Advanced Geospatial Data for Cascading Geo-Hazard and Disaster Risk Assessment: a Case Study of 2015 Earthquakes in Sabah

Khamarrul Azahari Razak, Zakaria Mohamad, Razain Abd Razak, Mohd Othman Sosi Said and Ahmad Zulfadli Ahmad Mazuvil (Malaysia)

Key words: Laser scanning; Remote sensing; Risk management; Spatial planning; Geo-enabled Disaster Solution; Multi-sensory LiDAR; Co-Seismic Landslides; Quantitative Hazard and Risk Assessment; 5th of June Earthquake Sabah; Malaysia

SUMMARY

Seismically induced events pose serious hazards and associated risks yet are very difficult to predict. Despite remarkable efforts of quantifying geological processes at regional scales, the understanding of the Earth's dynamic system remains elusive. Although Malaysia is in a relatively low seismic hazard zone, an increasing seismotectonic activity triggered a series of fundamental study to better understanding of cascading geohazards. Several conventional mapping techniques have been intensively used but shown significant limitations leading to incomplete hazard assessment and poor disaster risk management.

This study establishes a collaborative disaster-geospatial environment for reducing cascading geo-risk in Malaysia. We promote disaster-based geospatial information governance, infrastructure and technology development. In this paper, we utilized an advanced remotely sensed data coupling with multi-stage geo-processing modules for characterizing co-seismic landslides and parameterizing multi-hazards, e.g. debris flow, mudflow, rockfall and complex landslides. The study area is located in a tectonically active area in Malaysia (Kundasang, Sabah) with an area of about 20 km2. We acquired a high-density helicopter-based LiDAR data on August 24, 2015 using LiteMapper 6800-400kHz resulting in a total of 724 million point clouds over the channelized debris flow. With 0.06 m digital images captured using a Hasselblad H60 (DigiCam 60MP), the geometric and radiometric-derived co-seismic landslides data are intelligently extracted. A first scientifically recorded inventory of landslides induced by earthquakes derived from multi-scale LiDAR data is revealed. Overall, we aim at quantitatively assessing multi-hazard risk in an objective and reproducible manner. This study also contributes to simulating the spreading, entrainment, and deposition process of landslides at a local and medium scale.

In this paper, development and applications of seismically induced landslide hazard and risk

---

zonation in environmental risk management and governance, at different scales are conceptually presented and critically discussed. Quantification evaluation of uncertainties associated to spatial seismic hazard and risks prediction is addressed. It is crucial to highlight the changes of climate and land-use-land-cover in relation to temporal and spatial pattern of co-seismic landslides. It is also important to assess, model and incorporate the changes due to natural disasters into the sustainable risk management.

In conclusion, the characteristics and development of mass-movement, as one of the components of the geomorphological process-response system is crucial for the regional geodynamic study. An evidence-based decision, as a result of wide range of geospatial and temporal scales, is essential for building participatory-based disaster ecosystem in Malaysia. This study concluded that new and emerging techniques based on the airborne- and satellite-based remote sensing technology coupled with the satellite positioning system promises a better mapping tool for characterizing geodynamic activity. They can be used to identify, monitor, and model related seismically induced processes and activity for supporting comprehensive hazard and risk assessment. This research has contributed to a better understanding of the needs and requirements of highly accurate topographic data for developing an inventory, analysing susceptibility, assessing hazard, and simulating run-out zones, which are crucial inputs for vulnerability and quantitative risk assessment. This study is essential towards promoting trans-disciplinary disaster research and developing an ecosystem-based disaster reduction in Malaysia.