How to prepare for and tackle disasters: Principles and suggestions

As Environmental Health class (11)
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References and Key Concepts

- References
  - Keim ME (2010) "Chap. 23. Environmental Disasters". In: Frumkin H [Ed.] "*Environmental Health: From Global to Local. 2nd Ed.*", John Wiley & Sons, pp.843-875. (Chap. 24 in the same text's 3rd Ed., 2016)
  - Theodore L, Dupont RR (2012) "Chapter 20. Natural Diasters". In: "*Environmental Health and Hazard Risk Assessment: Principles and Calculations*". CRC Press, pp.549-571.
  - Gist R, Lubin B [Eds.] (1999) *Response to disaster: Psychological, Community, and Ecological Approaches*. Routledge
  - United Nations Office for Disaster Risk Reduction (UNISDR): https://www.unisdr.org/
  - Center for Research on the Epidemiology of Disaster (CRED): https://www.cred.be/
- Key Concepts (Keim, 2016)
  - Environmental disasters occur when three things come together: population exposure to an environmental hazard, conditions of vulnerability in that population and its environment, and insufficient capacity to reduce or cope with negative consequences.
  - Environmental hazards that lead to disasters may be natural or technological.
  - The hazards that cause disasters may vary greatly, but the public health consequences and the public health and medical needs of affected populations tend to be relatively consistent across disaster types.
  - Disaster risk is the product of the probability of disaster occurrence and the probability of a vulnerable population becoming affected minus the absorptive capacity of that population.
  - Disaster risk management is a comprehensive, all-hazard approach that entails developing and implementing strategies for all phases of the disaster life cycle – prevention, mitigation, preparedness, response, and recovery – in the context of sustainable development.

Definitions of "disaster" and "emergency"

◆ **Disaster:** A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental <u>losses that exceed the ability of the affected community or society to cope using its own resources</u>. (UN/ISDR, 2009). <u>If</u> a disruptive event does <u>not exceed</u> a community's or society's capacity to cope, it is classified as an **emergency** (WHO, 1998).

◆ According to the standard definition of **EM-DAT** (https://www.emdat.be/), which is part of CRED, the events fulfill at least one of the following criteria:

   ◆ 10 or more people reported killed
   ◆ 100 or more people reported affected
   ◆ Declaration of a state of emergency
   ◆ Call for international assistance

The impact on "prerequisites for health"

- http://www.who.int/hpr/NPH/docs/ottawa_charter_hp.pdf
- The fundamental conditions and resources for health are:
  - peace,
  - shelter,
  - education,
  - food,
  - income,
  - a stable eco-system,
  - sustainable resources,
  - social justice, and equity.
- Improvement in health requires a secure foundation in these basic prerequisites
- Disasters may harm most of those. However, preventing disasters is difficult because it's rare and unpredictable. Preparedness and mitigation are important.

Disaster risk exists at the crossing point of hazard, exposure and vulnerability (cf. https://www.preventionweb.net/risk/disaster-risk)

HAZARDS

EXPOSURE   VULNERABILITY
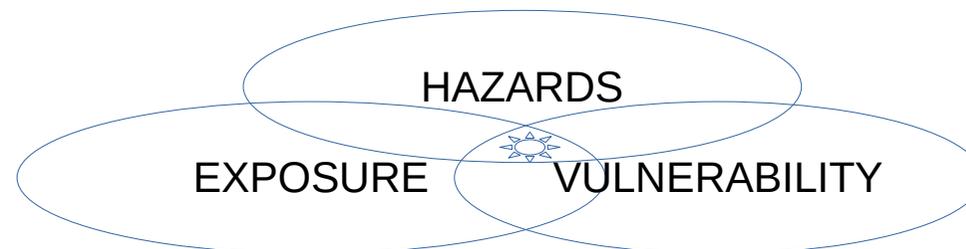
The "disaster cycle" and corresponding risk management measures

Mitigation

Preparedness

Prevention

Pre-impact

Post-impact

Response

Recovery
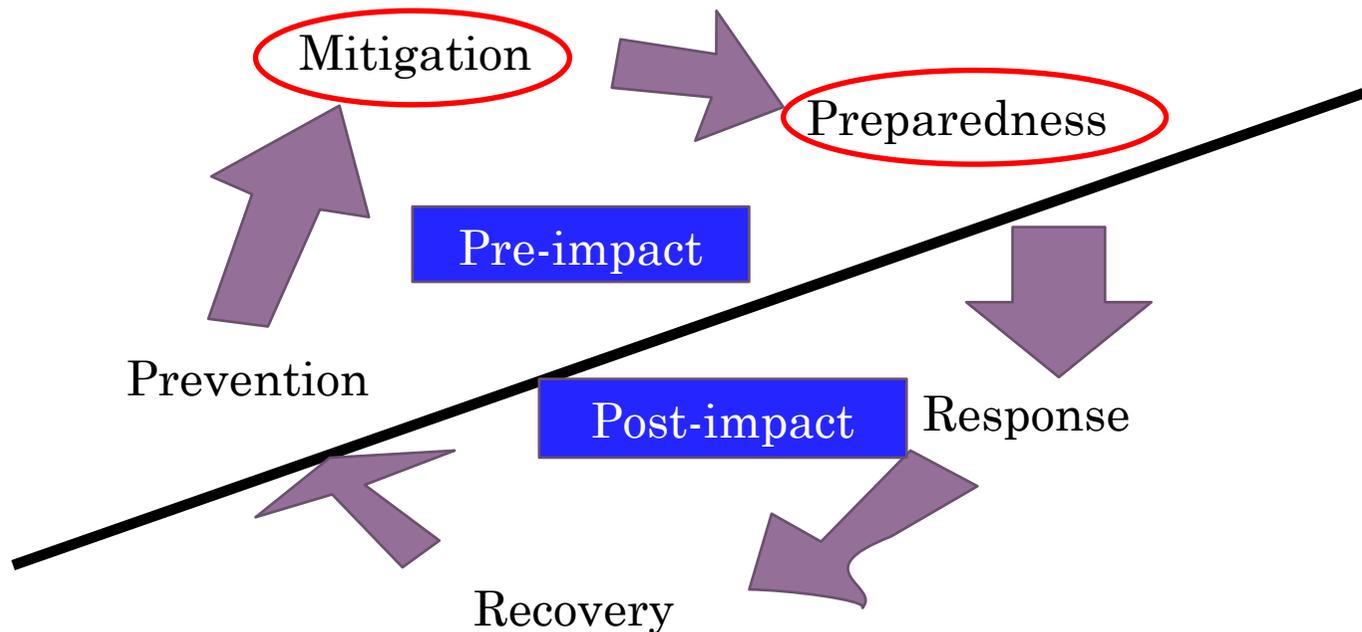
Source: Keim (2010) ibid.

