

# Comparison of two large earthquakes in China: the 2008 Sichuan Wenchuan Earthquake and the 2013 Sichuan Lushan Earthquake

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**Abstract** Over a period of 5 years, two large earthquakes struck Sichuan Wenchuan and Lushan successively. The two main seismic zones are only 87 km apart along the same seismic belt on the Longmenshan fault. Although there was only one magnitude of difference between the two great quakes, losses from the 2013 Lushan Earthquake were much lower than that of 2008 Wenchuan Earthquake. This study compares these disasters in terms of preparation and response in order to develop effective ways to reduce casualty and economic loss in future earthquakes. By determining what was done right after the Wenchuan Earthquake, we can better understand how to reduce future losses. This study focuses on seven factors: basic information, preparedness, government response, local residents' responses, medical rescue teams' work, earthquake-induced secondary effects, and injury character. We also recommend that three major actions should be emphasized to facilitate the most effective course of disaster planning and action. First, sufficient preparedness and strict preventive measures form the foundation to minimize damage and reduce casualties. Once the disaster had occurred, a single, well-run headquarters increases efficiency in rescue efforts. Finally, local rescue strength of both professional staff and citizens is the most critical factor to lower disaster casualties.

**Keywords** Disaster planning · Earthquake · Wenchuan Earthquake · Lushan Earthquake

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## Abbreviations

PLA	People's Liberation Army
CISAR	China International Search and Rescue Team
CAS	Chinese Academy of Sciences

## 1 Introduction

It was difficult to compare earthquakes because so many factors affect the severity of the consequences. These include population density, landscape, and earthquake-induced secondary effects, which are quite complex. However, the main seismic zones of Lushan and Wenchuan are only 87 km apart from each other ([http://en.wikipedia.org/wiki/2013\\_Lushan\\_earthquake](http://en.wikipedia.org/wiki/2013_Lushan_earthquake)), located along the Longmenshan fault, and with a similar social structure of the residents, buildings, and communities. Although the two earthquakes differed by only one order of magnitude, losses from the Lushan Earthquake in terms of casualties, building damage and economic loss, were much lower than that of 2008 Wenchuan Earthquake. This study compares the differences between the two big earthquakes in terms of seven key factors, in order to determine effective measures in the future to reduce loss. These factors include basic information, preparedness, government responses, local residents' responses, medical rescue teams' work, earthquake-induced secondary effects, and injury character.

## 2 Comparison of information and loss

Table 1 compares information and losses in the Lushan and Wenchuan Earthquakes. At 2:28 p.m. on May 12, 2008, a magnitude 8.0 earthquake struck the Wenchuan area of the Sichuan Province in China, resulting in 69,227 deaths (Chen et al. 2012), mainly for children under 5 years of age (Hu et al. 2011), 374,643 injuries (Chen et al. 2012), and 17,923 missing persons (Chen et al. 2012). Approximately 7,967,000 buildings were completely demolished (The National Almanac of China 2009), 24,543,000 were damaged (The National Almanac of China 2009), and the affected population was 462,400,002. Some countries in Sichuan Province, such as Beichuan Qiang Autonomous County, were completely buried due to slope failure. Infrastructure including gas, electricity, water, digital communications, and roads were disrupted ([http://en.wikipedia.org/wiki/2013\\_Lushan\\_earthquake](http://en.wikipedia.org/wiki/2013_Lushan_earthquake)). Total economic losses caused by the Sichuan earthquake were estimated to be ¥8,451.0 hundred million ([http://en.wikipedia.org/wiki/2013\\_Lushan\\_earthquake](http://en.wikipedia.org/wiki/2013_Lushan_earthquake)). Of that figure, direct economic losses reached ¥6,920.11 hundred million, and about ¥641.59 hundred million was spent on rescue actions (Yuan 2008).

