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Investigating external perturbations for the Lusi mud eruption, NE Java, Indonesia

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In May 2006, several aligned mud eruptions appeared in northeast Java (Indonesia). The most prominent eruption site was named Lusi and it has been active ever since erupting gas, mud, rocks, and water. Since its inception Lusi has a geysering behaviour displaying more powerful events of enhanced gas and mud discharge occurring every ∼30 minutes. The overall flow rate has been irregular through time reaching peaks up to 180,000 m3/day during the early phases, and occasionally decreasing to less than 20,000 m3/day in other periods. At the end of 2017 the flow rate reached 140,000 m3/day revealing that high overpressure is still present at depth to fuel the eruption site. Sudden flow rate increase are often followed by a steady decrease showing that Lusi is a highly unstable system in critical conditions potentially susceptible to external perturbations.
In order to investigate the dynamics controlling the eruption behaviour, more than 10 years of monitored flow rate have been correlated with the earthquakes with magnitude > 3.3 occurring in the central-eastern sector of the Java Island during the same time period.
A preliminary cross correlation analysis was performed between the two time series in order to investigate if the stress change linked to the earthquakes can induce a variation in the flow emission rate.
Both flowrate and seismic events time series were divided in three components: trend, seasonality and random error. Overall the flow rate shows a general decreasing trend from 2006 up to the end of 2014, while from 2015 until now the trend has been increasing. A general yearly seasonality can be observed on the detrended flow rate dataset. Similarly the observed earthquakes record shows a fluctuating trend with a general decrease from 2006 up to 2012, followed by a general increase until 2017.
Time series cross-correlation with daily lag highlights a positive correlation between flowrate and the magnitude indicating an increase in flow rate few days after the occurrence of seismic events.