THE PHLEGREAN FIELDS CALDERA: A HISTORY OF DEFORMATION

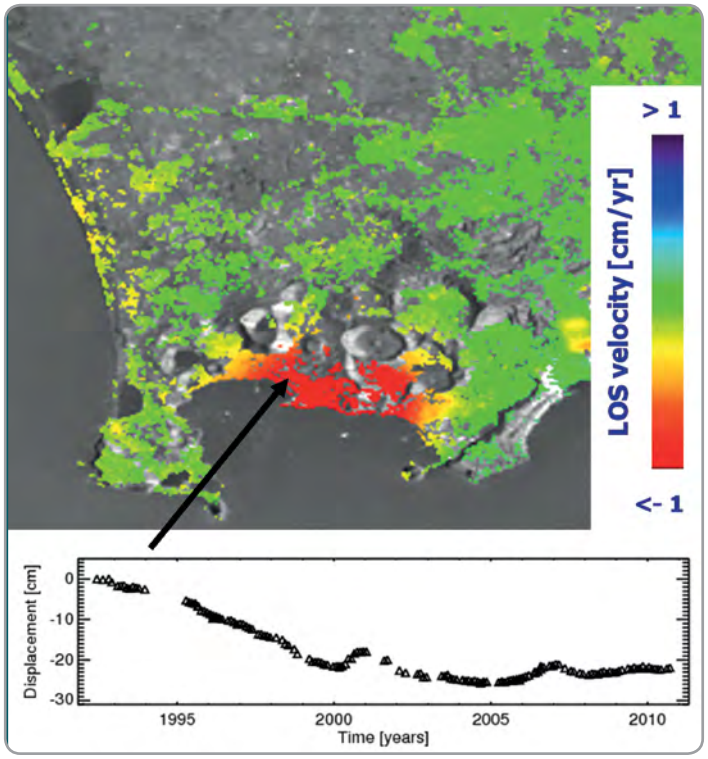
The deformation history of the Phlegrean Fields volcano imaged through ESA and Copernicus satellites.

The challenge

Located west of the densely populated city of Naples (Italy), the Phlegrean Fields caldera is one of the most dangerous volcanoes in the world. The caldera is the result of two major eruptions, which occurred approximately 37 ka and 12 ka ago, respectively. Starting from the end of the 1960's, the caldera has experienced rapid, large amplitude uplift episodes followed by long-term subsidence. In particular, during the 2012–2013 interval, the caldera has shown a rapid uplift of about 11 cm. This event led the Italian Civil Protection Department (DPC) to increase the monitoring activities to the level 2 in a range of 4 (where 4 represents the maximum alert). Accordingly, to keep one of the areas with the highest volcanic risk in the world under control, one of the greatest challenges is the continuous monitoring of several volcano parameters and, amongst others, the surface deformation.

The space based solution

Differential SAR Interferometry (DInSAR) is a well-established microwave remote sensing technique that, by exploiting two SAR images acquired at different times, allows estimation of ground deformation that has occurred between the two acquisitions with centimetre to millimetre accuracy. Therefore, by using DInSAR, it is possible to detect and monitor any kind of deformation on Earth surface, such as the one induced by earthquakes, landslides and volcanoes, as in the case of the Phlegrean Fields. DInSAR clearly benefits from the availability of long-time SAR archives, because of the possibility to follow the evolution of the ground deformation. The figure above shows the mean deformation velocity map generated on Phlegrean Fields by exploiting the ESA ERS and ENVISAT SAR data acquired since 1992 and 2002, respectively. The plot of the displacement time series shows the evolution of the deformation of the caldera and clearly demonstrates the importance of disposing of long-term SAR archives for monitoring high risky areas. It is indeed worth noting that the current DInSAR scenario is characterised by the huge availability of SAR data acquired by several satellite constellations. In particular, starting from 2014, the Copernicus Sentinel-1 (S1) satellites are supplying a massive SAR data flow thanks to their global coverage acquisition strategy. S1 constellation consists of 2 fully operational satellites and acquires new data, on land, every 6 days with the Interferometric Wide Swath mode, which guarantees a very large footprint and is specifically devoted to DInSAR applications. As an example of the S1 potential, the figure below shows the deformation in the 2014–2018 period measured at Phlegrean Fields, which experienced a resumption of the uplift.



