Approaches in Water Conservation and Management

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INDIAN WATER SCENARIO

Water-stressed districts in India
Top 5
Uttar Pradesh (35)
Rajasthan (29)
Tamil Nadu (27)
Punjab (20)
Haryana and Karnataka (19)

Million Indians experience high water stress

Million have per capita water availability close to or **lower than 1000 m^3** – the official threshold for water scarcity as per the Falkenmark Index

World Bank, COMPOSITE WATER MANAGEMENT INDEX NITI Aayog August 2019, Jal Shakti Abhiyan Concept Note, 2019

Water management: New Principles and Technology

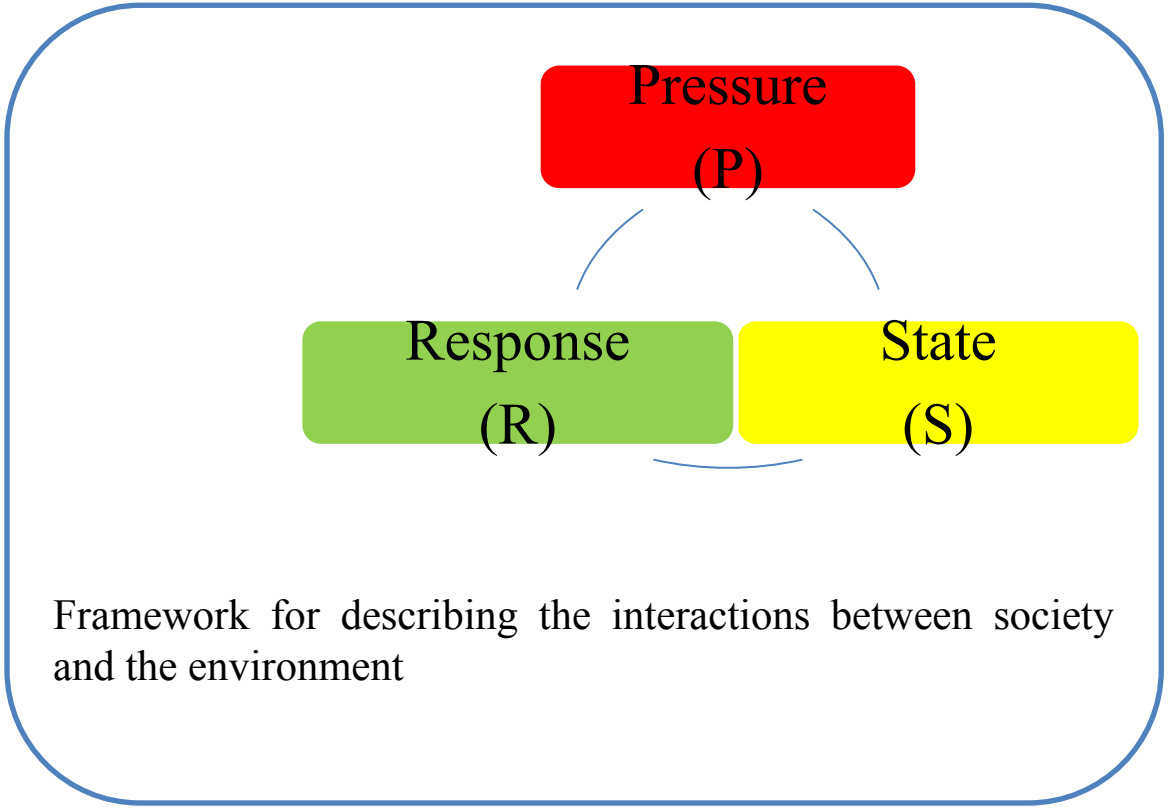
PRINCIPLES OF WATER MANAGEMENT : 3R's	
REDUCE	Reduce: (Water use Efficiency)
REUSE/RECYCLE	Reuse: Cascading use, Using treated wastewater for purposes such, vehicle washing, toilet flushing, Drain Dilution, Industrial gardening /agriculture/horticulture etc.
RECHARGE	Recharge: **Recharge of Water Bodies- Runoff Management /RWH**

WATER MANAGEMENT GOVERNANCE FRAMEWORK	
SUSTAINABILITY ANALYSIS	**Basin-sub basin – watershed level planning**
INTEGRATED MODEL	**Hydrology** **Environment** **Social and Cultural Aspects** **Institutions**
PARTICIPATORY APPROACH	**Stakeholder Engagement in Planning Implementation and Monitoring**

