Chapter 14
Impacts of Natural Disasters and Disaster Risk Management in China: The Case of China's Experience in the Wenchuan Earthquake

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1 Introduction

Natural disasters are extreme events which cause damage and destruction to human life safety, economic development, the living environment and resources. A natural hazard is a complex system with interactions between natural hazard-inducing factors (natural mutation factors) and the socio-economic system (the person-property-environment-resource composite system) under certain conditions. This complex system has intricate characters of structure, functionality, heterogeneity of spatial and temporal distribution, openness, high dimensionality, and uncertainty (Wei et al. 2002). Natural disasters often affect large numbers of people worldwide. Every 10 years the death tolls reaches 1 million and more millions of people are rendered homeless. Destruction to the global economy caused by natural disasters reached USD40 billion in the 1960s, USD70 billion in the 1970s and USD120 billion in the 1980s (Domeisen 1995).

1.1 Overview

Various frequent natural disasters affect China, which stretches across a vast area and has a significant monsoon climate. Over the past 30 years, along with the

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sustained and rapid development of China's social economy, natural disasters in China created multi-hazard concurrence, mass disaster occurrence and disease outbreaks. Rarely seen in history, there have been serious natural disasters, such as the Wenchuan earthquake, freezing rain and snowy weather in southern areas, extended winter-spring drought, the Yushu earthquake, debris flows and flash floods in Zhouqu. Losses from natural hazards continue to increase. Since the beginning of the twenty-first century, there have been 13 earthquakes above magnitude 8 in the world with two of them in China. China's casualties inflicted by earthquake were the highest in the world. In the twentieth century, there were about 1.2 million deaths caused by earthquakes in the world including 600,000 deaths in China. China, which occupies 70 % of the land, has 20 % of the population, and has 80 % of industrial and agricultural areas and cities in the world, is harshly affected by natural disasters (Zhang et al. 2006).

The most familiar disasters are those caused by meteorological factors, including droughts, floods, freezing rain and snowy weather, hail and sandstorm. In addition, there are continuous geological disasters, such as earthquakes, debris flows, land subsidence, avalanches, landslides and ground fissures. In addition, some natural disasters arise from oceanic occurrences, such as tropical storms, storm surges, sea ice, coastal erosion and red tide. Furthermore, there are environmental disasters like soil erosion, desertification, vegetation degradation, sharp decline of biodiversity, shortage of water and environmental pollution. Among all these natural disasters, meteorological disasters, which account for more than 70 % of all disasters, with great variety and high strength and frequency, pose serious threats to economic and social development and to people's lives and property. Such hazards impede the implementation of a sustainable development strategy.

According to Sun (2009), during 1978–2002, there have been 13 major floods and 12 major droughts. Disasters—primarily floods in the south and drought in the north—happened nearly every year. Since the 1990s, in the context of climate change and global warming, global meteorological disasters have increased significantly, and have affected social and economic development. Mitigating the damage from natural disasters, responding to the threat of climate change and promoting the coordinated development of the economy are important issues in dealing with disasters. Even national economic and social development are critical here, as well as vital parts of national security strategy in the twenty-first century. In future, exploration of the impacts of natural disasters on the social and economic development of China, recognizing the impacts of disasters from the perspectives of science and management, and then minimizing destruction remain crucial research projects.

1.2 Literature Review

There has been a great deal of research into the impacts of natural disasters on social and economic development (Ma and Gao 2010). There is an old saying in China:

"Famine happens every 3 years, epidemic happens every 6 years, and natural hazard happens every 11 years." This is a perfect description of the pattern of natural disasters in China. Take flood and drought disasters as an example, from 1766 BCE to 1937 CE, records show that there have been 1,058 floods, 1,074 droughts. The annual average of floods and droughts is 0.86 a year (Deng 1937). Hirshleifer (1966) analyzed the short-term and long-term impacts of plague outbreaks on the economy of Western Europe in 1348–1350. Yu (1988) and Du (1988) are representative publications of the research into China's hazard economics. According to the records of natural disasters in China, Wang et al. (1994) suggested that China's disaster regions could be divided into western, northern and southern parts, using the Hu Huanyong population line[1] and the 34°N line of latitude as the boundaries.

Along the Hu population line, there may additionally be a transition region, and the time characteristics of the China's natural disasters show droughts from March to October, floods from June to September. The Huang-Huai-Hai area has always been a frequent location for disasters frequently. Zhang and Shen (1995) argue that the opinion that natural disasters would cause negative impacts to economic growth, and based on the Harrod-Domar model, presented a method to calculate the economic losses from natural disasters indirectly.

To do so they quantitatively analyzed the relationship between natural disasters and economic growth. Hu (1996) calculated the statistics and pointed out that, a "hazard cycle" has clearly existed since 1949 with an average cycle length ranging from 3 to 3.5 years. On the impacts on food production, due to spread of the hazard-affected and damage-affected areas in China, while the per unit grain yield increased, grain losses rose, which directly led to fluctuation of food production. Zheng (1998) argued that the substance of disasters was the economic issue, and summed up four basic laws and five principles of the functions of disasters. In his analysis he showed the characteristics of the agricultural hazard economics, the cyclic fluctuations, the differentiation of regions and the orientation of macroeconomic policy. Lu et al. (2002) discussed the direct losses from natural disasters and their indirect economic losses, using input-output tables, and built a quantitative analysis model for disaster loss assessment. They took agriculture as an example to analyze the impacts on the entire economic system of agricultural yield losses caused by natural disasters. He (2002) investigated the theoretical framework and research approach of hazard economic analysis, and made an empirical study of the hazard economy.

