Abstract

River bathymetry is essential for understanding channel morphology and simulating river hydrodynamics yet collecting it through field surveys is time-consuming and expensive. This study tests whether the SWOT satellite can help fill that gap. We first compared two SWOT data products, Pixel Cloud (PIXC) and RiverSP, on the Wabash River in Indiana. PIXC worked much better: its width and elevation followed changes in discharge over time, while RiverSP widths jumped between near-zero and hundreds of meters with no clear link to flow, and it lacked the spatial detail needed to build cross-sections. We then applied the PIXC workflow to ten rivers of different sizes and shapes across the United States and India. For each river, PIXC points were filtered for quality, corrected for tidal and geoid effects, and fitted with a composite beta function at ten cross-sections along the centerline. The fitted profiles sat closer to the field survey data than the DEM did in nine out of ten rivers. On average, SWOT closed about one third of the vertical gap between the DEM and the true channel bed (normalized RMSE of 0.67), and for the Wabash River it closed as much as 71%. Neither channel planform nor depth predicted which rivers did well. The two factors that did matter were the seasonal range of water levels the satellite could observe and the per-pixel uncertainty on bank-edge pixels. These results show that SWOT PIXC data, with careful filtering and curve fitting, can already recover useful cross-section shapes and have strong potential as a source of channel geometry for rivers in places where field surveys are not available.

Keywords: bathymetry, SWOT satellite, channel morphology, river hydrodynamics, geoid