



जल शक्ति मंत्रालय
MINISTRY OF
JAL SHAKTI



भूमि संसाधन विभाग
DEPARTMENT OF LAND RESOURCES
MINISTRY OF RURAL DEVELOPMENT

Mapping and Planning of the Narmada River and Its Tributaries

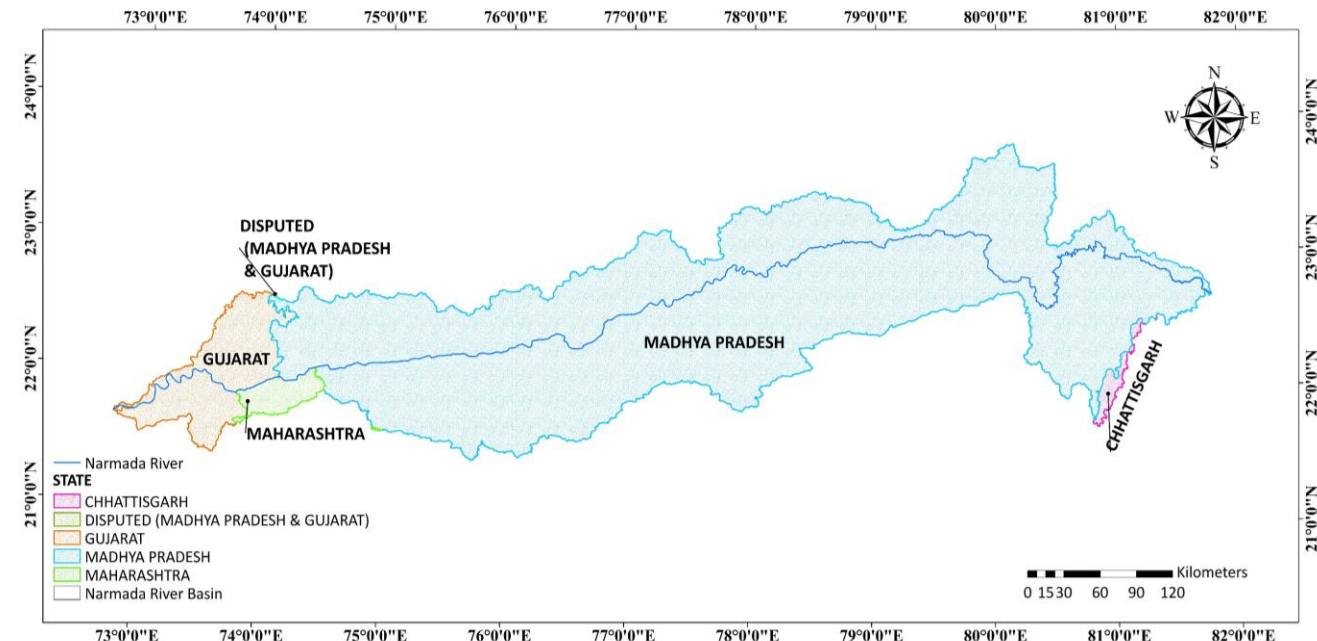
for Integrated River Management in Madhya Pradesh and Gujarat

Prof. Pranab Kumar Mohapatra

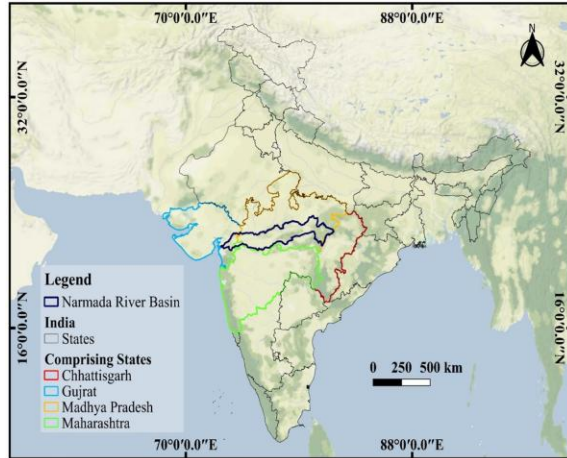
cNarmada, IIT Gandhinagar

National Workshop on Rejuvenation of Rivers/Streams
through Watershed Development Approach

29 September 2026 | Bharat Mandapam, New Delhi

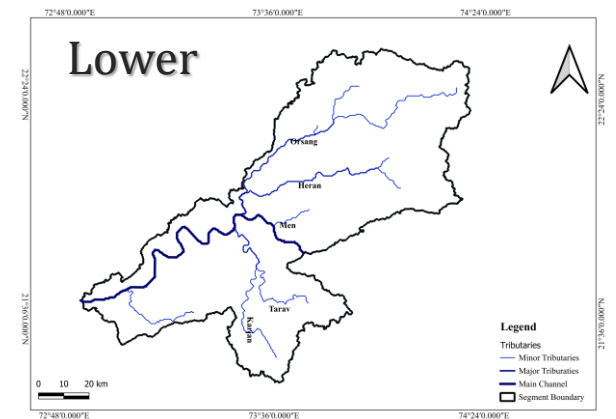
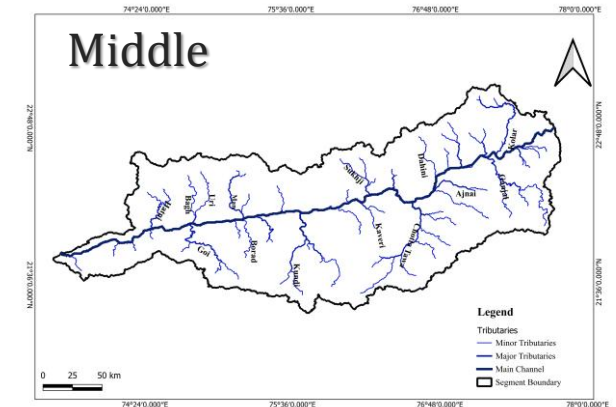
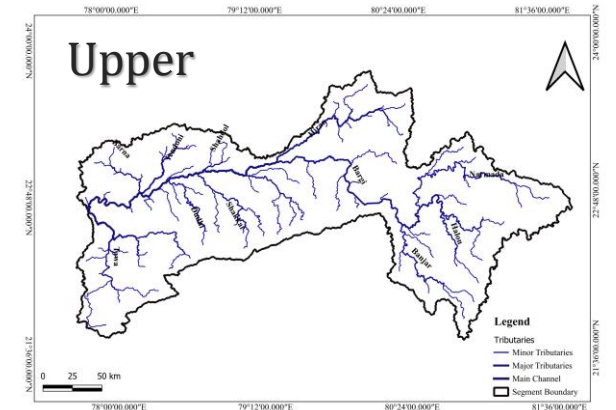
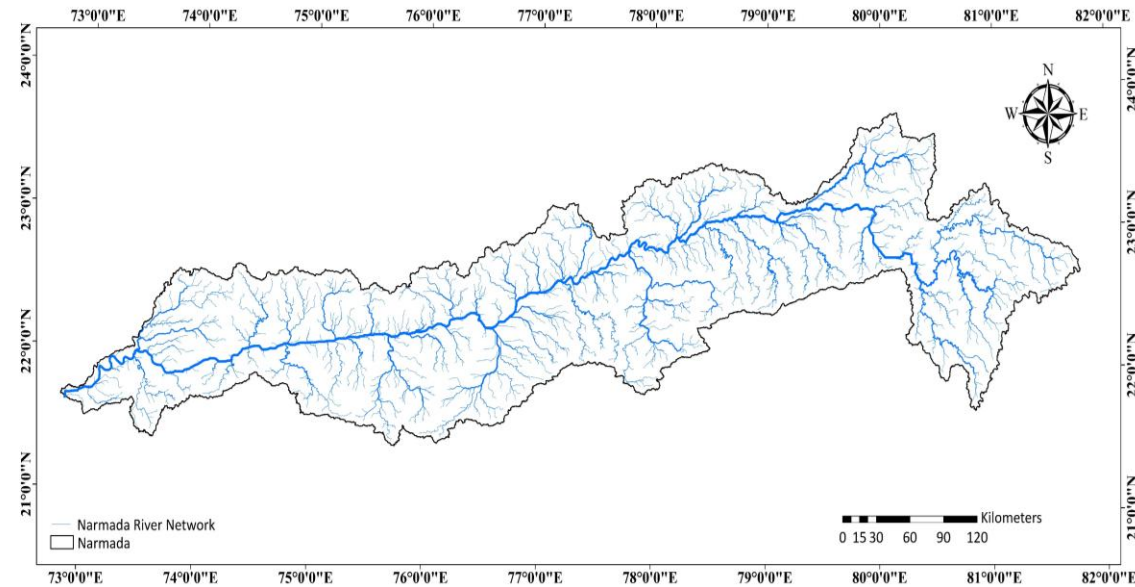