In order to draw a definite conclusion regarding the impacts of disasters on economic development, Benson and Clay (1998) analyzed the impacts of disasters on long-term economic development using trans-departmental data of 115 countries' real GDP from 1960 to 1993. The results demonstrated that economic growth rates in a country with frequent disasters is lower than a country with relatively

[1] Professor Hu Huanyong was a forefather of modern Chinese demography and the founder of China's population geography. He drew the "Aihui-Tengchong Line," which was known internationally as the "Hu Line," in 1934; the line marked a striking difference in the distribution of China's population.

fewer disasters. Xie (2003) analyzed the economic losses caused by floods, including reduction of agricultural production, asset ineffectiveness or cessation of industry and mining enterprises, recession of the urban economy, impacts on finance, poverty and famine. Then from the viewpoint of economics, he illuminated the impact of floods both at macro-level and micro-level. Liu et al. (2005) took the view that drought is one of the disasters which affect social economic development mainly in agriculture. Since 1949, China's annual average food loss caused by drought amounts to 5 % for several years and the loss trend is on the rise, especially in the northeast, northwest and north of China.

Kunreuther and Pauly (2006) came to the conclusion that the occurrence of natural disasters would constrain economic growth, in the first place because of the losses caused by disasters, and then because of investment which has to be made in hazard prevention, rescue and recovery which could have been directed to promoting the development of the economy. Yuan and Zhang (2006) pointed out that the establishment of specified standards for disaster statistics, provision for catastrophic disaster statistics, assessment of disaster statistics and quality improvement for statisticians is a "master pathway" to promote China's disaster statistics.

Zhang et al. (2008) argued that in the twentieth century, along with the tremendous changes in China's social economy, the effect of natural hazards presented significant changes over age and differences among phases. Particularly, from 1900 to 1949, China experienced a semi-feudal and a semi-colonial period, and that resulted in no reduction in the frequency of disasters, and in more casualties and famines, which exacerbated the poverty of people and led to social unrest. Later, from 1950 to 1979, following the initial founding of the New China, there were low capacities for disaster reduction, and disasters happened regularly. Therefore, disasters not only caused serious damage, casualties and property losses, but also critically affected the development of the social economy. After 1980, with rapid and sustained economic development in China, the ability to reduce disasters improved. Even as the affected population increased, therefore, the death tolls and famines reduced notably. Moreover, the destructive effects and incidences of natural disasters spread widely.

As well as damage to agriculture, industrial, transportation and other industries were widely affected. Though the direct and indirect losses caused by disasters increased, the relatively losses became smaller and the relationships among disasters, resources and the environment became intertwined, thus impacts on the sustained development of the social economy became profound. The analysis above indicates that the impacts of disasters are not only the result of natural conditions, but are also closely related to the socio-economic background. Economic development, therefore, with improvement in the country's hazard-reduction ability will help to alleviate the hardships arising from natural disasters.

On the basis of the above studies, we use 30 years of recent data from the China Civil Affairs' Statistical Yearbook and the China Statistical Yearbook, and focus on impacts of natural disasters on human life security, agriculture and economic security, in order to provide government policy-makers with an evidence base on disaster prevention and mitigation.

2 Impact Analysis of Natural Disasters on the Social and Economic Development of China

2.1 Impacts of Natural Disasters on the Security of Human Life

The impacts of natural disasters on human life security during the past 30 years were significant in a number of ways.

First, the number of affected individuals was between 209 and 498 million people, accounting for 20–39 % of national population. The annual average affected population reached 358 million people who made up 30 % of the national population. Death tolls and the number of people missing after disasters ranged from 1,528 to 88,928, and the annual average number of dead and missing people arising from disasters was 8,020. Next, 1991, 1994, 1997, 2000, 2005–2010 were the worst of the 30 years, and the affected population was more than 400 million people in the past 10 years, the affected population increased radically. Finally, the numbers of dead and missing people following disasters showed a decreasing trend. However, when struck by devastating earthquakes and other severe natural disasters, the numbers of dead and missing were very high.

2.2 Impacts of Natural Disasters on Agricultural Security

Our analysis shows that the impacts of natural disasters on agricultural security were extensive during the past 30 years. The area of crops affected ranged from 22.3 to 59.8 million ha and the annual average area of affected crops reached 45.1 million ha which accounted for 14.32–39.21 % and 30 % of the total sown area of farm crops (hectare) respectively. The crop damage areas ranged from 13.8 to 37.5 million ha and the annual average damaged area extended to 23.8 million ha which accounted for the proportion of the total sown crops area to 8.86–24.59 % and 16 % respectively.

In 1980, 1988, 1991, 1992, 1994, 1996, 1997, 2000, 2001 and 2003 the areas of crops affected extended to 50 million ha. The area of damaged crops covered more than 20 % of the total sown crop areas in 1980, 1994, 1996, 1997, 2000, 2001 and 2003. For nearly the whole of the 30 years period covered by the statistical record used, crops were brutally affected by disasters.

2.3 Impacts of Natural Disasters on Economic Security

The number of collapsed houses in each year totaled between 0.922 million and 10.977 million rooms, and the annual average number was 3.3954 million rooms. The number of damaged rooms ranged between 3.121 and 26.287 million, and the

annual average figure was 9.3225 million rooms. Direct economic losses extended from USD 8.23 billion to USD 212.30 billion, and the annual average direct economic losses caused by natural disasters amounted to USD 39.35 billion, which is ten times the losses suffered by the developed countries like the United States.

