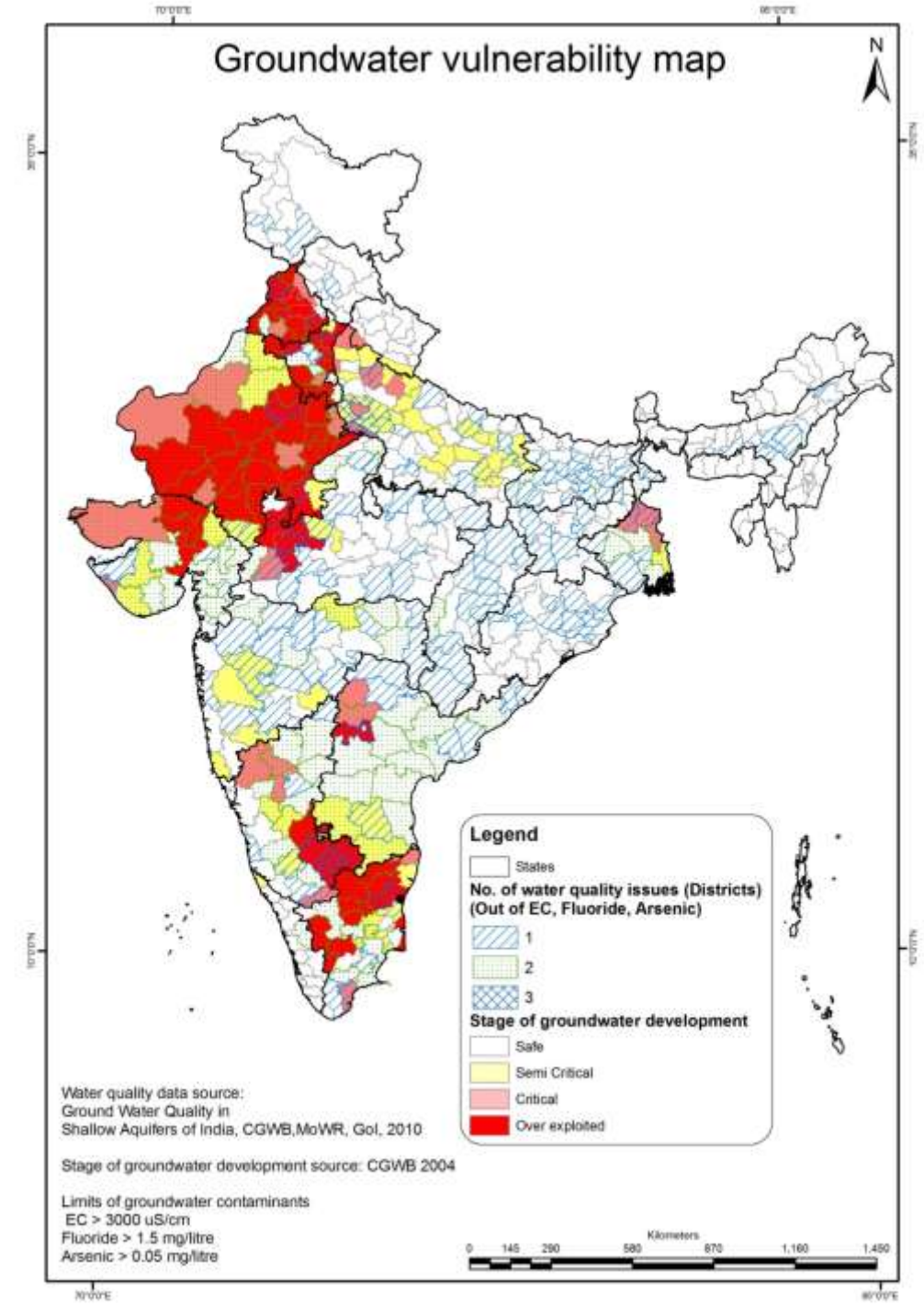
Socio- hydrogeology

What will we discuss…

- **Groundwater:**
  - And Society
  - situation in India: factors responsible
  - Competition: No Conflicts?
  - Governance in India overview
  - A Common Pool Resource
  - Governance
  - Protocols

Groundwater situation in India



Dependency on groundwater is huge in India:

- **90% of Rural Drinking Water Supply *(DDWS, 2009)***
- **70% irrigation *(Kulkarni et al 2009; MoA, 2013)***
- **48% urban water supply *(Narain, 2012)***

Almost 60% districts of India have problems related to groundwater availability and/or quality.

