Key Laboratory of Mountain Surface Processes and Ecological Regulation, Chinese Academy of Sciences

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Source: Mountain Research and Development, 37(4) : 509-512

Published By: International Mountain Society

URL: https://doi.org/10.1659/MRD-JOURNAL-D-17-00109.1

Mountain Research and Development (MRD)
An international, peer-reviewed open access journal
published by the International Mountain Society (IMS)
www.mrd-journal.org

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The Key Laboratory of Mountain Surface Processes and Ecological Regulation, Chinese Academy of Sciences, is a research institution focusing on processes and mechanisms of mountain environmental variation and its ecological regulation in China, especially in the upper reaches of the Yangtze River and the Qinghai-Tibet Plateau. By studying the movement of soil and water, as well as the material circulation of carbon, nitrogen, phosphorus, and more, the laboratory aims to reveal processes and mechanisms of mountain environmental variation specific to soil erosion and nonpoint source pollution, the vulnerability of mountain environments, and responses and adaptations of mountain environments under global change. Based on this, it seeks to propose countermeasures of environmental conservation and ecological control in mountain areas and to provide scientific evidence and technical support for sustainable development and ecological security in mountainous areas of China.

Research focus of the laboratory

Founded in 2009 and recognized as one of the core laboratories of the Chinese Academy of Sciences (CAS) in 2013, the Key Laboratory of Mountain Surface Processes and Ecological Regulation is the main unit in this environmental discipline within the Institute of Mountain Hazards and Environment, CAS. It currently employs 77 staff members (Box 1). Its mission is to explore environmental variation processes and ecological control mechanics of water–soil–nutrient systems on hill slopes. This includes examination of soil erosion and water–soil dynamics under the impacts of multiple factors, biogeochemical processes of cultivated slopes in the upper Yangtze Valley, the natural evolution of forest ecosystems and its eco-hydrological effects in typical mountain regions of southwestern China, and more. The laboratory seeks to provide support for sustainable development and ecological security in mountainous areas and offers an extensive educational program (Box 2).

Focused on the upper reaches of the Yangtze River and the Qinghai-Tibet Plateau, the laboratory concentrates on studies in 5 fields:

1. Patterns and processes of mountain ecosystems;
2. Formation and erosion of mountain-area runoff;
3. Biogeochemical processes of mountainous areas;
4. Succession, adaptation, and restoration process of mountain vegetation;
5. Ecological security and regulation in typical mountain regions of southwestern China.

Research achievements

Since it was founded in 2009, the laboratory has contributed to many important and valuable scientific achievements in the study of mountain surface processes and ecological regulation, including observation research and demonstration of environmental changes within the Tibetan Plateau, evolution of mountain environments, and related ecological effects on forests, soil and water conservation, food and water security, environmental safety of the Three Gorges Reservoir, and so forth. These research activities have improved knowledge and understanding of environmental variation processes and ecological control mechanics on hill slopes under global climate change, the results of which have been published in various peer-reviewed journals.

Representative achievement in the past 2 years: assessment of protection needs, and establishment of ecological barriers against desertification in Tibet

As the main body of the Tibetan Plateau and the center of the Third Pole, Tibet's geographical environment is very special, and its ecological status is extremely important globally. On 18 February 2009, the State Council of China approved the implementation of projects to assess protection needs and establish ecological barriers against desertification in Tibet (2008–2030). The aim was to construct national ecological security barriers by implementing 10 projects organized into 3 categories: protect existing ecological systems, establish vegetation barriers to halt desertification, and monitor ecological safety. These activities were scheduled according to a 5-year plan, with an initial investment of 15.5 billion Chinese Yuan (Wang et al 2017).

On 26 October 2016, the State Council Information Office of the People's Republic of China released a report: *Assessment of Protection Needs and Establishment of Ecological Barriers Against Desertification in Tibet* (2008-2014). The report was mainly completed under the leadership of Xiaodan Wang, deputy director of the Key Laboratory of Mountain Surface Processes and Ecological Regulation. He and his team investigated and evaluated the 10 projects by constructing more than 20

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Box 1: Staff composition

Professors (19)

Including 1 chief scientist of the National Program on Key Basic Research Project; 1 winner of the National Science Fund for Distinguished Young Scholars; 1 winner of the National Science Fund for Excellent Young Scholars; 2 individuals who achieved the first level in the National Ten Million Talent Project; and 5 scientists who received support from the One Hundred Person Project of the Chinese Academy of Science.

Associate professors (23)

Including 3 academic and technical leaders in Sichuan Province; 3 candidates of the Thousand Talents Plan in Sichuan Province; and 7 Western Light Scholars.

Research assistants (23)

Experimental and observational workers (10)

Administrative staff (2)

observation plots, sampling about 1300 sites, and analyzing the relevant remote sensing data since 1990. It took 3 years to complete their first assessment of the project to construct ecological security barriers in Tibet. The results showed that the project was conducted effectively and achieved its initial goals. The alpine ecosystem structure was found to be stable overall. and the rate of change of ecological patterns was less than 0.15%. The ecosystem services were stable, even increasing slightly by approximately 3–5%. Nevertheless, it remains challenging to build a strong barrier against desertification due to Tibet's fragile ecological environment (Wang et al 2017).

Box 2: Academic offerings

Master's degree programs

- Physical geography
- Ecology
- Soil sciences
- Environmental engineering

Doctoral degree programs

- Physical geography
- Ecology
- Soil sciences

Postdoctoral positions

- Geography

Field observation stations

In addition to its indoor laboratories in Chengdu, the key laboratory includes 5 field observation stations (Figure 1) equipped with various types of monitoring facilities and analytical instruments. The 5 field observation stations are described below.