The range of direct economic losses caused by natural disasters over 30 years, as a proportion of annual gross domestic product (GDP) was 0.7 to 5.6 %. The annual average direct economic loss was 2.5 % of GDP. As a result, the impacts of natural disasters offset a portion of China's economic achievements. In the past two decades, direct economic losses caused by natural disasters showed an increasing trend. However, once in the event of catastrophic natural disasters, the direct economic losses will come to a huge amount.

Over the past two decades, the percentage of direct economic losses to GDP has declined. However, in the event of catastrophic natural disasters, the direct economic losses will highly account for the proportion of GDP. Direct economic losses and the growth rate of GDP are negatively correlated. One piece of evidence for this is that, while the growth rate of direct economic losses caused by natural disasters reduced from 9.7 % in 2003 to −15 % in 2004, the growth rate of GDP increased from 12.9 % in 2003 to 17.7 % in 2004. Moreover, although the growth rate of direct economic losses caused by natural disasters rose from −15 % in 2004 to 27.4 % in 2005, the growth rate of GDP fell from 17.7 % in 2004 to 14.6 % in 2005.

2.4 Discussion of Natural Disaster Impact

The impacts of natural disasters on human life security have been significant over the past 30 years in China. The annual average affected population reached 358 million people who made up 57 % of the world's annual average affected population and 30 % of the national population. The annual average rate of dead and missing people stemming from disasters was 8,020 which amounted for 9.9 % of the world's annual average rate of dead and missing people. While the affected population has risen significantly in the past 10 years, the numbers of dead and missing people have tended to fall. In the event of devastating earthquakes and other severe natural disasters, however, large numbers of people die or become missing. That indicates the high vulnerability of the human life security system to severe natural disasters.

The impacts of natural disasters on China's agricultural security have been substantial. The annual average area of affected crops reached to 45.1 million ha which made up 30 % of the total sown area of farm crops. The annual average damaged area extended to 23.8 million ha, accounting for 16 % of the total area of sown crops. For nearly every one of the 30 year period covered by our data crops were severely affected by disasters, indicating the high vulnerability of the crop production system to natural disasters.

The impacts of natural disasters on China's economic security were notable. The annual average number of collapsed houses reached 3.3954 million rooms, and the annual average figure of damaged rooms was 9.3225 million rooms. The annual average direct economic losses caused by natural disasters amounted to USD39.35 billion, or 2.5 % of GDP and 22 % of the global losses. In the past two decades, while direct economic losses caused by natural disasters showed an increasing trend, the percentage of direct economic losses to GDP has declined. However, once in the event of catastrophic natural disasters, the direct economic losses will come to a huge amount and highly account for the proportion of GDP. Consequently, direct economic losses and the growth rate of GDP are negatively correlated. Natural disasters offset part of China's economic achievements, pose a great threat to national wealth, and constrain economic development. All these factors reveal the high vulnerability of China's economic system to natural disasters.

According to Qin et al. (2005), climate warming in China has been almost synchronized with the global trend, but the range of warming may be greater. By 2020, the national average surface temperature could increase by 1.7 °C, by 2030 2.2 °C and by 2050 2.8 °C. What's more, the extent of climate warming in China would increase from south to north, except for the increased rainfall in the western part of the northwest, while the north and southern part of northeast would be permanently dry. Climate warming would lead more droughts in China, the drought-prone area would continue to expand, and droughts would grow more intense. As a result, heavy rainfall, floods, soil erosion, landslides and other geological disasters would increase dramatically, and further aggravate the vulnerability to natural disasters of the socio-economic development system of China.

In order to effectively deal with the high risk of natural disasters in China, and build a low disaster-risk society, there is an urgent need for transition from disaster reduction to a comprehensive strategy of hazard reduction for sustainable development, and adding integrated hazard risk management throughout the whole process of natural hazard management. Accordingly, capacity-building for comprehensive hazard prevention and reduction must be strengthened and sustainable development alongside hazard risk needs to be achieved, thus reducing the vulnerability of the socio-economic development system to natural disasters.

3 Disaster Risk Management in China

3.1 The Chinese Integrated Disaster Management System

In order to enhance emergency management and implement the governments' function entirely, the national Emergency Management Office of the State Council was established in April 2006. It works as an operational "hinge," taking charge of the daily work of national emergency management, responding to public security events, collecting real-time information and harmonizing the related departments.

Since its establishment in 2006, the State Council Emergency Management Office has carried out some effective work to enhance disaster emergency management: it has helped implement the State Master Plan for Rapid Response to Public Emergencies in China; it has held an emergency management working meeting of the State Council and a management working meeting of enterprise emergency work, to deploy and unify emergency management. It coordinates governments of all levels to enhance emergency construction ability and to prepare for prevention of and dealing with public security emergencies. It has also started a Key Technologies research and design program for emergency platform construction to provide science and technology support for emergency management, and to increase emergency treatment efficiency.

So far, the Chinese disaster risk (public security) management system has established one office and four committees: the establishment of the State Council Emergency Management Office at the national level and corresponding organizations with regard to the four types of public security incidents. These are the National Committee for Disaster Reduction to manage natural disasters, the National Committee for Work Safety to manage industrial accidents, the National Committee for Patriotic Health to manage public health and the National Committee for integrated management to manage public security. The four committees are made up of a vice president or a committeeman of the State Council of China as committee director, a minister or vice minister from the main related ministries as administrative vice director or vice director, and the vice ministers from the corresponding ministries as committee members. At the local levels, there are corresponding disaster risk (public security) management organizations with accordance to the national level. Local emergency management centres and the committees of management for the four public security incidents have been gradually established. The disaster risk management organization system of China can be shown as follows (Fig. 14.1).