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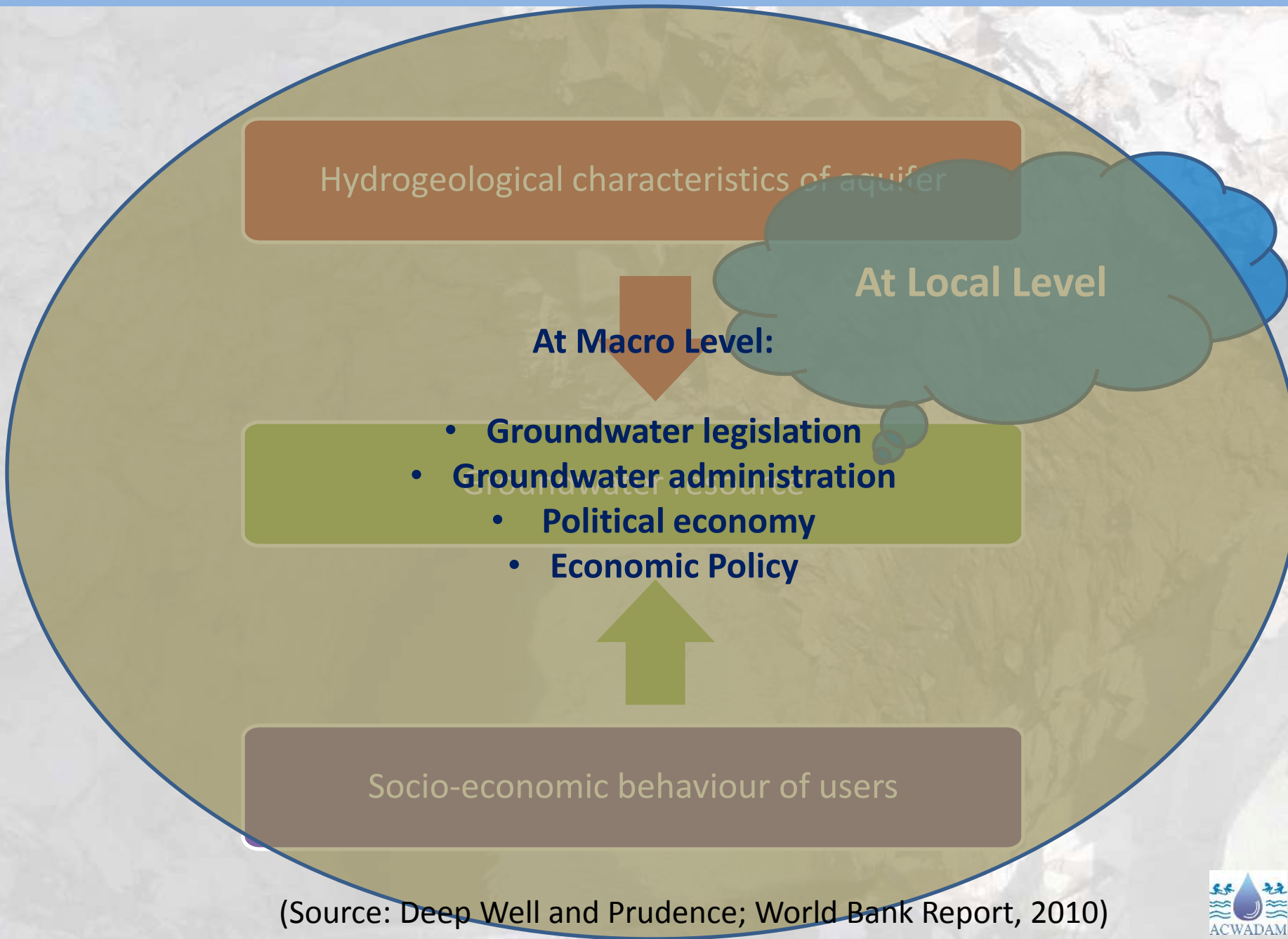
Major determinants of groundwater



