Monitoring wetland inundation dynamics from space using a fully automated multi-sensor mapping approach

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Surface water inundation drives myriad important wetland functions, including water storage, carbon sequestration, nutrient removal, and biodiversity. Reliable information on wetland inundation dynamics is often lacking, leading to large uncertainties when studying these functions. A number of regional to global-scale surface water products have been released in recent years using a variety of satellite data sources. However, their utility is limited due to their relatively coarse spatial and temporal resolution. The fusion of optical and synthetic aperture radar (SAR) data streams has been put forward as a way to enhance temporal resolution and leverage the inherent benefits of these two disparate data types. Harmonized methods are needed to achieve enhanced temporal resolution through the generation of consistent wetland inundation estimates. Here, we present novel algorithms for the automated mapping of inundation, making use of optical (Landsat and Sentinel-2) and SAR (Sentinel-1) data streams. Using a combination of static thresholds, spatial aggregation, inundation probability from time series imagery and random forest classifiers, these algorithms are shown to be efficient in deriving inundated surfaces from optical and SAR imagery without the use of externally derived training data. While both algorithms are highly scalable in both space and time, several key limitations will need to be addressed before generating regional dynamic inundation products, including: insufficient frequency of satellite overpasses; commission errors from dark surfaces in optical imagery; and challenges in quantifying sub-pixel inundated extent from SAR imagery, which is necessary to ensure consistency between data streams. Addressing these issues will allow for the generation of near-daily estimates of wetland inundation at the continental to global scale, representing a significant step forward in understanding wetland ecosystems in support of relevant policies and management strategies.

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