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Slope Hazard and Risk Assessment in the Tropics: Malaysia' Experience

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The increasing number of geological hazards in Malaysia has often resulted in casualties and extensive devastation with high mitigation cost. Given the destructive capacity and high frequency of disaster, Malaysia has taken a step forward to address the multi-scale landslide risk reduction emphasizing pre-disaster action rather than post-disaster reaction. Slope hazard and risk assessment in a quantitative manner at regional and national scales remains challenging in Malaysia. This paper presents the comprehensive methodology framework and operational needs driven by modern and advanced geospatial technology to address the aforementioned issues in the tropics.

The Slope Hazard and Risk Mapping, the first national project in Malaysia utilizing the multi-sensor LIDAR has been critically implemented with the support of multi- and trans-disciplinary partners. The methodological model has been formulated and evaluated given the complexity of risk scenarios in this knowledge driven project. Instability slope problems in the urban, mountainous and tectonic landscape are amongst them, and their spatial information is of crucial for regional landslide assessment. We develop standard procedures with optimal parameterization for susceptibility, hazard and risk assessment in the selected regions. Remarkably, we are aiming at producing an utmost complete landslide inventory in both space and time. With the updated reliable terrain and landscape models, the landslide conditioning factor maps can be accurately derived depending on the landslide types and failure mechanisms which crucial for hazard and risk assessment. We also aim to improve the generation of elements at risk for landslide and promote integrated approaches for a better disaster risk analysis.

As a result, a new tool, notably multi-sensor LIDAR technology is a very promising tool for an old geological problem and its derivative data for hazard and risk analysis is an effective preventive measure in Malaysia. Geological, morphological, and physical factors coupled with anthropogenic activities made the spatiotemporal prediction of possible slope failures very challenging. Changing climate and land-use-and-land-cover required a dynamic geo-system approach for assessing multi-hazard in Malaysia and it is still a great challenge to be dealt with. We also critically discussed the capability, limitation and future direction of geo-information tools particularly the active sensors for systematically providing the spatial input towards landslide hazard and possible risk. The cost-and-benefit of developed methods compared to traditional mapping techniques is also elaborated.

This paper put forth the critical and practical framework ranging from updating landslide inventory to mitigating landslide risk as an attempt to support the establishment of a comprehensive landslide risk management in Malaysia. The advancement of multistage processing sequence based on airborne-, and ground-based laser remote sensing technology coupling with the sophisticated satellite positioning system, advanced geographical information system and expert knowledge leading to a better understanding of the landslide processes and their dynamics in time and space. Given the state-of-the-art of multi-sensor-LIDAR and complexity of tropical environment, this first landslide project carried out at the national scale provides a better indication and recommendation on the use of modern and advanced mapping technology for assessing tropical landslide geomorphology in an objective, reproducible and quantitative manner.