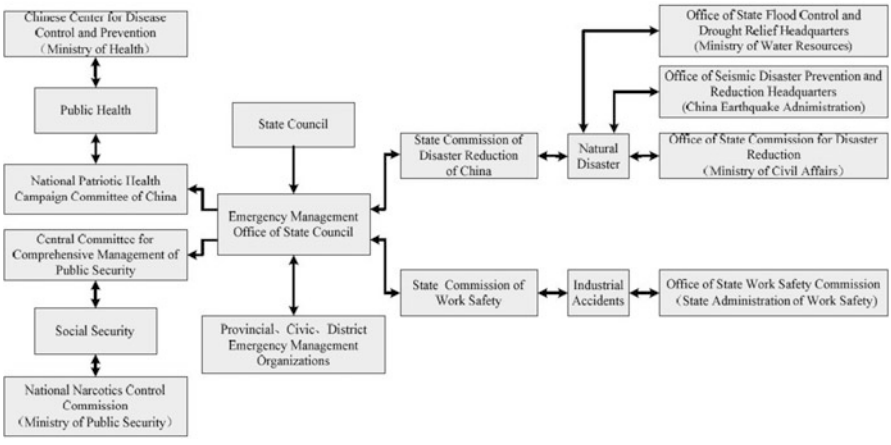

Fig. 14.1 Disaster risk reduction strategy of China ("One office and four committees")

Additionally, in order to enhance the disaster risk management work in these related ministries and commissions, corresponding management centers have been established, such as the Chinese center for disease control and prevention (Ministry of Health), the National Disaster Reduction Center of China (Ministry of Civil Affairs), the Chinese Supervision Center for Work Safety (State Administration of Work Safety), etc. Among these committees, the National Committee for Disaster Reduction (NCDR) is the national counseling and coordination body under the guidance of the State Council for emergency disaster response and relief. NCDR consists of 34 disaster related member agencies.

In conclusion, China has started disaster risk (public security) management work on the basis of traditional disaster management and reduction, and has formed a primary disaster risk management framework involving related professional fields. In addition it is intended to pass emergency laws to enhance the legal basis of disaster risk emergency management. The China Association for Disaster Prevention has also established the first professional organization for risk research, which has been named as the Risk Analysis Specialty Committee. Many Chinese universities and research institutes have also been doing research on natural disasters, engineering hazards, economic risks, crisis management and disaster risk management, and so on. However, compared with the international situation, disaster risk management in China faces not only an austere and significant challenge but also a very good opportunity.

3.2 Regional Adaptation Strategies for Disaster Risk Reduction: The Disaster Management Cycle

The Chinese regional integrated disaster risk management philosophy adheres to the principle of "give priority to disaster prevention, and combine disaster prevention with disaster resistance and relief." Namely, before disaster occurrence, it is important to establish and test the monitoring and warning system, to carry out emergency planning, to strengthen the ability to procure emergency materials, to build an ecologically healthy environment, to accelerate regional economy and reduce disaster vulnerability. When a disaster takes place, it is important to improve emergency response ability to emphasize actions oriented toward human welfare, to reduce the casualty rate and the rate of property loss and to provide maximum protection to natural resources and the environment. After a disaster, government and society's relief ability at all levels must be strengthened, especially community self-rescue and self-relief ability. Finally, based on the results of a rapid disaster loss assessment, it's urgent to recover lifeline and product line systems and accelerate the effectiveness and efficiency of reconstruction (Shi, 2005).

At present, governance of natural disaster risk in China is the responsibility of different ministries or bureaus related to the different kinds of natural hazards, e.g. the China Earthquake Administration takes charge of governance in the case of

earthquake disasters, and the China Meteorological Administration takes charge of governance following meteorological disasters. Further, the Ministry of Water Resources takes charge of governance in the case of floods and droughts, the Ministry of Land and Resources takes charge of governance following landslides and debris flows, the State Ocean Administration takes charge of governance in the case of ocean disasters, and so on. To enhance governance in the case of some large-scale disaster, the State Council has set up several leading groups for natural disaster governance, such as the State Flood Control and Drought Relief Headquarters and the State Earthquake Relief Headquarters. Correspondingly, each regional and local government has set up relevant departments. There are organizations in local governments at all levels in China. In a word, China has adopted a natural disaster governance system which combines vertical inter-government and inter-regional management modes, where vertical sector management comes before integrated regional management. The existing adaptation planning called the "disaster management cycle."

3.2.1 Monitoring and Warning

During the disaster preparedness period, mitigation and prevention work are the responsibility of the professional technical departments, namely the bars. In recent years, the Chinese government has increased investment in respect of natural disaster monitoring and warning system construction, and has established a natural disaster monitoring, warning and forecasting system, including meteorological disaster monitoring and forecasting, earthquake monitoring and forecasting, hydrological monitoring, forest fire prevention, forest and crop pest monitoring and forecasting, marine environment monitoring, and geological disaster monitoring and early warning. This natural disaster monitoring, warning and forecasting system can monitor a disaster's dynamic development and provide information for disaster emergency decision-making.

