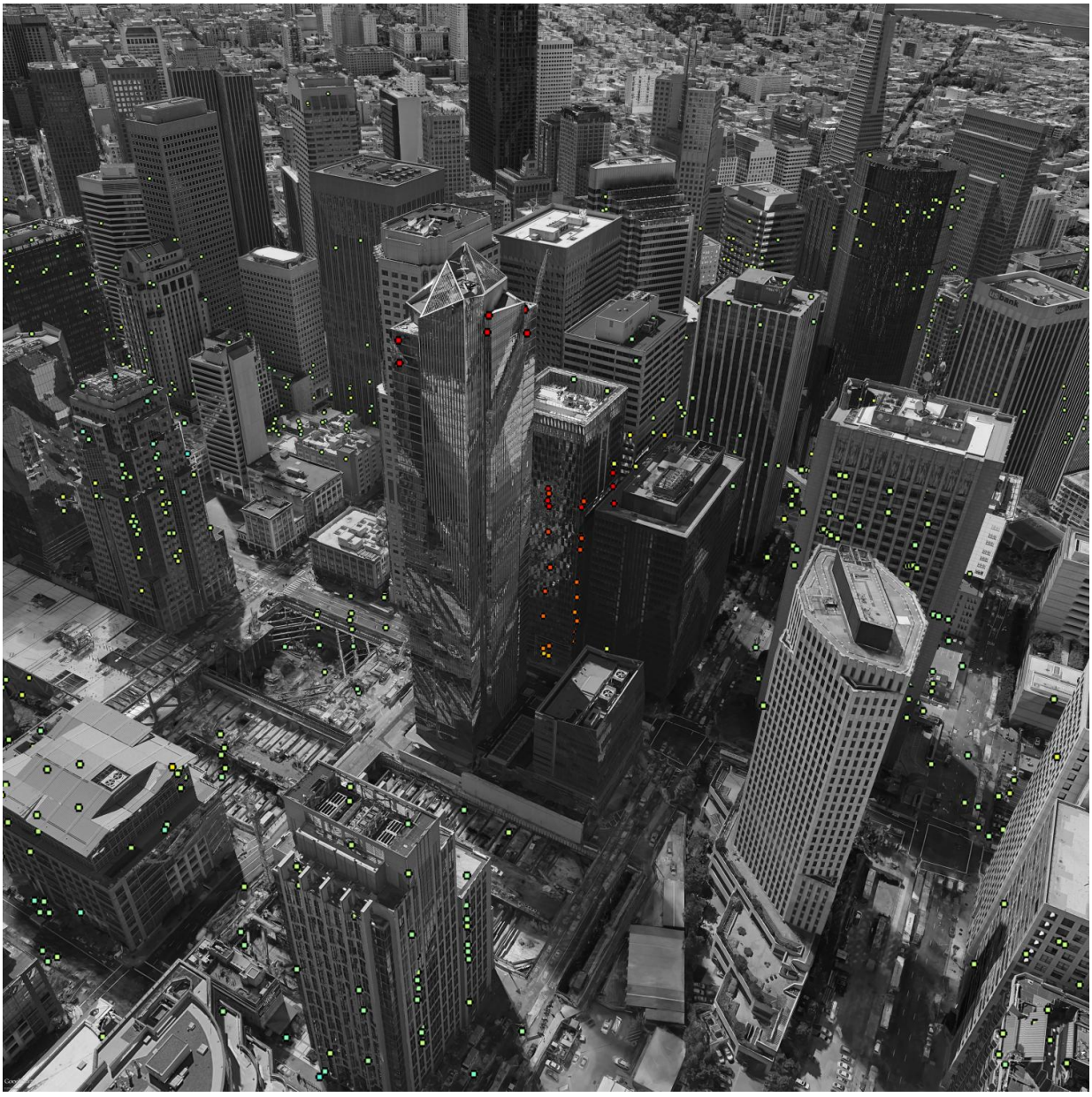
Satellites confirm sinking of San Francisco tower

November 25 2016



Data from the Sentinel-1 satellites acquired between 22 February 2015 and 20 September 2016 show that Millennium Tower in San Francisco is sinking by about 40 mm a year in the 'line of sight' – the direction that the satellite is 'looking' at the building. This translates into a vertical subsidence of almost 50 mm a year, assuming no tilting. The coloured dots represent targets observed by the radar. The colour scale ranges from 40 mm a year away from radar (red) to 40 mm a year towards radar (blue). Green represents stable targets. Credit: Contains modified Copernicus Sentinel data (2015–16) / ESA SEOM INSARAP study / PPO.labs / Norut / NGU

The Sentinel-1 satellites have shown that the Millennium Tower skyscraper in the centre of San Francisco is sinking by a few centimetres a year. Studying the city is helping scientists to improve the monitoring of urban ground movements, particularly for subsidence hotspots in Europe.

Completed in 2009, the 58-storey Millennium Tower has recently been showing signs of sinking and tilting. Although the cause has not been pinpointed, it is believed that the movements are connected to the supporting piles not firmly resting on bedrock.

