

國立臺北大學自然資源與環境管理研究所

115 學年度第一學期『環境災害與風險管理』

課程講義 (01)：基礎理論：危害、災害與風險
Fundamental Concepts: Hazard, Disaster, and Risk

- INTRODUCTION TO THIS COURSE

- The Textbook: Smith, K., C.J. Fearnley, D. Dixon, D.K. Bird, and I. Kelman (2024). *Environmental Hazards: Assessing Risk and Reducing Disaster* (7th ed.). Routledge.

Part One: The Nature of Hazard

- Chapter 1 – Hazard in the Environment
- Chapter 2 – Dimensions of Disaster
- Chapter 3 – Vulnerability, Resilience, and Sustainability
- Chapter 4 – Risk Assessment and Management
- Chapter 5 – Disaster Risk Reduction

Part Two: The Experience and Reduction of Hazard

- Chapter 6 – Earthquake hazards
- Chapter 7 – Volcanic hazards
- Chapter 8 – Tsunami hazards
- Chapter 9 – Mass Movements
- Chapter 10 – Storms
- Chapter 11 – Floods
- Chapter 12 – Drought
- Chapter 13 – Extreme Temperatures
- Chapter 14 – Wildfires
- Chapter 15 – Epidemic Diseases

Part Three: Environmental Hazard and Risk in an Anthropocene

- Chapter 16 – Anthropocene Changes
- Chapter 17 – Industrial and Waste Hazards
- Chapter 18 – Climate and Beyond
- Chapter 19 – Using Environmental Hazards Knowledge for Action
- Business Risk Management: Boothroyd, K. and C. Thompson (2025). *Fundamentals of Risk Management: Understanding, Evaluating and Implementing Effective Enterprise Risk Management* (7th ed.). Kogan Page.
- Environmental Health Risk: Theodore, L. and R. Dupont (2012). *Environmental Health and Hazard Risk Assessment: Principles and Calculations*. CRC Press.

- DEFINITIONS OF HAZARD, DISASTER AND RISK

- Hazard 危害、Risk 危機/風險、Disaster 災害
 - ⇒ **Hazard (cause)** -- A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.
 - ⇒ **Risk (likely consequence)** -- the combination of the probability of a hazardous event occurring and its negative consequences calculated in the form of losses.

- ⇒ **Disaster (actual consequence)** -- serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

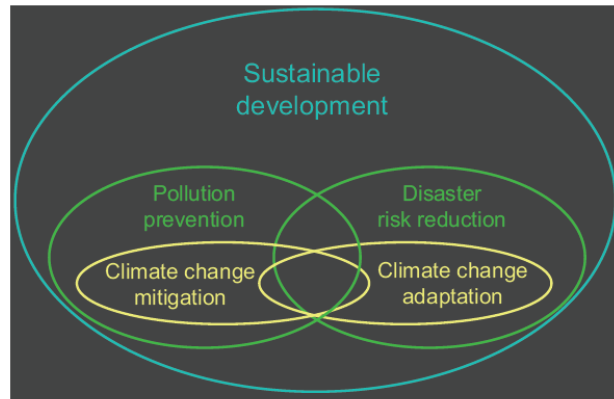
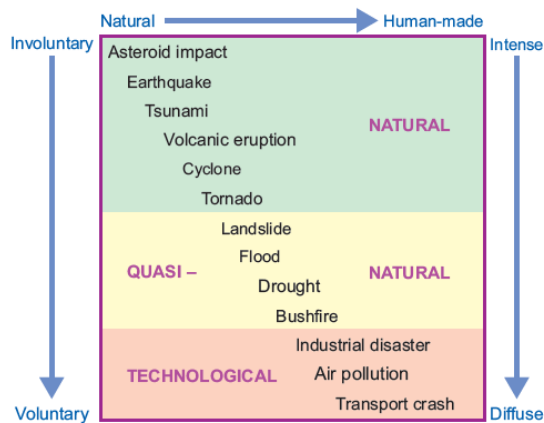
Table 1.2 Often-debated definitions from the UNDRR (2019)

Risk	'Defined as 'disaster risk' being 'The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity'.
Hazard	'A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.'
Exposure	'The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.'
Vulnerability	'The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.'
Resilience	'The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.'
Capacity	'The combination of all the strengths, attributes and resources available within an organization, community or society to manage and reduce disaster risks and strengthen resilience.'
Disaster	'A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.'