3.2.2 Emergency Response

During a disaster period, the emergency management offices and the disaster reduction committees of all levels are in charge of emergency response, together with the Civil Affairs departments, the Public Security departments, the armed forces, etc. The agencies work together quickly and closely to deal with the emergency as soon as it begins. At present, the disaster emergency response system guarantees that rescue taskforces, relief supplies, funds and information are on the ground and in place to address the immediate and real needs of the affected.

According to disaster emergency management, the Chinese government has strengthened the emergency planning system. In the Master State Plan for Rapid Response to Public Emergencies, public security events are divided into four kinds (natural disasters, industrial accidents, public health and social security) according

to their causes, characteristics and mechanisms, and into four grades (huge, bigger, big and ordinary grade) according to their degree of severity, their controllability and the area affected. "Huge" and "bigger" grade emergencies must be reported to the State Council within 4 h of the occurrence. Local governments or related departments have to start their related emergency plan promptly and effectively, in the responsibility and power range to control the further development. Additionally, several special plans and department plans for rapid response top emergencies have been drawn up.; and similar plans have also been compiled by national and local governments. This planning makes disaster risk management and disaster reduction more regular and systematic.

In the case of a natural disaster emergency, as prescribed in the "State Emergency Response Planning for Natural Disasters," according to the degree of loss arising from the disaster, the Ministry of Civil Affairs of China adopts a four-grade response system. In other words, different levels of emergencies are to be dealt with by governments of different levels. The more severe the situation it is, the higher level of the government that will respond and make decisions.

3.2.3 Restoration and Reconstruction

During the post-disaster period, the disaster relief and recovery work is controlled by the local disaster reduction committee, which works as a coordinator for the main departments to organize people in disaster area and helps them to recover their normal lives These include the Civil Affairs departments, the Health departments, the Development and Reform Commission, the Finance departments, the Communications departments, the Construction departments, the Railway departments, etc. Namely, the blocks are the main responsibility body. Among these different departments, the Civil Affairs department takes the main responsibility for the disaster victims' life relief, and the insurance companies carry out the compensation for the disaster victims to help them to recover as soon as possible.

In addition, the Chinese government encourages the public social donations and voluntary activities from the whole society, and NGOs are to be an important force in the post-disaster period. This social mobilization mechanism provides a solid material support for disaster management, and helps the people in less-developed areas to recover rapidly after disasters.

3.2.4 Legislation

China has instituted, promulgated and enforced laws and regulations as it moves forward to phase in a legal framework for disaster reduction. The laws and regulations are, however, all about single aspects of disaster risk management, such as the "Law of the People's Republic of China on Protecting Against and Mitigating Earthquake Disasters," the "Flood Control Law of the People's Republic of China," the "Law of the People's Republic of China on Safety in Mines" and so

on. There is no systematic and comprehensive series of laws and regulations about disaster reduction, especially in respect of disaster relief, disaster insurance, post-disaster subsidies for reconstruction, tax reduction for the victims, and so on. Moreover, existing laws and regulations are generally aimed at singe disaster types. It is therefore urgent to construct a law in respect of integrated disaster risk management, so as to carry out integrated disaster prevention and reduction. There is currently no explicit legal status for any integration and coordination of sectors.

Since the 1990s, moreover, in the context of climate change with global warming, global meteorological hazards have increased significantly, and are negatively affecting social economic development. Accordingly, capacity-building relating to comprehensive hazard prevention and reduction will be strengthened and sustainable development alongside hazard risk will be achieved, thus reducing the vulnerability of the socio-economic development system of to natural hazards.

4 China's Experience in the Wenchuan Earthquake

4.1 Overview of Earthquake Impact in Affected Areas

The Wenchuan earthquake struck China on May 12, 2008 with a strength of 8.0 on the Richter scale. Its strength and deadly impact made it one of the most disastrous earthquakes in the world (U.S. Geological Survey 2008). The earthquake epicenter was located in Yingxiu in Wenchuan County, Sichuan province. Figure 14.2 shows the location of Sichuan province and the impact zone of the Wenchuan earthquake. The area shaded dark grey is the most intense impact zone, while the semicircular lines surrounding it indicate boundaries between areas of progressively lower intensity.

The Wenchuan earthquake caused destruction across ten provinces in China, and its tremors were felt as far away as Thailand. Strong aftershocks, landslides, mud-rock flows, barrier lakes and other secondary disasters continued to threaten people's lives and property for many weeks, and made the rescue work difficult. Altogether, more than 45.5 million people were affected by the earthquake. By August 25, 2008, 69,226 people were confirmed to have been killed in the disaster, while 17,923 were missing and 374,643 had been injured (U.S. Geological Survey 2008: 4). At least 15 million people were evacuated from their homes following the earthquake. In total, an estimated 5.36 million buildings collapsed and 21 million buildings were damaged (U.S. Geological Survey 2008). The direct economic loss from the earthquake was more than USD125.7 billion, most of it due to loss of infrastructure and buildings (China State Council Information Office 2008). It is estimated that around 1.2 million people had lost their jobs by the end of July 2008 (China Ministry of Human Resources and Social Security 2008).

