Disaster mapping from medium spatial resolution ALOS PALSAR images

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Abstract:

Synthetic Aperture Radar (SAR) has the advantages of all-day and all-weather, multi-polarization and long-range propagation characteristics. SAR instrument can measure both intensity and phase of the reflected signal. In the past decades, SAR has been widely used in environmental monitoring, earth-resource mapping, and disaster mapping (Massonnet et al., 1993; Ozawa et al., 1997; Rosen et al., 1999).

The backscattering coefficients measured by SAR reflect the backscatter characteristics of surface targets. Changes happened to a target's surface roughness, geometric and structural characteristics will result in the change of its backscattering intensity recorded in SAR image. The 2008 Wenchuan earthquake, China have caused widely distributed geological disasters, such as landslides and barrier lakes, which resulted in the difference between pre- and post-event SAR images. Comparison between the pre- and post-event SAR intensity images will reveal the damage information. In this study, PALSAR Level 1.0 data acquired before and after the Wenchuan earthquake were used to analyze the geological disasters.

Methods

PALSAR Level 1.0 FBS data was the raw data of fine-beam single-polarization mode (HH) image. The PALSAR Level 1.0 data used in this study were listed in table 1. The PALSAR data were processed using Gamma MSP to produce a single-look complex (SLC) and multi-look intensity (MLI) images. The data were processed using a range-Doppler algorithm including secondary range migration (Werner and Wegmüller, 2006). The antenna pattern provided by JAXA was used for radiometric calibration to derive backscattering coefficient sigma nought (σ^0) which is usually expressed in dB. This permits to minimize the differences in the image radiometry and to make any SAR images obtained from different imaging geometries easily comparable and compatible to acquisitions made by different sensors (Infoterra GmbH, 2008). Finally, the multi-look intensity images were terrain corrected and geocoded using SRTM DEM data.

Table 1 SAR data review

Data type	Spatial resolution (m)	Polarization	Acquisition date
PALSAR FBS 1.0	10	HH	February 17, 2008
PALSAR FBS 1.0	10	HH	May 19, 2008

To compare the pre- and post-event acquisition data, an image co-registration process with high accuracy is needed. The two images were fine co-registered using affine geometric correction based on ground control points (GCPs) selected from image to image. The differential backscattering intensity image was calculated from pre- and post-event images using equation (1)

$$d_{i,j}[dB] = \sigma^0_{i,j\ post}[dB] - \sigma^0_{i,j\ pre}[dB] \quad (i=1,\ 2\ \ldots L,\ j=1,\ 2\ \ldots M) \tag{1}$$

where $d_{i,j}$ = pixel value to dB of differential backscattering intensity image at image line i and column j,

$\sigma^0_{i,j\ post}$ = sigma naught σ^0 of post-event backscattering intensity image at image line i and column j.

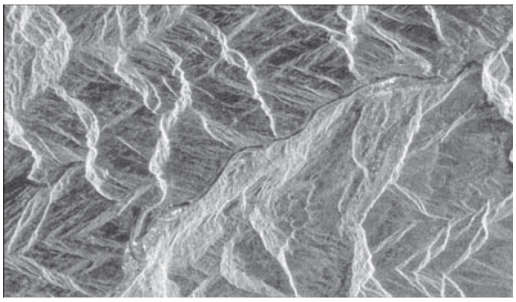
$\sigma^0_{i,j\ pre}$ = sigma naught σ^0 of pre-event backscattering intensity image at image line i and column j,

L, M=number of lines and columns in the product.

In this study, differential and false color composition methods were used to highlight the geological disasters of landslides and barrier lakes.

