Analyzing Pre- and Post-Earthquake Changes using Optical and SAR Satellite Images

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Abstract. On 28 September 2018, a magnitude of 7.5, shallow earthquake struck in the Central Sulawesi, Indonesia, located 77km away from the provincial capital Palu. A localized tsunami hit Palu after the mainshock, this worldwide deadliest earthquake in 2018 led to the deaths of an estimated 4,340 people. The impact area surrounding the Palu region had been measured using pre- and post-disaster satellite images in this paper, including SAR images of Sentinel 1A taken on July 7 and Oct. 5, and optical images of Sentinel 2 taken on Sep. 27 and Oct. 2, 2018. The results for three test regions show that the changed area approached to 171.83, 126.8, and 26.6 ha, respectively. The phenomenon of soil liquefaction caused by the earthquake can be estimate clearly by the multi-temporal polarimetric synthetic aperture radar images.

1 STUDY AREA

On 28 September 2018, a magnitude of 7.5, shallow earthquake struck in the Central Sulawesi, Indonesia, located 77km away from the provincial capital Palu. A localized tsunami hit Palu after the mainshock, this worldwide deadliest earthquake in 2018 led to the deaths of an estimated 4,340 people. There are five regions, i.e. region A-E are analyzed separately in this work shown as Fig. 1.

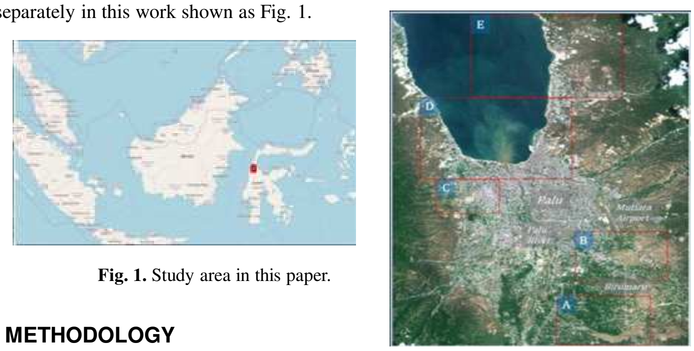

Fig. 1. Study area in this paper.

2 METHODOLOGY

2.1 Experimental data

In this study, synthetic aperture radar (SAR) images of the satellite Sentinel-1A (spatial resolution = 20 m in interferometric-wide swath mode) taken on July 7 and Oct. 5, and optical images of Sentinel 2 taken on Sep. 27 and Oct. 2, 2018 were used to analyze the impact area surrounding the Palu region. Sentinel-1 is the first satellite constellation that the European Space Agency (ESA) developed per the Copernicus Initiative, aiming for the provision of information services in relation to ecology and security. It consists of two polar orbiting satellites, which enable it to obtain C-band (microwave frequencies 4—8 GHz) SAR images at any time of the day.

2.2 Data processing

In the study, Sentinel-1 SAR data processing was performed using the open software tool SNAP to produce a terrain corrected and backscattering coefficient corrected radar image [3]. Although the VH polarization has excellent characteristics in the scattering of vegetation, but the surface characteristics of the water are weaker than VV. So the VV polarized image is based on the surface scattering characteristics of the flooding surface is relatively better than the VH polarization [4]. Meanwhile a de-Speckle filter processing module is used to reduce speckle noises what is quite often occurred in the radar images, let the characteristic signals of ground targets recovered back. Moreover, the change detection analysis on the VV polarized image is performed when the signal is lowered by 6 dB as the threshold value. By the way, Sentinel-2 optical image data also conducted to compute the NDVI results for the pre- and post-disaster. Then the NDVI change detection analysis was performed using an NDVI threshold.