- ◆ Complete prevention is impossible
- ◆ Resources are limited
- ◆ Difficulties
  - ◆ Rare event (obeys extreme distribution)
  - ◆ Multi-stage estimation is needed
- ◆ Action
  - ◆ Preparedness training
  - ◆ Robust infrastructure for mitigation

<Global action> Hyogo framework for action (2005-2015)
https://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf

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Disaster preparedness from the viewpoint of emergency medicine

- ◆ DMAT（Disaster Medical Assistance Team）: Based on the basic law for disaster management, "Emergency medicine under disaster situation must be managed by the disaster base hospitals and DMAT-Japan"
  - ◆ Mainly conducting the specialized activities in the very early stages like START, PAT, SCU, CSM, etc.
- ◆ Japan Red Cross's dERU(domestic Emergency Response Unit)
  - ◆ Mainly conducting sustainable evacuation station, outreach care, psychological (mental) care
- ◆ Role differentiation and cooperation were already assigned since 2009, so that they could effectively act in the case of Great East Japan Earthquake on 2011.3.11.
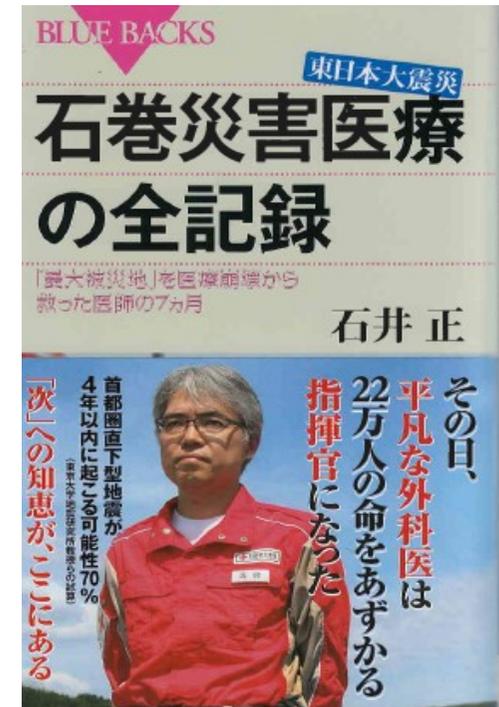
Ishinomaki city lost all functions of the municipal office on 2011.3.11 GEJE: Dr. Tadashi Ishii as the disaster medicine coordinator, _already established_
- **face-to-face relationships among practitioners**
- **information sharing**
- **practical training and manuals**

The 11 E's of public health preparedness
(Keim, 2016)

- Evaluation and monitoring of hazard
- Early warning
- Evacuation
- Emergency operations planning
- Education and training
- Exercises and drills
- Engagement of the public
- Electronic media and communication
- Epidemiology
- Equipment and supplies
- Economic and political incentive

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Disaster-prevention technology

- Prof. Toshitaka Katada (Gunma Univ.) "Disaster-prevention makes people survive", Syu-ei-sya, 2012.
    - The author conducted regular disaster-prevention education for elementary and junior-high school kids in Kamaishi-city before the Great East Japan Earthquake. 99.8% of those could survive through the earthquake, known as "Miracle at Kamaishi".
    - The reason of successful disaster-prevention was repeated education of "3 principles of evacuation" for those school kids
        - Never be held by the previous supposition
        - Do the best
        - Be the first evacuee
    - The proverbial truth "Tsunami-tendenko", which means "When attacked by tsunami, rush to escape one by one, don't wait for others"