Sustainability Analysis

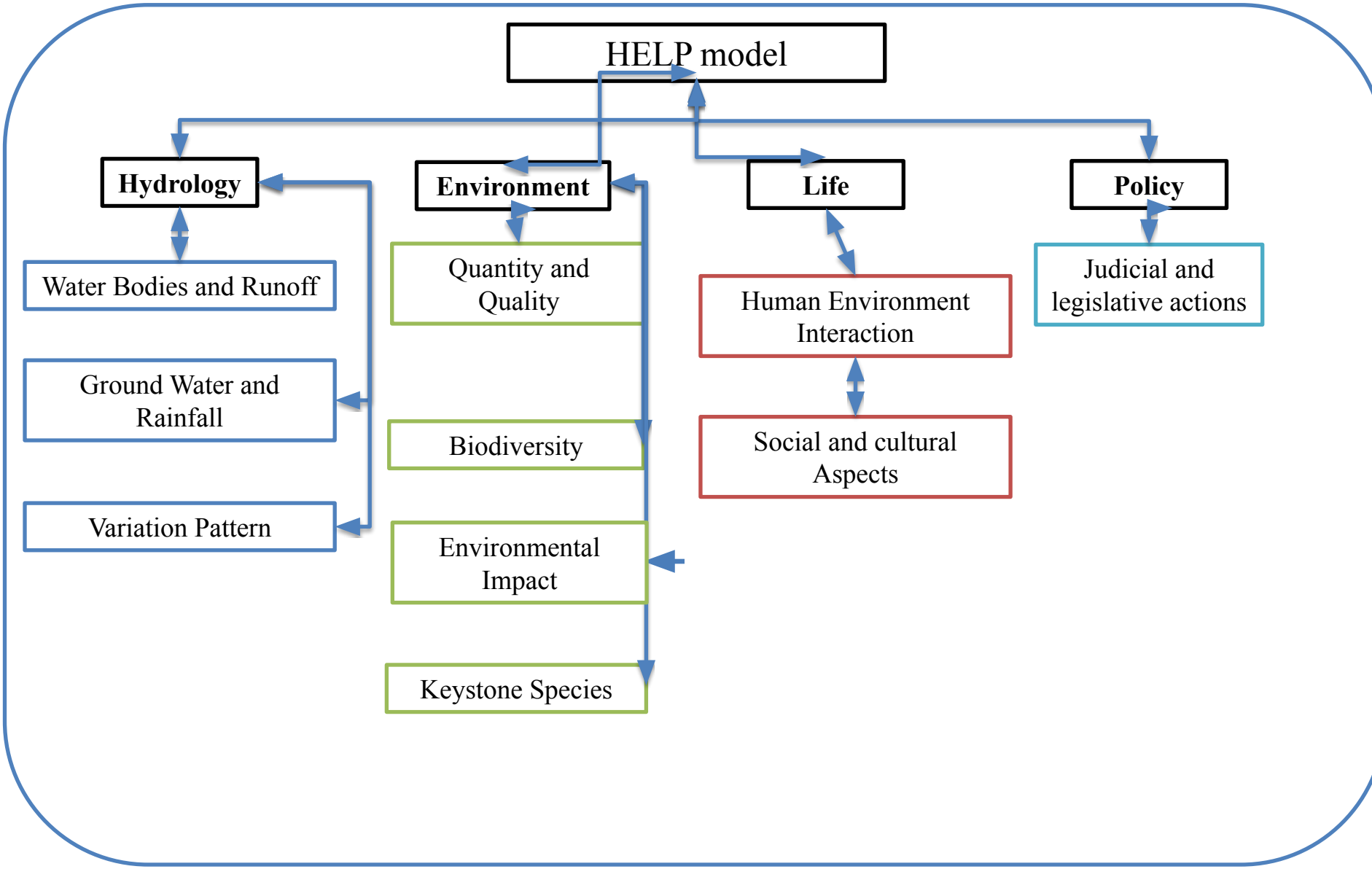
Sustainability assessment integrating technical, social, cultural, economical and ecological factors

PSR based Framework



Framework for describing the interactions between society and the environment

Integrated Model



Case Study 1- PSR-HELP Framework for Basin Rejuvenation

PSR – HELP Indicators for Assessment

Indicators	Pressure (P)	State (S)	Response (R)
Hydrology (H)	1. Change in characteristics of waterbodies in the catchment/watershed 2. Change in Ground Water Level (pre and post monsoon) 3. Variation in Rainfall 4. Change in water availability	1. Present Area of Waterbodies 2. Present Pre & Post Monsoon Level of GW 3. Present status of Rainfall 4. Status of water availability	1. Rejuvenation of waterbodies 2. Creation of sustainable waterbodies & water recharging structures

PSR – HELP Indicators for Assessment

Indicators	Pressure (P)	State (S)	Response (R)
Environment (E)	1. Change in Biodiversity • Dense Forest • Key Tree Species • Herbal/Medicinal Plant Species • Aquatic Species 2. Untreated Sewage Discharge 3. Change in Water Quality • Water Quality of different water sources in catchment. 4. Community health impact due to water borne diseases 5. Basin's Environment Pressure Index EPI 6. Impact of Mining and industrial activities 7. Riparian Zone if any	1. Biodiversity • Present Area of Dense Forest • Present Area of key tree/plant species • Total Area for fishing 2. Current status of Sewage Treatment 3. Present WQ • Water Sources in Catchment 4. Area of Agriculture & Habitation at present 5. Status of Community Health due to water 6. Status of Mining 7. Status of Riparian Zone	1. Plantation of Key Species 2. Specific plan for aquatic life conservation 3. Construction & Implementation of Sewage Treatment Plant 4. Intervention for vegetation, water quality & soil health 5. Reclamation of encroached land 6. Measures to regulate mining and industrial activities 7. Measure for demarcation & management of Riparian Zone

