landscape
- Fault gouge has formed groundwater barriers, producing natural subsurface dams and water resources

16 **Damages of Natural Hazards (1)**

- Death and damages: Great loss of human life, grave damages to property, changes in properties of Earth materials
- More life loss from a major natural disaster in a developing country; more property damage in a more developed country
- Catastrophe: Disastrous situations requiring a long process to recovery from grave damages

17 **Catastrophic Potential of Hazards**

18 **Hazard Evaluation (1)**

Fundamental Principles

- Most natural hazards: Identified and studied using the scientific method and predictable from scientific evaluation
- Risk analysis: A critical component in understanding impacts
- Different hazards are linked
- Hazardous events repetitive
- Importance of hazard planning and hazard mitigation

19 **Hazard Evaluation (2)**

- Study historic data: Hazards are repetitive events
  - Occurrence and recurrence intervals
  - Location and effects of past hazards

  - Observations of present conditions
  - Measuring the changes or rates of change
  - Historic trends of hazards

20 **Hazard Evaluation (3)**

- Studying linkages: Spatial and temporal links
  - Linkages between adjacent locations
  - Linkages between past, present, and future conditions
  - Linkages between hazards (e.g., volcano and mudflow)
  - Geologic setting and hazards (e.g., rock fractures and landslides)

21 **Disaster Forecast, Prediction, and Warning (1)**

- Forecast: The certainty of the event is given as the percent chance of happening
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- Prediction: Sometimes possible to accurately predict when, where, type and size of the certain natural hazardous events
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- Warning: A hazardous event has been predicted or a forecast has been made, the public must be warned

22 **Disaster Forecast, Prediction, and Warning (2)**

- Locations, precursors, probability of occurring
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- Determining the probabilities of a hazardous event at a given magnitude
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- Observing precursor events or signs
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- Forecasting the hazard
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- Warning the public

23 **Disaster Prediction and Warning (2)**

24 **Scientists, Hazards, and the Media**

- The media are generally more interested in the impact of a particular event on people than in its scientific aspects
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- Good relations between scientists and the news media is a goal that may be difficult to always achieve
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- Scientists have an obligation to provide the public with information about natural hazards
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- Reports concerning people's lives and property should be conservative evaluations based on the evidence at hand
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- Provide their readers, viewers, or listeners with accurate information that have been verified

25 **Risk Assessment**

- Risk determination
  - Type, location, probability, consequences
  - Risk estimate: Product of probability and consequences
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- Risk Threshold: Acceptable risks
  - Put probability and consequences into perspective
  - Society's perception and willingness
  -
- Limitations and opportunities of risk assessment

26 **Risk Impact (1)**

Hazardous Earth processes and risk impact
statistics for the past two decades
- Annual loss of life: About 150,000
- Financial loss: > $50 billions
- More life loss from a major natural disaster in a developing country (2003 Iran quake, ~30,000 people)
- More property damage occurs in a more developed country

27 **Risk Impact (2)**

Risk impact estimation:
- To human life: Potential loss and injury of life
- To property: Damage and destruction
- To society: Services and functions of society
- To economy: Manufacture, mining, commercial, real estate, etc.
- To natural environment: Direct or indirect adverse impact

28 **Human Response to Hazards (1)**

Reactive response
- Primarily after the hazardous event
- Recovery phases: Search response, rescue, restoration, and reconstruction
- Recovery period: Recovery length depending on the magnitude of hazard and impact intensity

29 **Human Response to Hazards (2)**

Reactive response and recovery priority
- Critical needs: Emergency operations, critical infrastructure, hospitals, shelter, food, and water supply
- Essential function: Transportation, communication, education, and other services
- Improvement and development: Rebuild damaged structures and develop better structures

30 **Human Response to Hazards (3)**

Anticipatory Response: Perceiving, Avoiding, and Adjusting to Hazards for avoiding or minimizing the impacts of disasters
- Land-use planning
- Insurance and other regulations for safety measures
- Evacuation
- Disaster awareness and preparedness: Individuals, families, cities, states, or even entire nations can practice

31 **Human Response to Hazards (4)**

General response in a given location
- Combination of reactive and anticipatory response
- Artificial control of natural processes
- Taking no or little action, being optimistic about chances of making it through disasters

32 **Global Climate and Hazards**

33 **Population Growth and Natural Hazards**

- Increase in population puts a greater number of people at risk
- Asia suffered the greatest losses from 1985 to 1997, with 77 percent of the total deaths and 45 percent of the economic losses
- Deadly catastrophes resulting from natural hazards linked to changes in land use, Hurricane Mitch in 1998, flooding of the Yangtze River in 1998, and Hurricane Katrina in 2005
- In quest: Artificially controlling some natural hazards

34 **Land-Use Change and Natural Hazards (1)**

- Land-use change amplifying the impact risks of natural hazards
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- Deforestation and fire in Honduras before Hurricane Mitch, 11,000+ deaths
  - – Massive deforestation in major river basin (e.g., 85 percent forest loss in Yangtze River, 4000+ deaths)
  - – Inappropriate construction code in tectonic earthquake zone, 2003 Iran earthquake, ~300,000 deaths
  - – Poor construction in Haiti, 2010 earthquake, above 300,000 death

35 **Land-Use Change and Increase in Natural Hazards (2)**

36 **Applied and Critical-Thinking Topics**

- List all the natural hazardous processes in the are where you live. What is done? What is more to be done?
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- Construct a U.S. vulnerability map of natural hazards by state, or construct a state map by county.
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- What is the difference between forecasting and warning
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- Can humans eventually control the impact risks of natural hazards? Explain your rationale.

37 **End of Chapter 5**