While large parts of the country can be said to have been affected by the Wenchuan earthquake, efforts were made to delimit the areas that had received

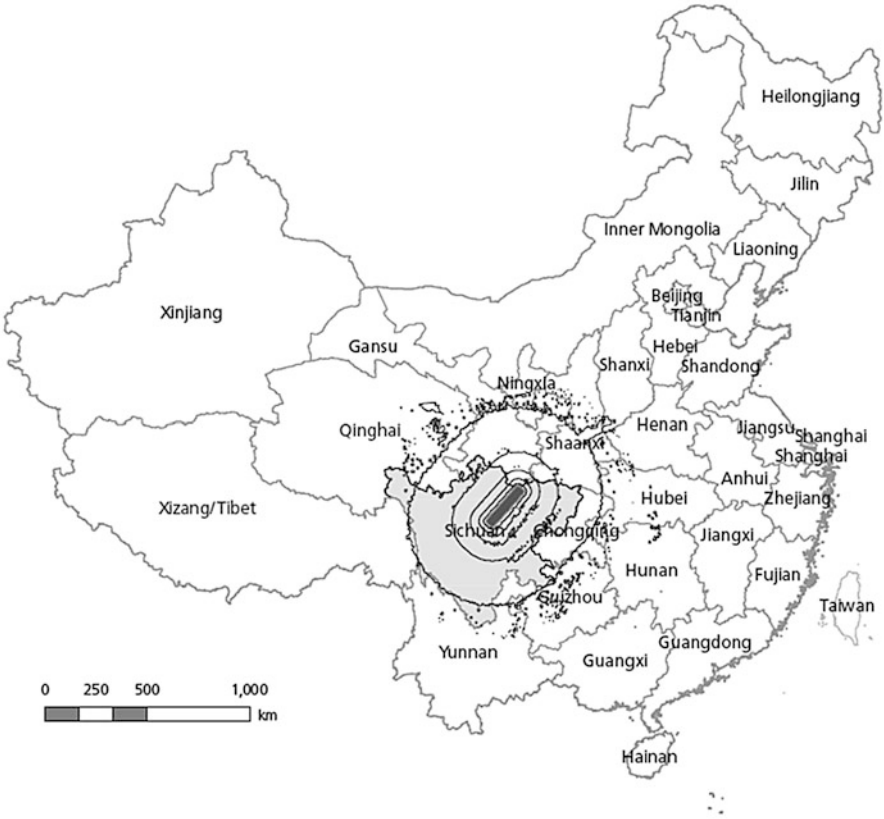

Fig. 14.2 Sichuan and the impact zone of the Wenchuan earthquake

the heaviest direct impact and were thus in most need of help. In what has been the Government's official classification since August 2008, 51 counties were eventually officially defined as "seriously" or "very seriously" affected by the Wenchuan earthquake. Decisions about which counties should be considered "seriously" or "very seriously" affected were political ones based on a review of what was known about the situation in the various counties at the time, rather than on strict scientific criteria. Most of the counties that were "very seriously" affected faced near-complete devastation.

At the time of the earthquake disaster, the total population of the 51 seriously and very seriously affected counties was 19,867 million people,[2] of which approximately four million were living in very seriously affected areas (The State Planning Group of Post-Wenchuan Earthquake Restoration and Reconstruction 2008:

[2] This was the official population count at the end of 2007.

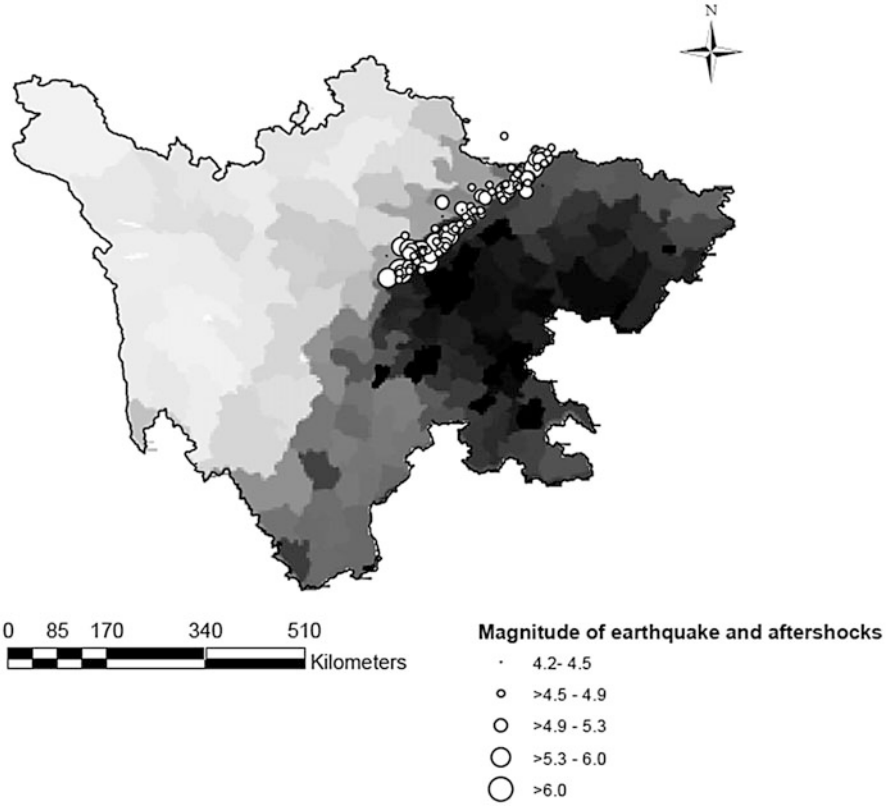

Fig. 14.3 Population density in Sichuan and location of the Wenchuan earthquake (Population Density)

p. 2). Covering an area of more than 130,000 km^2, these counties are spread across Sichuan, Gansu and Shaanxi provinces. Most are located in Sichuan, including all the counties classified as the most seriously affected.

