Drone image: Ganga around Bhagalpur

(Photo credit: SANDRP)

"Is Sand Mining Killing Our Rivers"

India Rivers Forum

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Sediment Dynamics vis-à-vis Sand Extraction

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Setting the Stage

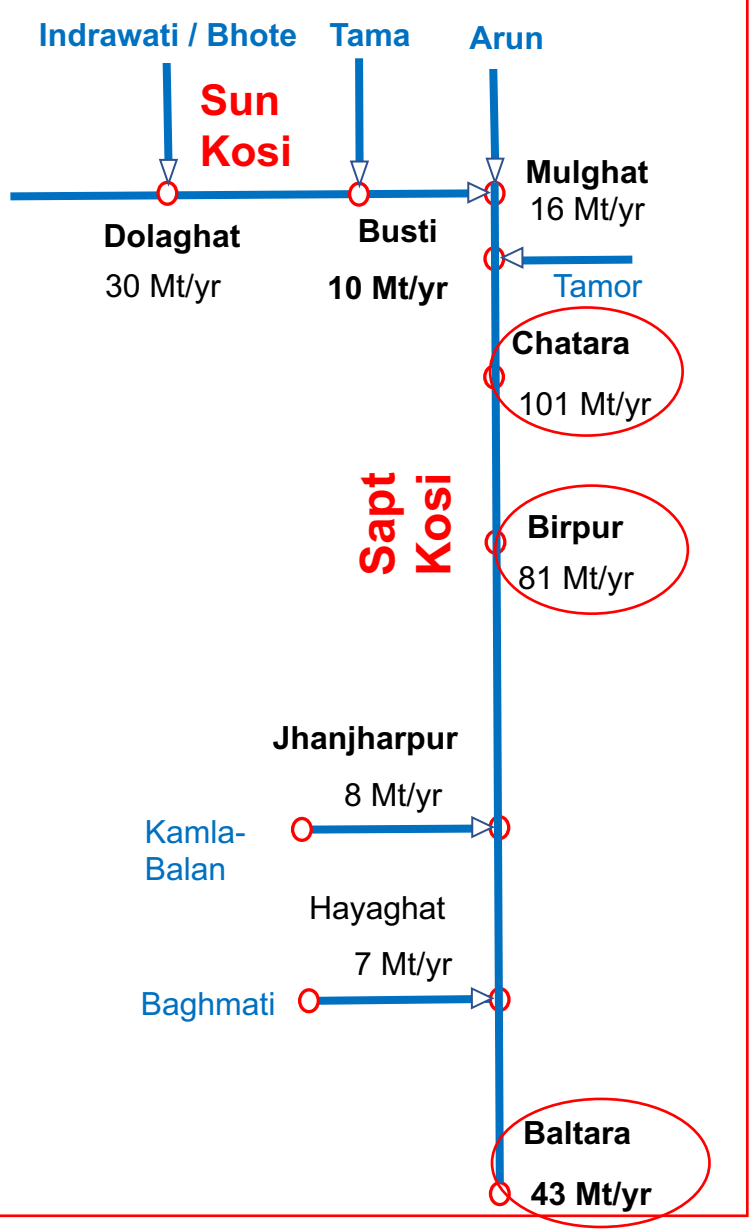
- Himalayan rivers are highly sediment-laden, in particular, the rivers of the Lower Ganga system.
- In-channel sedimentation is a natural process but has lately been aggravated by human interventions.
- In-channel sedimentation is spatially non-uniform – need to know the 'hotspots' of siltation, rates of deposition, and accumulated sediment volume.
- Strategic sand extraction may be required in many reaches to maintain the sediment regime of the river to an acceptable level and to prevent any serious disaster.
- Sand is required for various human needs, and there are no good practical alternative available.

BUT…….

- Indiscriminate sand extraction is disastrous for the river – needs a proper assessment of river processes and estimates of 'extractable' sand based on scientific studies.
- No lack of policy (e.g. MOEF 2020 guidelines) but rather lack of process understanding, administrative will and means/resources for implementation.

Challenge: How to strike a balance between human needs and river ecosystem protection?