Watersheds, tributaries and the main river

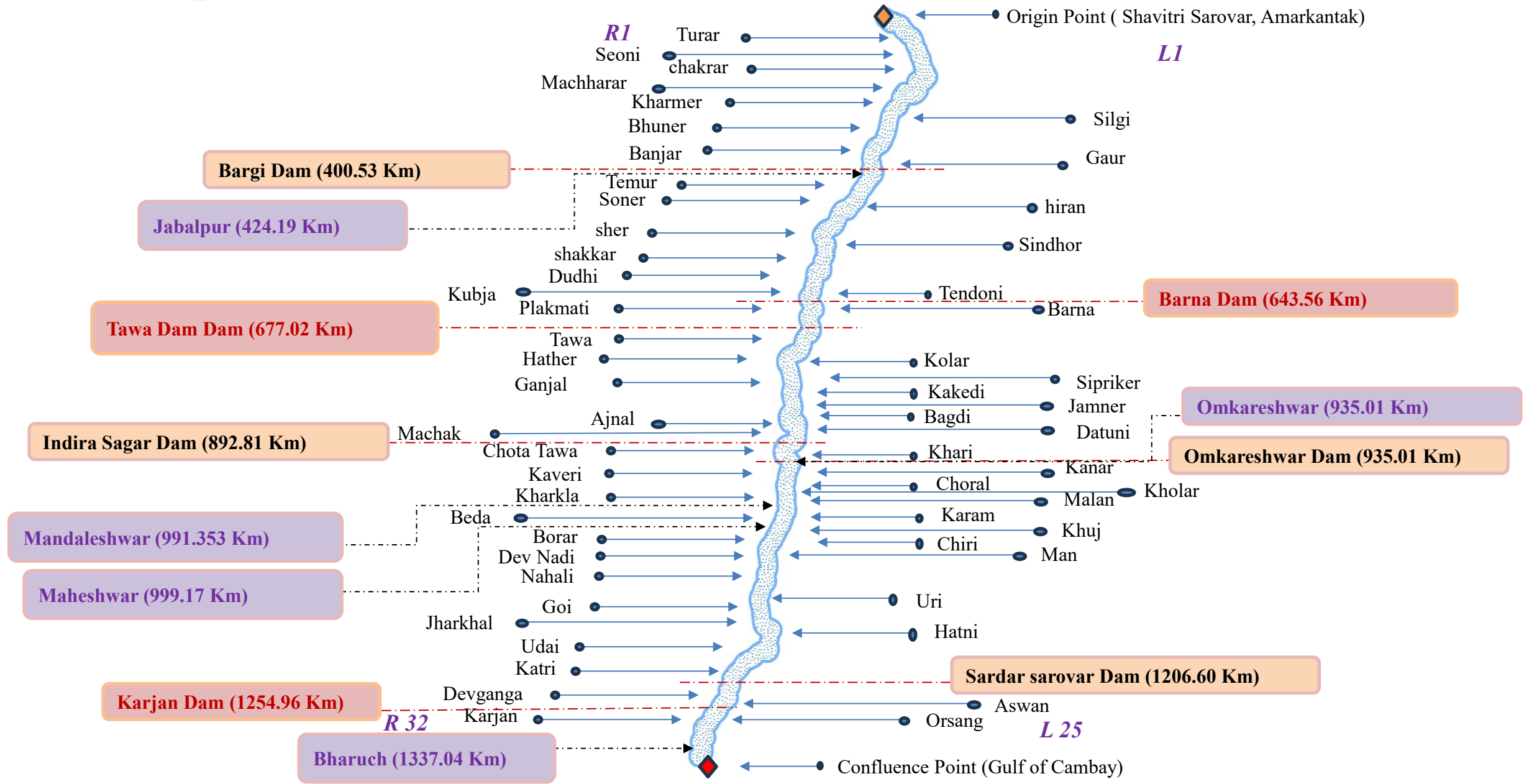


Madhya Pradesh and Gujarat

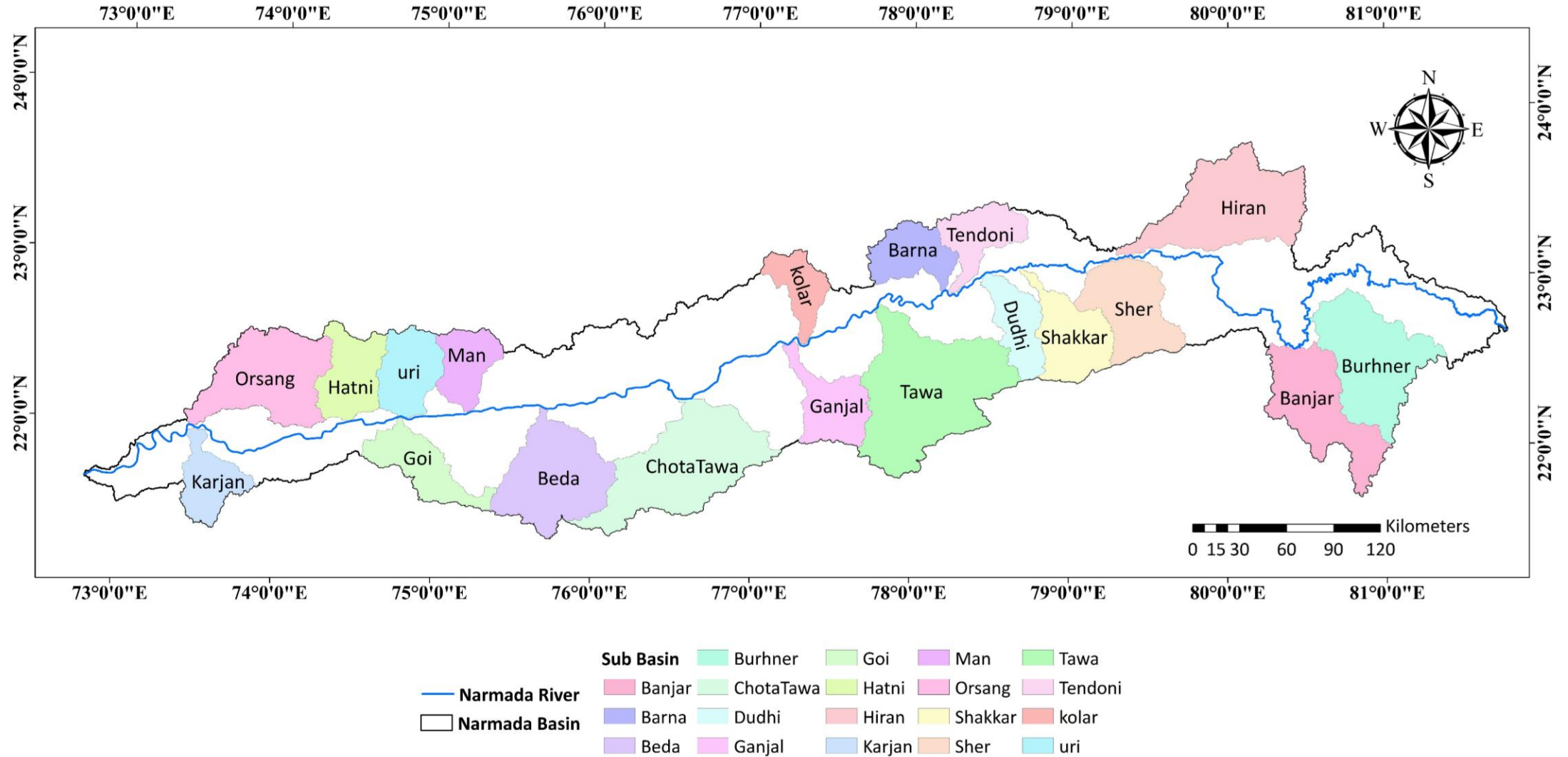
A connected basin beyond administrative boundaries



Flow Diagram: Narmada River and its Tributaries

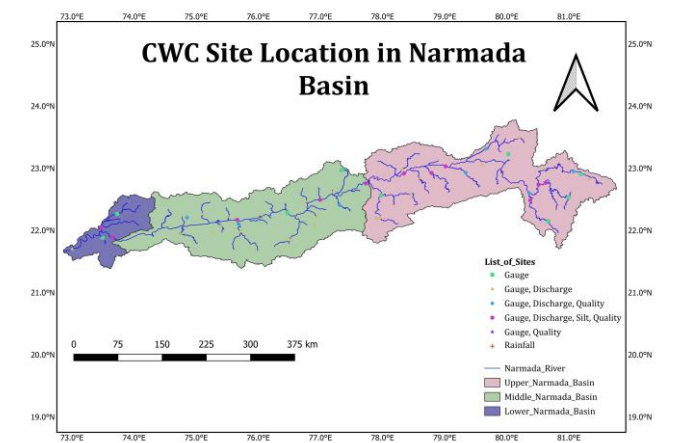


Narmada: Major Sub-catchments

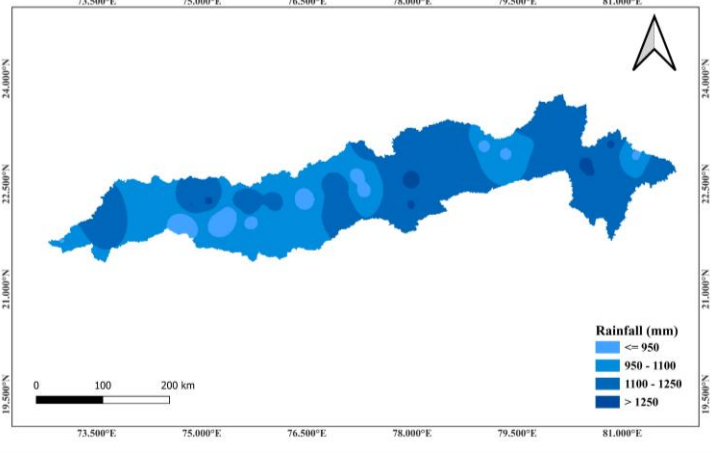


Six evidence layers for basin planning

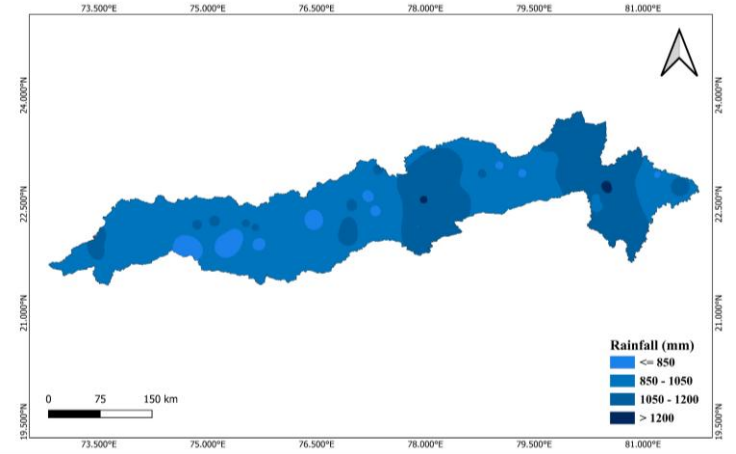
CWC monitoring sites



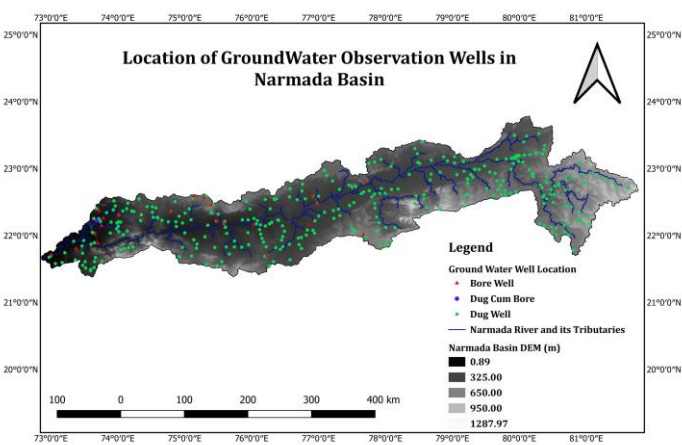
Average Annual rainfall



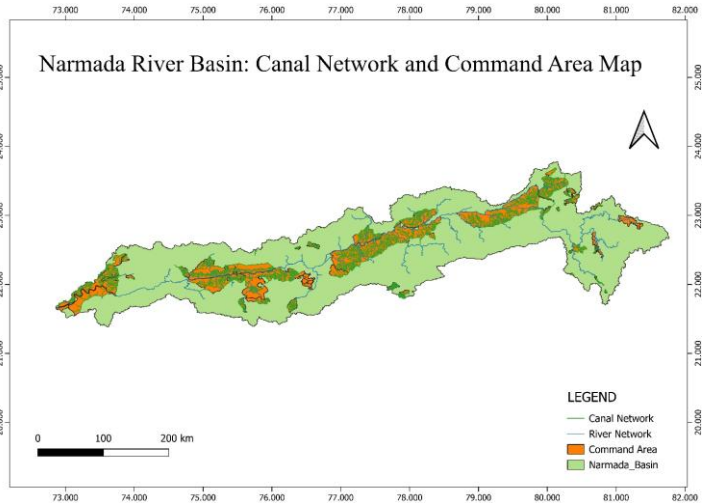
Monsoon rainfall



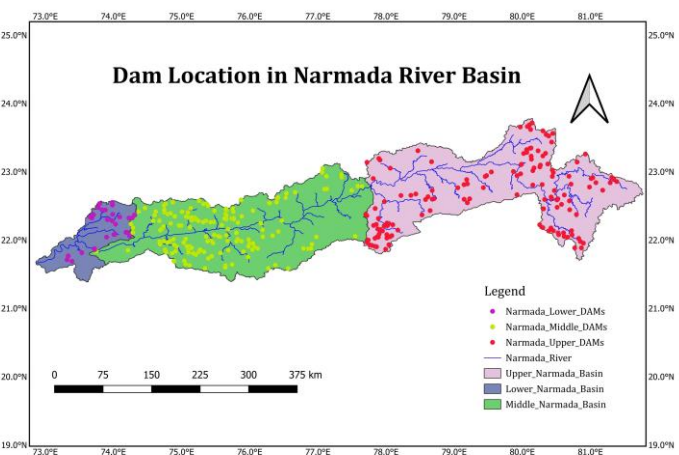
Groundwater wells



Canals and command areas

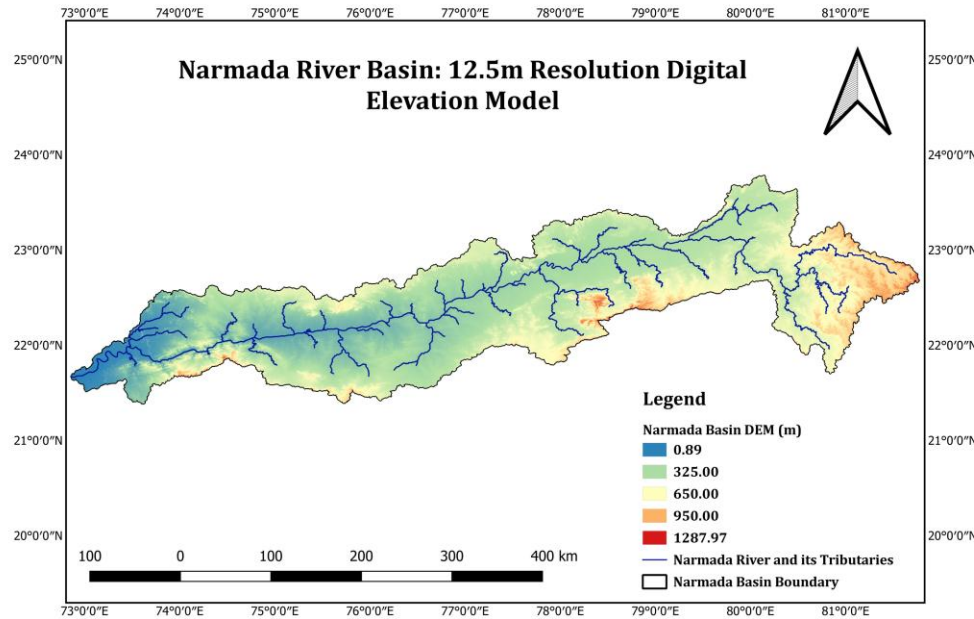


Dam locations

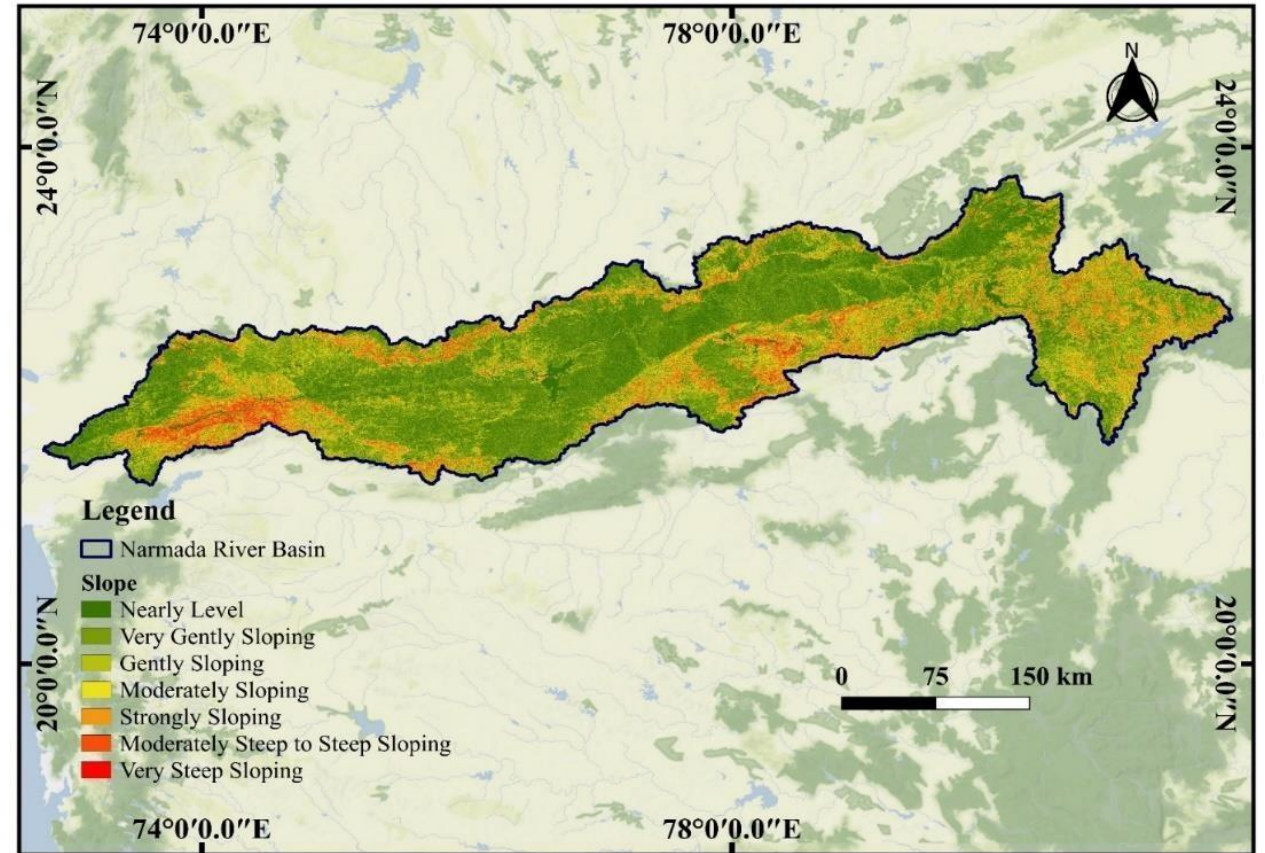


Together, these layers connect water inputs, observations, and flow regulation.

