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Spatiotemporal Modelling of Landslide Susceptibility Using Satellite Rainfall and Soil Moisture Products through Machine Learning Techniques

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To mitigate the risk of landslides, building a model that can provide information on the spatial and temporal probabilities of landslides is essential yet challenging. Landslides are influenced by environmental factors, such as topography, geology, and mechanical properties of the soil, as well as triggering events like rainfall and earthquakes. This research leverages Random Forest algorithm for classification by creating multiple decision trees. Each tree is trained on a distinct, randomly selected subset of the dataset. The dataset includes specific static variables for each location, such as lithology, slope angle, aspect, curvature, and land use. Additionally, the study considers two dynamic variables for each location: high-resolution soil moisture data obtained from satellites to examine the impact of soil water content, and rainfall data.
By utilizing a unique rainfall-induced landslide database, which includes the location and time of landslide occurrences in the study area. The algorithm extracts the corresponding rainfall and soil moisture values preceding each landslide event and trains the model by adjusting both static and dynamic variables. The rainfall data is analyzed on two different time scales: short-term cumulative rainfall (1-72 hours before a landslide event) and medium-term cumulative rainfall (5-15 days before a landslide event). The outcomes are individual trees that determine the final class (landslide or non-landslide location) for each pixel based on the majority vote. The model's outputs, out-of-bag errors, and partial dependence plots provide insights into how each parameter influences the model's landslides predictions, and help to evaluate the impact of rainfall and soil saturation conditions on landslides occurrence both in space and in time.