片田敏孝
Katada Toshitaka

人が死なない防災

生存率

釜石の小中学生は、なぜ主体的に避難できたのか。

99.8%
の背景

集英社新書
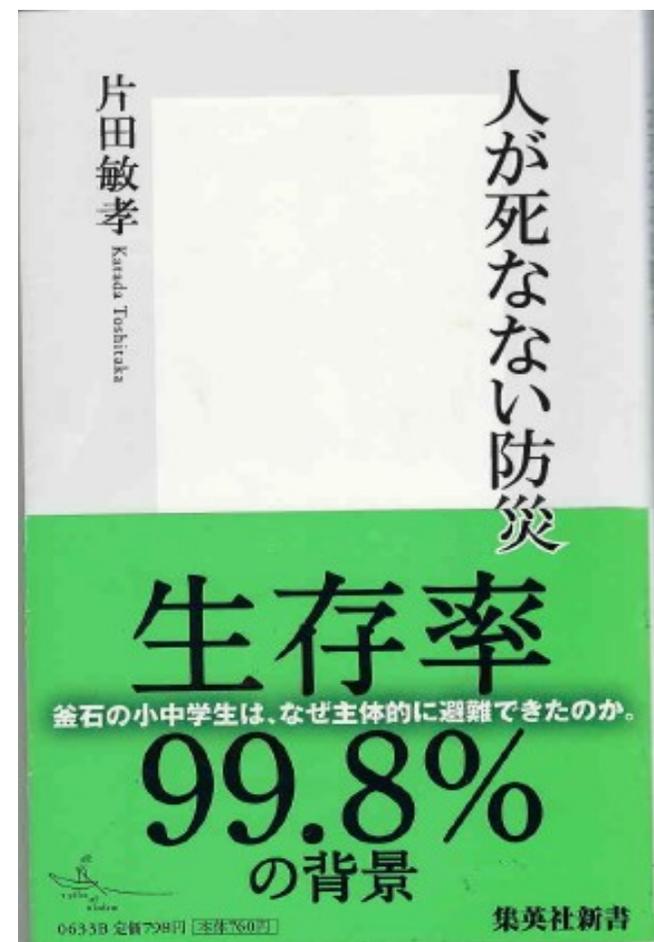
Three stages of prevention

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)
	  Financial (susceptibility or resilience)
		Risk reduction
		
		Risk transfer
			Vulnerability reduction

	Preparedness (susceptibility or resilience)	Risk reduction	
Tertiary prevention	Response Recovery	Risk retention	Residual risk

Examples of each risk management techniques (Keim, 2016)

- Risk avoidance: Floodplain management may prevent flood disasters altogether, and logging restrictions on unstable hillsides may prevent landslides. For technological disaster, regulation of industrial and commercial practices, including HACCP to avoid food poisoning.
- Risk reduction: Mitigation like local plans and regulations (limiting quantity of chemicals stored on-site at a water treatment plant), structure and infrastructure projects (placing berms around chemical storage tanks to contain leaks), natural system protection (wetland restoration to help protect against flooding), and education and awareness programs (heat wave preparedness training). → All hazards preparedness
- Risk transfer: Purchasing insurance contracts enables people to share risk across a large population.
- Risk retention (Accepting loss when it occurs and focusing on response and recovery): Instead of assessing premiums in advance, risk retention pools assess losses across all members of the group once they occur.

The four elements of a resilience framework (Fig. 24.5, Keim, 2016)

The four elements of a resilience framework

1. **Context** e.g., social group, region, institution.

2. **Disturbance** e.g., natural hazard, conflict, insecurity, food shortage, high fuel prices.

3. **Capacity to deal with disturbance**

4. **Reaction to disturbance** e.g., survive, cope, recover, learn, transform.

System or Process

Shocks

Stresses

Exposure

Sensitivity

Adaptive capacity

Bounce back better

Bounce back

Recover but worse than before

Collapse

Resilience of what?

Resilience to what?

Technological disasters and hybrid disasters (Keim, 2016)

- Technological
  - Toxic
    - Chemical
    - Radiological
  - Thermal
    - Fires
    - Explosions
  - Mechanical
    - Transport accidents
- Hybrid
  - Resulting from simultaneously occurring natural hazards and technological hazards
  - (eg) Massive urban fires after 1906 San Francisco earthquake, massive urban fires after 1995 Kobe earthquake, radiation disaster after 2011 Fukushima (Great East Japan) earthquake and tsunami.

# Annual incidence of disasters and the 10 deadliest disasters, worldwide, 1964-2013 (cited from Keim, 2016)

Figure 24.1 Annual Incidence of Natural and Technological Environmental Disasters—Worldwide, 1964–2013

Source: CRED, 2015.

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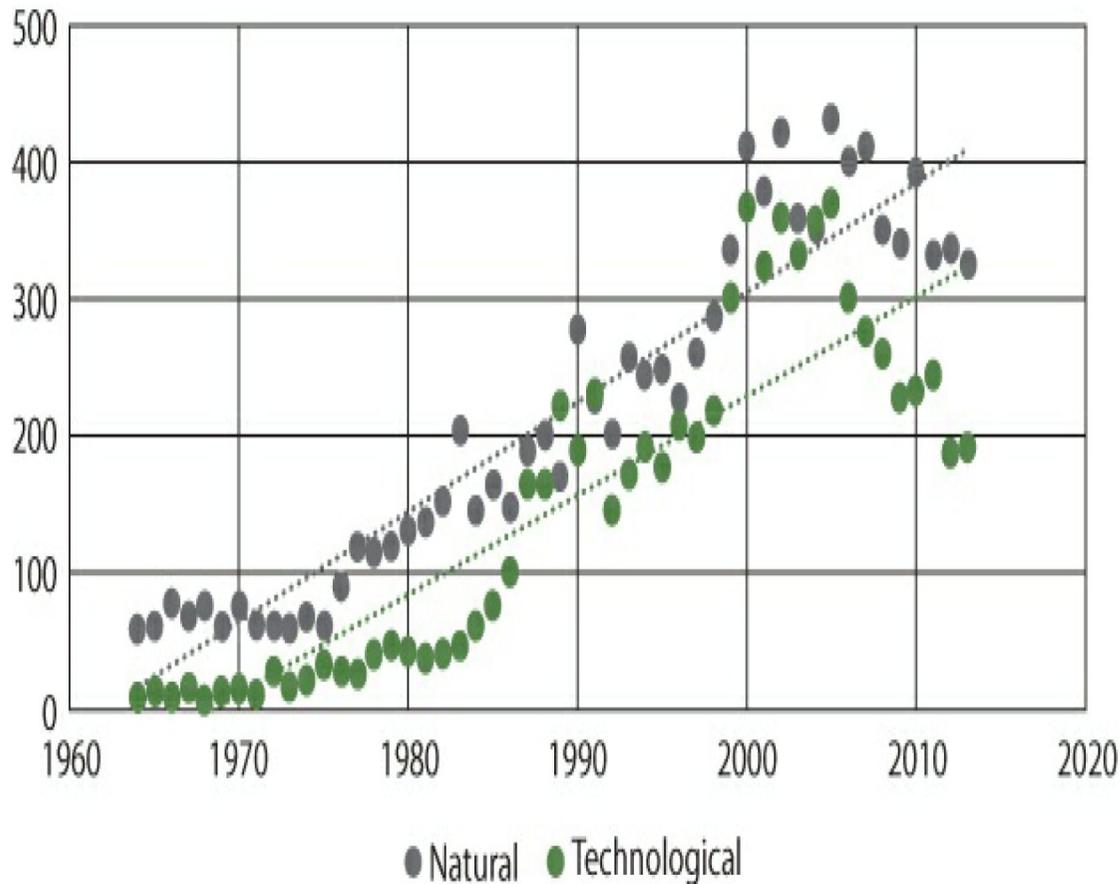
Type	Year	Location	Victims
Drought	1965	India	1,502,000
Drought	1983	Ethiopia, Sudan	450,520
Tropical cyclone	1970	Bangladesh	304,495
Earthquake	1976	China	276,994
Earthquake	2004	Indonesia	227,290
Earthquake	2010	Haiti	226,735
Tropical cyclone	1991	Bangladesh	146,297
Tropical cyclone	2008	Myanmar	140,985
Drought	1981	Mozambique	103,000
Drought	1973	Ethiopia	100,000