Five years after the Wenchuan Earthquake, at 8:02 a.m. on April 20, 2013, a magnitude 7.0 earthquake struck the Lushan area, resulting in 196 fatalities, mostly in adults (14–65 years), 13,000 injuries ([http://en.wikipedia.org/wiki/2013\\_Lushan\\_earthquake](http://en.wikipedia.org/wiki/2013_Lushan_earthquake), <http://news.sina.com.cn/c/2013-04-27/090126968052.shtml>), and 21 people missing (<http://news.sina.com.cn/c/2013-04-27/090126968052.shtml>). This disaster destroyed 724,000 buildings and damaged 1,173,300 (<http://www.chinanews.com/gn/2013/04-22/4754182.shtml>). A total economic loss induced by the Lushan Earthquake was estimated to be approximately ¥851.71 hundred million ([http://en.wikipedia.org/wiki/2013\\_Lushan\\_earthquake](http://en.wikipedia.org/wiki/2013_Lushan_earthquake)). Although there

**Table 1** Comparison of information and damage data of two earthquakes

	Wenchuan Earthquake	Lushan Earthquake	Comparison
The location of the epicenter	In Wenchuan County, Ngawa Tibetan and Qiang Autonomous Prefecture, Sichuan, 80 km from Chengdu, along the Longmenshan fault	In Lushan County, Ya'an, Sichuan, 116 km from Chengdu, along the Longmenshan fault	Along the same seismic fault
Time and date of the event	At 14:28, on Monday, May 12, 2008	At 8:02, on Saturday, April 20, 2013	Afternoon versus Morning; Work day versus holiday
Magnitude	8.0	7.0	1 more
Maximum intensity	XI MMI	IX MMI	2 more
Depth	19 km	13 km	6 km more
Aftershocks	42,719 ( <a href="http://en.wikipedia.org/wiki/2008_Sichuan_earthquake">http://en.wikipedia.org/wiki/2008_Sichuan_earthquake</a> )	1,815 ( <a href="http://en.wikipedia.org/wiki/2013_Lushan_earthquake">http://en.wikipedia.org/wiki/2013_Lushan_earthquake</a> )	23.5 times
Affected area (km <sup>2</sup> )	500,000	12,500	40 times
Affected population	46,240,000	2,000,000	23.1 times
Fatalities	69,227	196	353.2 times
Major fatality age group	Children	Adult	
Injuries	374,643	13,000	28.8 times
Ratio of dead to injured (%)	18.5	1.7	10.9 times
Most common injury	Lower extremity	Head	
Missing	17,923	21	853.5 times
Buildings destroyed	7,967,000	56,000	142.3 times
Buildings damaged	24,543,000	1,468,900	16.7 times
Economic loss	¥8,451.0 hundred million	¥851.71 hundred million	9.9 times
Most serious secondary disasters	Quake lakes (Cui et al. 2008)	Landslide, falling stones rolling stones (Chen et al. 2013)	
Common secondary disasters	Landslide, falling stones, rolling stones, road collapse, damage to reservoirs (Cui et al. 2008)	Mud-slide, road collapse, earth flow, quake lakes, damage to reservoirs (Chen et al. 2013)	

was only a 1 magnitude and 2 intensity difference between the two earthquakes, the extent of damage differed markedly. In the Wenchuan Earthquake, the disaster-affected area (km<sup>2</sup>) was 40 times greater than that of the Lushan Earthquake, the number of destroyed buildings was over 142 times greater, the economic loss was nearly 10 times greater, the number of affected persons was over 23 times greater, the number of deaths was a striking 353 times greater, the number of injured persons was nearly 29 times greater, and the number of missing persons was a surprising 853 times greater than that of the Lushan Earthquake (see Table 1). The following sections discuss the factors that created such extreme differences in the devastation caused by the two quakes.

### 3 Preparedness and acute response to the earthquakes

Table 2 shows different preparedness levels and responses to the disasters. Before the 2008 Wenchuan Earthquake, no one expected such a large earthquake could occur in this region. Therefore, the Chinese people were not prepared to weather such a disaster (You et al. 2009). First, not enough emergency drugs and equipment were stored by the Health and Civil Affairs Bureau (You et al. 2009). Secondly, the emergency response system was not effective and efficient to deal with the devastation. Thirdly, at the community level, local medical staffs were not adequately trained for emergency medical care or in the use of specialized supplies (You et al. 2009). This reduced the speed and efficiency of acute disaster response. Finally, at the personal level, the public lacked awareness and experience in how to respond to large earthquakes. Many casualties appear a similar social structure of the residents, homes, and communities to have been caused by inappropriate escape and evacuation methods, such as jumping out of windows or falling off of buildings (You et al. 2009).

