Sediment transport and the Indian Rivers Interlink project

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Introduction

What is the Interlink Project?

The Indian Rivers Interlink (IRI) project aims to link several of India's major rivers via a network of reservoirs and canals. Variations of the IRI have been discussed since 1980, but the current plan has increased support under Prime Minister Narendra Modi. Construction on the first three canals (#s 24, 26 and 27) has controversially begun.

If the Interlink project continues, fourteen canals would ultimately divert water from tributaries of the Ganges and Brahmaputra rivers to areas in the south and west. This is expected to affect sediment transport to the Ganges-Brahmaputra Delta. Additional canals would transport Himalayan sediments 500 km south to the Mahanadi delta and more than 1000 km south to the Godavari and Krishna deltas (Fig. 1).

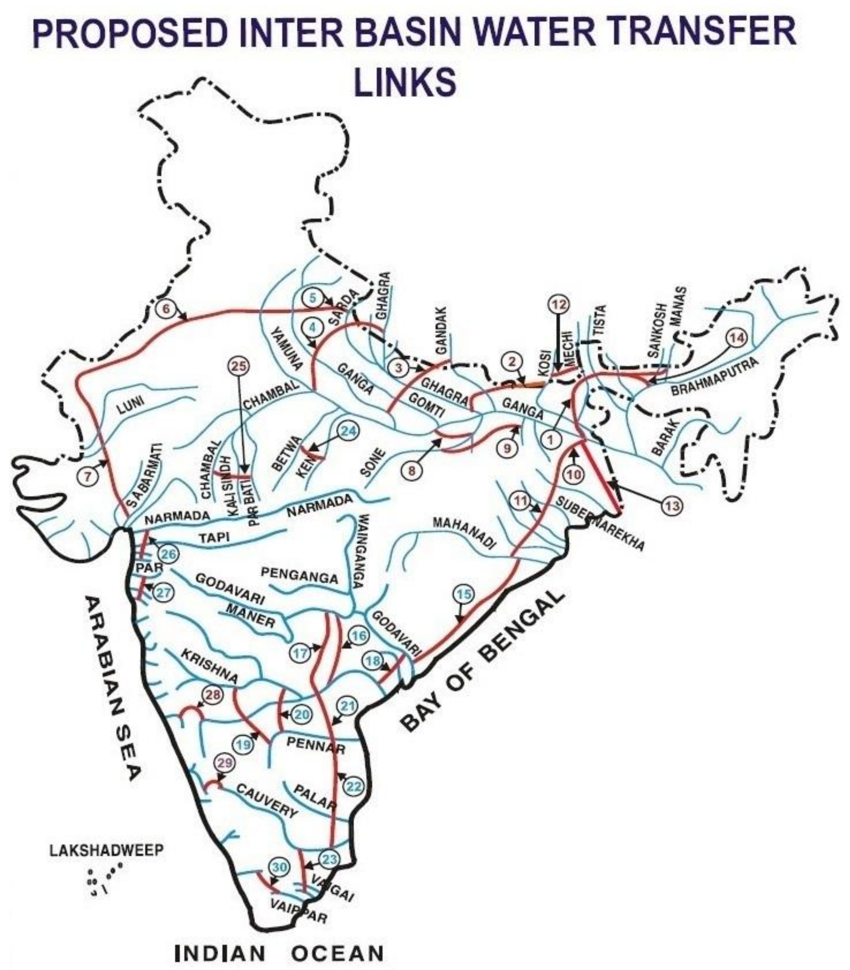


Fig. 1: Summary of link canals and major rivers. From the National Perspective Plan, National Water Development Agency (NWDA), www.nwda.gov.in.

Aim

We aim to model the impacts of the proposed diversions on sediment transport to the Ganges-Brahmaputra Delta. We use *HydroTrend* v. 3.0, a climate-driven hydrological water balance and transport model (Kettner & Syvitski, 2008), to examine water and sediment discharge where the Ganges and Brahmaputra enter Bangladesh.