(Source: Deep Well and Prudence; World Bank Report, 2010)

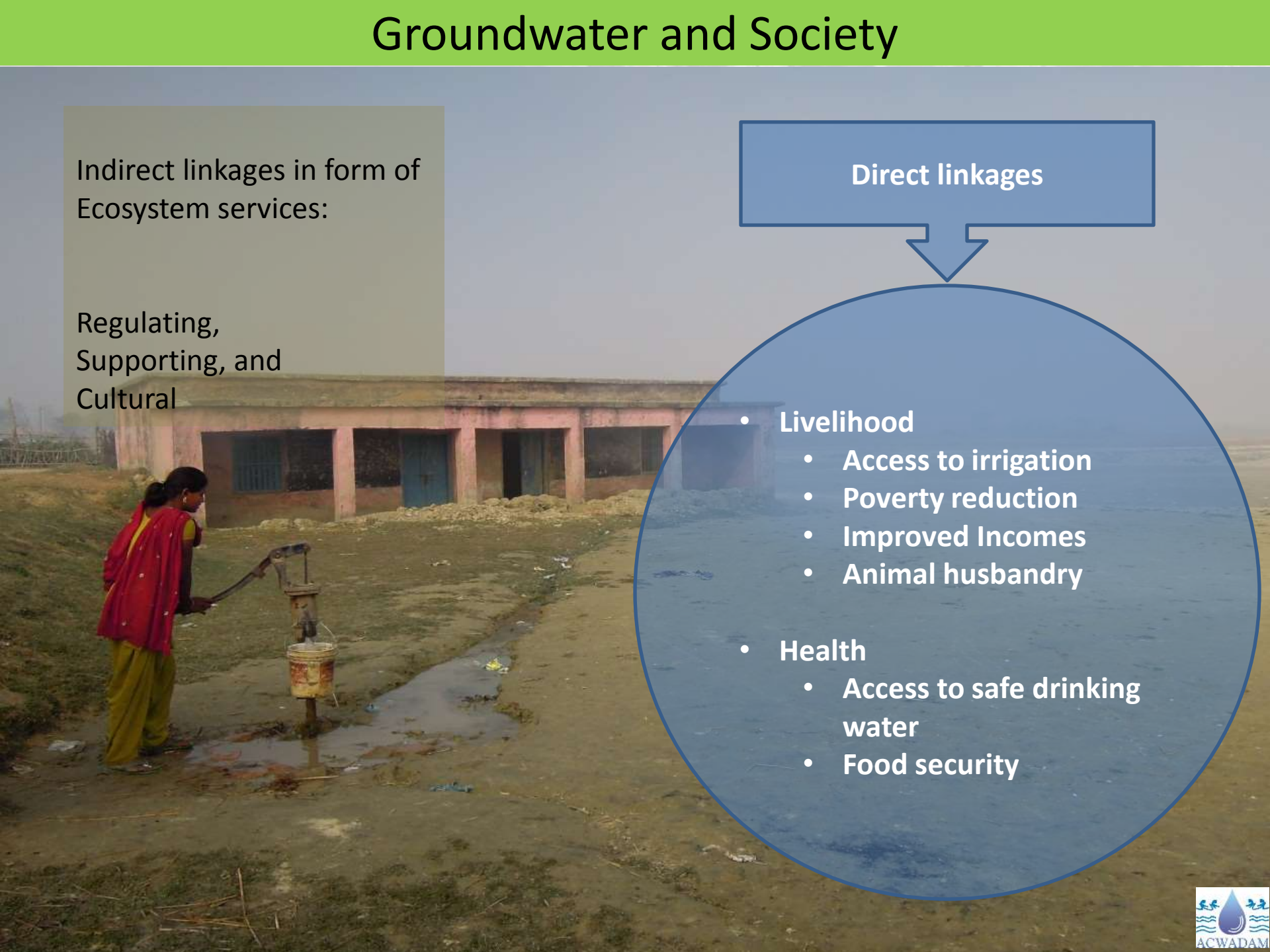
Groundwater and Society

Indirect linkages in form of Ecosystem services:

