An Ecosystem Perspective to Groundwater Governance in India

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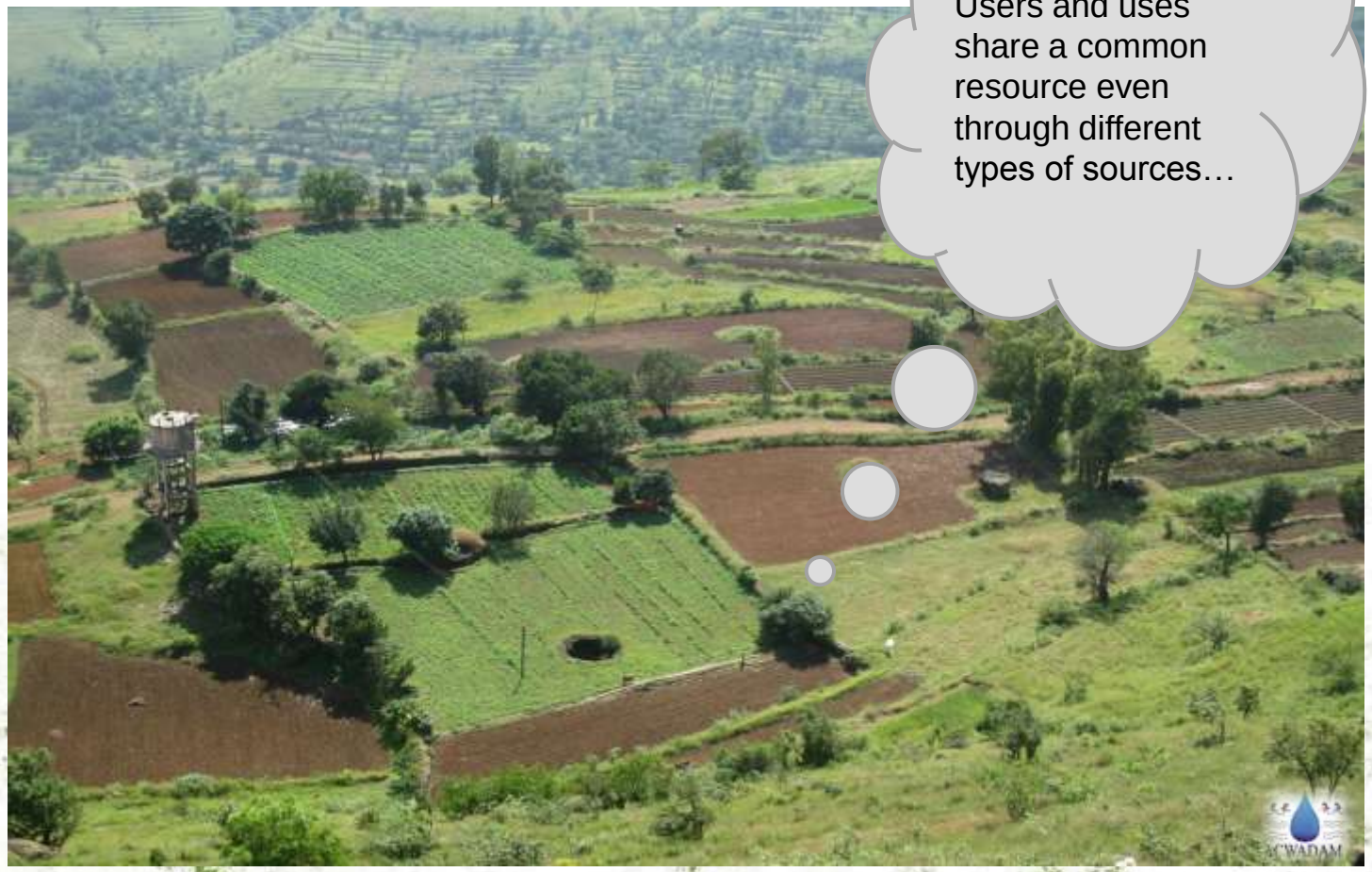
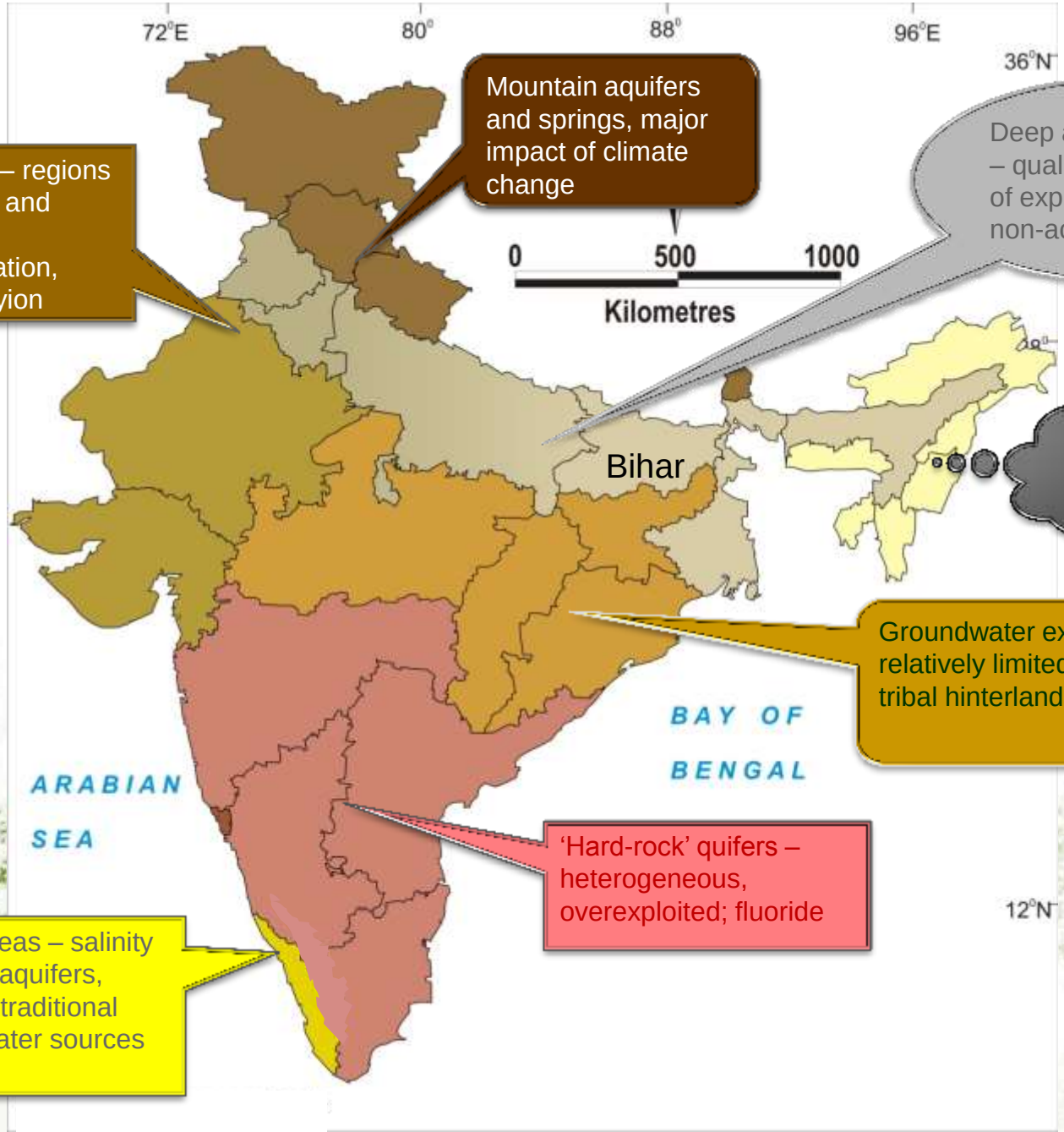
Source


Users and uses share a common resource even through different types of sources…

Access

Distribution

Broad typology of challenges…



Mixed type – regions of intensive and extensive overexploitation, contaminatyion

Mountain aquifers and springs, major impact of climate change

Deep alluvial aquifers – quality issues + mix of exploitation and non-access

Groundwater – high dependence low visibility

Groundwater extraction relatively limited, forests, tribal hinterlands, poverty

'Hard-rock' quifers – heterogeneous, overexploited; fluoride

Coastal areas – salinity ingress to aquifers, erosion of traditional drinking water sources

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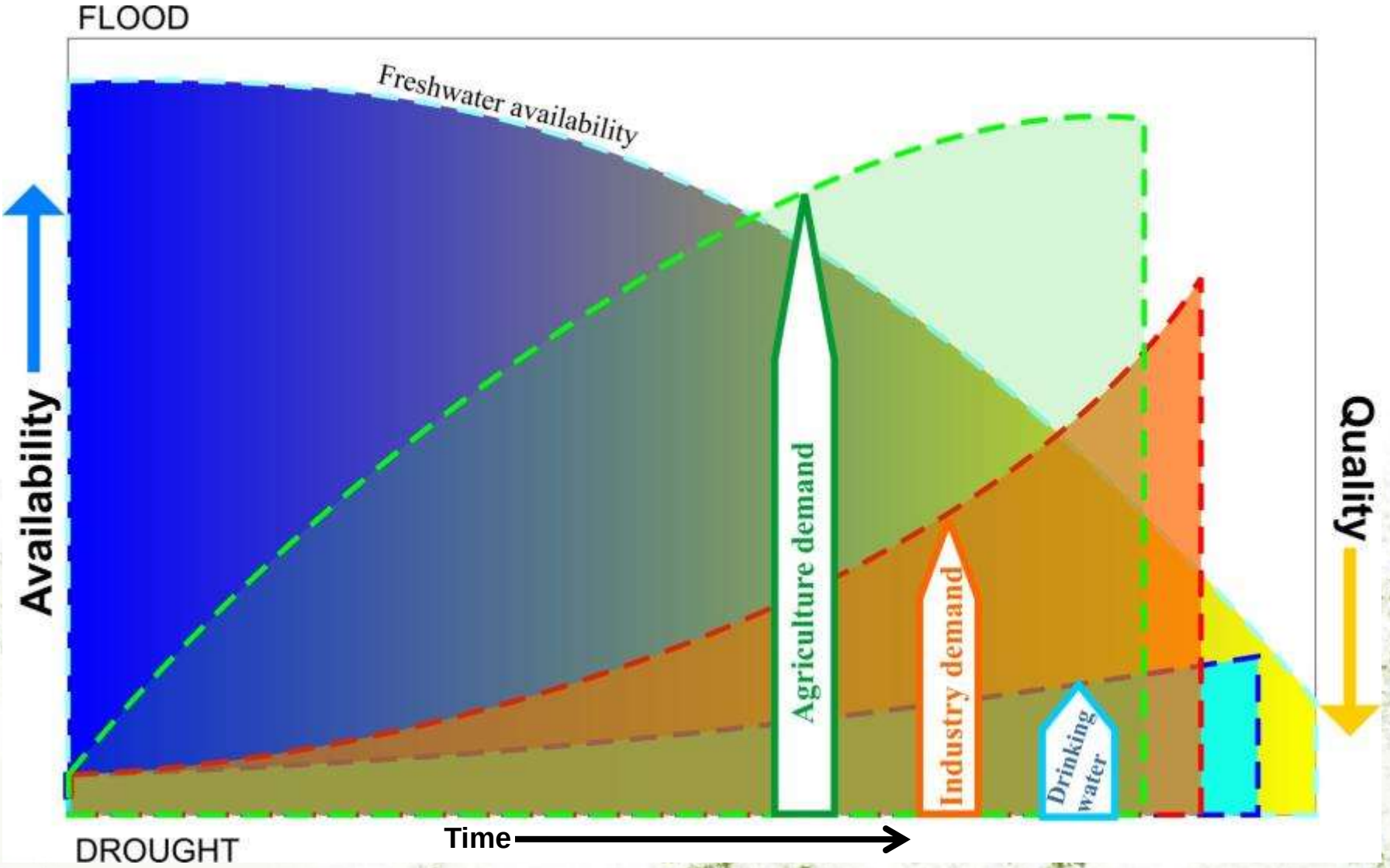
Water security: synopsis of demand, supply and stocks



