Temporal change detection on tsunami damaged agricultural field by the 2011 Tohoku earthquake using TerraSAR-X data

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Abstract: An earthquake hit on the eastern coast area of Japan at 14:46 (JST) on March 11, 2011. Magnitude as determined by the Japan Meteorological Agency is Mw 9.0. Enormous tsunami struck this area after the earthquake and more than 18,000 people were died and missing. It is reported that total 215 km² agricultural fields were damaged by tsunami. The damaged agricultural field was flooded by sea water, and debris were scattered on several area. The sea water drained with time passage, however, several field had been flooded until two month after the tsunami disaster. After the earthquake, many earth observation satellites acquired images of the damaged area. Satellite images were helpful to determine flooding area immediately after the disaster. It is important to extract drainage process of damaged agricultural field for recovery of them. To extract drainage process of flooding field, analysis of time series SAR (Synthetic Aperture Radar) data is expected because of it is possible to obtain images under all weather condition.

In this study, we compare TerraSAR-X data series observing the tsunami damaged agriculture area after the disaster occurrence. TerraSAR-X is X-band SAR and frequently observed the damaged area after the disaster both TerraSAR-X and TanDEM-X satellites. We analyzed data obtained on 12, 13, 15, 16, 17, 21, 23, 26, 28 and 31 March, 2011. Incidence angle of analyzed data were 18.8 ~ 59.7 degree and both ascending and descending orbit data were analyzed. Backscattering coefficient (gamma naught: γ^0) values were calculated for each image. Mean backscattering coefficients were computed for each agricultural parcel using vector boundary data. These agricultural parcel data were collected before the earthquake.

It is obvious that difference of backscattering characteristics between the areas reached by the tsunami and the areas not reached by the tsunami on the image obtained on 12 March, 2011, the day after the disaster. Wakabayashi-ku district in Sendai-shi is located on coastal area and one of the seriously damaged municipalities. The mean backscattering coefficient in this district is -16.6 in the areas reached by the tsunami while the value is -9.5 in the areas no reached by the tsunami. The flooded area confirmed by optical sensor, ALOS AVNIR-2 obtained on March 19 shows low backscattering coefficient on the image obtained on 23 March.

The result of this study suggests availability of TerraSAR-X data to evaluate and extraction of drainage process of the tsunami flooded area.

Keyword: Synthetic Aperture Radar, backscattering coefficient, paddy field, flood, temporal change