About HydroTrend

Hydrotrend v. 3.0 (Kettner & Syvitski, 2008) takes inputs of climate data (meteorological station data or global circulation model output) and basin characteristics (altitudinal temperature gradients, topography, glacier equilibrium line altitudes, sediment transport and erosion coefficients). Outputs are daily synthetic river discharge and sediment loads (multiple grain sizes).

Input & Validation Data I

Canal and dam data

Data sources for water input/outtake:

1. Open Street Map (Fig. 3)
2. Google Maps/Google Earth
3. Feasibility reports (NWDA/WRIS)
4. Jain, Agarwal & Singh (2007)
5. Mizra, Ahmed & Ahmad (2008)
6. News Articles
7. Georeferenced maps (Fig. 2)

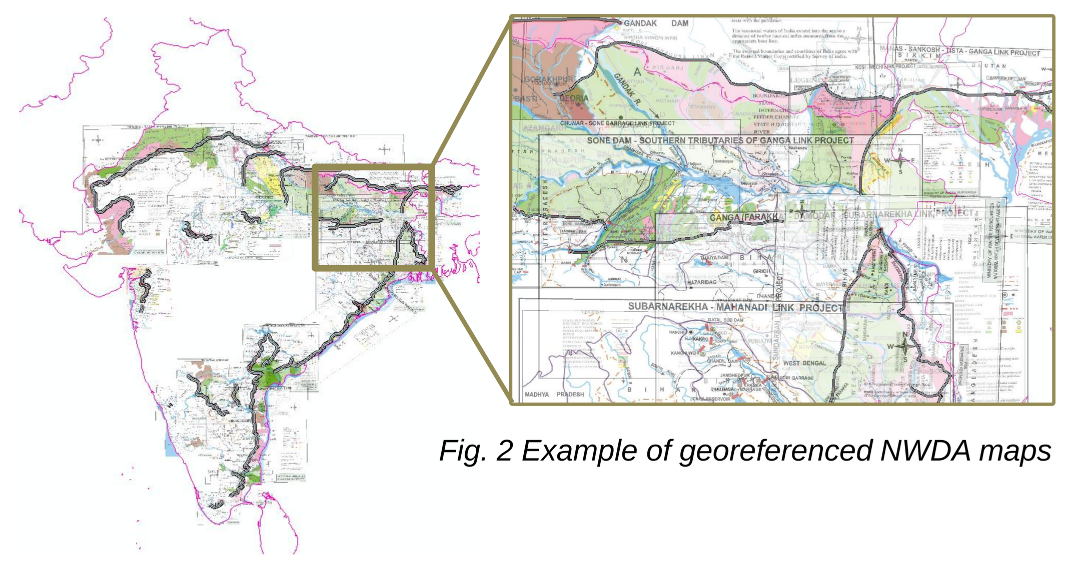
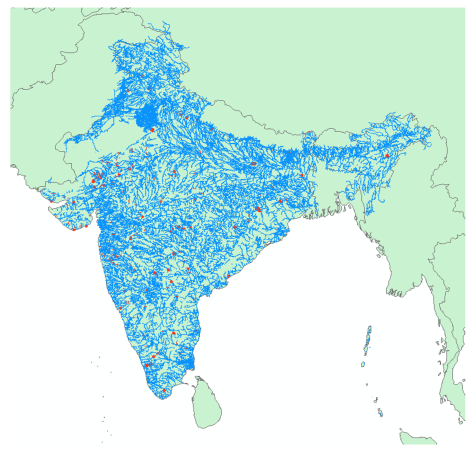


Fig. 2 Example of georeferenced NWDA maps

Fig. 3 Open Street Map India: Crowd-sourced rivers and dams



Dam Site	Latitude	Longitude
Manas	26.803	90.954
Sankosh	26.7794	89.9313
Tista	26.754122	88.590066
Farakka	24.805	87.934
Bahadurabad	25.17	89.67

