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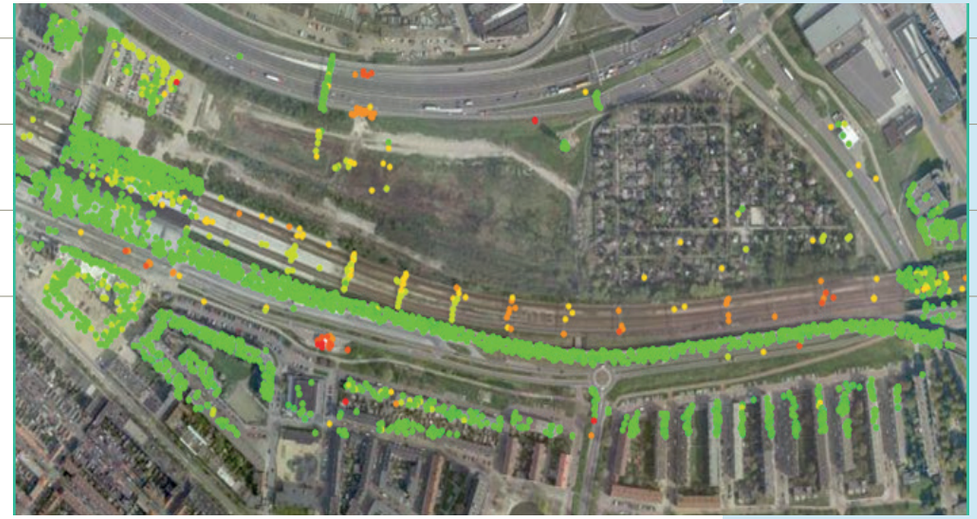
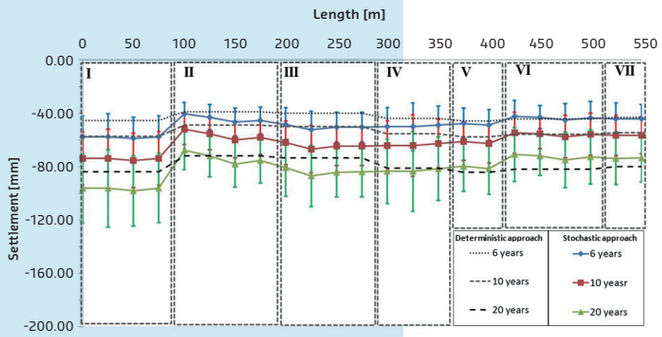
Monitoring the quality of railway tracks from space



InSAR reflection points on the Hoekse Line (courtesy of SkyGeo)

Subsidence can play a key role in the performance, serviceability and safety of engineering works such as railway embankments. Research by Deltares in 2007 indicated that 40% of the maintenance costs for railways in the Netherlands are linked to preserving the geometry of the railway track. Deltares developed a predictive settlement model for railway embankments built on soft soils. The main achievement of this project is the stochastic prediction of secondary settlement using satellite data and subsoil data. This prediction will improve the assessment of the quality of railway tracks in the long term and help to rationalise existing monitoring campaigns.



The procedure for predicting secondary settlement consists of three steps. In the first step, the results of geotechnical investigations (CPT measurements, laboratory tests and borehole data), the detailed geological GeoTop model and satellite data (DInSAR) are all used to build a subsoil model of selected sections in homogeneous sub-areas. In the second step, the subsoil model is used to predict settlement using a deterministic approach with the Isotache model in Deltares D-Settlement. In the third step, the subsoil model is used as the basis for a stochastic approach. This approach uses variational data assimilation to calibrate soil parameters (thickness and secondary compression index). The variational data assimilation minimises the difference between the predicted and measured (from DInSAR satellite data) settlement trends for the railway track. Finally, the calibrated subsoil model allows for the prediction of secondary settlement during different time intervals. These predictions are accompanied by an uncertainty estimate based on a Monte Carlo probabilistic approach to the variability of geotechnical parameters.

The predictive settlement model is being applied to a railway embankment on the Hoekse Line connecting the towns of Schiedam and Hook of Holland in the west of the Netherlands. Secondary settlement is being predicted for each section of 25 m in a 550-m-long stretch over periods of 6, 10 and 20 years. The assumption is that there is no additional loading on the subsoil during these periods. The stochastic approach provides confidence bounds (average and standard deviation) for settlement predictions, whereas the deterministic approach supplies just one set of settlement predictions. The results show that the deterministic predictions are within the confidence bounds of the stochastic predictions. The stochastic approach results in settlement varying between 50 and 120 mm over 20 years. The deterministic approach indicates average settlement over the length of the stretch of 80 mm in 20 years. The approach highlights the potential of DInSAR satellite techniques for predicting track settlement using settlement models, probabilistic techniques and additional geotechnical data.

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Further reading:
http://www.nrcresearchpress.com/doi/10.1139/cgj-2016-0425