Detection of surface displacements and liquefied areas in the 2011 Christchurch earthquake from SAR data

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Abstract: The Mw 6.3 earthquake affected Christchurch, New Zealand (NZ) on February 21, 2011. It was one of the aftershocks of the Mw7.0 September 2, 2010 Darfield, NZ earthquake. The Christchurch earthquake caused widespread damage across the city, especially in the center area. Significant liquefaction occurred in a large area, which caused ground movement and destroyed infrastructures. The liquefaction was reported worse than the 2010 Darfield earthquake with more than 200 thousand tone of silt. Remote sensing has been known as an efficient tool to grasp the damage condition after natural disasters.

In this study, the pre- and post-event ALOS/PALSAR and TerraSAR-X (TSX) images are used to detect the ground movement and damaged areas. The pre-event PALSAR image was taken on January 10, 2011 while the post-event one was on February 25, 2011, four day after the earthquake. The pre-event TSX image was taken on September 18, 2010 while the post-event one was on March 2, 2011. Firstly, an interferometric analysis (InSAR) was applied to the two pairs of SAR images. The ground movement caused by the earthquake and liquefaction was detected from the interferogram from the PALSAR data. However, the coherence of the TSX data was very low, due to the short wavelength of X-band and the different shooting seasons. About 5 cm ground movements were detected in the non-damaged urban area from the InSAR result from the TSX data. Then the extraction of liquefaction areas was applied according to the coherence. From the PALSAR data, the low coherence urban areas were extracted as liquefied areas. Although the liquefied areas also showed low coherence in the TSX data, the reduction was not so significant as from the PALSAR data. The extracted results were verified by a liquefaction map made through field surveys.

Keyword: Liquefaction, InSAR, TerraSAR-X, ALOS/PALSAR, crustal movement