Terrain and drainage pathways



**Slope controls
runoff pathways**



Basin mapping guides field assessment; site design needs finer evidence

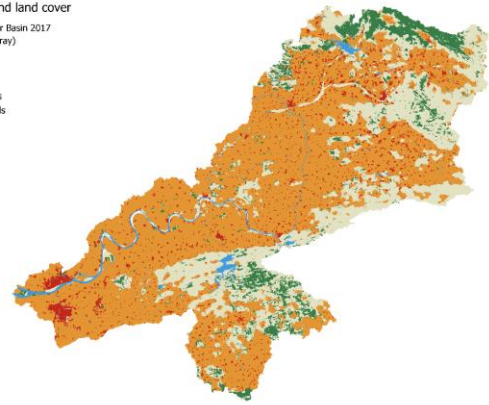


Land Use Land Cover

Lower Basin

Land use and land cover
Narmada Lower Basin 2017
Band 1 (Gray)

- Water
- Trees
- Crops
- Built Areas
- Rangelands



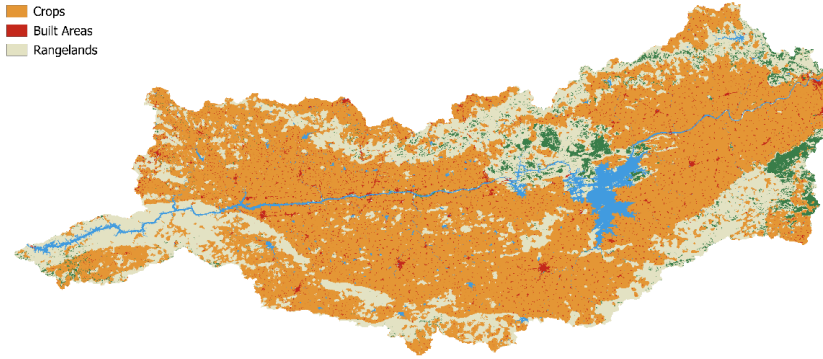
0 10 20 km



Middle Basin

Land use and land cover
Narmada Middle Basin 2023
Band 1 (Gray)

- Water
- Trees
- Crops
- Built Areas
- Rangelands



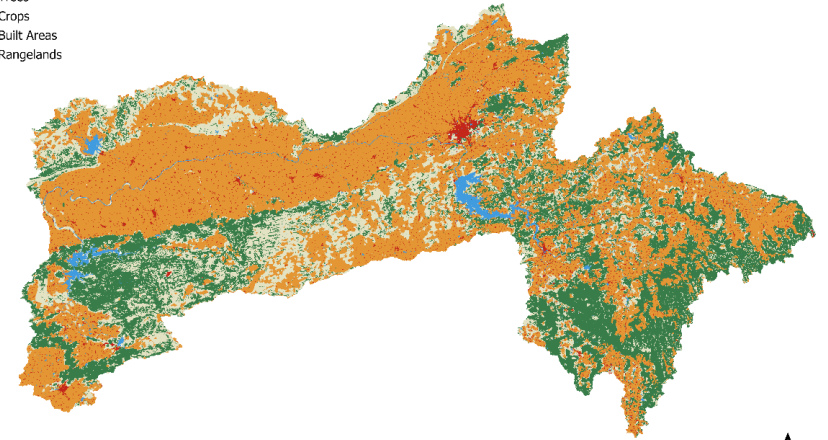
0 10 20 km



Upper Basin

Land use and land cover
Narmada Upper Basin 2023
Band 1 (Gray)

- Water
- Trees
- Crops
- Built Areas
- Rangelands

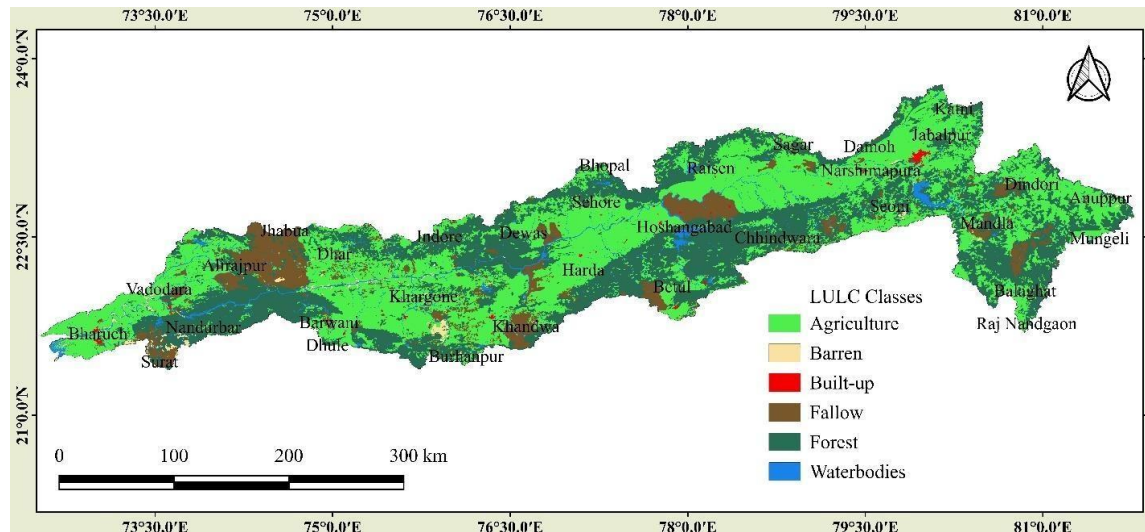


0 10 20 km

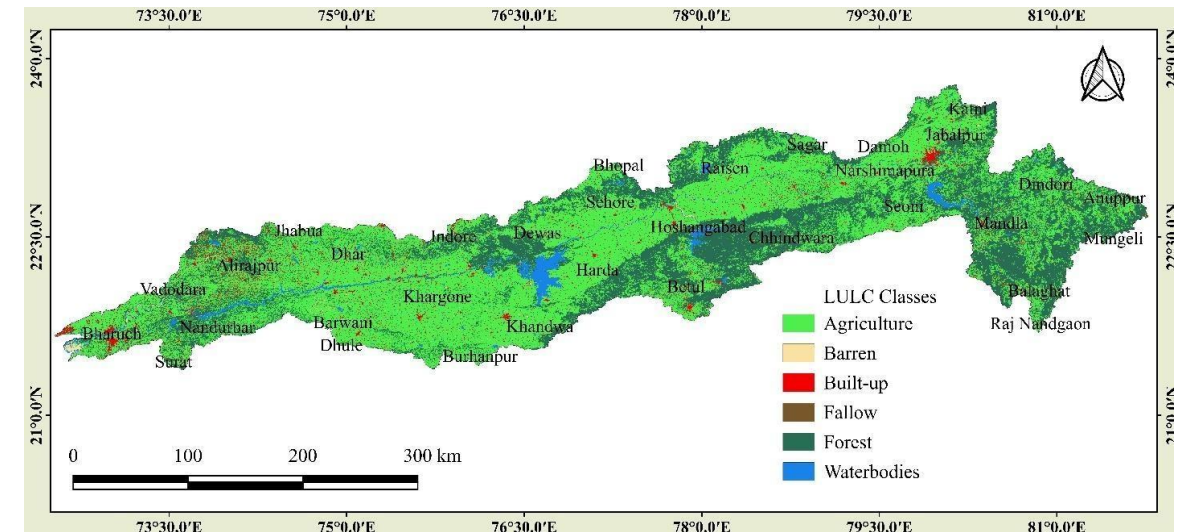


Land-cover change across the basin

1995

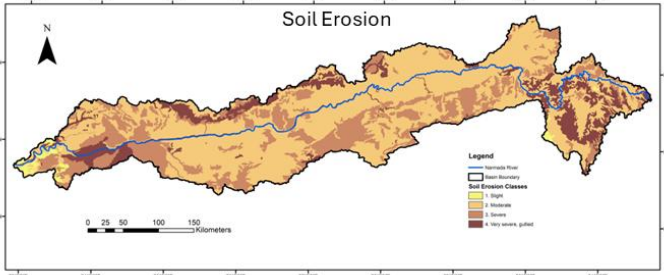
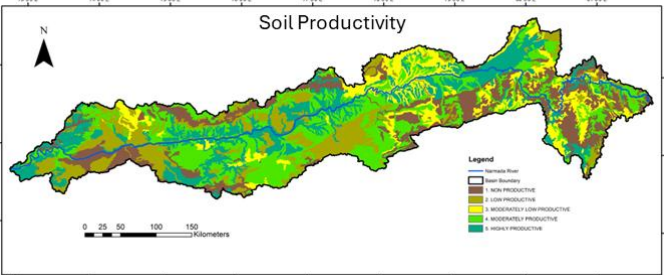
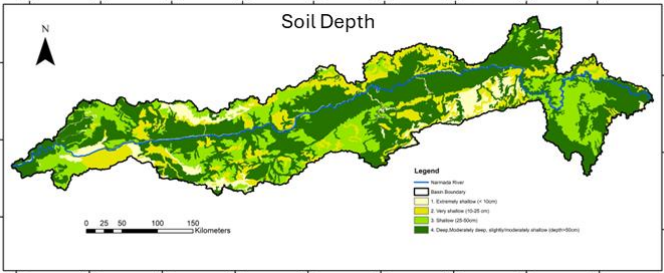
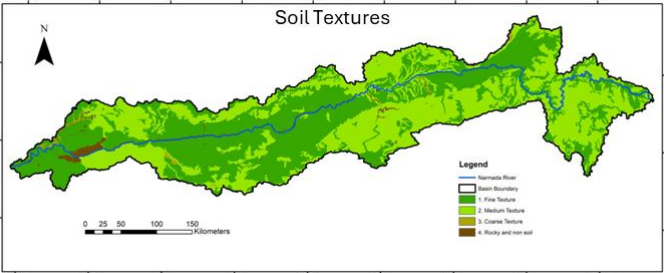


2024

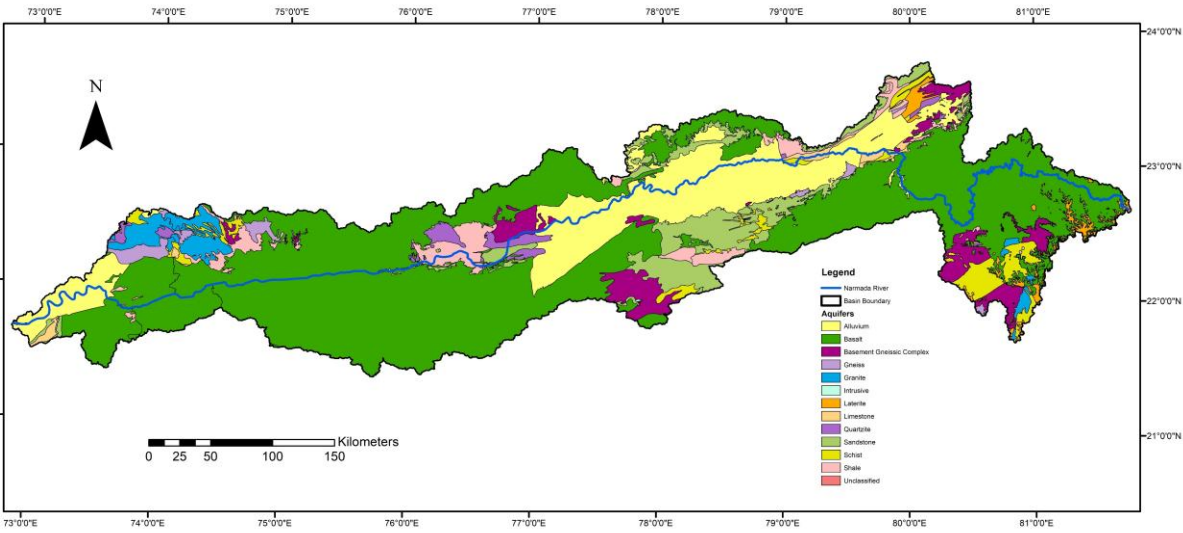
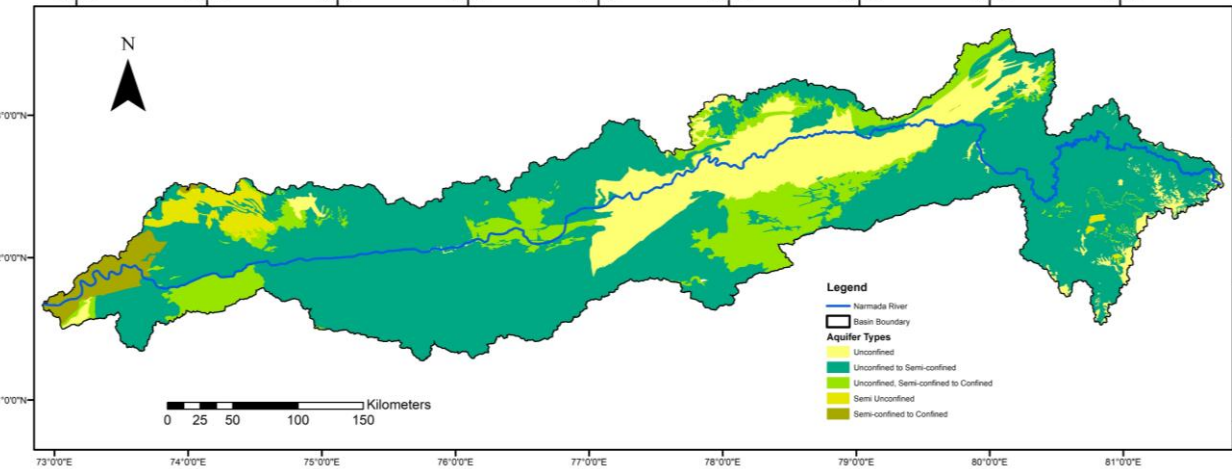
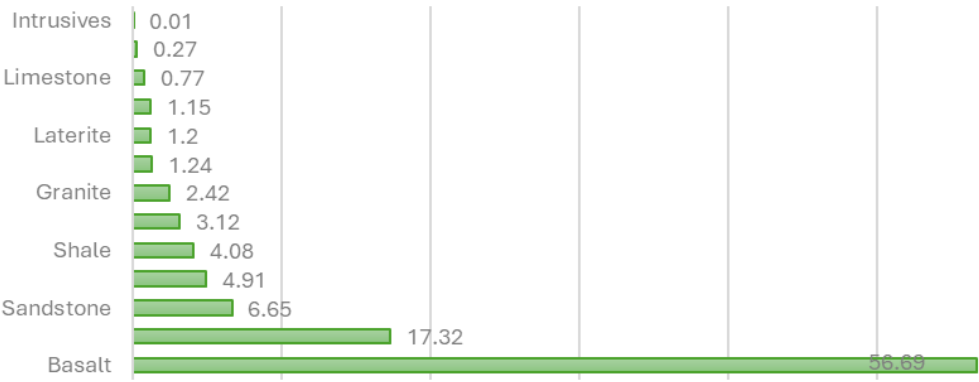


