Earthquake Patterns and Risk Management in Our Country

I. Introduction

A. Causes and Mechanisms of Earthquakes

Earthquakes result from the release of energy within the Earth, primarily caused by plate movements. According to the theory of plate tectonics, the Earth's surface consists of multiple plates that accumulate stress as they collide, move apart, or slide past each other. This stress is eventually released in the form of seismic waves, generating earthquakes.

Our country is located at the intersection of the Eurasian Plate, the Indian Plate, and the Pacific Plate, making it highly susceptible to tectonic compression. For instance, the northward movement of the Indian Plate against the Eurasian Plate causes the uplift of the Qinghai-Tibet Plateau and frequent seismic activity. Additionally, our country experiences volcanic earthquakes and induced seismicity, such as microseisms potentially triggered by the Three Gorges Reservoir.

B. Characteristics of Earthquakes

The strength of an earthquake is measured by magnitude (e.g., the Richter scale) and intensity. Magnitude indicates the amount of energy released at the epicenter, for example, the 2008 Sichuan Earthquake had a magnitude of 8.0. Intensity indicates the violence of earth motion produced there by the earthquake, which depends on the depth of the earthquake's focus and local geological conditions. Earthquake waves consist of P-waves (primary waves, which travel fastest), S-waves (secondary waves, which are more destructive), and surface waves (which cause ground undulations). These seismic wave characteristics determine the extent and severity of earthquake damage.

C. Distribution of Global and Our Country's Earthquake

Globally, most earthquakes occur along plate boundaries, such as the Circum-Pacific Seismic Belt and the Alpine-Himalayan Seismic Belt. Our country lies on the eastern segment of the latter, experiencing frequent seismic activity, particularly in its western and northern regions.

II. Earthquake Patterns in Our Country

A. Distribution and Major Active Seismic Zones

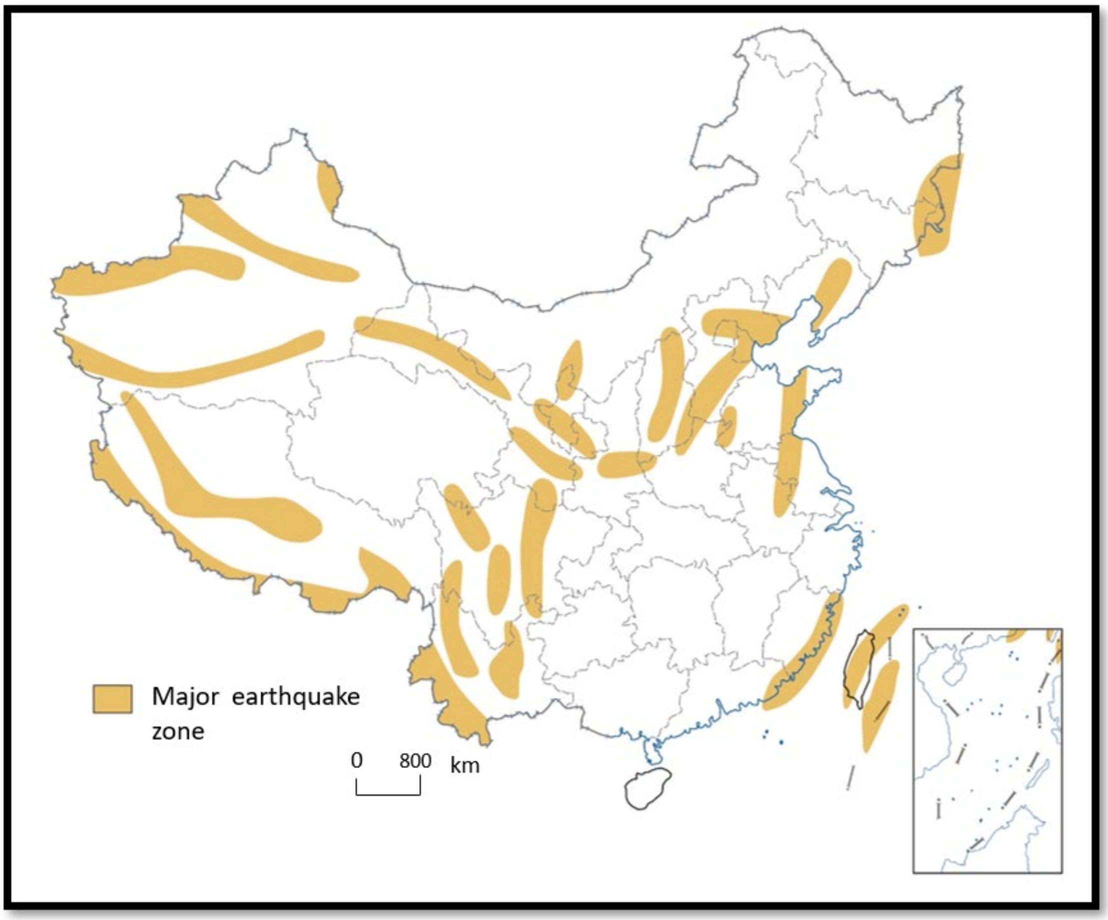
Earthquake activity in our country is mainly concentrated in 23 seismic belts across five regions:

