Chapter 1

Introductory Chapter: Earthquakes, Life at Risk

Valentina Svalova

Additional information is available at the end of the chapter

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1. Natural hazards and disasters

Natural hazards are potentially damaging physical events and phenomena, which may cause the loss of life, injury or human life disruption, property damage, social, economic, and political disruption, or environmental degradation.

Natural disasters cause fear and horror for people. The most unpredictable is earthquakes. Active volcanoes are constantly monitored that gives the possibility to anticipate a possible eruption. Tsunamis have a number of predictive features that give possibility to mitigate their consequences.

There are different groups of natural hazards: geological, hydrometeorological, outer space, and biological hazards.

Disasters cause widespread human, material, economic, or environmental losses.

Frequency of natural disasters has been steadily increasing for the last 35 years. Munich Re registered an average number of 405 disaster events per year in 1980–1989, 650 events in the 1990s, 780 events in the period of 2000–2009, and more than 800 events in the 2010s [1]. **Figure 1(a–f)** shows that the total number of disasters increases, but the number of geological disasters has not been much changed for the last 30 years compared to the number of hydrometeorological and climatological events. Victims and economic damage increase drastically.

Earthquakes, volcano eruptions, tsunamis, curst, suffusion, coast erosion, and landslides belong to geological hazards [2–4].

The most affected regions for natural disasters are connected with tectonic plate boundaries in collision and subduction zones and Pacific Ring of Fire (**Figure 1g**).