Changing land cover is an input to watershed assessment

Soil and Aquifers

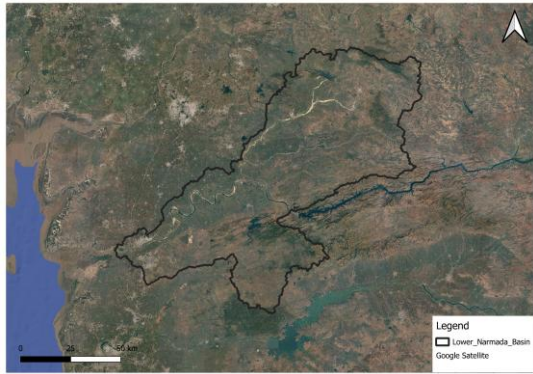


Percentage-wise Distribution of Aquifers

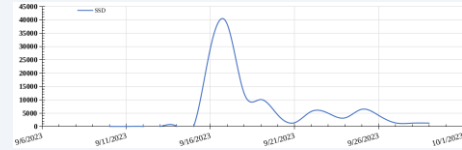
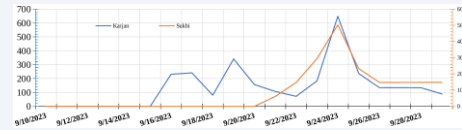


Hydraulic Modelling

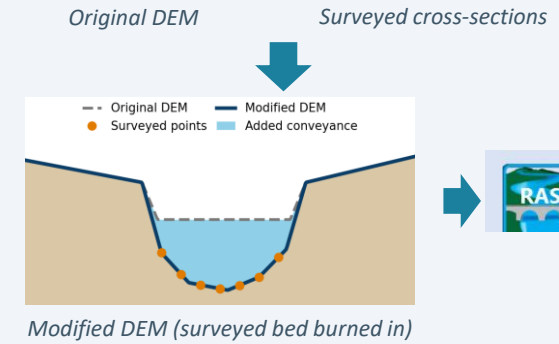
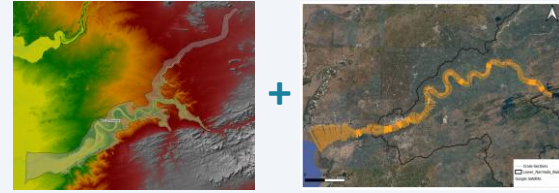
1 Study area & dams



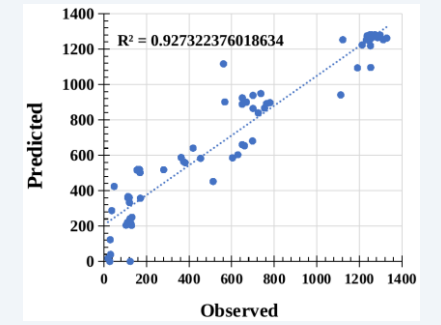
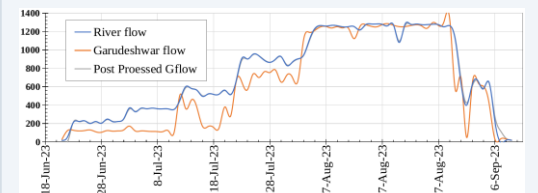
2 Dam release inflows



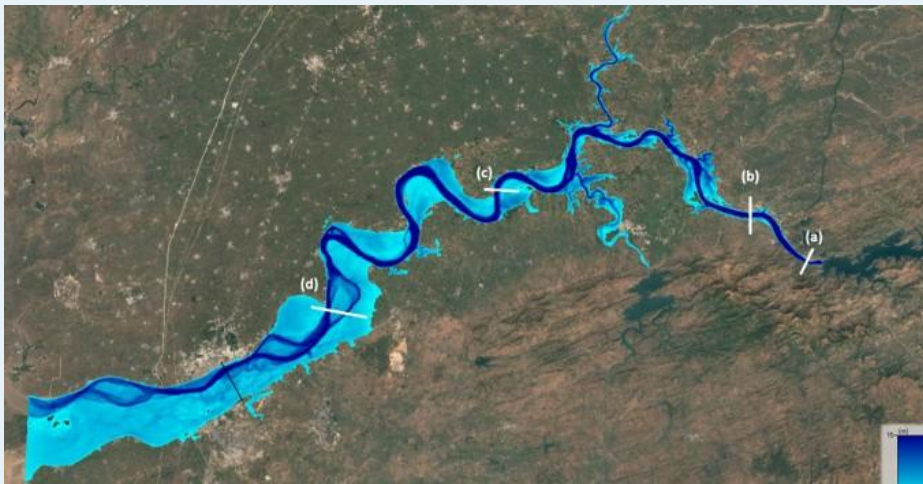
3 DEM correction & HEC-RAS 2D



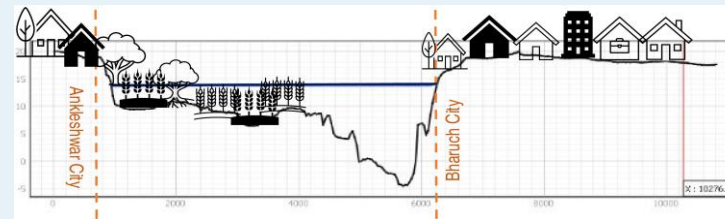
4 Calibration ($R^2 = 0.927$)



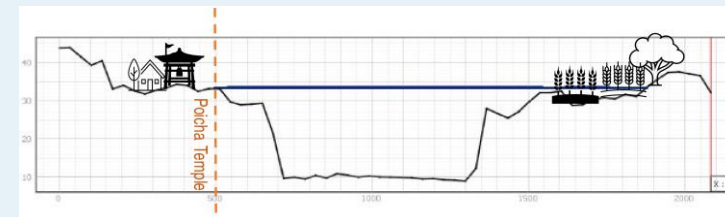
5 Outcome – September 2023 flood



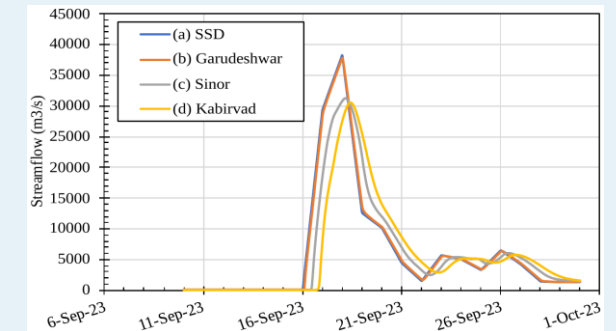
Inundation extent



Water level: Ankleshwar – Bharuch

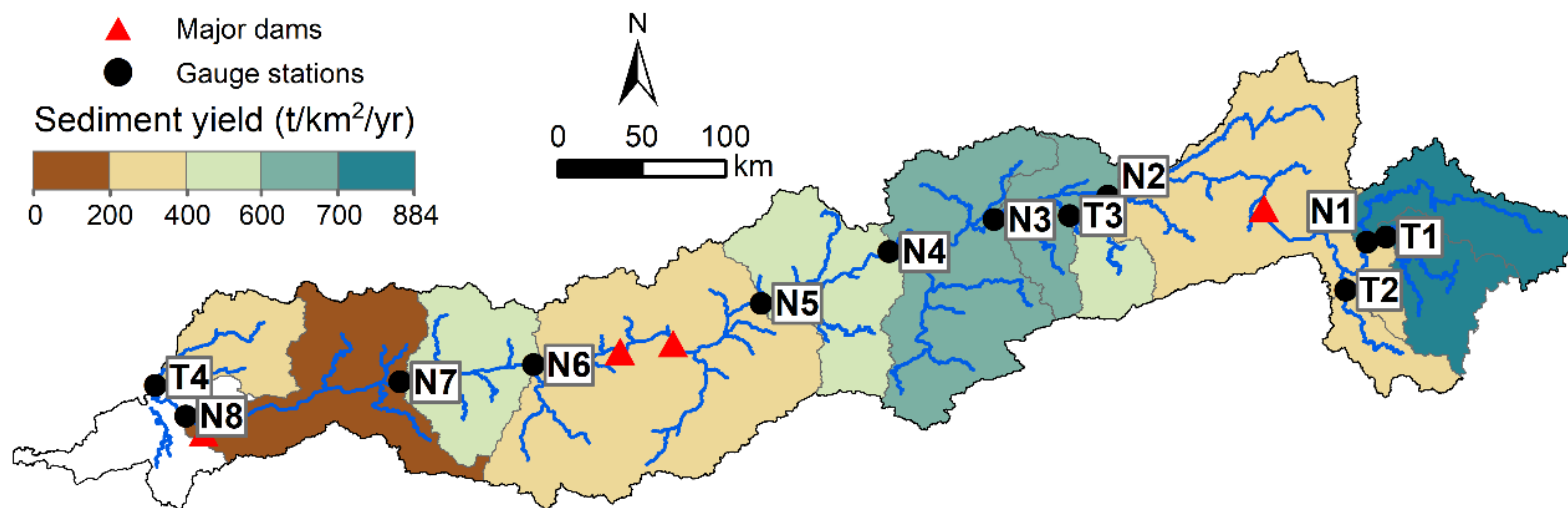


Water level: Poicha Temple

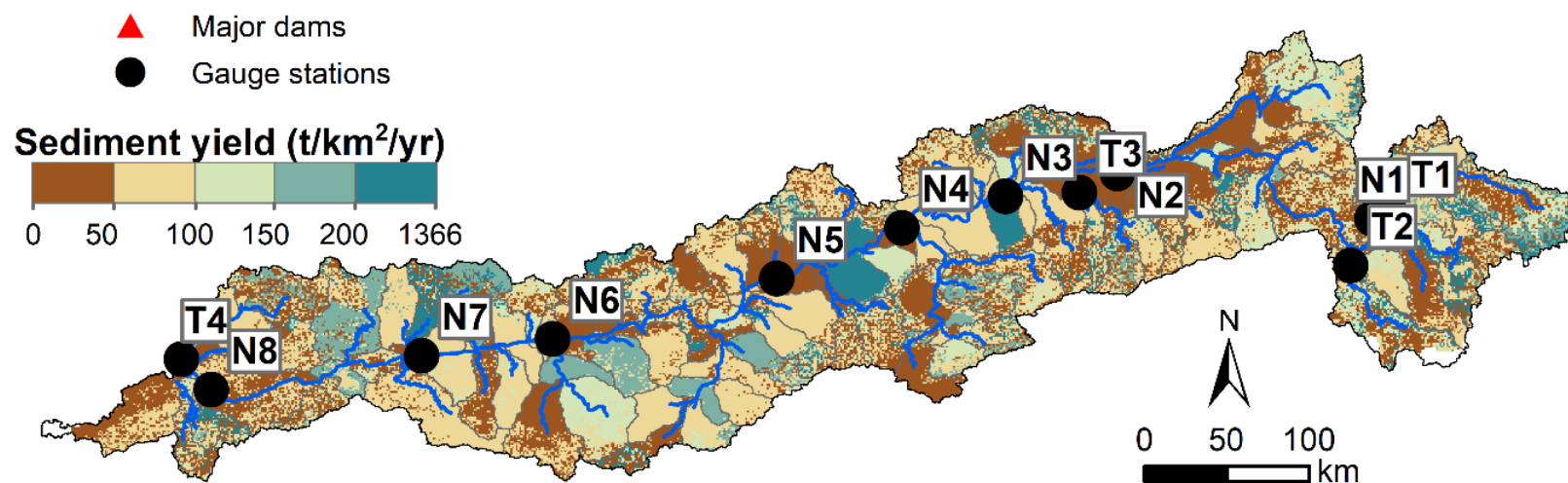


Peak flow routed downstream

Sediment sources in the Narmada basin



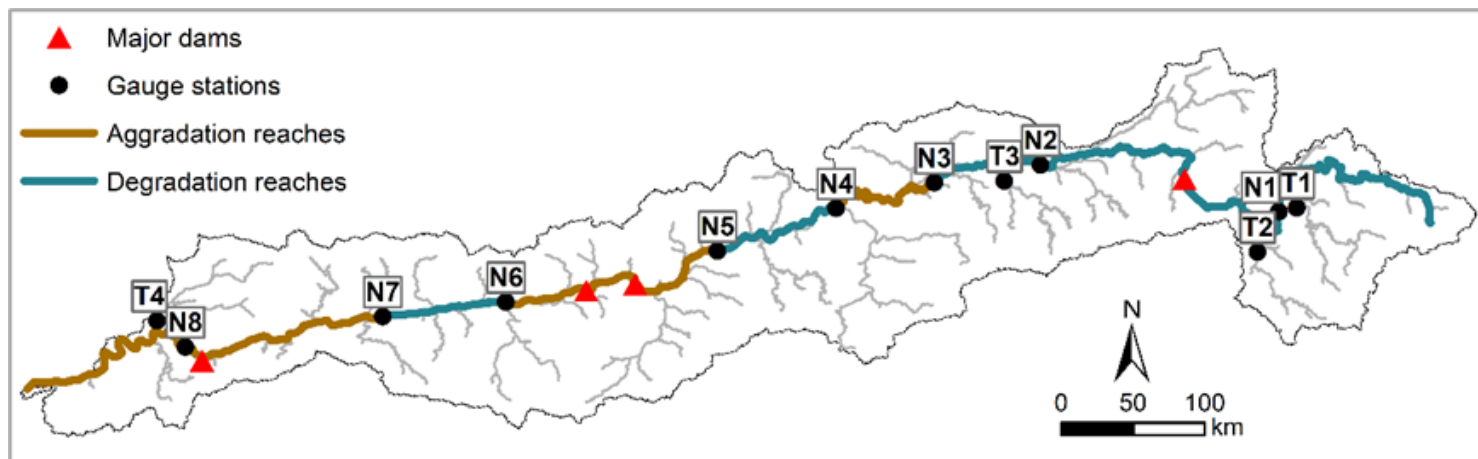
(a) Observed sediment yield by sub-basin, from 12 CWC gauges (1987–2015)