Comparison of public health impacts between natural and technological disasters,1964-2013 (cited from Keim, 2016)

50 Years of Environmental Disasters at a Glance:
A comparison of natural and technological disasters, (1964-2013)

Legend: ■ Natural ■ Technological

Percentage of deaths — 5%, 95%

Mean deaths per event — 1,282 / 32

Percentage of people affected — 0.1%, 99.9%

Injury rate* — 136 / 7,134 (* injuries/100,000 affected)

Percentage of injuries — 5%, 95%

Mortality rate — 1,708 / 14,955 (* deaths/100,000 affected)

Percentage of damage costs — 2%, 98%

Displacement rate* — 2,086 / 22,104 (* displaced/100,000 affected)

Percentage rendered homeless — 1%, 99%

Death/injury ratio — 0.58 / 0.78

Figure 24.2 Comparison of the Public Health Impacts of Natural and Technological Disaster Events, 1964–2013

Source: CRED, 2015.

Key public health impacts for natural and technological disasters (Keim, 2016)
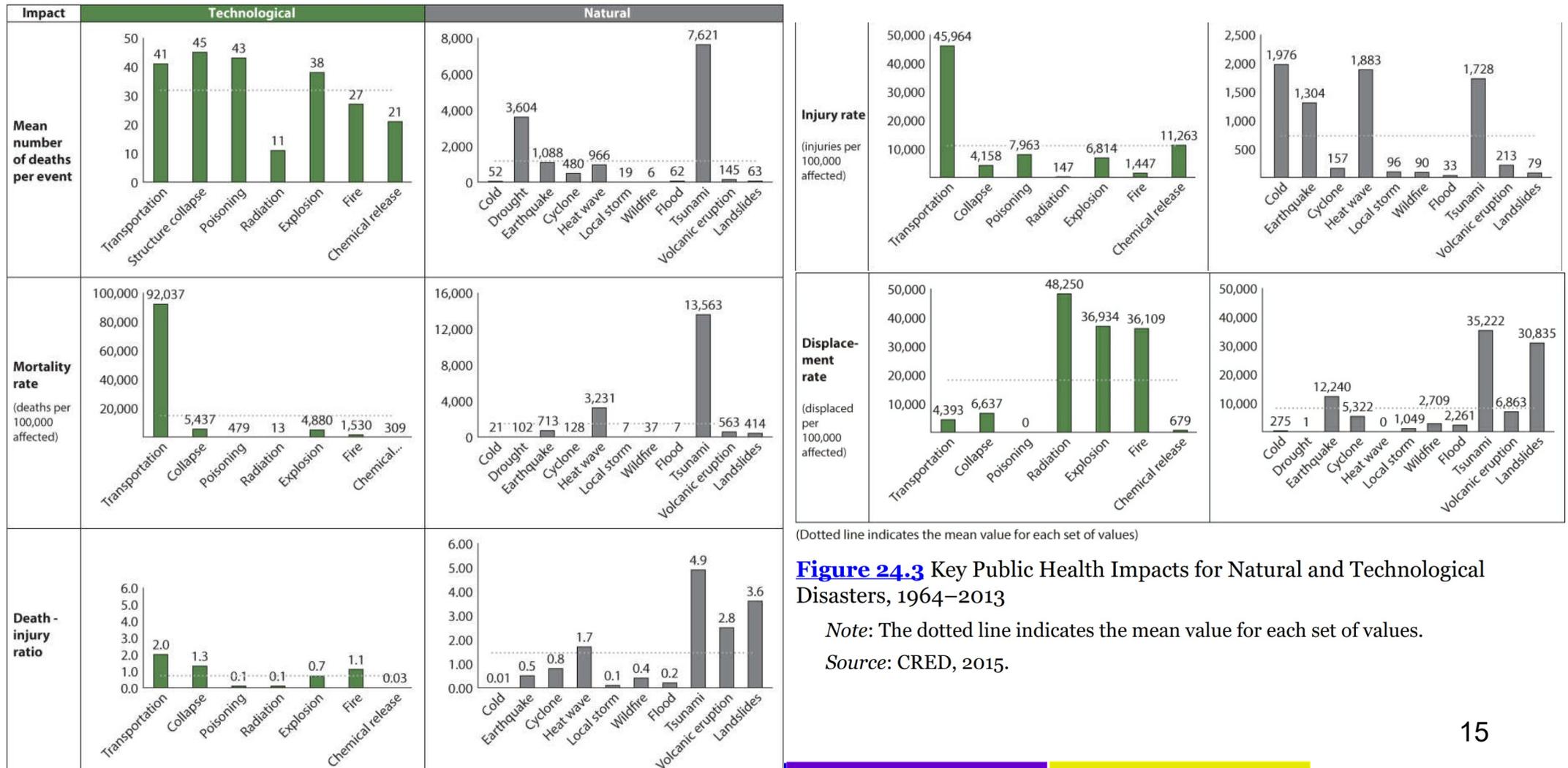
**Figure 24.3** Key Public Health Impacts for Natural and Technological Disasters, 1964–2013