- ⇒ "Risk is opportunity" (Risk or Crisis) = (Danger + Opportunity)
- ⇒ Risk = Hazard × Exposure × Vulnerability
- ⇒ Risk = $f(\text{probability, severity, vulnerability, exposure, ...})$

• ENVIRONMENTAL HAZARDS AND RISK ASSESSMENT

- Natural Hazards and Technological Hazards => Na-Tech Disasters (Context Hazards)
- Voluntary vs. Involuntary; Natural vs. Manmade; Intense vs. Diffuse
- Risk Assessment: Safety, Health, Ecological, Public Welfare, and Financial
- Exposure and Vulnerability
 - ⇒ 'End-Points' vs. Scales (Temporal, Spatial, etc.): Chronic vs. Acute
 - ⇒ Risk vs. Security => Emergency and Crisis
- Vulnerability to Disasters => Vulnerability to Climate Change
 - ⇒ Vulnerability and Resilience => Reliability
- Environmental Hazard Paradigms: Engineering, Behavioural, Development, and Complexity
- The Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework)



THE SWISS-CHEESE MODEL OF RESPIRATORY VIRUS PANDEMIC DEFENSE

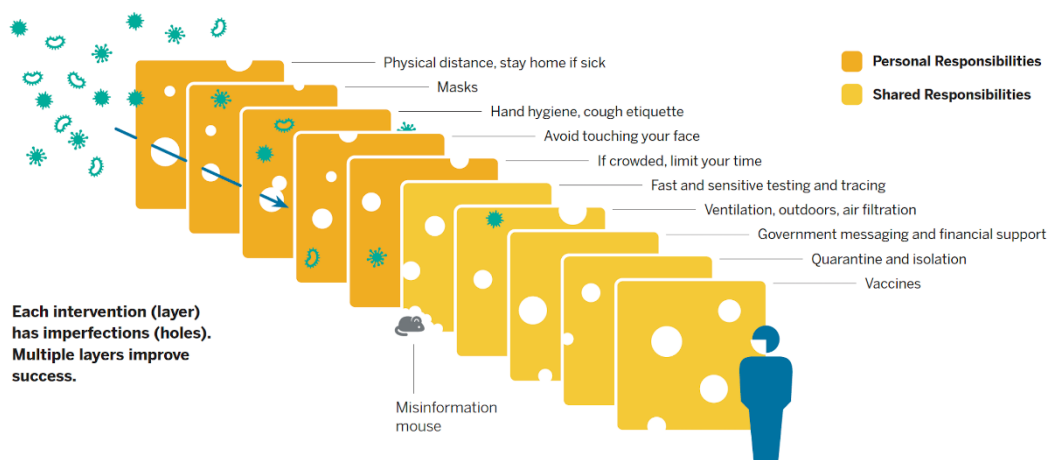


Table 1.1 Commonly used (but limited) major categories of environmental hazards with examples

Natural hazards

Geological: earthquakes, volcanic eruptions, tsunamis, landslides, karsts, subsidence, heave, land degradation

Atmospheric: cyclones, storm surge, tornadoes, storms, extreme temperatures, wildfires, lightning, precipitation

Hydrological: drought, flood, glacial, periglacial, wildfires, ice and snow avalanches

Biological: outbreaks, epidemics, pandemics, infectious diseases, dangerous plants and animals

