



Reimagining Rejuvenation of Rivers *through* Watershed Development Approach

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Declining & Shifting Streamflow Patterns Across Indian River Basins

Evidence from major river basins (1951–2021)



Sabarmati & Indus Basins

Strongest streamflow increase
(1951–2021)



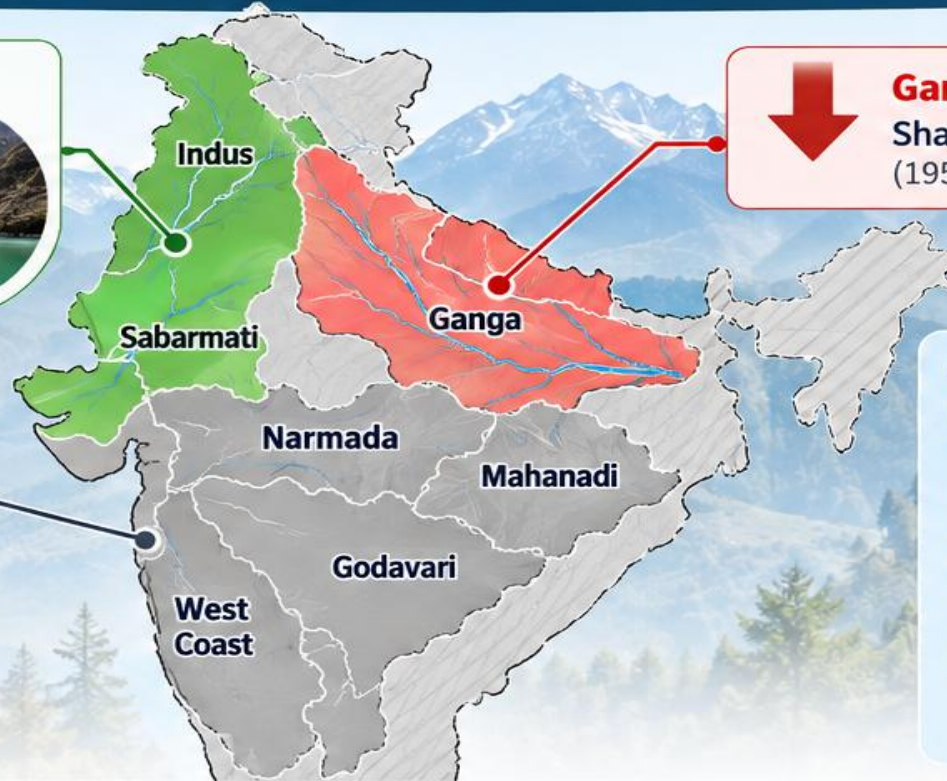
Ganga Basin

Sharpest streamflow decline
(1951–2021)



Mahanadi, Narmada, Godavari & West Coast Basins

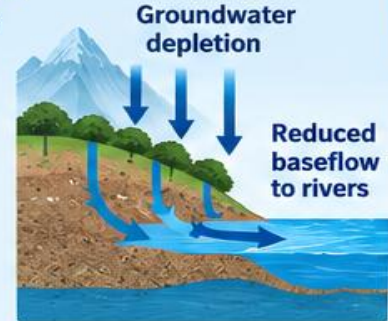
No significant long-term trend
(1951–2021)



Groundwater depletion reduces downstream flow

Ganges–Brahmaputra region

Upstream groundwater
depletion can cut flow to the
Bay of Bengal by up to
1,200 m³/s/year
(despite rising rainfall)



Himalayan springs under stress

~50% of Himalayan perennial
springs have dried up or turned
seasonal
(NITI Aayog, 2018)



From perennial to seasonal flow

Rivers once flowing 9–12 months
now flow mainly **June–October**;
dry season = disconnected pools
or dry beds



India's land restoration target under UNCCD

Restore **26 million ha (Mha)**
of degraded land by 2030
(revised up from 21 Mha)
(UNCCD)



India's river-flow regime is shifting — from sustained perennial flow toward
increasingly seasonal and spatially uneven availability.

