Evaluating the impact of dams on sediment transport pattern in the main stem of Parker River

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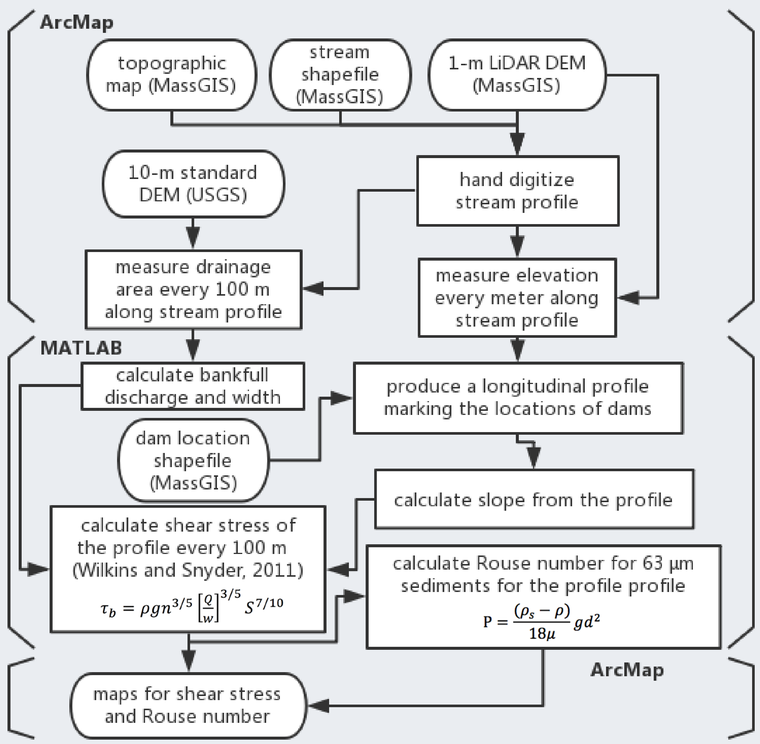
Abstract

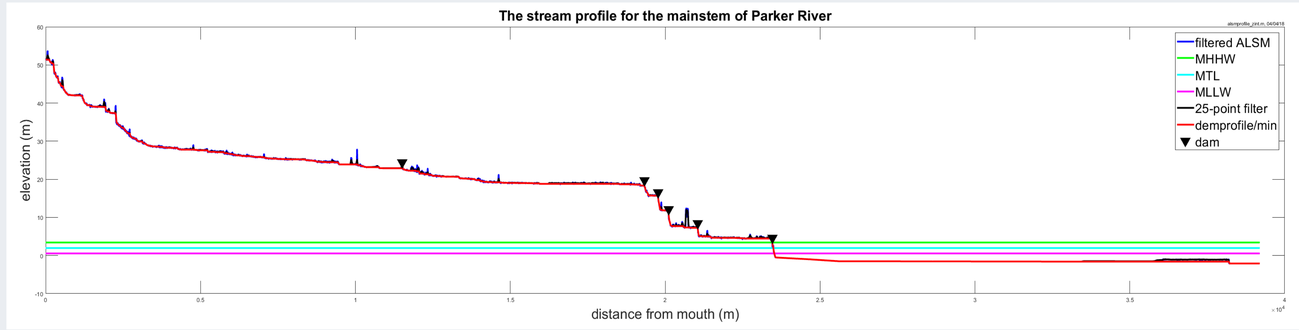
Human induced changes in upland watershed often have significant impact on the sediment supply at the river deltas and could lead to coastal erosion and expansion in different scenarios. Dams decrease the grade of the river and the flow velocity, and thus increase sedimentation rate at the locations of the dams and decrease sediment supply downstream of the dams. The main stem of Parker River in northeast Massachusetts hosts 6 dams and drains into Plum Island Estuary with about 35 km^2 of salt marshes. As suspended-sediment supply might affect the resilience of salt marshes against sea level rise (Kirwan et al. 2010), I am interested in understanding the impact of dams on sediment transport in the Parker River. I used 2011 LiDAR DEM data from MassGIS to take geometric measurements along the river profile and calculate shear stress following the method of Wilkins and Snyder (2011) and Rouse number of 63 µm sediments (silt-sand boundary), in order to evaluate sediment transport pattern in the main stem of Parker River.

The resulting maps of shear stress and rouse number show a homogeneous distribution. Rouse number at all locations are lower than 2.5 and thus sediments with a size of 63 µm or smaller will be able to stay suspended along the whole profile. This result implies that dams have little impact on the suspended sediment transport along the main stem of Parker River.