SUMMARY: Groundwater development and management

Groundwater: “lender of the last resort”

- More than 30 million wells, with at least 60% accessing groundwater in some form of the other
- Uncertain civic water supply offset by dependence on groundwater – *springs, tube wells, bore wells and tankers*
- One of the largest supplementary sources of industrial water supply

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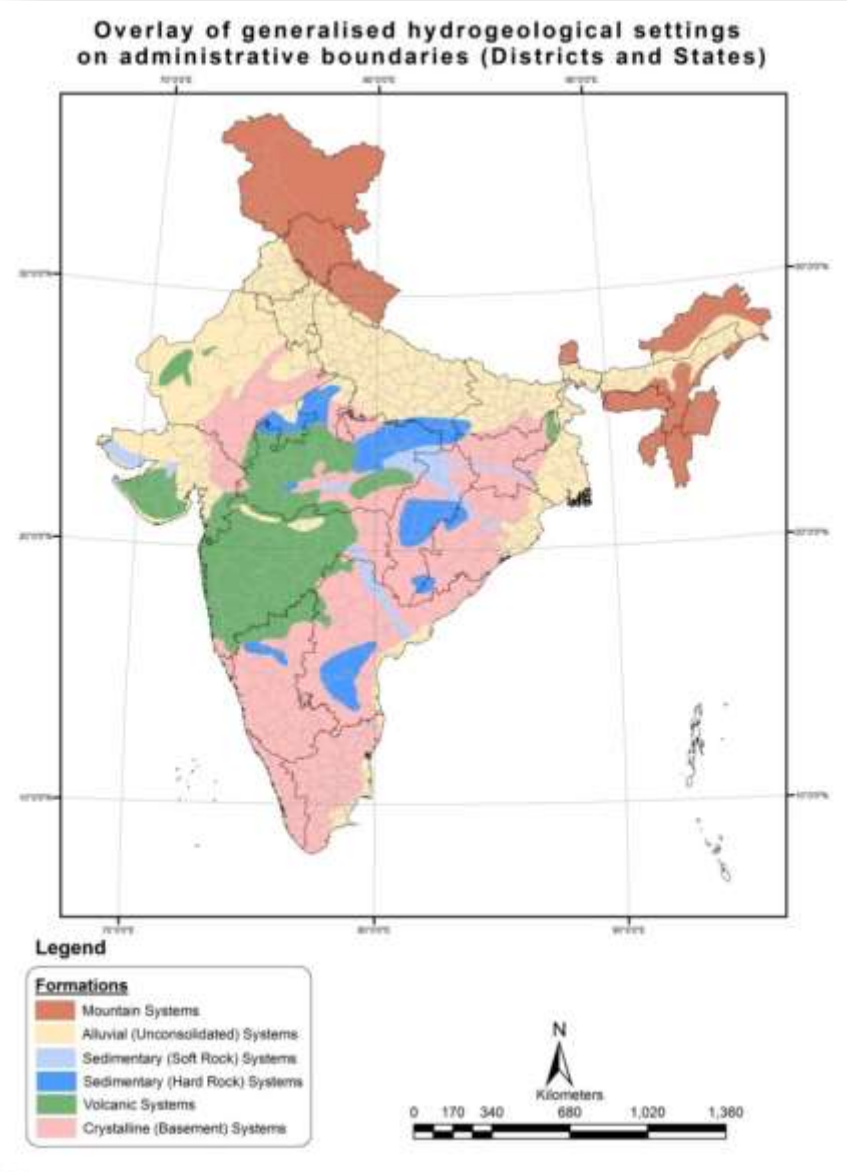
India's Lithodiversity…



Mountain Systems – rock structure plays a significant role in groundwater occurrence and movement.

Alluvial (Unconsolidated) Systems - water in sand and silt lenses, with clays separating aquifers.

Sedimentary (Soft Rock) Systems - coarse sandstone, grit, coal, fossil-bearing rocks - usually contain many openings and water travels through them quickly

Sedimentary (Hard Rock) Systems - sandstones, limestones, siltstones; contain; bedding, fractures and joints may play a significant role in groundwater storage and movement

Volcanic Systems - mostly basalt – some dykes - water stored in vesicles and weathered zones - movement mostly through joints

Crystalline (Basement) Systems - granites, schists, gneisses - groundwater accumulates and moves through weathered zone, joints and fractures

COMMAN, 2005; Kulkarni et al, 2009

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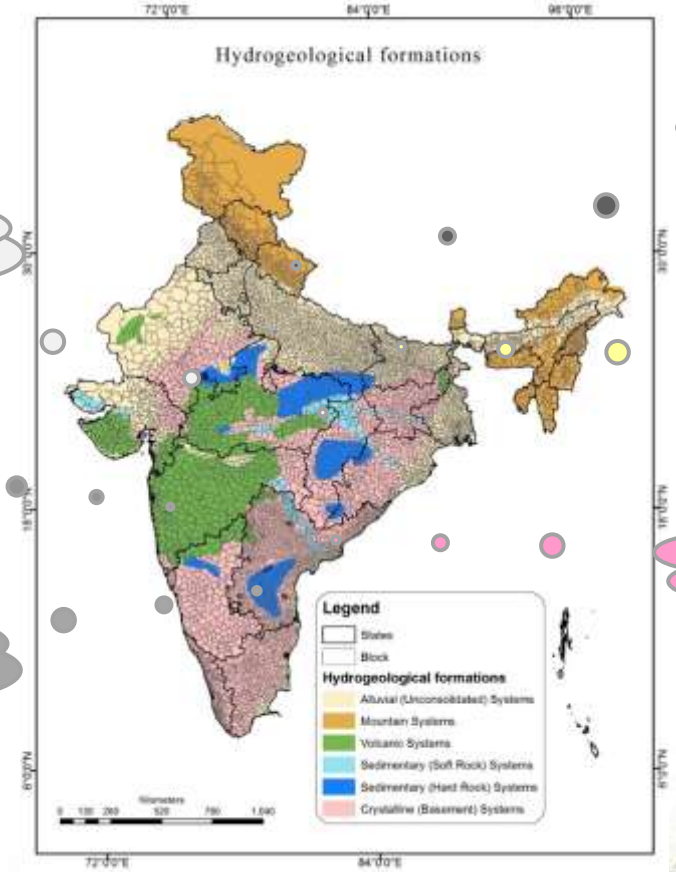
Karst springs, contact springs

Contact springs

Fracture springs



After: COMMAN 2005; GSI (various years), ACWADAM (various publ.), CGWB (2012)

All types – fracture springs dominate?

