Surface displacements at the Kumamoto plain using persistent scatterer interferometry and comparison with groundwater levels

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After the 2016 Kumamoto earthquake, change in groundwater levels has been observed at the Kumamoto plain, which is likely associated with the alteration of the aquifer system by the earthquake. Surface displacement can occur due to groundwater level changes at a confined aquifer because pore pressure changes lead to the deformation of its granular skeleton. Persistent scatterer interferometry (PSI) using a satellite imaging is a powerful method to estimate spatial and temporal pattern of surface displacements. In this study, we estimated surface displacement at the Kumamoto plain from May 2016 to June 2017 using PSI analysis of ALOS-2/PALSAR-2 images. Moreover, we compared the displacement pattern in the period after the earthquake with the displacement from Jan. 2007 to Jan. 2011 using ALOS/PALSAR images.

As a result of analysis, we estimated surface displacement with the magnitude of about 2-3 cm along the Futagawa and Hinagu fault systems. We interpreted that the displacements along the fault traces were due to the afterslip. On the other hand, we also found surface displacements apart from the fault traces. For example, surface uplift up to 4 cm/year was observed during about 1 year after the earthquake around the west flank of Aso volcano. The displacement began several months after the earthquake, and generally correlated with the areas of groundwater level increased. Since the displacement pattern was not observed in ALOS/PALSAR results, we speculated that the displacement was induced by the groundwater level changes by the earthquake. In addition, we estimated the skeletal storage coefficients from surface displacements and groundwater levels, and found that the coefficients differed by the earthquake at several locations, indicating the temporal alteration of permeability or compressibility of the aquifer. Our results demonstrate the effectiveness of the surface displacement monitoring combined with groundwater level data at the aquifer system.

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