Sediment Budget of the transboundary Kosi River



Total sediment accumulated since the embankment construction:

Chatara-Birpur:

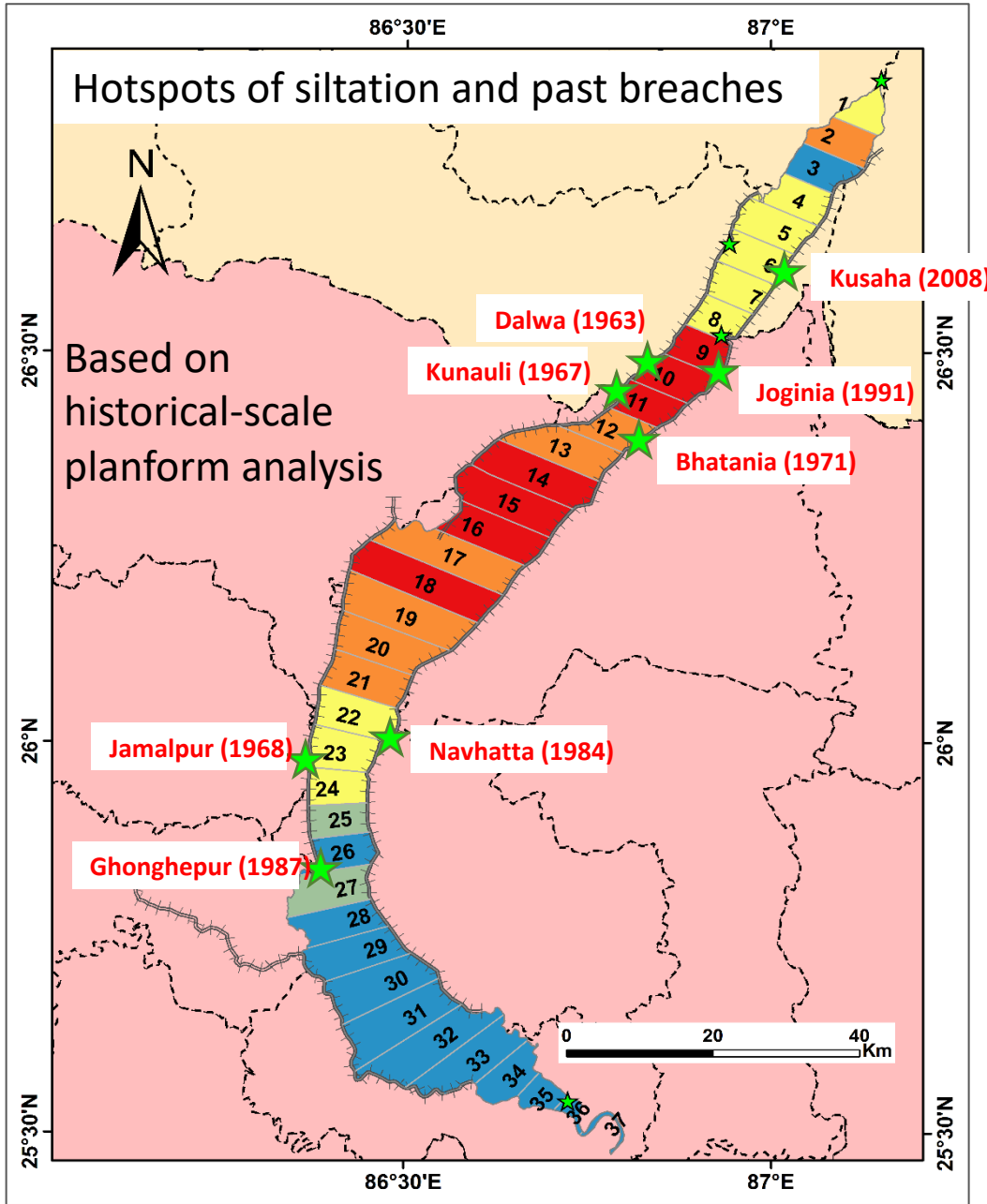
= 1080 million tonnes

= 408×10^6 m^3

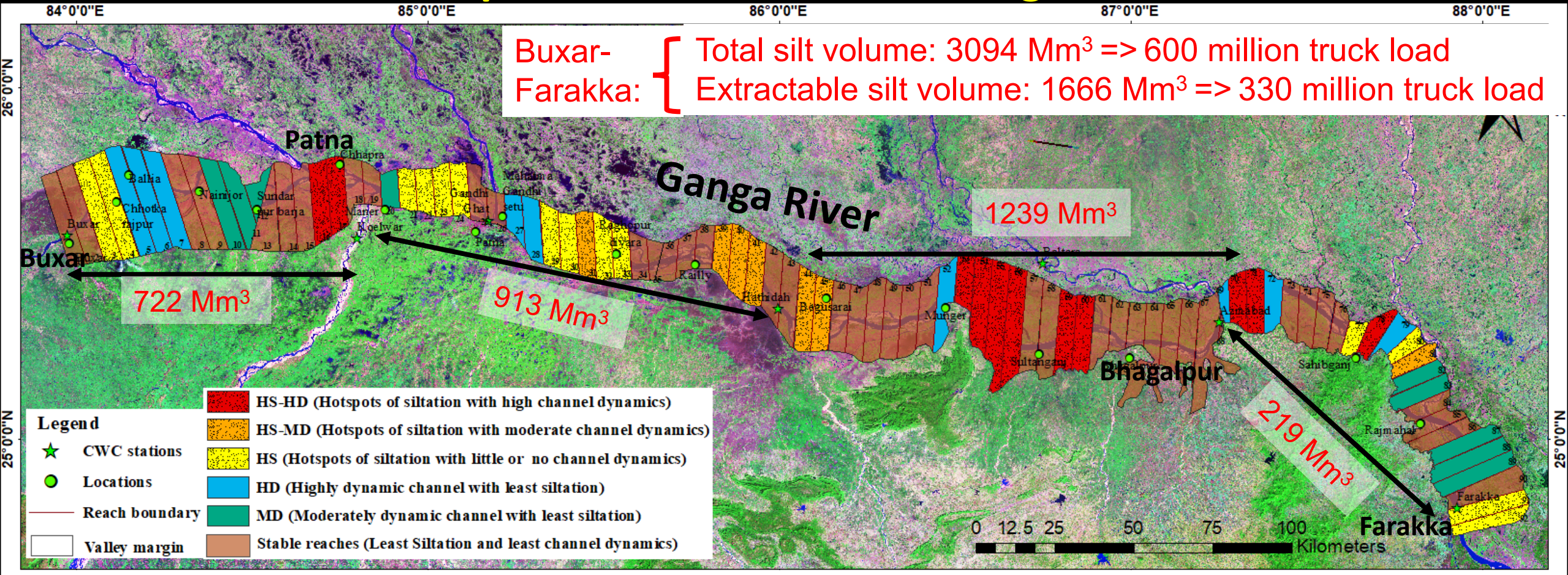
Birpur-Baltara:

= 2862 million tonnes

= 1080×10^6 m^3



Hotspots of siltation in the Ganga River

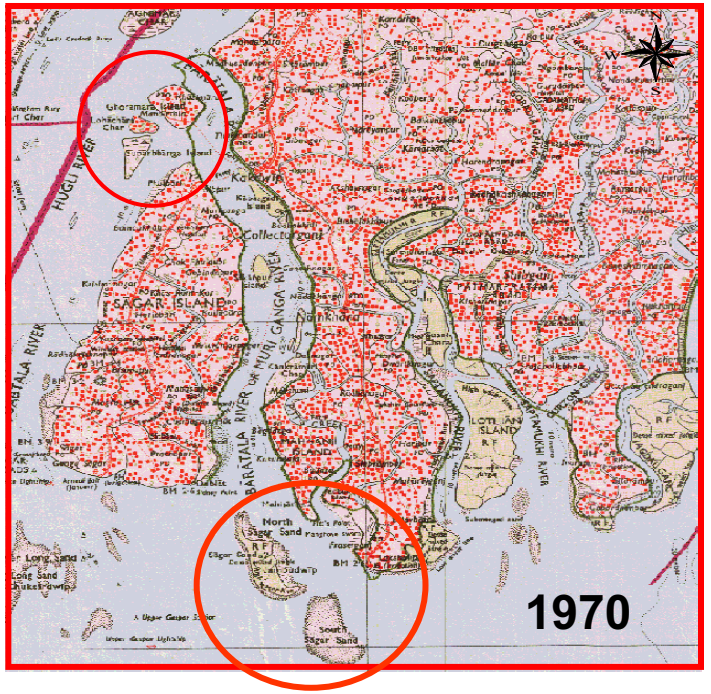


- Lowermost stretch of the Ganga river basin has very low slope, flat plains.
- Three most-sediment charged rivers – Ghaghra, Gandak and Kosi meet the Ganga.
- Flow reduction from upstream interventions, diversions, and groundwater abstraction.
- Lower sediment volumes in Farakka stretch – deposition in the upstream stretches; possible underestimation due to ponding.