Depression springs

Contact, depression & fracture springs

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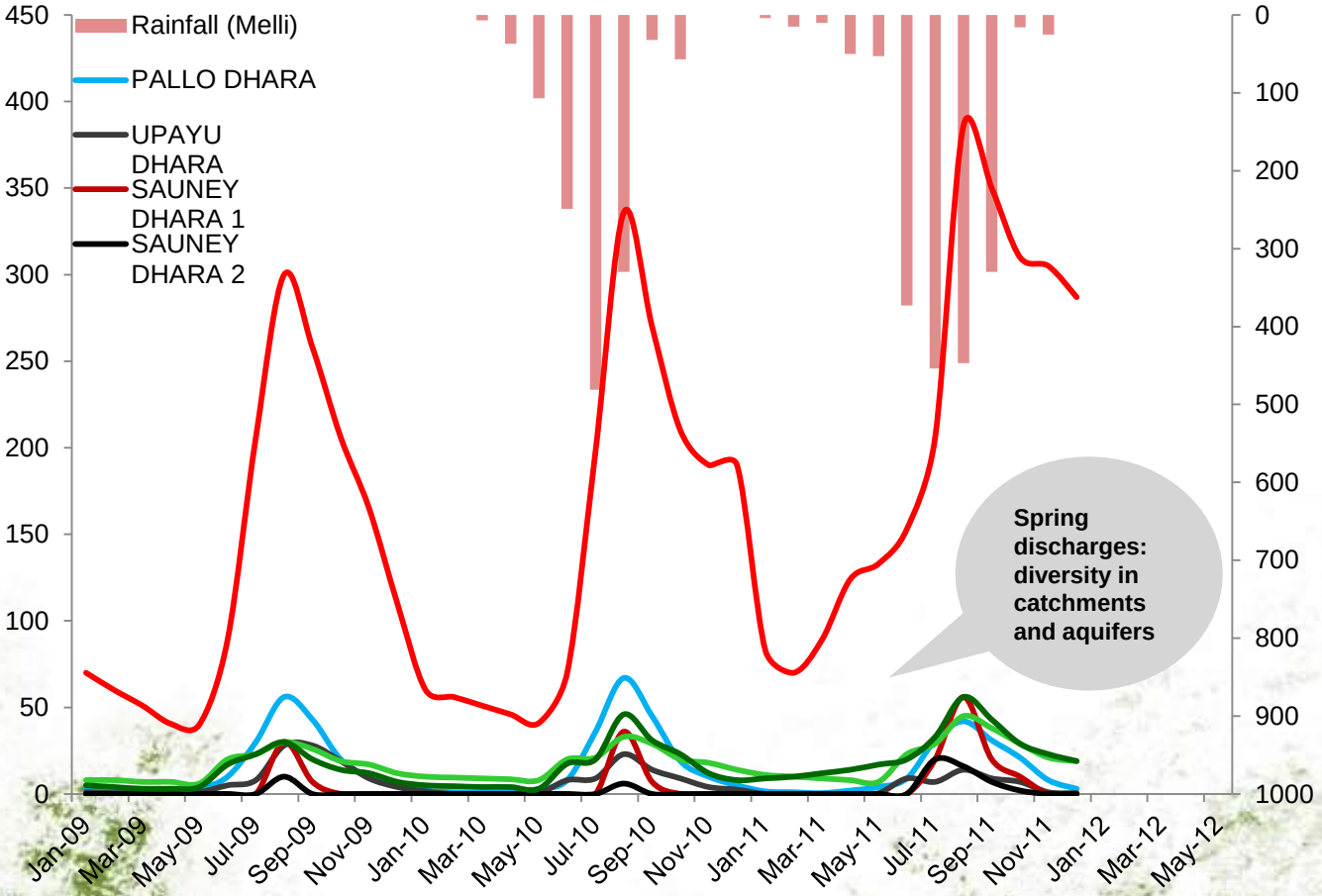
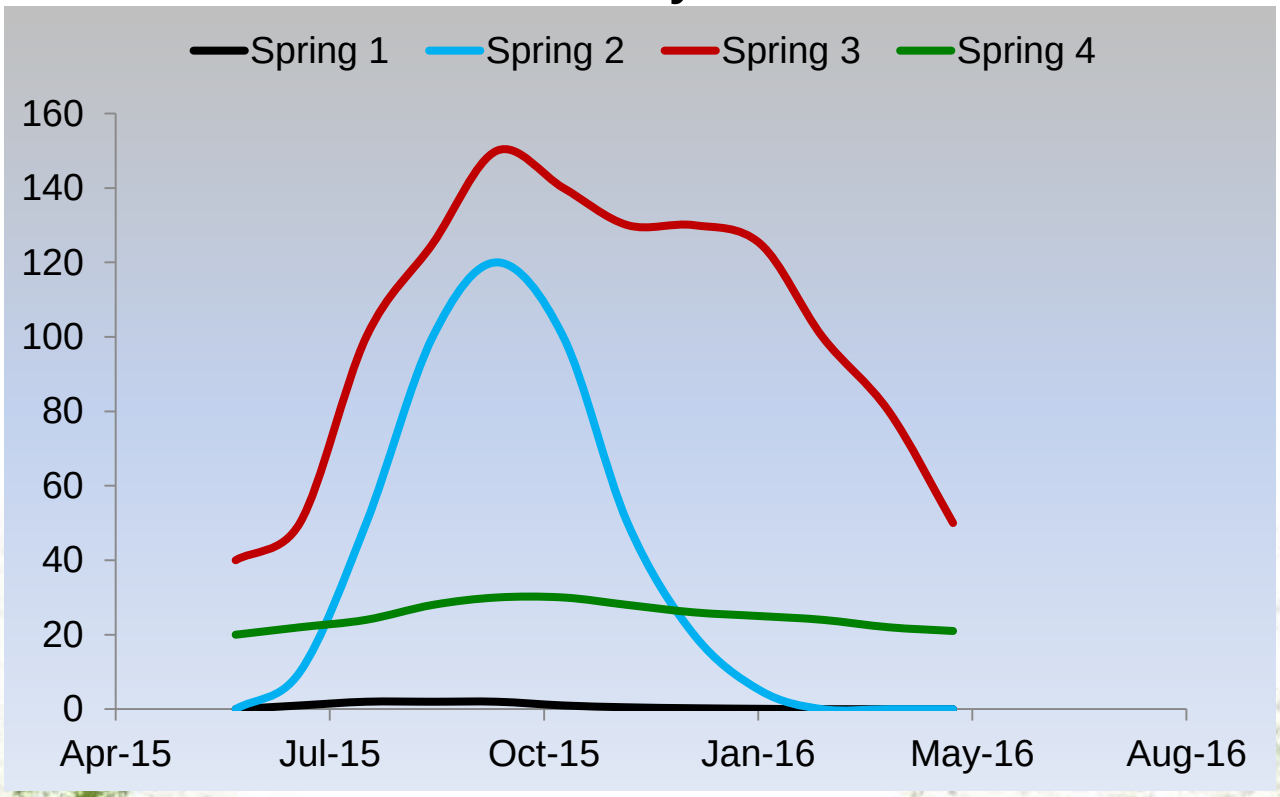
...so are springs tapping mountain aquifers

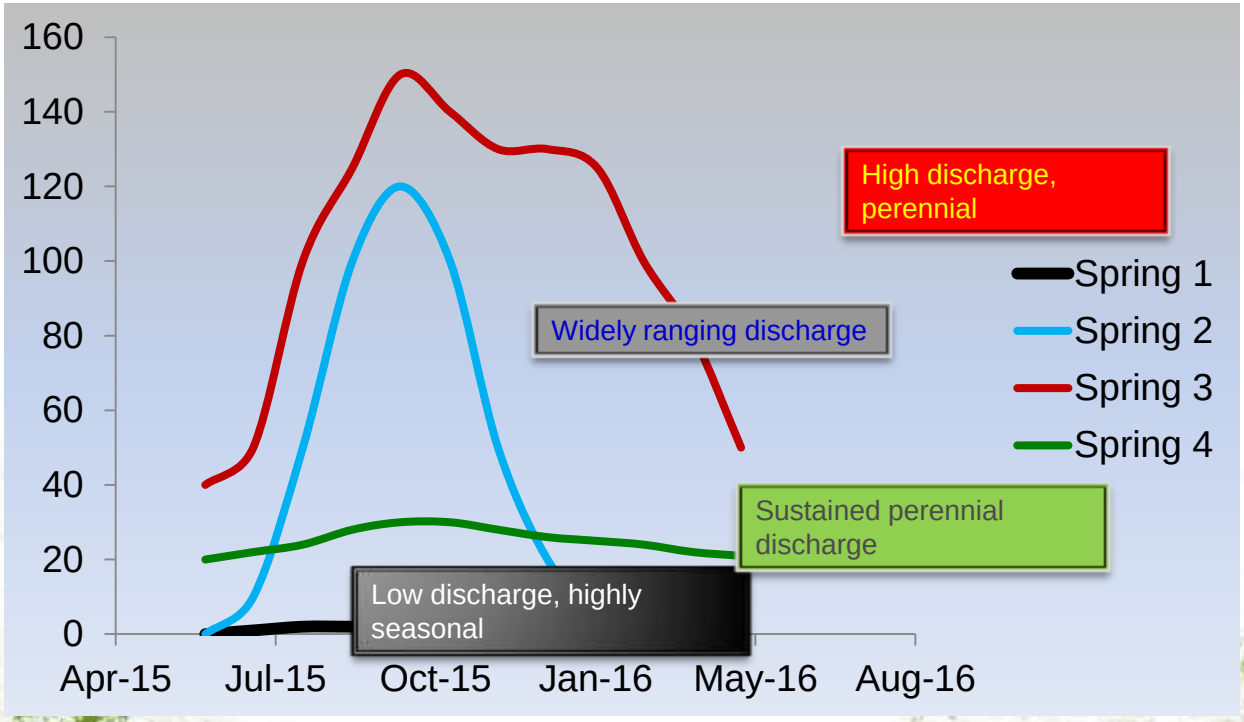


Credit: Mr. Suren Mohra, RMC&DD-Sikkim

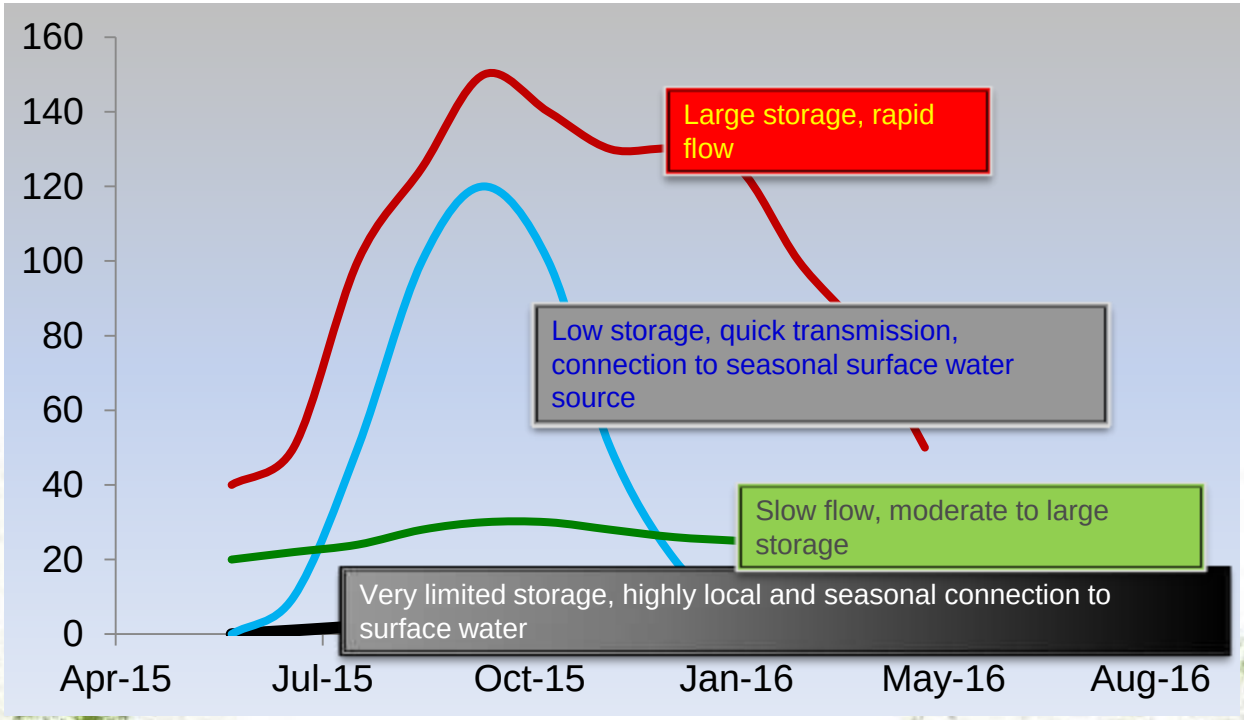
Springs and aquifers: discharge trends – annual cycle