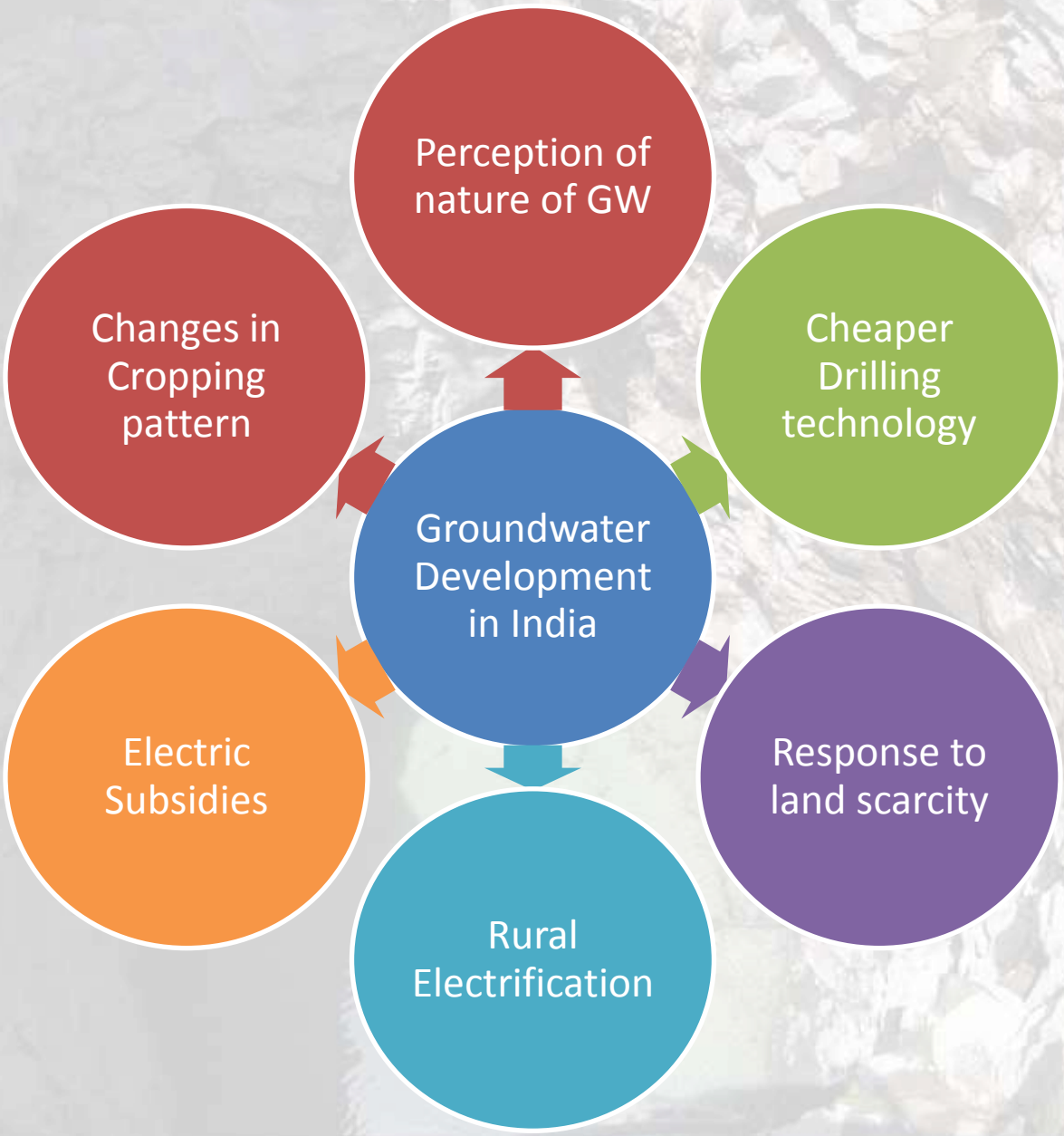
Regulating, Supporting, and Cultural

Direct linkages

- **Livelihood**
  - **Access to irrigation**
  - **Poverty reduction**
  - **Improved Incomes**
  - **Animal husbandry**
- **Health**
  - **Access to safe drinking water**
  - **Food security**

