Study on Environmental Safety Management System and Improvement of Management Capacity in Western Sichuan

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Abstract. The western Sichuan is a region with various first-class environmental problems like earthquakes and geological disasters. In field studies, people responsible for the environmental safety of western Sichuan argue that the region is confronted by the shortage of fund and expertise. And there are even people claiming that “all they need is money”. It seems that “fund” and “expertise” lie in the core of the problem, which is still in question. The paper, aiming at improving the management system and capacity of geological disasters in western Sichuan, used the landslide in Die Xi in 2017 as the case study to explore the problems and challenges confronting the region, including the weak legal system, defective management mechanism and ineffective disaster prediction.

1. Introduction
The paper, from the perspective of typical landslide geological hazards in western Sichuan, analyzed the disaster factors causing the landslide of Die Xi in 2017 through field study and proposed three main factors causing environmental safety problems in western Sichuan.

2. Issues on Environmental Safety confronting western Sichuan

2.1 Natural factors
Geological studies show that a combination of three natural factors triggered the disaster[1]. Geological structure was the first factor in this process. The Xinmo Village, where the landslide took place, is located in the intersection of the Longmen Mountain seismic belt and the Songpan seismic belt, on the left sloping bank of Songping Ditch that branches off Diexi River. The big slope elevation difference and slope gradient, almost vertical in direction, expose this place to geological disasters due to the instability of loose rocks as the basement; Second, historical factors. Affected by the Diexi earthquake in 1933 and the Wenchuan earthquake in 2008, the mountain structure in this area was damaged for many times. The third is the meteorological factor. One week before the disaster, the region had suffered from continuous rainfall, which increased the mountain's downward force on the one hand while on the other hand, softened the mountain, reducing its anti-sliding force. To sum up, the complex and fragile geological conditions of the landslide area, coupled with repeated earthquakes, worsened the stability of rocks. As a large amount of rain seeped into the rock, it generated crack water pressure and softened the rock's anti-sliding force, which eventually led to the landslide. From the perspective of natural factors, the occurrence of the disaster was inevitable, but the loss of life and property caused by the disaster could have been avoided because natural factors create only necessary conditions for the environmental safety problems, not necessarily causing loss of life and property.
2.2 Technical factors
On June 25, 2017, Xu Qiang, an expert on geological hazards from the Ministry of Land and Resources, announced at a press conference that one reason for the failure to detect the hidden disaster in Xinmo Village was the complex topography of the site and limited human resources invested in the investigation. In addition, due to the dense vegetation at the site, the use of high-precision satellite remote sensing was also limited, and the existing technology was not enough to find hidden dangers[2].

After the Wenchuan earthquake in 2008, Sichuan province conducted investigation on hidden geological hazards in the area, and found hidden landslide sites behind Xinmo Village, which was named Unstable Slope of Xinmo Village Fireplace in Diexi Town and numbered 513223000034 (as shown in Figure 1 below). The high topographic position landslide was located above the hidden danger site, though there is no direct scientific basis for the correlation between the two. But it is certainly that the hidden site was part of the landslide chain reaction. It is impossible to rule out the possibility that the hidden site is sort of a preliminary indication of the landslide, though it is difficult to form an overall effective assessment of environmental safety problems due to technical reasons. From the technical point of view, it is still very difficult to fully grasp the geological activities and accurately predict geological disasters, especially for places of special geological conditions, which is still beyond the reach of current science and technology.

![Figure 1. Diagram of Unstable Slope Position in Xinmo Village Fireplace of Diexi Town.](image)

2.3 Human factors
According to the Bureau of Land and Resources of Mao County in 2017, the geological disasters in Mao County include landslide, potentially unstable slope, collapse and debris flow, among which landslide accounts for up to 38.4%, higher than the other types of disasters. Meanwhile, Diexi has always been listed as one of the most vulnerable area of geological disaster that needs prevention and protection intervention. In the Implementation of Hidden Geological Hazard Prevention of Sichuan Province of 2017 issued by the Bureau of Land and Resources of Sichuan on April 21, 2017 (as shown in Table 1 below) [3], more detailed statistics were released geological disaster prevention at the grass-root level. From this perspective, the paper analyzed human factors involved in the prevention failure of Diexi landslide.
Table 1. Implementation of Hidden Geological Hazard Prevention of Sichuan Province of 2017.