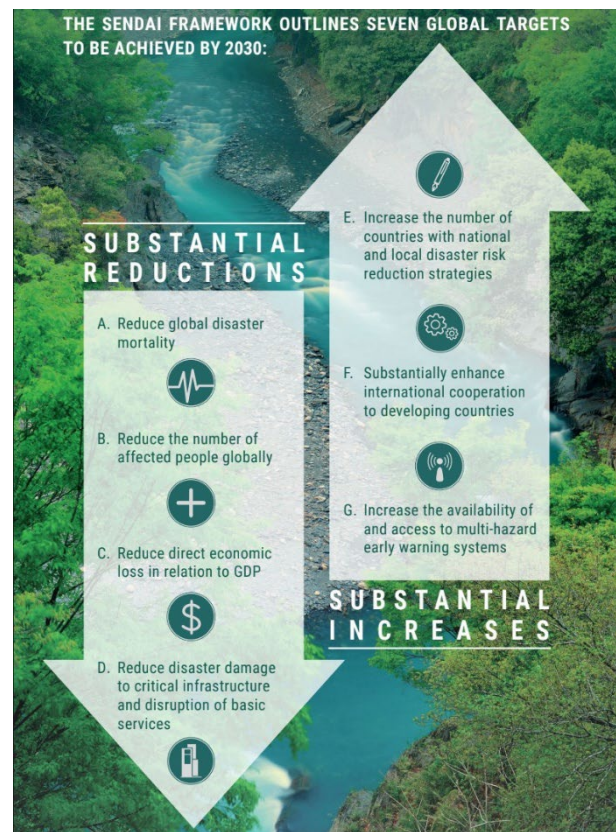
Technological hazards

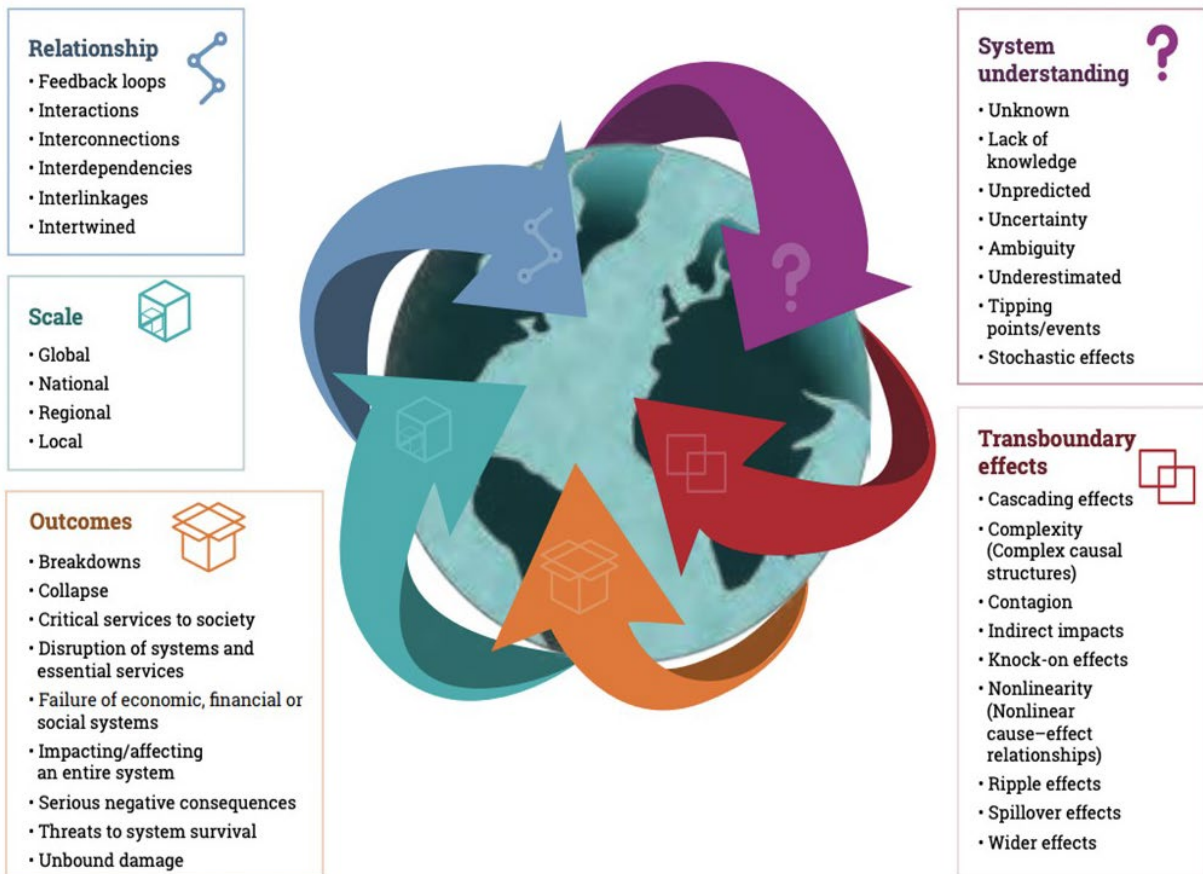
Transport: aircraft, car, bus, train and other vehicle crashes, shipwrecks

Industrial: Explosions and fires, release of toxic or radioactive materials, hazardous materials (storage, transport or misuse of)

Unsafe buildings and facilities: structural collapse, fire

Specific human activities: pollution, mining, land contamination, soil degradation, fracking, oil spills





- **EXAMPLES OF DISASTERS (CATASTROPHES)**
 - Global-Scaled Emerging Disaster: COVID-19 – A Global Threat
 - Natural-Technical (Na-tech) Hazard:
 - Japan's 2011 Earthquake, Tsunami and Nuclear Power Plant
 - ⇒ The Swiss cheese model of respiratory pandemic defense
 - Cascading Hazards in Haiti
 - Complexity in the Real World: The Bam Earthquake
- **SOFTWARE PACKAGES TO BE APPLIED**
 - [RStudio IDE](#) and [R Packages](#): [Introduction to R for Natural Resource Scientists](#)
 - Software Packages for Monte Carlo Simulation and Risk Analysis: [Oracle Crystal Ball](#)
 - AI assisted coding skills: VS-code, python...
- **HOMEWORK ASSIGNMENT #1 (2026/09/21 Due) (A4 一頁)**
 1. 請用你自己的文字及語意定義說明“Hazard, Risk and Disaster”。
 2. 請舉例說明特定危害（例如，洪災、流感、投資虧損、、、）之風險評估要件（暴露、脆弱度、、、）構成內容與描述。
 3. 請比較說明 Natural-Technical (Na-tech) Hazards, Socionatural Hazards, Cascading Hazards 之差異。