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# Use of Sentinel-1 SAR data to monitor Mosul dam vulnerability

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The structural monitoring of dams is an important practice to guarantee their safety. Moreover, the water reservoir and the efficient operation and safety of surrounding areas need to be monitored. Considering the importance of large dams as multipurpose infrastructure for flood control, energy production, water supply and irrigation, ensuring their longevity is a key aspect on their management. Therefore, it is of great importance to detect dam deterioration potentially resulting in its shutdown or failure, preventing life and economic losses. Traditional dam monitoring requires the identification of soil movements, tilt, displacements, structural stress and strain behaviour. Since the '90, innovative remote sensing techniques based on satellite Synthetic Aperture Radar (SAR) data were developed to detect and monitor surface displacements. The main advantages of SAR data are the non-invasiveness of their acquisition, the possibility to cover large areas in a short time and the advancement. Moreover, the availability of SAR satellite acquisitions from the 1990s enables to reconstruct the historical evolution of dam behaviour. Furthermore, the use of SAR Interferometry (InSAR) techniques, Differential InSAR (DInSAR) and Advanced stacking techniques (A-DInSAR), produce accurate velocity maps and displacement time-series. The importance of these techniques emerges when environmental or logistic conditions do not allow to monitor dams applying the traditional geodetic techniques.
An iconic case demonstrating the relevance of remote sensing observations is the Mosul Dam, the largest Iraqi dam, where monitoring and maintaining are impeded for political controversy, thus the risk for the population is very high. It is considered one of the most dangerous dams in the world because of the erosion of the gypsum rock at the basement and the difficult interventions due to security issues. It consists of 113 m tall and 3.4 km long earth-fill embankment-type, with a clay core. It was completed in 1984 and started generating power on 1986. Since then, frequent consolidation works have been carried out pumping cement mixtures into the soil foundation to keep it stable and prevent it from sinking and then breaking apart.
To overcome the impossibility of directly monitoring the structure, analysis of recent deformation affecting the Mosul dam is achieved considering C-band Sentinel-1 SAR data, acquired from the end of 2014 to the present. These 20-m ground resolution data can provide a millimetric precision on displacements. Furthermore, ESA archive available SAR data (ERS and Envisat) are considered to reconstruct the temporal evolution of the deformations.
In this work, different stacks of data are processed applying SBAS and PS A-DInSAR techniques; deformation fields obtained from SAR data are evaluated to assess the temporal evolution of the strains affecting the structure. Obtained results represent the preliminary stage of a multidisciplinary project, finalised to assess possible damages affecting a dam through remote sensing and civil engineering surveys.