| Hidden Hazard | Scale (m$^3$) | The Amount of Threatened Properties (ten thousand yuan) | The Number of People Threatened | Time of Discovery | Time of First Report | Causes | Monitoring Method | Warning Method | Suggestion for Disaster Prevention |
|---------------|--------------|---------------------------------------------------------|--------------------------------|------------------|---------------------|--------|------------------|---------------|----------------------------------|
| Unstable Slope in DiexiHaizi of Block 1, Jiaochang Village, Diexi Town | 25 | 138 | 45 | 200808 | 201506 | Earthquake +Rainfall | Patrol + Simple Monitoring | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Unstable Slope in Fireplace of Xinning Village, Diexi Town | 80.6 | 0 | 0 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Unstable Slope of Longshui Village, Diexi Town | 0.4 | 0 | 0 | 200808 | 201506 | Earthquake +Rainfall | Patrol + Simple Monitoring | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Unstable Slope of Heshang Stockade, Lianghekou Village, Diexi Town | 16.1 | 60 | 45 | 200808 | 201506 | Earthquake +Rainfall | Patrol + Simple Monitoring | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Shaotan Ditch (Sanyintang) of Diexi Town | 14.4 | 260 | 42 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Gong Striking | Public prediction and prevention |
| Landslide of Daping, Shaotan Ditch of Diexi Town | 1.6 | 60 | 29 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Gong Striking | Public prediction and prevention |
| Debris flow of Huilong Ditch, Xuezhaizi, Painshanying Village, Diexi Town | 12 | 20 | 20 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Gong Striking | Public prediction and prevention + Relocation |
| Landslide at Xinmo Village, Diexi Town | 120 | 340 | 96 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Gong Striking | Public prediction and prevention |
| Debris flow at Gunshui Ditch, Lianghekou Village, Diexi town | 18 | 44 | 47 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Unstable landslide at Maosanding, Diexi Town | 6.4 | 40 | 82 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Unstable slope at the back mountain of village government of Painshanying Village, Diexi Town | 6.4 | 112 | 18 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Collapse of the bath house of Xuegaanzi Village, Diexi Town | 0.28 | 68 | 70 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Landslide at Second Cooperative of Xuegaanzi Village, Diexi Town | 19.2 | 32 | 15 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Terrace landslide at Block 2, Xuegaanzi Village, Diexi Town | 4 | 28 | 6 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Unstable Slope at Xuegaanzi Village, Diexi Town | 2.2 | 12 | 4 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |
| Unstable slope at Shui Ditch of Painshanying Village, Diexi Town | 5 | 54 | 26 | 200808 | 201506 | Earthquake +Rainfall | Patrol + Simple Monitoring | Shouting +Hand-operated Warning | Public prediction and prevention |
| Collapse of north DiexiHaizi at Block 1, Jiaochang Village, Diexi Town | 0.72 | 0 | 0 | 200808 | 201506 | Earthquake +Rainfall | Patrol | Shouting +Broadcasting + Hand-operated Warning | Public prediction and prevention |

The table shows that as of April 2017, a total of 17 hidden geological hazards have been identified in Diexi, including two disaster sites in Xinmo Village, one of which is located in Xincun, namely the...
unstable slope in the fireplace of Xinmo Village of Diexi mentioned above. From the statistics in the above table, we can have a direct understanding of works on geological disaster prevention in Diexi in recent years, including the site, scale, rating, causes, monitoring efforts and early prevention measures. Comparative analysis of the data revealed two problems in the construction of environmental safety in this region.

First, the accuracy of information on the hidden hazard sites. In the second column of the table, “Unstable slope of Fireplace”, the listed amount of property and number of people threatened by the hidden hazard was zero. However, From Figure 1 above, we find that all the hidden hazard sites were discovered after the Wenchuan earthquake in 2008 while the hazard sites were first reported to the provincial bureau in 2015, a 7-year gap between the two timings. And the situation was confirmed in April of 2017, another two-year gap. Therefore, the conditions were confirmed ten years later since it was first discovered, revealing inefficiency in management.

Second, the accuracy of assessing the scale and rating of hidden hazard. Based on the Geological Hazard Rating issued by the Bureau of Land and Resources, geological hazards should be rated by scale, hazard conditions and disaster conditions. As the table focuses on hidden hazard sites that have not taken place in real scenario, it adopts only scale and disaster conditions as the indicators to rate the hidden hazard. However, due to the complexity of geological disasters, the assessment on the scale and disaster conditions of hidden hazard should not base on single factor or decided in an inflexible manner. For example, in the assessing the scale of hidden hazard, factors such as crack, settlement and water accumulation can also be considered in addition to quantity. The danger of rating error is obvious, which might lead to false location of the hidden hazard, and might be ignored by the public who thought it was not serious enough. At the same time, it would be classified into a lesser grade, thus lacking corresponding prevention efforts from relevant bureau.

