



Radar satellites are able to identify millimetre movements of the road surface, which may result from the collapse of the underlying pipeline © Meadowsaffron on foter.com

SATELLITE INFORMATION-AS-A-SERVICE

VINCENZO MASSIMI AND COLLEAGUES PROPOSE A NEW MODEL FOR THE USE OF SATELLITE IMAGERY AND DEMONSTRATE ITS USE IN THE CREATION OF A NEW SERVICE FOR COMPANIES MANAGING INTEGRATED WATER AND SEWAGE NETWORKS

Land and infrastructure monitoring is a key activity to ensure people's safety, environmental protection and the safeguarding of assets at all stages of the lifecycle of infrastructure design, production and management.

However, traditional campaigns for the regular monitoring of large and remote areas require considerable financial resources and time and are often complex to implement. The use of satellite data can overcome these limitations and provide frequent, accurate and accessible information thanks to the wide availability of spatial information.

A great business opportunity comes from the two flagship space programmes of the European Union, Galileo and Copernicus Sentinel, which have been launched and will be completed in the next few years. Galileo is the EU's high-precision GNSS, with 24 operational satellites plus six in-orbit spares. Copernicus is the system for monitoring the Earth, which includes an Earth observation satellite constellation with six satellites missions named Sentinel. The data collected from Sentinel satellites are available as free and open data.

The Sentinel missions carry a range of technologies, such as radar (Sentinel-1) and multi-spectral imaging instruments for land, ocean and atmospheric monitoring (Sentinel-2 and -3). These missions are designed as a two-satellite constellation, where its configuration

optimises coverage, offering a global revisit time ranging from one to six days together with a constant revisiting time.

What makes Copernicus Sentinels data perfect for land and infrastructure monitoring? From the point of view of service providers, features such as the data availability over a long time and worldwide, with scheduled revisit time, low-cost and high-quality of data, which are fundamental characteristics to build services that meet the user's needs in a global market.

A new model

Sentinel satellite data in conjunction with the power of cloud infrastructures provide an unprecedented opportunity to design operational Earth monitoring services, delivered through a geospatial platform. Shifting from the provision of data to the provision of services, intended as continuous access to information for the users, is the key point upon which to build a platform able to meet the real user needs in the big data era.

Shifting from 'on request monitoring services' model to long time information services subscriptions (InfoaaS) is the real disruptive market innovation: users pay for the information not the processing! Delivering accurate, targeted and actionable knowledge, directly

to professionals and decision makers for their operations, the service platform provides continuous monitoring information and geanalytics, enables users to the multiple advantages of satellite-based information, avoiding a number of potential problems, such as internal bureaucracy or a lack of expertise in the management of geospatial data.

Subscribed users receive the information in form of maps, reports, alerts and geospatial indexes, which are dynamically displayed through an intuitive on-line dashboard, on mobile applications or in a machine-to-machine (M2M) way directly in users' applications.

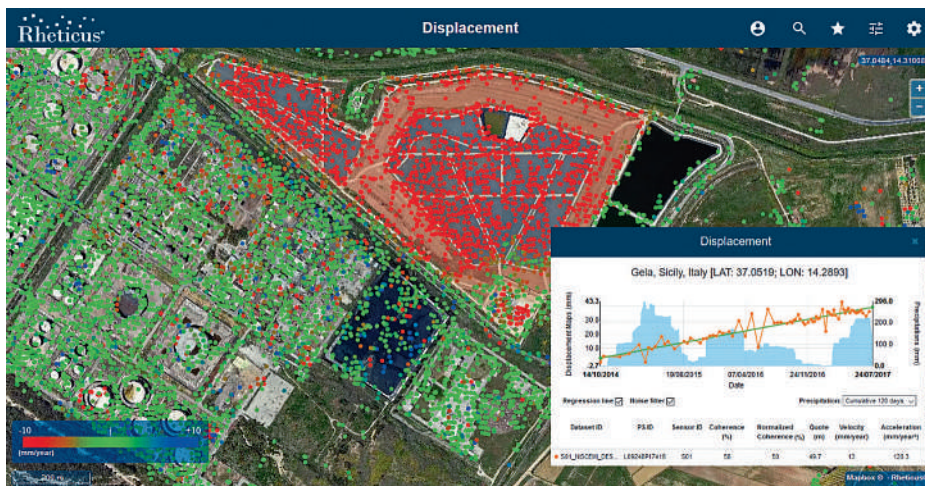
An example of a cloud-based service platform available on subscription is Rheticus (www.rheticus.eu) developed by Planetek Italia. This is an automatic cloud-based geoinformation platform that consumes open data and services such as Sentinel images, weather data and OpenStreetMap. It provides several continuous Earth monitoring services, ranging from the detection and monitoring of geohazards and infrastructural instabilities, to marine water quality monitoring, wildfire detection or land cover monitoring.

