Earthquake Disasters Mitigation in China

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2. The Progresses in Earthquakes Prevention and Mitigation
3. Lessons from Recent Earthquakes Emergency Response and Relief
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China is located between two major seismic zones of the world---The Circum-Pacific seismic zone and Euro-Asian seismic zone.
China plate has being pushed by India Plate and the Pacific plate, where the seismicity is characterized by high frequency, large magnitude, vast distribution and severe disasters.
According to the historical records, in Chinese mainland, 29 out of total 31 provinces have been stricken by earthquakes with $M \geq 6.5$. 
Since 20 century, (Since 1900)  
- $\geq 8.0$: 9  
- $7.0\sim7.9$: 70  
- $6.0\sim6.9$: 404  

In China.  

Nearly 700,000 people died in earthquakes
Distribution of death toll caused by earthquakes in China (-2221BC—2000AD)
The largest death toll caused by earthquake in the world

If we trace back to the earlier history, a large earthquake with $M \approx 8.5$ occurred in 1556, in Huaxian county, Shanxi Province, the earthquake caused death toll of 830,000. It is the largest death toll caused by earthquake disaster in the world in the human history.
Catastrophic earthquakes in China since 1900

- The Haiyuan 8.5 earthquake in 1920 (200,000 dead)
- The Guliang 8.0 earthquake in 1927 (40,000 dead)
- The Tangshan 7.8 earthquake in 1976 (240,000 dead)
- The Wenchuan 8.0 earthquake in 2008 (87,150 dead)
1/2 death toll caused by various natural disasters in China (1900-1996)
Seismic ground motion parameters zonation map of China (implemented in 2016)
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(1) A system of laws on protecting against and mitigating the hazard of earthquakes in China has been established.

1 law and 4 regulations at the national level.
Management Based on Legal System Regarding Earthquake Disaster Prevention and Mitigation in China

Several major laws and regulations have been released:

- ✓《Law of the People’s Republic of China on Protecting against and Mitigating Earthquake Disaster》(1997)
- ✓《The Protection Act for Facilities of Earthquake Monitoring and Environmental Condition of Earthquake Observation》(1994)
- ✓《Emergency Response Act for Destructive Earthquakes》(1995)
- ✓《Stipulation for Issuing Earthquake Prediction》(1998)
- ✓《Stipulation for Management act for earthquake monitoring》(2004)

Main Chapters

1. General Principles
2. Planning for Prevention and Mitigation
3. Earthquake Monitoring and Prediction
4. Earthquake Disaster Prevention
5. Earthquake Emergency Response and Rescue
6. Transitional resettlement, recovery and reconstruction
7. Supervision and management
8. Legal duty
9. Supplementary provisions
All the 31 provinces, municipalities and autonomous regions enacted the provincial laws and regulations on earthquake disaster prevention and mitigation based on both the state laws and regulations, and local conditions.

Both the state and provincial law systems present comprehensive mandatory requirements and duties of governments at different levels, the related departments and various sectors of the society in planning, earthquake disaster prevention, emergency response and rescue, monitoring and prediction, relief, recovery and reconstruction.
(2) The management Systemten and working Mechanism of Government-led, Department-responsible for and Social participation were established.

• At the National level,
  ---Commanding Headquarters for Earthquake Relief and Rescue.
  ---Joint Meeting of The State Council on Earthquake Disaster Prevention and Mitigation

• At Local government levels
  ---The leading groups of earthquake disaster prevention and mitigation at provincial, city, county, and even town level have been established.
  ----The leading groups will be automatically transferred into the headquarters of earthquake rescue and relief after earthquakes.
The unified emergency commanding system is improved and strengthened at province, city, county and town levels after the Wenchuan Earthquake in 2008.