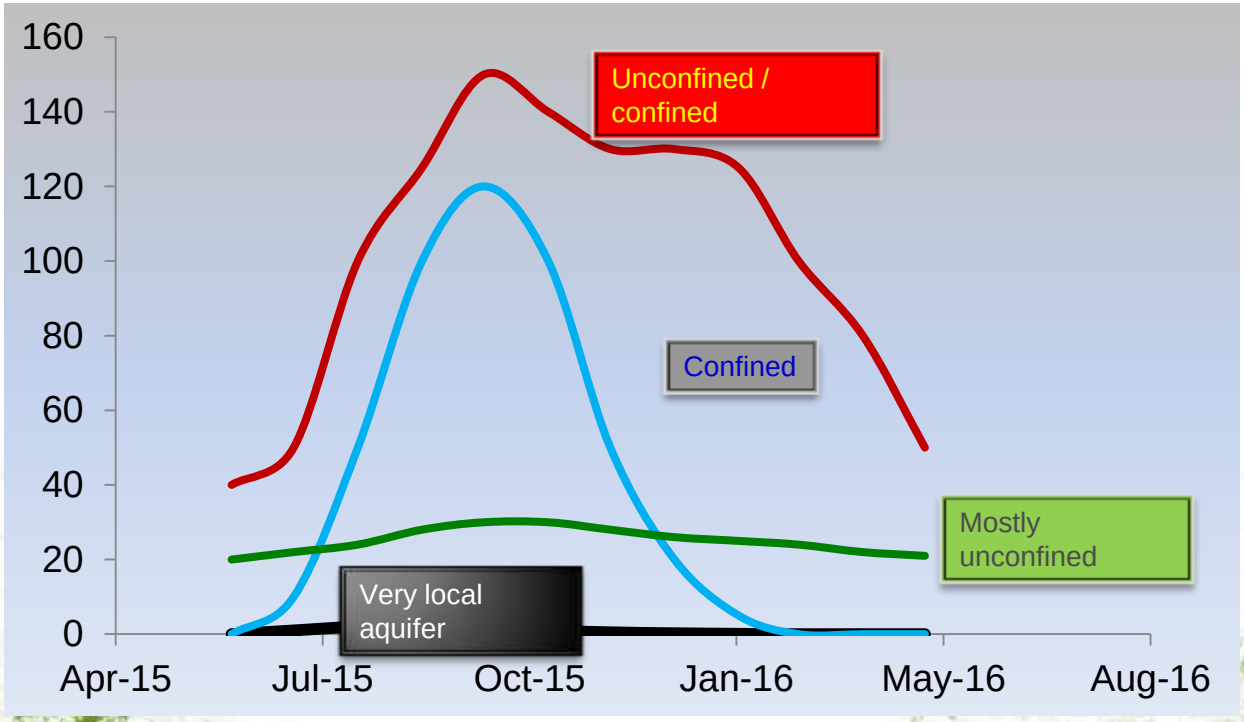
Describing a spring based on its discharge



Spring discharge: accumulation and flow in underlying aquifers



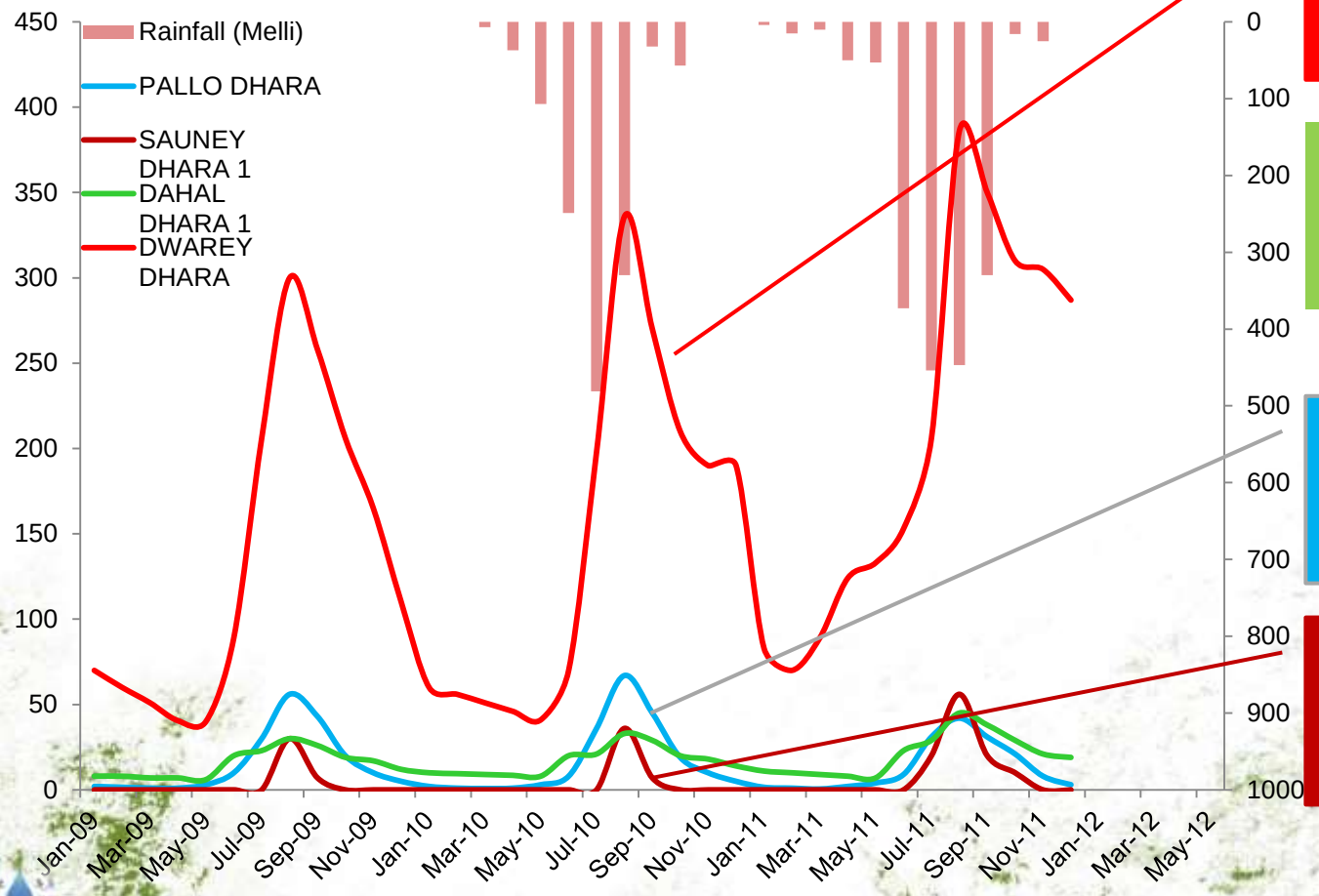
Spring discharge: mostly likely aquifer types



Indicator matrix

	Recharge zone - proximity to spring	Recharge zone - size
Spring 3	Could be either closeby or far away (large aquifer storage)	Large
Spring 2	At distance	Small
Spring 4	At distance (moderate to low transmissivity)	Large
Spring 1	Very close	Small, probably negligible

...so are springs tapping mountain aquifers



Baseline= 90 lpm
Impact= 97 lpm
8.33% increase over the whole year

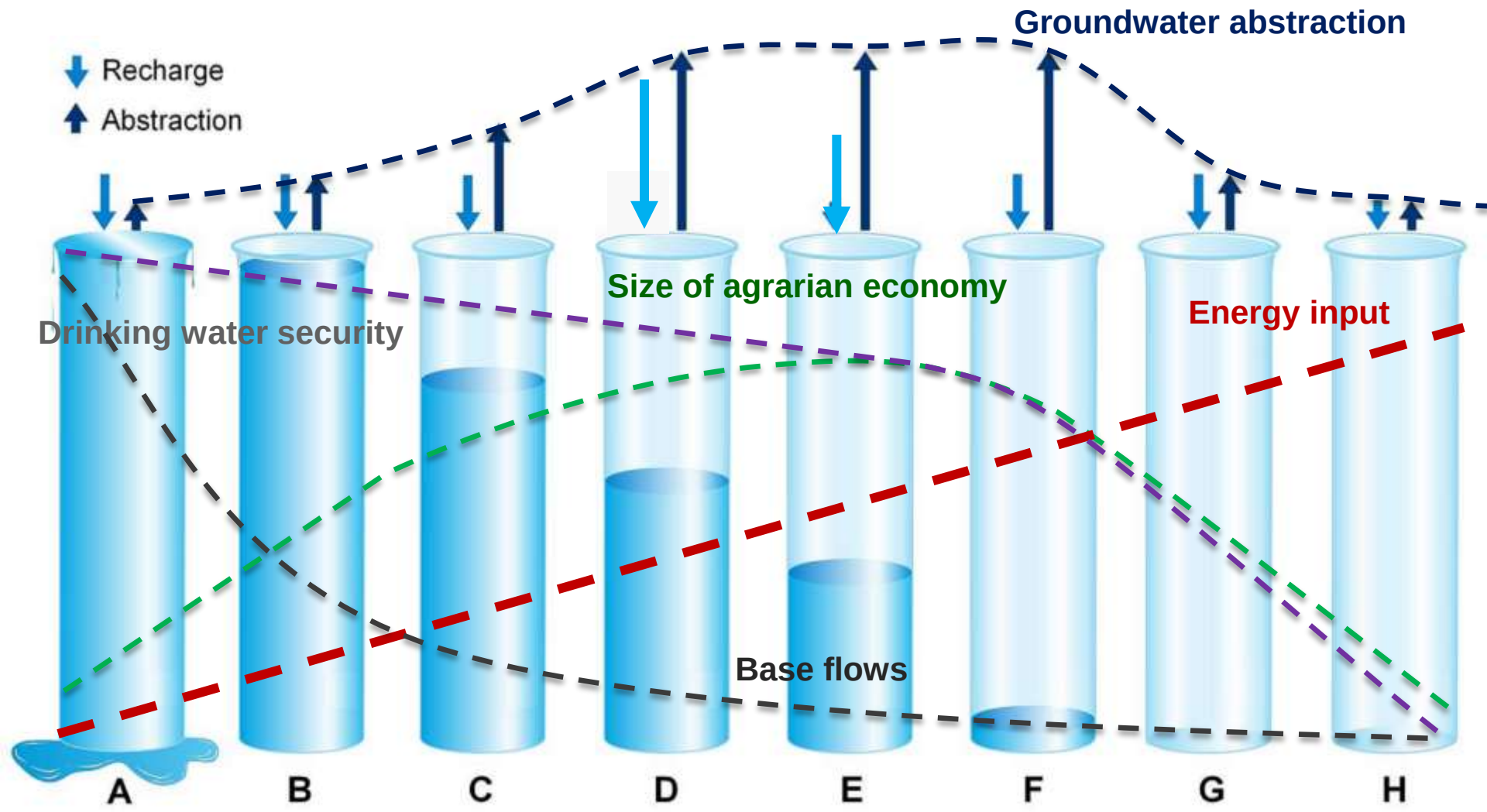
Baseline= 9.5 lpm
Impact= 10.5 lpm
10.6% increase over the whole year