Tab. 1 Example of outtake points determined for the Manas-Sankosh-Tista-Ganga link (#13)

Data sources for discharge/water volumes:

1. Feasibility reports (NWDA/WRIS)
2. HydroTrend with Pervez & Henebry (2014) data
3. RiverWatch (AMSR-E) (Brakenridge et al., 2007)

Precipitation

For monthly average precipitation and daily standard deviations, we use interpolated averages between 43 National Oceanic and Atmospheric Administration (NOAA) National Climate Data Center Global Surface Summary of Day (GSOD) observation stations located in China, Nepal, India, Bhutan and Bangladesh. These averages come from Pervez & Henebry (2014) (Fig. 4).

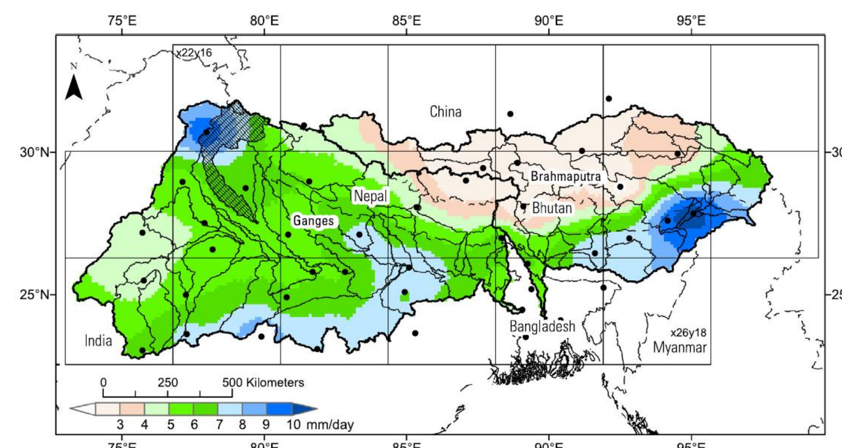
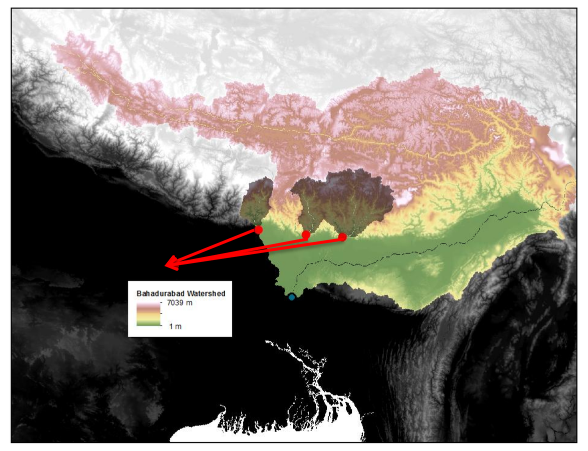


Fig. 4 Precipitation stations and contours of average precipitation, from Pervez & Henebry (2014)

Input & Validation Data II

Hypsometric Curves

Hydrotrend takes as input a hypsometric curve (cumulative area vs. elevation) of the drainage basin (e.g., Fig. 6.) Here, watersheds above and below each outtake point are delineated using the Terrain Analysis Using Digital Elevation Models (TauDEM) V. 5 (David Tarboten, Utah State University).



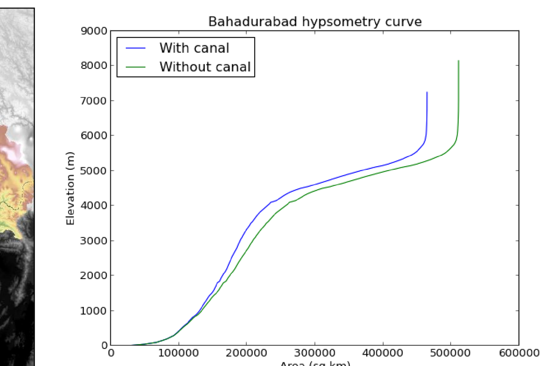


Fig. 6 Change in hypsometry with and without link #13.

