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The challenges in using UAV and plane imagery to quantify channel change in sandy braided rivers

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The development of numerical models of river morpho-dynamics is hampered by the lack of high-resolution data at multiple time and space scales for model validation. Such data are especially challenging to obtain for sand-bed braided rivers that typically have multiple channels of varying depth and contain rapidly migrating low-relief bar-lobes and dunes. This paper reports on the efforts to meet these challenges using repeat UAV surveys and plane sorties to quantify morphological change and bedform migration rates along the South Saskatchewan River, Canada.

The South Saskatchewan River, near Outlook (SK Province) is [U+F07E]600 m wide with very well sorted medium sand (D50 = 0.3 mm) and negligible clay. The Gardiner Dam, 20 km upstream of the study reach, traps much of the very fine sediment so that the waters are clear at low flow and therefore the river bed is entirely visible. Fieldwork campaigns in 2015 and 2016 captured: (i) 1:5000 aerial colour photographs over a 17.5 km reach; (ii) high temporal frequency repeat imagery, obtained using quadcopter and fixed-wing UAV platforms for multiple 100 x 500 m sub-reaches. Plane images were processed via Structure from Motion (SfM) photogrammetric techniques using Pix4D and supporting ArcGIS and Global Mapper analysis. The resulting point cloud was corrected for tilt and filtered in MATLAB at multiple spatial scales to remove noise. Elevations in sub-aqueous zones were obtained using a statistical model, relating image brightness to water depth, developed using single beam echo-sounder data collected near to the flight time. The final DSM for the plane imagery combines these two methods and has a 0.5 m spatial resolution with vertical accuracy of [U+F07E]6 cm. UAV imagery is also processed using Pix4D with application of a diffraction water depth correction, required due to the lower flight height, and gives a resulting vertical accuracy of 2 cm.

Initial results highlight the following issues: (i) there are a series of technical challenges associated with the definition of the emergent/submergent boundaries, low texture areas, accounting for pixel 'discolouration' by algal mats and flooded vegetation, pixel colour saturation at water depths > 2 m, and shadow effects in the lee of large dune bedforms; (ii) tracking of individual dunes using orthophoto mosaics is relatively easy but migration rates are spatially highly variable; (iii) morphological changes to individual dunes as they migrate present difficulties for converting to bedload transport rates; (iv) the basic components of the braided planform stay in-tact during each flood year unless there is an extreme flood when the whole braided morphology is reset. This paper will give more details on the processing workflow, the technical challenges and associated solutions, and the potential application of the data generated for validation of a 2D morpho-dynamic model of sand-bed braided river evolution.