Baseline= 16.5 lpm
Impact= 18 lpm
8% increase but over 300 days

Baseline= 11 lpm
Impact= 13 lpm
17% increase but over 80 days

Credit: Mr. Suren Mohra, RM&DD-Sikkim

Aquifer: an entity in many dimensions…

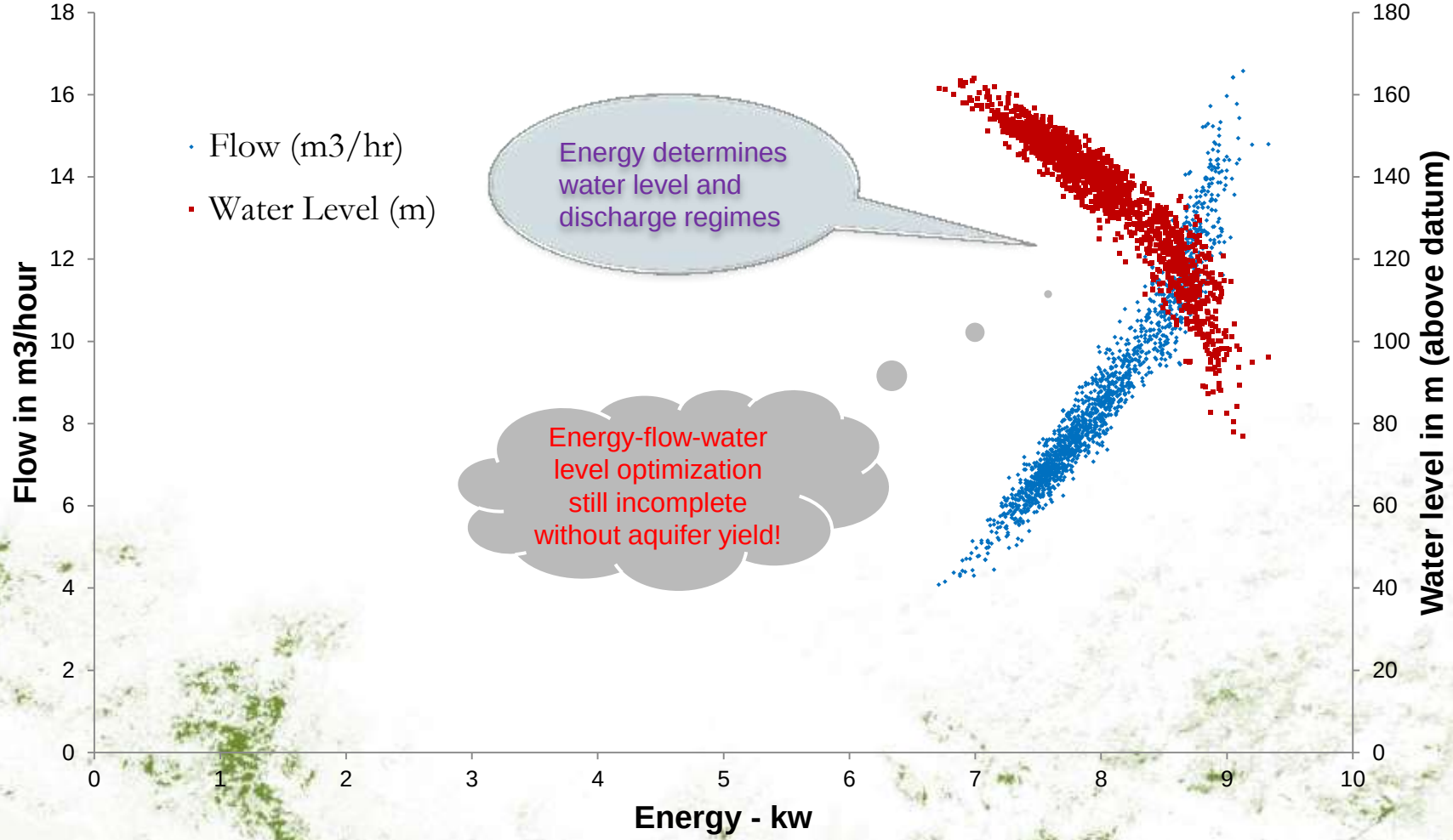


After: COMMAN 2005; Shah, 2009

Groundwater management

- Understanding multiple dimensions
- Sources and resources
- Time: seasonal and long-term
- Quantity and quality

Externality: challenge and opportunity – *one well, one month, variability in energy input*



After *Datamatrix-WOTR, 2012*

Comparison of approaches

	Conservation	*Recharge*	*Sources*	*Water budgeting*	*Resource focus*
Watershed approach	Major	Incidental, but impact indicator groundwater	Not necessarily important	Sometimes	Watershed focus strong
Drinking water pilots	Minor	Major focus	Major focus around source sustainability	Seldom	Prospects of groundwater
Crop-water budgeting	Fairly high	Fairly high	Every source monitored but drinking water a clear focus only at times	Very strong and basis for interventions	HUN – Mainly watersheds
PGWM	Major focus, with indicator being drinking water security	One of the major focal interventions	Push to 'community' sources from 'individual ones'	Water balance, followed by some degree of water budgeting	Aquifers (mostly as part of watersheds)

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Unpacking the key elements
...aquifer based groundwater management

- To understand groundwater resources in all their dynamics
  - Hydrogeology – quantities and quality
  - Uses, users and the "aquifer/groundwater community"
- Current state of groundwater resources – degree of depletion
  - Primary and secondary data collection
  - Exploring past and present patterns of use
- To understand the status of groundwater quality and its impact on living beings
  - Water quality investigation, including past data
  - Health data surveys
- To study the availability, demand and supply
  - Patterns of water use, estimate demand and analyse supply
  - Estimate groundwater resources availability under various scenarios
- To facilitate the community in the process of decision making for the sustainable and equitable management of groundwater resources
  - Institutional framework development (including linkages to PRIs)
  - Capacity building and communication
  - Exposure visits
  - Participatory decision making system
- Robust regulation to account for various externalities
  - Social regulation at local levels
  - Statal legislation with major revamp of current legislative systems

Participation key to each of these...

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High dependence, low attention...

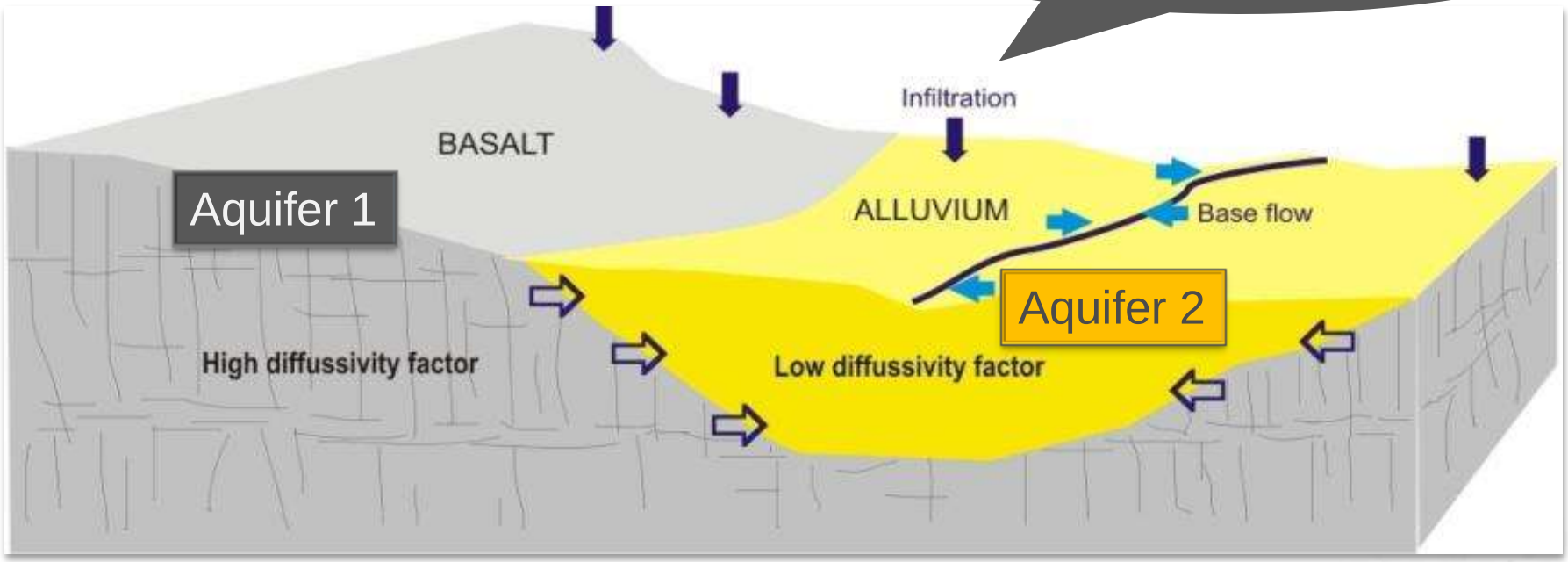
- Focus on supply side
- Sometimes innovative augmentation approaches
- Not always sustainable, in the absence of managing demand

Understanding availability (at the scales of a ‘resource’) not always a priority

Managing demand and equitable distribution is often not perceived as ‘low-hanging fruit’

Aquifers as CPR

One village with two aquifers…acute drinking water crisis



Aquifer 1 farmers

- Uplands
- Mostly small land-holdings
- Mostly rainfed farming
- Wells with poor yields, probably seasonal
- Acute scarcity in summer
- Water quality not a major issue

Aquifer 2 farmers

- Low-lying, often fertile lands
- Mostly medium to large land-holdings
- Mostly irrigated farming
- Wells with high yields, perennial
- No scarcity, even in summer
- Water quality is a major issue, water scarcity negligible

