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Dam monitoring through high and very high-resolution satellite SAR data and new generation SAR missions

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Structural health assessment is an important practice to guarantee the safety of infrastructure in general. In case of dam monitoring, it is necessary to control the structure itself and the water reservoir, to safeguard efficient operation and safety of surrounding areas. Ensuring the longevity of the structure requires the timely detection of any behavior that could deteriorate the dam and potentially result in its shutdown or failure. Traditional structural dam monitoring requires the identification of soil movements, tilt, displacements, stress and strain behavior.
The detection and monitoring of surface displacements is increasingly performed through the analysis of satellite Synthetic Aperture Radar (SAR) data, thanks to the non-invasiveness of their acquisition, the possibility to cover large areas in a short time and the new space missions equipped with high spatial resolution sensors. The availability of SAR satellite acquisitions from the early 1990s enables to reconstruct the historical evolution of dam behavior, defining its key parameters, possibly from its construction to the present.
Therefore, we presented two applications SAR data analysis to monitor dam structural health and, with the final aim of exploiting deformation fields as a starting point to re-create a simplified model, providing preliminary hints about the stress-strain status of the dam.
The relevance of this process emerges when environmental or logistic conditions do not allow monitoring dams through traditional geodetic and numerical techniques. In such cases, results obtained from SAR data combined with a modelling stage constitute a reliable diagnostic tool of dam structural health to avoid any extraordinary failure that may lead to loss of lives. The method is tested on two different real cases, the Mosul dam, the largest Iraqi dam, and the Mullaperiyar dam, a critical Indian dam. The choice of these dams takes into account the different structure design and materials. Mosul dam is an earth-fill embankment-type with a clay-core, while Mullaperiyar dam is a gravity dam made with concrete prepared from limestone and burnt brick powder.
Sentinel-1, Cosmo-SkyMed and TerraSAR-X datasets have been analyzed, providing information with different resolution, not only on the main infrastructures but on the surrounding areas too. Some sliding portion of the basin boundaries and some sinkholes have been identified. The seasonal behaviour of the ongoing deformations and their connection with the water level on the basins have been considered.
The obtained results are the first stage of a multidisciplinary project, finalized to assess possible damages affecting a dam through remote sensing and civil engineering investigations.