Chief Commander
- Provincial party or government leader

Vice Commanders
- Secretary General / vice, provincial government
- Director, Earthquake Administration
- Director, Civil Affairs Department
- Leader, Lanzhou Military Region Command
- Leader, Provincial military command
- Leader, Provincial Armed Police

Commanding Headquarters Member: 40

Office of Commanding Headquarters
(Earthquake Administration of Gansu Province)
Gansu Provincial Government authorized the provincial Earthquake Administration as Office of The Provincial Commanding Headquarters for Earthquake Disaster Rescue and Relief in 2010.
Our administration was used as the commanding center during the Minxian 6.6 Earthquake in 2013
（3）A Professional Management And Working Institutions was set up.
------ China Earthquake Administration
(Headquarters)
Working Organizations of Prevention
And Mitigation of Earthquake Disaster in China

Since its foundation in 1980, China Earthquake Administration (CEA) has established a multi-discipline professional contingent. Now, CEA has 31 provincial sub-branches, 5 research institutes, 3 observatory and exploration centers. Besides, there are city and county earthquake administrations in local governments. Totally, about 20,000 staff work for the above institutions, including more than 10,000 scientists and engineers.
12 Missions of the Earthquake Administrations

A. Supervising, inspecting and managing the works on earthquake disaster prevention and mitigation.

B. Drafting and implementing national and local public policies, regulations and laws in earthquake disaster mitigation.

C. Compiling and implementing the plan of national and local earthquake disaster mitigation, establishing the channel and system of financial budget for earthquake disaster mitigation and managing the funds.
D. Establishing systems of earthquake monitoring, earthquake disaster prevention and emergency rescue jointly with other organizations concerned.

E. Compiling the national earthquake fortification requirements. — Zonation Map of Seismic Ground Motion Parameters.

F. Undertaking the duties of the offices for The Headquarters of Earthquake Relief with national and local levels and the offices of The Leading Groups of Earthquake Disaster Mitigation with provincial, city and county levels.

G. Organizing monitoring and studying earthquakes triggered by reservoirs and preventing the secondary disasters.
H. Accepting and deal with administrative reconsiderations and actions.
I. Coordinating, organizing and training emergency rescue forces, including professional rescue teams and volunteer teams.
J. Promoting and implementing the innovation and progresses in earthquake science and aseismic technology.
K. Conducting and guiding propaganda and education of earthquake knowledge.
L. Implementing the other tasks arranged by both the central government and local governments
(4) A Working System of “3+1” Has Been Developed

“3+1”=
- Monitoring and Prediction
- Prevention
- Emergency response and rescue
+ Scientific and Technological Innovation
Monitoring and Prediction

- Constructed The National and Regional Digital Seismic Observatory Networks.
- Developed a rapid report system of epicenter, magnitude, occurrence time and focal depth as well as intensity distribution.
- Developed a Step by Step Asymptotic way from Long-term, Middle-term, Short term to impending earthquake prediction.
There are totally 162 national seismic stations
162 National seismic station, 32 Regional seismic networks with more than 800 stations, 4 Seismic array
China National Strong Motion Observation Network (~2000 stations)
Earthquake Disaster Prevention

• Almost all major engineering projects and infrastructures were planned and designed based on the results of seismic safety evaluation.

• About 90% of ordinary buildings and industrial facilities in cities and towns adopted the national requirement of seismic fortification.

• About 60% of rural farmers' houses were designed and constructed with seismic measures. In 2020, 90% of farmers' houses in strong earthquake prone regions will meet the national requirement of seismic fortification.

• Carried out active faults detecting and seismic zonation in large cities for land use planning and urban construction.
All major engineering projects and infrastructures should be designed and constructed according to earthquake fortification parameters from its seismic safety evaluation.
Hospitals and schools are required to design and construct with a higher level of earthquake fortification.