The large majority of people in the earthquake-affected areas were rural residents who were relatively underprivileged compared to those in other parts of China. The Wenchuan earthquake and its aftershocks were centered just north of the most densely populated areas in Sichuan as seen in Fig. 14.3. The North–west part of the impact area is sparsely populated, while the south-east area is densely populated. There are large differences between the North–west and the south–East with regard to resources, ecology and economic development. The plain area in the east, with Sichuan's capital Chengdu at its centre, is a fertile, well-irrigated agricultural region. The area was developed as an industrial base during the Mao era, and its level of industrialization remains comparatively high, including industries in the fields of mechanical equipment, electronics, energy, chemicals, steel and biopharmaceuticals. Many of these local industries were seriously damaged in the earthquake.

By contrast, the mountainous western region is geographically isolated, scarce in resources and population, and home to many of China's ethnic minorities. It is relatively isolated and economically underdeveloped, with a vulnerable ecology and limited industrial development. Most of the heavily-hit zones are located in these western mountains and valleys, which are difficult to access under normal circumstances and were extremely difficult to reach for rescuers facing destroyed or blocked roads as well as secondary disasters (The State Planning Group of Post-Wenchuan Earthquake Restoration and Reconstruction 2008: 2–3).

4.2 Aftershocks

As is often the case for earthquakes on reverse faults, aftershocks are of high intensity and long duration due to a lag in tectonic strain release. According to (Cui et al., 2009), as of 10 a.m. June 5, a sum of 10,254 aftershocks had been detected by the China Earthquake Monitoring Web. Among these aftershocks, the number with a magnitude 4.0 and above was 197, 166 had magnitudes among 4–4.9, 26 had magnitudes among 5.0–5.9, and five aftershocks occurred with magnitudes of 6.0 or greater. The strongest aftershock was of magnitude 6.4.

Within 10 h after the major shock of May 12, there occurred one aftershock of magnitude 6.0, and 12 of >5.0. As time passed, the number decreased, but the magnitude remained high. Two weeks after the major quake, an aftershock of magnitude 6.4 Mw occurred. The aftershocks occurred mainly in the middle and northern portion of the Longmenshan Fault zone. Aftershocks showed a tendency of moving to the northeast along the Longmenshan Fault zone, moving toward Wenxian County in Gansu Province and Ningqiang County in Shaanxi Province.

4.3 Partner Support regarding Wenchuan Earthquake

The "Partner support" program is a system where provinces or cities provide support to a related affected area on a one-to-one basis, under the principle of "one province helps one significantly affected county." With resources reasonably placed based on the economic development level of each area, 19 provinces (cities) support 18 heavily affected counties (cities) as well as seriously damaged areas (seriously affected district) in Gansu and Shaanxi provinces. Table 14.1 displays these inter-city relationships. Provinces (cities) assigned under the program provide assistance for 3 years. Each supporting province (city) is required to allocate 1 % of local financial revenue in the preceding year for goods and work operations every year.

Table 14.1 Partner support regarding the Wenchuan Earthquake in China

Supported areas		Supporting areas
(Sichuan)		
Wenchuan	←	Guangdong
Beichuan	←	Shandong
Qingchuan	←	Zhejiang
Mianzhu	←	Jiangsu
Dujiangyan	←	Shanghai
Shifang	←	Beijing
Jinagyou	←	Henan
Pingwu	←	Hebei
Anxian	←	Liaoning
Pengzhou	←	Fujian
Maoxian	←	Shaanxi
Lixian	←	Hunan
Heishui	←	Jilin
Songpan	←	Anhui
Xiaojin	←	Jiangxi
Hanyuan	←	Hubei
Chongzhou	←	Chongqing
Jiange	←	Heilongjiang
(Gansu)		
Seriously affected district in Gansu province	←	Shenzhen
(Shaanxi)		
Seriously affected district in Shaanxi province	←	Tianjin

Source: United Nations Centre for Regional Development (2009)

4.4 The Government's Recovery Plan

As soon as the immediate post-earthquake emergency had passed, the Government started planning longer-term post-disaster reconstruction. From the beginning, the Government did not merely aim for full recovery. Instead, it aimed for reconstruction to contribute to political processes initiated with the 1999 "Development of the West" policy, and to the Hu Jintao administration's heavily promoted "scientific development" approach, which seeks to pursue a "harmonious society" by addressing inequities that have arisen with China's economic growth.

The General Office of the State Council announced "The State Overall Planning for Post-Wenchuan Earthquake Restoration and Reconstruction" on September 23, 2008 (The State Planning Group of Post-Wenchuan Earthquake Restoration and Reconstruction 2008). The Plan served as a long list of guiding principles for the process of reconstruction. Although the Plan stated that the main priority was to reconstruct residential houses and public facilities within a period of 3 years, it also encouraged local authorities to consider the reconstruction process as a

development opportunity, and it explicitly stated that one of the objectives for recovery and future development in Sichuan was to contribute to existing strategies of economic and rural development.

There is a strong focus on rural development, continued economic growth and market reform throughout the policy document. It states that "We shall promptly restore the public facilities and infrastructures, earnestly expand employment, and increase the residents' income..." Urban and rural spatial layout, population distribution, industrial structure and productivity layout were to be readjusted "so as to promote the harmony between man and nature". The Plan calls for using reconstruction to spur development and self-sufficiency, particularly in poverty-stricken and ethnic minority areas. Future development was to be ensured by furthering industrialization and urbanization, as well as by constructing new rural areas. The Plan underlined that such processes should be conducted in an environmentally friendly manner, with strict protection of farmland.