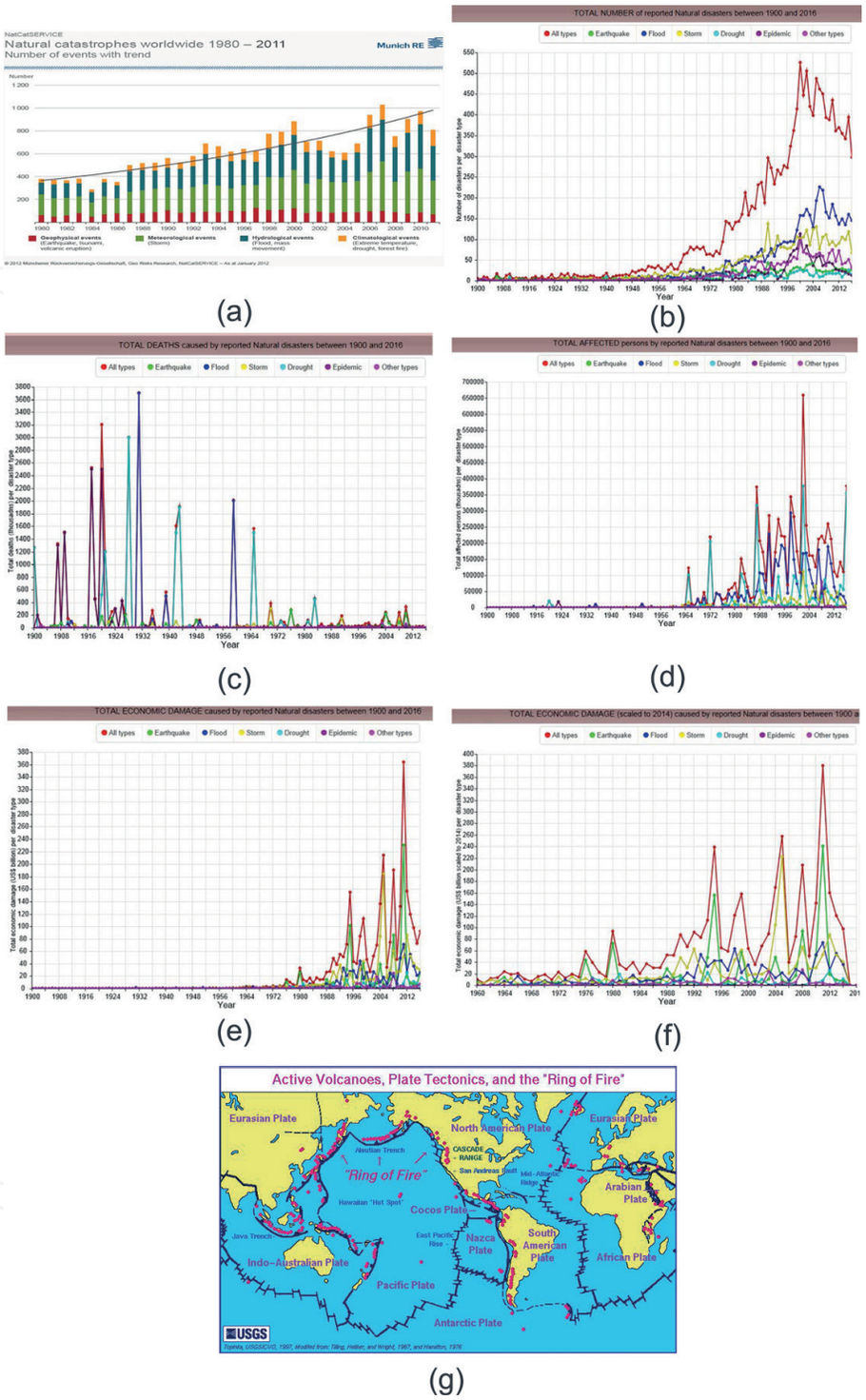

Figure 1. (a) Natural disasters number for the years from 1980 to 2013. 1: geological events; 2: meteorological events; 3: hydrological events; and 4: climatological events (NatCatSERVICE, 2014). (b) Natural disasters total numbers, 1900–2016. (c) Deaths of natural disasters, 1900–2016. (d) Affected persons, 1900–2016. (e) Economic damage from natural disasters, 1900–2016. (f) Economic damage scaled to 2014 from natural disasters, 1960–2016. (g) Map of active volcanoes, plate tectonics, and Pacific Ring of Fire (USGS). http://emdat.be/.

According to the global risk analysis carried out by the World Bank, 7.5% of the total area of the planet, that is of about 10 million km^2, with 20% of the world population, that is approximately 1.2 billion people, is subjected to earthquakes.

Nearly, 0.4 million km^2 with a 93 million population are affected by volcanoes in Iceland, Japan, the Philippines, Indonesia, the United States, Mexico, Central America, Colombia, Ecuador, Chile, and other countries.

Areas of landslides risk are inhabited by 66 million of inhabitants and occupy a land area of 820,000 km^2.

Mountainous and coastal areas are the most affected regions, but that does not mean that the other areas are safe.

Landslides cause huge damage in the world and kill many people each year. There are different types of slides as lahars, solifluction, avalanches, glaciers, and others.

Fourteen million people are exposed to tsunamis. The major potentially affected areas are located along the coasts of countries facing the oceans and seas (UNISDR 2009).

Millions of human lives are lost due to earthquakes and volcano eruptions, and property damage has exceeded hundreds of billions USD. It is not possible to make reliable earthquake forecast now, but there exist a few success examples.

A global tsunami warning system was set up to tackle with the challenging problems of tsunami disasters. Also, local and regional warning systems generate scientific-based information. Scientific modeling and tsunami forecasting are still to be improved so that the time available between warning and action can be used in the best possible way.

2. Hydrometeorological hazards

Among all natural hazards, the hydrometeorological hazards cause the disaster events most frequently (**Figure 1**). They are heavy rains, storms, hurricanes, droughts, tropical cyclones, rainstorm floods, heat waves, and low temperature disasters. Also, they include lightning, tornadoes, dust storms, hail, frost, fog, and haze.

The breakdown of all disasters associated with natural events worldwide from 1980 to 2011 by regions is illustrated in **Figure 2a**. **Figure 2(b–g)** shows the maps of some natural disasters in the world, 2/3 of all fatalities. About 1.5 million fatalities, that is near 2/3 of all, and 40% of all events (8080) occurred in Asia and the Pacific. Asia and the Pacific are also leading in economic losses with 45%. North America with Central America and Caribbean are the second with 37% of total losses. More than 1/4 of all fatalities are registered in Africa, although only 9% of all events occur there. The regions with economically less developed countries have more fatalities [1].

