Space-borne terrain deformation monitoring for large infrastructure projects

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Ground settlement and associated deformation of existing infrastructure is a major risk in urban development projects. Project owners have a responsibility to document and manage settlement records before, during and after construction works. Traditionally, land surveying (e.g. leveling and total station) techniques have been the state-of-practice to provide settlement monitoring data. However, in big infrastructure projects, conventional geodetic data acquisition is a major cost driver. Modern space-borne radar interferometry (InSAR) provides the opportunity to drastically increase the number of monitored locations, while at the same time reducing expenses for traditional geodetic survey work. Furthermore, the method allows for highly effective monitoring during all phases of a project.

The application of InSAR technology is demonstrated for three large development projects near Oslo, the capital of Norway. Showcase examples include a new highway development project and two railway line upgrade projects. In two of the cases, InSAR monitoring was performed by exploiting very high resolution TerraSAR-X data (ca. 1.5 x 1.5 m spatial ground resolution), and in one case, using high resolution Radarsat-2 data (ca. 7 x 7 m spatial ground resolution). A combined area of 127 km² was monitored for all three projects, yielding a total of roughly 800,000 measurement points on the ground. Achieved measurement point density based on the TerraSAR-X data was around 37,000 points per km², while density based on the Radarsat-2 data resulted in approximately 6,000 points per km² in built-up areas. Both data resolutions offer millimetric deformation precision, with surfaces of buildings and infrastructure providing the best signal reflection and phase coherence, resulting in high-quality results. In all cases, the interferometric time series analyses were communicated to the end users through a web-based map portal, enabling simple visual interpretation of the results, as well as integration with the settlement records of the project.