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Discharge estimation from braiding patterns in arid areas

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Typically discharge data is rare in arid regions due to a lack of gauging devises and highly varying river systems, which are difficult to observe. However the demand for such data is enormous in light of the decreasing water resources and population growth. Braided wadi streams are the most typical river types in arid areas. They are characterised by highly dynamic runoff and sedimentation processes. Ephemeral discharge events significantly alter the braiding structures of the wadis.

These fluviomorphologic changes can be monitored and judged by spaceborn sensor data. Twelve project wadis in Jordan and the Sultanate of Oman are being investigated regarding runoff-induced morphologic changes. Change detection is performed with multitemporal optical satellite data from different sensors. Braiding indexes like total sinuosity, sinuosity of the main channel, channel count, island count and effective river width are determined by GIS analysis and digital image processing. The observed structural changes are correlated with in-situ discharge measurements. Additionally, the analysis is supported by hydraulic data from extensive field work.

As the discharge increases, so do the values of total sinuosity, channel count, island count and effective river width. Solely the sinuosity of the main channel decreases. The relationships can be best explained by power functions, which mostly exhibit coefficients of determination between 0,7 and 0,95. The effective river width shows the most significant results. By applying the corresponding power function within one project wadi it is possible to calculate the discharge with an accuracy of up to +- 20%. By incorporating hydraulic parameters like wadi slope and wadi roughness, locally these results can be further improved.

Based on this research, efforts are being made to develop a more general approach which can be transferred to further ungauged wadi systems. Primary results show that the analysis of river patterns is a promising tool for estimating wadi discharges in arid areas. Due to the spatial coverage of satellite data, also remote areas can be observed in a fast and economic way in regards to potential water resources.