

# Chapter 18

## Urban Disaster Risk Evaluation

Field of expertise: Spatial Studies for Disaster Risk Reduction and Recovery

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### Summary

In Japan, people have learned from past disasters and have applied lessons learned to urban disaster safety. However, urban disasters evolve because they are a reflection of the external forces of nature in the form of hazards through ever-evolving cities and societies. In order to mitigate urban disasters, it is important to reduce the vulnerability of cities, which requires proper assessment of urban disaster risks.

**Keywords:** hazard, vulnerability, exposed value, damage mitigation, preparedness, urban system, urban recovery, evolution of disasters

### Introduction

On March 11, 2011, the 2011 Earthquake off the Pacific Coast of Tohoku, with a magnitude 9.0, struck the Tohoku region of Japan. Although many tsunami mitigation measures had been taken in Japan during the 20th century, the scale of the tsunami was so large that it affected a wide area of approximately 500 kilometers from north to south and 200 kilometers from east to west in Japan. Reconstruction measures were implemented in the affected areas over the following 10 years, and public awareness of urban risk has been increasing.

### 1: Issues Revealed by the 2011 Great East Japan Earthquake

#### What happened?

Due to the 2011 Earthquake off the Pacific Coast of Tohoku, eight prefectures (110 cities, towns, and villages) along the Pacific coast, from Iwate Prefecture to Chiba Prefecture, as well as Tochigi, Gunma, and Saitama prefectures, recorded seismic intensity of 6-lower or higher. The earthquake and tsunami caused 22,252 human casualties (dead or missing), as well as damage to 121,995 houses that were completely destroyed and 282,939 houses that were partially destroyed (as of March 8, 2019) (Fire and Disaster Management Agency, 2019).

Since the Meiji era, the Sanriku coastal area has been affected by the 1896 Meiji Sanriku Tsunami, the 1933 Showa Sanriku Tsunami, and the 1960 Chilean Tsunami, and tsunami countermeasures had been implemented based on these disasters. The content of the countermeasures are different from one to another because each area has its own social

conditions. After the Chilean tsunami, facilities were built in many places to prevent damage due to the high economic growth period of Japan, including the seawall in Taro Town (now Taro District, Miyako City, Iwate Prefecture), the tallest in the world, but the 2011 tsunami overcame these structures and caused tremendous damage.

### The reality of the damage

Sixty-one coastal municipalities in the six prefectures in eastern Japan, from Aomori to Chiba, were affected by the tsunami. In order of the number of dead or missing, Miyagi (11,886), Iwate (6,255), and Fukushima (4,092) were the three heavily damaged prefectures. The three most affected municipalities were Ishinomaki in Miyagi Prefecture (3,972), Rikuzentakata in Iwate Prefecture (1,806), and Kesennuma in Miyagi Prefecture (1,432).

Each municipality had taken damage mitigation measures such as seawalls, sluices, breakwaters, and levees in each coastal area. Figure 18-1 shows the number of tsunami countermeasure structures in relation to the total number of beaches in each municipality (Tanaka & Muraio, 2017). Many cities, towns and villages in Iwate Prefecture had sluice gates and levees/seawalls, while cities, towns and villages in Fukushima Prefecture had a higher ratio of breakwaters than seawalls. The extent of damage in each municipality depended on the size of the tsunami, topography, location of the village, and the status of tsunami countermeasures. However, there were many cases where proactive measures such as coastal forests, breakwaters at the mouth of bays, sluice gates, and tsunami evacuation routes and stairs worked effectively.

