

Intisari

Gunung Semeru merupakan gunung api aktif di Jawa Timur dengan karakteristik erupsi strombolian-vulkanian yang terjadi hampir setiap hari. Tingginya frekuensi aktivitas vulkanik ini memerlukan sistem pemantauan perubahan elevasi yang berkelanjutan. Metode konvensional berbasis terestris seperti *total station* dan GNSS bisa diaplikasikan, namun sering tidak dapat digunakan, terlebih pada saat terjadi letusan besar yang menghalangi akses atau sensor terpasang rusak. Oleh karena itu, digunakan metode *Differential Interferometric Synthetic Aperture Radar* (DInSAR) sebagai metode alternatif yang dapat bekerja tanpa kehadiran langsung di lapangan dan tidak bergantung pada kondisi cuaca. Penelitian ini diharapkan bisa menganalisis perubahan elevasi permukaan Gunung Semeru akibat erupsi 19 November 2025 menggunakan metode DInSAR berbasis data Sentinel-1.

Data yang digunakan adalah dua pasang citra Sentinel-1A Level-1 *Single Look Complex* (SLC) mode *Interferometric Wide* (IW), terdiri atas pasangan orbit *ascending* (23 Oktober-28 November 2025) dan orbit *descending* (31 Oktober-6 Desember 2025). Penggunaan orbit *ascending* dan *descending* digunakan untuk membandingkan hasil lintasan yang memberikan representasi perubahan elevasi paling optimal. Pengolahan dilakukan menggunakan perangkat lunak SNAP 11 melalui tahapan pembentukan interferogram, *Goldstein Phase Filtering*, dan *phase unwrapping* menggunakan algoritma SNAPHU. Nilai *displacement* LOS kemudian dikonversi menjadi perubahan elevasi vertikal menggunakan sudut datang radar (*incidence angle*) masing-masing orbit.

Hasil penelitian menunjukkan konsistensi yang tinggi antara kedua orbit. Nilai rentang *displacement* LOS maksimum berkisar antara +0,6 cm hingga -11,3 cm untuk orbit *ascending*, dan +5,7 cm hingga -10,9 cm untuk orbit *descending*. Nilai positif menunjukkan pergerakan permukaan yang mendekati sensor, sedangkan nilai negatif menunjukkan pergerakan yang menjauhi sensor satelit. Selisih 0,35 cm pada zona deflasi kawah dan 0,04 cm pada zona inflasi lereng. Setelah konversi ke komponen vertikal, diperoleh estimasi perubahan elevasi maksimum sebesar -11,2 cm di kawah Jonggring Saloko akibat pengosongan *conduit* pasca-erupsi, serta perubahan elevasi maksimum sebesar 1,0 cm di jalur aliran Besuk Kobokan yang merepresentasikan akumulasi material vulkanik baru. Validasi dilakukan secara kualitatif terhadap kesesuaian lokasi, bukan terhadap besaran nilai elevasi, melalui *overlay* pada citra Google Earth Pro dan laporan PVMBG yang mencatat aliran awan panas guguran sejauh 13,2 km ke arah tenggara mendukung kesesuaian dari hasil estimasi.

Kata Kunci: Gunung Semeru, Sentinel-1, DInSAR, Perubahan Elevasi, *Ascending*, *Descending*

Abstract

Mount Semeru is an active stratovolcano located in East Java, characterized by Strombolian-Vulcanian eruptive activities that occur almost daily. This high frequency of volcanic activity necessitates a continuous elevation change monitoring system. Conventional terrestrial-based methods, such as total stations and GNSS, can be applied, but they are often restricted during major eruptions due to hazardous access or physical damage to the installed sensors. Therefore, the Differential Interferometric Synthetic Aperture Radar (DInSAR) method is utilized as an alternative approach capable of operating without direct field presence and independent of weather conditions. This study aims to analyze the surface elevation changes of Mount Semeru caused by the November 19, 2025, eruption using the DInSAR method based on Sentinel-1 data.

The data used in this study consist of two pairs of Sentinel-1A Level-1 Single Look Complex (SLC) images in Interferometric Wide (IW) mode, comprising an ascending orbit pair (October 23–November 28, 2025) and a descending orbit pair (October 31–December 6, 2025). The utilization of both ascending and descending orbits serves to compare which flight path provides the most optimal representation of elevation changes. Data processing was conducted using SNAP 11 software through several stages, including interferogram formation, Goldstein Phase Filtering, and phase unwrapping utilizing the SNAPHU algorithm. The Line of Sight (LOS) displacement values were subsequently converted into vertical elevation changes using the radar incidence angle of each respective orbit.

The results demonstrate high consistency between the two orbits. The maximum LOS displacement range varies from +0.6 cm to -11.3 cm for the ascending orbit, and +5.7 cm to -10.9 cm for the descending orbit. Positive values indicate surface movement toward the sensor, whereas negative values represent movement away from the satellite sensor. A difference of 0.35 cm was observed in the crater deflation zone, and 0.04 cm in the slope inflation zone. Following the conversion to the vertical component, the estimated maximum elevation change was determined to be -11.2 cm at the Jonggring Saloko crater, resulting from post-eruption conduit emptying, and a maximum elevation change of 1.0 cm along the Besuk Kobokan path, representing the accumulation of new volcanic materials. Visual validation through overlaying onto Google Earth Pro and reports from the PVMBG, which recorded pyroclastic density currents extending up to 13.2 km toward the southeast, support the reliability and consistency of the estimated results.

Keywords: Mount Semeru, Sentinel-1, DInSAR, Elevation Change, Ascending, Descending.