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# SAR interferometry, water balance measurements, and clay shrinkage to estimate soil water storage change from the field to the catchment scale

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Radar interferometry (InSAR) is a remote sensing technique capable of measuring subtle surface elevation changes of large areas, with high spatial resolution. The technique is well established for applications like tectonic and volcanic induced deformation monitoring. Apart from a few studies using InSAR to quantify aquifer storage coefficients and hydraulic heads from land subsidence and some attempts to monitor open water level changes, applications in hydrology are virtually absent.

Satellite radar (SAR) data of a study area, as used for InSAR, are generally acquired weekly to monthly, with a high spatial resolution (several tens of meters). The relatively high resolution (compared to many other remote sensing data) and the spatial extent, allow for detailed monitoring of hydrological variables. Using combinations of acquisitions of these data interferometrically may potentially be capable of measuring temporary surface elevation changes brought about by the swelling or shrinkage of clay. In unsaturated zone hydrology it has long been recognized that the soil shrinkage curve links elevation changes from clay dynamics to soil water storage changes. Therefore, satellite based radar interferometry can potentially offer an alternative methodology to estimate soil water storage change at field or regional scales.

This study aims at investigating the possibilities and limitations of InSAR for soil water storage change estimations in clay areas. To do so, a novel combination of traditional and modern field measurements of water balance terms and TerraSAR-X data has been exploited. Measurements of soil water storage change and surface elevation change revealed in situ shrinkage curves with slopes close to 1, indicating normal shrinkage where soil water storage change approximates soil volume change. InSAR measurements revealed differences between different soil and land use types. Therefore care has to be taken in selecting areas subjected to InSAR analysis. We show that if this is done adequately, the InSAR observations correlate well with in situ measured soil surface elevation changes from clay shrinkage in a period of soil water depletion.

Based on these results, the potential of the combination of high resolution SAR data and clay soil characterization in terms of the shrinkage curve for up-scaling from point scale in situ measurements to field and catchments scale remote sensing observations is evident. The values of SAR data for this application is expected to increase further with the upcoming Sentinel-1 SAR data which will provide SAR data every 6 days.