UNIVERSITI TEKNOLOGI MARA

THE MODELLING OF RAINFALL - LANDSLIDE HAZARD MAPPING USING GIS AND REMOTE SENSING FOR PREDICTION AND MONITORING SYSTEM

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ABSTRACT

Landslides are natural phenomena that are defined as a tremendous flow of materials such as soils, rocks, organics, that travel from upslope to downslope, causing extensive devastation to human lives, properties, and infrastructures globally. Landslides can be triggered by a variety of factors, including strong earthquakes, heavy or prolonged rainfall, and a variety of human activities. In Malaysia, landslides are mainly triggered by frequent and prolonged rainfall, mostly associated with monsoon rainfall. Ulu Kelang, Selangor received the most exposure to rainfall since it is located at the toe of the Titiwangsa mountain range, making it an area prone to landslide occurrences. This study aims to develop a model rainfall-landslide hazard map for landslide prediction and monitoring to reduce and avoid related damage and loss caused by landslides. The investigation of causative and triggering factors that lead to landslide occurrences was carried out to generate rainfall thresholds and landslide susceptibility maps. Using a 3x4 hazard matrix technique, the landslide hazard map was carried out by integrating landslide susceptibility in the region of interest and the rainfall events that caused the disasters. The landslide hazard maps provide spatial and temporal predictions of landslides. Landslide susceptibility maps offer static spatial information on the likelihood of landslide occurrence at a fine spatial resolution, whereas rainfall thresholds aid in the creation of a temporal prediction at a very coarse spatial resolution. A rainfall threshold was established by using 3-day cumulative rainfall (R_3) to 30-day cumulative rainfall (R_{30}) based on 18 historical landslides. In the plotted rainfall threshold ($R_3 - R_{30}$) diagram for historical rainfall events, three rainfall warning levels were classified; R1, R2 and R3 represented low, moderate, and high rainfall rates. The reliability test that results from 80% of the reliability index for R3 shows rainfall as a triggering factor for landslide events. The landslide susceptibility map (LSM) was generated using the relative frequency ratio (RFR) technique to investigate the effects of nine causative factors, which includes land cover, slope, elevation, normalized difference vegetation index (NDVI), lithology, soil moisture index (SMI), slope aspect, plan curvature, and stream power index (SPI). The LSM's validation was carried out utilising the area under the curve (AUC) methods. The findings demonstrate that the susceptibility model is good and realistic, with a 92.38% success rate and 88.63% prediction rate. The hazard matrix included four susceptibility classes (very low susceptibility, S1; low susceptibility, S2; moderate susceptibility, S3; high susceptibility, S4) and three rainfall threshold levels (R1, R2, R3) to define four hazard levels ranging from H1 (low hazard) to H4 (very high hazard). The combined results associated landslide hazards to rainfall threshold levels, with a varied probability of landslide initiation. The findings intend to reduce the risk of landslides, develop a mitigation plan, and support local authorities in making land use planning decisions. The rainfall-landslide model has the potential to be used as a landslide early warning system (LEWS) for predicting and monitoring landslides in Ulu Kelang, Selangor.

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