Note: The dotted line indicates the mean value for each set of values.

Source: CRED, 2015.

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Major causes of death during disasters (Keim, 2016)

- Natural disaser
  - Drought: malnutrition
  - Wildfires: ashpyxiation, burns, toxic exposures
  - Heat waves: heat stroke, exacerbations of cardiovascular diseases
  - Storms: drowning, traumatic injury
  - Floods: drowning
  - Earthquakes: traumatic injury, asphyxia
  - Landslides: traumatic injury, asphyxia
  - Volcanic eruptions: traumatic injury, burns, toxic exposures
  - Tsunamis: drowning, traumatic injury
  - Cold weather: hypothermia
- Technological disaster
  - Chemical release: poisoning, asphyxia
  - Poisonings: poisoning
  - Nuclear: traumatic injury, burns, radiation illness
  - Radiological: radiation illness
  - Fires: burns, asphyxia
  - Explosions: traumatic injury, burns
  - Transportation accidents: traumatic injury, burns, drowning
  - Structural collapse: traumatic injury, asphyxia

Top 10 disaster affected countries (cited from CRED (2018) Economic Losses, Poverty & Disasters, 1998-2017.)

Top 10 countries/territories in terms of absolute losses (billion US$) 1998-2017

- High income
- Upper-middle income
- Lower-middle income
- Low income
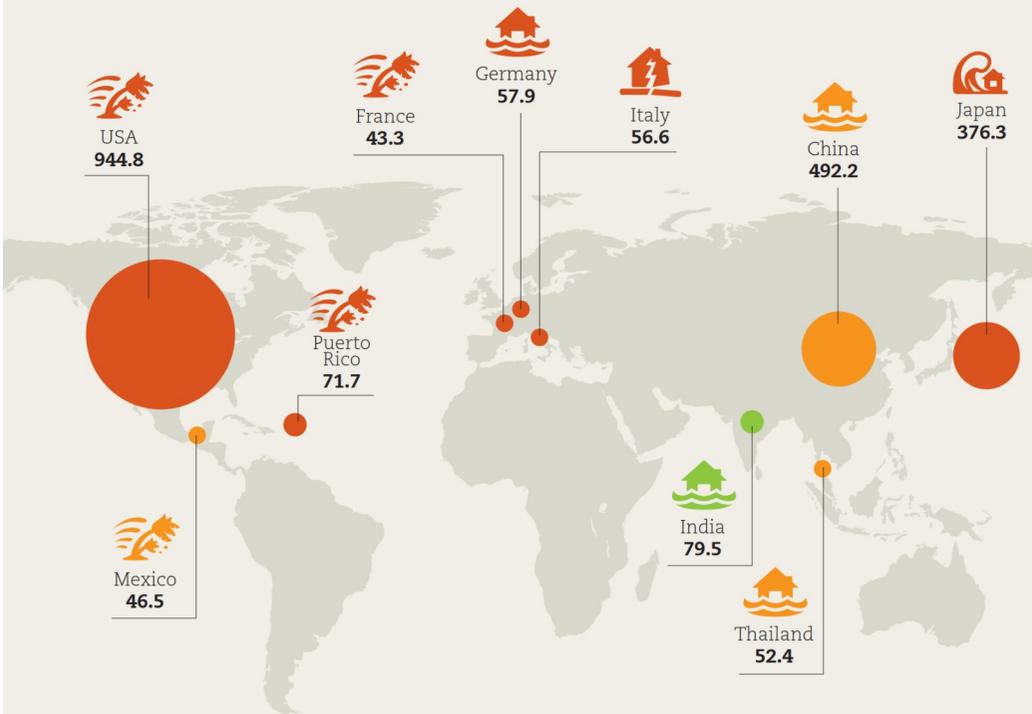
USA 944.8
Puerto Rico 71.7
Mexico 46.5
France 43.3
Germany 57.9
Italy 56.6
China 492.2
Japan 376.3
India 79.5
Thailand 52.4

Disaster type responsible for the majority of losses

- Earthquake
- Earthquake & Tsunami
- Storm
- Extreme temperature
- Flood
- Drought

³ Excluding small states. See Annex for the list of small states. See Annex for the methodology on the calculation of economic losses related to GDP

Top 10 countries/territories in terms of average annual percentage losses relative to GDP

