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Case Study

Surface Movement Monitoring

TerraSAR-X-based Surface Movement Monitoring for Improved Safety in Urban Areas

Challenge

In recent years the occurrence of substantial ground subsidence has become a serious problem in the Chinese capital Beijing. Statistics provided by the city's authorities reveal that the over-extraction of underground water caused a drop of the capital's water table from 12m to 24m in the past 10 years. The ensuing surface subsidence endangers the local population and infrastructure: roads and houses sink and even crack, the safety of subway lines is jeopardised, underground water and gas pipelines are increasingly prone to ruptures.

The cities authorities have established a terrestrial surveying programme using levelling data and GPS to monitor the subsidence and highlight potential risk areas. However, due to restricted budgets this levelling network can only provide point information about subsidence with sparse spatial density and restricted extent: it does as such not deliver a continuous and sufficiently extended understanding of the entire deformation area.



Road collapse in Beijing © CFP

Infrastructure constructions, excavations or natural phenomena can cause movements of the Earth's surface. These typically happen very slowly yet may have sudden and far-reaching effects that endanger infrastructure or even human lives.

Our Response

Airbus Defence and Space experts conducted a monitoring campaign using TerraSAR-X StripMap scenes (3m resolution) of Beijing, acquired over the period of one year. The monitoring was focused on the Eastern part of the city, where the largest subsidence phenomena were reported.

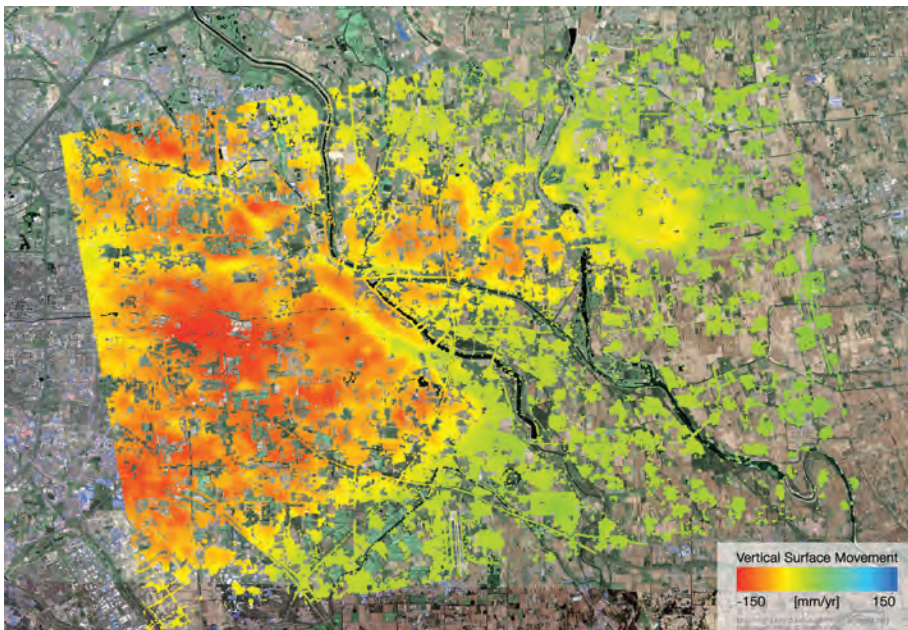
The outcome of the study yielded surface subsidence of up to 150 mm per year (visualised by the orange colour scheme in the graphic).

These results correlated strongly with the levelling results. Additionally the overall subsidence phenomena could be derived: the surface movement extends to a large area, but subsidence distribution is inhomogeneous with parts of very strong horizontal surface displacement gradients. The latter can be identified as areas with the strongest risk of damages to surface infrastructure due to inhomogeneous structural stress - valuable information for initialising counteractions.

TerraSAR-X can subsequently be utilised to monitor the effects of countermeasures taken by the authorities. Currently a pipeline is constructed to channel water from the Yangtze River to the capital. Upon completion of the project in 2014 the drawing wells will be closed and part of the water is also intended to be used to replenish the drained ground water and reverse subsidence. The continued monitoring with TerraSAR-X can reveal the success of these countermeasures or help to identify any undesired effects.

Benefits

- Reliable and continuous subsidence monitoring in urban areas with small time intervals (11 days), further improved with upcoming TerraSAR-X / PAZ constellation (4 and 7 days)
- Wide-area overview allows the identification of non-predicted hot-spots of surface movements, which allows more targeted terrestrial surveying grids optimising costs and efforts
- Very high sensitivity to even small-scale changes (millimetre range)
- Processing techniques adaptable to surface conditions
- Better identification of potential hazard zones and timely implementation of countermeasures, management of potential compensation liabilities



Surface Movement Map for Beijing - © DLR 2014 and © Airbus DS / Infoterra GmbH 2014

- 🔍 **Challenge** Prevent damage to infrastructure and human lives due to surface movement phenomena.
- 💡 **Solution** Space-based monitoring using TerraSAR-X data complements terrestrial measurement campaigns.
- ✅ **Results & Benefits** TerraSAR-X based monitoring provides an improved understanding of the surface movement and supports the implementation of countermeasures.

Solution Applicability

Space-based monitoring of surface movement phenomena using TerraSAR-X data can complement terrestrial measurement programs and can support the city administration with the timely detection of risks to human lives and infrastructure.