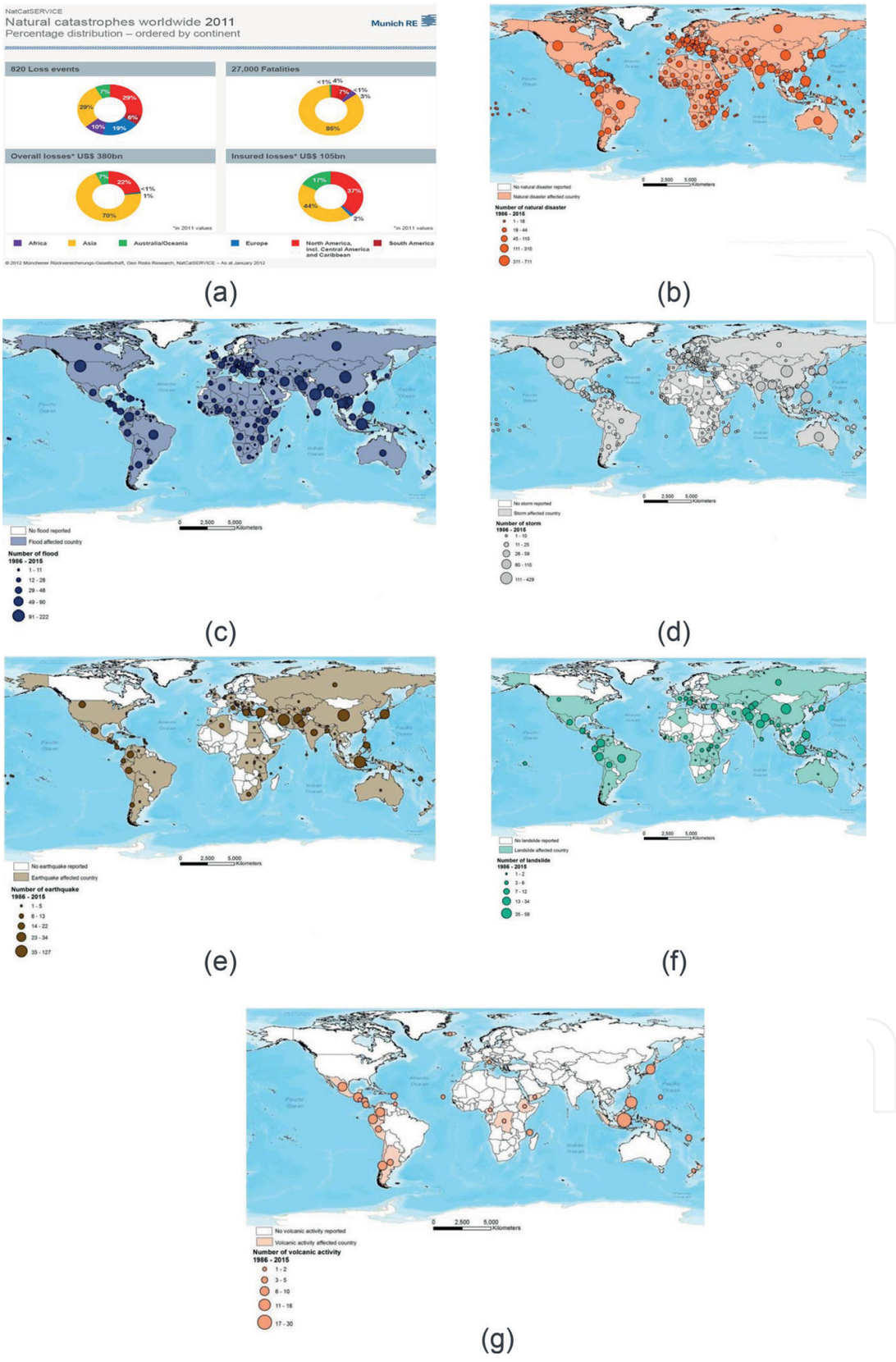

Figure 2. (a) Regional distribution (in per cents) of loss events (total 20,200), fatalities (total 2,275,000), and losses (total USD 3530 billion in 2011 values) for 1980–2011 (NatCatSERVICE; [1]). (b) Number of natural disaster by country, 1986–2015. (c) Number of flood by country, 1986–2015. (d) Number of storm by country, 1986–2015. (e) Number of earthquake by country, 1986–2015. (f) Number of landslide by country, 1986–2015. (g) Number of volcanic activity by country, 1986–2015. http://emdat.be/.