3. Evaluation of Works on Environmental Safety in Diexi

First, the management of environmental safety was not fully implemented. The mechanism and regulations issued before Diexi land sliding included Emergency Response of People's Republic of China, Regulations on the Prevention and Control of Geological Disaster, National Emergency Plan against Geological Disaster, Geological Disaster Prevention of Sichuan, Government Opinions on Strengthening Geological Hazard Prevention and Control, Aba Prefecture Geological Disaster Prevention Plan of 2016, Aba Prefecture Prevention and Control of Geological Disasters in Flood Season, Aba Prefecture Emergency Plan for Sudden Geological Disaster, Mao County Sudden Geological Disaster Emergency Plan, Mao County Geological Disaster Prevention Plan of 2015. The preventive and early warning measures taken by governments at all levels for geological disasters in China mainly involve a people-based system under the leadership of the Communist Party of China and an effective geological disaster response network relying on the strength of the public and professional institutions, which can send out, supervise, forecast and deal with hidden dangers in a timely manner. However, the plans at the provincial and county level are not highly detailed in terms of specific implementation means as it keeps emphasizing the instructions of superior documents repeatedly.

Second, backward prevention and early warning system. The Aba Prefecture Annual Geological Disaster Prevention Plan of 2016 proposed monitoring measures and methods for geological disasters, including actively using monitoring instruments like landslide extensometer, rainfall monitor, debris flow infrascopic alarm and crack alarm to monitor hidden geological disasters such as landslides, collapses and debris flows. But in real terms, the methods used for geological disaster monitoring in Diexi are generally backward, mainly relying on manual works and tools like tape measure, measuring rope and wood pile. And warning is sent mainly by gong striking and whistles. Among the monitoring methods of the 17 disaster sites in the above table, "patrol" is adopted by all sites while four of them adopted simple monitoring. Methods used for sending early warning include shouting, broadcasting, gongs, and hand-operated alarms.
Third, failure of prediction and prevention at the public level. The prediction and prevention system of geological disaster at the grass-roots level is composed of the three-layer monitoring network and management system at counties, towns and villages. The three-layer monitoring stations are established at the three levels respectively, which constitute a relatively complete system of geological disaster prediction, prevention and early warning. The system, with the county-level station as the core, lies on village stations as the foundation while the town stations serve as the hub of guidance, supervision, inspection, and coordination of prediction and prevention works of villages[4]. It is not hard to find that the earning warning network on the basis of public prediction and prevention functions as hidden hazards are discovered at the grass-level and reported to the superior, who would feedback on the danger of the hidden hazard, thus forming a closed loop of ensuring that every geological hazard can be found in time for assessment, detection and management. The Diexi landslide is characterized by slow deformation, the loss of which could be avoided in theory if the prediction and prevention network could play an effective role in monitoring and early warning. Through the interview and investigation after the disaster of Diexi landslide, some details showed that the system did not work. In the interview, it was said that the water source of Xinmo Village used to come from a stream in the gap of Fugui Mountain. After the Wenchuan earthquake, the stream volume had a significant drop. In March 2016, the village decided to install a water pipe at the water source of Fugui Mountain. However, the village chief Wang Yunjian and the village accountant Zhang Mingliang found that the water reduction was caused by a huge rock blocking the stream and guiding the water inside the mountain, leading to a crack in the body of the mountain, which had declined for more than three meters. For this reason, a villager Yang Daixiao investigated the crack for three days. According to Yang Daixiao, the crack was tens of meters wide and 200 meters long, with a lot of water in the crack. After the villagers reported the situation, the deputy chief of the town stationed in the Xinmo Village went there to check the crack, but there was no feedback[5].

4. Improve Management Route of Environmental Safety of Western Sichuan

4.1 Construction of Legal System of Environmental Safety Management

The legal system regulating environmental safety of western Sichuan consists numerous national policies and documents for emergency response with few local policies and basic laws governing disaster prevention. The current legal system is embedded in an upside-down framework, but in need of adjustment to fill in the blanks or correct inconsistency. Environmental safety legislation covers a wide range of topics, including engineering protection management for first-level and second-level environmental problems as well as non-engineering prevention measures, reflecting the coordination between environmental safety and livelihood of the people, politics, economy, culture, education, etc. It requires a perfect legal system to standardize the rights and obligations of subjects and objects involved in the mechanism.

Targeting the above problems, we could work on the following aspects: under the law of environmental safety, add the Basic Legislation on Natural Disaster, which could serve as a supplement of the environmental law to adjust natural and man-made disasters while guiding existing disaster-related rules and regulations, which is similar to the Basic Law on Disaster Response in Japan. Refer to the systems of developed countries such as Europe, the United States and Japan to actively promote the development of a variety of supporting laws and improve the systems of prevention, relief, insurance and reconstruction. Learn from the Japanese model of "law revision after massive disaster" to revise and perfect relevant laws, regulations and plans[6]. In addition, while ensuring the consistency of laws and regulations at all levels, the supplementary functions of local governments' regulations and plans should be clarified to make the system more practical.