Method

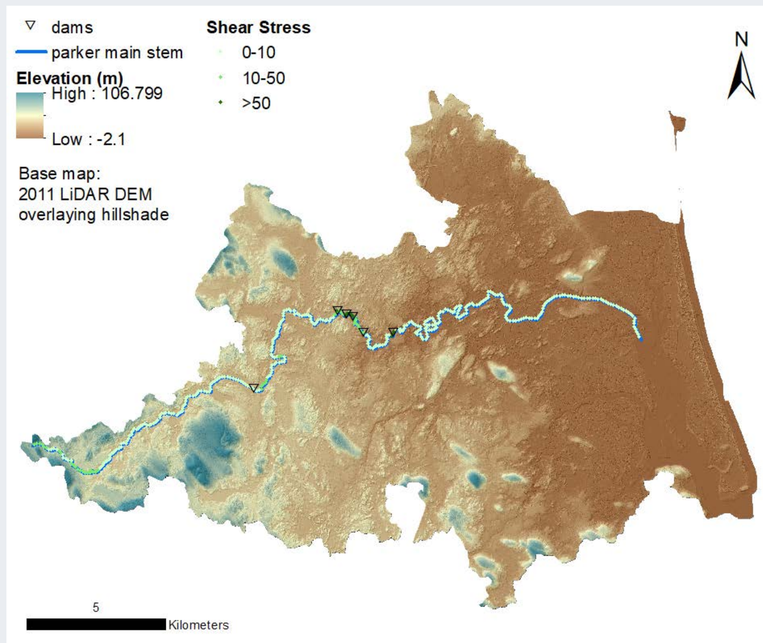


Results

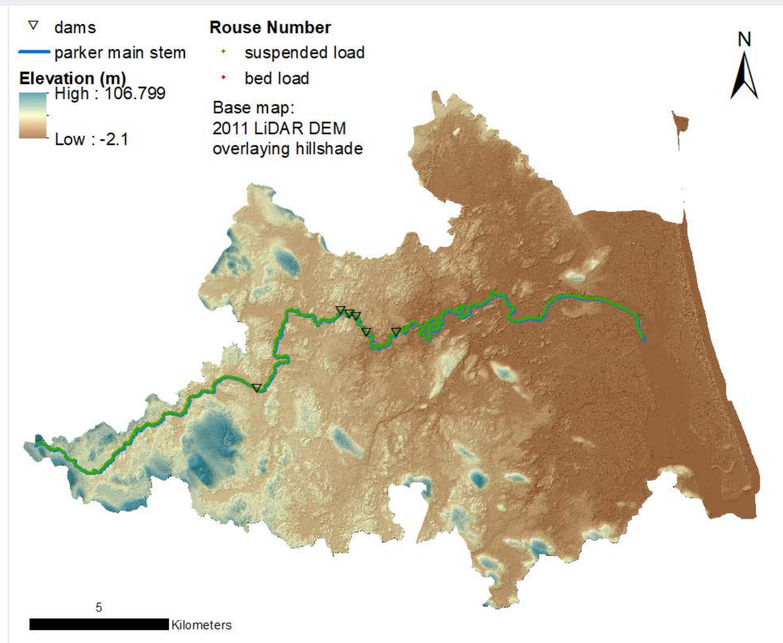


Tidal influence extends up to the first dam

* MTL – mean tide level, MHHW – mean spring high water, MLLW – mean neap low water



Most parts of the Parker River main stem have a shear stress between 0 and 10 Pa. Relatively higher shear stress is observed at the head water region where slopes are steeper and at locations of dam headwall.



All parts of the Parker River main stem have a Rouse number below 2.5 for sediments of 63 µm for bank-full discharge events. Thus, sediments with a size of 63 µm or smaller are transported in the form of suspended load.

Discussion and Conclusion

The homogeneous pattern of shear stress is consistent with the slope variation shown in the longitudinal profile: most regions of the main stem are relatively flat with similar slope, except the headwater region and the headwall of dams. The pattern of Rouse number indicates that shear stress along the whole profile is large enough in comparison to the settling velocity of silt-sized sediments at bank-full discharge, and could move sediments of 63 µm or smaller downstream without deposition. Thus, in the main stem of Parker River, dams will not prevent the transport of suspended sediment. Further examination on sediment supply is needed to better understand suspended sediment transport from Parker River to the coast, and help plan saltmarsh restoration effort in Plum Island Estuary.

Reference

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