Role of the Farakka barrage and impact on the GBM delta

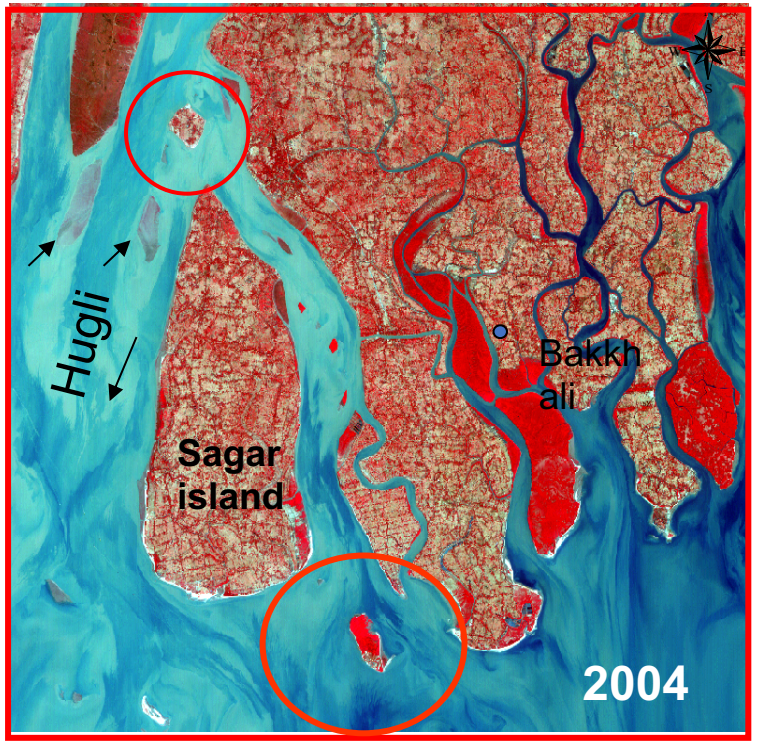
- Farakka barrage has acted as a major ‘barrier’ for sediment dynamics – large islands developed upstream of the barrage.

A large sand bar upstream of Farakka barrage (Photo taken in Feb 2018)

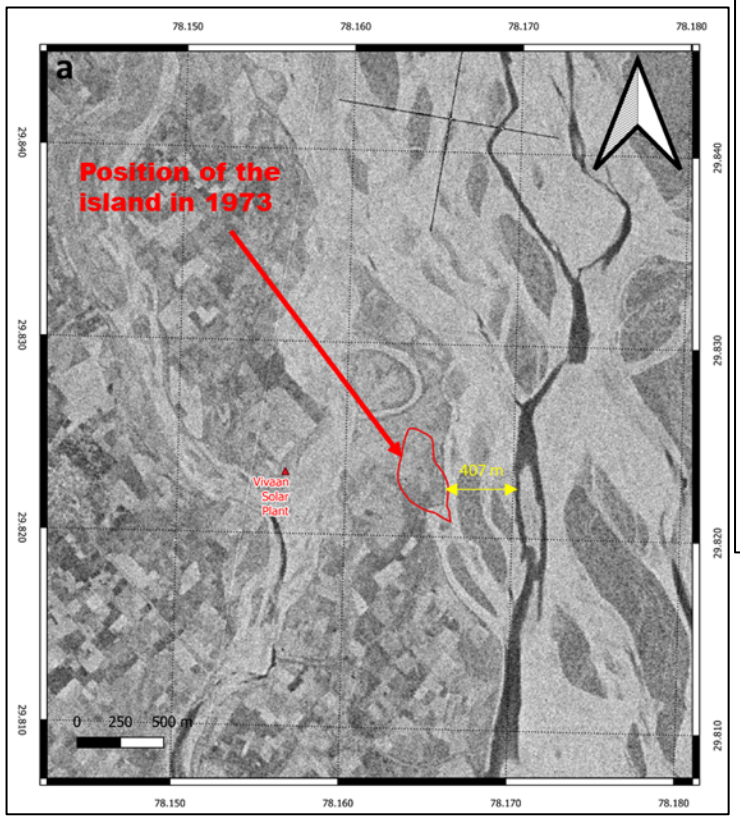


- Sediment starvation in the GBM delta (’Sinking delta’) affecting delta ecosystem
- Some reported mining in the Hugli river downstream of Farakka might have added to the problem.
- Landscape dynamics in the GBM delta (1970-2004)
  - Several islands disappeared and some reduced by ~ 40%
  - Severe coastal erosion around many islands