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3. Natural risk

The concept of risk is used for systematic analysis of natural hazard and disasters [5–15].

There are some definitions of geological risk. The most common ones are: risk is the expectation of the damage or risk is the product of the probability of hazardous event on the produced damage.

The problem of risk management is considered as measures leading to risk reduction. Geological risk management includes:

1. Identification of hazard and disaster;
2. Vulnerability;
3. Risk analysis;
4. Acceptable risk;
5. Risk assessment;
6. Risk mapping;
7. Measures for risk reduction:

    - legislative;
    - organizational and administrative;
    - economic, including insurance;
    - engineering and technical;
    - modeling;
    - monitoring;
    - information.

Apocalyptic image of earthquakes should make local governments pay more attention to the prevention of such natural phenomena. It is important to know which areas are prone to earthquakes and take appropriate measures in order to reduce vulnerability to such hazards.

Vulnerability to earthquakes and other natural hazards depends on location, frequency of earthquake events, type of human activity in the area, and other factors.

Hazardous areas must be avoided when possible. Activities must be restricted there. Local governments are responsible for regulations meant to reduce the risks of exposure from earthquakes and other natural hazards.

Exposure to earthquakes and natural hazards may be reduced if individuals educate themselves on the past history of these phenomena.

People can also benefit from the professional services of engineering geologists, civil engineers, or geotechnical engineers.

Due to the huge losses that earthquakes and other natural hazards imply, their forecast, prognosis, and prevention are of maximum importance for all the people living in the area of hazards and disasters.

4. World Conference on Disaster Risk Reduction

The World Conference on Disaster Risk Reduction is a series of United Nations conferences focusing on disaster and climate risk management in the context of sustainable development.

There were three conferences: in Yokohama in 1994, in Kobe in 2005, and in Sendai in 2015. As requested by the UN General Assembly, the United Nations Office for Disaster Risk Reduction (UNISDR—United Nations International Strategy for Disaster Reduction) served as the coordinating body for the Second and Third UN World Conference on Disaster Reduction in 2005 and 2015.

First and second conferences adopted the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters in 2005 and the Yokohama Strategy and Plan of Action for a Safer World in 1994. The Third UN World conference adopted the Sendai Framework for Disaster Risk Reduction 2015–2030. It was held in Sendai, Japan on 14–18 March, 2015. A total of 6500 delegates participated in the conference and 50,000 people in the associated Public Forum.

Sendai city is in Miyagi Prefecture in north-east of Japan. It was hit by the Great East Japan earthquake and tsunami on 11 March, 2011 in 130 km from the epicenter of earthquake. The conference included the discussion of how Japan's early warning system can save lives when earthquakes and tsunamis strike. The conference announced of a US$4 billion fund to prepare for disasters over 4 years. The Sendai Framework has seven targets and four priorities for action. It was endorsed by the UN General Assembly in June 2015.

5. Sendai Framework for disaster risk reduction 2015–2030

The Sendai Framework confirmed that the State has the main role to reduce disaster risk. But other stakeholders such as local government and the private sector must share responsibility. It means (unisdr.org):

"The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries."

The Sendai Framework sets four priorities of activity (unisdr.org):

1. Understanding disaster risk;
2. Strengthening disaster risk governance to manage disaster risk;

3. Investing in disaster risk reduction for resilience;
4. Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation, and reconstruction.

Seven targets have been agreed (unisdr.org) to support the assessment of global progress in achieving the outcome and goal of the Sendai Framework:

1. Substantially reduce the global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020 and 2030 compared to 2005–2015;
2. Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020 and 2030 compared to 2005–2015;
3. Reduce the direct disaster economic loss in relation to global gross domestic product by 2030;
4. Substantially reduce the disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;
5. Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;
6. Substantially enhance the international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the framework by 2030;
7. Substantially increase the availability of and access to multihazard early warning systems and disaster risk information and assessments to the people by 2030.

Author details

Valentina Svalova

Address all correspondence to: inter@geoenv.ru

Sergeev Institute of Environmental Geoscience RAS, Moscow, Russia

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