Co-seismic uplift along the coastal area of Noto peninsula, central Japan, caused by the 2024 Noto Peninsula Earthquake

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On January 1, 2024, at 16:10, an earthquake (Mj=7.6) occurred with its epicenter in the northeastern part of the Noto Peninsula. This earthquake caused a maximum seismic intensity of 7 in Ishikawa Prefecture and observed seismic intensity of 6 weak or higher in a wide area of the Peninsula, resulting in extensive damage. The focal mechanism of this earthquake is a reverse fault type with a northwest-southeast compression axis. In the northern coastal area of the Noto Peninsula, which corresponds to the hanging wall side of the fault, a maximum uplift of about 4 meters was detected in the northwestern part of the Peninsula by analyzing synthetic aperture radar images (Geospatial Information Authority of Japan, 2024). Multiple active fault segments are known to exist in the northern coastal area of the Noto Peninsula (Inoue & Okamura, 2010). Notably, the Monzen-Oki segment was found to be active in 2007 (Sato et al., 2007). The uplift during the earthquake has been investigated through the analysis of the distribution altitude of coastal organisms such as shellfish (Hiramatsu et al., 2008) and the disparity in elevation values between two periods derived from airborne laser scanning data (Nohara et al., 2007), confirming the effectiveness of these methods in estimating the uplift amount.
In this study, we examined the crustal deformation resulting from the 2024 Noto Peninsula Earthquake by surveying the uplift along the northern coast of the Noto Peninsula during the earthquake. The survey employed two methods: (1) utilizing coastal organism indicators and (2) utilizing point cloud data obtained from airborne laser scanning. In method (1), we measured the heights of coastal organisms, such as *Spirobranchus* sp.1 and oysters inhabiting the intertidal zone, and seaweed inhabiting the infralittoral zone, using GNSS surveying. In method (2), we estimated the uplift by calculating the displacement of the point cloud data before and after the earthquake using the CCICP (Classification and Combined Iterative Closest Point) method (Oda et al., 2016), comparing the data obtained from airborne laser scanning after the earthquake with the data acquired before the earthquake, mainly from 2007 to 2010.
Method (1) allows the direct measurement of the uplift during the earthquake on-site, though comprehending the uplift trend over a broad area necessitates surveying numerous locations. Conversely, method (2) enables a comprehensive understanding of vertical displacement components of the ground over a wide area during two time periods. However, depending on when and where the point cloud data was acquired, it may contain vertical displacement components unrelated to the earthquake in 2024. Moreover, in some areas, changes in landforms, such as slope failures, may affect the accuracy of estimating crustal deformation.
Therefore, in this study, we sought a more accurate distribution of uplift by combining methods (1) and (2), reporting on the overall uplift trend along the coast of the Noto Peninsula. However, for the on-site survey using coastal organisms, there are still many sections remain uninvestigated due to road severance caused by the earthquake, rendering this report tentative.
Finally, we would like to express our deepest condolences to those who lost their lives in this earthquake and offer our heartfelt sympathies to all those affected by the disaster.

Keywords: The 2024 Noto peninsula Earthquake, co-seismic uplift, airborne laser scanning, coastal organisms, active faults segments