4.2 Improving mechanism of environmental safety management

From the perspective of public administration, effective institutional mechanism and administrative management is an important part of disaster response[7]. In the implementation of the system and
mechanism, the legal basis of the administrative subject as the main obligator of environmental safety is a proper reflection of the counterevidence relationship between the obligations of the administrative subject and the rights of beneficiaries. The accuracy and timing of information mentioned in the analysis of man-made disaster factors involved in Diexi landslide exposed the inefficiency of the management mechanism of environmental safety. The overlapping functions and management, as well as inconsistent law enforcement greatly affect the decision-making and efficiency of disaster prevention and control. At the same time, the failure of public prediction and prevention mentioned in the above analysis is also caused by the absence of the accountability system in the relevant environmental safety administrative departments.

The establishment of the Ministry of Emergency Management in the context of the institutional reform in 2018 is expected to solve the problem of multiple management and unclear powers and responsibilities caused by scattered administrative departments and functions. Under the system of the Ministry of Emergency Management, relevant administrative agencies or entrusted agencies should actively explore the establishment of an effective mechanism of disaster assessment and strengthen the identification and management of hidden dangers. Establish and improve the prevention and early warning system and information release system, and clarify the procedures and responsibilities. All regions and departments should strengthen cooperation, coordination and information transmission, promote the implementation in a coordinated way, track, analyze, supervise and inspect the implementation progress of all links, and give timely feedback, scientific response and proper solutions to problems encountered in the implementation process. We can ensure the accuracy of information by establishing horizontal and vertical information verification system and introducing third-party supervision. In addition, the obligations and responsibilities of relevant personnel should be clarified in the provisions of laws and regulations, improves the assessment, rewards and punishment measures, and form restraints on participants in the legal system of environmental safety to complement the civil servant law and criminal law, thus forming a strong sense of responsibility.

4.3 Application of technologies and raising public awareness in the context of environmental safety management

The law of environmental safety requires the perfection of "software" such as laws, systems and mechanisms, the "hardware" support from advanced science and technologies, and more importantly, the coordination of public awareness across the society. At the level of science and technology, the relevant legal documents and policies from government, enterprises and organizations should be encouraged to increase environment-related investment in scientific research, personnel training and R&D, encourage development of basic theories and key technology R&D, explore the essence of environmental safety law, improve the mechanism of investigation and risk assessment. In the actual process of disaster prevention and relief, new technologies and methods such as big data, cloud computing, unmanned technology and GIS should be applied to improve information acquisition, risk assessment, prediction and prevention on regional environmental safety. As to public awareness, environmental safety should be incorporated into the compulsory course of the construction of the rule of law while being included in the performance check in schools and government. There could also be propagations, policy-related subsidies and tax breaks to encourage social forces, and family, personal investment in disaster prevention and relief.

5. Conclusion

The analysis of geological hazards in Diexi reveals the construction and practice of environmental safety management in western Xichuan to some extent. In fact, compared with other regions in China, the western Sichuan has been taking a leading role in this regard. However, we cannot avoid the fact that environmental safety management in western Sichuan still needs to be further improved and implemented. The paper suggests that the above-mentioned aspects could serve as a starting point, including improvement of laws and regulations, systems and mechanisms, clarification of rights and
obligations, sound application of science and technology, clearing information channels, and strengthening of public prediction and prevention.

References
[1] Qinliang, (2017). Primary Analysis of Mao County Massive Landslide on June 24. http://www.yantuchina.com/people/detail/946/34812.html.
[2] The Sixth Press Conference of Mao County Front-tier Emergency Response Center.http://www.sc.gov.cn/10462/10464/10797/2017/6/26/10426408.shtml.
[3] Sichuan Bureau of Land and Resource. Announcement of Annual Hidden Geological Hazard Prediction and Prevention of 2017 by Sichuan Bureau of Land and Resource. http://www.sc.gov.cn/10462/10464/10727/10866/2017/4/25/10420939.shtml.
[4] Xue Ningbo, Ma Qingwen, Wang Chenghua. Public Prediction and Prevention of Geological Disaster in Mountain Region and Earning Warning of Sudden Disaster [J]. Science of Soil and Water Conservation in China,2008(S1):12-15.
[5] Zhou Yiting, (2017). Survival and Death in 100 Seconds. http://www.sohu.com/a/154099824_146449.
[6] Guo Anning, Liu Xudun. Massive Natural Disaster and National Safety—Reflection on Wenchuan Earthquake and Massive Future Disasters [J].Beijing Planning and Construction,2009(03):178-184.
[7] R.J. Stillman. Perspectives and Case Study of Public Administration (Volume I)[M]. Translated by Li Fang, et al. Beijing: China Social Sciences Press,1988:173-177.