Assessment of Post-Earthquake Sediment Related Disaster Scale and Recovery - A Case Study of the Lushan Area

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After the 921earthquake with its epicenter in Jiji, central Taiwan, on September 21, 1999, the situation of hillslope disaster in the central region of Taiwan became very serious (as shown in Figure 1). Due to the loosening of the soil and rock in the mountainous area after the 921 earthquake, there were numerous surface cracks at the sources of the landslides. During typhoon and heavy rainstorm events, the surface runoff carried large amounts of soil and sand from the upstream in the mountain areas, causing many serious the debris flow and large-scale landslide. For example, in the Lushan Hot Spring area of Ren'ai Township, Nantou County, after the 921 earthquake, there were hillslope disasters approximately every 1 to 5 years due to Typhoon Mindulle in 2004, Typhoon Sinlaku in 2008, Typhoon Morakot in 2009, the 0610 rainstorm in 2012, the 0613 rainstorm in 2017, the 0518 rainstorm in 2019, as well as Typhoon Khanun and Typhoon Haikui in 2023. However, from a disaster management perspective, satellite images or ground photos were mostly used in the past. The limitations in image resolution of the satellite imagery, climatic conditions, and shooting angles made it impossible to conduct comprehensive quantitative analysis of disaster events.

In recent years, the rapid development of UAVs (unmanned aerial vehicles) has seen significant improvements in both UAV performance and the reduction of associated costs. UAV photogrammetry and UAV with LiDAR systems can now be used to monitor changes in the disaster environment and surface elevation, as well as to create high-precision orthophotos, 3D models, and digital surface elevation data of disaster areas. Taking the Lushan Hot Spring area of Ren'ai Township, Nantou County as a case study, field investigations and aerial surveys were conducted after Typhoon Khanun and Typhoon Haikui in 2023, as well as in April 2024, to produce digital elevation models of the river channel. Through multi-period orthophoto and terrain comparisons, the scale of the disaster event can be quantified, and the recovery status of the Lushan Hot Spring area after the sediment-related disaster was tracked.

The analysis of the three-phase terrain comparison results shows that (as shown in Figure 2), from the post-disaster period of Typhoon Khanun in 2023 to the disaster of Typhoon Haikui, the impact of secondary soil and debris flow caused the average sedimentation height of the Talowan Riverbed to increase by 3.77 meters. During the period from after Typhoon Haikui in 2023 to April 2024, relevant units continued to carry out river dredging work, which led to an average downward dredging depth of the Talowan Riverbed by 6.15 meters. With the application of emerging technologies such as UAVs in recent years, it is possible to perform quantitative descriptions of disaster impact assessments and recovery analyses, providing comprehensive scientific evidence for disaster management.

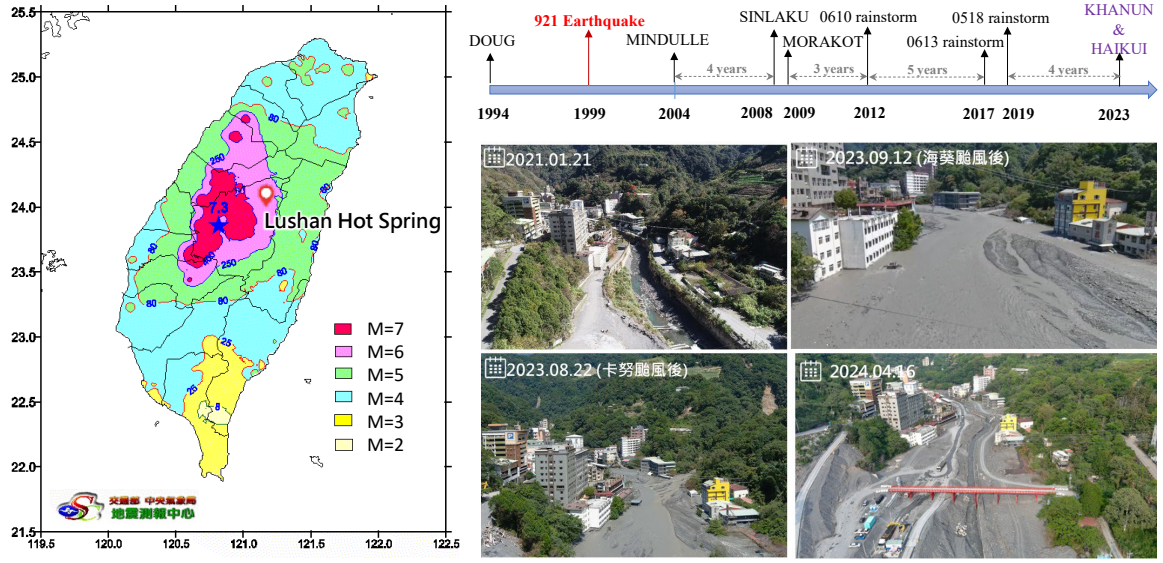

Figure 1. After the 921earthquake, multiple hillslope disasters occurred in the Lushan Hot Spring area.

