8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

GROUND DISPLACEMENT AND BUILDING DAMAGE ESTIMATION OF THE 2017 KERMANSHAH EARTHQUAKE USING SAR REMOTE SENSING

Sadra KARIMZADEH
Assistant Professor, University of Tabriz, Iran
sa.karimzadeh@tabrizu.ac.ir

Masashi MATSUOKA
Professor, Tokyo Institute of Technology, Tokyo, Japan
matsuoka.m.ab@m.titech.ac.jp

Keywords: Seismic displacement, Kermanshah earthquake, Sentinel-1, ALOS-2, InSAR

We used two synthetic aperture radar (SAR) datasets with different resolution to monitor the Kermanshah earthquake displacements and the buildings in Sarpol-e Zahab town. We have obtained two high resolution dual-polarized (HH and HV) ALOS-2 images in stripmap (SM) mode and three dual-polarized (VV and VH) Sentinel-1 images in interferometric wide (IW) mode from ascending orbits. The incidence angle of ALOS-2 and Sentinel-1 datasets were 36.2° and 38.9°, respectively. Temporal baseline of ALOS-2 dataset is 42 days, whereas pre-event and co-seismic temporal baselines of Sentinel-1 dataset are 13 and 18 days, respectively. Human activities after disasters increase and deteriorate the damage proxy maps which sometimes make the damage proxy maps meaningless. Thus, we need post-event images with shortest gaps with the event. Since the revisit cycle of ALOS-2 is rather large, we only use two ALOS-2 images to calculate ground displacement (Figure 1); proxy maps were calculated from Sentinel-1 dataset (Figure 2).

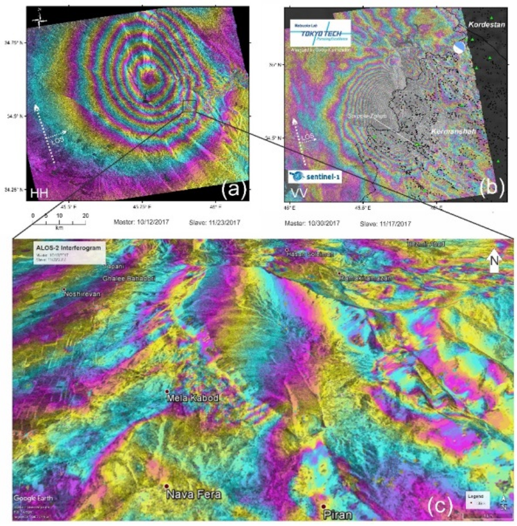

Figure 1. (a) and (b) Wrapped interferforgrams of ALOS-2 and Sentinel-1 in HH and VV polarization, respectively; each fringe shows 12 cm and 3 cm displacement in ALOS-2 interferogram and Sentinel-1 interferogram, respectively. (c) Location of the Mela Kabod landslide and its phase changes.

We calculated ground displacement map of the earthquake using Interferometric Synthetic Aperture Radar (InSAR) method for two ALOS-2 images (2017/10/12 and 2017/11/23) with spatial resolution of 10 m and two Sentinel-1 images (2017/10/30 and 2017/11/17). The InSAR results showed about 85 cm movements in south west of the fault in the line-of-sight (LOS) of the satellite, also the results indicate major triggered slips such as landslides (e.g. Mela Kabod landslide) in the ground surface, where two SAR signals cannot interfere with each other and looks like "sprayed sands" (Figure 1).