PSR – HELP Indicators for Assessment

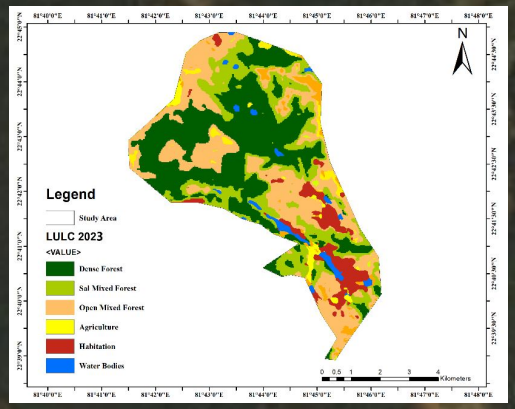
Indicators	Pressure (P)	State (S)	Response (R)
Life (L)	1. Change in Livelihood • Mining • Tourism (Religious & Eco) • Culture • Forest Produce/Medicinal • Aquatic • Other Sources 2. Water Availability 3. River Ecosystem in Academic Curriculum 4. Impact on Social and Cultural Practices	1. Present Livelihood Activities • Mining • Tourism (Religious & Eco) • Culture • Forest Produce/Medicinal • Aquatic • Other Sources 2. Status of DW for Habitants 3. Participation of Children for understanding river ecosystem 4. Status of water based Social and Cultural Practices	1. Measures taken for livelihood enhancement & management 2. Scheme for Ensuring Water Availability 3. Development of Participatory Mechanism for Water oriented activities 4. Revival of water based Social and Cultural Practices

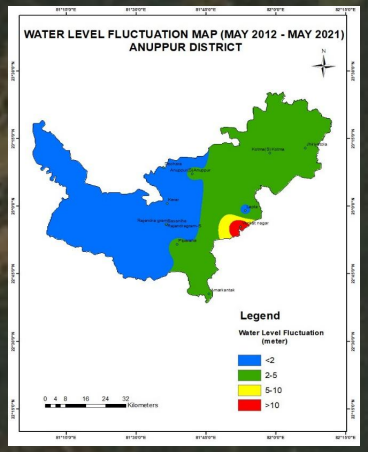
PSR – HELP Indicators for Assessment

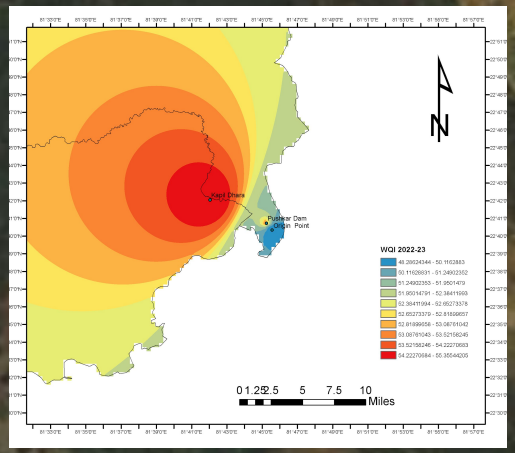
Indicators	Pressure (P)	State (S)	Response (R)
Policy (P)	1. Judicial & Legislative Intervention 2. PIL, Agitation and other mode	1. Present state of compliance w.r.t. Policy enactment and implementation 2. Status of Plantation, Cleanliness Drive and Capacity Building	1. Necessary Action taken by concerned authorities/agencies 2. Activities conducted for Stakeholder Sensitisation and Community Monitoring Practices

Amarkantak, District Anuppur, Madhya Pradesh

Origin place of Narmada and Sone Rivers







Kabir Sarovar

Puskar Sarovar

Narmada Udgam

Savitri Sarovar

Pond (Indradaman)

Mai Ki Bagiya

Gayitri Sarovar

Surajkund

Sonmuda Amarkantak

Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

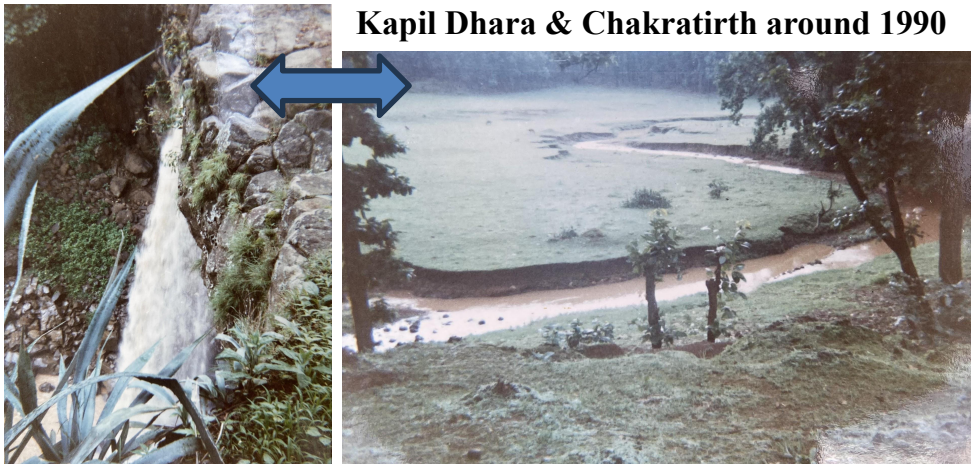
Indicators	Pressure (P)	State (S)	Response (R)
Hydrology (H)	1. Waterbodies Reduced by 31.01% in 20 years 2. Depletion in GW: 3.2 mtr post monsoon and 1.87 mtr pre monsoon 3. Rainfall increased by avg. of 5.7% in 2 decades.	1. 4.89% is area (as of 2023) of waterbodies in study area 2. 11.42 mtr Pre-Monsoon and 8.40 mtr Post Monsoon (as of 2020) 3. 1306.44 mm in 2022 which is more than average rainfall 1220.23 mm in 2 decades	1.State and Local Administration is developing plan for Rejuvenation of waterbodies. -Locals along with NGO Narmada Samagra did cleanliness/de-siltation of Savitri Rivulet (5m deep x 6m wide x 300m long) in 2022. -Forest Dept. is working on soil and moisture conservation through various techniques. 2.Cleaning/renovation of old 4-5 wells was done in 2023.

