

Learning from Earthquakes

The M_w 6.6 Earthquake of April 20, 2013 in Lushan, China

This report is based on two accounts from EERI members. Marshall Lew, AMEC, Los Angeles, CA, made a one-day visit on May 28th to Lushan County of Ya'an City in Sichuan Province in southwestern China; Yu Xiao, urban planner, College Station, TX, paid a two-day visit to the same area in early June. Because Lushan County was one of the 41 severely damaged areas in the 2008 Wenchuan earthquake, the main goal of Xiao's field visit was to determine whether lessons from the previous quake are being used to guide emergency management, temporary shelter/housing, and recovery planning. After her visit, she received updates from contact persons in China.

Introduction

A moment magnitude M_w 6.6 earthquake (USGS) struck Lushan County at 8:02 am local time on April 20, 2013. The county is about 130km west of the city of Chengdu in southwestern China (see Figure 1). It has a population of over 110,000 and the main township has a population of about 20,000. There were more than 200 fatalities and over 11,000 injured.



Figure 1. Area of April 20th earthquake (Source: *The Guardian*, 2013)

Seismic and Geotechnical Aspects

The focus was relatively shallow, about 12.3km below the surface. The causative fault was the Longmenshan fault. This is the same fault that caused the M_w 7.9 Wenchuan earthquake of May 21, 2008; however, the Lushan earthquake is not an aftershock of the previous event as it ruptured a portion of the fault not ruptured then. The epicenter was in the Longmenshan mountains, where the fault is in a zone of active tectonically related thrust faults that form the boundary between the high Tibetan Plateau to the west and northwest and the Sichuan Basin lowlands to the east and southeast. The mountain front is known for its extremely steep rise from an elevation of about 600m in the basin to about 6,500m in the mountains over a horizontal distance of about 50km.

As in the Wenchuan earthquake, there were many landslides and rockslides that damaged and blocked roads and highways in the mountainous terrain. During the emergency and recovery period, traffic had to be regulated through roads restricted to one-way traffic; this resulted in long round-trips as sometimes circuitous routes were required to return to the starting point.

Structural and Lifeline Damages

From observations in Lushan, the damages appeared similar to those in the Wenchuan earthquake, although on a smaller scale and much more limited in area. It is reported that the damage in Baoxing, higher in the mountains than Lushan, was more severe. After the 2008 quake, a new town was constructed in Lushan (see Figure 2), and the damages there were far less severe than in the old town.

Lushan Urban Area (Luyang Town)

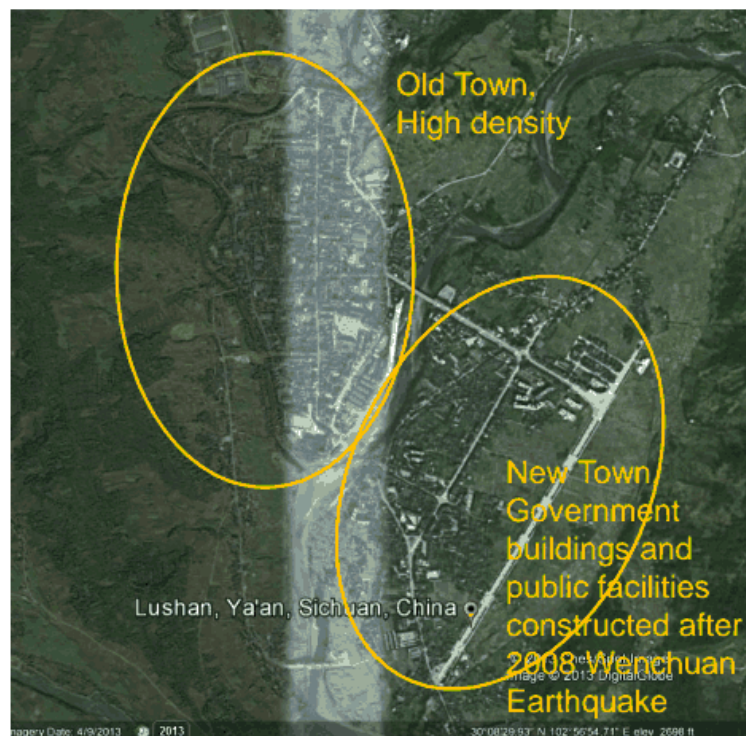


Figure 2. Aerial view of Lushan. (Source: Google Earth, 2013)