Since the Wenchuan Earthquake, the Chinese people made an effort to learn from the catastrophe and are now relatively well-prepared for earthquake emergencies. The first step was to set up a national and local emergency response planning system. Next, adequate emergency drugs and equipment were stored at the emergency disaster control headquarters for rapid transport. In addition, the central government now pays more attention to the development and training of emergency professional medical rescue teams. In 2010, the Ministry of Health began to organize medical rescue teams specializing in disaster medicine called National Emergency Medical Rescue Teams (NEMRTs) ([http://www.gov.cn/gzdt/2010-11/26/content\\_1754686.htm](http://www.gov.cn/gzdt/2010-11/26/content_1754686.htm)). By the end of 2012, 22 NEMRTs covered 20 provinces and cities ([http://www.gov.cn/gzdt/2011-12/19/content\\_2024088.htm](http://www.gov.cn/gzdt/2011-12/19/content_2024088.htm)). These teams are activated during the acute disaster phase, not only for natural disasters, but also for airplane accidents and public health emergencies. The China International Search and Rescue Team (CISAR), the Chinese Red Cross, the Chinese Medical Association, the Chinese PLA, and many other organizations also organized emergency rescue teams. Local emergency rescue teams also have been created by local governments using Chinese medical and firefighting institutions forces. Finally, at the community level, local residents and medical staff have been well trained. By 2013, more than 12 million people in Sichuan Province had taken part in an earthquake drill to raise awareness of how to respond to a large disaster (<http://news.sina.com.cn/c/2013-04-25/180626947498.shtml>).

Due to improved preparation and based on the previous disaster relief experience and along with a national plan, survivors of the Lushan Earthquake rapidly recovered from their initial shock and began search and rescue activities. The local rescue teams and medical authorities rapidly organized and began to offer relief. By the time outside rescue

**Table 2** Comparison of different preparedness and responses to the disasters

	Wenchuan Earthquake	Lushan Earthquake
Time to rescue and treatment	The same day	The same day
Health facilities collapse (%)	24.08–67.45 %	No hospital collapsed ( <a href="http://society.people.com.cn/n/2013/0421/c1008-21221708.html">http://society.people.com.cn/n/2013/0421/c1008-21221708.html</a> )
Transportation system	Access to the epicenter area in 3 d; main roads were restored 14 days after the main shock (Liu et al. 2008)	Access to the epicenter area in 9 h ( <a href="http://news.sina.com.cn/c/2013-04-20/170026890577.shtml">http://news.sina.com.cn/c/2013-04-20/170026890577.shtml</a> ); main roads were restored 3 days after the main shock ( <a href="http://news.xinhuanet.com/politics/2013-04/20/c_115469679.htm">http://news.xinhuanet.com/politics/2013-04/20/c_115469679.htm</a> )
Telecommunication systems of earthquake area available	42–150 h after the main shock (Hu 2008)	8.5–36 h after the main shock ( <a href="http://news.sina.com.cn/c/2013-04-20/170026890577.shtml">http://news.sina.com.cn/c/2013-04-20/170026890577.shtml</a> , <a href="http://www.chinanews.com/gn/2013/04-22/4753999.shtml">http://www.chinanews.com/gn/2013/04-22/4753999.shtml</a> )
Air transfer	Available	Available
Preparedness	Not well	Well and sufficient
Type of building structure	Brick and concrete structure	Mainly concrete structure
Government action		
Headquarters	National level	Sichuan province level
Forces	PLA, CAPF, national rescue teams	PLA, CAPF, national and local rescue teams, volunteers
Financial aid	Yes	Yes
Reconstruction	Yes	Yes
Coordination	Successful	Successful
Establishment of emergency rescue system	Available	Efficient and effective
Medical rescue teams		
Major forces	External medical staff (army, national rescue teams, outside medical staffs, etc.)	Local medical staff (local rescue teams, medical staffs, volunteers, etc.)
International aid	Yes	No

teams arrived, 14 h after the earthquake, they had set up an effective triage, transport, and treatment corridor. They retrieved and treated 6,492 victims and transported 974 injured people to Chengdu in <13 h (<http://www.scwst.gov.cn/index.php/gzkb/5816-2013-04-20-14-58-08>). The critical electricity supply and the traffic to Lushan and Baoxing were recovered within 9 and 33 h ([http://news.xinhuanet.com/2013-04/22/c\\_124610222.htm](http://news.xinhuanet.com/2013-04/22/c_124610222.htm), [http://news.xinhuanet.com/newscenter/2008-05/13/content\\_8161009.htm](http://news.xinhuanet.com/newscenter/2008-05/13/content_8161009.htm), [http://news.xinhuanet.com/politics/2013-04/20/c\\_115469679.htm](http://news.xinhuanet.com/politics/2013-04/20/c_115469679.htm)). Their rapid and effective response greatly reduced the extent of the disaster (Yang et al. 2013).

