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Estimating surface water fractions for enhanced flood monitoring

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Abstract: Flooding is one of the most widespread and destructive natural disasters globally, posing severe threats to lives, infrastructure, and ecosystems. Timely and accurate flood monitoring is therefore critical for disaster response, mitigation planning, and effective water resource management. There is an increasing reliance on remote sensing techniques for capturing flood extents over large and inaccessible areas. However, the effectiveness of satellite-based flood monitoring is often limited by the trade-offs between spatial and temporal resolution inherent in different sensors.

For instance, the Moderate Resolution Imaging Spectroradiometer (MODIS) provides daily observations, which are valuable for capturing rapidly changing flood conditions, but at a relatively coarse spatial resolution from 250-metre to 1000-metre. In contrast, Landsat products offer much finer spatial detail at about 30-metre resolution, but their 16-day revisit cycle may miss short duration flood events. To address this gap, we propose a non-linear regression-based method that utilizes both data sources to estimate daily surface water fractions for sub-pixel level information.

In this approach, Landsat 8 reflectance are spatially aggregated to the MODIS scale. The aggregated Landsat 8 reflectance and normalized difference indices are employed as training variables. The corresponding target data are surface water fractions derived from the binary Water Observations (WO) maps. A Gaussian Process Regression (GPR) model is trained to learn the relationship between them. The GPR model is then applied to bias-corrected MODIS data to generate daily water fraction estimates.

The proposed method is evaluated over a flat floodplain around Bourke town in New South Wales, Australia. Model performance is assessed comparing water fraction estimates against the WO-derived water fractions. Results show that the model effectively captures surface water fraction information from MODIS observations at a daily scale, providing a useful approach for improving flood monitoring and supporting decision-making in regions where high-frequency, high-resolution observations are not readily available.

Keywords: *Remote sensing, flood monitoring, surface water fraction*