Preliminary building damage mapping following the 2016 Kumamoto Mw7.1 Earthquakes using PALSAR-2 image

Yanbing Bai
Bruno Adriano
Erick Mas
Hideomi Gokon (Univ. of Tokyo)
Shunichi Koshimura
A Mw 6.4 earthquake occurred on April 14, 2016 21:32 (JST) in Kumamoto City, Kyushu Island, Japan. This event was followed by two big aftershocks of Mw 6.4 on April 15, 2016 00:09 (JST) and Mw 7.1 on April 16, 2016 01:30 (JST). It was reported that the latest event generated most of the damage in Kumamoto city and surroundings (1).

The ReGiD Lab. From IRIDeS, Tohoku University in collaboration with JAXA and the University of Tokyo conducted a preliminary building damage estimation using a model that is being developed using only post-event Synthetic Aperture Radar (SAR) images from Katmandu city taken after the 2015 Nepal Earthquake (Bai et al., 2016).

In this preliminary damage assessment, we employed a post-event SAR image captured after the main shock of Mw 7.1 (third significant earthquake) on April 17, 2016. The image from Kumamoto city was acquired by the Advanced Land Observing Satellite 2 (ALOS-2) / L-band Synthetic Aperture Radar (PALSAR-2)

The training data used in the damage estimation model is from Nepal earthquake and they are probably different.

(1)http://irides.tohoku.ac.jp/topics_disaster/2016kumamoto-eq.html
There were 3 big earthquakes starting on April 14. The Mw7.1 generated most of the building damage, and a landslide to the northeast of Kumamoto city.
Methodology for Damage Estimation

Pre-processing
- The PALSAR-2 data was converted from digital number to backscattering coefficient (sigma-naught [dB]) using the equation provided by JAXA website\(^1\). Then, the PALSAR-2 data was filtered using a Lee filter (Lee 1980) using a 3 x 3 pixel window.

Damage estimation
1. We calculated 16 texture parameter based on the Grey-Level Co-occurrence Matrix (Haralick et al., 1973), Gray histogram properties (Anys et al., 1994), and the HH-polarization information.
2. Using the building footprint downloaded from the Geospatial Information Authority of Japan website\(^2\), the average value of each texture parameter is calculated for each building.
3. Finally, using as training sample the damage observed after the 2015 Nepal earthquake, a random forest algorithm (Breiman et al., 2001) was used to classify the building damage into two categories in Kumamoto city.

\(^1\)http://www.eorc.jaxa.jp
\(^2\)http://www.gsi.go.jp
PALSAR-2 Post-event Image (2016/04/17)

- Acquisition mode: StripMap (SM1)
- Ascending Orbit direction (azimuth)
- Right side observation (range)
- HH-polarization
- Data format Level 1.5
- Pixel Spacing: 2.5 m

The PALSAR-2 image was provided by JAXA
The training data used in the damage estimation model is from Nepal earthquake and they are probably different.
Preliminary Building Damage Mapping

Sources: Geospatial Information Authority of Japan, LandScan 2011, Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
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Laboratory of Remote Sensing and Geoinformatics for Disaster Management
International Research Institute of Disaster Science - Tohoku University
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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Laboratory of Remote Sensing and Geoinformatics for Disaster Management International Research Institute of Disaster Science - Tohoku University
Final Comments

- According to the damage estimation, the damage is scattered throughout the Kumamoto city.

- To verify the estimation, survey photos were used as ground truth data (GTD). While some locations where the model detected damage agree with the GTD, other buildings that were actually damaged were not detected by the model.

- The estimation is expected to improve when local training data is used. For preliminary assessment Nepal earthquake data was used as the training data even though building characteristics may differ from the ones in Japan.

Acknowledgement

ALOS-2/PALSAR-2 image is owned by JAXA, and the dataset was provided by JAXA. Survey photos were provided by Dr. Hideomi Gokon from the University of Tokyo.