Alpine ecosystem observation and experiment station of Mt. Gongga: This station is located in the Hailuogou Valley on the eastern slope of Mt Gongga (29°36′N, 101°54′E), at the southeast edge of the Tibet Plateau, approximately 360 km west of Chengdu city, Sichuan, China. The regional climate in eastern Mt Gongga is mainly influenced by the Asian summer monsoon and features an annual average temperature of between 13°C (at 1600 m asl) and 4°C (at 3000 m asl), and an annual average precipitation of between 1000 mm (at 1600 m asl) and 1900 mm (at 3000 m asl). Overall, there are significant differences in weather, soil, and vegetation between the lower and higher elevations of the valley.

The station was established in 1987, became a CAS open field observation station in 1992, and was authorized to be the state key field observation station in 2001. Its aim is to provide scientific evidence and experimental data for environmental protection and proper resource utilization in mountain areas. Researchers at the station concentrate on the interaction between multilevel alpine ecosystems and human activities. The station mainly focuses on the following research fields: monitoring climate change and its impacts on alpine cryospheric, hydrological, and biological systems; investigating mechanisms of productivity formation and evolution of high alpine ecosystems; understanding mechanisms of interaction between the cryosphere, the biosphere, and human activities; and providing scientific bases and key technologies to ensure ecological security and regional sustainable development.

Yanting agro-ecological experimental station of purple soil: This station is located in Linshan, Yanting (31°16′N, 105°27′E), in the north-central Sichuan Basin. It was established in 1980 and became a member of the Chinese Ecosystem Research Network (CERN) in 1991. In 2005, it was selected to be a state key field research station. In 2007, the station became one of the soil and water conservation demonstration parks under the Ministry of Water Resources. It is also one of the observatory sites of the Global Terrestrial Observation System (GTOS) and a key field station under the Ministry of Agriculture. The station encompasses an experimental area of 10.5 ha, including various experimental sites to conduct multiple scientific missions. A nested automatic monitoring/sampling network for eco-hydrological

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

parameters (eg rainfall, runoff, sediment, nutrient concentration, pathogens) has also been established at scales ranging from plot to catchment.

The station is dedicated to meeting national needs for food and water security as well as conserving the ecological environment of the Upper Yangtze River, especially in the region of the Three Gorges Reservoir. Long-term in situ monitoring and research projects in the field are conducted to study water–soil–plant–atmosphere interface processes and their underlying mechanisms on slopes. The station is also committed to developing techniques/measures for water conservation, soil conservation, high-efficiency fertilization, and establishment of sustainable agriculture models on hill slopes. These should help optimize strategies for conservation of the ecological environment, regional food safety, and water security in the Upper Yangtze River.

Zhongxian soil and water loess and nonpoint source pollution research station of Three Gorge Reservoir: Founded in 2007, this station is located in Shibao town (30°25′N, 108°10′E), Zhongxian County, Chongqing City, centrally situated within the Three Gorges Reservoir area. The station focuses on the more severe ecological environmental problems of soil and water loess, nonpoint source pollution, and the water-level fluctuation zone affected by water storage and resettlement related to the Three Gorges Reservoir. The station draws on soil and water conservation, environmental science, and ecology to study processes of soil erosion, the coupling and transfer law of water/sand pollutants, ecological environmental degradation, and protection of the water-level fluctuation zone under conditions of natural change and human disturbance related to the Three Gorges Reservoir. Further, it seeks to study approaches and measurements for rational construction of control module for water and sediment and sustainable ecological agricultural systems, also protecting the ecological environment of the water-level fluctuation zone.

Shenzha alpine steppe and wetland observation and research station: Built in 2010, this station is located in Shenzha County (30°57′N, 88°38′E), Tibet Autonomous Region, China. The station is the highest ecological observatory in the world (4730 m asl) and was jointly funded by the Tibet Research and Development department and CAS. It lies in the plateau subfrigid zone and semiarid monsoon climate zone, with an annual average temperature of 0.4°C and annual average precipitation of 298.6 mm. Severe weather affecting the area includes dust storms, hail, drought, and strong wind.

The station aims to establish a world-class ecological system monitoring station under climate change that provides (1) a long-term platform for field observation of water, soil, atmosphere, and biology in typical alpine steppe and wetland ecosystems; (2) demonstrations of management and sustainable animal husbandry for an ecological safety barrier for Tibet; and (3) a base for research cooperation and a platform for international communication.

Wanglang forest ecology and remote sensing experimental station: This station is located in the Wanglang national nature reserve (32°98′N, 104°08′E), Pingwu County, Sichuan, China. The mean altitude in the area is 2650 m; annual rainfall measures 801 mm; the annual temperature is 2.9°C; and the average summer temperature is 12.7°C. Founded in 2017, the station focuses on the effects of climate change on forest physiology and ecology, especially on the subalpine dark coniferous ecosystem.

Looking forward

Under the leadership of Professor Genxu Wang, its director, the Key Laboratory of Mountain Surface Processes and Ecological Regulation has made great progress in competing for scientific projects, publishing high-quality academic papers, training personnel, and facilitating scientific research cooperation. In the future, the laboratory will continue to strive toward the following objectives:

http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00109.1

further development of the study of mountain surface processes and their regulation; enhancement of the laboratory's ability to innovate in this research field; establishment of the laboratory as an international base for research on mountain environments; and fulfillment of national needs for sustainable development and ecological security in mountainous areas.

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http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00109.1