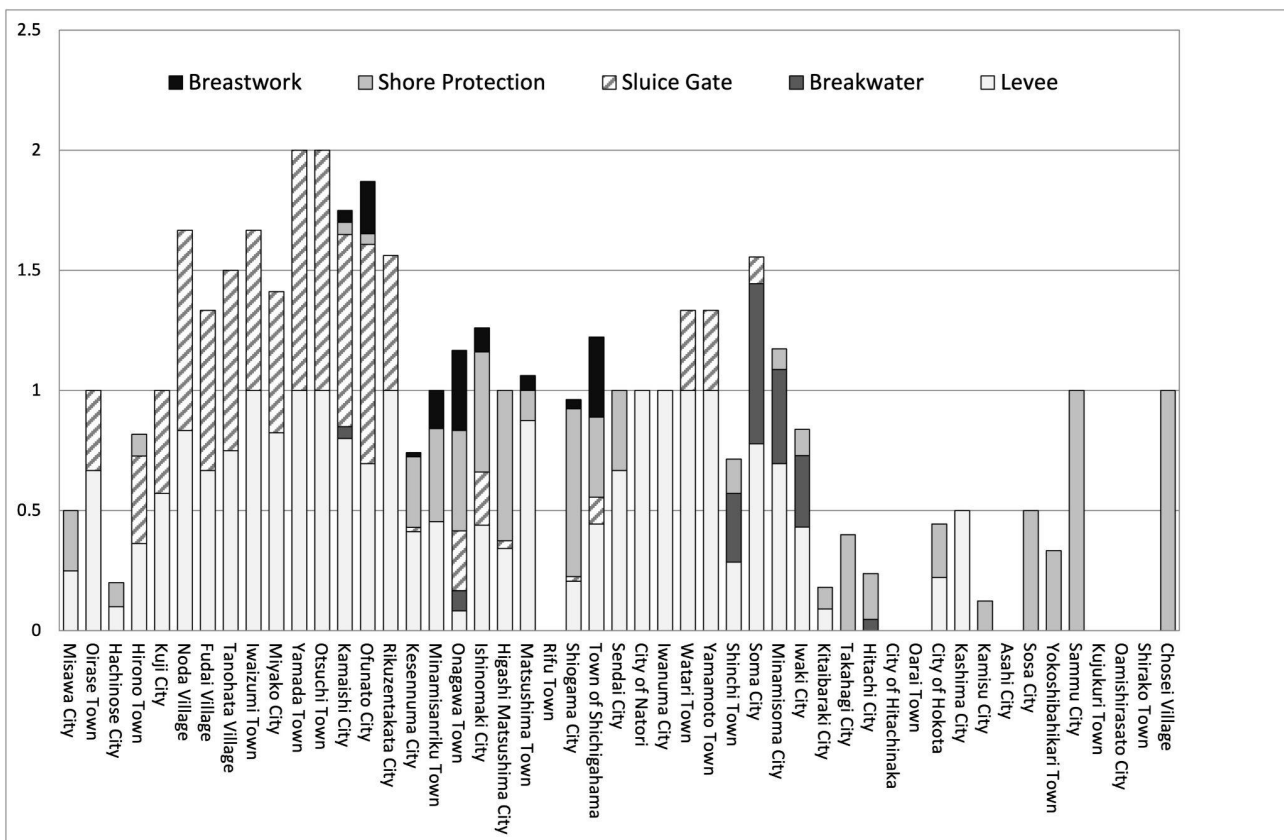


Figure 18-1. The number of tsunami countermeasure structures to the total number of beaches in each municipality

## 2: Urban Disaster Risk and the History of Tsunami Countermeasures in Japan

My specialty is urban disaster safety. What constitutes a "city" is a difficult topic that has been debated for many years, and I will not discuss it here. A "city" is a comprehensive concept. To enhance the disaster risk management of these "cities", it is necessary to assess the risk of urban disasters.

Urban Disaster Risk is a product of hazards, vulnerabilities and exposure. Taking these three indicators into consideration, it is important to anticipate what will happen in a certain area in advance in order to proceed with disaster countermeasures. However, even in the 21st century, it is difficult to predict when, where, and to what degree a hazard (tsunami or earthquake) will occur. In fact, we couldn't predict the Mw 9.0 earthquake of 2011. Since the occurrence of the Great East Japan Earthquake, various measures have been taken to prepare for hazards with a larger scale of damage.