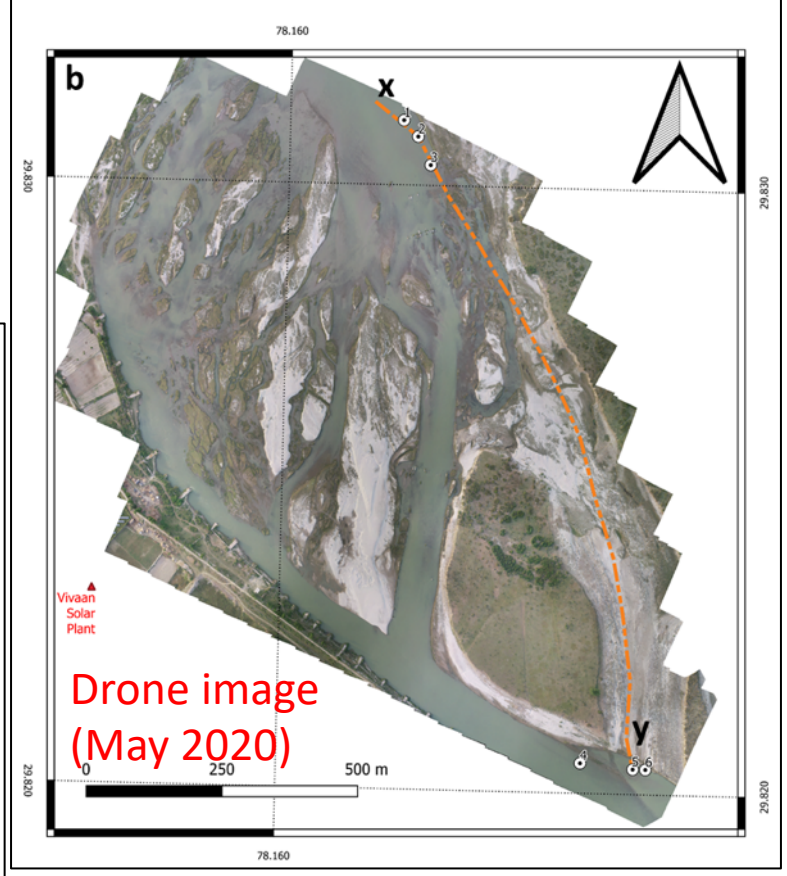
    => Coupling of sea level rise and sediment starvation



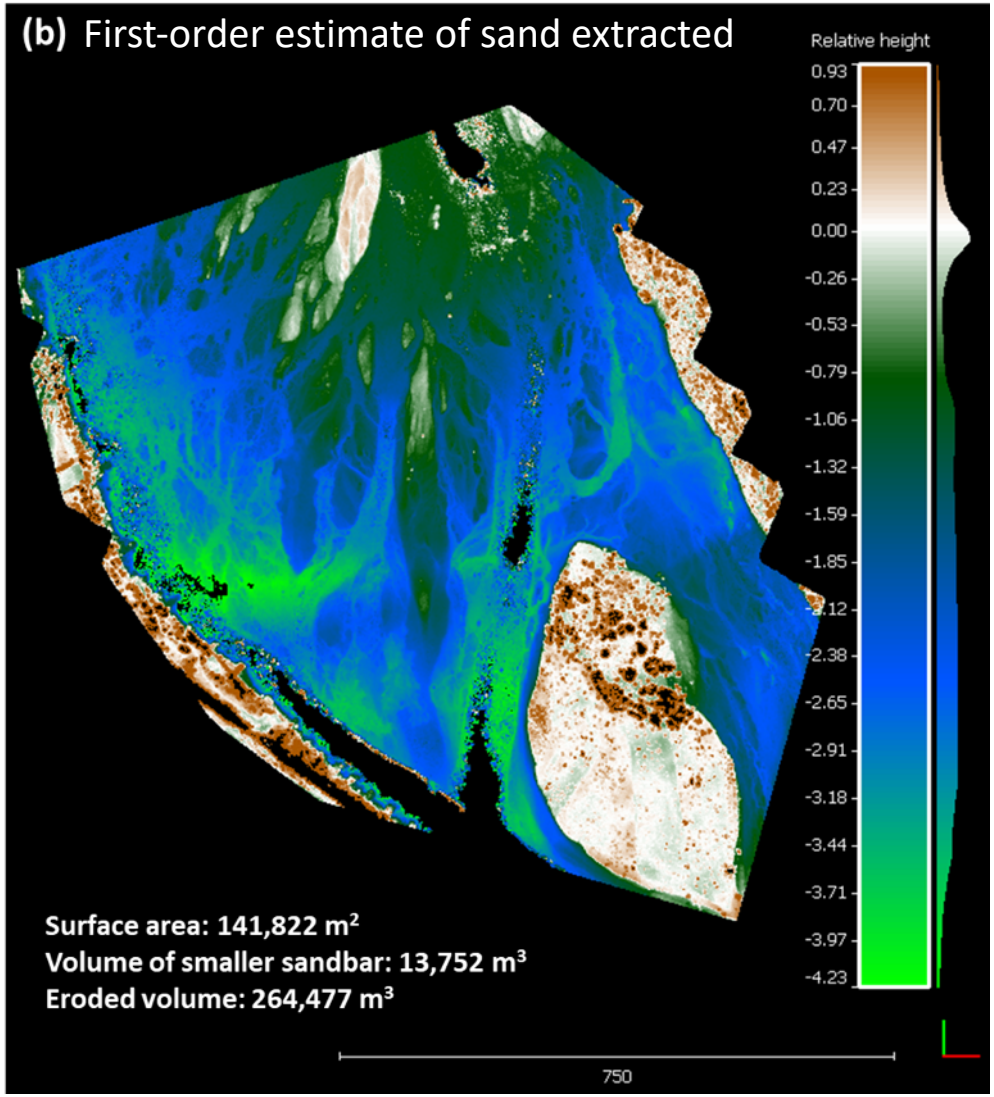
Impact of mining - Upper Ganga (Bhogpur)