Rheticus Displacement is the service devoted to providing continuous monitoring of ground displacements, using Sentinel-1 radar data. The service offers monthly monitoring of millimetric displacements of the ground surface and of infrastructure in areas with active landslide or subsidence. The service also provides information on anthropic changes and infrastructural dynamics over the area where the infrastructure is established. The availability of historical data archives, allows backwards analysis of ground displacements over the time.

The mapping activity is made through the monitoring of points on the ground with high stability called persistent scatterers (PS). The PS are produced through the fully automatic MT-InSAR processing chain based on the SPINUA algorithm ("Stable Point Interferometry even in Un-urbanized Areas") developed by GAP. With the Rheticus Displacement service, it is possible to measure continuously over time the distance between the satellite and the measured point on the ground, recording the time elapsed between the electromagnetic wave emission and reception of the backscattered signal from the ground itself. Thanks to the six days revisiting time of the Sentinel-1 constellation, the service provides the repeated measurements of the sensor-target distance along the satellite's line of sight. A comparison of the distances measured over time allows for the calculation of the displacements of the ground surface with millimetric precision.

In action

The public sewerage network of Milan in Italy runs for approximately 1,500 km over 300 square kilometres. MM SpA, the



Interface of Rheticus Displacement service showing ground surface movements over the Eni refinery in Gela, Italy © Planetek Italia

company managing the integrated water and wastewater services of the city of Milan, had been searching for a method to quickly detect ground surface movements caused by the structural defect/leaks of its collector that could affect the area above the primary network and adjacent areas. The purpose was to prevent damage to surface structures (roads, buildings, services) by detecting the movements underway the effects of which are not yet visible.

Rheticus Displacement, being a service designed for monitoring ground surface movements over time, is considered the most accurate and affordable survey method to prevent and identify possible failures of the sewage system. MM SpA can continuously monitor the stability of the ground displacements that affect the sewer network, measuring millimetric surface deformations based on the six day-revisiting time of the Sentinel-1 data.

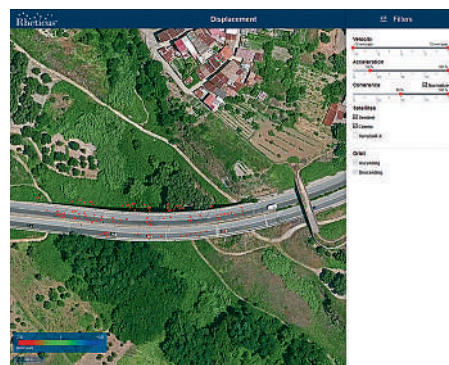
MM SpA is continuously updated about subvertical movements of the soil, which have a high probability of determining collector failure and exacerbating the subsidence.

In the first year of monitoring activities, a large historical Sentinel-1 archive data (from 2014) has been processed, producing more than one million PS. About 50 PS showed sensitive subvertical movements affecting 24 roads. MM SpA reported that 80% of field inspections, which were planned using the information provided by the system, confirmed ongoing issues on the network.

Dynamic and actionable information

The successful experience with MM SpA gave a push to further developments. The Rheticus Displacement service has since been integrated with Hexagon Geospatial's Smart M.App technology to add dynamic analysis and new features to water and sewer networks monitoring.

The result is Rheticus Network Alert, a web tool that helps companies managing integrated water and sewage networks to maintain and inspect these networks. It



Interface of the Rheticus automatic cloud-based geoinformation platform that consume open data and services like Sentinel images, weather data, OpenStreetMap, to enable continuous monitoring of land and infrastructures © Planetek Italia



Dynamic analysis and new features have been added to water and sewer networks monitoring, integrating Hexagon Geospatial's Smart M.App technology © Planetek Italia

identifies up-to-date risks in the network by using satellite data to identify areas of ground instability that could indicate leaking pipes. Operators can quickly determine the locations of concern and act upon the information.

Network Alert provides the level of warning on each pipeline segment, simplifying maintenance activity and inspection priority management.

USERS PAY FOR THE INFORMATION NOT THE PROCESSING!

Vincenzo Massimi, Francesco Coletta, Claudio La Mantia and Sergio Samarelli work at Planetek Italia (www.planetek.it)