Evaluation of the geomorphic indices using the crustal movement of the 2007 Noto Hanto earthquake, north-central Japan

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Some geomorphic indices that represented quantitative the landscape shape formed by river erosion have been developed as a basic tool to identify widely the crustal movement, and show a correlation with the relative tectonic activity. In japan, the examination of the activity of the active fault using some indices is not performed. Although the activity of the active fault distributed inland are provided detailed data by the trench investigations, the examination of the activity of the active fault distributed on the seafloor often becomes in limited information such as the former shoreline of the marine terrace. This study calculated some indices in the focal area of the 2007 Noto Hanto earthquake, and compared with the crustal movements.

The 2007 Noto Hanto earthquake (M_{JMA} 6.9) occurred in the coastal area of the northwestern Noto Peninsula. The crustal movement caused by the earthquake was revealed based on geodetic measurements, including InSAR and airborne LiDAR, and the distribution of uplift rate shows tendency to decrease from the north near the epicenter to the south. In addition, the distribution of coseismic vertical displacements based on airborne LiDAR and the height of former shoreline of marine terrace show a similar distribution pattern, and the cumulative uplift associated with the faulting occurs through the Late Pleistocene in this area.

This study examined using six indices: mountain-front sinuosity (Smf), the ratio of valley floor width to valley height (Vf), stream length gradient (SL), drainage basin asymmetry (Af), and drainage basin shape (Bs). Smf is explained as the ratio of length of mountain front along the foot of mountain to the straight length of mountain front. The poorer development of sinuosity means the higher uplift rates, and is consistent with the lower value. Vf is explained by the ratio of width of valley floor to relative elevation between ridge and valley floor. In an area with high uplift rates, topographic profile illustrates a V-shaped profile with the both lower values. SL is explained as multiply the channel slope and the total channel length, and the high value consist with the active tectonics. AF shows tilting of basins, explained as the ratio of the total area of the basin and the area of a basin on the right side of the major stream. Bs shows the shape of basins that calculated by the ratio of the length of a basin and the width of a basin. The basin with high uplift rates is elongate (higher values), and basin shape become more circular with lower or cessation of the activity. In morphometric analysis, the 5-m DEM of the Geospatial Information Authority of Japan publication was utilized.

In the calculation result of 50 basins, Smf and Vf performed lower at the norther part, and the values of the southern part become higher. SL shows similar tendency, but the values vary widely than Smf and Vf. In the values of Af and Bs, these tendencies are not identified. The relationship between these indices and the height of former shoreline show low correlation, correlation coefficients are 0.56 in SL, 0.34 in Smf, and 0.21 in Vf. Therefore, the values of the indices were classified based on basic geomorphic information because it is assumed that the values include influence except the river erosion. As a result, the cases which correlations become higher are as follows; in the case of Smf, the existence of the sea cliff on the front of the sinuosity, in the case of Vf, set the ridge of the cross-section at the same period, in the case of SL, set the topography or geological feature near valley head at the same period. Thus, it is important that the comparison of the index values is careful about the influence of coastal erosion and the geologic time scale in the basin.

Keywords: morphometric analysis, river erosion, crustal movement, 2007 Noto Hanto earthquake