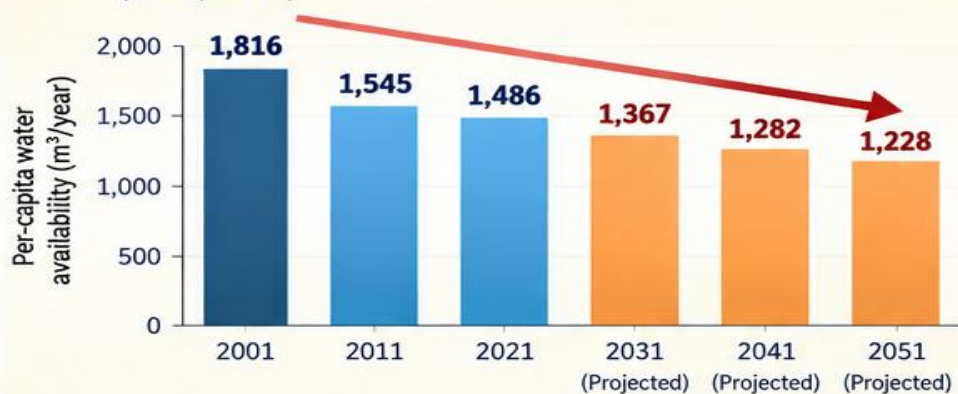


Implication

River rejuvenation requires upstream catchment,
groundwater, spring and soil–water conservation
interventions—not channel treatment alone.

Structural Water Stress & the Recharge–Extraction Gap

1 Declining Per-Capita Water Availability (CWC, 2019)

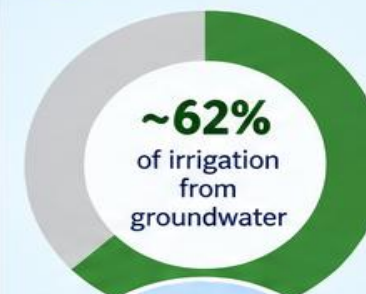


2 Rising Water Demand with Viksit Bharat @2047

Growth in agriculture, industry and urban sector will **increase water demand**, leading to structural constraint, not just drought risk.



3 Heavy Dependence on Groundwater



4 The Recharge–Extraction Gap

Recharge without extraction management acts as a net subsidy to overdraft, not baseflow restoration.



5 Irrigation Expansion May Raise Groundwater Demand

Har Khet Ko Pani / PMKSY irrigation expansion is likely to increase, rather than reduce, groundwater demand elasticity.



Reinforces the need for demand-side management under RRWDA (WDC-PMKSY 3.0)



India faces a long-term **structural water stress** driven by declining per-capita availability, rising sectoral demand and unsustainable groundwater extraction.



Integrated recharge–demand management is essential for water security, resilient agriculture and Viksit Bharat @2047.

ICAR LEGACY

Seven decades of watershed science behind this pilot

1950s

SWC centres at Dehradun, Kota, Bellary, Ooty, Vasad, Agra, Chandigarh

1956

42 research watersheds set up at all centres

1974

CSWCRTI (now ICAR-IISWC) formed; Operational Research Projects at Sukhomajri, Nada, Fakot, G.R. Halli

1983

47 ORPs across agro-ecological regions; drought-proofing proven at Fakot, 1987

1991

Model scaled into NWDPRA across 29 states

2025

Revised erosion map: degraded land down from 39.9% to 26.3%

2026

ICAR-IISWC-SARRA MoU for rejuvenation plan of the Kamal Ganga, Uttarakhand



FAKOT, TEHRI GARHWAL · 370 HA · GAINS HELD 20 YEARS AFTER EXIT

- Runoff decreased from 42% → 14%
- Soil loss reduced from 11.1 → under 2 t/ha/yr
- Food production increased 882 → 7,462 Quintals
- Forest fodder dependence 60% → 12%



Sukhomajri, (Haryana)

Wheat Yield increase by (+120%);

Milk (L/day) in 25 years: 248 → 1,018

A Basin in Crisis: Downward Spiral of River flow

- **Catchment Degradation:** Deforestation, unscientific land use, and urban encroachment in upper and middle catchments have destroyed natural sponge mechanisms, causing immediate high-intensity surface runoff rather than slow infiltration.
- **Loss of Baseflow:** Many Indian rivers and streams have transformed from perennial bodies to seasonal or ephemeral channels because groundwater tables have fallen below the riverbed elevation, cutting off subsurface baseflow feeds during lean months.
- **Siltation and Channel Choking:** High soil erosion rates deposit vast quantities of silt into riverbeds, reducing water-carrying capacity and aggravating floods during monsoons and dry spells during summers.