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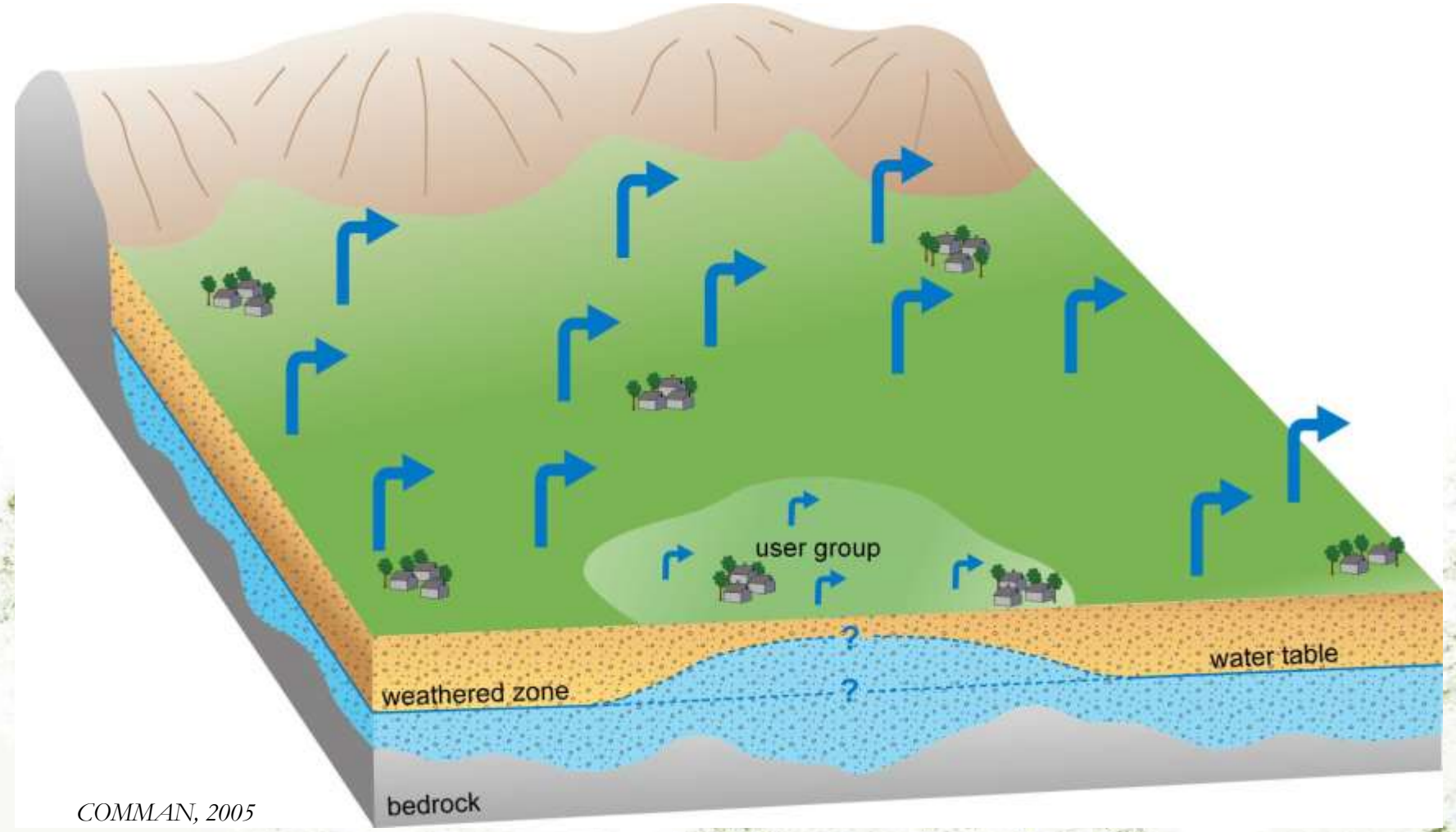
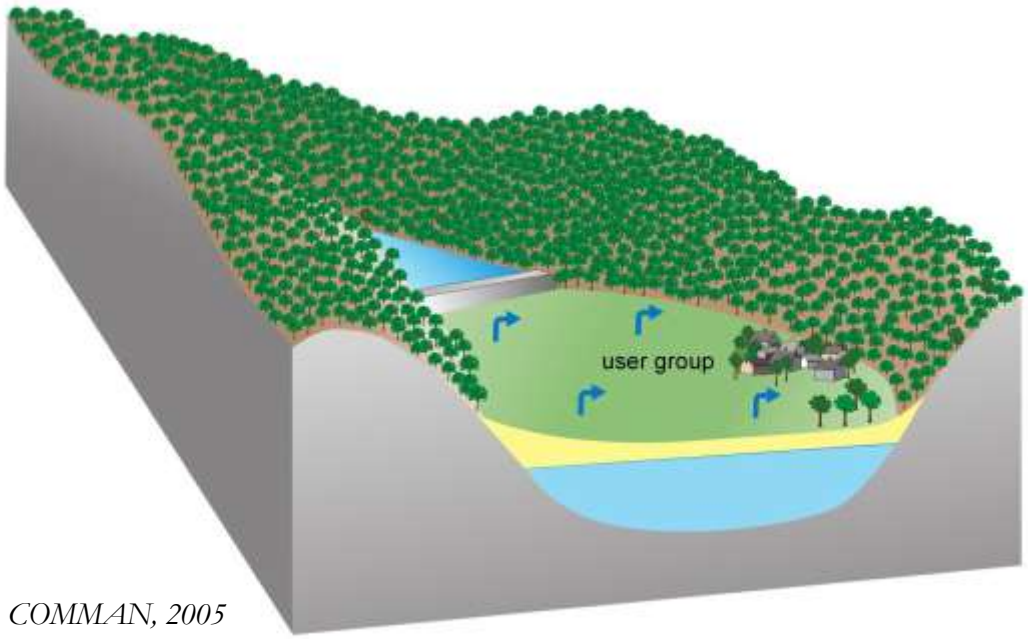
Why legislate if people participate…?



COMMAN, 2005

Protocols	*Typology 1*	*Typology 2*	*Typology 3*	*Typology 4*	*Typology 5*	*Typology 6*
Geohydrology in WSD including groundwater recharge	* ?		* ✓	* ✓		* ✓
Protection of recharge areas	* ✓	* ?	* Land-use protection ?	* ✓		* ✓
Efficient well use			* ?	*		
Pump capacity regulation		*	*		*	
Distance (wrt drinking water well) regulation	* ✓	*	* ✓	* ✓	* ?	
Depth Regulation (wrt drinking well)	* ✓	* ?	* ✓		* ?	
Regulation of Agricultural water use	* ✓	*	* ✓	* ✓	*	
Groundwater management through sharing	* User groups ✓ Nachanbor	* Sharing	* Sharing ✓ Patpadi	* User groups ✓ Borkhalya	* User groups	

Understanding the 'common pool' nature of groundwater

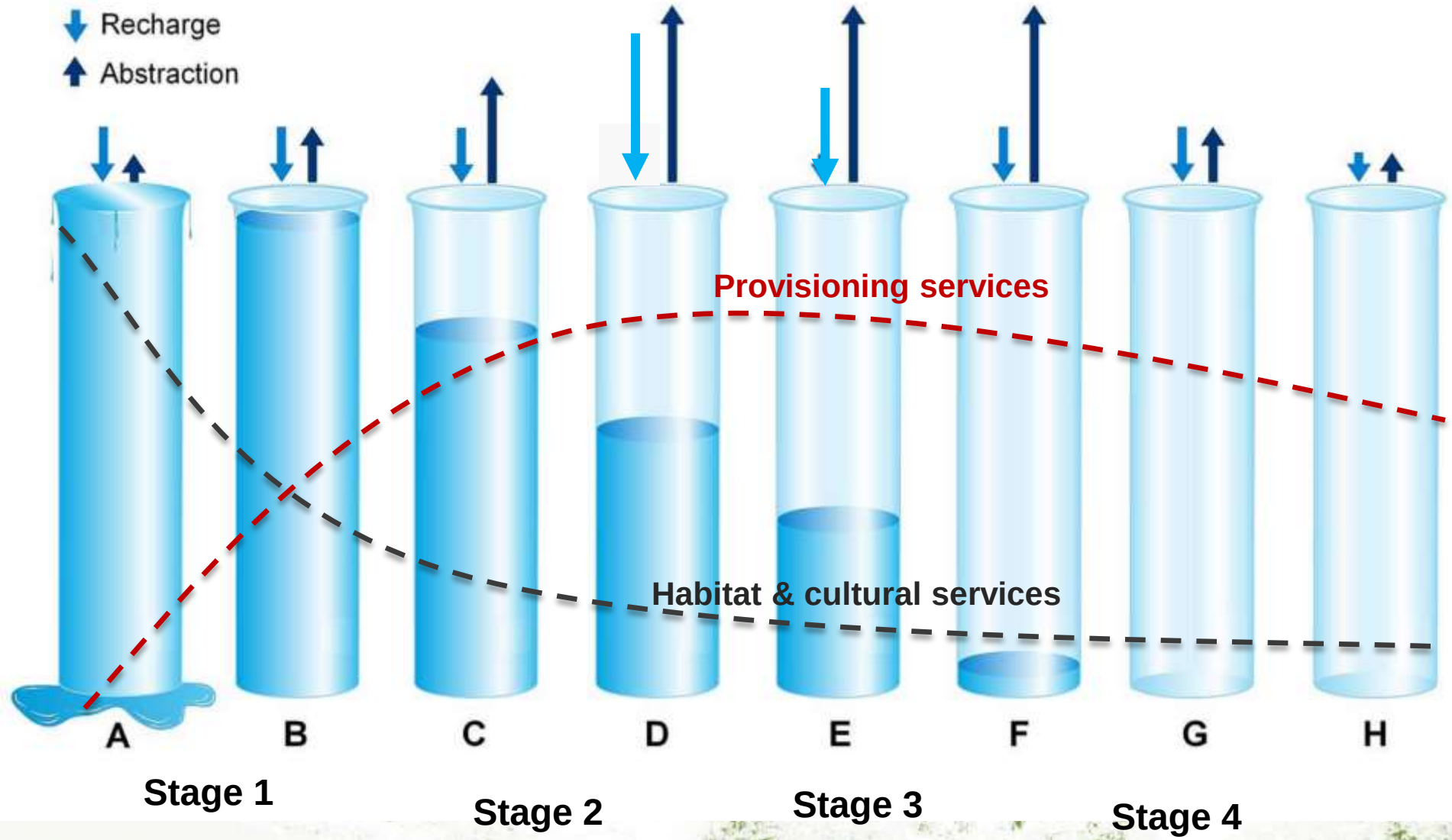


COMMAN, 2005

All these <u>need</u> good governance and are part of the <u>governance</u> itself…