Results

Fig. 1 shows the Terrain corrected and geocoded backscattering coefficient images of PALSAR. Fig. 2 shows the differential backscattering intensity image of PALSAR between pre- and post-event images, where landslides were highlighted as bright areas and barrier lakes were highlighted as dark areas along the river. Fig. 3 shows the false color composition image of pre- and post-event backscattering intensity image of PALSAR, where landslides were highlighted as green areas and barrier lakes were highlighted as purple areas along the river



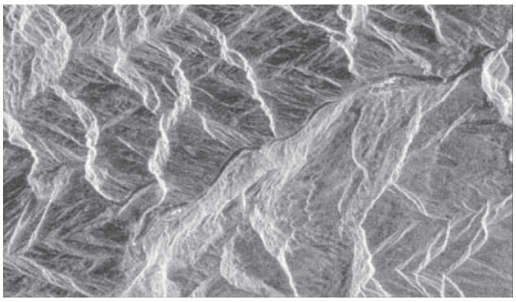


Fig. 1 Terrain corrected and geocoded backscattering coefficient images: (a) pre-event backscattering intensity image of PALSAR acquired on February 17, 2008; (b) post-event backscattering intensity image of PALSAR acquired on May 19, 2008.

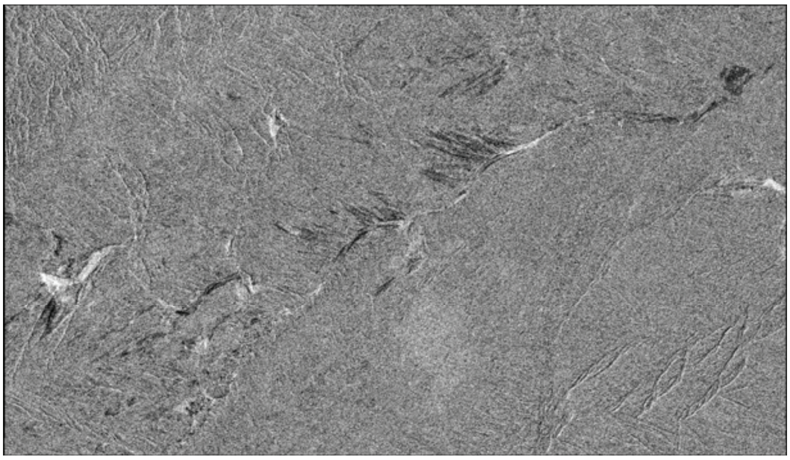


Fig. 2 Differential backscattering intensity image of PALSAR between pre- and post-event images.

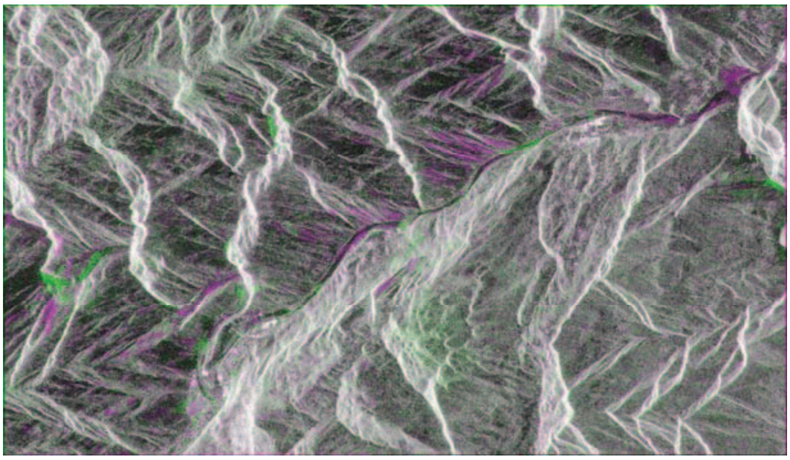


Fig. 3 False color composition image of pre- and post-event backscattering intensity

image of PALSAR, R, B= pre-event backscattering intensity image of PALSAR acquired on February 17, 2008, G= post-event backscattering intensity image of PALSAR acquired on May 19, 2008.

Conclusion

The results show that medium spatial resolution SAR data, such as 10 m resolution ALOS PALSAR data, especially when both pre- and post-event images are available, was useful in revealing the distribution of landslides and barrier lakes. The landslides showed stronger backscattering intensity, while barrier lakes showed lower backscattering intensity.

References

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