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LiDAR application for visualization of a landslide prone landscape with wavelet and openness analysis

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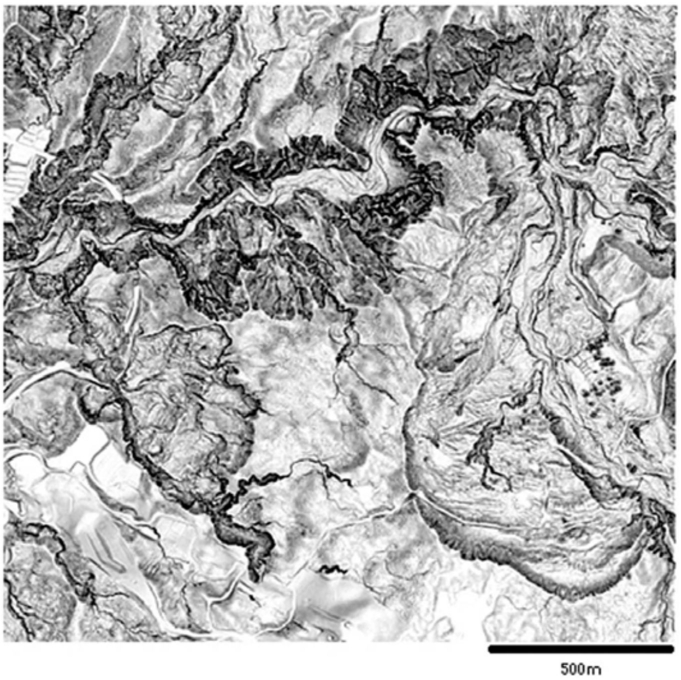

To identify locations at risk of a landslide, we must first interpret landslide morphology. The ability to obtain a contour map or morphological image to be used for this interpretation means clearly representing micro-topography (scarps, level differences, cracks, depressions, mounds, etc.) which are interpretation points. LiDAR, which has advanced astonishingly in recent years, can perform high density and high precision land surface observations, even on vegetation covered land, so it is now possible to interpret landslide morphology of forested land, which was formerly difficult to do based on conventional aerial photograph interpretation or on large-scale topographical maps. But the results of the interpretation depend upon the types of topographical images which have been prepared. For example, the way micro-topography appears on a shaded relief map varies according to the hypothetical light source direction, so the interpretation results can also be impacted by the light source direction. Thus, a wavelet and openness analysis map was prepared as a topographical image capable of emphasizing cracks and other micro-topography which are indispensible for landslide interpretation, but which does not require a hypothetical light source.

Topographical image maps, which do not require a hypothetical light source, include slope gradient maps, openness maps, etc., but in cases where LiDAR data better represents actual topography and is good quality, an openness map can represent the texture of the ground surface in greater detail than a slope gradient map, so it can be stated that it is more appropriate for landslide morphology interpretation. And topographical analysis methods applicable to emphasizing micro-topography include two-dimensional laplacian analysis and two-dimensional wavelet analysis, but the method we used is wavelet analysis, which applies the Mexican Hat function which, in recent years, has begun to be reported as effective in the abstraction of micro-topography of landslides.

At the same time as underground openness was obtained using 1mDEM prepared based on LiDAR data (point density: 5.4 points/m2) in a certain landslide zone, the 4m cycle Mexican Hat Function was used to perform wavelet analysis. Later, as a result of superimposing the openness map obtained on the wavelet analysis map, a clear stereoscopic topographical image could be prepared. This wavelet and openness analysis map is presumed useful in interpreting landslides, because it provides the following benefits.

(1) It clearly expresses micro-topography on steeply inclined slopes.
(2) It can easily interpret channels and ridges.
(3) Visualization does not require a hypothetical light source, so the direction of the slope has no impact on the interpretation of the micro-topography.

It is now necessary to objectively verify how easy it is to perform landslide morphology interpretations using a wavelet and openness analysis map by comparing results of landslide interpretations performed by multiple people. And an even more easily interpreted map can be made by coordinating the colors and color strengths. We wish to eventually apply this method to other landslide regions to expand this map so it can be applied as a practical landslide interpretation method.

Keywords: Landslide morphology, LiDAR, Wavelet analysis, Visualization