RRWDA: Integrated Watershed-to-Basin Management Framework

For a 100,000-ha basin, anchored by a scientifically monitored Model Micro-Watershed and replicated across comparable watersheds

01 | MODEL

Gauged Micro-Watershed

- Intensive monitoring
- Baseline characterization
- Scientific planning
- Intervention implementation
- Impact evaluation



02 | REPLICATE

Comparable Micro-Watersheds

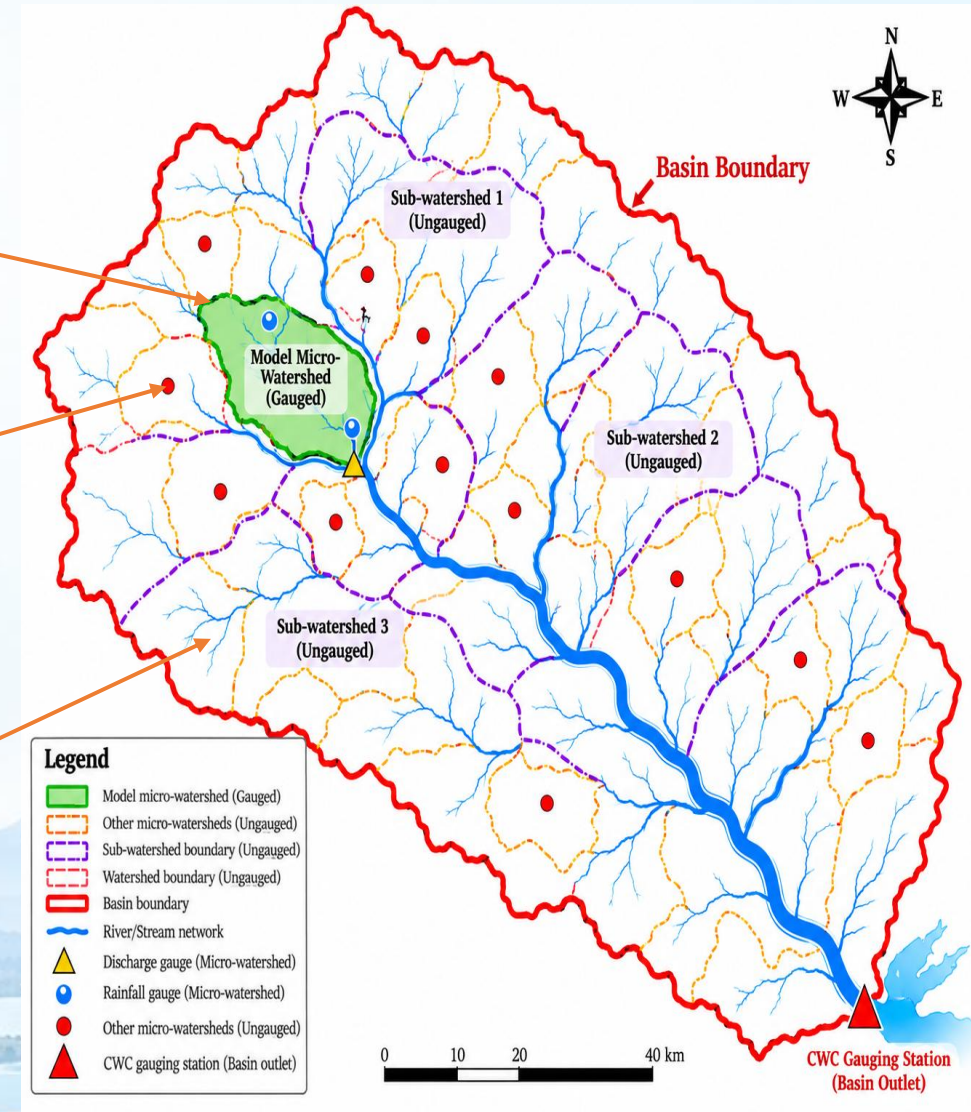
- Similar physiography
- Similar management interventions
- Replicated treatment protocols
- Limited/strategic monitoring



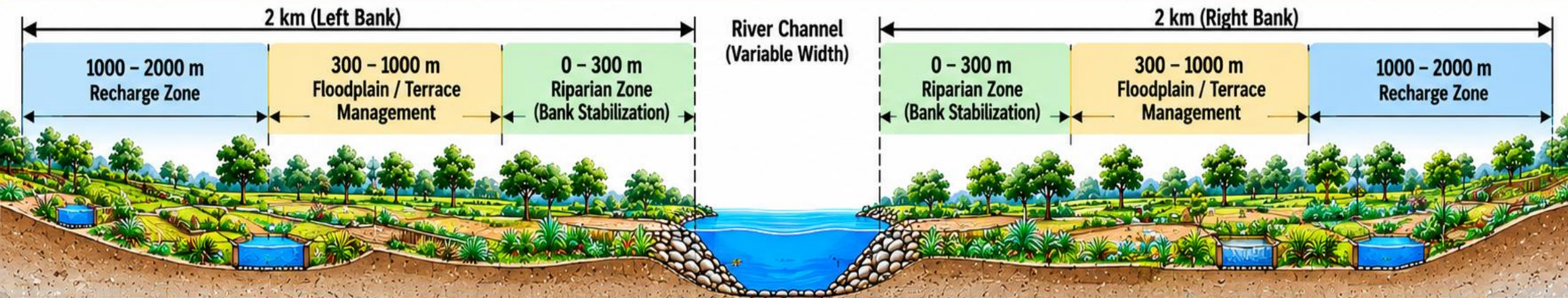
03 | VALIDATE & SCALE

Sub-Watershed → Basin

- Sub-watershed response
- Basin outlet monitoring
- CWC validation
- Basin-scale assessment