- Southwest Region: Includes Zizang, central and western Sichuan, and central and western Yunnan.
- Western Region: Covers areas such as the Hexi Corridor in Gansu, Qinghai, Ningxia, and the northern and southern foothills of the Tianshan Mountains in Xinjiang.
- North China Region: Encompasses both sides of the Taihang Mountains, the Fenwei

Graben, the Yinshan-Yanshan zone, central Shandong, and the Bohai Bay area.

- Southeastern Coastal Region: Includes Guangdong, Fujian, and surrounding areas.
- Taiwan Province and Its Adjacent Waters: A highly active seismic zone due to complex tectonic interactions.

Figure 1: Distribution of major earthquake zones in our country



Map reference: 中華人民共和國自然資源部審圖號 GS(2023)2767 號 (Date of reference: 17 January 2024)

B. Historical Earthquake Records

Our country has an extensive history of recorded earthquakes.

- The 1556 Huaxian Earthquake in Shaanxi Province, with a magnitude of 8.0, caused approximately 830,000 deaths, making it one of the deadliest earthquakes globally.
- In modern times, the 1976 Tangshan Earthquake (magnitude 7.8) resulted in 240,000 fatalities
- The 2008 Sichuan Earthquake highlighted the region's high frequency of severe seismic events.

  Statistical data indicate that our country experiences approximately 20 earthquakes of magnitude 5.0 or higher annually.

C. Geological Background

Seismic activity in our country is closely linked to its complex geological structures. In the west, major fault zones include the Tianshan Fault Zone and the Longmenshan Fault Zone, while the eastern region is marked by the Tanlu Fault Zone. These fault lines act as "triggers" for earthquakes. Furthermore, soft loess deposits and mountainous terrain increase the likelihood of secondary geological disasters such as soil liquefaction and landslides during seismic events.

III. Earthquake Risk Assessment

A. Risk Factors

Earthquake risk is determined by both natural and human factors. Natural factors include fault activity, focal depth, and geological conditions. Human factors, such as high population density in areas like the North China Plain and the poor construction quality in rural regions, significantly exacerbate earthquake risks.

B. Seismic Hazard Zoning in Our country

Our country's seismic zoning map categorises the country into high-, medium-, and low-risk areas. High-risk areas include the Sichuan Basin, the margins of the Qinghai-Tibet Plateau, and the North China Plain. Low-risk areas include the Northeast Plain and central Nei Mongol Zizhiqu. Major cities like Beijing and Chengdu are located in high-risk zones and require heightened seismic preparedness.

C. Secondary Disasters

The vibrations of an earthquake may affect the stability of hill slopes and trigger geological disasters such as landslides and mudslides. Since they are triggered by earthquakes, they are called secondary disasters. Landslides and mudslides produce large amounts of sand and mud, which can block rivers and form barrier lakes. For example, during the Sichuan Earthquake, landslides buried Beichuan County, and 33 barrier lakes formed, posing downstream flooding risks. In urban areas, damaged gas pipelines can lead to post-earthquake fires, increasing the overall disaster impact.