Fig. 5 Watershed of the Brahmaputra River above Bahadurabad gauging station. Shading shows areas effectively removed from the watershed by proposed canal #13, the Manas-Sankosh-Tista-Ganga link, which would transport water from the shaded areas out of the Brahmaputra watershed and into the Ganges river and further south.

Preliminary Results: Link #13

As a "proof-of-concept," we performed a preliminary model run for the watershed above Bahadurabad Station. We looked at the impacts of link #13, the Manas-Sankosh-Tista-Ganga link, on water and sediment discharge.

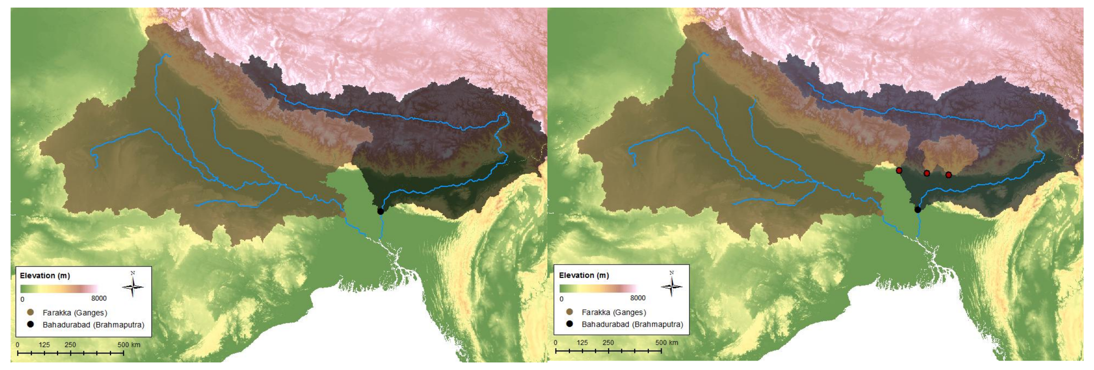


Fig. 7 a) Farakka (orange) and Bahadurabad (grey) watersheds with no link canal. b) Farakka and Bahadurabad watersheds with link #13 in place.