In the old town and the mountain villages, the construction was largely brick and mortar (see Figures 3 and 4), and it performed poorly. The government buildings in the new town, built to modern code, generally sustained less damage (see Figure 5).



Figure 3. Urban housing damage in the old town



Figure 4. Examples of damage to conventional brick and mortar construction



Figure 5. Lushan Hospital. The left building, built after the 2008 Wenchuan earthquake, is base isolated and was fully functional after the April 2013 earthquake. The right building was built before 2008 and is damaged and unoccupied.

Electrical power, telecommunications and water service were interrupted by the earthquake. It was reported and observed that there was damage at power facilities and water treatment facilities. The underground water system was damaged and above-ground pipes provided water service at the time of writing. Mobile telephone service is being provided with mobile cell towers (“cell on wheels”).

Emergency Management

According to government officials from Yaan City and Lushan County, the emergency response after the Lushan earthquake was a great improvement from the uncoordinated and chaotic responses following the Wenchuan quake. After 2008, emergency management offices were added as part of the standing government structure of all levels of local governments to better manage emergency situations. Lushan County’s emergency management office has one full-time staff. Also after 2008, government agencies made emergency response plans and conducted regular drills: for instance, in May of 2012, Sichuan Province conducted a provincial-wide emergency response drill, and Yaan City conducted a drill in response to a hypothetical Ms7.0 Earthquake.

The state monitors seismic activities and holds regular consultation meetings on potential hazards. In March of 2013, seismic abnormalities were observed in Shaotong, Yunan Province, and Lushan was identified as a potential earthquake impact area. On March 18th and 19th, the Lushan County Earthquake Bureau checked the condition of emergency communication equipment in the county’s villages and towns. In early April, the county and its communities purchased emergency supplies such as satellite phones, walky-talkies, generators, flashlights,

tents, and food. Between April 13th and 19th, the county inspected all the emergency preparations.

The earthquake hit the next day and, owing to the emergency response preparations and drills, the emergency response was well-coordinated and generally effective. Government employees reported to the pre-arranged emergency meeting places immediately after the quake. Within one hour of the quake, the Lushan County Emergency Management Headquarters was established and its sign was erected at the entrance of the main road to receive outside assistance. Within a little over one hour, helicopters arrived to make an initial assessment of the extent of earthquake damage. Within two hours, Sichuan provincial government officials arrived in the earthquake zone. By 3:00 pm, the first press release about the earthquake was made and the first external responders began arriving. Power and water were restored in parts of the urban areas on the same day and restoration progressed in the following few days.

Because of landslides, the road from Ya'an City to Lushan County was not easily passable. Military and medical teams were allowed to enter first to save lives. To control the situation and coordinate assistance, all news reporters and volunteers were asked to report to the Emergency Management Headquarters before they went to other locales. A hotline was set up for the public to report un-registered reporters and spontaneous volunteers.

Damage assessment started one week after the quake. All urban housing stock and more than 30,000 rural houses were assessed within a little over one month. About 150 outside experts came to help with the damage assessment. Village officials had been trained to perform damage assessment on rural residential housing. Damage was evaluated in four levels: **Asu** No Damage; **Bsu** Require repair; **Csu** Require reinforcement, temporarily unusable; and **Dsu** Require comprehensive reinforcement or demolition, occupation forbidden.

