Monitoring urban infrastructures using InSAR requires the use of SAR data at the highest possible spatial and temporal resolution. In this work, we demonstrate how using the highest resolution imagery for monitoring civil engineering installations of the size of a few meters yields a dramatic increase in information. In specific, we focus on the Hessigheim lock structure situated on the river Neckar, north of Stuttgart, Germany (Figure 1). As a consequence of subsurface leaching processes, these lock structures are being extensively monitored since 1970, combining groundwater observations, in situ geodetic and extensometer measurements, all performed at least at yearly intervals.

To increase spatial and temporal resolution, we monitor these locks using SAR data available since 1992. We show the results obtained using the full spectrum of available SAR resolutions -- ERS, Envisat, TerraSAR-X StripMap and SpotLight modes (Figure 2) -- comparing them with the available in situ measurements. We further discuss the methodology, challenges and benefits of using high resolution SpotLight data, both in cases of point and distributed scatterers for this application.

This brings the end-users a more complete coverage of the objects of interest, increasing the likelihood of discovering instabilities early on, improving the ability to isolate actual signal from surrounding scatterers and finally improving the localization of the signal. The additional measurement density is shown to increase the usability of InSAR on small-sized objects.

In future, we plan to perform similar analyses using Sentinel-1 imagery. We will compare the added benefit of the coherence obtained from a 6- to 12-day repeat cycle in offsetting the effect of larger pixel sizes, and demonstrate its usability for infrastructure monitoring.

We acknowledge ESA for the ERS, Envisat and Sentinel-1 imagery, and Airbus for the partial donation of SpotLight imagery.

Figure 1. Aerial view of the Hessigheim lock structure and vicinity. Each lock chamber’s usable length is 110 m with a clear width of 12 m and lifting height of 6.2 m.
Figure 2. InSAR-derived deformation [mm/y] of the Hessigheim lock structure using (top-left) ERS, (top-right) Envisat, (bottom-left) TerraSAR-X StripMap and (bottom-right) TerraSAR-X SpotLight data. As the resolution goes up, the measurement point density is higher over the lock structure, power house and greenhouses, revealing clearer deformation patterns.