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Multi-temporal analysis of the Oroville dam spillway collapse: natural and technological hazard mitigation strategies and our capability of detecting precursory phenomena

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Oroville dam is an earthen embankment on the Feather River, located in the Northern California region. Starting October 2016, heavy precipitation events hit Northern California after a 5-year drought. Extreme rainfall amounts provided in few weeks about 1meter (39 inches) of rain which is more than 2-3 times the average rainfall expected for this region. This season's big storms caused an unprecedented inflow of water in the reservoir, peaking in early February at more than 4,300 cubic meters per second (150,000 cubic feet per second). According to the Department of Water Resources, on February 12, 2017, Oroville Dam's main and emergency spillways collapsed and were seriously damaged respectively. Therefore safety reasons imposed the evacuation of almost 200'000 inhabitants from nearby areas . The main spillway failure required to slow water release and consequently the lake water level rose approximately by 15 m in 5 days. For the first time the emergency spillway was affected by overtopping. Several hypotheses on the spillway collapse have been outlined: weak foundations because of the drought, limited collector drains, absence of downstream protection against erosion.
This work aims to shed new lights on possible precursory deformation affecting the dam main spillway. Space-borne Synthetic Aperture Radar (SAR) Sentinel-1 acquisitions have been analyzed through the traditional multi-temporal differential interferometric techniques, the Persistent Scatterers (PS) and the Small-Baseline Subset (SBAS). The great potential of these remote sensing techniques is due to availability of large data archives and the capability to retrieve displacement with millimeter accuracy. Four different ESA Sentinel-1 datasets are available over this area, two acquired with ascending and two with descending orbits, thus pledging a good spatio-temporal coverage on potential precursory deformation affecting the spillways. Outcomes of the SAR data analysis are compared with available ground-based dataset such as GPS measurements, basin water levels together with rain data.