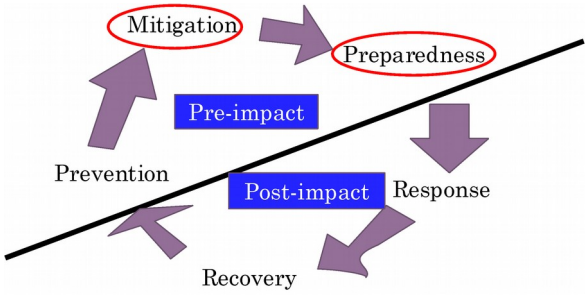
Environmental disasters

Keim ME (2010) “Chapter 23. Environmental Disasters”. In: Frumkin H [Ed.] “Environmental Health: From Global to Local. 2nd Ed.”, John Wiley & Sons, pp.843-875.
Theodore L, Dupont RR (2012) “Chapter 20. Natural Disasters”. In: “Environmental Health and Hazard Risk Assessment: Principles and Calculations”. CRC Press, pp.549-571.

[Definition of disaster] A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses that exceed the ability of the affected community or society to cope using its own resources. (UN/ISDR, 2009). If a disruptive event does not exceed a community's or society's capacity to cope, it is classified as an emergency (WHO, 1998). [Cited from Keim ME, 2010]

Table. Relative public health impacts of natural disasters (Modified from Keim, 2010)

	Geophysical				Meteorological			
	Seismic		Volcanic		High precipitation		Low precipitation	
Public Health Impact	Earthquake	Tsunami	Volcanic Eruption	Landslide	Tropical Cyclone	Flood	Drought	Wildfire
Deaths	**Many**	**Many**	Few to moderate	Few to moderate	Few, but many in poor nations	Few, but many in poor nations	Few, but many in poor nations	Few
Injuries	**Many**	**Many**	Few to moderate	Few to moderate	Few	Few	Unlikely	Few
Loss of clean water	Focal to widespread	Focal to widespread	Focal to widespread	Focal	Focal to widespread	Focal to widespread	**Widespread**	Focal
Loss of shelter	Focal to widespread	Focal to widespread	Focal to widespread	Focal	Focal to widespread	Focal to widespread	Focal to widespread	Focal
Loss of personal and household goods	Focal to widespread	Focal to widespread	Focal to widespread	Focal	Focal to widespread	Focal to widespread	Focal to widespread	Focal
Major population movements	Focal to widespread	**Focal to widespread**	Focal to widespread	Focal	Focal to widespread	Focal to widespread	Focal to widespread	Focal
Loss of routine hygiene	Focal to widespread	**Focal to widespread**	Focal to widespread	Focal	Focal to widespread	Focal to widespread	**Widespread**	Focal
Loss of sanitation	Focal to widespread	**Focal to widespread**	Focal to widespread	Focal	Focal to widespread	Focal to widespread	Focal	Focal
Disruption of solid waste management	Focal to widespread	**Focal to widespread**	Focal to widespread	Focal	Focal to widespread	Focal to widespread	Focal	Focal
Public concern for safety	**High**	**High**	**High**	Moderate to high	**High**	Moderate to high	Low to moderate	Moderate to high
Increased pests	Focal to widespread	Focal to widespread	Unlikely	Unlikely	Focal to widespread	Focal to widespread	Focal to widespread	Unlikely
Damage of health care system	Focal to widespread	Focal to widespread	Focal to widespread	Focal	Focal to widespread	Focal to widespread	Focal	Focal to widespread
Worsening of chronic illnesses	Focal to widespread	Focal to widespread	Focal to widespread	Focal	Focal to widespread	Focal to widespread	**Widespread**	Focal to widespread
Loss of electrical power	Focal to widespread	Focal to widespread	Focal to widespread	Focal	Focal to widespread	Focal to widespread	Focal	Unlikely
Toxic exposures	Widespread for CO poisoning	Widespread for CO poisoning	Widespread for air, soil, and surface water	Focal	Widespread for CO poisoning	Widespread for CO poisoning	Focal	Widespread for air
Food scarcity	Focal	Focal	Focal	Focal	**Common in low-lying coastal area**	Focal to widespread	**Widespread in poor nations**	Focal



Source: Keim (2010) ibid.

Disaster prevention vs Emergency management vs Risk management (Modified from Keim, 2010)

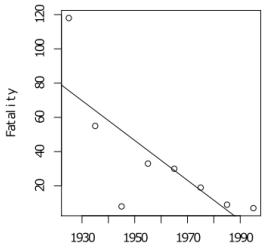
Stages of prevention	Stages of disaster life cycle management	Categories of risk management techniques	Components of disaster risk management
Primary prevention	Prevention	Risk avoidance	Hazard avoidance
Secondary prevention	Mitigation Structural (exposure)	Risk reduction	Vulnerability reduction
	Financial (susceptibility or resilience)	Risk transfer	
	Preparedness (susceptibility or resilience)	Risk reduction	
Tertiary prevention	Response Recovery	Risk retention	Residual risk

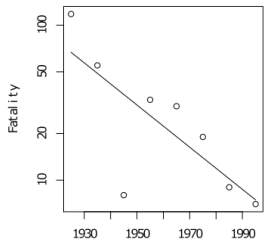
[How to evaluate natural disasters – cited from Theodore L, Dupont RR, 2012 and others]