Finally, at the personal level, the Chinese people’s ability to help themselves and offer aid to others helped reduce deaths and injuries from the Lushan Earthquake. Structures were stronger, since many people had rebuilt or reinforced their houses to make them safer in the event of earthquake. According to our observation and injury analysis, collapses and burials were less pronounced than in the previous quake. People tried to keep calm and restore order, whether they were victims or rescue staff.

Although Baoxing country was cut off from outside help and received no supplies for long periods, there appear to have been no price increases of everyday goods, and people did not seem so anxious. They were seen waiting in line patiently for food, water, and medical aid, with no crowding when the first medical rescue team arrived. This was likely due to the better response all around, as well as education after the large Wenchuan Earthquake that helped people become more prepared for the Lushan quake.

#### 4 Chinese government responses to the two disasters (see Table 2)

The Chinese central government exhibited strong leadership in both the immediate response and reconstruction phases of the two disasters. The Chinese state-led emergency response system brought together emergency resources and prevent delay, coordinating the efforts across several agencies. Just 90 min after the 2008 Wenchuan Earthquake, Premier Jiabao Wen flew to the earthquake area to oversee the rescue work ([http://www.china.com.cn/news/txt/2008-05/17/content\\_15287221.htm](http://www.china.com.cn/news/txt/2008-05/17/content_15287221.htm)). The central government closely coordinated with the local governments and associated ministries such as the Ministry of Health, public security, communications, railways, water resources, and foreign affairs to activate all available rescue strength.

However, the most important rescue strength for the Wenchuan Earthquake was the PLA troops. The Chinese military deployed more than 140,000 soldiers for emergency rescue, which was the largest armed forces action in peace time ([http://news.qq.com/a/20100215/000098\\_1.htm](http://news.qq.com/a/20100215/000098_1.htm)). The number of emergency medical rescue professionals was 66,590, with 12.6 % from outside, 56.4 % from Sichuan Province (unaffected areas), 30.0 % from the seismic area, and 0.5 % from international support teams. Others came from Taiwan, Hong Kong, and Macao (Chen et al. 2012; Zhang 2009; [www.scfda.gov.cn/directory/web/WS03/images/1289269176023.doc](http://www.scfda.gov.cn/directory/web/WS03/images/1289269176023.doc)). The central government also undertook full refugee support, including settling survivors to safe areas and supplying food and water.

The central government and high-level leaders also played a large role in coordination and direction in the 2013 Lushan Earthquake rescue. For instance, within 10 h, Chinese Premier Keqiang Li had arrived at the epicenter to direct and coordinate rescue work (<http://www.chinanews.com/gn/2013/04-20/4748937.shtml>). Rather than setting up national-level headquarters by the State Council, the emergency response headquarter was set up in Sichuan Province for deploying and coordinating all rescue resources. In this quake, the government focused on getting more aid and support from medical and rescue professionals. With their help, the government could make quick decisions, share information, and coordinate for powerful rescue teams. Compared with the 2008 Wenchuan Earthquake response, PLA sent out less soldiers, but the total number of PLA soldiers activated for the stricken area was over 18,000 (<http://www.chinanews.com/mil/2013/04-22/4750960>). PLA troops still played an important role in emergency rescue in China. However, local rescue teams and volunteers have undertaken most of the duties and coordinated well with military forces this time.

By 8:00 pm on April 20, 2013, the local government had activated and dispatched nearly 30,000 professional rescue staff comprising medical aid, electrical and communication repair workers, firemen, police forces, and engineering technicians to the earthquake area (<http://news.sina.com.cn/c/2013-04-25/180626947498.shtml>). Although all health facilities in the affected area suffered damage in different degrees (such as Lushan People's Hospital, Baoxing Hospital, and Yaan People's Hospital), the local medical colleagues

quickly reorganized and began to provide services after the disaster (<http://society.people.com.cn/n/2013/0421/c1008-21221708.html>) (Yang et al. 2013). With the availability of electricity the next day, Baoxing Hospital had recovered its surgical ability ([http://news.ifeng.com/mainland/special/lushandizhen/content-3/detail\\_2013\\_04/22/24496736\\_0](http://news.ifeng.com/mainland/special/lushandizhen/content-3/detail_2013_04/22/24496736_0)). In order to prevent hospital overload, a wide patients' distribution system was set up. Serious injuries were transported to West China Hospital and Sichuan People's Hospital in Chengdu, 113 km away from the epicenter. Due to their efficient work, nonlocal medical professionals also worked alongside Sichuan colleagues (Yang et al. 2013).

