



COPERNICUS data and products for Earth monitoring and geophysical processes exploration

The European Union's Earth Observation Programme, Copernicus, provides data, information and services, based on satellite Earth Observation imagery and in situ data. INGV has long experience and practice about Copernicus data, thanks to past and current involvement in EU projects funded in the framework of Copernicus Programme. INGV exploits Copernicus data (e.g. The Sentinels operated by European Space Agency and EUMETSAT), to generate products useful for monitoring purposes, and integrate them with its own ground data network, and expert knowledge, aimed at understanding geophysical processes of our planet. Moreover, INGV, thanks to Copernicus space segment, plays a key role for emergency management especially to address natural hazards and disasters, and provide support to Italian Civil Protection Department.

SAR space geodesy and deformation sources analysis

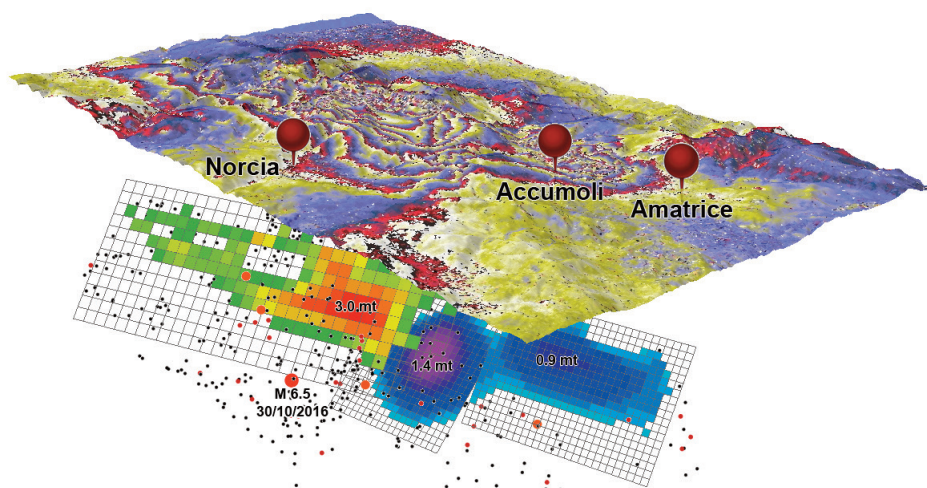
INGV has more than 20 years of experience in the study and analysis of fast (co-seismic & sineruptive) and slow ground deformation. Thanks to Synthetic Aperture Radar (SAR) data and interferometric techniques - InSAR, INGV

researchers can measure not only the amount of induced displacement, and its temporal behaviour, but also estimating the parameters of geophysical sources of the phenomena. INGV knowledge on geology and geophysics allows

exploiting space data to retrieve earthquakes fault model, volcanic magma sources and gravitational displacements, such as landslides and deepseated gravitational slope deformations.

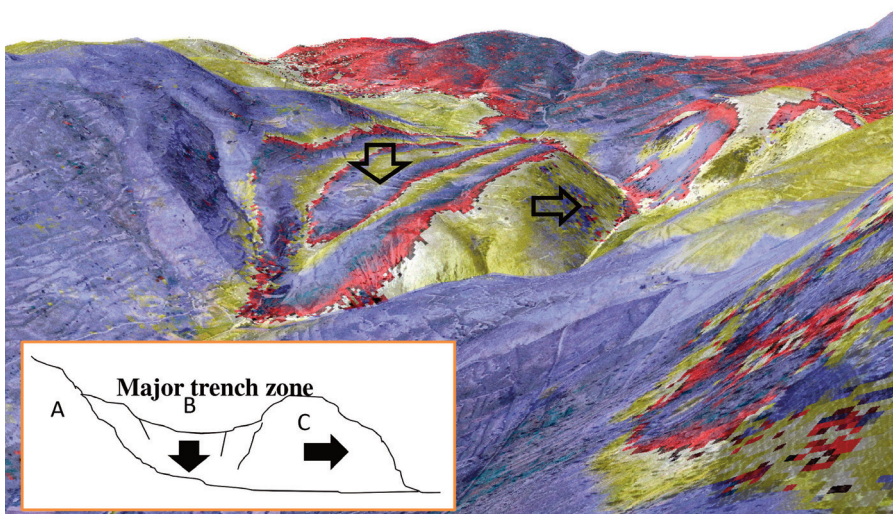
RAPID GROUND MOTION: Coseismic displacement and fault model