Comprehending the proposed HELP indicators using PSR Framework for River Sustainability on Amarkantak Region

Indicators	Pressure (P)	State (S)	Response (R)
Environment (E)	1. Change in Biodiversity - Dense Forest decreased by 35.57% - Sal Mixed Forest: decreased by 36.53% - Medicinal Plants: 47% Aquatic Species: Labeo rohita, Labeo catla, Zig-Zag eel, Indian flapshell turtle/(Lissemy s punctata) decreased 2. Direct Sewage Discharge till 2023. 3. WQI: During 7 years period, Origin: 13.95 (improvement); Pushkar Dam: 2.84 (degrading); Kapil Dhara: 0.3 (degrading slow) 4. Community health impact due to water borne diseases 5. Basin's EPI = 156.26% in 20 years	1. Biodiversity - Dense Forest Area in Study Area is 28.40% (as of 2023) - Sal Mixed Forest in Study Area is 17.80% (as of 2023) - 10 sq. km. area restricted from fishing 2. STP (1.2 MLD) operationalized in February 2024. 3. As of 2022-23 WQI of Origin is 47.99, Pushkar Dam 53.28 and Kapil Dhara 55.36. 4. Area of habitation in study area: 4.67% (as of 2023) 5. No Bauxite Minin	1. Forest Department setup Nursery of 5000 Sal Saplings was developed in 2022-23. 2. Ban on fishing around 2002 under sacred/holy place guidelines. 3. Presently 10 Wards our of 15 wards are connected to STP. 4. Intervention for vegetation, water quality & soil health 5. Local Administration and Forest Department has initiated removal of encroachment recently. 6. Mining was discontinued around 2000. However, improper compliance with environmental management plan is observed. 7. This needs attention and proper planning for developing Riparian Area and its Management.

