EGU21-4693, updated on 30 Jul 2021
https://doi.org/10.5194/egusphere-egu21-4693
EGU General Assembly 2021

Quantifying how hydrological and geomorphical dynamics in the land-river interface create opportunities and trade-offs for sustainable development

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Hydrological and geomorphological processes within the land-river interface (LRI) can be directly linked to several Sustainable Development Goals (SDG). The transfer of water and material along the LRI provides a range ecosystem services that support environmental, economic and social needs. However, the LRI is also very dynamic from a hydrologic and geomorphic perspective. Benefits can turn into hazards and vice versa, depending on natural and human-induced variations in flow and associated geomorphic activity. This study aimed to identify these critical areas by (i) quantifying the natural and human controlled variation in hydrology and geomorphology, and (ii) mapping associated SDG-related opportunities and trade-offs. The upper reaches of the Himalayan Beas River (India) were used as a case study, where the LRI is characterised by three main sections: (i) a free-flowing confined upper valley, (ii) a heavily regulated confined middle valley, and (iii) and a valley with wide floodplains flowing into the Pong Reservoir. Remote sensing imagery from Sentinel-2 (ESA) (2016-2019) were used to quantify the monthly spatial recurrence of river channels and gravel bars. In addition, data was collected on human and natural infrastructure within the catchment (including road network, urban areas, cropland, national parks, etc.). Combination of both datasets indicated that hydrological and river geomorphological processes in the upper part are the most spatially and temporally variable, leading to fertile soils (SDG 1,2), but also the highest risk of flooding in urban areas and cropland (SDG 11, 13) . The middle part is characterised by stable river channels (i.e. no lateral movement) due to the presence of two dams and confines valleys, leading to limited interaction with the surrounding land, except for the provision of water (SDG 6) and a higher risk of landslides (SDG 1,11). Finally, the lower part is again more dynamic in terms of geomorphological processes, with wide gravel bars and side channels. These dynamics allow larger urban areas and cropland to develop (SDG 1, 11), but also exposes cropland to flooding and erosion (SDG 2, 6). By quantifying the spatiotemporal dimension of hydrological and geomorphological processes and how these relate to LRI characteristics, this study provides a dynamic baseline to identify opportunities and trade-offs in optimising the role of the LRI in driving sustainable development.