## 5 Acceptance of emergency medical rescue teams

Past observations of earthquakes indicate that rapid extrication and treatment are critical for the patients' survival in emergency settings (Ashkenazi et al. 2005). The immediate needs of disaster victims must be met within hours of the disaster. After the 2008 Wenchuan Earthquake, most hospitals were destroyed and limited facilities were available for medical service in earthquake area. Therefore, external emergency medical rescue teams, including international teams, played a major role in the Wenchuan Earthquake medical rescue work. Within the first 24 h, the Ministry of Health organized 51 medical rescue teams comprising more than 2,000 medical workers and dispatched them to Wenchuan ([http://news.xinhuanet.com/newscenter/2008-05/13/content\\_8161009.htm](http://news.xinhuanet.com/newscenter/2008-05/13/content_8161009.htm)). Although the acceptance of international rescue teams took days, it was the first time that international support had been received in acute rescue response since 1949 ([http://news.xinhuanet.com/newscenter/2008-05/18/content\\_8201008.htm](http://news.xinhuanet.com/newscenter/2008-05/18/content_8201008.htm)).

Immediately after the 2013 Lushan Earthquake, NEMRTs throughout the nation were activated. Within the first 24 h, about 180 doctors of NEMRTs, 1,400 provincial rescue workers, and volunteers mobilized from other parts of China had arrived at the Lushan area and began to work ([http://en.wikipedia.org/wiki/2013\\_Lushan\\_earthquake](http://en.wikipedia.org/wiki/2013_Lushan_earthquake)). However, the local medical rescue teams played a major part in the 2013 Lushan Earthquake and accounted for more than 75 % in all medical rescue teams (Jiang et al. 2013). The assembled medical personnel peak in the first 72 h post-quake of Lushan was 87.62 %, which was much higher than that of Wenchuan Earthquake's 56.06 % (Jiang et al. 2013).

## 6 Earthquake-induced secondary disasters (Table 1)

The 2008 Wenchuan Earthquake-induced many secondary disasters, including quake lakes, collapses, landslides, debris flows, barrier lakes, rock falls, and damage to reservoirs. The effects of heavy rain worsened the situation, causing mudslides, road collapses, destruction of buildings, and mass casualties (Hu et al. 2011). However, the most dangerous secondary disaster was quake lakes (Table 1). These formed when rivers were blocked by large landslides, induced by the main shock and strong aftershocks. By May 27, 34 quake lakes had formed, and it was estimated that 82.4 % of them were potential danger to the local people ([http://en.wikipedia.org/wiki/2008\\_Sichuan\\_earthquake](http://en.wikipedia.org/wiki/2008_Sichuan_earthquake)).

In the case of the Lushan Earthquake, landslides as well as falling and rolling stones were the main causes of earthquake-induced secondary disaster (Table 1). According to the investigation of the Institute of Mountain Hazards and Environment, Chinese Academy of Sciences (CAS), by 4 pm on April 23, 2013, there were a total of 863 geological disasters, including 355 collapses and landslides, 3 dammed lakes, 61 blocked roads, 264 houses

collapsed, and 180 houses damaged in seriously affected areas ([http://english.imde.cas.cn/ns/es/201305/t20130503\\_101621.html](http://english.imde.cas.cn/ns/es/201305/t20130503_101621.html)). These secondary disasters resulted in road blocks as well as heavy casualties. Many collapses and landslides induced by the earthquake supplied debris flow with abundant material sources, stimulating debris flow hazards under heavy rain in the following days.

## 7 Mortality and injury characteristics

Although the two quakes differed by only one order of magnitude, the number of deaths, missing, and injured people in the Wenchuan Earthquake were 353.2, 853.5, and 28.8 times higher than those in Lushan Earthquake, respectively. Many of the dead were children, who were more vulnerable because of four factors: the earthquake intensity, being at school, collapsed houses, and slopes (Hu et al. 2011; [http://en.wikipedia.org/wiki/2008\\_Sichuan\\_earthquake](http://en.wikipedia.org/wiki/2008_Sichuan_earthquake)).