(b) Sediment yield modelled with SWAT at HRU scale (colour classes differ from (a))

SWAT model with MUSLE erosion per hydrological response unit; calibrated monthly at Mandleshwar (N6) for 1987-1996 and validated for 1997-2007. NSE: discharge 0.91 / 0.95, sediment 0.86 / 0.71 (calibration / validation). Under-predicts the steep sub-basins (N1, T1, T3), where mass wasting is not modelled.

Reach wise sediment budget and implications

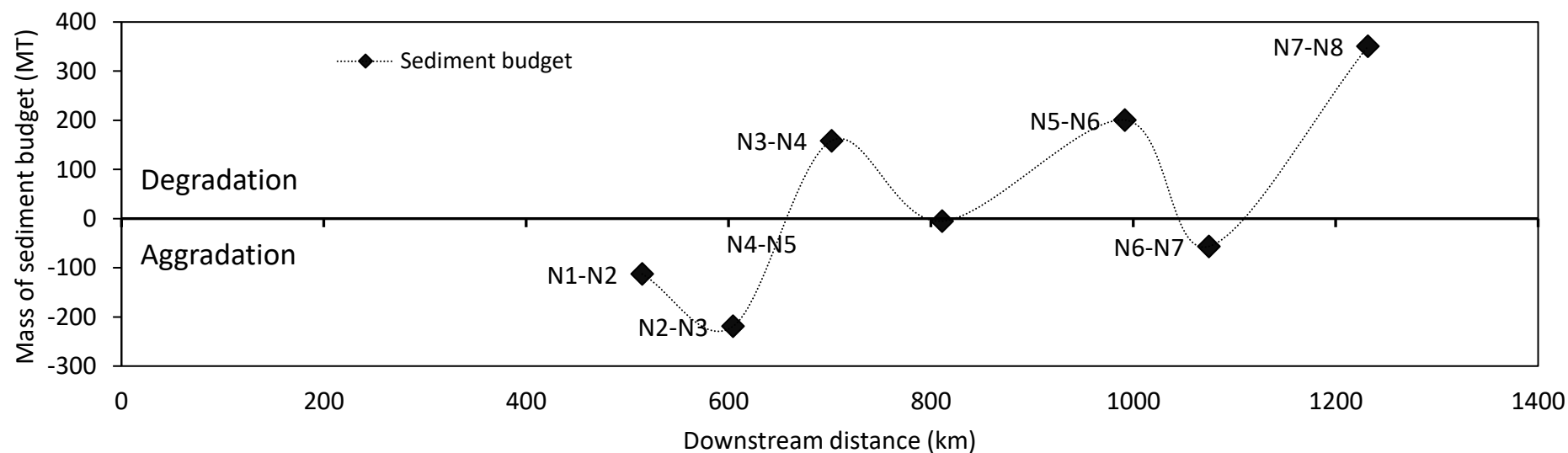


STORING SEDIMENT · AGGRADING

N3-N4 · N5-N6 · N7-N8

LOSING SEDIMENT · DEGRADING

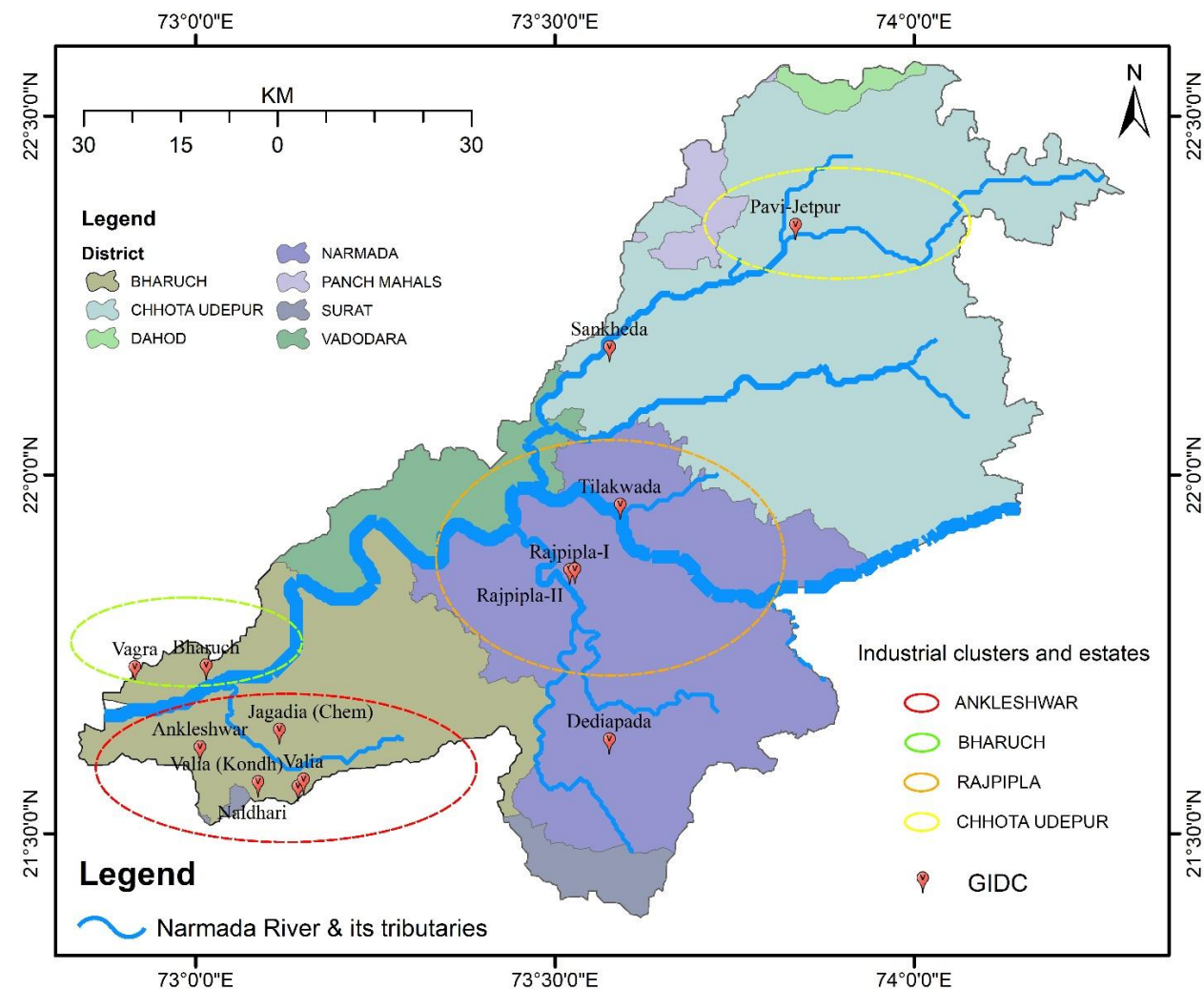
N1-N2 · N2-N3
N4-N5 · N6-N7



Pressures on river health

Lower Narmada Industrial clusters

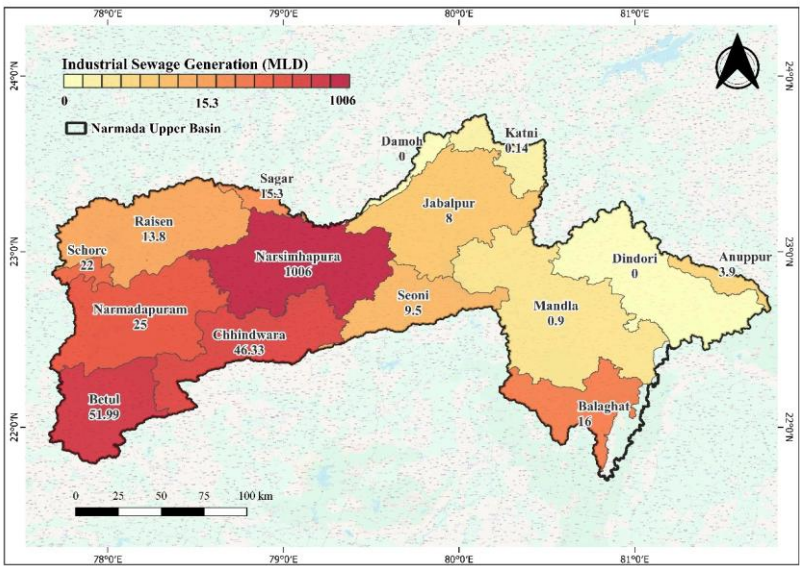
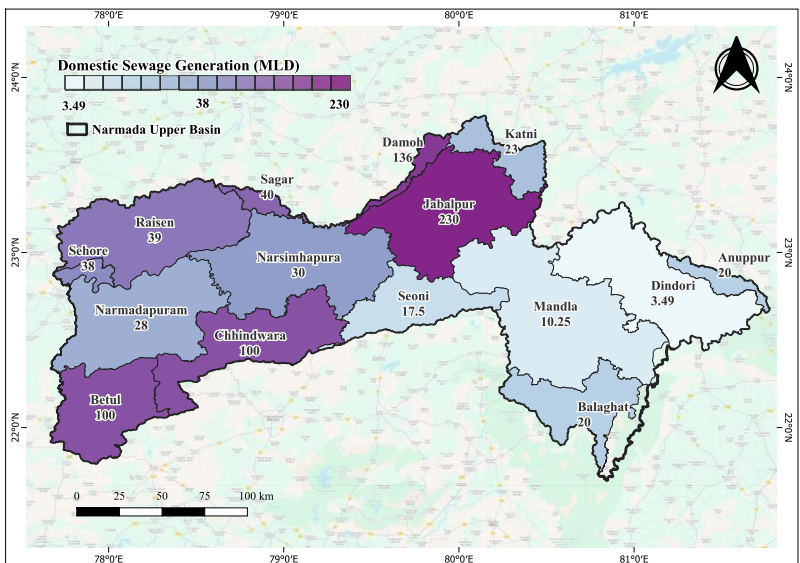
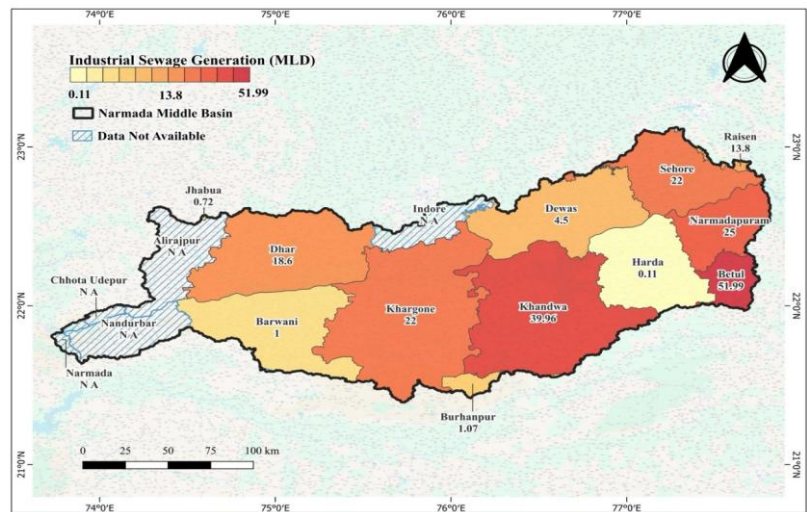
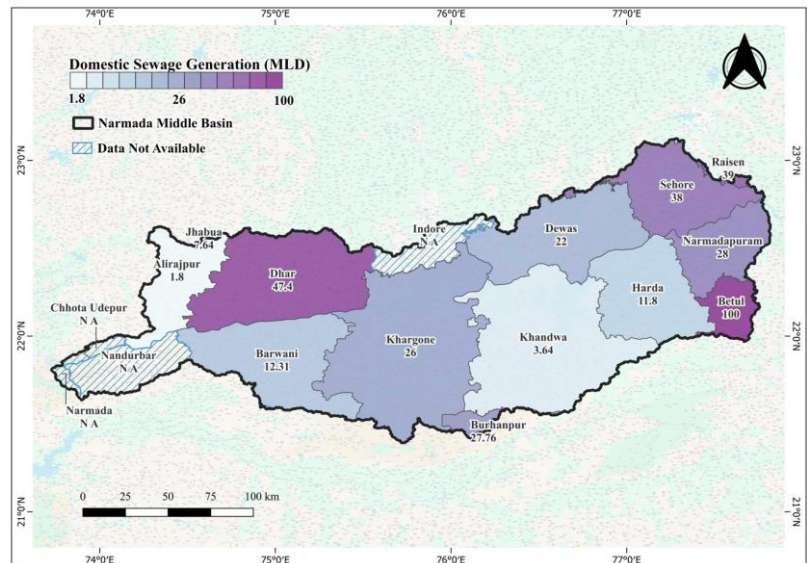
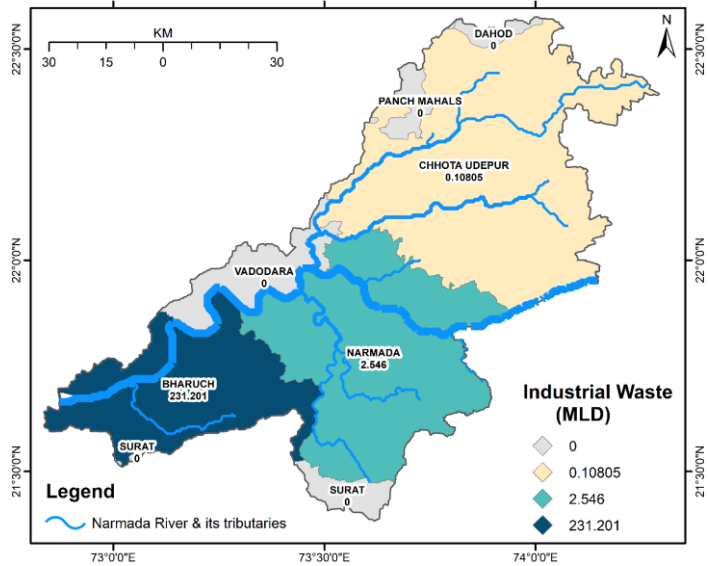
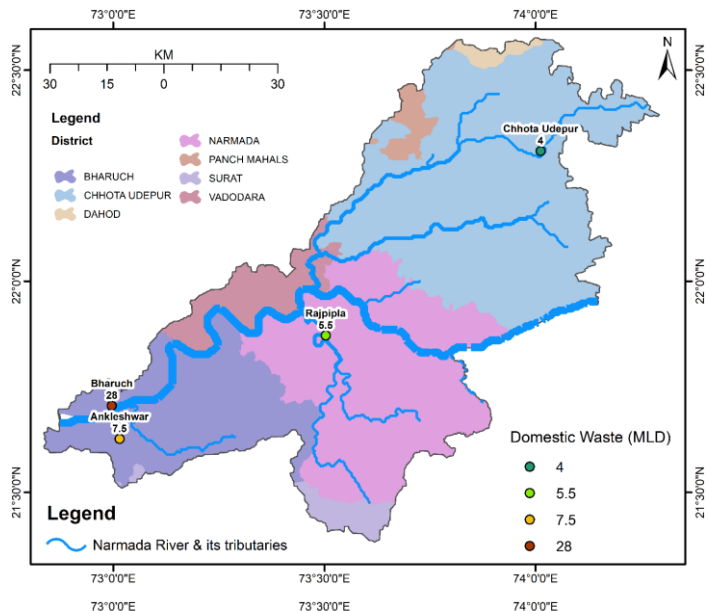
Source locations
Receiving-water monitoring



