Effects of topography and geology on vegetation recovery after shallow landslides

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Shallow landslides are instability events that lead to mass wasting of soil and vegetation in sloping areas and are commonly triggered by intense rainfall. Since vegetation is an important factor influencing the occurrence of rainfall-triggered shallow landslides and reduces the likelihood of landslides through different hydromechanical mechanisms, conducting in-depth research in this field for disaster risk management is meaningful. Investigating vegetation recovery processes after shallow landslides can provide significant insights for improving future disaster habitation works. However, vegetation recovery processes after shallow landslides and their influencing multivariate factors are not well known. Therefore, the objective of this study is to clarify the effects of geology and topography on vegetation recovery after shallow landslides in two research areas, the Shobara district, Hiroshima Prefecture, Japan, and the Obara district, Aichi Prefecture, Japan. Image analysis of historical aerial photographs was used to extract damaged areas. Each vegetation-condition indices over time were quantitatively accessed from satellite imagery. GIS tools were used to produce topographic and geological indices. The relationships among those factors were quantified using a multivariate analysis of variance. Time series analysis was conducted by using the seasonal autoregressive integrated moving average. We observed that some vegetation indices show seasonality, and the value of some vegetation indices such as Greenness tend to increase with time reflecting vegetation recovery. The temporal trends of various vegetation indices also show some differences between the two districts, and that vegetation in the preliminary recovery stage followed nonlinear growth patterns, while that in the mid and later stages tended to show linear growth patterns. The results of trend analysis indicate that vegetation dynamics are detectable and predictable. Slope forms as reflected in the combination of slope gradient and vertical curvature significantly affected most vegetation condition indices in the Shobara district. By contrast, in the Obara district, the vegetation condition indices were significantly affected by maximum curvature, horizontal curvature, and elevation. The Tukey honestly significant difference test showed that if curvature, slope aspect, hill-shading, slope gradient, or elevation take certain values, it leads to significantly different vegetation recovery from other groups of topographic factors. Except for subtle differences between the two districts, characteristics of significant explanatory factors were quite consistent. Our results indicate that terrain factors and their interactions are associated with soil erosion risk and water runoff, controlling water availability and evaporation rate, and eventually affecting the establishment of vegetation. The results enrich decision-making and policy planning in disaster rehabilitation works.

Keywords: topographic factors, vegetation recovery, time-series analysis, multivariate analysis of variance