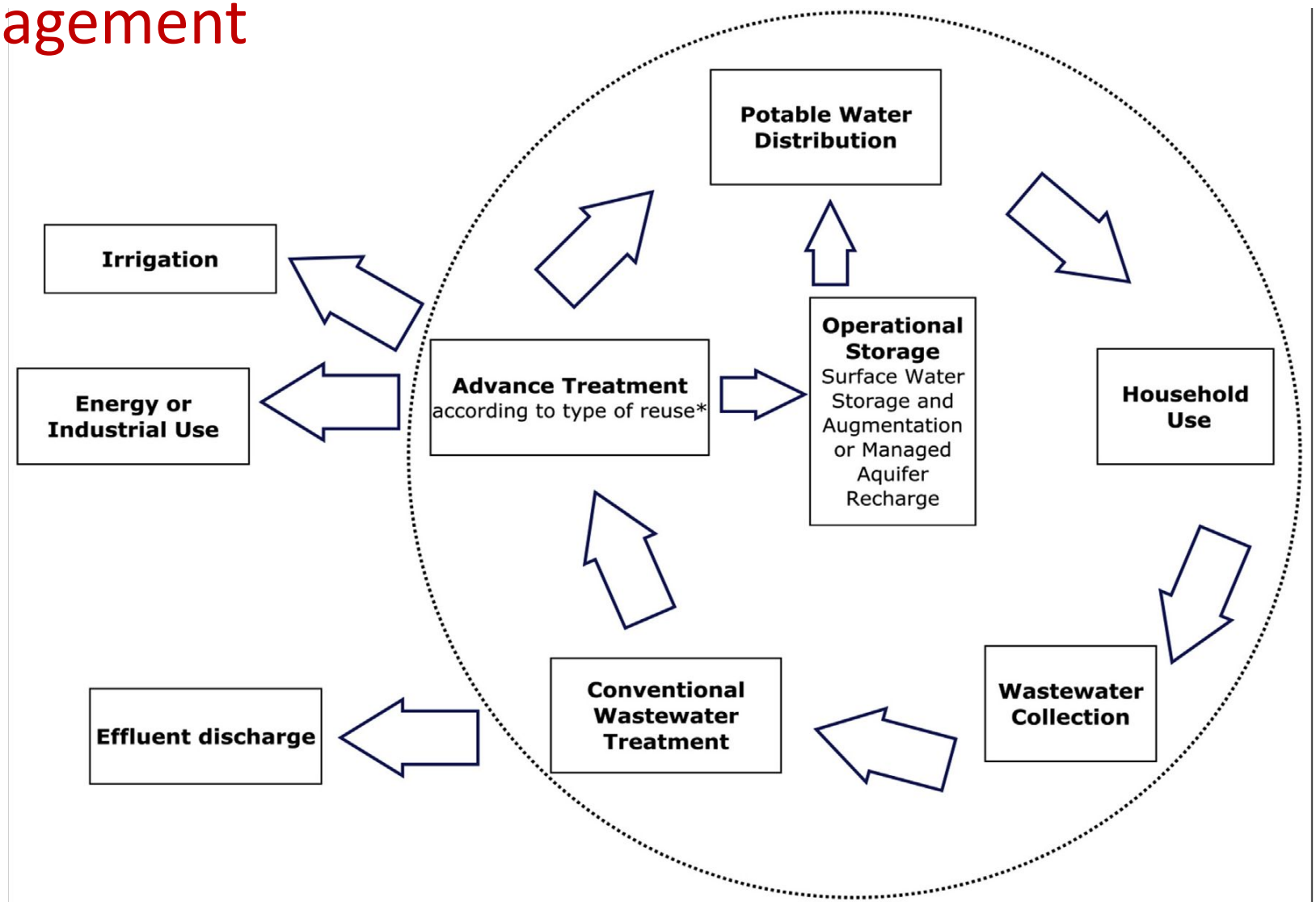
Water Sources

Kapil Dhara & Chakratirth around 1990



Kapil Dhara Waterfall during 2011, 2016 and 2019

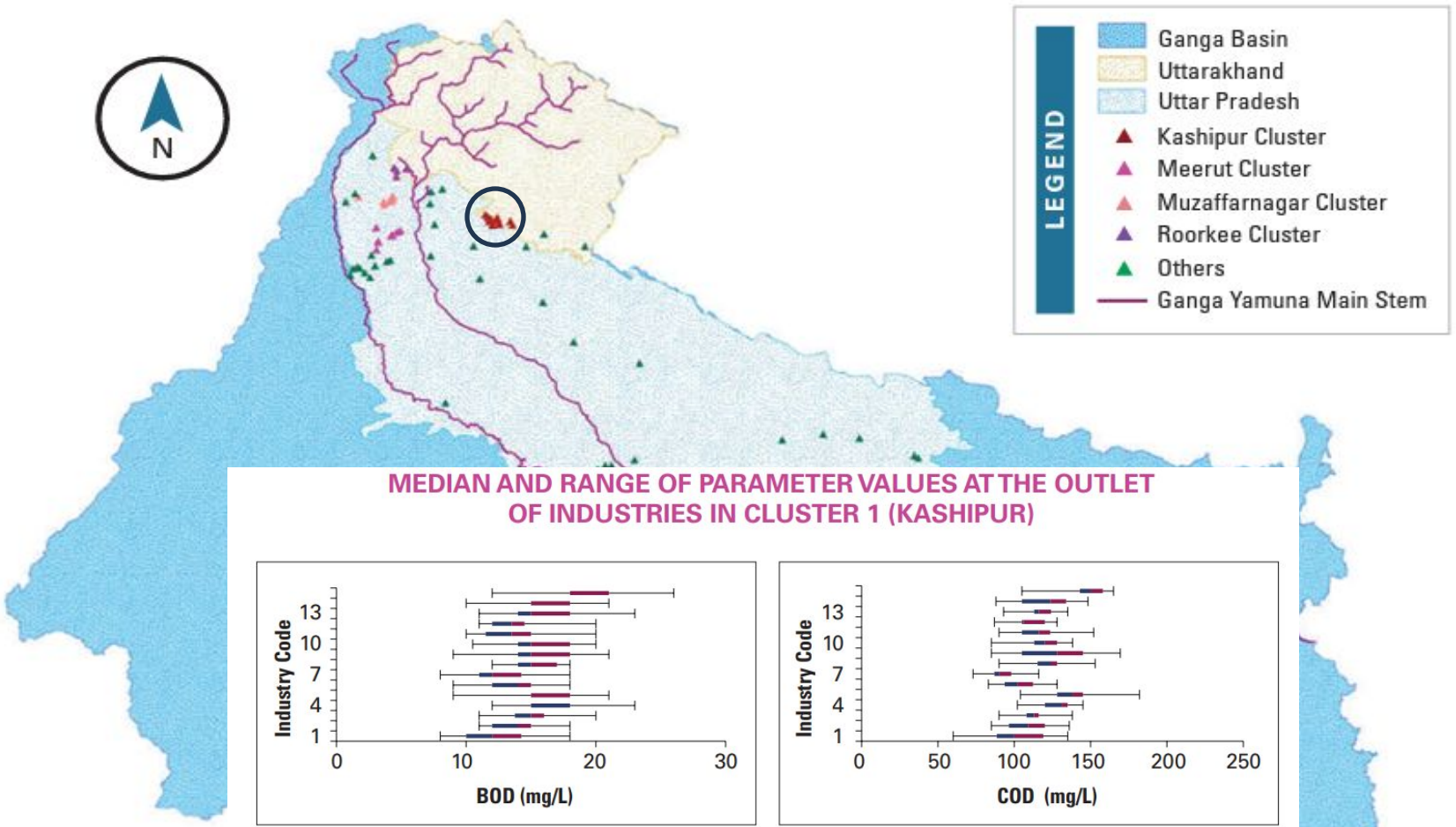
Case Study 2: Circular Approach of Water Management



