Radar Satellites

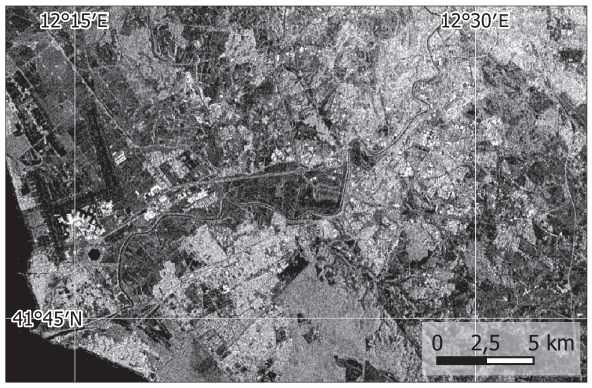
Radar satellite data provide a very special perspective on Earth's surface, capturing information beyond what optical sensors can reveal. In contrast to optical data, which relies on the reflection of sunlight, radar sensors actively emit microwave pulses and measure the return signal. This active sensing capability allows radar satellites to operate independently of external illumination by sunlight, making them suitable for a wide array of Earth observation tasks.

One key advantage of radar satellite data is its ability to penetrate cloud cover, a significant limitation for optical sensors. SAR can "see" through clouds because of its longer wavelength, providing continuous monitoring in regions prone to persistent cloud cover, such as tropical rainforests or high-latitude areas. Together with its independence of daylight conditions, this enables consistent monitoring. This is crucial for applications like disaster monitoring, where real-time information is essential. This constant observational capability proves invaluable for applications like maritime surveillance, where tracking vessels in remote or poorly lit regions can be challenging for optical sensors.

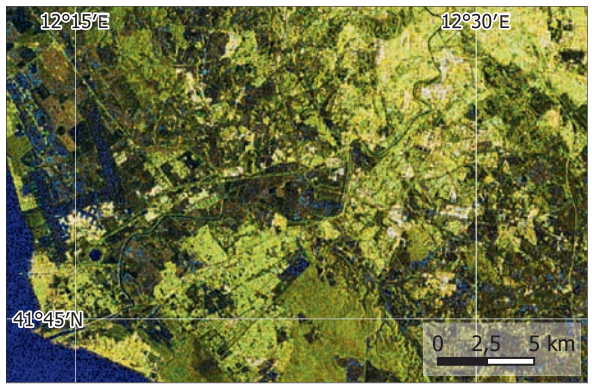
Another distinctive feature of radar data is its ability to measure topography and surface deformation with high precision. Interferometric SAR (InSAR) techniques are used to analyse the phase difference between multiple radar images, allowing for the detection of ground subsidence, elevation changes, and even millimetre-level deformations. This makes radar data indispensable for monitoring ground stability in earthquake-prone regions or tracking subtle shifts in infrastructure.

Radar data's ability to penetrate vegetation provides a unique advantage for forestry applications. While optical sensors are limited in their ability to see through dense canopies, radar can penetrate vegetation layers and capture information about forest structure, biomass, and even detect illegal logging activities.

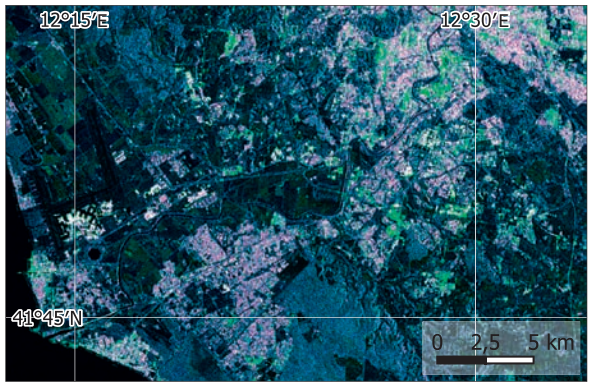
As for every technology, radar data has its limitations. The spatial resolution of radar imagery is generally coarser than that of high-resolution optical data. While optical sensors can provide detailed information about surface features, radar data may lack the ground resolution needed for specific applications addressing fine-scale details. In addition, the interpretation of radar data is less intuitive than that of optical data and requires sophisticated software tools to extract and evaluate the subtle information contained in the data.



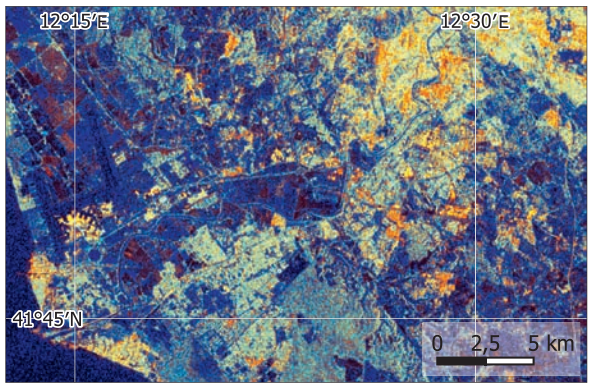
5. Radar image of the region southwest of Rome. Single polarisation image. Data: Sentinel-1, 2022-03-23.



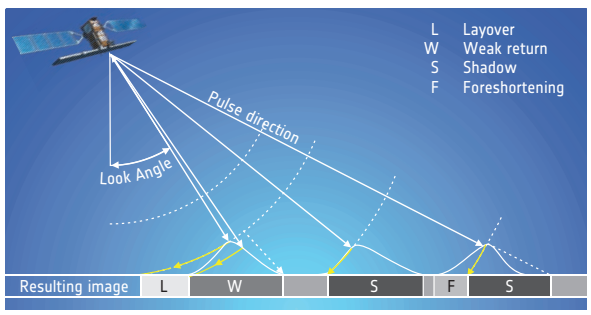
6. Radar image of the region southwest of Rome. Multi-polarisation image. Data: Sentinel-1, 2022-03-23.



7. Radar image of the region southwest of Rome. Multi-polarisation image optimised for urban analyses (built-up areas appear in violet colour). Data: Sentinel-1, 2022-03-23.



8. Radar image of the region southwest of Rome. Multi-polarisation image optimised for good discrimination of different landcover classes. Data: Sentinel-1, 2022-03-23.



9. Radar satellites send radiation pulses to the surface of Earth and measure the reflected signal. From the time the signal takes to return to the satellite, the distance of the reflecting point is calculated. This allows to produce radar image maps.