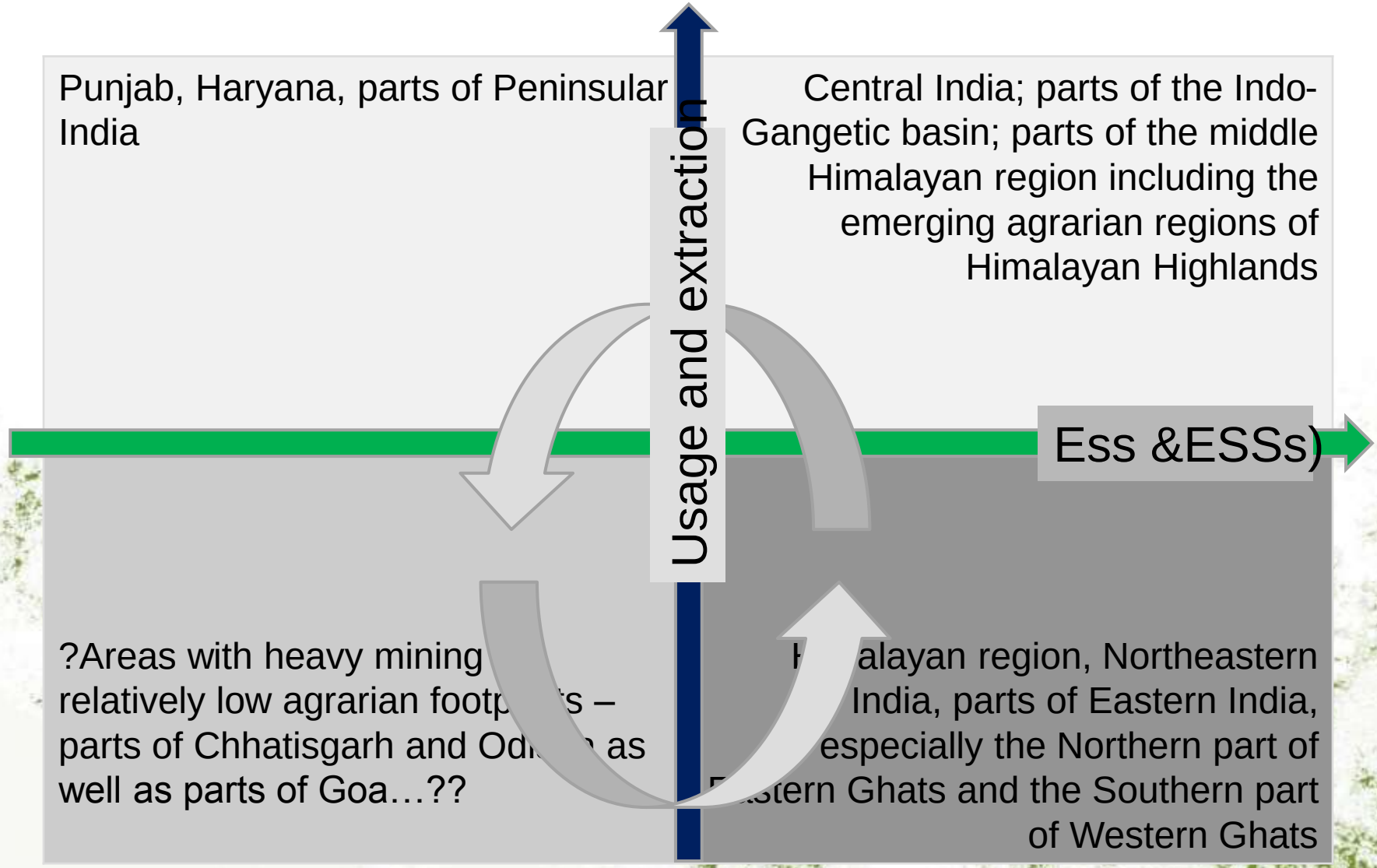
- People are more likely to participate if the focus on groundwater–related development work shifts from *sources* to *the resource (aquifers)*
- Protection of groundwater resources not possible unless users agree to "co-operate" in the process of groundwater management
- Partnerships and collaborations important given the nature of groundwater competition and potential conflict:
  - Users: *farmer vs farmer ; industry vs industry; households vs households*
  - Uses: *drinking water vs agriculture; agriculture vs industry; anthropogenic uses vs ecology*

Aquifer: an entity in many dimensions…

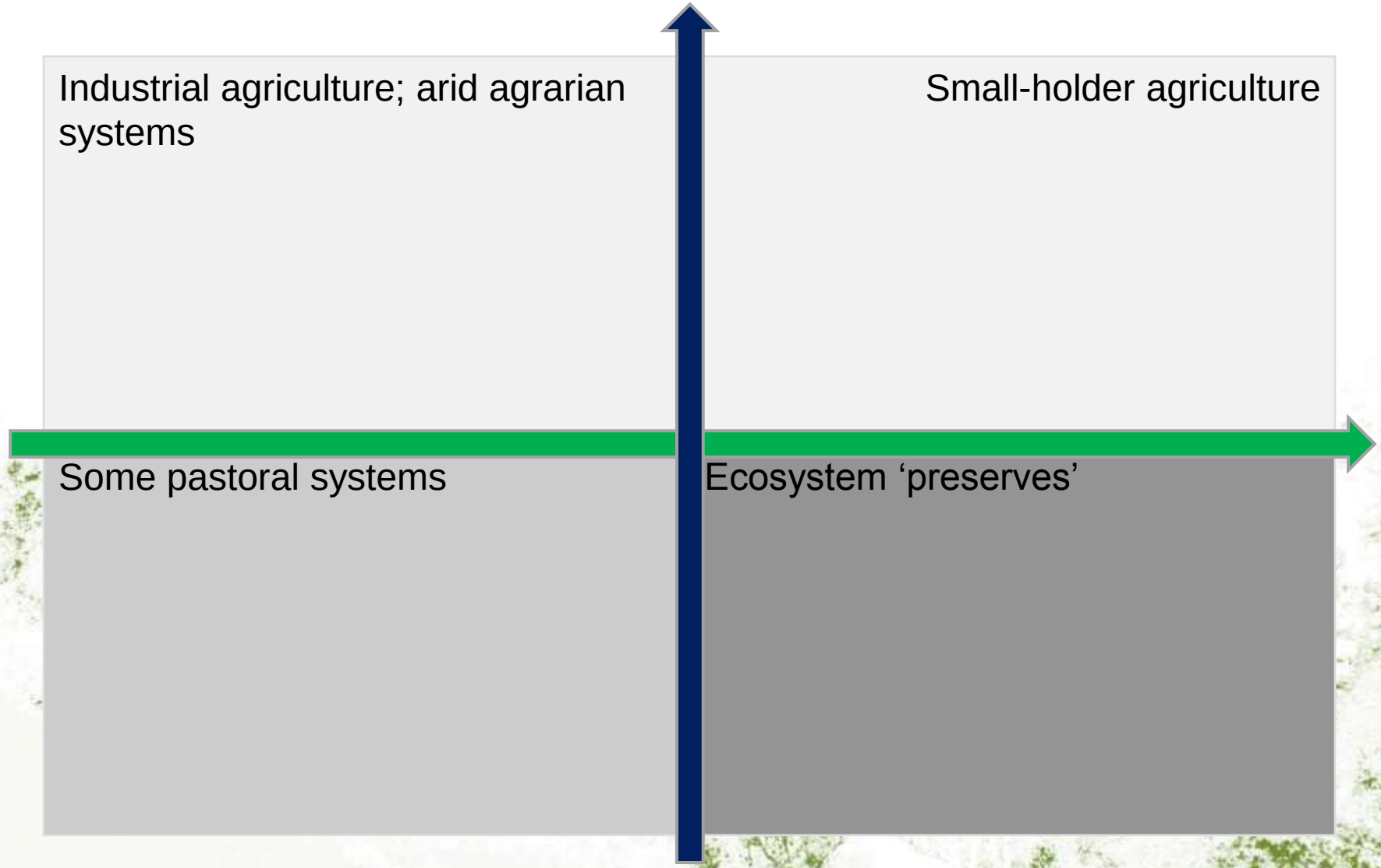


After: COMMAN 2005; Shah, 2009

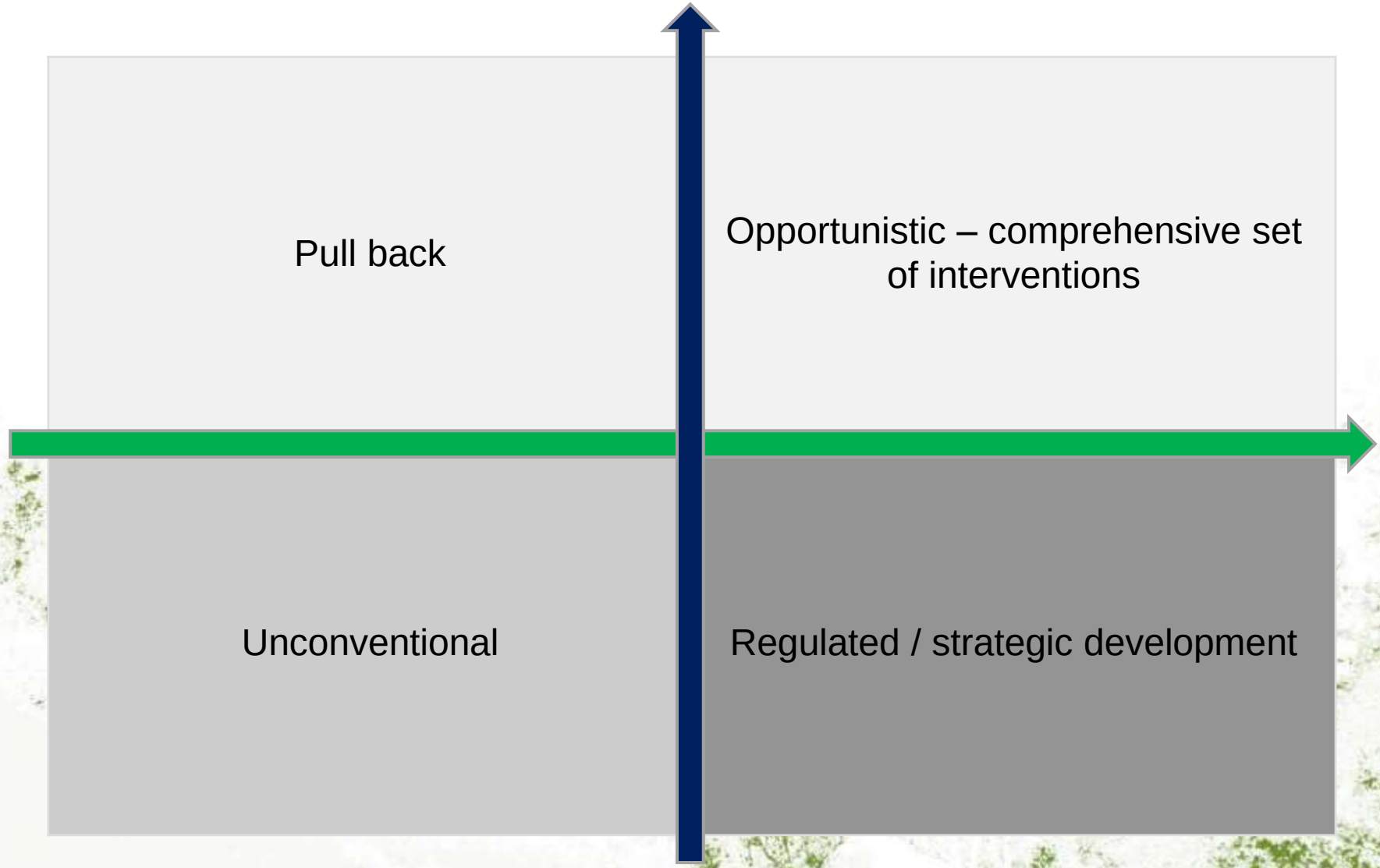
Situations


Punjab, Haryana, parts of Peninsular India
Central India; parts of the Indo-Gangetic basin; parts of the middle Himalayan region including the emerging agrarian regions of Himalayan Highlands
Usage and extraction
Ess &ESSs)
?Areas with heavy mining relatively low agrarian footp s – parts of Chhatisgarh and Odi as well as parts of Goa…??
alayan region, Northeastern India, parts of Eastern India, especially the Northern part of stern Ghats and the Southern part of Western Ghats