Temporary Shelter/Housing

Tents were used as temporary shelters for disaster victims. Besides the county's emergency reserve, tents from the Ministry of Civil Affairs, Sichuan province and other sources arrived shortly after the quake. In rural areas, individual blue tents can still be seen standing beside damaged residential buildings everywhere (see Figure 6). In urban areas, tents were placed in a few concentrated areas, such as in and around Lushan County Sport Stadium, in parks, and on school playgrounds (see Figure 7). Tents were also placed in the courtyards of work units and along several roads in the new district constructed after the Wenchuan earthquake. The concentrated tent areas are fully functional neighborhoods. They are equipped with police and fire stations, radio stations, medical clinics, offices for legal services, temporary neighborhood associations, public libraries, and temporary Communist Party branches. NGOs, such as psychological consultation centers, are also present at these tent neighborhoods. Residents are required to register at the neighborhood association offices.



Figure 6. Temporary shelters in surrounding villages



Figure 7. Concentrated tent neighborhood at the Lushan County Sport Stadium

Modular wooden structures were considered as temporary residential housing, but not adopted because of their high costs and negative environmental impact. One of the lessons learned of the Wenchuan quake was that, once occupied by wooden structures, farmlands can not be restored to productive agriculture. Wooden structures have been only parsimoniously used for government offices, banks, schools, and other public service facilities (see Figure 8).



Figure 8. Wooden structures make up the public health system headquarters

The government ordered the tents in the urban areas to be torn down by June 15th and in the rural areas by June 30th. To facilitate the transition in the rural areas, the government has paid 3000 RMB per household for villagers to build temporary housing on their original housing sites using readily available and recycled materials. Villagers were given technical assistance on how to build these temporary houses that they expect to occupy during the 2-3 year reconstruction period. In the urban areas, the government encouraged the residents to live with relatives or rent temporary houses. At the time of the visit, nothing was known about whether wooden structures will be provided for those who have nowhere to go.

By Mid-July, most of the tents were torn down in the urban areas although villagers were allowed to keep some tents in which to store goods. About seven residential structures, all in the new town area, were completed and allocated to disaster victims, with more to come (see Figure 9). Residents who moved into these houses do not receive additional funds for temporary housing.



Figure 9. Board houses under construction for disaster victims

Recovery Planning

The Yaan City Earthquake Bureau hired a company part of the Institute of Geology, China Earthquake Administration, to map fault lines underneath the Lushan Earthquake disaster impact area. The fault line mapping results will feed into the recovery master plan. The draft report of the fault line mapping was completed by the end of June and the final report is expected to be completed by the end of July, 2013.

The China Academy of Urban Design and Planning (CAUDP) was charged to draft the post-earthquake recovery master plan. Lushan County, Yaan City, and Sichuan Province are all involved in this planning process by providing information, identifying projects, and negotiating funding. Public participation in the planning process, if any, was merely symbolic. The government posted announcements on walls and broadcast in moving vehicles that the general public should stop all reconstruction efforts so that the recovery can take place in accordance with the official recovery plan.

Regardless of this order, some businesses had already completed the repairs of their stores and some were in the process of getting the repairs done. Notwithstanding the government planning and provision of technical assistance, the familiar problems of bad construction practices and low-quality materials remain, especially at the local level (Schiavenza, 2013).

Overall, people seem to be satisfied with the government policies on emergency management, temporary housing, and recovery. They believe that CAUDP will make a good plan for them and Lushan will rebuild to be better than before. The recovery master plan was issued by the State Council on July 6th. The recovery area was divided into four types of sub-zones: population concentration zones, agricultural development zones, ecological protection zones, and disaster avoidance zones. The disaster avoidance zones appear to be quite linear, which may correspond to the major fault lines.

On July 15th, the State Council announced financial assistance plan for earthquake recovery: the central government will provide 46 billion RMB to Sichuan province in the next three years, of which 15 billion RMB is earmarked for ecological repairs, geological disaster mitigations, and industrial development. On July 19th, Sichuan Province announced a pair-assistance program through which six undamaged cities in the province will assist six severely damaged districts. The total assistance should amount to 0.5% of each city's 2012 fiscal income.

References

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