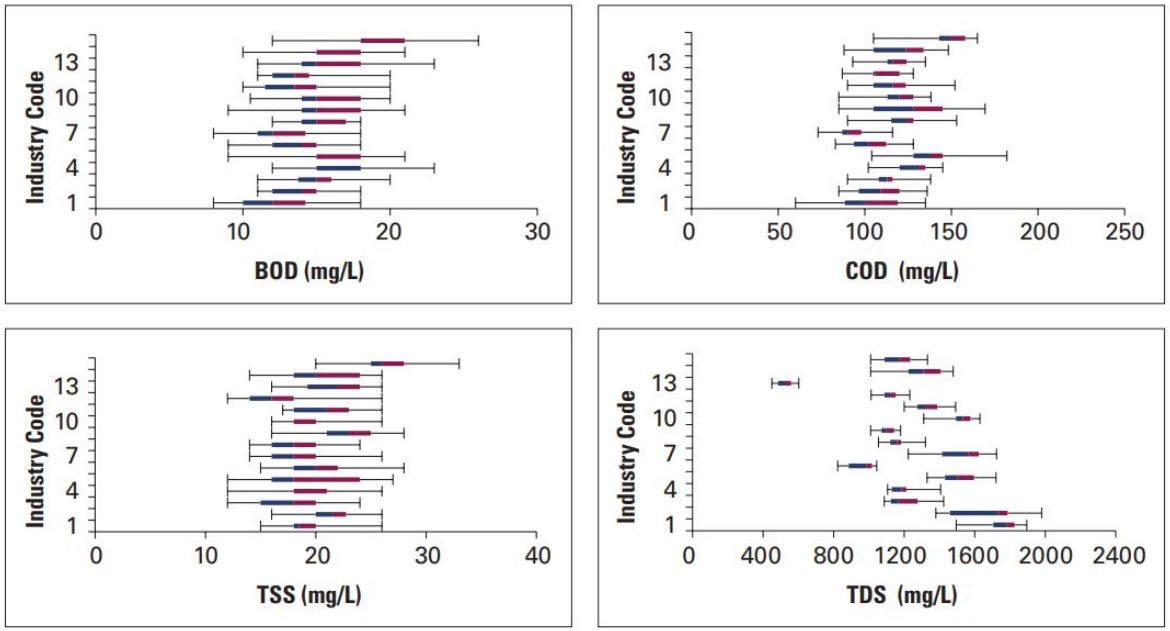
*Ultra filtration, reverse osmosis and ultraviolet disinfection for direct potable reuse.

Current Opinion in Environmental Science & Health

LOCATIONS OF 21 CLUSTERS WITHIN THE ADMINISTRATIVE BOUNDARIES OF THE STATES OF UTTARAKHAND AND UTTAR PRADESH



MEDIAN AND RANGE OF PARAMETER VALUES AT THE OUTLET OF INDUSTRIES IN CLUSTER 1 (KASHIPUR)



SUMMARY OF DRAIN WATER QUALITY FOR KASHIPUR

Industry Code	Flow (MLD)		DO (mg/L)	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	VSS (mg/L)
1	Upstream	4.8 ± 6.3	0.3 ± 0.5	40.8 ± 6.6	163 ± 21	36.9 ± 4	13.8 ± 3.7
	Downstream	10.1 ± 7.7	2.9 ± .99	25.2 ± 4.2	138 ± 16.4	28.5 ± 2.6	10.1 ± 2.07
2	Upstream	8.9 ± 7.2	1.1 ± 0.4	26.2 ± 6.7	133 ± 12	28.8 ± 6.4	10.7 ± 3.6
	Downstream	12.4 ± 8.4	1.5 ± 0.9	21.6 ± 3.6	115 ± 12.2	27.5 ± 2.3	10.3 ± 2.3
3	Upstream	9.0 ± 6.7	0.2 ± 0.3	51.5 ± 14.4	286 ± 77.9	53.6 ± 10.3	23.6 ± 8.2
	Downstream	15 ± 6.2	0.4 ± 0.5	31.8 ± 3.9	189 ± 43.5	37.9 ± 3.7	13.1 ± 2.4
4	Upstream	14.4 ± 6.5	0.3 ± 0.5	31.9 ± 3.9	190 ± 43	37.9 ± 3.8	13.9 ± 4.7
	Downstream	17.0 ± 6.9	0.7 ± 1.0	24.6 ± 2.7	142 ± 11.9	28.6 ± 3.5	10.7 ± 3.9
5	Upstream	2.3 ± 1.8	0.6 ± 0.6	16.5 ± 4.1	67.6 ± 9.9	20.1 ± 6.5	7.2 ± 3.0
	Downstream	3.6 ± 2.3	1.3 ± 1.0	26.9 ± 5.2	148 ± 11.8	30.3 ± 5.0	10.8 ± 2.4
6	Upstream	6.2 ±5.0	1.1 ± 0.8	28.6 ± 4.5	418 ± 405	31.9 ± 3.8	11.9 ± 2.9
	Downstream	8.1 ± 5.1	1.8 ± 1.1	22.3 ± 3.3	116 ± 11.1	26.9 ± 2.6	10.0 ± 2.4
7	Upstream	8.1 ± 5.4	0.9 ± 0.8	25.2 ± 2.8	132 ± 8.9	30.9 ± 3.9	11.7 ± 3.4
	Downstream	10.3 ± 5.2	2.4 ± 1.3	19.6 ± 4.4	114 ± 8.6	24.5 ± 2.2	8.9 ± 1.3
8	Upstream	-	-	-	-	-	-
	Downstream	2.4 ± 1.3	1.2 ± 0.7	31.3 ± 4.8	158 ± 19.1	38.9 ± 4.3	14.1 ± 2.7
9	Upstream	1.2 ± 2.3	1.4 ± 1.7	24.6 ± 3.2	141 ± 7.2	28.5 ± 2.7	10.2 ± 1.4
	Downstream	2.3 ± 2.4	1.7 ± 0.7	25.5 ± 4.0	145 ± 15.8	27.9 ± 3.0	9.9 ± 1.9
10	Upstream	0.6 ± 0.8	0.6 ± 0.9	10.6 ± 2.3	66.5 ± 15.8	12.1 ± 3.1	4.4 ± 1.27
	Downstream	2.0 ± 1.2	1.0 ± 0.8	20.6 ± 3.4	133 ± 10.4	25.5 ± 2.3	9.6 ± 1.2
11	Upstream	-	-	-	-	-	-
	Downstream	3.5 ± 1.1	1.4 ± 0.9	22.3 ± 4.3	131 ± 20.7	24.2 ± 4.7	9.7 ± 2.7
12	Upstream	1.3 ± 1.5	0.1 ± 0.3	39.6 ± 6.0	231 ± 45.3	43.0 ± 3.1	15.9 ± 2.7
	Downstream	2.2 ± 1.8	0.4 ± 0.6	28.7 ± 4.3	157 ± 19.0	32.9 ± 5.5	11.8 ± 3.2
13	Upstream	0.6 ± 0.7	0.3 ± 0.4	34.8 ± 15.2	156 ± 56.8	33.9 ± 11.8	12.5 ± 4.9
	Downstream	1.0 ± 0.7	0.8 ± 1.1	47.2 ± 15.1	249 ± 77.3	50.2 ± 10.9	19.5 ± 6.7
14	**Upstream**	0.5 ± 1.0	0.1 ± 0.1	14.2 ± 10.0	108 ± 66.5	16.3 ± 11.9	5.6 ± 4.3
	Downstream	1.0 ± 1.4	0.2 ± 0.4	32.8 ± 3.9	169 ± 7.5	34.0 ± 4.7	12.0 ± 1.9

