Differences Between Optical & Radar Satellite Data

The two main types of satellite data are optical and radar used in remote sensing. We're going to take a closer look at each type using the Ankgor Wat site in Cambodia, which was the location of the competition we ran on last week's blog as part of World Space Week. We had lots of entries, and thanks to everyone who took part!

Constructed in the 12th Century, Ankgor Wat is a temple complex and the largest religious monument in the world. It lies 5.5 kilometres north of the modern town of Siem Reap and is popular with the remote sensing community due to its distinctive features. The site is surrounded by a 190m-wide moat, forming a 1.5km by 1.3km border around the temples and forested areas.

Optical Image

The picture at the top, which was used for the competition, is an optical image taken by a Multi-Spectral Imager (MSI) carried aboard ESA's Sentinel-2A satellite. Optical data includes the visible wavebands and therefore can produce images, like this one, which is similar to how the human eye sees the world.

The green square in the centre of the image is the moat surrounding the temple complex; on the east side is Ta Kou Entrance, and the west side is the sandstone causeway which leads to the Angkor Wat gateway. The temples can be clearly seen in the centre of the moat, together with some of the paths through the forest within the complex.

To the south-east are the outskirts of Siem Reap, and the square moat of Angkor Thom can be seen just above the site. To the right are large forested areas and to the left are a variety of fields. In addition to the three visible bands at 10 m resolution, Sentinel-2A also has:

- A near-infrared band at 10 m resolution,
- Six shortwave-infrared bands at 20 m resolution, and
- Three atmospheric correction bands at 60 m resolution.

Radar Image

As a comparison we've produced this image from the twin Sentinel-1 satellites using the C-Band Synthetic Aperture Radar (SAR) instrument they carry aboard. This has a spatial resolution of 20 m, and so we've not zoomed as much as with the optical data; in addition, radar data is noisy which can be distracting.

The biggest advantage of radar data over optical data is that it is not affected by weather conditions and can see through clouds, and to some degree vegetation. This coloured Sentinel-1 SAR image is produced by showing the two polarisations (VV and VH i.e. vertical polarisation send for the

radar signal and vertical or horizontal receive) alongside a ratio of them as red, green and blue.

Angkor Wat is shown just below centre, with its wide moat, and other archaeological structures surrounding it to the west, north and east. The variety of different landscape features around Angkor Wat show up more clearly in this image. The light pink to the south is the Cambodian city of Siem Reap with roads appearing as lines and an airport visible below the West Baray reservoir, which also dates from the Khmer civilization. The flatter ground that includes fields are purple, and the land with significant tree cover is shown as pale green.

Conclusion

The different types of satellite data have different uses, and different drawbacks. Optical imagery is great if you want to see the world as the human eye does, but radar imagery offers better options when the site can be cloudy and where you want an emphasis on the roughness of the surfaces.