- High income
- Upper-middle income
- Lower-middle income
- Low income
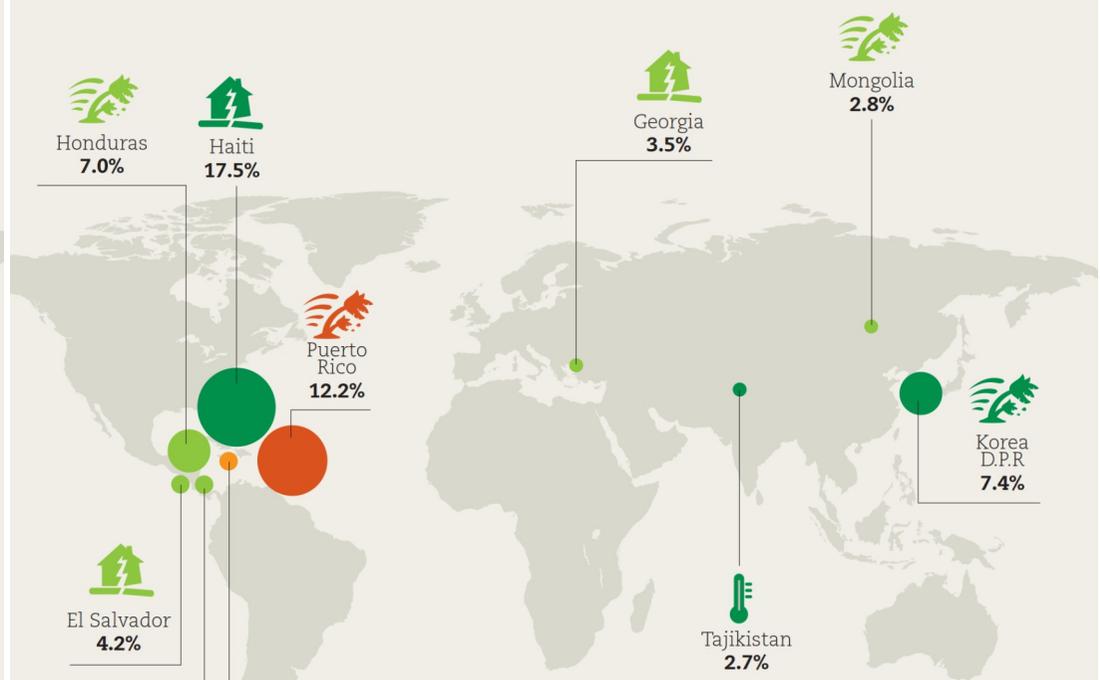
Honduras 7.0%
Haiti 17.5%
Mongolia 2.8%
Georgia 3.5%
Puerto Rico 12.2%
Korea D.P.R 7.4%
El Salvador 4.2%
Nicaragua 3.6%
Cuba 4.6%
Tajikistan 2.7%

Disaster type responsible for the majority of losses

- Earthquake
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- Storm
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- Flood
- Drought

Evaluation of disasters' impacts

- HESPER (WHO)
  - The Humanitarian Emergency Settings Perceived Needs Scale (HESPER): Manual with Scale (English, French, Arabic, and Urdu versions are available from the URL below)
  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/

HESPER

- The HESPER Scale assesses a wide range of social, psychological and physical problem areas. However, it does not provide an answer as to whether, or how to, offer help. It simply aims to identify those serious perceived problems that are common in a population. These problems should then be assessed and addressed in more detail.

- The HESPER Scale was developed by the World Health Organization and King's College London in order to fill several gaps in the humanitarian field. It enables needs assessments to be based directly on the views of people affected by humanitarian emergencies, and provides a more accurate picture of the serious problems with which the overall emergency-affected population wants help.

Appendix 1 - Humanitarian Emergency Settings Perceived Needs Scale (HESPER)

Date:	Interviewer name:		Participant number:
Location (name of city, village or camp):		Gender:	Age:

Rating: 0 = no serious problem 1 = serious problem 9 = does not know / not applicable / declines to answer	Ratings

I am going to ask you about the **serious problems** that you may **currently** be experiencing. We are interested in finding out what you think – a serious problem is a problem that **you** consider serious. There are no right or wrong answers. I am going to ask you about your own serious problems first.

1. Drinking water Do you have a serious problem because you do not have enough water that is safe for drinking or cooking?	
2. Food Do you have a serious problem with food? For example, because you do not have enough food, or good enough food, or because you are not able to cook food.	
3. Place to live in Do you have a serious problem because you do not have a suitable place to live in?	
4. Toilets Do you have a serious problem because you do not have easy and safe access to a clean toilet?	
5. Keeping clean *For men:* Do you have a serious problem because in your situation it is difficult to keep clean? For example, because you do not have enough soap, water or a suitable place to wash. *For women:* Do you have a serious problem because in your situation it is difficult to keep clean? For example, because you do not have enough soap, sanitary materials, water or a suitable place to wash.	
6. Clothes, shoes, bedding or blankets Do you have a serious problem because you do not have enough, or good enough, clothes, shoes, bedding or blankets?	
7. Income or livelihood Do you have a serious problem because you do not have enough income, money or resources to live?	
8. Physical health Do you have a serious problem with your physical health? For example, because you have a physical illness, injury or disability.	
9. Health care *For men:* Do you have a serious problem because you are not able to get adequate health care for yourself? For example, treatment or medicines. *For women:* Do you have a serious problem because you are not able to get adequate health care for yourself? For example, treatment or medicines, or health care during pregnancy or childbirth.	
10. Distress Do you have a serious problem because you feel very distressed? For example, very upset, sad, worried, scared, or angry.	
11. Safety Do you have a serious problem because you or your family are not safe or protected where you live now? For example, because of conflict, violence or crime in your community, city or village.	
12. Education for your children Do you have a serious problem because your children are not in school, or are not getting a good enough education?	
13. Care for family members Do you have a serious problem because in your situation it is difficult to care for family members who live with you? For example, young children in your family, or family members who are elderly, physically or mentally ill, or disabled.	
14. Support from others Do you have a serious problem because you are not getting enough support from people in your community? For example, emotional support or practical help.	
15. Separation from family members Do you have a serious problem because you are separated from family members?	
16. Being displaced from home Do you have a serious problem because you have been displaced from your home country, city or village?	
17. Information *For displaced people:* Do you have a serious problem because you do not have enough information? For example, because you do not have enough information about the aid that is available; or because you do not have enough information about what is happening in your home country or home town. *For non-displaced people:* Do you have a serious problem because you do not have enough information? For example, because you do not have enough information about the aid that is available.	
18. The way aid is provided Do you have a serious problem because of inadequate aid? For example, because you do not have fair access to the aid that is available, or because aid agencies are working on their own without involvement from people in your community.	
19. Respect Do you have a serious problem because you do not feel respected or you feel humiliated? For example, because of the situation you are living in, or because of the way people treat you.	
20. Moving between places Do you have a serious problem because you are not able to move between places? For example, going to another village or town.	
21. Too much free time Do you have a serious problem because you have too much free time in the day?	