The Second Hospital of Lanzhou University

Jiuquan high school in Gansu province
Urban planning should be based on seismic micro-zonation
Common buildings are required to design and construct according to the national seismic ground motion zonation maps.
The rural farmers’ houses are recommended and encouraged to adopt effective technical measures to meet local earthquake fortification.
Earthquake Emergency Response and Rescue

● Established the emergency commending systems at state, province, city and county level, as well as their operation centers.
● Compiled contingency plans for governments at different levels, institutions, organization, large enterprises, schools and army. The plan system all most covers from top to bottom vertically and from side to side horizontally.
● Established national and provincial professional emergency rescue teams for natural disasters as well as thousands of volunteer teams.
● Constructed the National Training Bases for Searching and Rescue (Beijing, Lanzhou).
● Constructed national, provincial and city storehouses of relief goods and materials and its transportation mechanism.
The National Rescue Team (China International Rescue Team) was organized in 2001, and carried out many time rescue actions within China and overseas.
National Training Base of Searching and Rescuing on Land (Lanzhou)—2009
The training facility of mine accident rescue

A tilted building for earthquake rescue training

CEA leader and National Armed Police leader were inspecting the training base

Rescue skill training
The volunteer rescue teams at Cities and counties continue to increase.
The rescue teams at various levels carry out regular earthquake drills and exercises
Gansu rescue teams have played important role in emergency rescues during the Wenchuan 8.0 earthquake in 2008, Yushu 7.0 earthquake and Zhouqu debris flow in 2010 and the Minxian 6.6 earthquake in 2013.
The system of stockpiling and transporting relief goods and materials to the disaster affected areas was established.
Emergency shelters were constructed in parks, stadiums and squares in cities.
Innovation in Earthquake Sciences and Technology

• Some research progresses in earthquake science, involving in seismology, geophysics, seismic geology, geochemistry, and earthquake engineering, were made.

• Some technologies and methods in earthquake monitoring, earthquake disaster prevention and emergency response and rescue, were developed.

• International academic exchange and cooperation were carried out with many countries, especially the US in recent years.
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Earthquake fortification of buildings and engineering projects is an most effective and reliable way to prevent and mitigate disasters, especially for saving people’s life.

<table>
<thead>
<tr>
<th>Earthquakes</th>
<th>Magnitude</th>
<th>Intensity</th>
<th>Focal depth</th>
<th>Dead + missing people</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yushu Earthquake in April 14, 2010</td>
<td>7.0</td>
<td>IX</td>
<td>14km</td>
<td>2428+270</td>
</tr>
<tr>
<td>Ludian Earthquake in Aug.3, 2013</td>
<td>6.5</td>
<td>IX</td>
<td>12km</td>
<td>617+112</td>
</tr>
<tr>
<td>Mexico Earthquake in Sept.19, 2017</td>
<td>7.1</td>
<td>IX</td>
<td>57km</td>
<td>333</td>
</tr>
<tr>
<td>Jiuzhaigou Earthquake in Aug.8, 2017</td>
<td>7.0</td>
<td>IX</td>
<td>21km</td>
<td>25+5</td>
</tr>
</tbody>
</table>
The economic loss caused by the derivative disaster is difficult to be estimated in Jiuzhai Valley.
The relationship between damaged extent and distance away from the active faults in Xiaoyu Dong town, Sichuan
Some un-collapsed buildings in Beichuan County, Sichuan.
The houses constructed for demonstrating Seismic Safety Project of Rural Houses in Dongfeng Xincun village, Wenxian county, were in good condition under the effect of Wenchuan earthquake.(Right)
(2) An accurate rapid evaluation on casualty and damage may provide a valuable information for making decision by the commander in the first stage of emergency response.

The Minxian 6.6 earthquake in 2013:
Dead=95 (80-120), Wounded=2414 (about 2000)

The Jiuzhaigou 7.0 earthquake in 2017:
Dead+missing=25+5 (20-50), 60,000 tourists in high risk of landslides and collapse
(3) Rescuing victims usually is the first task immediately after a devastating disaster in China.
Because capability of defending natural disasters in China is obviously lower than US, a lot of victims need emergency rescue for China, while rapid resilience is the main urgent task for US after a disaster occurs.

