Detection of slope deformation by using InSAR analysis - A case of Shikoku Mountains and Asahi Mountains

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Preface: In the SAR interferograms throughout Japan produced by Geospatial Information Authority (GSI) of Japan using the ALOS-2 data of JAXA, many phase changes indicating the slope deformation of ca. several centimeters can be confirmed. There are many reports that such phase change detects the creep phenomenon of slopes such as landslide blocks (e.g. Squarzoni et al., 2003; Une et al., 2008; Delacourt et al., 2009; Sato et al., 2012), but not all slope deformations are detected due to the observation performance of satellites. Therefore, in order to establish a method of slope deformation monitoring using SAR interference analysis in the future, it is important to accumulate information on the relationship between the observation condition of SAR, the topography / geological condition, the land cover condition, and the surface displacement in the field for observed phase change.
In this presentation, we report the characteristics of phase changes detected by InSAR and of the surface displacement observed by field survey in the Shikoku Mountains (Kochi Prefecture) and Asahi Mountains (Yamagata Prefecture).

Result: Field surveys were conducted on Shikoku Mountains from 9 to 11 March 2016 and Asahi Mountains from 14 to 16 November 2016.
(1) Shikoku Mountains: Among the 4 surveyed sites, clear surface displacements were identified at two sites (SK-1 site: Okushiraga Valley in Motoyama Town, SK-2 site: Tebako Valley in Ino Town).
At the SK-1 site, the SAR interferogram (October 2014 - October 2015) detected a variation of ca. 8 cm away from the satellite. As a result of field survey, a relatively new some open cracks were found in the concrete retaining wall at the side of the forest road which is in contact with the phase change area, and it is indicating that deformation of the slope block harmonized with the phase change type occurred.
(2) Asahi Mountains: Among the 5 surveyed sites, clear surface displacements were identified at two sites (AS-1 site: Tsukinuno area in Oe Town, AS-2 site: Kamikonuma area in Nishikawa Town). At the AS-1 site, a wide range phase changes were continuously detected in SAR interferograms of a multiple periods, including the period from September 2014 to June 2015. At the concrete pavement section of the forest road crossing the phase change area, a step and opening crack harmonious with the direction of the displacement indicated by the phase change was found. The AS-2 site is a landslide countermeasure site, and phase change was detected in SAR interferograms at multiple periods including the period from January to April 2016. In the field, clear vertical and right-lateral displacements harmonious with the direction of phase change were identified in the asphalt road and the side irrigation channel crossing the edge of phase change area located on the side cliff of the landslide block (Figure). In this point, there are at least three repair traces of road. There is a high possibility that the latest repair was done within 2016 and it is the displacement caused by the displacement detected by the SAR interferograms.

Summary and Challenges: There were no artificial structures at the edge of the phase change at the sites where the phase change occurred but the surface displacement was not identified in the field. Conversely, if the deformation indicated by the phase change is certain, it shows that InSAR can detect and monitor deformations that humans can not recognize on the ground. However, it cannot be judged whether or not the surface displacement identified at the site was caused by the deformation detected by

InSAR in the post-survey like this time. For that reason, we would like to examine the verification using the constantly deformation observation at the site in the future.

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Keywords: InSAR analysis, slope deformation, landslide, surface displacement