Mapping socio-economic-environmental synergies and trade-offs to sustainably manage the land-river interface: a fluvial geomorphologists' perspective

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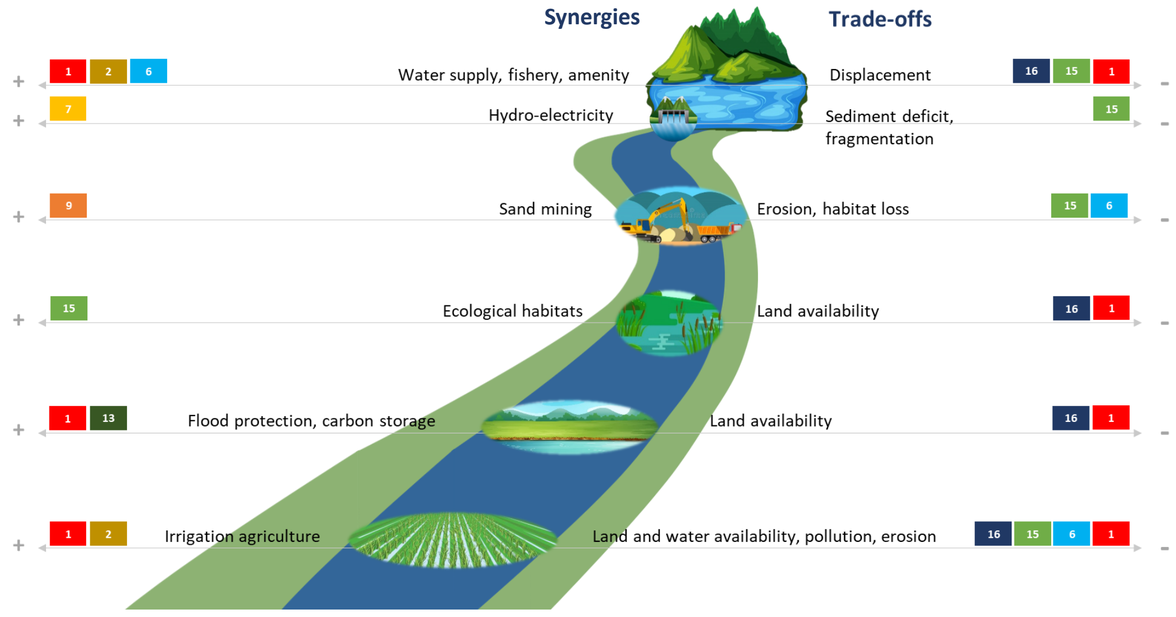
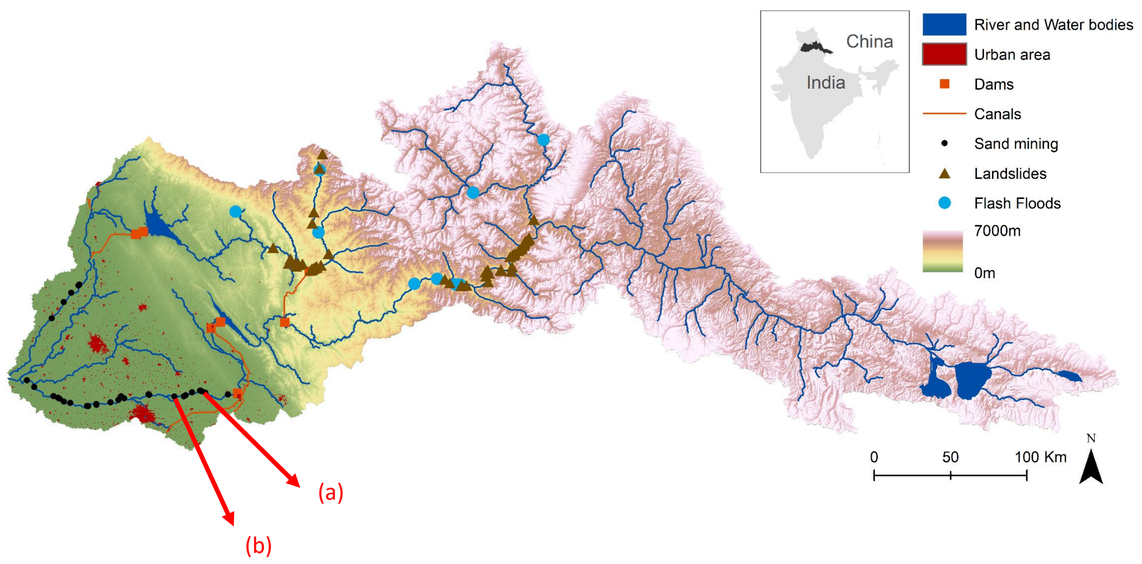
Project aim