Therefore, it is important for saving lives to organize and train professional emergency rescue teams, community volunteer teams and the public, so that they can rescue each other or themselves in the most earliest time.
(4) Establishing a unified commanding system composing of the party, government and army leaders may implement effective rescue and relief after a devastating event.

Zhouqu debris flow in 2010  
Lushan 7.0 earthquake in 2013  
Minxian 6.6 earthquake in 2013
The unified commanding system had a very good performance during Emergency Response to Zhouqu debris flow at different level governments in 2010.

Premier Wen Jiabao held a meeting on the special plane heading for Zhouqu to decide setting up The State Council Temporary Headquarters for the Zhouqu Disaster Rescue and Relief at 13:15, August 8.

After he arrived Zhouqu, He immediately investigated the disaster and commanded rescue and relief with the national and provincial headquarters numbers at the site.
The provincial Commanders directed and the working group of the State Council supported and coordinated during the Minxian 6.6 earthquake in 2013 and Ludian 6.8 earthquake in 2013.
(5) Establishing a goods and materials stockpile network with reasonable sites may improve the efficiency of emergency relief and sheltering victims.
Transporting relief goods and materials to the disaster affected areas in time was a big problem during emergency response to the Wechuan earthquake.
(6) Education and drill before earthquakes may make people, especially students to take right actions in case of emergency.
More than 1,300 students and teachers in Deyang middle school evacuated within 3 minutes during the Wenchuan 8.0 earthquake in 2008, and then the teaching building collapsed. This rapid right action comes from the routine education and emergency drill.
(7) The strict traffic control may ensure emergency rescue, evacuation and relief at the stage of emergency response.
After The Jiuzhaigou 7.0 earthquake in August 8, 2017, the Sichuan Provincial Traffic Directing Center immediately implemented traffic control in the earthquake affected regions according to the order from the Provincial Headquarters of Earthquake Relief. This action made more than 60,000 tourists, including 126 foreign tourists evacuated within 21 hours from the earthquake hit areas with the high risk of landslides and collapse of rocks induced by aftershocks.
(8) Emergency medical treatment, cure and disinfection may reduce secondary death and prevent epidemic.
(9) Monitoring, early warning and getting rid of the secondary disasters, such as landslides, debris flows and floods may prevent secondary casualty after earthquakes.

The aftershocks induced landslides and rolling rocks after the Jiuzhaigou 7.0 earthquake in 2017.

Blowing up the barrier debris in the river to prevent flood after Zhouqu debris flow affected by the Wechuan earthquake.
(10) Paying close attention to public opinions and Releasing the Information related to aftershocks, disaster situation and relief in time may keep the society stable.
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4. Seismic Safety Project on Rural Houses

Since 20 century, most of detective earthquakes in China occurred in rural areas. More half casualty caused by earthquakes are the people who lived in countryside. The main reason is collapse of farmers’ houses due its very poor seismic performance. In order to improve seismic capabilities of farmers’ houses, the central government carried out the Seismic Safety Project of Rural Houses in 2004 and the State Council held a conference in 2006 to promote the project into practice. And then local governments with different levels carried out the project in various way. The newly constructed rural houses by the project have shown a remarkable efficiency of earthquake disasters reduction.
In 2006

- **Reinforced Concrete Structure**

- **Brick-Concrete Structure**

- **Brick-Wood Structure**

- **Adobe-Wood Structure**
A moderate strong earthquake could cause the farmers' houses to collapse or suffer serious damage.
In Gansu Province, the government issued two documents respectively in 2006 and 2014 and held the provincial conference to promote the project.
The recent progress of the project in Gansu province

In 2006, there were totally 4.86 millions farmers families in Gansu province. At present, 70% of the farmers families have constructed seismic safety houses combined with various projects in rural areas, such as

- Reconstruction after natural disasters,
- Restoration of dangerous and old houses,
- Immigrants relocations,
- New countryside construction,
- Beautiful Village construction
- Anti-poverty project.
Reconstruction after natural disasters

Usually, each family may get a financial aid of US$3000-6000, about 1/5-1/2 of reconstruction cost from the central and local governments to rebuild their houses in the original site or a new site. But the rebuilt houses have to design and construct according to the unified maps.
Restoration of Dangerous and old houses

The family who live in a dangerous or old houses may rebuild their house with a financial aid about US$2000-3000, which is about 1/5-1/10 rebuilt cost. Most of budget for this project comes from the central government to support the western poor region of China.
● The New Countryside Construction Project

The construction sites were planned and provided by the local governments. Each family may also get a financial aid about 1/3 construction cost from the government.