IV. Earthquake Risk Management in Our country

A. Enhancing Earthquake Monitoring, Forecasting, and Early Warning

- Improve the seismic monitoring network, especially in western regions and offshore areas.
- Develop advanced observation technologies (e.g., LiDAR, InSAR, UAVs).
- Reform earthquake observatory systems and establish a multi-level monitoring framework.
- Strengthen earthquake forecasting and probability prediction based on fault modeling.
- Build a national early warning system, improve information dissemination, and promote multi-platform delivery to individuals and key industries.

B. **Improving Earthquake Disaster Risk Prevention and Control**
- Complete national risk surveys and build a dynamic earthquake risk database.
- Develop detailed fault detection and hazard zoning.
- Implement stricter seismic fortification standards for buildings and infrastructure.
- Promote retrofitting of vulnerable structures in seismic-prone areas, including rural housing.

C. **Strengthening Earthquake Emergency Response and Rescue**
- Establish a robust emergency response system with clear command structures.
- Modernise emergency rescue equipment and communication systems.
- Build and upgrade training bases and standardise rescue team development.
- Develop rapid post-earthquake assessment mechanisms and scientific investigation teams.

D. **Enhancing Public Services for Earthquake Disaster Reduction**
- Build a four-tier service system (decision-making, public, professional, and special services).
- Improve data accuracy and product development.
- Integrate data platforms and promote multi-party service provision, including market-driven efforts.

E. **Boosting Scientific and Technological Support**
- Advanced fundamental research on earthquake mechanisms and prediction.
- Develop innovative technologies and establish key research platforms (labs, observation stations).
- Reform scientific research systems and strengthen cooperation among institutions.
- Promote international cooperation, especially within the Belt and Road Initiative framework.

F. **Empowering Digital Technology**
- Integrate digital technology into all aspects of earthquake risk management.
- Develop a unified earthquake data environment and governance system.
- Ensure cybersecurity and modernize IT infrastructure.
- Build a digital earthquake archive for long-term information management.

G. **Promoting Earthquake Preparedness Education**
- Carry out nationwide public education campaigns, especially around Disaster Reduction Day.
- Integrate earthquake safety education into communities, schools, and industries.
- Develop engaging science communication content and promote through multimedia.

- Encourage the development of a disaster reduction science industry.

H. Strengthening Legal Framework and Governance

- Update laws and regulations related to earthquake risk management.
- Improve enforcement mechanisms and integrate with general emergency administration.
- Standardise administrative procedures and promote smart law enforcement.
- Enhance public legal awareness through education and outreach.

V. Challenges and Future Prospects

A. Current Challenges

The existence of bottleneck of scientific earthquake prediction, the weak earthquake-resistance of old houses in rural areas, and the emergence of high-rise buildings in the process of urbanisation have also increased potential risks. For example, in rural Sichuan, there are still a large number of adobe houses that are unable to withstand moderate to strong earthquakes.

B. Technology and International Cooperation

Artificial intelligence and big data are being used to analyse earthquake precursors, such as changes in crustal stress. Our country has learnt advanced monitoring technology and earthquake-resistant design experience from Japan and the United States.

C. Sustainability

In the future, it is necessary to balance earthquake prevention and ecological protection, such as reducing environmental damage in the management of barrier lakes. The 14th Five-Year Plan and the Outline of the Long-Term Goals for 2035 proposed that we should build resilient cities by attaching great importance to urban public safety, strengthening urban safety risk prevention and control, and enhancing the ability to resist disasters and accidents, handle emergencies, and manage crises.

D. Education and awareness raising

In the future, an earthquake science app can be developed to provide instant warnings and risk avoidance guides. Schools can introduce virtual reality (VR) technology to simulate earthquake scenarios and enhance students' coping capabilities.

VI. Conclusion

Our country's earthquake patterns are characterised by high frequency and high destructiveness. Risk management has achieved remarkable results through monitoring and early warning, earthquake-resistant design, post-disaster reconstruction and public education. However, our country still faces lots of challenges such as the difficulty in prediction and the weak building structures to stand earthquakes in rural areas. In the future, we need to strengthen technological innovation, international cooperation and science education. Disaster prevention and mitigation are vital for protection of lives and properties.

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