Rivers and the land that surrounds them are focal points of economic activity and development in most countries. They are essential to humans for water supply, agriculture, transport and energy; hold significant importance socially and culturally; and have critically important ecological habitats that sustain high biodiversity. However, they are rarely managed in a holistic manner. Institutional boundaries, socio-economic drivers and barriers, and complex interactions between environmental processes limit our ability to integrate policies across the Land-River-Interface (LRI).

The aim of this research project is to support the design of integrated and sustainable policy solutions for the LRI that enhance multiple Sustainable Development Goals (SDGs). To this end, investigation and modelling of the spatially-explicit social, economic and environmental synergies and trade-offs within the LRI are being carried out under multiple socio-economic and climate scenarios. The research focusses on the transboundary Beas-Sutlej river catchment in the Himalayan region, and is co-designed with local stakeholders (universities, farmers, water management boards, regional and national government).



Case study: Himalayan Sutlej-Beas River catchment



Research approach

The spatial connectivity between land and river, and the resulting processes can cause opportunities and risks, which can lead to socio-economic-environmental synergies and trade-offs towards attaining multiple SDGs.

LRI process	Opportunities	Risks
Fluvial geomorphology	Nutrients to floodplain soils Sand deposition (resource) Aquatic ecosystems	Bank erosion and loss of land Destruction and pollution of agricultural land
Hydrology	Water provision Hydro-electricity Aquatic ecosystems	Flooding (damage and loss)
Geomorphology	Nutrients delivery Sediment supply	Landslides (damage and loss)

Step 1 Quantifying LRI processes → **Step 2** Identifying risks and opportunities → **Step 3** Mapping synergies and trade-offs for attaining SDGs

Example: quantifying fluvial geomorphological processes

Data sources

River planform 1947: Revenue Survey of India (British Library)
River planform 1989-2018: Landsat (20m, NASA)
River discharge: RivDIS (Vorosmarty et al., 1998)

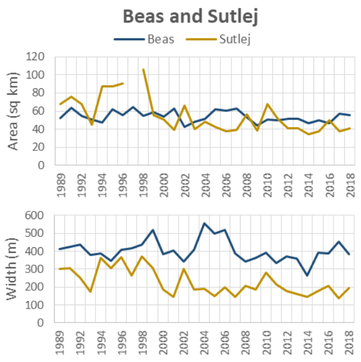
Data analysis

Google Earth Engine was used to compute images of the *modified Normalised Difference Water Index (mNDWI)* to extract the river planform over the different timescales.

Impact of dam construction at centennial timescale

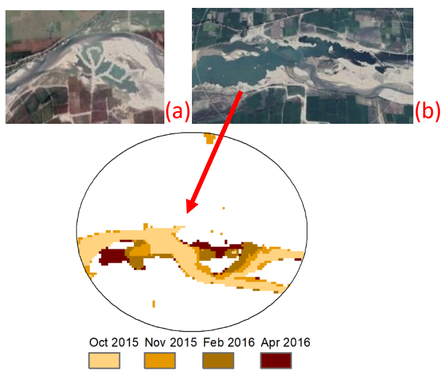
A significant decrease in the total bank-full river area for both rivers is observed in the post-dam period compared to pre-dam.
The available discharge data indicates that peak flows have reduced while baseflows have increased due to the dams.

Continuous change at annual timescale



River planform change since 1989 was different in the Sutlej and Beas rivers. While the Sutlej river shows a statistically significant continuing decrease in area and width, the Beas rivers appears to be more stable.

Impact of sand mining at monthly timescale



An example of episodic geomorphic change is caused by sand/gravel mining along the Sutlej river. In a couple of months, sand bars entirely disappear.

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https://www.cranfield.ac.uk/research-projects/social-economic-environmental-trade-offs-in-managing-the-land-river-interface

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