German Aerospace Center
DLR

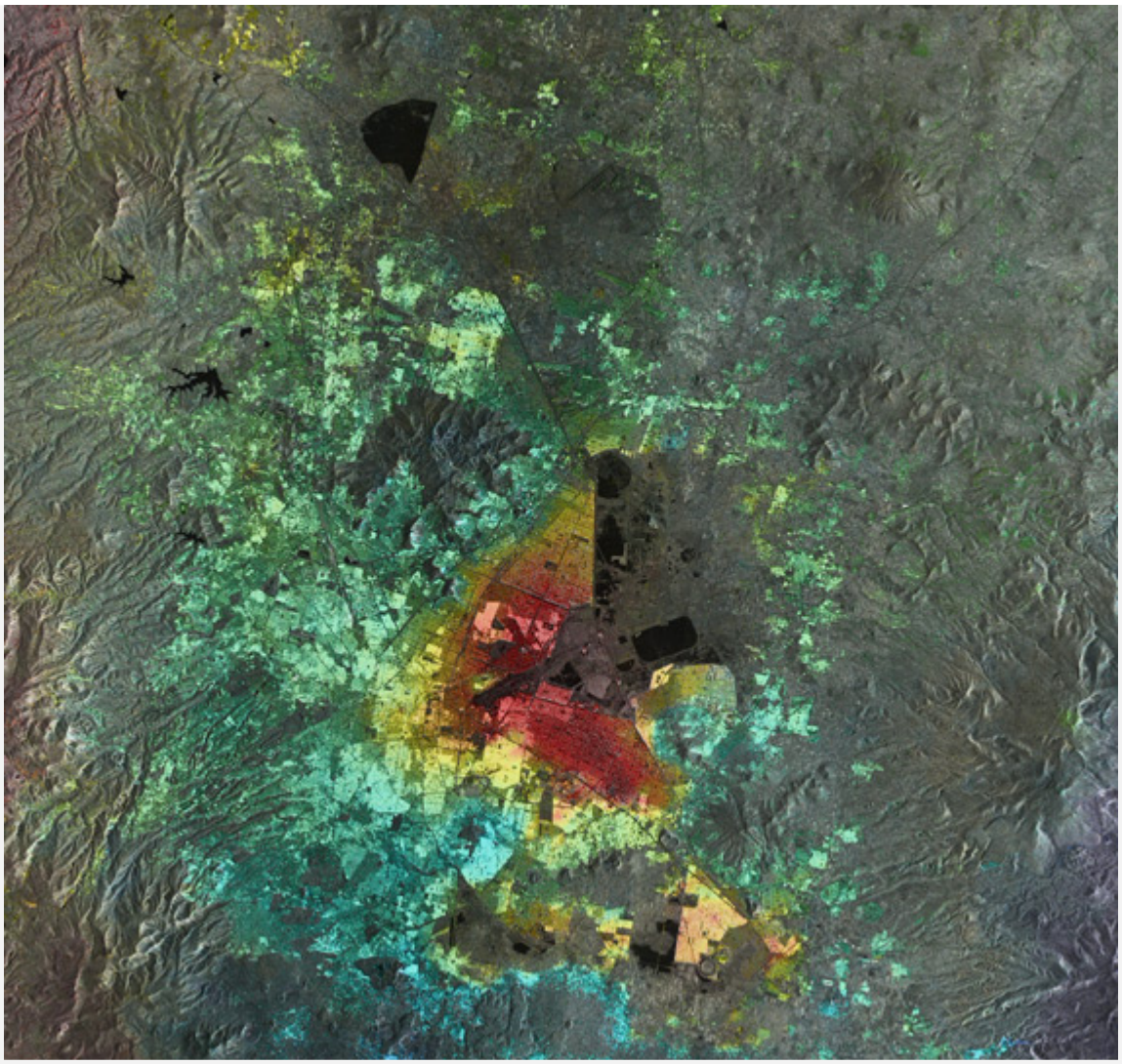
News Archive

TerraSAR-X image of the month: Mexico City

21 May 2010

Mexico City is one of the most densely populated cities in the world. Water is in short supply there and increasing amounts of groundwater are being extracted to meet the needs. For the last four months, the German Aerospace Center's (Deutsches Zentrum für Luft- und Raumfahrt; DLR) radar satellite, TerraSAR-X, has been imaging the city from space. Amongst other things, the images show that even within this imaging period, the ground has sunk by as much as 10 centimetres in some places as a result of the water extraction.

The areas of the Mexican capital in which TerraSAR-X has recorded the greatest changes in ground level are coloured dark red. The green areas are those in which no change has been detected via the superposition of the radar images between 20 September 2009 and 30 January 2010. "What is particularly noticeable even to anyone on a short visit is the subsidence in the city centre, where two of its most famous landmarks, the Bellas Artes Opera House and the cathedral in the main square, are sinking rapidly," says Michael Schmidt, coordinator at Conobio, the National Commission for the Exploration and Use of Biodiversity, in Mexico City. "When you look at the cathedral from the front, you can immediately spot that it is leaning."