Currently, neither national institutions nor individual hospitals have published injury data. Therefore, there is only a sample study of 346 injured patients, based on our records from April 20 to April 27, 2013. The mean value for the patients' age was 43 years (ranging from 3 months to 92 years). The elderly patients over 65 years accounted for 18.2 %, and the proportion of patients younger than 15 years old was 11.2 %, which is similar to the data from the 2008 Wenchuan Earthquake (Lu-Ping et al. 2012; Qiu et al. 2010). The most common area of injury in the Lushan Earthquake was the head. The diagnosis of head injury reached 34.3 %, of which skull fractures and intracranial bleeds took the main part of the injury burden (42.5 and 31.8 %). Our neurosurgeons performed the heaviest work in this rescue, which differed somewhat from the 2008 Wenchuan experience. (Lu-Ping et al. 2012; Redmond and Li 2011) Fractures accounted for 48.9 % of all injuries and were the predominant diagnosis (pelvic, spine, maxillofacial, extremities, thorax, and head), which corresponds well with the Wenchuan Earthquake studies (Lu-Ping et al. 2012). However, the incidence of pelvic fracture was <1 %, which was significantly lower than the 14.1–6.2 % reported in the 2008 Wenchuan earthquake (Lu-Ping et al. 2012).

## 8 Discussion

Earthquakes are natural disasters that cannot be avoided and forecast. However, the damage can be minimized with effective disaster planning, robust building regulations, and successful emergency rescues. Through our comparison of the measures taken after the Wenchuan Earthquake and the Lushan Earthquake, we developed four points that can facilitate the most effective course of action in acute disaster emergencies.

*Firstly*, strict building standards should be implemented following reconstruction. Since we cannot prevent earthquakes, the best way to minimize damage and reduce casualties is via prevention measures. In an effort to learn lessons from the Wenchuan Earthquake, people have rebuilt or reinforced their homes to better withstand earthquakes. In fact, all hospitals and schools after the new standards and reinforcement withstood the Lushan Earthquake. *Secondly*, past observations of earthquakes indicate that rapid extrication and treatment are critical for the patients' survival in Ashkenazi et al. 2005. The immediate needs of disaster victims must be met within hours of disaster impact. In the Lushan Earthquake, local residents, rescue teams, and medical authorities rapidly organized and



began to help themselves and others after the disaster ([http://en.wikipedia.org/wiki/2008\\_Sichuan\\_earthquake](http://en.wikipedia.org/wiki/2008_Sichuan_earthquake), [http://news.xinhuanet.com/politics/2013-04/20/c\\_115469679.htm](http://news.xinhuanet.com/politics/2013-04/20/c_115469679.htm), <http://news.sina.com.cn/c/2013-04-20/170026890577.shtml>). Their rapid and effective work lowered the injury and death rates. Government and communities should hold mandatory drills on how to survive and help oneself in earthquakes and other devastating disasters, ensuring that each citizen knows how to escape and minimize risks from earthquake. *Thirdly*, more professional rescue teams at both the national and local levels should be organized and trained. Advances in rescue technology should be applied by rescue teams. By the end of 2012, there were only 22 NEMRTs scattered in 20 provinces and cities ([http://www.gov.cn/gzdt/2011-12/19/content\\_2024088.htm](http://www.gov.cn/gzdt/2011-12/19/content_2024088.htm)). This was inconsistent with the fact that China, with 7 % of the world's land area, bore 33 % of major quakes worldwide during the period of 20th century (Li et al. 2009). *Finally*, the reason why most efforts went smoothly after the Lushan Earthquake was that all rescue resources were coordinated by the headquarter settled in Sichuan Province. (See Table 1) Therefore, it is important to make a single headquarter responsible for command, control, and coordination in emergency situations and centralize all powers efficiently to the disaster-affected areas.

## 9 Conclusions

Sufficient preparedness and strict preventive measures form the foundation to minimize earthquake damage and reduce casualties. It is critical to organize and train more local professional rescue teams. At the same time, disaster education and training for the public should be a key focus. The citizens' ability to respond correctly to a quake and their ability to help themselves can significantly reduce the casualties after devastating disasters. Once a disaster had occurred, a single and powerful headquarter helps rescue efforts go more efficiently and smoothly.

This study compared the effects of two similar earthquakes in recent Chinese history with very different responses and impacts. Lessons learned from the first quake have helped the Chinese people and government prepare for the future. It is our hope that the resulting set of recommendations for responding quickly and effectively to earthquakes will reduce their devastation in the future.

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