EGU21-10888
https://doi.org/10.5194/egusphere-egu21-10888
EGU General Assembly 2021

Average Quantifying the snowmelt dominant river erosion in Afghanistan between 2004-2020

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Flooding of rivers is one of the major causes of soil erosion leading to significant changes in the geomorphological environment. Particularly, in countries such as Afghanistan, where the transboundary are designated according to the Amu River shorelines, are significantly affected by riverbank erosions. Amu River is driven by streamflow from the Pir Pranjal ranges of Afghanistan and Tajikistan. Numerical analysis of the river flow dynamics in such regions is subject to the scarce data availability on ground stations. Thus, ERA5 Reanalysis data provides a significant means for the temporal analysis of the geomorphological changes in such multi-national watersheds.

In this study, we propose a framework to quantify the Amu riverbank erosion in the Kaldar District of the Balkh Province of Afghanistan. The proposed framework is based on establishing an empirical relationship between the riverbank erosion area based on the discharge intensity and the specific stream power. To determine these two parameters, the river discharge is modeled using the ERA5 Reanalysis hydrological parameters based on multivariate regression. The river width is determined using the Normalized Difference Water Index-based (NDWI) derived from the Landsat-7 and Landsat-8 datasets. The riverbank erosion area is determined using shoreline analysis carried out using these datasets. The shoreline analysis indicates that Afghanistan is losing precious land due to the riverbank erosion over the past two decades (2004-20) amounting to as much as 86 sq. km and on average 5.4 sq. km every year. According to the ERA5 Reanalysis data, the water contribution from snowmelt in the spring and the summer was significantly dominant compared to the precipitation, which is consistent with several other watersheds in the north-western Himalayas. The river width and the discharge are observed to follow a power-law relation with an r^2 of 0.7. Additionally, the discharge intensity and the specific stream power showed significant relation (r^2 of 0.84 both) corresponding to the riverbank erosion area, where the peak flood events were observed to be outliers.