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Reconstruction of reservoir water level and storage using Sentinel-1 C-SAR

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Sentinel-1 C-band Synthetic Aperture Radar (SAR) provides a new means for indirectly monitoring water reservoir level and storage by mapping water cover at resolutions suitable for large water bodies. Monitoring these fluctuations is essential for informed water resource management even in otherwise gauges reservoirs for the purpose of verification, detection of anomalies due to changes in floor morphology, etc. However, classification of water on SAR images can be ambiguous, to which end several non-parametric methods such as Otsu, Kittler–Illingworth (Kavats et al., 2022), k-means (Cheng et al., 2022), and entropy-based image thresholding (Sekertekin, 2021) have been proposed. Here we evaluate the capability of these methods to accurately reconstruct reservoir biweekly water level and storage. The analysis is performed on Sentinel-1 Ground Range Detected (GRD) imagery, acquired in the VV polarization mode from the COPERNICUS/S1_GRD image collection from October 2014 till today using Google Earth Engine (GEE). Processing is performed using the GEE JavaScript API and executed through the R programming environment using the rgee package. Water level and storage are derived from water cover using respective level-area and level-storage curves. The methods are applied to two reservoirs located in Greece and the Czech Republic, which are characterised by distinct seasonal water availability and demand leading to the respective reservoir level fluctuations. Results are validated by comparing against official measurements, indicating satisfactory fit. These findings highlight the potential of the proposed methods automated continuous reservoir monitoring, especially in regions facing increasing climatic variability as climate change is expected to increase the intensity of droughts and seasonal fluctuations in water availability. The study contributes to improving methodologies for assessing water dynamics in diverse climatic environments and supports the development of more efficient strategies for water resource management.

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