AN INTRODUCTION TO DEBRIS FLOW HAZARDS IN TIBET, CHINA

Dongtao Ma¹, Hai Huang, Xianlin Wang,² Shucheng Zhang³

ABSTRACT

Tibet is located at 26°50’~ 36°33’ N and 78°25’~ 99°06’ E in the southwest boundary of China, which is bounded by Sichuan, Yunnan, Qinghai provinces and Xinjiang Uygur Autonomous Region in China, and Nepal, India, Bhutan, Sikkim and Myanmar. The total territory area is 1,201,000 km² with the average altitude of more than 4,500 m. There are 21,425 glaciers with a total distribution area of 35,000 km² in Tibet. The annual precipitation in most Tibet is between 200 mm and 500 mm, the annual mean temperature is between –4°C and 17°C. It is recorded that 500 earthquakes in magnitude between Ms 4.0-Ms 6.0 and 86 strong earthquakes over Ms 6.0 have occurred in last century in Tibetan territory, and the biggest one broke out at 22:09:34 on August 15, 1950 in Chayu with the magnitude reaching Ms 8.6±0.3. Owing to complicated geology, Neo-tectonic movements, geomorphology, climate and plateau environment, debris flows are widely distributed along the Jinsha River (the upper reaches of the Yangtze River), the Nu River (the upper reaches of the Thanlwin River) and the Lancang River (the upper reaches of the Menan Khong River) in the east, and the Yarlung Zangbo River, the Pumqu River and the Poiqu River in the south and southeast of Tibet (Fig.1). The distribution area of debris flow hazards in Tibet reaches about 489,500 km², which occupies 40.8% of its total territory. Debris flow is the most dangerous, widespread and frequent mountain hazards in Tibet.

According to the triggering water sources of debris flow, which can be classified into rainwater type, glacier type (snow and glaciers melt water, ice and snow avalanche, and glacial lake outburst), and rainwater and glacier compound etc 3 categories. Most disastrous debris flows are generated by glacial lake outburst and rainstorm from South-Asian Monsoon Circulation. In comparison to other mountain regions in China and the world, debris flow hazards in Tibet always have following characteristics: • the catchment’s area most rainwater debris flow is 1-20 km², but the glacial debris flow is larger 20 km² usually; • the gradient of gully bed and slope the gradient of gully bed is 10%-30%, the gully slope often exceeds 30°, and the relative height of debris flow gully is higher than 1000 meters; . • occurring season most of rainwater break out at June and July, and the glacial debris flow happen in July and August, July is the most disastrous month in a year; • high occurring frequencies and long period for example, Guxiang Gully broke out 37, 70 and 85 debris flows in 1953, 1963 and 1964 respectively, which bursted 4 times in September of 2007, the total is more than 400 times in the last 50 years; • large scale the catchment’s area of Guxiang Gully is only 25.2 km², but the discharge of debris flow occurred in later September,

1 Dr. of Science & Professor, Key Laboratory of Mountain Hazards and Surface Process, Chinese Academy of Sciences, Chengdu 610041, China (Tel: +86-28-66299356; Fax:+86-28-85222258; email: dtma@imde.ac.cn )
2 Post graduated students, Graduated School of Chinese Academy of Sciences, Beijing 100039, China (hhai84@163.com; xiaobiehaoren@163.com)
3 Professor, Institute of Mountain Hazards and Environment, Chinese Academy of Sciences & Ministry of Water Conservancy; P.O. Box 417, Chengdu 610041, China (Tel: +86-28-85458553; Fax:+86-28-85222258; email: xfscz@china.com )
In 1953, the river Parlungzangbo, with a catchment area of 11,551 km², reached 28,600 m³/s, which blocked the main river and formed a large dammed lake. The investigations show that there were 1,064 debris flows in 1977, but under the global climate changes warming and its induced extensive glacier and snow cover melting, the hazard’s spots reached 3,054 and 7,210 in the year of 1993 and 2000 respectively in Tibet.

Debris flows not only endanger the traffic lines, cities and towns, farmland and mountain environment in Tibet, but also generate more dangers to the neighboring countries like Nepal, India and Bhutan. On June 10, 2000, Yigongzangbo broke out a lake outburst debris flow and flash floods with the peak discharge of 120,000 m³/s, which resulted in 30 deaths and 100 disappearances, more than 50,000 people in five districts of Arunachal Pradesh, India were homeless. The highways reached 25,000 km in 2000, but 20% of the highways or 5000 km long is threatened by debris flow, among which, most disastrous debris flow distribute along Sichuan-Tibet Highway and Sino-Nepalese Highway. Meanwhile, Lhasa, Xigaze, Linzhi and Zedang etc 4 cities and Bomi, Basu, Zuogong and Zhangmu etc 20 towns are under the menace of debris flow hazards, accounting for 30% of all cities and towns in Tibet.

Most researches of debris flow hazards in Tibet are still at the initial stage of field investigations, the detailed and thorough researches are to be made by using of RS, GIS and GPS methods, as well as some new survey and reconnaissance technologies in the future in order to find out the real formation background, mechanism of hazards. It is necessary to carry out joint researches and expeditions between with neighboring and related countries in the future. Mitigation plans of hazards should be made according to the distribution, types and dangerous degrees of debris flow. It is important to set up regional and international warning and forecasting systems in some catastrophic hazard spots providing or exchanging information between Tibet and the neighboring countries. At the same time, some weather stations, hydrometric stations and disaster observation stations in disasters easily occurred regions should be established.

**Keywords:** Tibet, Debris Flow Hazards, Formation conditions, Characteristics, Mitigation Countermeasure