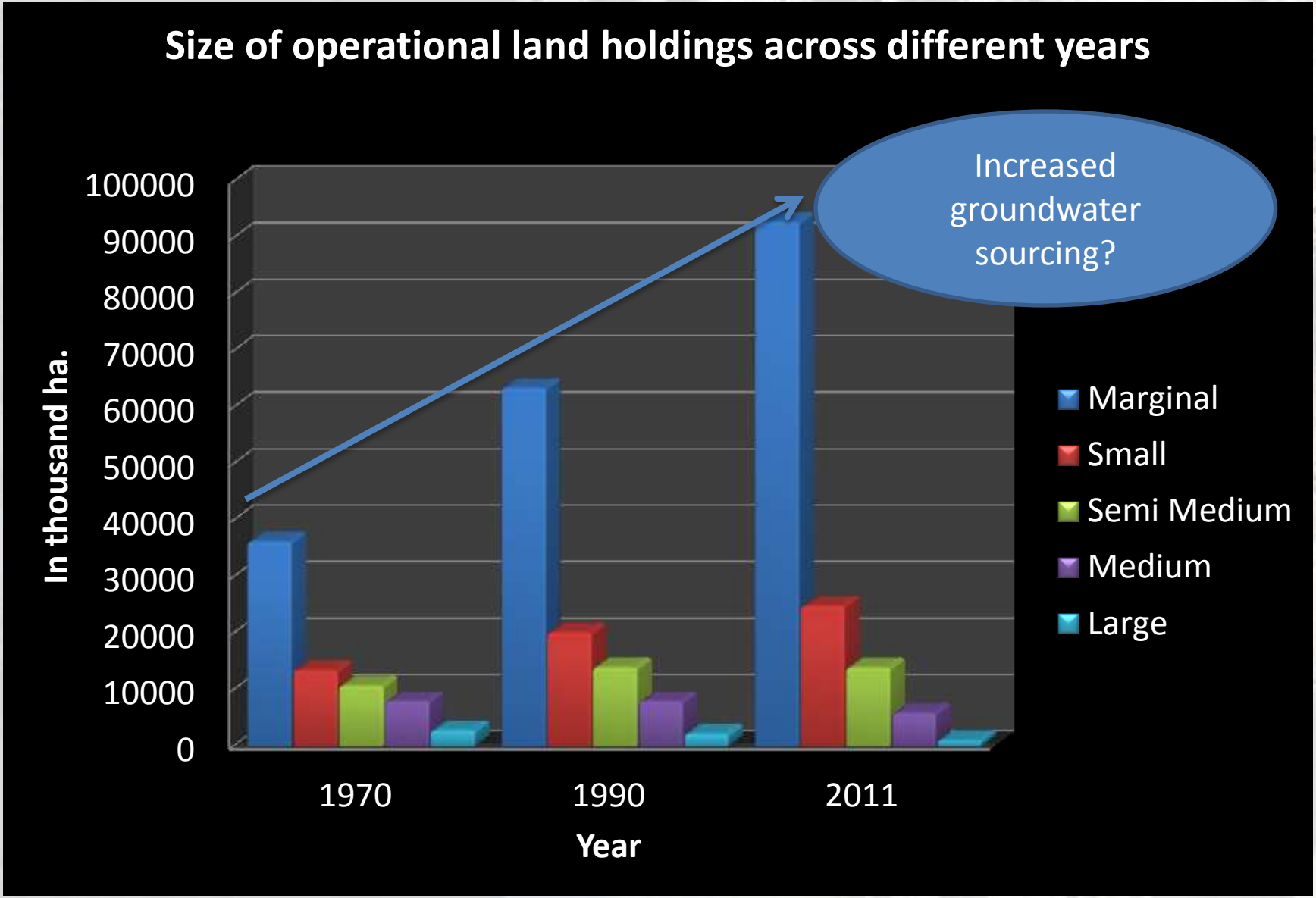


Factors responsible for groundwater development in India



