Automatic planform delineation and bathymetry retrieval from multispectral remotely sensed imagery for rivers

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# ABSTRACT

Remotely sensed imagery provides a potential way to efficiently identify changes in river channel morphology, especially in large rivers. Here we describe methods that use multi-spectral images to (a) automatically reconstruct the above-water boundaries of large river channels, including riverbanks, mid-channel bars, islands and point bars (a Channel Planform Extraction tool); (b) within those boundaries we also explore methods to extract bathymetry below the water (a bathymetry retrieval workflow). Together these methods could potentially provide repeat morphological changes in large rivers, at low cost, which is particularly attractive to less wealthy countries. We test the methods on the Han River in central China, which is heavily impacted by dams, channel training structures, and sediment mining.

The Channel Planform Extraction tool automates the delineation of channel planform features, and the measurement of planform metrics, from multi-spectral remotely sensed images. The results can identify channel change over time, of which the spatial and temporal resolution depends on the input images. The Channel Planform Extraction tool successfully extracted the interannual channel planform change over 600 km river length of the Han River from 1987 to 2018, based on free Landsat images with 30m spatial resolution. It took around fifteen minutes for each run to extract one year’s results. We found that the previously braiding section has become simplified and less active with mid-channel bars diminished or vegetated and narrowed by up to 70% over 1000 m.

The bathymetry retrieval workflow is used to derives depth for unsurveyed areas by building an empirical relationship between quantile transformed spectral values and surveyed depths. We tested it with pansharpened Landsat and Sentinel images that are of 15 m and 10 m spatial resolution respectively, combined with occasionally surveyed cross-sectional depths during 2017 and 2019. We revealed that free satellite images could detect depth up to 13.8 m, but only in very limited conditions, where suspended sediment was extremely low below dams. Nevertheless, this workflow can be used in any rivers that have surveyed depth data for calibration and is likely to work very well where turbidity is low.