The last few questions refer to people in your community*, so please think about members of your community when answering these questions.

22. Law and justice in your community Is there a serious problem in your community because of an inadequate system for law and justice, or because people do not know enough about their legal rights?	
23. Safety or protection from violence for women in your community Is there a serious problem for women in your community because of physical or sexual violence towards them, either in the community or in their homes?	
24. Alcohol or drug use in your community Is there a serious problem in your community because people drink a lot of alcohol, or use harmful drugs?	
25. Mental illness in your community Is there a serious problem in your community because people have a mental illness?	
26. Care for people in your community who are on their own Is there a serious problem in your community because there is not enough care for people who are on their own? For example, care for unaccompanied children, widows or elderly people, or unaccompanied people who have a physical or mental illness, or disability.	

Other serious problems:

Do you have any other serious problems that I have not yet asked you about? Write down the person's answers. 27.
28.
29.

Priority ratings for serious problems:

Read out the titles of all questions you have rated as '1', as well as any other serious problems listed above. Write down the person's answers (write down the number and title of the questions).
1.   Out of these problems, which one is the most serious problem?
2.   Which one is the second most serious problem?
3.   Which one is the third most serious problem?

Interviewers should be trained in the HESPER before use (see Appendix 2 of the HESPER manual).

*   Throughout the HESPER form, the term 'community' should be replaced with the term that is most suitable to the local geographical area (for example village, town, neighbourhood, camp and so on).

Public health impacts by natural disasters

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

Public Health Impact	Geophysical				Meteorological			
	Seismic		Volcanic		High precipitation		Low precipitation	
	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
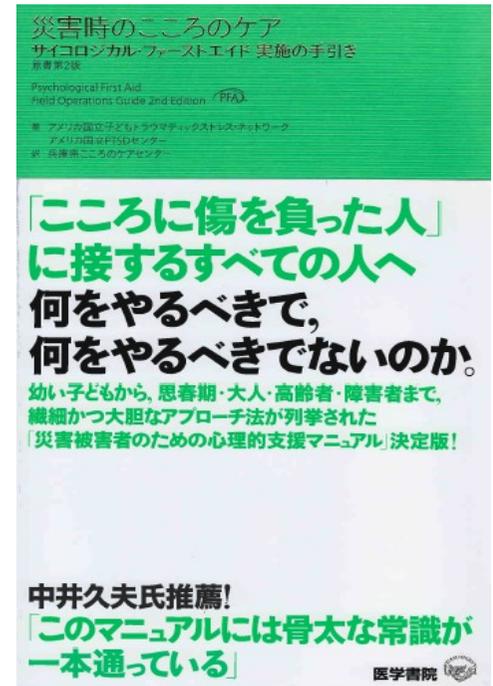
- **Commonly needed preparedness:**
- Psychological first-aids,
- Minimum standards in humanitarian responses (Sphere project),
- Clean-up safety (CDC)

Flood in Solomon Islands in 2014

- Deadly flood has attacked Solomon Islands in April 2014, caused by tropical cyclone *ita*.

- 16 evacuation centers had been set up in local schools to provide shelter for more than 10,000 homeless people, a huge proportion of the population in the Honiara city of only 72,000. More than 60,000 people were affected.

- 17 people were killed, 30 people were unidentified anywhere.

- Australia offered $50K, NZ offered $300K as initial aid.

- NGO World Vision NZ started to aid immediately.

- One of the biggest problems was **the information loss**: In each evacuation station, it was unclear how many evacuee needs how much and what kinds of aids, lots of goods were not distributed.

- After the flood, rota virus outbreak occurred due to **the loss of sanitation and safe water**, followed by still ongoing measles outbreak due to **the loss of health care systems** (for the babies born after the flood, measles immunization was impossible)

Types of administrative systems

- Tree-shape (as usual) = scale-free network
  - Pros: High communication efficiency, Robust against the peripheral loss
  - Cons: Very weak for the loss of hub (center, municipal office)
- Alternative network
  - Random-link network: Good and necessary as personal channels, but low efficiency
  - Asymmetric, asynchronous system: top-down and bottom-up in different paths