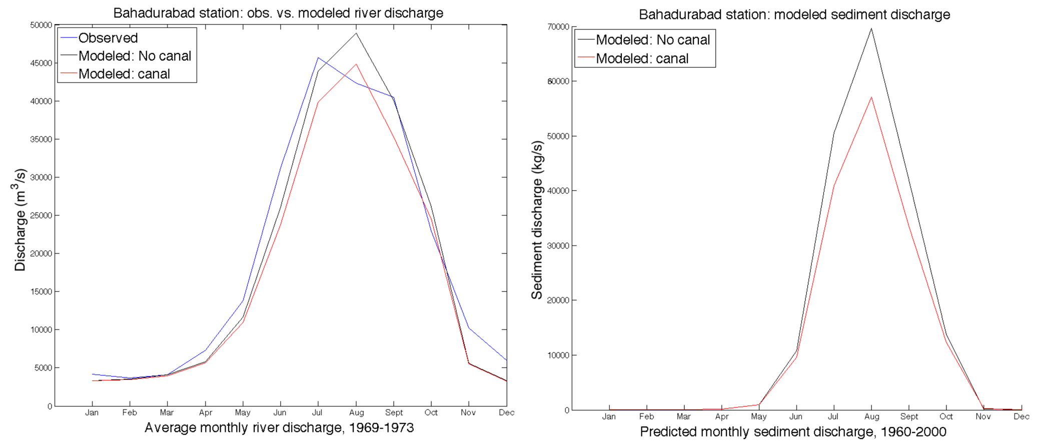


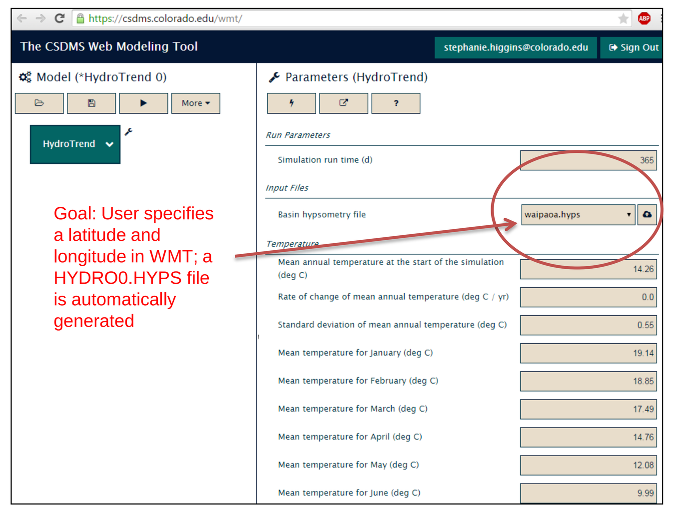
Fig. 9 a) Observed vs. modeled river discharge for Bahadurabad station with and without link #13. b) Predicted sediment discharge change due to link #13.

Modeled no-link discharge agrees well with observations, but this is primarily due to "tweaking" of the mass balance coefficient in HydroTrend. Improved precipitation data may be needed. As expected, sediment discharge is predicted to decrease by as much as 20% due to link #13 – however, model uncertainty must be quantified before we can say whether or not this reduction is significant.

Running HydroTrend in WMT

A new service component

Automatically generating hypsometry input files (HYDRO0.HYPS) and other input files for HydroTrend will ultimately be possible through WMT. Users will be able to enter a latitude and longitude and select a Digital Elevation Model (GTOPO30, Hydro 1K, SRTM, or a user-supplied DEM.) TauDEM, GDAL, and new Python wrappers produce watershed hypsometric curves and shapefiles above the specified point.



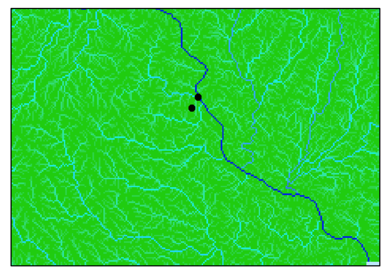


Fig. 10 TauDEM's existing "move point to stream" tool has now been updated to be compatible with the USGS's HYDRO1K projection.

Fig. 9 The WMT interface for HydroTrend.

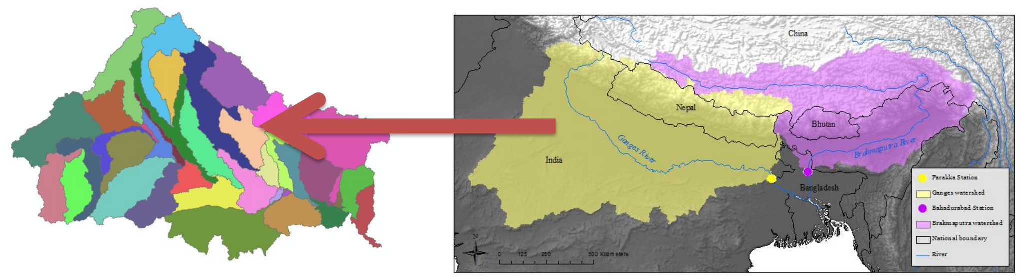


Fig 10 Automatically generating input files will simplify application of HydroTrend to multiple sub-basins, allowing improved modeling of large catchments. Example Ganges sub-basins: Pervez & Henebry (2014)

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Acknowledgments

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