

## **Key Laboratory of Mountain Hazards and Earth Surface Processes, Chinese Academy of Sciences**

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# Key Laboratory of Mountain Hazards and Earth Surface Processes, Chinese Academy of Sciences



*The Key Laboratory of Mountain Hazards and Earth Surface Processes, Chinese Academy of Sciences, is a research institution specializing in the mechanisms of mountain hazards in China and their mitigation, research that is especially relevant to key project construction and environmental protection for Chinese mountain regions. It leads research on mountain hazard mitigation in China.*

## Introduction

The Key Laboratory of Mountain Hazards and Earth Surface Processes, Chinese Academy of Sciences (CAS), concentrates on the study of fundamental theories of and technologies for mitigating mountain hazards, especially debris flows and landslides, according to the mission of Institute of Mountain Hazards and Environment, CAS. It was recognized in 2005 as one of the key laboratories of CAS that provides support to national engineering, construction, and hazard mitigation efforts.

The laboratory has 71 permanent staff, including 15 professors, 23 associate professors, 9 experimental and observational workers, 1 chief scientist of the State Key Fundamental Research Program of China, 1 winner of the National Science Fund for Distinguished Young Scholars, 1 individual who achieved the first level in the National Ten Million Talent Project, 4 Western Light Scholars, 3 academic and technical leaders in Sichuan Province, and 2 candidates for academic and technical leadership in Sichuan Province. The laboratory offers postdoctoral positions in physical geography, doctorates in physical geography and geotechnical engineering, and master's degrees in physical geography, cartography and

geographic information systems, environmental engineering, geotechnical engineering, hazard prevention and mitigation, and soil sciences.

## Research objectives

The laboratory's main research areas include the upper reaches of the Yangtze River and the Tibetan Plateau. The laboratory focuses on the formation and prevention of hazards including debris flows, landslides, and soil erosion, as well as the stability and transportation processes of rocks and soils. It explores the processes that produce mountain hazards through theoretical and numerical studies, field research, and experimental investigation, and it studies the responses of human societies to these hazards through regional analysis.

## Research achievements

A series of innovative and practical achievements have been made in the field of mountain hazards and earth surface processes since the founding of the laboratory in 2005, including the development of models of the geographical distribution of mountain hazards and a database and information platform on mountain hazards. Moreover, the laboratory has developed engineering approaches to forecast and prevent debris flows and landslides along highways, railways, and oil and gas pipelines; in the vicinity of hydropower stations; in urban areas; and in scenic landscapes and parks in western China. It also contributed significantly to relief and reconstruction efforts after the 2008 Wenchuan earthquake.

Representative achievements in the past 5 years are as follows:

1. *The debris flow enlargement mechanism and quantitative risk*; The laboratory systematically investigated the dynamic evolution of large-scale debris flows. By analyzing the granular source, basal entrainment, and cascaded breaching of landslide dams in gullies, a method of computing the debris flow enlargement ratio was proposed (Cui et al 2013). The enlargement mechanism was studied in depth to seek explanations for the large Zhouqu debris flow on 8 August 2010 and the Qingping debris flow on 13 August 2010. Based on the interaction between debris flow and buildings, a quantitative risk analysis method was developed.
2. *Multiphase depth-integrated physical models and numerical simulation of landslides and debris flows*; Several new physical models and corresponding numerical algorithms, such as a solid-water 2-phase model that takes into account the basal erosion and entrainment of debris flows (Iverson and Ouyang 2015) and a thermo-porous-mechanical model for high-speed landslides, were constructed. With an adaptive algorithm and remeshing scheme, the dynamic process of earth surface flow over complex terrain was numerically simulated.
3. *Risk analysis and key technology for urgent treatment of dammed lakes*; The distribution of dammed lakes in the Wenchuan earthquake area, the Palongzangbu River basin, and the Boqu River basin on the Tibetan Plateau was systematically mapped. Quantitative risk

**FIGURE 1** Location of field observation stations. (Map courtesy of Institute of Mountain Hazards and Environment)



- evaluation and methods to rapidly empty dammed lakes were proposed and have been applied.
4. *Formation of landslides and debris flows and key mitigation technology;* After the Wenchuan earthquake in 2008, the laboratory undertook substantial efforts to understand hazard mechanisms and improve mitigation. New insights on the distribution, characteristics, and evolution of hazards were obtained. A set of theoretical and technological hazard mitigation systems for use in mountainous areas after large earthquakes were developed by the laboratory.

### Field observation stations

The key laboratory consists of indoor laboratories and field observation

stations (Figure 1). It is well equipped with various types of observational and laboratory facilities and sophisticated analytical instruments for the study of mountain hazards and earth surface processes—in particular debris flows, landslides, and soil erosion.

#### **Dongchuan debris flow observation and research station**

The Dongchuan Debris Flow Observation and Research Station, established in 1961, is located in the lower reaches of Jiangjia Valley (103°08'E; 26°14'N), 30 km from Dongchuan and 190 km from Kunming (Cui et al 2005). It became a CAS open field observation station in 1988 and was recognized as a first-class CAS station. The station was authorized to be

the state key field observation station in 2000. It focuses on the field investigation and physical modeling of natural debris flows and their mitigation.

#### **Bomi geological hazard observation station**

Built in 2010, the Bomi Geological Hazard Observation Station is a key station of geological hazard observation in the southeastern Tibet plateau. The Bomi station focuses on geological hazard trends under climate change and earthquakes, mechanisms of hazard chains, and engineering solutions to prevent hazards. By adopting automatic fixed-point monitoring and laboratory modeling experiments to study the terrain, water resources, meteorology, and earthquakes, it



established a regional geological hazard data platform to serve scientific research, engineering, and construction.

#### **Yuanmou gully erosion and collapse experimental station**

The Yuanmou Gully Erosion and Collapse Experimental Station lies in Yuanmou Valley, a typical dry, hot valley in southwest China. It is located in Julin town, Yuanmou city, Yunnan Province, and was built in 1992. It has a 40-ha experimental region, with an elevation of 1256–1331 m, and the average slope is around 35%. It focuses on the long-term observation of meteorological variation and runoff of sloped lands with different vegetation and the measurement of gully erosion and collapse.

#### **Looking forward**

The laboratory successfully incorporates the efforts of multiple

scientific disciplines and engages a number of high-level foreign scientists to aim at cooperatively solving cutting-edge scientific and technical issues related to mountain hazards and their mitigation, soil erosion, and engineering construction safety under the leadership of Professor Xiaoqing Chen, its director. The laboratory aims to develop the discipline of mountain hazards, to enhance its innovative ability in this research field, to improve its position in the international research arena, and to become an international base for research on mountain hazards.

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