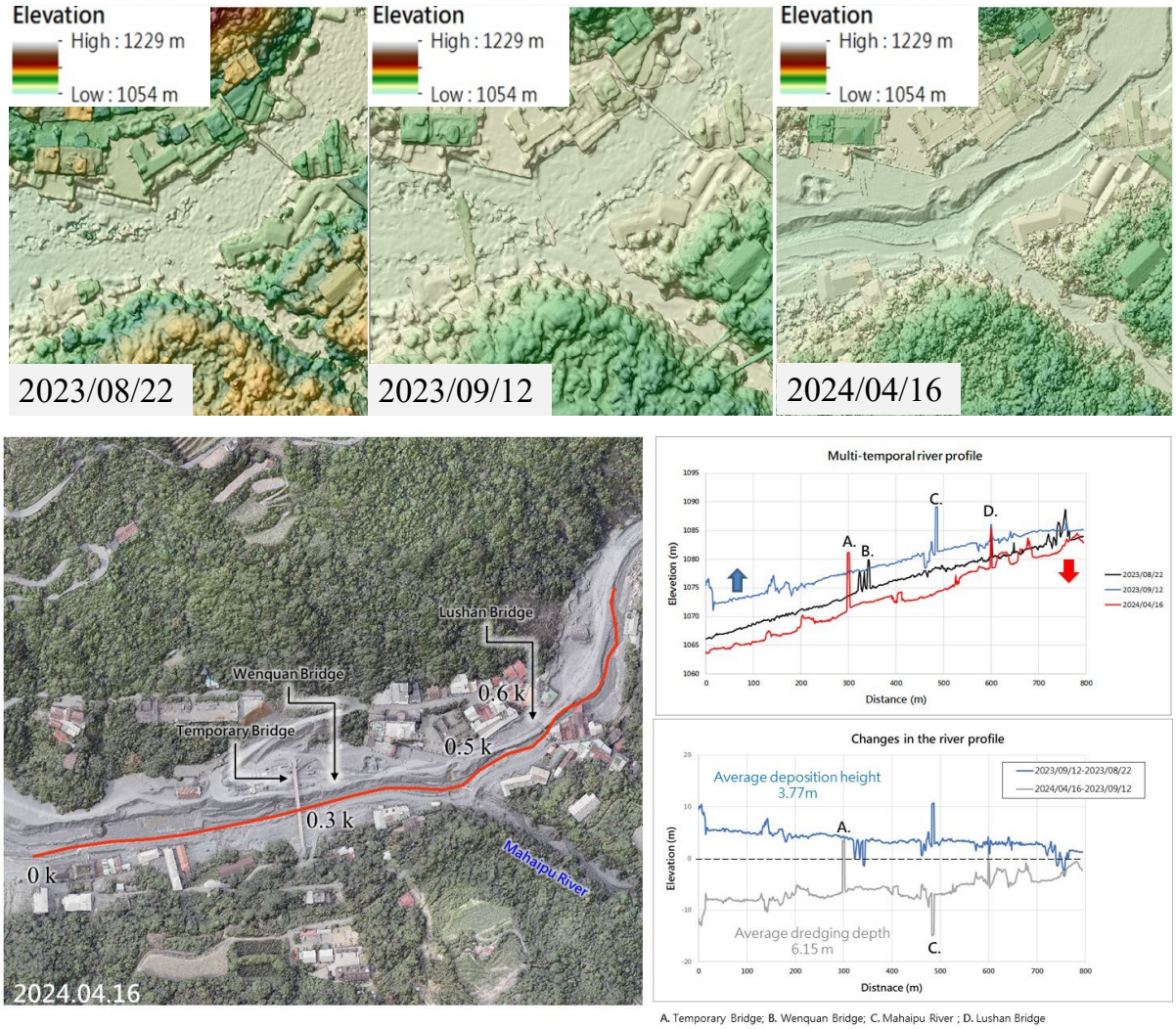

Figure 2. Three times of the digital surface elevation produced by Unmad Aerial Vehicle and the comparison for the investigation of Talowan river channel change.

REFERENCES

Investigation report on the heavy rainfall and Typhoon event disaster in 2023, National Science and Technology Center for Disaster Reduction. (in Chinese)

Report on Emergency soil and water conservation plans for debris flows and landslides for reconstruction area of the 921 earthquake, Agriculture Policy and Review, Ministry of Agriculture. (in Chinese) https://www.moa.gov.tw/ws.php?id=3977

Isoseismal Map in the 921 Earthquake, Central Weather Administration.