Detection and Analysis of Weak Spots in Levees Based on Satellite Radar Interferometry

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Detection and Analysis of Weak Spots in Levees Based on Satellite Radar Interferometry

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Monitoring of flood defense systems is an aspect of crucial importance in achieving safety standards, and avoiding catastrophic failure events. The current monitoring methods rely on expert observers, which lead to subjective and often unreliable inspections. Hence, there is a need for innovative techniques to monitor levee stability in order to help the authorities making right decisions in the future. Previous studies shown that Persistent Scatterer Synthetic Aperture Radar Interferometry (PS-InSAR) provides high precision measurements of levee deformation. In this contribution, we explore the feasibility of using the PS-InSAR technique in order to enable continuous levee deformation monitoring, such as detecting, tracking and analyzing changes that are indicative of potential problematic locations. These locations may be very localized, only detected by a single PS, or cover a longer levee segment, showing a range of anomalously behaving PS. Aiming towards an automatic detection algorithm for such locations using 'fingerprinting', an expert-supported approach is developed, which considers properties and conditions of the levee sections. From a monitoring perspective, the objective is to minimize the number of false alarms and missed detections. The applicability of the proposed approach is demonstrated via case studies located in different parts of the Netherlands. Levees on these locations have been monitored from both ascending and descending orbits, using Envisat, TerraSAR-X and Radarsat-2 acquisitions in order to estimate the line-of-sight deformation time series of each Persistent Scatterer (PS) between 2002 and 2016. The proposed approach intends to improve the applicability of the technique by using all available prior information on the structural behavior of levees. It is concluded that a systematic application of satellite radar interferometry may complement existing approaches for assessing levee stability and failure investigations in an innovative, frequent and cost-effective way.

Severe Ground Subsidence in California Central Valley Over the Past Year: Seen from Sentinel-1

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In 2014 and 2016 ESA launched its new generation of C-band SAR satellite constellation, Sentinel-1A and 1B. The new sensors opened a new era for SAR and InSAR applications in many fields. The uniqueness of Sentinel-1 is that it is the first sensor to use the TOPS mode as its default scanning mode. By steering the antenna along azimuth direction and switching between three subswaths consecutively, TOPS mode can cover approximately three times bigger the area when comparing with conventional stripmap mode. The large coverage of TOPS together with its other advanced parameters makes it an ideal data source for large scale and high accuracy ground deformation monitoring work.

Furthermore, Sentinel maintains an optimal temporal and spatial baseline, which greatly facilities the applications of InSAR and time series analysis. With the constellation, the minimum temporal baseline is only 6 days. Meanwhile, Sentinel keeps running in a 200 meters tube in its orbits. The relatively small spatial baseline minimized the coherence decorrelation to the greatest extent. Both conditions are in favor of doing time series analysis despite the sacrifice in azimuth resolution due to the TOPS mode. At last, the continuous acquisitions and the abundant dataset over almost every corner of the world opens numerous chances for earth observation.

In this study we conducted a case study to derive ground movement time series in California Central Valley. This AOI is famous for its severe ground subsidence due to excessive underground water extraction. In this experiment we use Sentinel-1A dataset that covers a period of one year and a half (from November 2014 to June 2016) to study the ground movement of California Valley. We use two different datasets and standard PSI technique for the time series analysis, and the result indicates severe ground subsidence reaching a maximum rate of approximately 250 mm/yr at some locations. The cross validation between InSAR results and GPS points inside AOI also verifies the deformation trend.