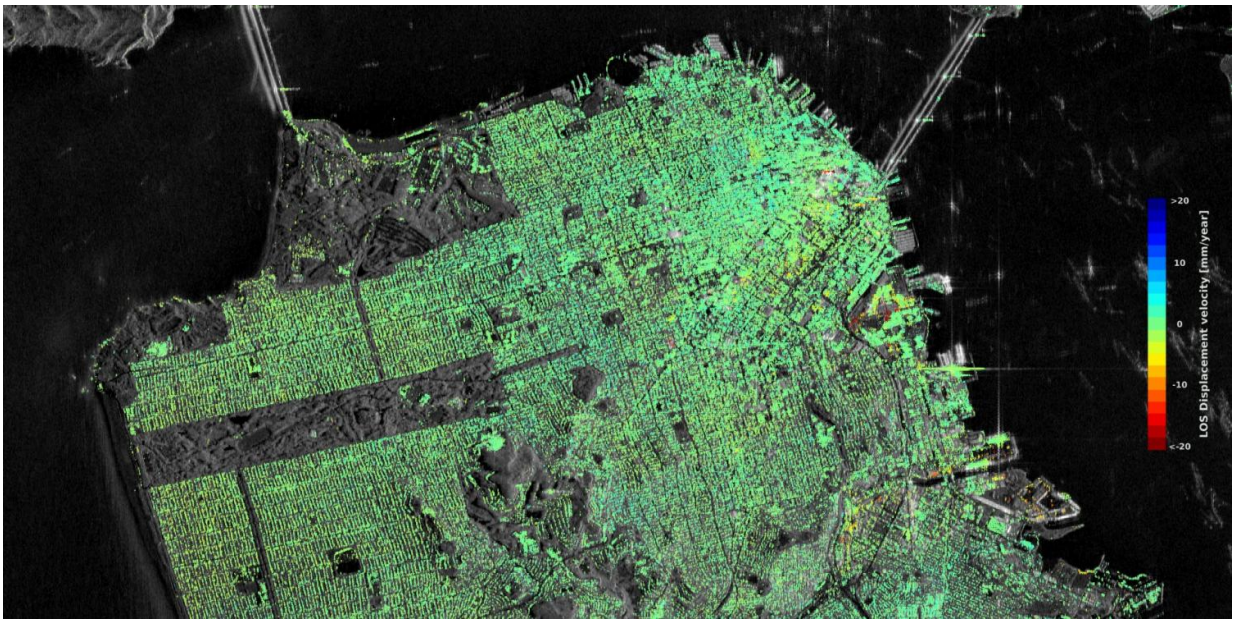
To probe these subtle shifts, scientists combined multiple radar scans from the Copernicus Sentinel-1 twin satellites of the same area to detect subtle surface changes – down to millimetres. The technique works well with buildings because they better reflect the radar beam.

It is also useful for pinpointing displacement hotspots over large areas, thanks to Sentinel-1's broad coverage and frequent visits.

Working with ESA, the team from Norut, PPO.labs and Geological Survey of Norway have also mapped other areas in the wider San Francisco Bay Area that are moving. These include buildings along the

earthquake-prone Hayward Fault, as well as subsidence of the newly reclaimed land in the San Rafael Bay.

An uplift of the land was detected around the city of Pleasanton, possibly from the replenishment of groundwater following a four-year drought that ended in 2015.



Sentinel-1 radar data show ground displacement of downtown San Francisco. While green indicates no detected movement, points in yellow, orange and red indicate where structures are subsiding, or sinking. Credit: Contains modified Copernicus Sentinel data (2015–16) / ESA SEOM INSARAP study / PPO.labs / Norut / NGU

European cities experience similar subsidence, and the San Francisco study is helping because it contains a multitude of features.

For example, the area around Oslo's train station in Norway is reclaimed

land. Newer buildings, such as the nearby opera house, have proper foundation into bedrock, but the older parts of the station experience severe subsidence.

"Experience and knowledge gained within the ESA's Scientific Exploitation of Operational Missions programme give us strong confidence that Sentinel-1 will be a highly versatile and reliable platform for operational deformation monitoring in Norway, and worldwide," noted John Dehls from the Geological Survey of Norway.

The studies of San Francisco and Oslo are paving the way for moving from targeted case studies to a nationwide or even continental-scale land deformation service.

"The Copernicus Sentinel-1 mission is, for the first time, making it possible to launch operational national deformation mapping services," said Dag Anders Moldestad from the Norwegian Space Centre.

Data from the Sentinel-1 satellites acquired between 26 December 2014 and 28 October 2016 show that parts of the Oslo train station are sinking by 10–15 mm a year in the 'line of sight' – the direction that the satellite is 'looking' at the building. This translates into a vertical subsidence of 12–18 mm a year. It can also be observed that the new opera house – the white structure located by the fjord south of the subsiding area – has not moved. Credit: Contains modified Copernicus Sentinel data (2014–16) / ESA SEOM INSARAP study / InSAR Norway project / NGU / Norut / PPO.labs

The open data policy and regular coverage plan of Copernicus promise cost-efficient and reliable services.

"In Norway, we have already initiated a framework project to provide

nationwide basic deformation products to the public, with a free and open data policy. Many other countries in Europe are also working towards setting up similar services," noted Dr Moldestad.

The Sentinel-1 twins provide 'radar vision' for Europe's Copernicus environment monitoring programme. In addition to watching land movements, they feed numerous other services for monitoring Arctic sea ice, routine sea-ice mapping, surveillance of the marine environment, mapping for forest, water and soil management, and mapping to support humanitarian aid and crisis situations.

Provided by European Space Agency