Surficial movements related with the earthquake are observed in both interferograms, but the main rupture probably happened at depth. We also used backscattering coefficient and phase correlation (coherence) as two indices for change mapping over town of Sarpol-e Zahab (Karimzadeh and Matsuoka, 2017; Karimzadeh et al., 2018]. As mentioned, due to larger latency of ALOS-2 data, only multitemporal proxy map from Sentinel-1 dataset is calculated. Due to complex behavior of the backscattering coefficient, the building classification was not reliable. Thus, by combining RGB visualization and coherence values, we provided a change proxy map of buildings in Sarpol-e Zahab. We applied a methodology based on a normalized RGB color composition for the produced InSAR phase correlation maps (coherence), in which subtraction of pre-event and co-seismic coherence represents the red band, subtraction of co-seismic and pre-event coherence represents the green band and the mean coherence value of pre-event and post-event images are in blue band. Figure 2 shows that majority of buildings in three parts of the town were severely damaged. Majority of new government-built buildings are located in NW Sarpol-e Zahab. These buildings are almost new, but due to non-engineered walls they were not able to resist against the severe seismic activity. On the other hand, the site condition was soft due to replacement of refilled soil after Iran-Iraq war. In central and SW parts of the town, the main reason of severe damage is type of buildings that the buildings were almost old and the material used in these houses were mainly stone and brick. Second reason is the proximity of these buildings to the agricultural lands which are formed by soft soil as well. Since the building inventory of the town was not available, we validated the results of building condition with a damage map create by optical imagery by UNITAR. Based on optical images, more than 600 individual buildings (yellow circles in Figure 2) are damaged in the town. In order to do a fair validation between SAR and optical results, we chose randomly 50 collapsed and intact buildings and calculated their multitemporal differential coherence and relative standard deviations. The results show that differential coherence value from red band is higher among collapsed buildings (Figure 2).

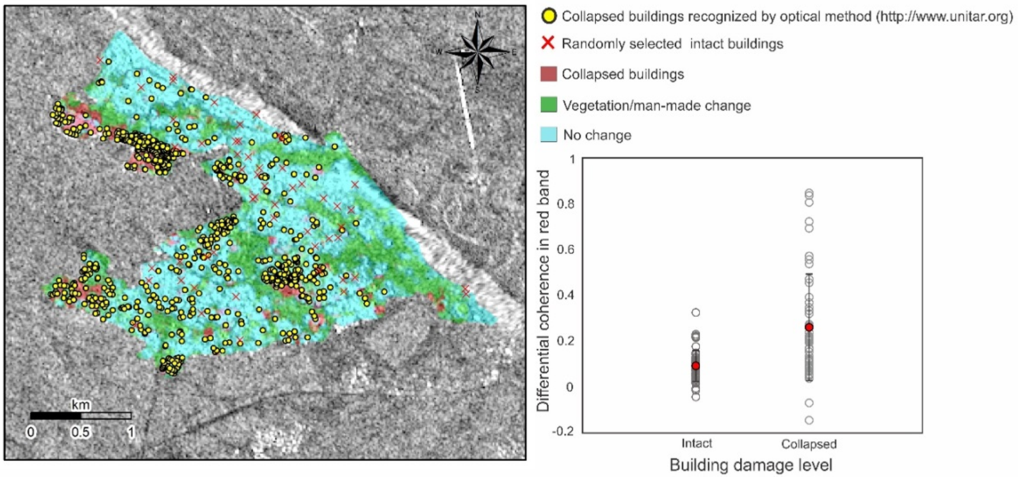

Figure 2. Left: RGB change map of Sarpol-e Zahab together with collapsed buildings from UNITAR. Right: Differential coherence values (gray circles) between 50 randomly selected collapsed buildings and 50 randomly selected intact buildings over Sarpol-e Zahab. Red circles are mean values of each category and black bars are standard deviations.

REFERENCES

Karimzadeh, S. and Matsuoka, M. (2017). Building damage assessment using multisensor dual-polarized synthetic aperture radar data for the 2016 m 6.2 Amatrice earthquake, Italy. *Remote Sensing*, *9*, 330.

Karimzadeh, S., Matsuoka, M., Miyajima, M., Adriano, B., Fallahi, A., and Karashi, J. (2018). Sequential SAR coherence method for the monitoring of buildings in Sarpole-Zahab, Iran. *Remote Sensing*, 10, 1255.

Shelters and people gathering sites areas in Sarpol-e Zahab (North of Sarpol City), Kermanshah, Iran, http://www.unitar.org/unosat/node/44/2745?utm_source=unosatunitar&utm_medium=rss&utm_campaign=maps.