Example 2: Reuse of Treated Wastewater in Industry

The Tertiary Treatment Plant (TTP) based on Reverse Osmosis at Trans-Yamuna (Trans-Yamuna TTP) to produce a permeate of 20 MLD Treated Water for industrial use (Treated Water) to be supplied to IOCL.

Parameter	Unit	Values of Trans-Yamuna TTP
pH	_	7.3- 8.2
Turbidity	NTU	<30
BOD_5	mg/L	<5
TSS	mg/L	<10
COD	Mg/L	<50
TDS	mg/L	<900
M-Alkalinity as CaCO3	mg/L	<300
Ca –hardness as CaCO3	mg/L	<200
Mg –hardness as CaCO3	mg/L	<110
Total Hardness as CaCO3	mg/L	<360
Chloride as Cl	mg/L	<250
Sulphate as SO4	mg/L	<75
~~Silica~~Silicate as SiO2	mg/L	<20
Iron as Fe	mg/L	<0.3
Organic matter as KmnO4	mg/L	<30

Reuse of Treated Wastewater

Opportunities

- Inter Sectoral Use
- Regulatory and Societal Pressure
- Awareness and performance

Challenges

- Standards
- Gaps In Infrastructure
- Legislative/ Administrative Framework
- Risk Management

Impact Assessment on environment

Soil, Water, Sediments

Physico Chemical Properties									
pH	Cond. (µmho/cm)	Org. Carbon (%)	Org. Matter (%)	ESP	Na (mg/100g)	K (mg/100g)	Ca (mg/100g)	Mg (mg/100g)	SAR