River-Rejuvenation Interventions within a 2-km River-Side Corridor



Riparian Zone (0 – 300 m)

Riparian Protection / Bank Stabilization



Key Interventions (Examples)

- Riparian plantation (native species)
- Bio-engineering for bank stabilization (brush layering, coir logs, vegetative barriers)
- Protection of vulnerable banks
- Habitat improvement and ecological buffer
- Control of encroachment and regulated land use

Floodplain / Terrace Management (300 – 1000 m)

Floodplain / Terrace Management

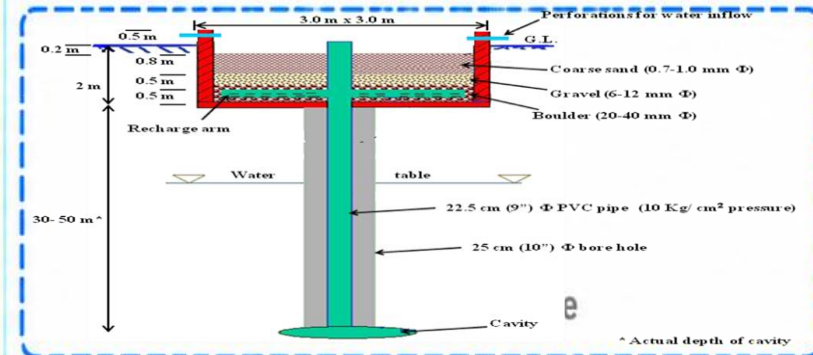


Key Interventions (Examples)

- Floodplain wetland restoration
- Sediment control and deposition management
- Agricultural best practices (e.g., agroforestry, contour farming)
- Gully control measures on adjacent slopes
- Confluence management (tributary junctions)
- Retention structures for runoff attenuation

Recharge Zone (1000 – 2000 m)

