A Field Investigation on the Catastrophic Azijue Debris Flow in Eastern Margin of Tibet

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Introduction

The Azijue debris flow, with an estimated volume of 3.2 million m^3, occurred at about 20:00 on 30 August 2020 in Ganluo County, Sichuan Province, southwestern China, as shown in Fig. 1. The debris flow dropped from 2,983 m a.s.l. to 770 m a.s.l. at downstream part of the Niri River, travelling 2,213 m vertically and 8,700 m horizontally. It killed 3 persons, buried 2 villages with over 30 houses and 2 bridges, damaged a local middle school, and formed a barrier dam in the Niri River. Meanwhile, the rapidly flowing debris mass interrupted Chengdu-Kunming Railway, an important transportation line in southwestern China, for about 14 days.

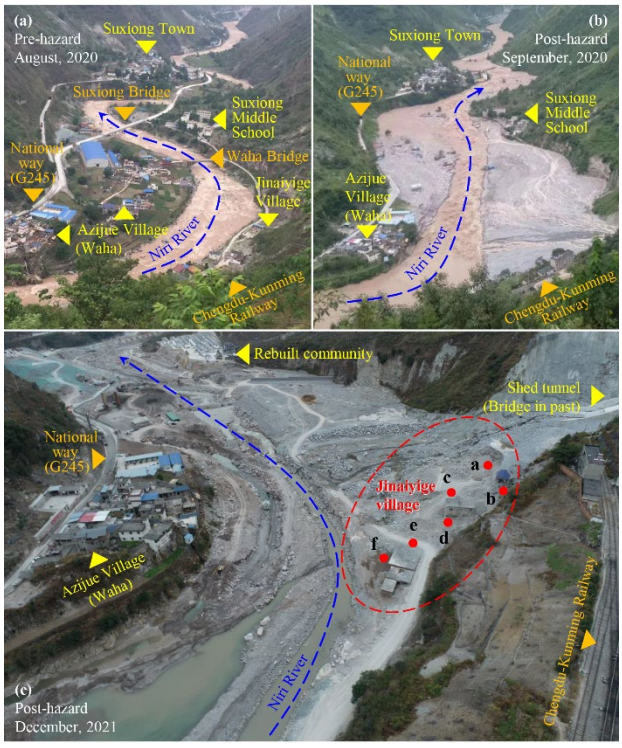

Fig. 1 Pre- and post-hazard overview of the final deposition area. Images (a) and (b) were provided by residents, whereas image (c) was collected using a UAV camera.

To understand the triggering mechanisms, long-runout movement, and multi-stage depositing mechanisms of the Azijue debris flow—a chained geohazard—a detailed field investigation was conducted using an unmanned air vehicle (UAV) and remote sensing technologies. During the investigation, we collected regional geological settings, topographical features, and precipitation data for the debris flow event, as well as detailed photographs and descriptions of the debris flow gully. The aim of this article is to improve understanding of geo-environmental effects on large-scale geohazards and to support mitigation strategies.

Geological settings and precipitation

Ganluo, a county on the Tibet's eastern margin which is a transition zone from the low-altitude Sichuan Basin to the high-altitude Tibetan Plateau, is tectonically active and surrounded by several active fault zones. The densely distributed active faults have contributed to many high-intensity earthquakes around the study area, including five major ones (Mw > 7.0) and nine large ones (Mw = 6.0~6.9). The formations observed along the investigated debris flow gully were the Kaijianqiao (Z_ak), Suxiong (Z_as) and Ebian ($P_{t1}eb$) Formations, consisting of sedimentary, igneous, and metamorphic rocks, respectively

Ganluo has a typical subtropical moon climate, with an average yearly rainfall of about 880 mm. However, the distribution of seasonal precipitation is uneven, as it is dominated by tropical marine air masses from the Indian Ocean during the hot summers, and by polar continental air masses during the dry, cold winters (Chen et al. 2020). Moreover, the precipitation in

Ganluo has obvious difference on temporal and spatial distribution. Most rainstorms occur at night compared to the daytime, and concentrates on top of mountain but not at the lower valley.