SAR data collected by satellite missions are routinely used to map ground displacement induced by earthquakes. The deformation data are also used to estimate the source of the seismic event. INGV modellers invert the interferometric data, jointly with GNSS (when available), to calculate the fault geometry and the slip occurred on the fault plane, which is responsible for the surface effects of the earthquake. The recent earthquakes that hit Central Italy (the Mw 6.0 close to Amatrice and the Mw 6.5 close to Norcia), have been analysed thanks to SAR images acquired by ESA Sentinel-1, JAXA ALOS2, and ASI COSMO Sky-Med datasets.



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RAPID GROUND MOTION: Gravitational deformation mapping

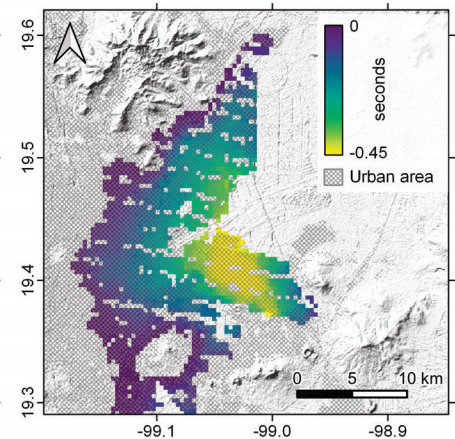
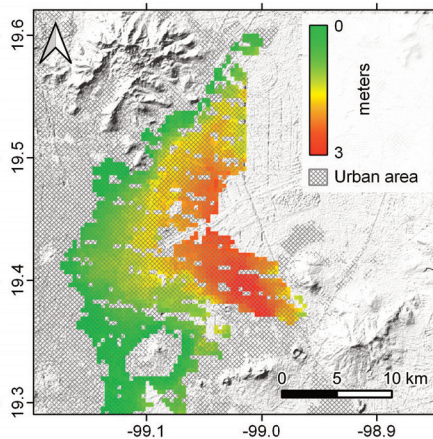
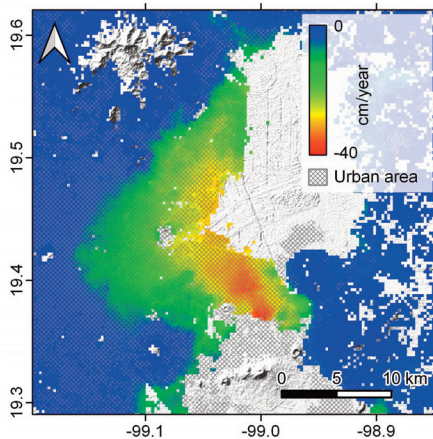
High resolution InSAR is used to identify slope deformations invisible to the human eye which are then thoroughly mapped using other space and ground based-techniques. The high-resolution COSMO-SkyMed interferogram shows the 5 cm ground motion occurred near L'Aquila during the M6.3 earthquake in 2009, when a large part of this rocky slope slide down as a coherent mass without any surface evidence.

SLIDE GROUND MOTION: Subsidence in urban areas

The applications based on multi temporal InSAR, for example Small Baseline Subset (SBAS) or Persistent Scatterer Interferometry (PSI) methods, are used monitor slow deformation processes, especially in urban areas. Multi-temporal InSAR results allow to model soil compaction and water table

changes. The annual rate of soil compaction has been studied in Mexico City and allowed the calculation of the soft-soil thickness changes. Through the modelling of such changes by means of geotechnical data, we can estimate the change in the soft soil resonant period during the observed period,

and consequently infer the changes in the seismic response of the soil for a better characterization of seismic hazard at local scale. Important information can also be gathered about water withdrawal and over exploitation of aquifers that can cause severe damage in urban environments.



Our study on Ciudad Guzman allow the monitoring of creeping phenomenon which produced ground fissuring of about 1.5 km length in the city. The retrieved deformation

time series, by means of multi-temporal InSAR applied to ENVISAT, Sentinel-1, and COSMO Sky-Med images, are used in order to propose a genetic model of the observed deformations

by adopting numerical modelling of the subsidence process, highlighting the role of buried geological structures that controls the spatial arrangements of the deformation.