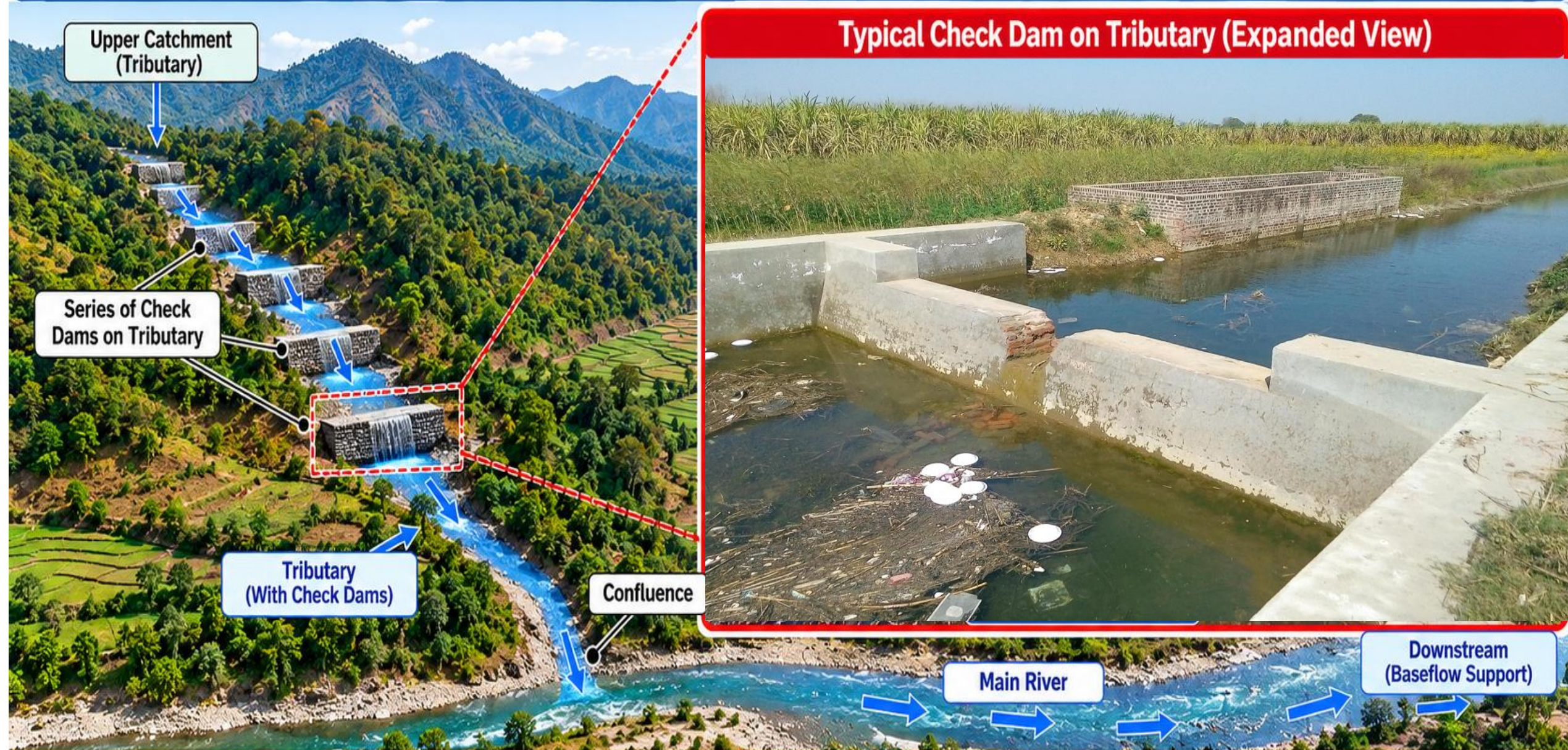
Groundwater Recharge Enhancement



Key Interventions (Examples)

- Recharge ponds / percolation tanks
- Recharge shafts / injection wells (where suitable)
- Contour trenches and staggered trenches
- Check dams (on tributaries / gullies)
- Infiltration measures and rainwater harvesting
- Afforestation / vegetation treatment for enhanced infiltration

Role of Check Dams on Tributaries for River Rejuvenation



The primary river-rejuvenation interventions are confined to the **2-km river corridor** however, hydrologically connected tributaries extending beyond this corridor may be selectively treated where they demonstrably contribute to the sustainability of the intervention reach.

River Rejuvenation: A Catchment-Scale Integrated Approach

1 Ridge-to-Valley Watershed Treatment

- Contour trenches & gully plugs
- Soil & moisture conservation
- Afforestation & pasture development

2 Water Harvesting & Groundwater Recharge

- Renovation of tanks & ponds
- Farm ponds & recharge pits
- Drainage deepening & subsurface dykes

3 Sustainable Agriculture & Agroforestry

- Field bunding & laser levelling
- Climate-resilient & conservation agriculture
- Agroforestry & micro-irrigation

4 Drainage Treatment & Runoff Management

- Gabions & check dams
- Nala bunding & desiltation
- Runoff & sediment control

5 River & Riparian Restoration

- Native riparian plantation
- Riverbank stabilization
- Floodplain protection & desiltation

6 Community Water & Livestock Support

- Village pond renovation
- Drinking-water source recharge
- Livestock water & storage

7 Livelihood & Institutional Strengthening

- Watershed committees
- SHG & FPO promotion
- Capacity building
- Panchayat level water stewardship

The strategy treats the entire landscape, from ridge to river, to restore natural hydrology

Expected Outcomes and Impact

The watershed-based river rejuvenation initiative will deliver the following outcomes-----



Year-round

river flow (from 4–5 months at present)



10–15 m

rise in groundwater levels



3–4

irrigations per crop (from 2)



180%

cropping intensity (from 120%)



2×

farm income – at least two-fold



Water security for all villages in the catchment



Significant reduction in runoff, soil erosion and siltation



Restoration of the ecological and cultural integrity of the river/ stream



Long-term hydrological and environmental sustainability

NATIONAL POLICY FRAMEWORK

Watershed-Based River Rejuvenation in India

1. Convergence

Align MGNREGS, PMKSY-WDC, and Atal Bhujal resources -with river basin planning and management to pool financial and technical resources, PPCP, Multilateral assistance, outcome based blended finance

2. Basin Scale Mapping

Use remote sensing, GIS and models to target critical recharge zones, degraded catchments and dying streams, National watershed information system

3. Legal and regulatory Backing

Protect riparian buffers, curb sand mining and indiscriminate land use changes

4. Participation

Institutionalize community water budgeting and hydrological monitoring so local stakeholders can track groundwater tables and streamflow health

Strategic Objective: Scale nationwide river revival through integrated institutional planning and community stewardship.

THANKS