A new approach for marine terrace extraction using DEM

*Junki Komori[1], Masanobu Shishikura[2], Ryosuke Ando[1]

1. The University of Tokyo, 2. National Institute of Advanced Science and Technology

We devised a new DEM analyzing method for terrace extraction, working on the southern part of Boso Peninsula, eastern Japan, as a survey area.
Marine terraces are coastal landforms that were originally platforms created by erosion just beneath the sea level and subsequently emerged above the sea surface through relative sea level fall, such as tectonic uplift or climatic sea level fall. For example, the marine terraces in the southern part of Boso Peninsula, where we tried the new method in this study, are considered to be formed by the interplate earthquakes along the Sagami trough. Many researchers surveyed and utilized such marine terraces for the estimations of the paleoearthquakes or the history of sea level changes. For this purpose, it is required to figure out the terrace distributions and obtain the heights and the formation ages of the terraces.
In the previous studies, the terrace extraction was performed, in early times, with aerial photography or field surveys. However, field surveys are time-consuming and thus unsuited method for collecting sufficient amount of data, and aerial photography requires training for reading and further cannot provide height data needed for numerical analyses. Recent studies attempted to numerically extract terrace features using DEM with geomorphological parameters such as slope, relief and curvature. Scott and Pinter (2003) developed a numerical terrace extraction method, focusing on the difference in the values of slope and relief between the terrace cliffs and platforms. Although this method shows successful result with the terraces which have relatively gentle cliff and sufficiently isolated platforms, with the narrow marine terraces, such as the south part of Boso Peninsula targeted in this study, its ability to identify the terrace platforms is weakened.
In this study, we devised the elevation view imaging as the new method for marine terrace features extraction using DEM. This imaging visualizes the terrace features as orthographic projection, where the geomorphological parameters are plotted with respect to the elevations. This method is based on the fact that the terrace features, namely some geomorphological parameters, must have horizontally or mildly sloped uniform distributions given that the terraces are formed at horizontal shoreline.
The study area is the rocky coast, located in the southeastern part of Boso Peninsula, where the erosional coastal features are prominent. There are formed four marine terraces which are considered to emerged during the 1703, M8.2, Genroku Kanto Earthquake and the paleoearthquakes that had similar source areas to it. The DEM dataset used in this study was obtained by using LiDAR and has 0.5 m grid interval.
We adopted a parameter based on positive and negative openness, devised by Yokoyama et al. (1999), for the imaging. This parameter has characteristics that can represent concavities and convexities of landforms restraining the effect of local topographic change. The elevation diagram showed a peak in the vicinity of paleo-shoreline angle. The elevation view imaging with this parameter indicated the continuous peaks at the altitudes corresponding to the terrace cliff features.
Kayanne and Yoshikawa (1984) surveyed this area and obtained the altitude of each paleo-shoreline. These altitudes are substantially matched with the result of this study. The elevation view imaging has characteristics that (1) the images are readily interpreted than aerial photography, (2) the objective criteria for classification is provided that the terrace features are distributed almost lineally in the images, (3) this method is also applicable in the narrow marine terraces which are difficult to distinguish by using the previous DEM analysis methods and (4) the altitudes data, which is important for the estimation of the histories and mechanisms of terrace formations, are simultaneously obtained.

Keywords: DEM, marine terrace, Kanto earthquake