Communities

Municipal

Prefectural

National
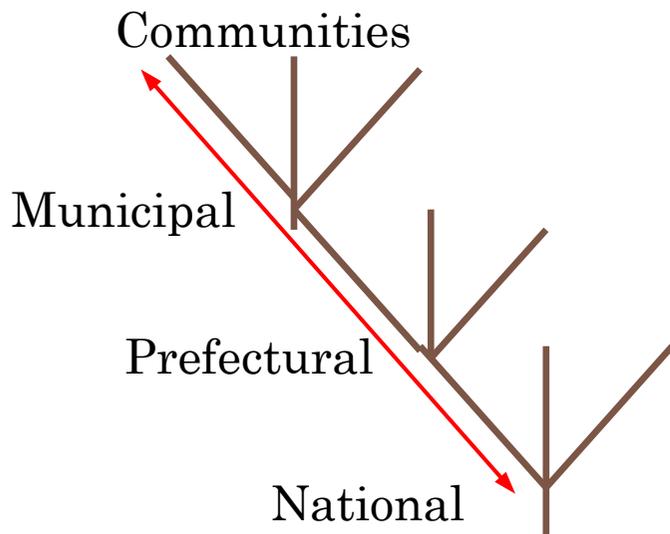
Directly connected each other

Communities

Virtual cloud
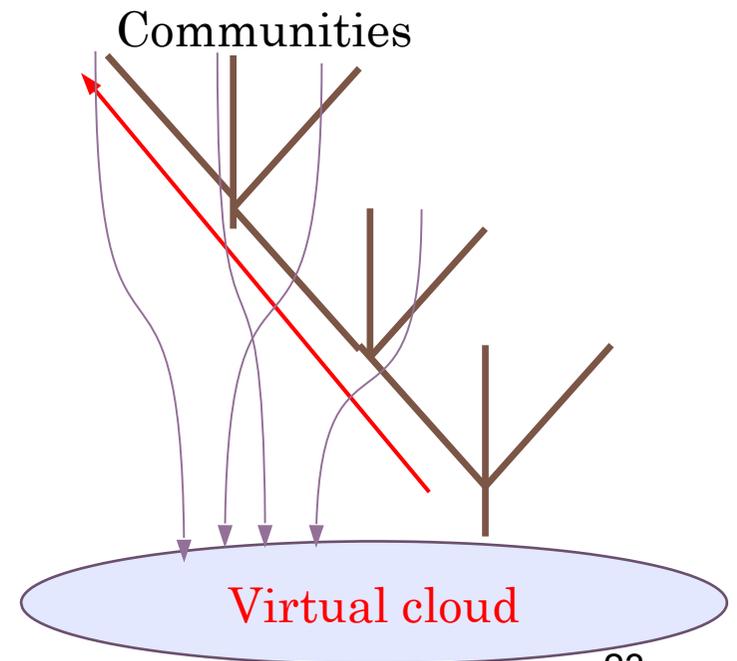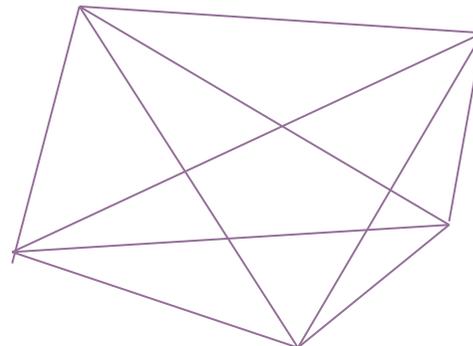
SPSNU system as possible preparedness (Just a tentative idea)

- ◆ Asymmetric, asynchronous system
  - ◆ Multi-channel, <u>one-direction</u> <u>Solar-Powered Satellite Network Unit</u> (it should be text-base, not mutual verbal communication because the latter requires 24hrs responsible operators on the admin side)
  - ◆ Robust for the loss of power, the loss of hub (municipal office), and the loss of usual network, community based
  - ◆ The database can be put on the virtual cloud (Google, Amazon, and many other E-commerce companies supply, they may cooperate as CSR), which is accessible not only by the national center, but also by the overseas aid providers (~donors), who can negotiate each other.

SPSNU for each community

Municipal

Prefectural

National

Virtual cloud DB

Overseas aid providers
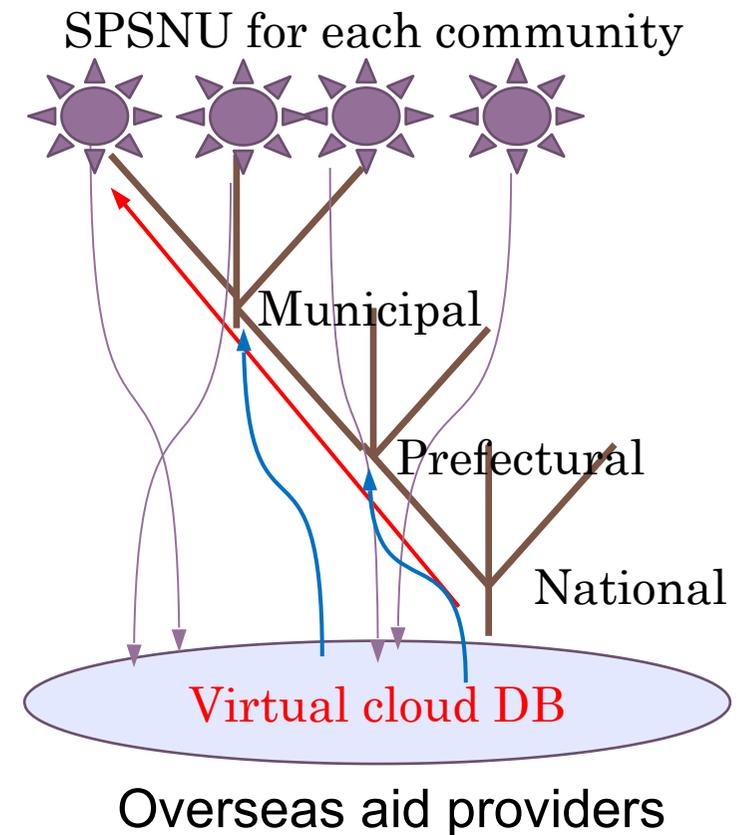
Red lines show the flow of goods, grey lines show the upward info, blue lines show the downward info.