TerraSAR-X image of the month: Mexico City

Built on fine-grained sediment

One of the triggers of extreme subsidence is the extraction of groundwater. The city stands on the fine-grained sediment of a former lake. When water is extracted from the soil via a well, the subterranean volume is reduced. "Even if pumping stopped and the sedimentary layers absorbed moisture again, they would not return to their original thickness," says geologist Christian Minet of the DLR Institute for Remote Sensing Methodology. Instead, steep and deep groundwater funnels would be formed in the Mexican capital - with the result that various districts in the city would subside. This means that at its front, over the fine-grained marine sediment, the cathedral is sinking, but, on the other hand, the rear part is standing on parts of a former Aztec temple.

Cathedral in Mexico City

Few alternatives are available to the nearly 17.6 million inhabitants of the metropolitan area. The city is situated on a plateau at an altitude of 2300 metres and is encircled by mountains such as Popocatepetl. So water has to be pumped across the high volcanic chain into the valleys. Seventy percent of the inhabitants of the capital city are supplied with water from under the ground. Not everyone, however, suffers from a water shortage. "The rich parts of the city are supplied as a matter of priority, so that any districts containing embassies, businesses and select residential areas hardly ever experience any water shortages," says Michael Schmidt. "The upper-middle class and the upper class often experience water shortages only indirectly, such as when their staff do not turn up, because they have no water for washing themselves in the morning." Some parts of the city are still being supplied with water only four days a week on average.

Radar image in 'wide-angle mode'

Particularly in built-up areas, TerraSAR-X is able to obtain good measurement results. For example, the non-coloured areas on the radar image are open spaces that change over time as a result of vegetation or movement. To create this an image, the TerraSAR-X radar equipment was operated in a special ‘wide-angle mode’, the 'ScanSAR mode', in which a strip of land 100 kilometres wide can be depicted in one piece. As the radar is usually capable of 'illuminating' a significantly smaller area of land – about 30 kilometres across, a special trick has to be used in order to obtain a greater strip width. For this purpose, the radar beam is repeatedly swung from short to long range, so that, first of all, a small area measuring 25 × 3 kilometres is illuminated at close range. Then, more distant areas - offset by 25 kilometres – are illuminated, until four partial strips of the image have been scanned. The process is then repeated. Finally, a montage is produced from the individual scenes. The cost of the larger scene is a reduction in resolution from three metres to sixteen metres, but this causes no restrictions for numerous applications. Such a recording mode is made possible by the electronically steered phased-array antenna, which facilitates the rapid and inertia-free movement of the radar beam.

The image of Mexico City was created by means of a refined scanning method known as Terrain Observation by Progressive Scans (TOPS) mode, which avoids the weakness of the classic ScanSAR – the varying illumination of individual surface patches. The result is an image without any variations in brightness. Numerous applications, especially in oceanography, will profit from this enhancement, including the improved recognition of ships, for example, and the detection of wave patterns and oil slicks at sea. With TerraSAR-X, the TOPS procedure could be demonstrated for the first time from space. Investigations into further refinements of the procedure are being conducted at DLR's Microwaves and Radar Institute as part of a study for the European Space Agency (ESA). Its aim is to implement the standard TOPS mode in ESA's Sentinel-1 satellite, which is planned for launch in 2012.

The TerraSAR-X mission

TerraSAR-X is the first German satellite that has been manufactured under what is known as a Public-Private Partnership between DLR and Astrium GmbH in Friedrichshafen. The satellite travels around Earth in a polar orbit and records unique, high-quality X-band radar data about the entire planet using its active antenna. TerraSAR-X works regardless of weather conditions, cloud cover or the absence of daylight and is able to provide radar data with a resolution down to one metre.

DLR is responsible for using TerraSAR-X data for scientific purposes. It is also responsible for planning and implementing the mission as well as controlling the satellite. Astrium built the satellite and shares the costs of developing and using it. Infoterra GmbH, a subsidiary company founded specifically for this purpose by Astrium, is responsible for marketing the data commercially.

Contact

Manuela Braun
Deutsches Zentrum für Luft- und Raumfahrt (DLR) - German Aerospace Center
Corporate Communications
Tel: +49 2203 601-3882
Fax: +49 2203 601-3249
E-Mail: manuela.braun@dlr.de

Dr.-Ing. Pau Prats
German Aerospace Center
Microwaves and Radar Institute, SAR Technology
Tel: +49 8153 28-2684
Fax: +49 8153 28-1449
E-Mail: pau.prats@dlr.de

Christian Minet
German Aerospace Center (DLR)
Remote Sensing Technology Institute, SAR Signal Processing
Tel: +49 8153 28-3323
Fax: +49 8153 28-1420
E-Mail: Christian.Minet@dlr.de

Contact details for image and video enquiries as well as information regarding DLR's terms of use can be found on the DLR portal imprint.