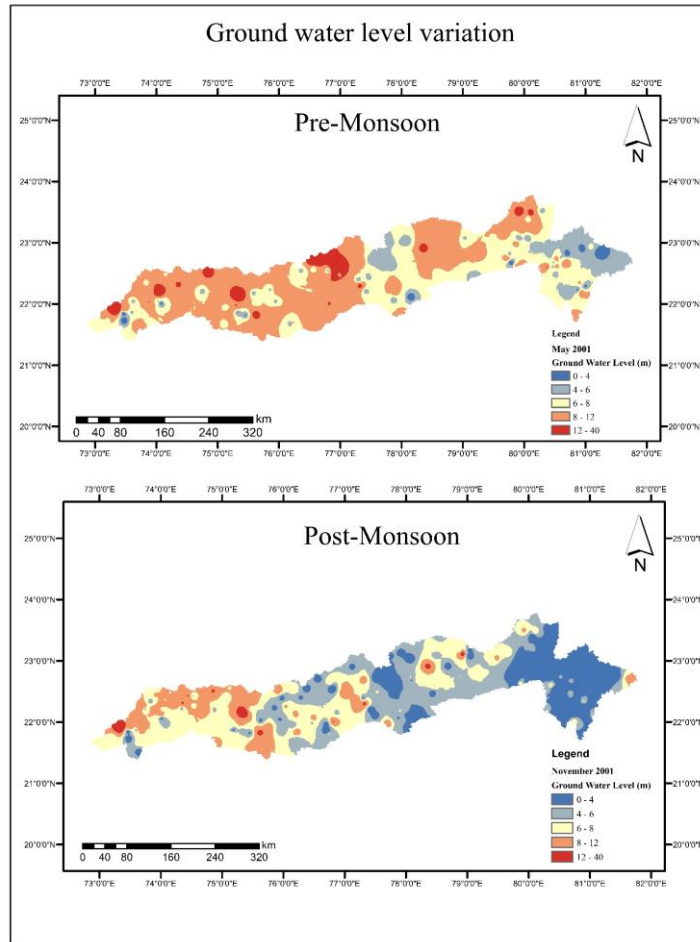
Watershed treatment and pollution control belong in the same plan

Source: cNarmada Pollution Source Mapping Report, March 2026; GIDC

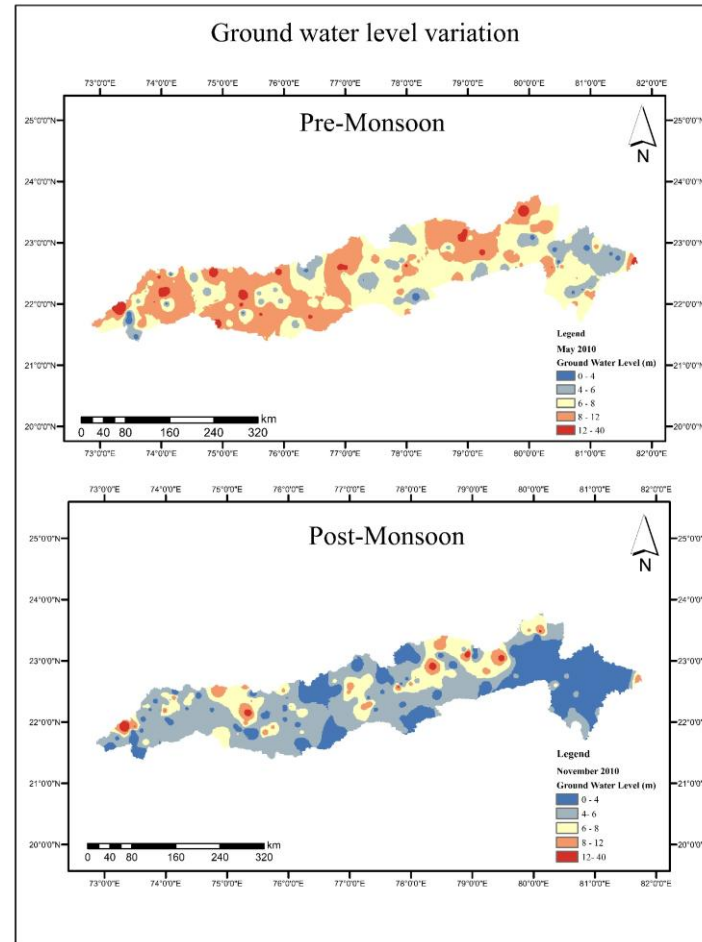
Pressures on river health



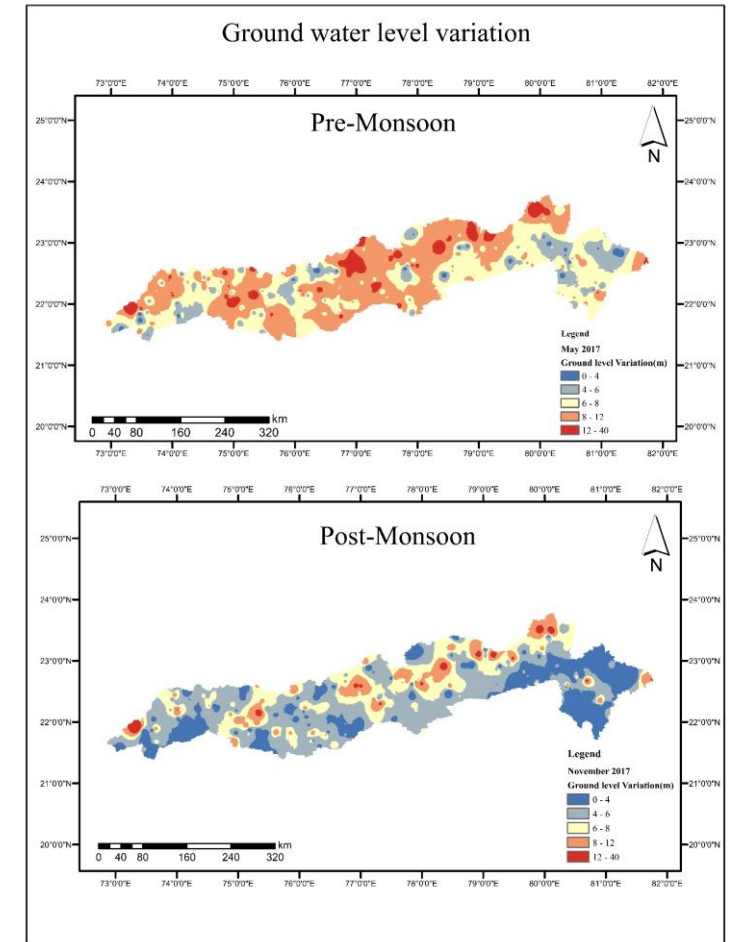
Groundwater Analysis & Key Findings



Groundwater Levels - 2001



Groundwater Levels - 2010

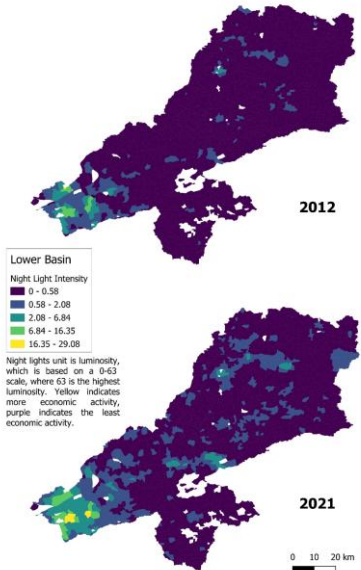


Groundwater Levels - 2017

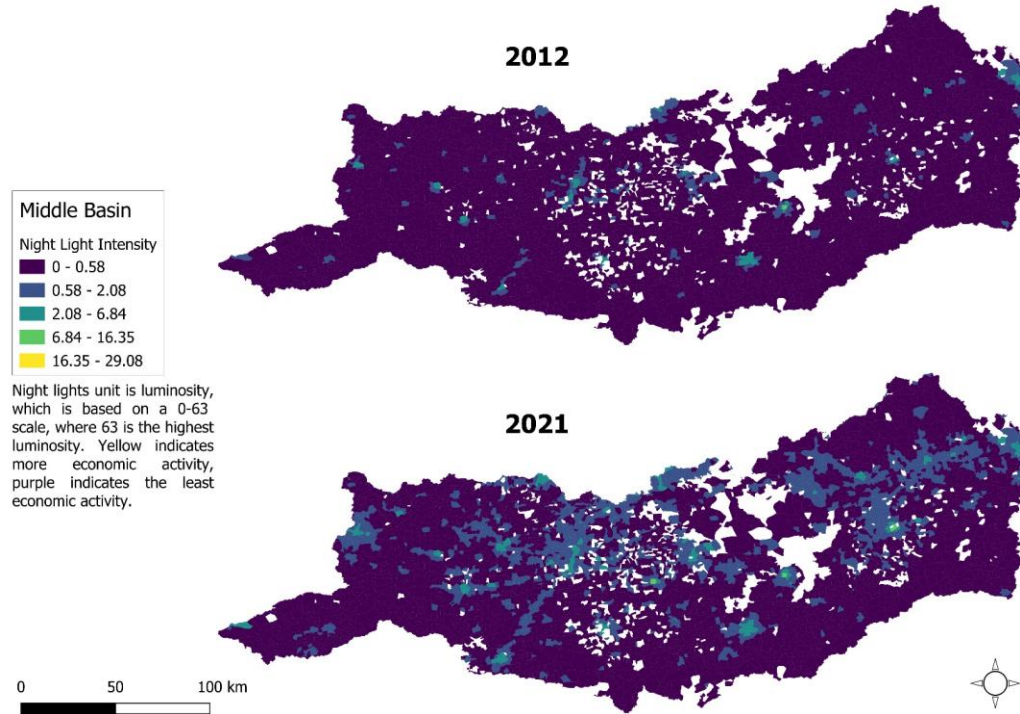


Economic Activity (2012 to 2021 using nightlights)