USD 157 billion was allocated in the Plan for restoration work in the 51 counties classified in the Plan as seriously and very seriously affected in the provinces of Sichuan, Gansu and Shanxi. Local governments at all levels were given a predominant role, and the Plan introduces diverse and collaborative funding arrangements including "counterpart assistance" from provinces in other parts of China to designated earthquake counties.

In order to reach the overriding goals, the Plan stipulates six specific objectives which were to be attained by the end of the 3-year reconstruction period:

(1) To complete the restoration and reconstruction of urban and rural residences, making it possible for the disaster-affected population to live in safe, economical, practical and land-saving houses.
(2) To ensure that at least one member in each family has a stable job, and that urban household per capita disposable income and rural household per capita net income surpass the pre-disaster levels.
(3) To ensure that everyone in the disaster-affected population enjoys basic social security and has access to fundamental public services such as compulsory education, public sanitation and basic medical treatment in addition to public culture and sports, social welfare etc.
(4) To completely restore infrastructure functions such as transportation, communications, energy, water conservancy etc. to meet or surpass pre-disaster levels.
(5) To develop the economy, improving and expanding industries with special advantages, optimizing industry structure, and enhancing capacity for scientific development.
(6) To gradually restore ecological functions, improve environmental quality and ensure visible improvement in disaster prevention and mitigation ability.

4.5 Recovering from the Wenchuan Earthquake

The results from the three post-Wenchuan earthquake surveys (Dalen et al. 2012) give grounds for describing the recovery process as successful. Communities in disaster areas were severely disturbed, but in the long term society remained stable. Their report shows that most damage caused by the earthquake was quickly repaired, that households were able to resume economic activities relatively quickly, and that education and healthcare systems continued to function under extraordinarily difficult circumstances, and resumed normal operations well before the end of the recovery period. In material terms, the recovery process did succeed in "building back better" by providing new and improved public facilities, houses and infrastructure.

A fundamental observation is that China's Government efficiently managed and coordinated the disaster response and recovery processes, striking a balance between the commitment of considerable financial, human and organizational resources on the one hand and devolution to local and external agencies on the other.

However, the fact that societies in earthquake-affected areas remained stable also meant that social inequalities and other structural problems that were to some extent mitigated in the period immediately following the disaster were reproduced by the end of the recovery process. Few of these challenges were directly caused by the earthquake disaster; instead, they are related to socio-economic inequities and other problems prevailing in Chinese society in general.

5 Policy Implications

The Integrated Disaster Risk Management Strategies of China are shown as below:

5.1 To Establish the "National Disaster Reduction Planning"

Disaster reduction has been high on the agenda for the central government, which views it as vital to sustainable economic and social development, coordinated development and harmony between economy, natural resources and ecology. The central government has created the State Disaster Reduction Commission (SDRC) to harness the synergy of relevant efforts and initiatives. In 1998, the Disaster Reduction Plan of the People's Republic of China (1998–2010) was designed to identify guidelines, targets, commitments and measures for disaster reduction efforts. With the guidance of the Disaster Reduction Plan, all the local governments, departments, and industries have enhanced their disaster reduction work effectively, and their integrated disaster reduction ability has been improved. During the 12th Five-Year Plan, there is an urgent need to establish a further "National Disaster Reduction Plan".

5.2 To Accelerate the Creation of a Disaster Reduction Ability

The Chinese government has paid much attention to creating disaster reduction ability. This can be seen from the disaster risk management research programs. The National Natural Science Foundation of China has sponsored and carried out a large number of risk management research projects, such as "regional disciplines of Chinese natural disaster" and so on. The Ministry of Science and Technology also supports risk management research in the fields of major natural disasters, engineering accidents, public health, and public security, through the Key Technologies R&D Program in every five-year planning period.

During the period of the 12th Five-Year Plan (2011–2015), China will make consistent efforts to improve its ability to prevent and mitigate disasters. The country's disaster reduction ability will be accelerated, by learning from developed and other developing countries, and through all the possible means, to utilize its disaster reduction resources efficiently and effectively.

5.3 To Improve the Emergency Response Program

The Master State Program for Emergency Response is the general program for national emergency responses and is the criterion file for the prevention and treatment of public security events, clarifying the classification and framework of incidents, prescribing the organization system and operation mechanism for dealing with a severe emergency. Although the Master State Program is of great importance and guidance, it only pays major attention to the in-disaster integrated response, and overlooks the need for integrated optimization among the in-disaster emergency management, pre-disaster mitigation, and post-disaster recovery and reconstruction. It is therefore necessary to improve the rapid emergency response plans, harmonize all the aspects of integrated disaster reduction, and ensure the emergency response program is political, scientific and feasible.

6 Conclusion

China faces increasingly complex natural situations for disaster management, but has insufficient experience both for creating appropriate institutions and for capacity building. These are therefore a subject of focus for policy makers and bureaucrats in China. China is using a stronger government role to take the leadership in dealing with disasters, together with a multiple approach and more participation from all fields. The chain of governance can lead to improved efficiency, or to the opposite.

China is confident that it can create effective cooperation for disaster management both at home and abroad, while keeping developments in line with the interests of both China and the bordering states. This latter is in the initial stages, and some sensitive issues need to be resolved. In addition, more sub-regional or local cooperation within China should be stressed. Finally, China is improving its abilities in disaster management together with its domestic comprehensive and sustainable growth, including political, social, cultural, economic and conceptual changes. Moreover, China is now focusing on the impact assessment of climate change in relation to disasters, and not simply on the issue of disaster management only.

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