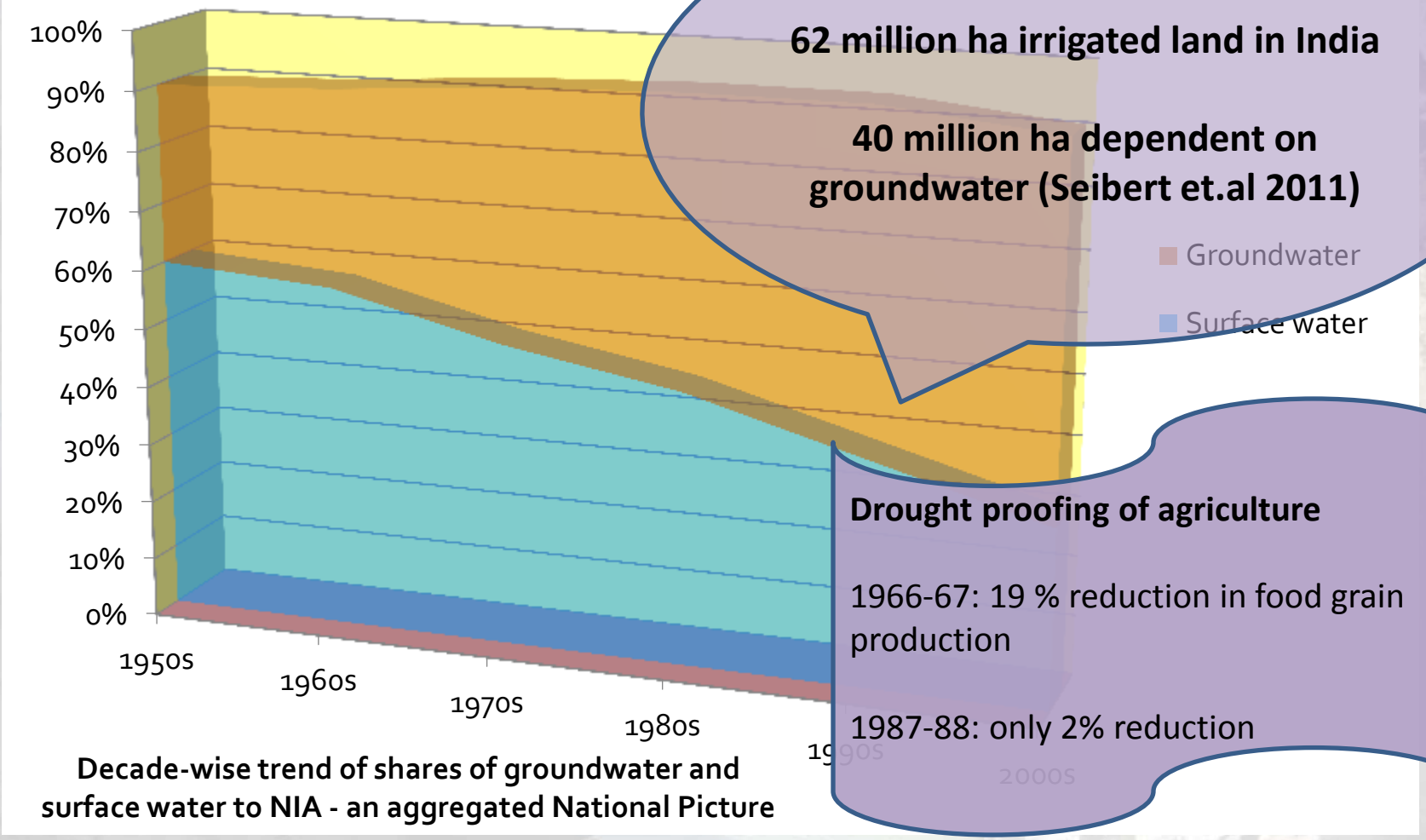
Groundwater situation in India: Factors responsible