3 RESULTS ANALYSIS

Two Sentinel-1A SAR images taken on July 7 and Oct. 5, and optical Sentinel-2 images taken on Sep. 27 and Oct. 2, 2018 are used in this study. According to above mentioned data analysis procedures, the results for test region A, B, and C are shown as Fig. 2, Fig. 3, and Fig. 4, respectively. For example the false colour composite map of the VV polarized results before and after the disaster for the region A is shown as Fig. 3(d) (bottom right), which can quickly delineate the major variation area. The result overlaid with natural colour images derived from Sentinel-2 images to visually recognize flooding area shown as Fig. 3(a) and Fig. 3(b) (top-left and top-right ones). Finally, the analysis results indicate that the changed area for three regions approached to 171.83, 126.8, and 26.6 ha, respectively. All analysis results for pre- and post-disaster had been published on a risk mapping cloud plateform, named Hogazai. Hogazai's (https://www.facebook.com/HogazaiRiskMap) philosophy is to pursue a complex technology and profession, through intelligent and automated means, to quickly produce information, while at the same time making it easy for readers to understand in a simple way [5].

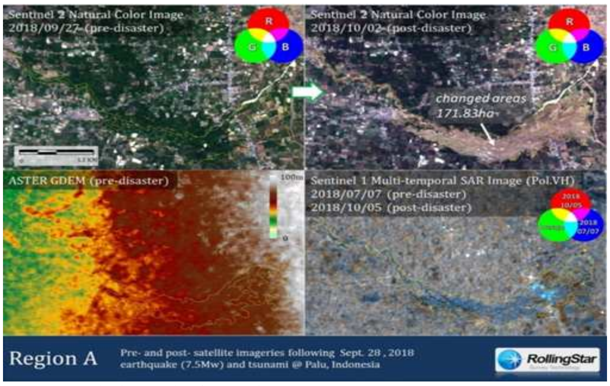

Fig. 2. Analysis results for Region A.

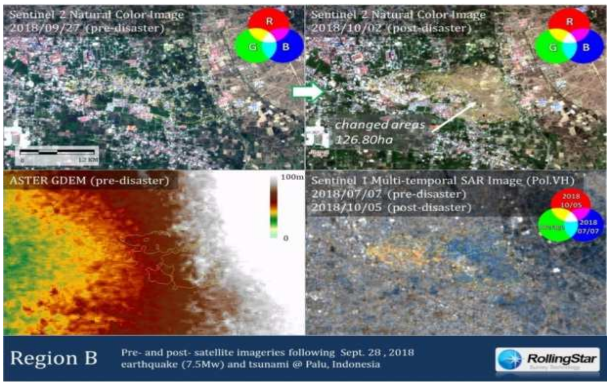

Fig. 3. Analysis results for Region B.

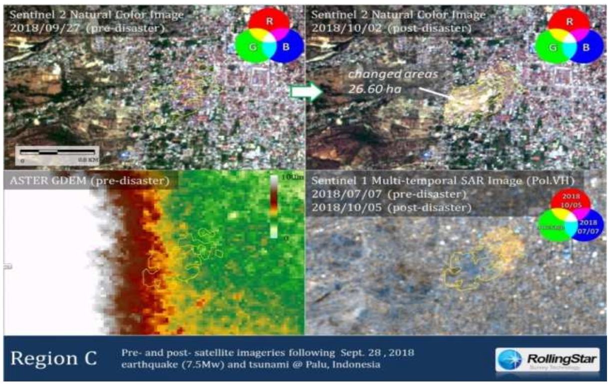

Fig. 4. Analysis results for Region C.

3 CONCLUSIONS AND SUGGESTIONS

The impact area surrounding the Palu region had been measured using pre- and post-disaster satellite images in this paper, including SAR images of Sentinel 1A taken on July 7 and Oct. 5, and optical images of Sentinel 2 taken on Sep. 27 and Oct. 2, 2018. The results for three test regions show that the changed area approached to 171.83, 126.8, and 26.6 ha, respectively. The phenomenon of soil liquefaction caused by the earthquake can be estimate clearly by the multi-temporal polarimetric synthetic aperture radar images and optical satellite images.

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