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SPATIAL EXPOSURE OVER CYCLONE INTENSITY: COMPARATIVE ANALYSIS OF TROPICAL CYCLONE-TRIGGERED LANDSLIDES IN INDONESIA

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ABSTRACT

Indonesia is conventionally regarded as lying outside the active tropical cyclone belt due to its equatorial position and the negligible Coriolis force near the equator. Yet historical records show that tropical cyclones have repeatedly affected Indonesian territory, generating extreme rainfall that triggers landslides with significant casualties. This study presents a preliminary descriptive-comparative analysis of three tropical cyclone events that made landfall near Indonesia, Cempaka (2017), Seroja (2021), and Senyar (2025) to examine whether cyclone intensity or spatial exposure better explains landslide severity. Landslide areas were detected using NDVI-differencing on Sentinel-2 Surface Reflectance imagery in Google Earth Engine, with a slope mask from SRTM (>15°) applied to discriminate landslide terrain from flood inundation. Severity was normalised by the area of steep terrain within each provincial area of interest, enabling cross-event comparison. Preliminary results suggest that cyclone intensity, measured by minimum central pressure and maximum sustained wind speed, does not consistently predict normalised landslide extent. Senyar, the weakest cyclone (996 mbar, 85 km/h), is associated with the largest human impact, while Seroja, considerably stronger (971 mbar, 130 km/h), affected a province of lower population density and different terrain character. These findings indicate that spatial exposure, steep terrain combined with high population density, is a more consistent explanatory factor than meteorological intensity alone. This has direct implications for hydrometeorological risk preparedness in Indonesia, suggesting that exposure-based spatial prioritisation should inform early warning frameworks rather than cyclone intensity thresholds alone.

Keywords: tropical cyclone; landslide; spatial exposure; remote sensing; hydrometeorological risk; Indonesia.

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