High-resolution Corona images (1973)



- Large island - part of the flood plain in 1973, now within the channel belt
- Past mining activities created mining pits, expansion of channel belt and erosion of the west bank
- First order estimates of sand extracted



(Sinha, 2020, NMCG Report)

What should be done?

Process understanding of sediment dynamics in rivers needs to be translated into action – Himalayan vs cratonic rivers.

Need an end-to-end solution – from sand extraction to impact assessment to utilization plans.

Environmental concerns for excessive sand extraction need to be addressed as well.

MOEF 2020 guidelines address several issues specific to sand extraction but yet to be fully implemented by Mining departments.

Need a comprehensive Sediment Management Policy Framework for the rivers, particularly for the Himalayan rivers.

Sediment Management Framework

Where? → Identification of hotspots of sediment production and deposition

Geomorphic analysis – sediment connectivity, channel form & dynamics

How Much ? → First order estimates of modern sediment flux over 10-10^2 years scale

Cross-section surveys, drone surveys, Hydrology and sediment load data

How? → Protocols for sand extraction

Strategic dredging, replenishment studies, Sand utilization plans

What next? → Monitoring and impact assessment, Stakeholder's engagement

Continuous monitoring, EIA, Environmental community participation and engagement.

Himalayan vs peninsular river sands

- **Himalayan sands**
  - Mica rich, high clay content and alkali, highly weatherable and hence not suited for construction activities where high strength is required (e.g. foundation, large engineering structures).
  - Grain size is quite fine in the lower reaches.
  - In the upper reaches, gravels are extracted then crushed to appropriate size.
  - Possible bulk usage: Road construction, filling of low-lying areas, flood control measures, agricultural applications.

- **Cratonic sands**
  - Coarser, feldspar rich, much more resistant and hence preferred for construction activities – provide higher strength (well suited for foundation and large engineering structures).
  - This explains the extensive mining of sand in south Bihar rivers and in central India draining from the peninsular India.

Specific Recommendations for sand extraction (in addition to MoEF 2020 guidelines)

(Sinha, 2020, NMCG Report)

- Sand extraction in a river should not be governed by its present-state or morphology but by defining a '**reference state**' i.e. a minimum acceptable or agreed upon morphological and ecological state of the river.
- Mark the **zones of aggradation or degradation** along the river based on historical analysis - all mining should be located around the aggradational stretches.
- Must also take into account the associated processes such as **channel dynamics and bank erosion** (natural vs anthropogenic).
- **Depth of sand extraction** should be determined based on the rates of accumulations (sand budget) at these locations and it should alter the general slope of the stretch in a major way.
  - => Sand extraction rate < sand is redeposited from either bedload or suspended load.
- Limited extraction of sand from **filled paleochannels** away from the active channels preferred but **should not affect** groundwater recharge.
- Riverbed mining should always be taken up in non-contiguous, small patches to **maintain the riffle-pool structure** of the river longitudinally - an important ecological criterion.
- Cutting of riverbanks and widening of river channel must be avoided during sand mining.
- All **ecological hotspots** along the river should be avoided for sand mining irrespective of their regime – **No-go areas**.