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Landslide Early Warning in Indonesia: A Gap Analysis

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For the last decade, rainfall-triggered landslides have been one of the major hazards in Indonesia. According to the National Agency for Disaster Management (BNPB) reports, from 2010 to 2020, a total of 5822 landslides occurred in Indonesia and caused 1812 casualties, 1627 injured, and 234 missing. More than 75% of those landslides occurred in Java, the most populous island in the region. Settlements alongside agricultural fields often are located in areas that are susceptible to landslides. As relocation would be costly, a landslide early warning system (LEWS) could provide the necessary information for communities susceptible to landslides to prepare for the upcoming hazard. The objective of this study is to map the issues with the existing landslide early warning system in Indonesia and our plan to improve landslide forecasting by tailoring available rainfall forecasts and monitoring.

The United Nations International Strategy for Disaster Reduction (UNISDR) has defined an end-to-end early warning system that essentially comprises knowledge risk, hazard forecasting, alerts dissemination, and community response. In the definition, the UNISDR also highlighted timely and meaningful warning information for appropriate preparedness and action in a sufficient time. Landslide prediction itself is challenging in terms of when and where precisely the landslides occur as different landslide types have different characteristics and trigger mechanisms. Moreover, when rainfall forecast data is used as input for a physically-based hydrological and landslide model, the uncertainty and accuracy of the rainfall will affect the forecast skill.

National LEWS with a longer lead-time is operational, utilizing generic rainfall thresholds derived from 1-day and 3-day cumulative rainfall triggering landslides occurred in Indonesia (mostly in the Java Island) as warning signals. The rainfall thresholds were derived from NASA Tropical Rainfall Measuring Mission (TRMM) rainfall estimates with a spatial resolution of 0.25°×0.25°. Different studies showed that the thresholds derived from that product are lower than those derived from raingauge measurements, potentially leading to more false alerts. These thresholds are applied for all catchments in Indonesia even though the region has different climate regimes and geomorphological characteristics, leading to insufficient accuracy for the local landslide prediction. As for the forecast, the current LEWS applies rainfall forecast with the same spatial resolution as TRMM, which is not suitable for (sub-)catchment-scale prediction.

This study proposes an approach to tailor rainfall data from various high-resolution sources, like radar, NWP models, and satellite, where historical landslide data are to be used to derive dynamical rainfall thresholds at local scale.