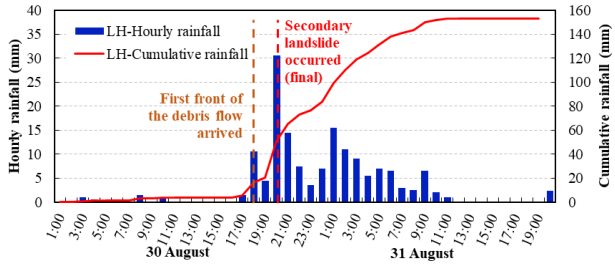

Fig. 2 Hourly rainfall from 30–31 August 2020 at LH station.

Results and discussions

The Azijue debris flow had a long movement path from its source area to the final deposition area, as shown in Fig. 3. Overall, according to the longitudinal profile of the gully (Fig. 3), the flow path had a small apparent friction coefficient of 0.25, representing a gentle apparent friction angle of 14.3°. In this case, there was a long transition zone, from point A to point C, with a straight and steep gully floor. Following it, a complex deposition zone consisted of two sub-horizontal platforms (points C to D and points D to E), a major secondary landslide gully (points E to F), and a final deposition area in the Niri River (points F to G). In this transition zone with an average slope of 20°, the debris flow originated from a source area with a slope of 31°, which gradually decreased to 8° at the end of the zone (point C). Within the upper part of the transition zone, a normal fault cut the gully 2,100 m horizontally from the source area (point A). Following the steep transition zone (average 20°), the gentler deposition zone (points C to G, average 7°) included two sub-horizontal platforms (points C to D and points D to E, 3°) and the final deposition area (points F to G, 1°). The two platforms, connected by a natural landslide dam (point D, 18°), were separated by a narrow gully (points E to F, 16°) from the final deposition area. A cross section of the debris flow gully shows a ‘V-shape’ in the narrow, steep, and curved segments, as at S-1 and S-5, with a slope of 18°. It shows a ‘U-shape’ in the wide, gentle, and straight parts, like at S-3, S-4 and S-6.

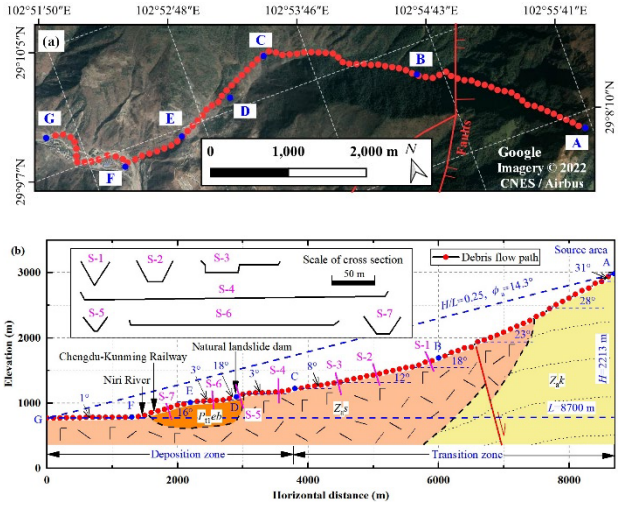

Fig. 3 Longitudinal profile of the Azijue debris flow path. The geological formation was estimated according to geological information provided by Li et al. (2019): (a) location map of the longitudinal profile; (b) longitudinal profile.

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References

Chen A., Ng Y., Zhang E and Tian M (2020) Subtropical Monsoon Climate. In: Dictionary of Geotourism. Springer, Singapore. Doi: 10.1007/978-981-13-2538-0_2376

Li C, Wang X, He C, Wu X, Kong Z and Li X (2019) China national space database (V1) of 1:200,000 digital geology map (Public version). Development Research Centre of China Geological Survey and National geological data Museum of China. Doi: 10.23650/data.A.2019.NGA120157.K1.1.1.V1