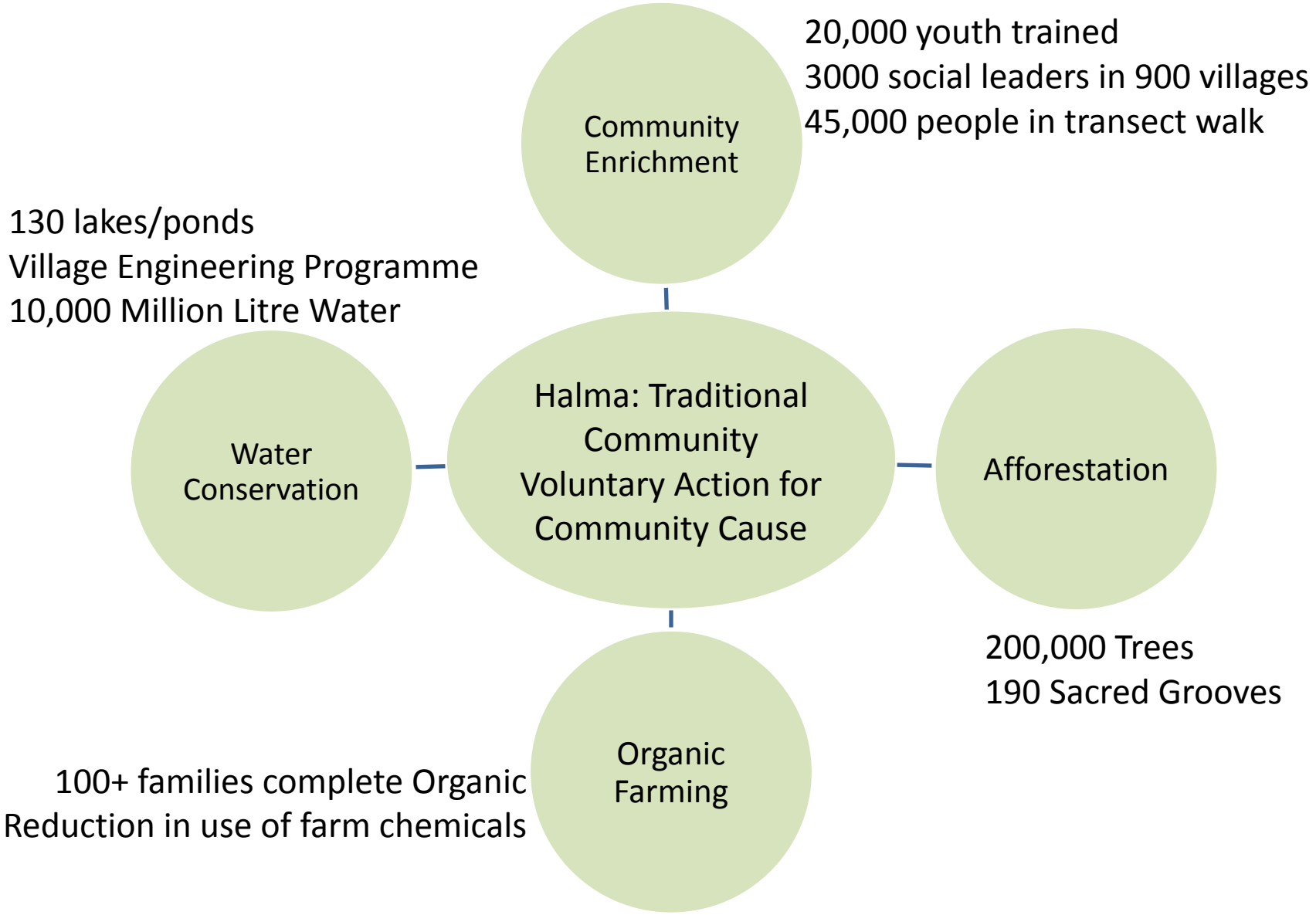
Heavy Metals										
As	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Sb	Se

Parameters (µg/kg)					
Phenol	2-Chlorophenol	4-chloro 3-methylphenol	2,4-dichlorophenol	2,4,6-trichlorophrnol	pentachlorophenol

Sediment Profiling for HM, and PAH

Naphthalene (NPT)	Acenaphthalene (ANY)	Acenaphthene (ANE)	Fluorene(FLE)	Phenanthrene (PHE)	Anthracene (ANT)	Fluoranthene (FLT)	Pyerene (PYR)	Benzo(a)Anthracene (BaA)	Chrysene (CHR)	Benzo(b)Ffluoranthene (Bb	Benzo(k) Ffluoranthene BK	Benzo(a)Pyrene (PBaP)	Benzo(ghi) Pyrlene (BPE)	Dibenzo(a,h) Anthracene (DB	Indeno(1,2,3-cd)Pyrene (IP

Case Study 3: Revival of Tradition Practices









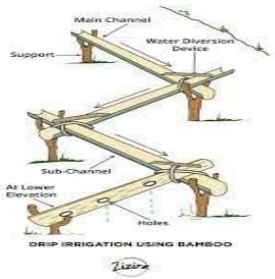
Some Traditional System of Water Conservation in India

Johads: Small Earthen Check Dam

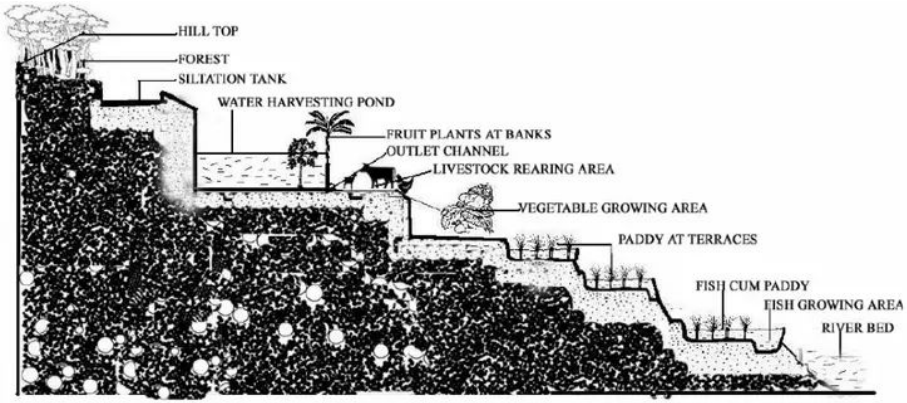
Talab/Bandhi: Natural or Man made

Tankas: Underground household storage

Bawaris/Baoli/Jhalaras: Stepwells



Bamboo Drip Irrigation



Zoho system

THANK YOU.....