Earthquakes, tsunamis, typhoons, and other hazards are part of the earth's activities, and they cannot be controlled by mankind's current technology. Therefore, the most important way to reduce the risk of urban disasters is to reduce the vulnerability of cities. In general, this is called urban disaster risk reduction, and there are two types of measures that should be taken in advance: mitigation to prevent damage, and preparedness to lessen damage. A well-balanced approach is required, taking into account the local situation (organization system and financial situation), but if a high level of damage prevention capability is secured, the cost of response and recovery and reconstruction can be reduced.

Surrounded by the sea, Japan has suffered from many tsunami disasters in the past. Learning from these disasters, concrete measures have been taken step by step since the 19th century. After the Meiji Sanriku Tsunami of 1896, many of the affected villages were relocated to higher ground but returned to their original locations, and many of them were hit again by the Showa Sanriku Tsunami of 1933. In order to invest in disaster prevention, it is necessary to have social and economic stability. In Japan, this kind of investment in disaster prevention started after the 1960 Chilean tsunami (Figure 18-1), but from a global perspective, such investment in disaster prevention in the 20th century was rare. In the latter half of the 1990s, national policies on tsunami damage forecasting, hazard mapping, and tsunami evacuation began to be formulated.

The Great East Japan Earthquake struck Japan, which had been moving forward with tsunami countermeasures in terms of both mitigation and preparedness. Due to the enormous scale of the damage, it took ten years to recover. While there has been some criticism of the investment in disaster prevention, such as the construction of a 400 kilometer-long seawall along the affected areas, which are facing the challenges of aging populations with low birthrates and depopulation of rural areas, there have been many discussions on urban disaster reduction and recovery over the past 10 years, and people's awareness and interest in disaster risk have deepened through various opportunities, including the 2015 United Nations World Conference on Disaster Risk Reduction, where the Sendai Framework for Disaster Reduction was adopted. From the perspective of urban safety, rather than destroying a certain paradigm, I think the Great East Japan Earthquake revealed what we need to do more of, and provided an opportunity for disaster risk reduction to become even more prevalent in society.

### **3: Urban Disaster Science in Development**

The definition of a "city" is broad and ambiguous. I dare to refer to the physical environment of urban space as the subject here. The city is a huge artificial production built by mankind. Unlike cell phones and automobiles, which are mass-produced after they have been tested and proven to be 99.99% safe and reliable, cities have been changing and evolving for decades or even millennia

since their inception. We don't just start living in a city by saying, "this city has been confirmed to be safe from earthquakes, so you can start living there tomorrow." Many people around the world find themselves living there (after they are born) or start living in existing cities for one reason or another. Within cities, there is a constant movement of population, increasing and decreasing over time, and it is difficult to even understand the proper balance for disaster management. This is why we need to learn from past disasters about the vulnerability of cities. In this sense, there is a lot to learn about the situation before the Great East Japan Earthquake, how it was destroyed, how it was recovered, and how the reconstructed disaster areas can cope with the future in the 21st century.

#### **4: Urban Vulnerability Assessment**

We have obtained a lot of knowledge from past disasters. I have been conducting urban vulnerability assessments using building damage data obtained from past disasters. The history of urban vulnerability assessment research is still short. Now that people are more aware of risks than ever before, it can be a tool for risk communication and a basis for local governments to consider disaster management. Research on such assessments will become more and more important in the future.

#### **Conclusion - from the author**

Japan is prone to many natural disasters, but this is also the flip side of the fact that we are blessed with so much nature (good food from the sea, mountains, hot springs, beautiful scenery, etc.). I look forward to seeing the kind of society that will emerge when ideas about urban disaster risk reduction and disaster culture that Japan has cultivated are widely disseminated.

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