A new countryside construction project in Chongxin county, Gansu province.
Immigrants relocation project.

The Construction sites were planned and provided by the local government. Each family also may get a financial aid which is about a half construction cost from the government. The other half part may get a 10 year loan without interest for the poor families. The government pay the interests.

The immigrants relocation from a learies of coal mine in Huating county, Gansu

The immigrants relocation from a mountain areas in Guliang county, Gansu province.
• **Beautiful village construction projects.**

These projects are usually constructed in original village sites, where farmers are rich enough to rebuild their houses according to a unified planning and design. Each family may get a financial aid about 1/5 rebuilt cost from the government.

The beautiful village in Lingtai county, Pingliang City, Gansu province.

The beautiful village in Xixia town, Yumen city, Gansu province.
At present, most of provinces in China has enacted laws or policies on promoting seismic safety project of farmers' houses in major earthquake monitoring and preventing regions, where all rural houses are required to meet the national earthquake fortification in 2020.

In 2016, The People’s Congress of Gansu province enacted the law.
The earthquake administrations and the urban and rural construction departments with different levels carried out a series of training programs and compiled technical books and guidelines for a large number of rural masters to construct seismic safety farmers houses.
Many demonstration projects of seismic safety houses were constructed in various regions by local governments, which have shown remarkable efficiency of earthquake disaster mitigation.
The houses constructed for demonstrating Seismic Safety Project of Farmer’s Houses in Dongfeng Xincun village, Wenxian county, were in good condition under the effect of Wenchuan earthquake. (Right)

The houses in Hejiaping Village, Wudu district, 20km away from the Dongfeng Xincun village in the same intensity zone, collapsed during the Wenchuan earthquake.
Only one survived house on the main path of Zhouqu debris flow, reconstructed after the Wenchuan Earthquake in 2008.

Two meters high foundation made out of rocks with concrete.

Reinforced concrete frame with constructional columns and round beams at the top and bottom of the house.
The famers’ houses which have seismic measures, such as reinforced concrete constructional columns, the top ring beam and bottom ring beam, were in a good condition during the Minxian 6.6 earthquake in 2013. However, The houses without seismic measurements collapsed or seriously damaged under the effect of the same earthquake.
We hope this project will make Chinese farmers always smile rather than cry after a natural disaster.
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5. Conclusions (1/2)

- China is a strong earthquake prone country. In history, earthquakes caused enormous casualties and economic loss.

- In recent 30 years, remarkable progresses in monitoring, prevention and mitigation, emergency response and rescue and scientific and technical innovation were obtained. The comprehensive capability against earthquakes has been obviously advanced.

- Compared with the United States, China is not a strong country in earthquake disaster prevention and mitigation with some potential risks, such as high risk in urban areas, weak fortification in rural areas, potential problems of infrastructures, lower public popularization of knowledge in earthquake disaster mitigation.
5. Conclusions (2/2)

- Earthquake disaster prevention and mitigation in China will be reformed according to the principle of “two insist on” and “three transforms”.
  
  **“Two insist on”**
  - Insist on the development thought of people as the center (oriented).
  - Insist on putting prevention first, combining prevention with mitigation, and relief together.

  **“Three transforms”**
  - From relief after disasters to prevention before the disasters
  - From coping a single disaster to comprehensive disasters mitigation
  - From reducing disaster loss to mitigating disaster risk
Thank you for your attention!

谢谢！