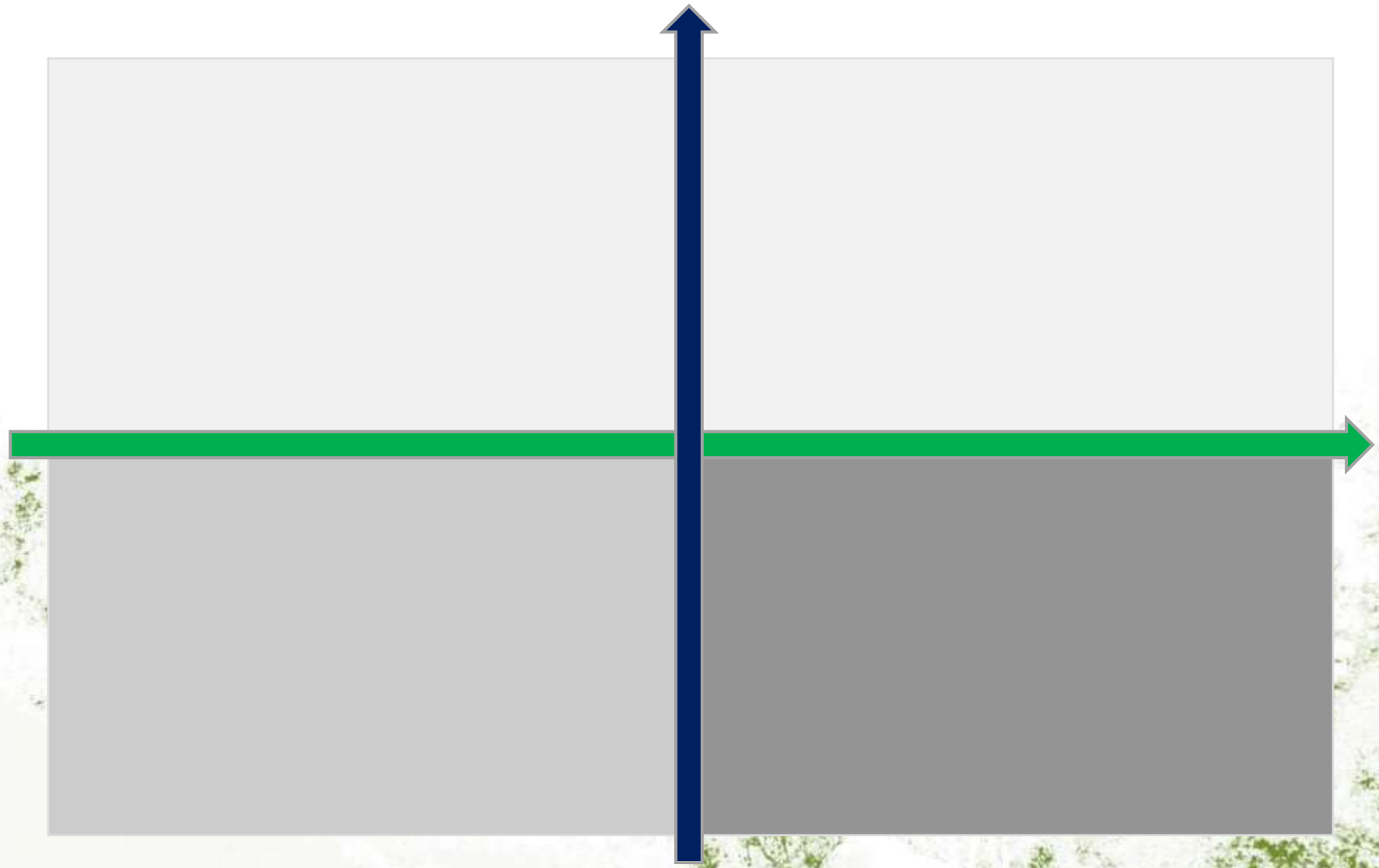
Typology of agro-eco systems



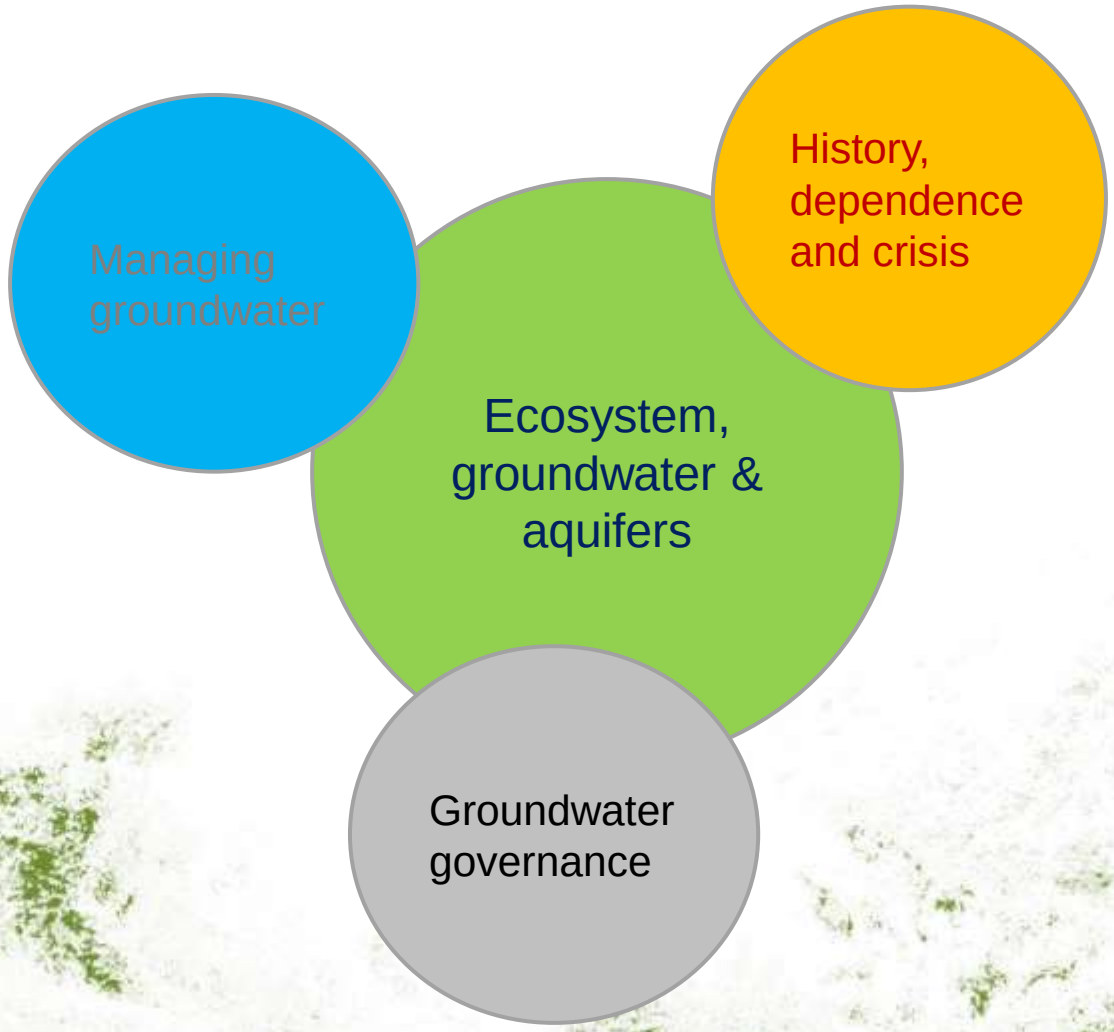
Interventions



Scenarios



Groundwater resources



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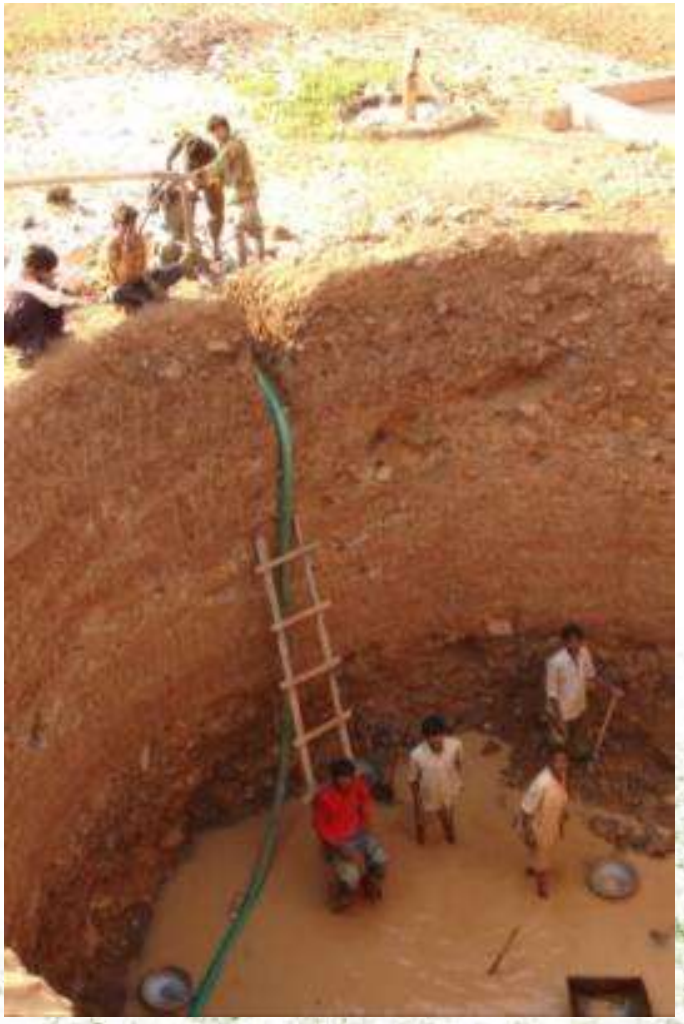
GROUNDWATER GOVERNANCE…
SCIENCE, PARTICIPATION AND REGULATION

- Transparency, participation, information, custom & rule of law is a process

- The art of administrative action and decision making

- Balance between protection (aquifers) & moderation of use – to forge the right balance between human and environmental needs



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Protocols	*Mountains*	*Alluvial*	*Sedimentary*	*Volcanic*	*Crystalline*
Groundwater recharge through watershed management approaches	√			√	√
Protection of recharge areas (aquifers) – ecosystem service			√		
Efficient well use (wells) including optimising energy input					√
Pump capacity regulation (wells)	√				√
Regulating distances between sources	√				√
Regulating depths of sources					√
Regulation of agricultural water use – cropping, farm management and technology		√		√	√
Aquifer based groundwater budgeting			√	√	√

Protocols of groundwater management are often mechanisms of adaptation…

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