- Response to land scarcity
- According to NSSO statistics, operational landholding in India was 2.61 ha in 1960-61 while the same was 1.06 ha in 2002- 03
- 78 % small marginal farmers own 32 % land and 45 % irrigated by GW



Source: Agriculture census, 2010-11, Min. of Agriculture

SURFACE VS. GROUNDWATER IRRIGATION



62 million ha irrigated land in India

40 million ha dependent on groundwater (Seibert et.al 2011)

Drought proofing of agriculture

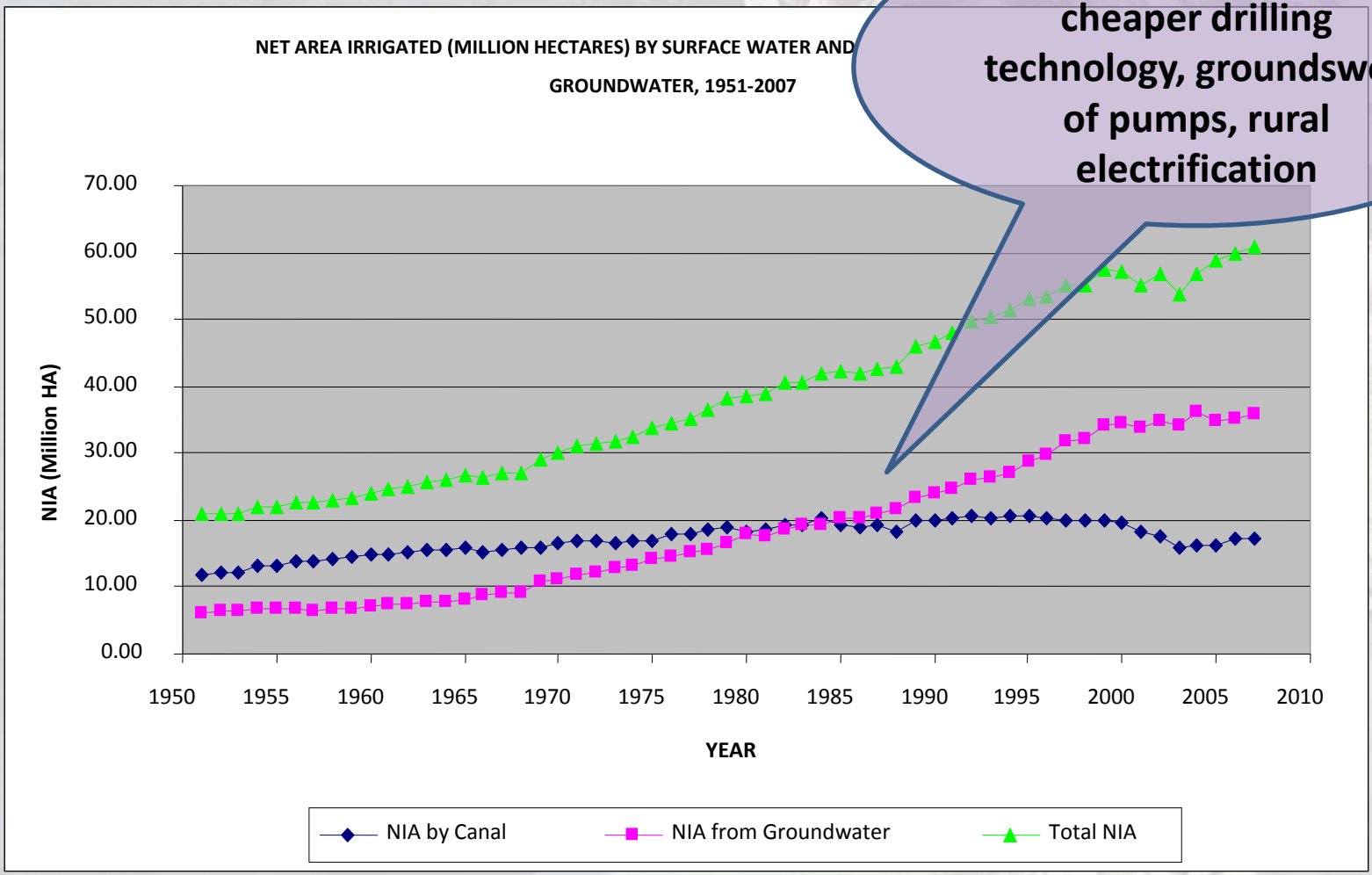
1966-67: 19 % reduction in food grain production