1. General classification of natural disasters
    1. Land – avalanches, earthquakes, lahars (mudslides, landslides), volcanic eruptions
    2. Water – floods, limnic (gaseous lake emissions), tsunamis
    3. Weather – blizzards, hurricanes, or cyclonic storms, droughts, hailstorms, heat waves, tornadoes
    4. Space – gamma ray bursts, impact events (meteorites, asteroids), solar flares
2. The way how those affect health
    * Natural disasters → environmental effect → financial, environmental, and/or human lossses
3. 5 case studies
    1. Hurricanes
        1. Originates over oceans in certain regions near the equator (in USA, usually storms arising in the Carribean Sea and Gulf of Mexico).
        2. Characteristics: high winds, torrential rain, high water waves, tornados. Usually it moves in a path resembling the curve of parabola. Fully developed hurricanes has high winds with more than 150 mph velocity.
        3. In USA, the paths of hurricanes were recorded since 1870s. Average frequency of hurricanes attacking USA is slightly more than 2 per year. The most frequently attacked place is Florida, followed by Texas.
        4. Predicting annual fatality rate for 2010-2015 may be useful for insurane company.
        5. The data is shown right.
        6. Predicting 2010-2020 value, regression analysis can be used. Sometimes linear (left), hockey-stick, second-order (parabolic), or third-order (cubic) function can be applied. Here log-linear model (right) is the most appropriate.

Table 20.1 Fatality Rate/Property Loss Data for Case Study 1

10 Year Interval	Median Year	Fatality Rate per Hurricane	Property Loss per Hurricane x 10^(-6) $
1920-1930	1925	118	83
1930-1940	1935	55	210
1940-1950	1945	8	250
1950-1960	1955	33	456
1960-1970	1965	30	325
1970-1980	1975	19	1410
1980-1990	1985	9	676
1990-2000	1995	7	2103
2000-2010	2005	(not available)	(not available)
2010-2020	2015		





    2. Floods (cf. Tsunami in coastal area)
        1. Negative effects
            1. Soil erosion as well as sediment deposition problems downstream

2. Inundated property and loss of life
3. Interference with the economic use of lands
4. Severe damage to bridge abutments sewer outfalls, and other infrastructure within floodways
5. Impairment to navigation and hydroelectric power production
6. Contamination of water and accompanying disease outbreaks
7. Failed crops

2. Positive effects
    1. Recharge of groundwater
    2. Improving soil fertility by providing nutrients in which it is deficient
    3. Providing additional water resources in arid regions
    4. Maintaining ecosystems in river corridors
    5. Maintaining flood plain biodiversity
3. How to maximize net gain using an example
    1. Total annual net income in $10^6/year, AI = 10(H-100), where H is the levees of height in inches.
    2. Total annual cost (AC) in $10^6/year, AC=100000/(500-H)
    3. Profit P = AI-AC, which is maximized at H=400, by solving these equations. Considering breakdown operation, H must range within 473.2 and 126.8, by solving P=0: (500-H)(H-100)=100000/10

3. Earthquakes
    1. Direct consequences: Ground shaking/Ground rupture/Landslides/Avalanches/Tsunamis/Floods/Excessive tidal forces
    2. (eg.) A large metropolitan area located along the western coast of the USA has commissioned a study to determine, on average, the annual property loss that could arise due to an earthquake (plus secondary aftershocks), located at the center of the city (it is the worst scenario). We can calculate the expected frequency of an earthquake with magnitude 5.25-9.25 as 0.0334/year, which is almost once every 30 years. By taking this value with possible property loss, it is possible to determine the appropriate annual insurance cost.
4. Meteorites
    1. (eg.) Feb 15,2013 - A "small" meteorite streaked through the skies above Russia's Urals region. The blast, equivalent to 300,000 tons of TNT, shattered windows, damaged more than 3,000 building and injured over 1,000 people. [https://www.youtube.com/watch?v=dpmXyJrs7iU]
    2. Very rare events. Special approach is needed. (cf.) Reinhardt CF et al. (2015) Asteroid risk assessment: A probabilistic approach. *Risk Analysis*, doi:10.1111/risa.12453.
5. Combined hurricanes and floods
    1. (eg.) April 2014 – Honiara flush flood
    2. Combined effects of strong wind and risen sea and river water levels should be considered. The direction of wind is also important. (cf.) Drews C, Galarneau TJ Jr. (2015) Directional Analysis of the Storm Surge from Hurricane Sandy 2012, with Applications to Charleston, New Orleans, and the Philippines. *PLoS ONE*, 10(3): e0122113. doi:10.1371/journal.pone.0122113.

[Major evaluation guidelines and forms]

- HESPER (WHO)
    - The Humanitarian Emergency Settings Perceived Needs Scale (HESPER): Manual with Scale http://www.who.int/mental_health/publications/hesper_manual/en/
- CASPER toolkit (CDC)
    - http://www.cdc.gov/nceh/hsb/disaster/casper.htm
    - E-learning course http://www.cdc.gov/nceh/hsb/disaster/CASPER_elearning/
- Mortality surveillance (CDC)
    - http://www.bt.cdc.gov/disasters/surveillance/pdf/disaster-mortality-form.pdf
    - http://emergency.cdc.gov/disasters/surveillance/pdf/disaster-mortality-instructions.pdf
- Morbidity surveillance (CDC)
    - http://www.bt.cdc.gov/disasters/surveillance/pdf/naturaldisastermorbiditysurveillancetallysheet.pdf
    - http://www.bt.cdc.gov/disasters/surveillance/pdf/naturaldisastermorbiditysurveillancelinelist.pdf
    - http://www.bt.cdc.gov/disasters/surveillance/pdf/naturaldisastermorbiditysurveillanceindividualform.pdf
- Shelter assessment (CDC)
    - http://www.bt.cdc.gov/shelterassessment/