

Identifying Temporal Change of Merapi Eruption Type by Satellite SAR Data Analysis

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Abstract:

Mt. Merapi in Indonesia is known to be one of the most active and dangerous volcano in the Torrid Zone. It has frequently erupted and produced pyroclastic flows following the collapse of the summit lava dome. However, distribution patterns of the pyroclastic flow deposits accompanied with the eruptions have not been clarified in detail. For this problem, we used ten Synthetic Aperture Radar (SAR) data acquired by JERS-1 and RADARSAT-1 satellites during April 1996 to June 2006, which allowed to observe Mt. Merapi regardless of the weather conditions and the sun illumination.

A Temporal Arithmetical Calculation successfully extracted the pyroclastic flow deposits from the SAR intensity and brightness images, which highlighted the temporal changes in the extents of the deposits, travel distance, and flow direction. A low-level feature extraction of binary images could identify the boundary of pyroclastic deposits for each eruption. This method uses a region descriptor that measures its geometric scalar properties. In general, the area of a region in the plane, $A(S)$, is defined as:

$$A(S) = \iint_{x y} I(x, y) dy dx \quad (1)$$

where $I(x, y) = 1$ if the pixel is within a shape, $(x, y) \in S$, and 0 otherwise. The center gradient of the pyroclastic flows was obtained by vectorizing the detected boundary image. Thus, two simple linear equations are derived for these vector data and the gradient of each flow is defined by averaging two boundaries for the flow deposits.

The extents of the deposits and the travel distances were variable with the eruptions, while the flow direction had a constant pattern in that they rotated clockwise from the south toward the west (Fig. 1). This result coincided with the historical eruptions of Mt. Merapi where the conduit location can change; therefore a new dome, which is associated with the pyroclastic flows, will threaten a different zone from the previous eruptions.

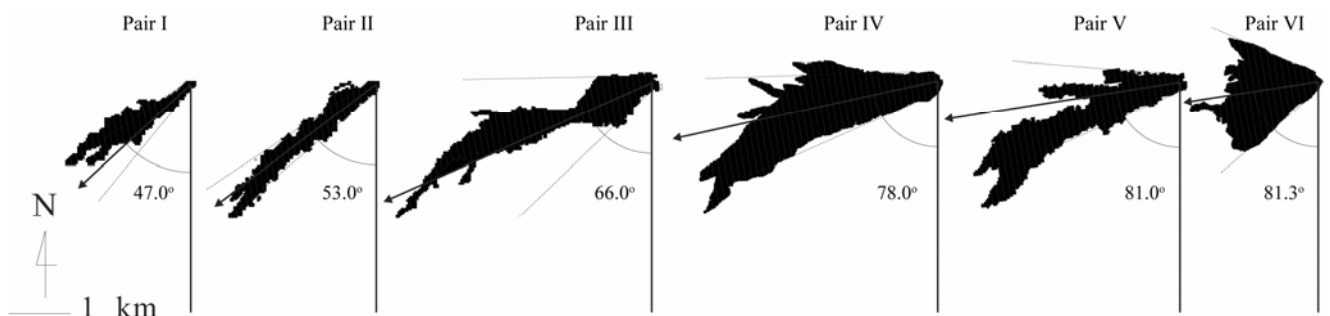


Fig. 1 Distributions of pyroclastic flow deposits extracted from the SAR data pair.