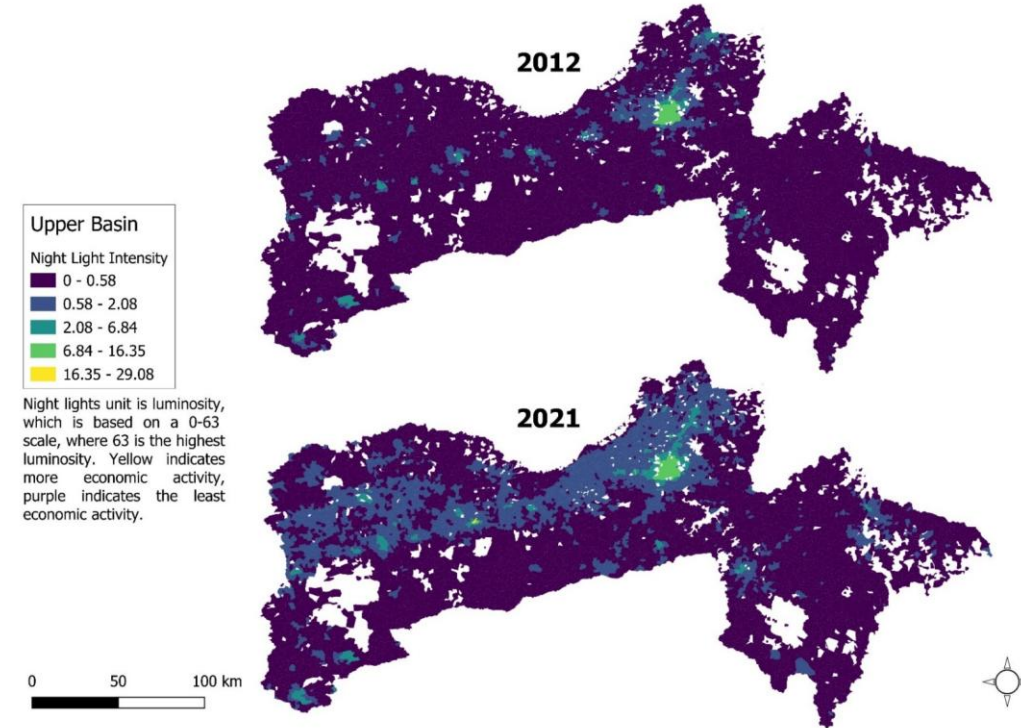
Lower



Middle

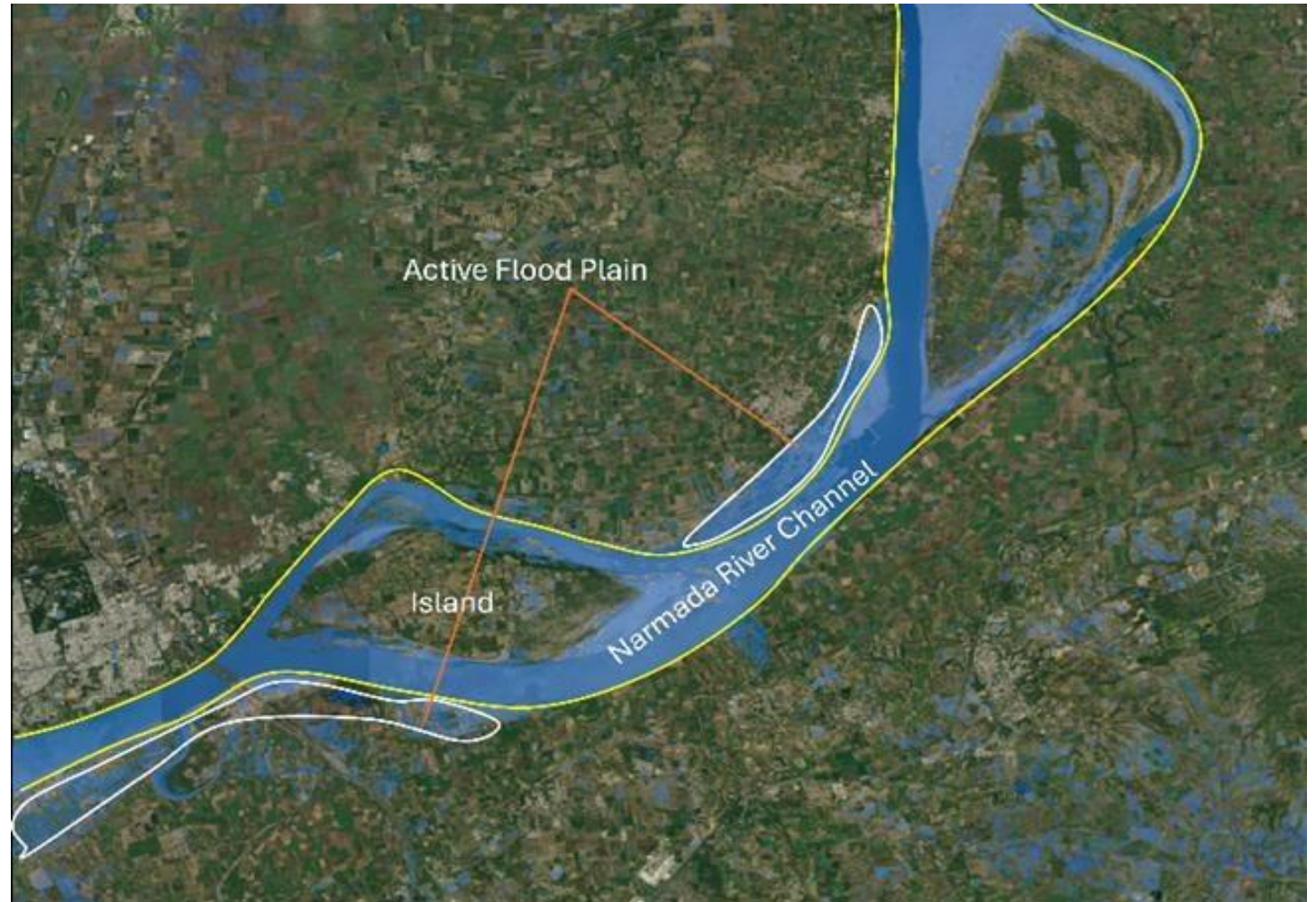


Upper



River corridor and floodplain

**Bharuch–Ankleshwar
2015–2024**



Satellite observations support river-corridor assessment

Source: cNarmada geomorphological mapping; Google Earth base imagery

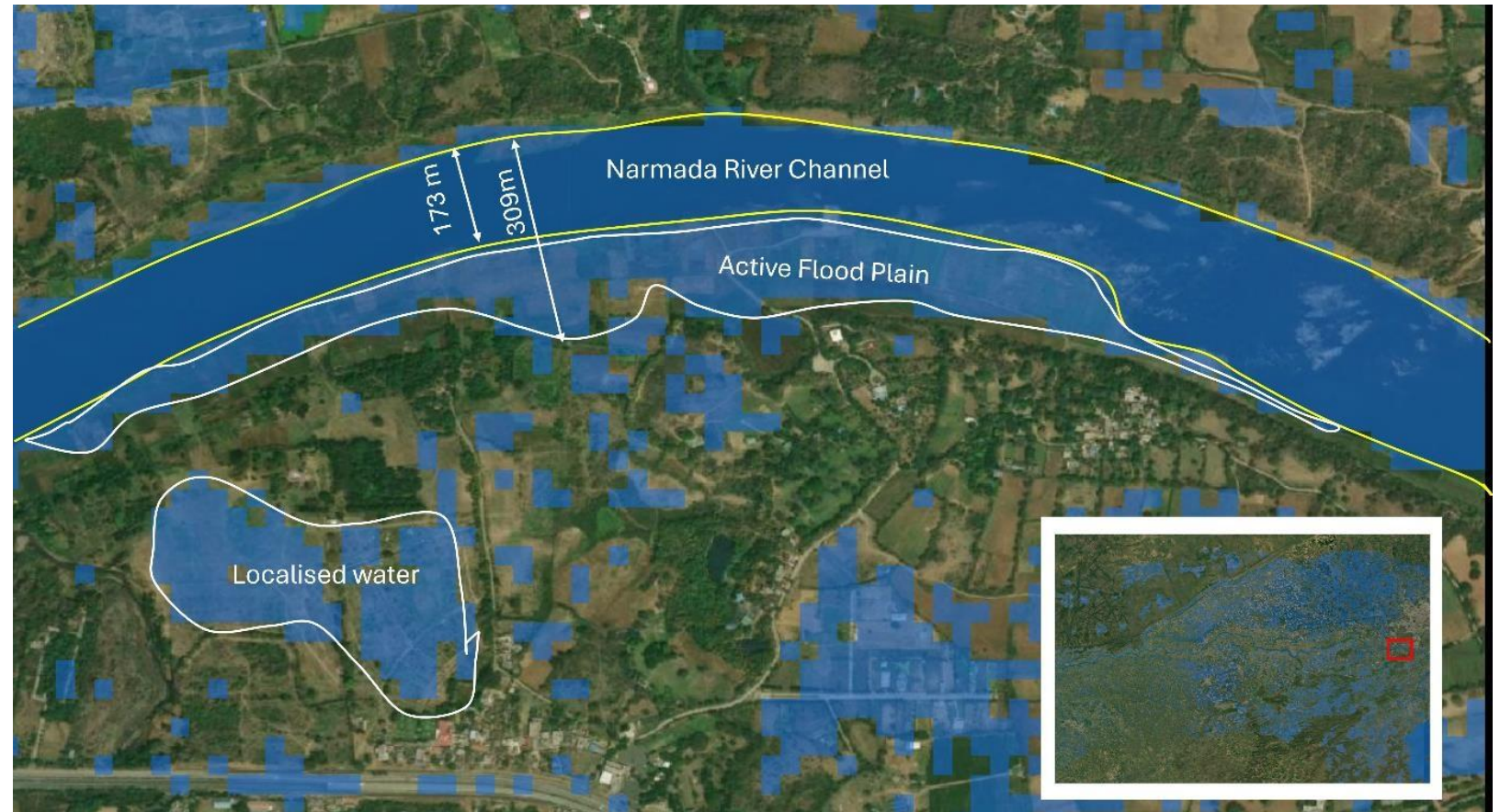
Interventions suited to the river setting

Proposed options

Slope treatment upstream

Riparian protection

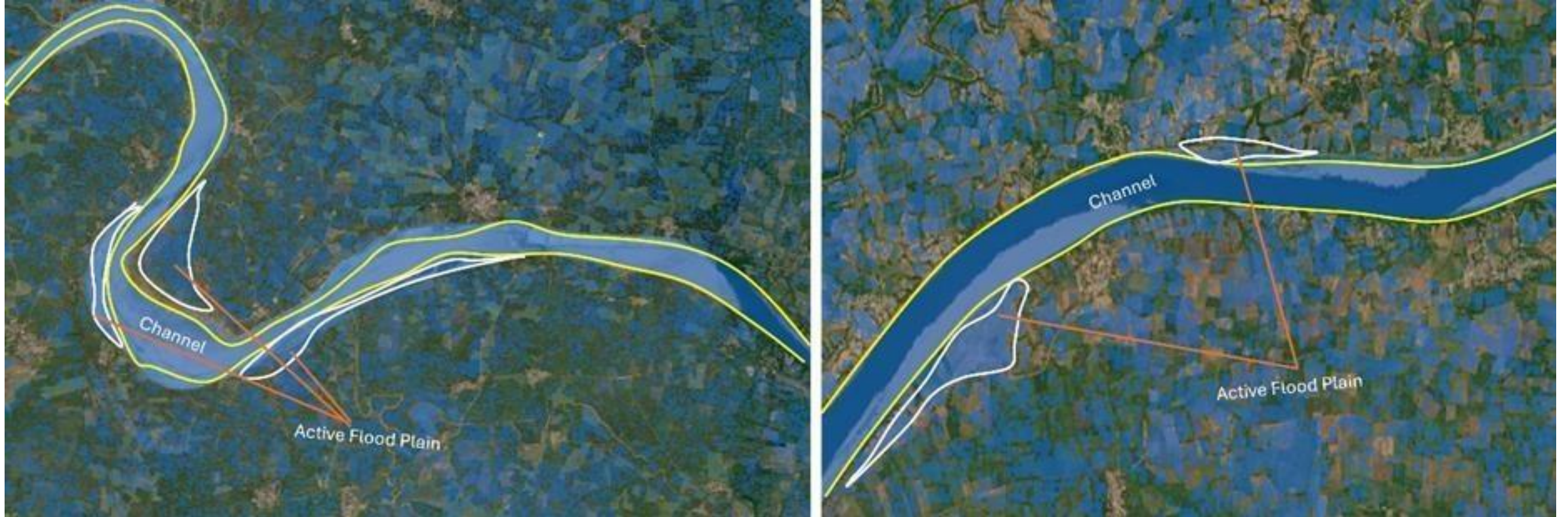
Recharge where suitable



Local geology and river connectivity determine the choice

Madhya Pradesh: tributaries and floodplain

Bhatgaon–Narhera reach



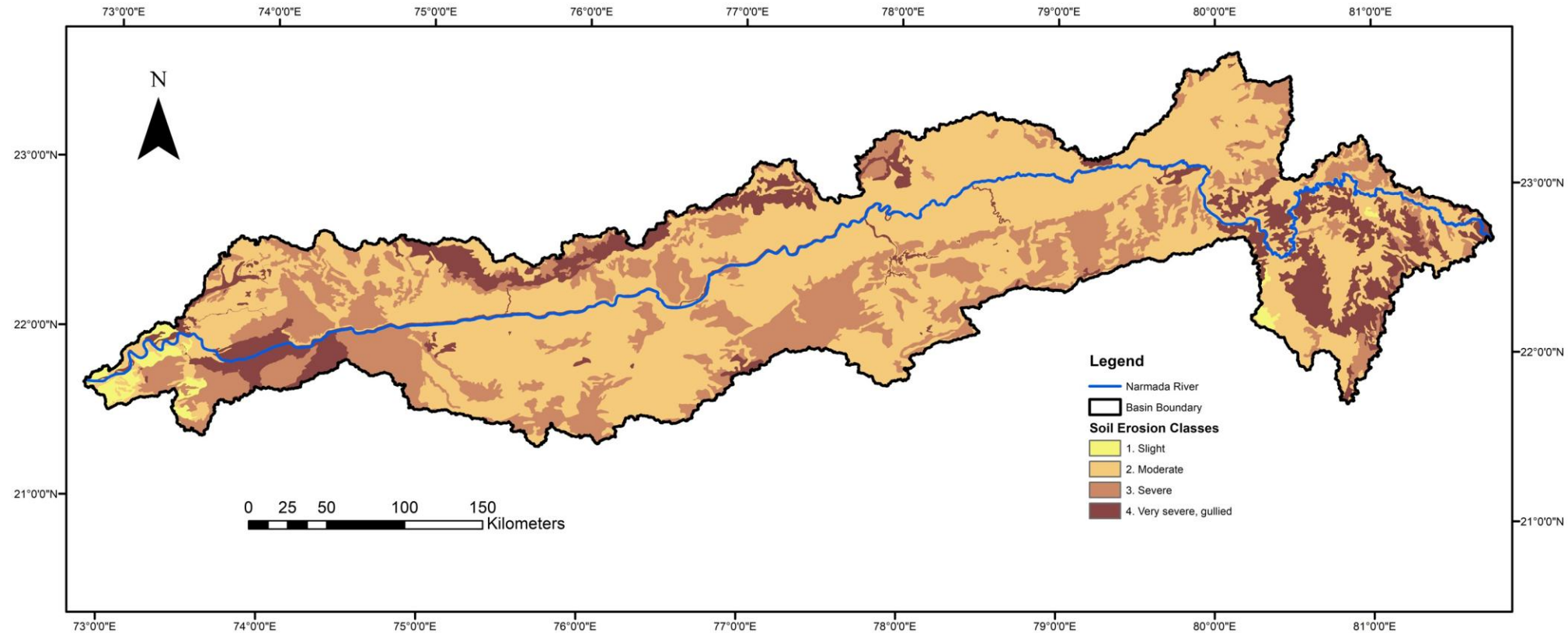
Proposed focus: upstream sediment sources and space for the river