Mean deformation velocity map in satellite Line of sight (LOS) obtained by exploiting ERS/ENVISAT SAR data on Phlegrean Fields from 1992 to 2010.

Thematic Area: CIVIL PROTECTION

Region of Application: CAMPANIA

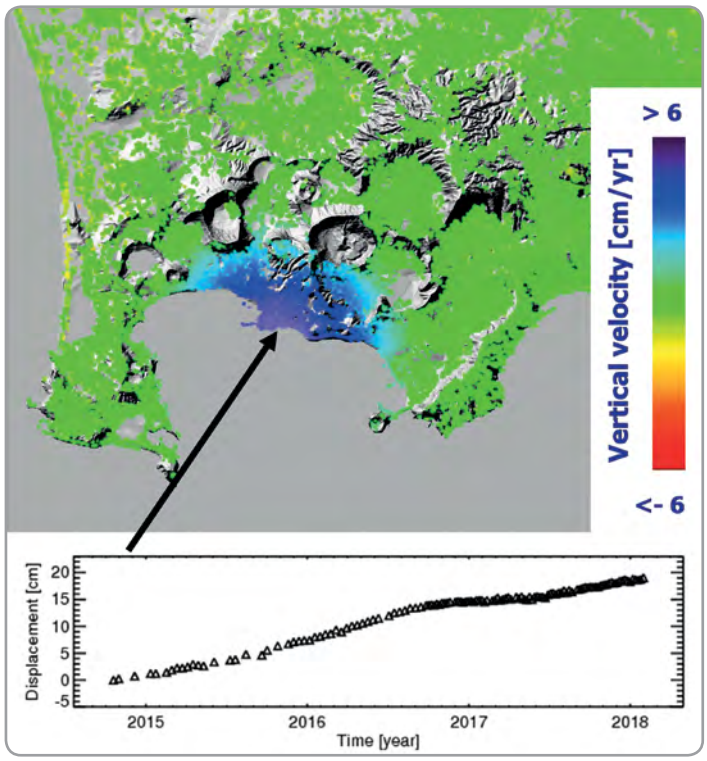
Sentinel mission used: S1

Copernicus Service used: –

Usage Maturity Level: 5

Benefits to Citizens

When a volcano shows new or unusual signs of deformation activity, as for the Phlegrean Fields, monitoring data may help in the assessment and then timely communication of information about the volcanic hazards. CNR-IREA routinely provides the ground deformation measurements derived from S1 data to DPC and the volcano observatory of the National Geophisycs and Volcanology Institute (INGV-OV). Based on the history of the Phlegrean Fields and the analysis of the monitoring data from in-situ and space-borne sensors, the scientists can determine the possible ascent of magma towards the surface. This type of knowledge helps them to figure out the possible types of volcanic activity and the associated hazards to people. This information is crucial for DPC to determine which alerts and policies are needed to prevent loss of life and property.



Vertical deformation velocity map obtained by exploiting Sentinel-1 SAR data on Phlegrean Fields from 2014 to 2018.
Credit: Contains modified Copernicus Sentinel data [2018]

> "Satellite ground deformation measurements provide a useful complement to the in-situ volcano monitoring infrastructures."
>
> ***F. Bianco, INGV-OV***

Outlook to the future

The Copernicus Sentinel programme is a fundamental instrument for natural hazard monitoring, thanks to the free access to a data archive that is routinely acquired at global scale.

Acknowledgements

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ABOUT COPERNICUS4REGIONS

This Copernicus User Story is extracted from the publication "**The Ever Growing use of Copernicus across Europe's Regions: a selection of 99 user stories by local and regional authorities**", 2018, Edited by NEREUS, the European Space Agency and the European Commission.
The model cases focus on local and regional authorities who successfully applied Copernicus data in 8 major public policy domains.
The views expressed in the Copernicus User Stories are those of the Authors and can in no way be taken to reflect the official opinion of the European Space Agency or of the European Commission.
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