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Ground deformation associated with the eruption of Lumpur Sidoardjo mud volcano, eastern Java island

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Mud volcanism is a process that drives the extrusion of materials in the sediment to the surface. While it shares common features with magmatic eruptions; for example, eruption of mud volcanoes often results in elongated calderas and aligned vents. However, the mechanics of mud volcanism is not fully understood because of the rare occurrence. Here we take an advantage of observing ongoing eruption in Lumpur Sidoarjo (LUSI) mud volcano, eastern Java island, to gain insights into the mechanics of mud volcanism. LUSI has been erupting since May 2006 and released more than 12 million cubic meter of mud so far, buried some 20 square kilometers and forced 8000 people to evacuate.

We delineated the temporal evolution of ground deformation from Synthetic Aperture Radar images taken from the ALOS satellite. We processed a total of 93 images from two ascending and three descending images between May 2006 and April 2011 using the StaMPS software (Hooper, GRL, 2008) to obtain the displacement time series of persistent scatterers.

Although we were not able to obtain the time series in areas near the center of activity due to the lower coherence resulting from the mudflow, we observed an extension of line-of-sight (LOS) distance by a total of up to 200 millimeters within a few kilometers from the activity center from both ascending and descending images. This indicates that the deformation around the center of activity is dominated by subsidence. We also found an area of subsidence with a similar or even larger rate extending to the west of the activity center. This indicates that the depressurization beneath the activity center is not the only mechanism to cause this eruption but we need to consider another source to explain the observed displacement field. We also found a LOS shortening to the north of the activity center only from ascending images. This indicates an uplift and westward displacement in this area.

Despite the decreasing rate of gas emission, our time series analysis shows that the deformation is quasi-linear during the time of the analysis. This suggests that the source of deformation has been stationary over time and and also it will a take long time for this eruption to cease.