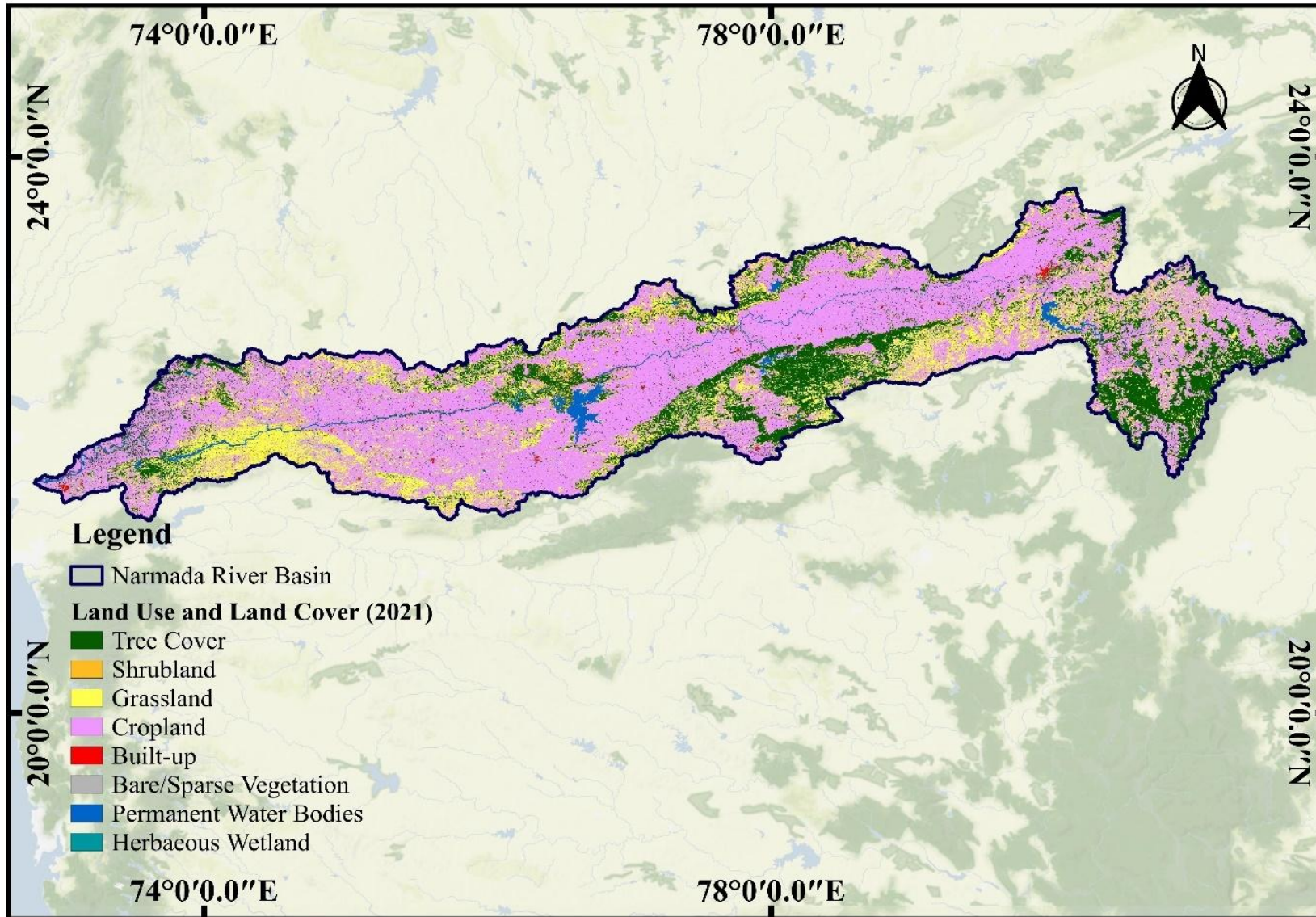
Additional Slides

Screening watershed priorities

Proposed planning application

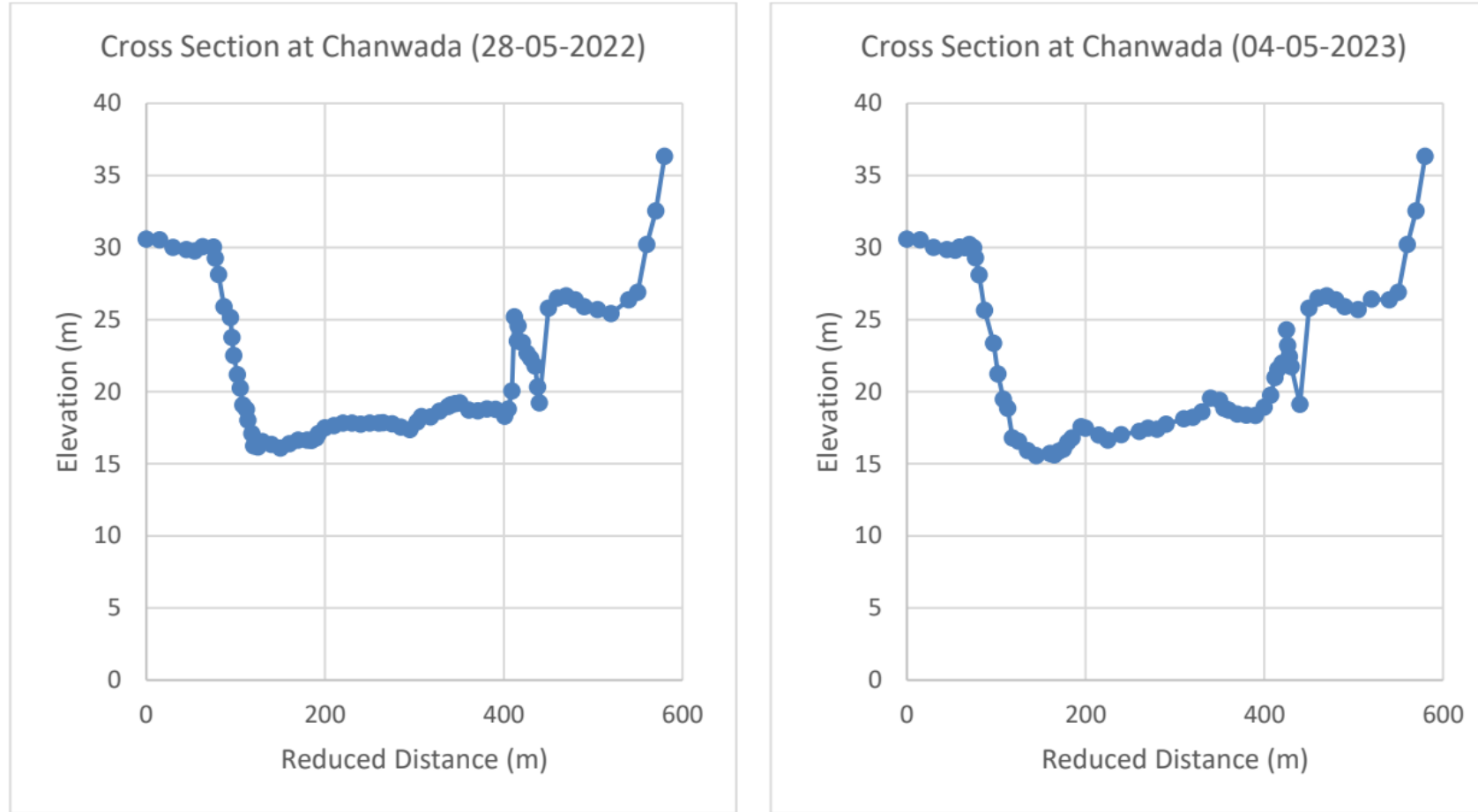


Erosion pressure and downstream sensitivity guide candidate selection



Spatial variation of land use and land cover

Gujarat: Orsang River at Chanwada



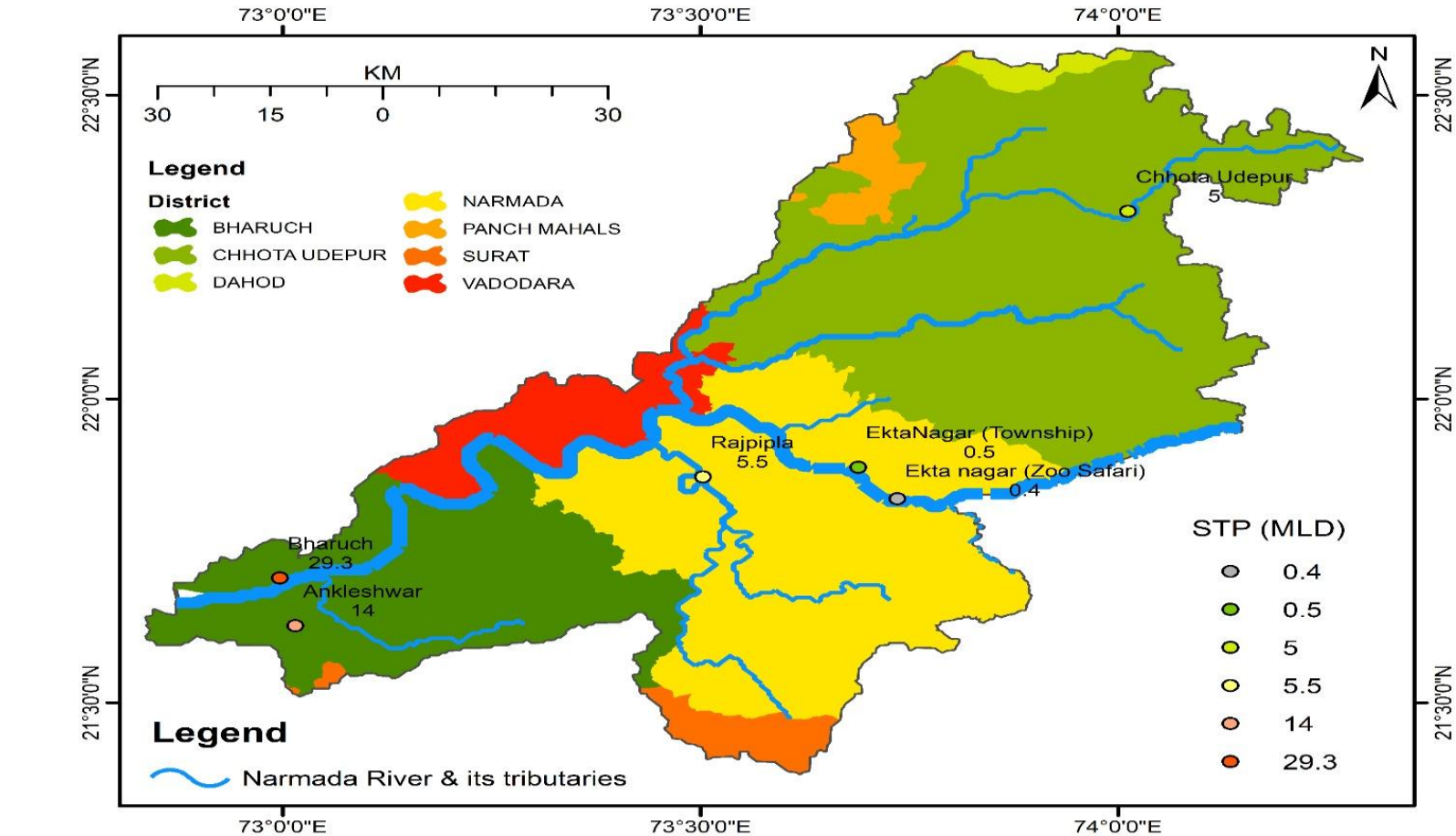
Repeated cross-sections provide a baseline for channel assessment

District plans and accountable action

DRMP

Named agency

Cost and timeline



Treatment inventory: March 2026 report snapshot

Proposed delivery: watershed priorities within District River Management Plans