1987-88: only 2% reduction

Decade-wise trend of shares of groundwater and surface water to NIA - an aggregated National Picture

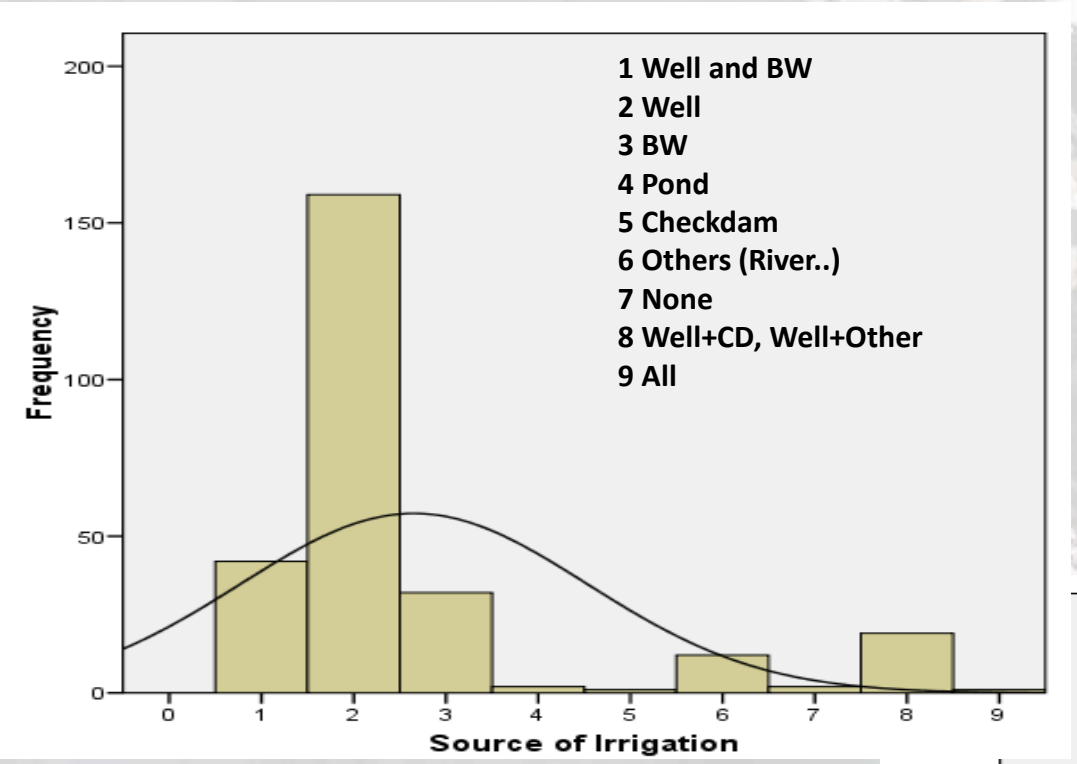
Source: Indian Agricultural Statistics, 2008

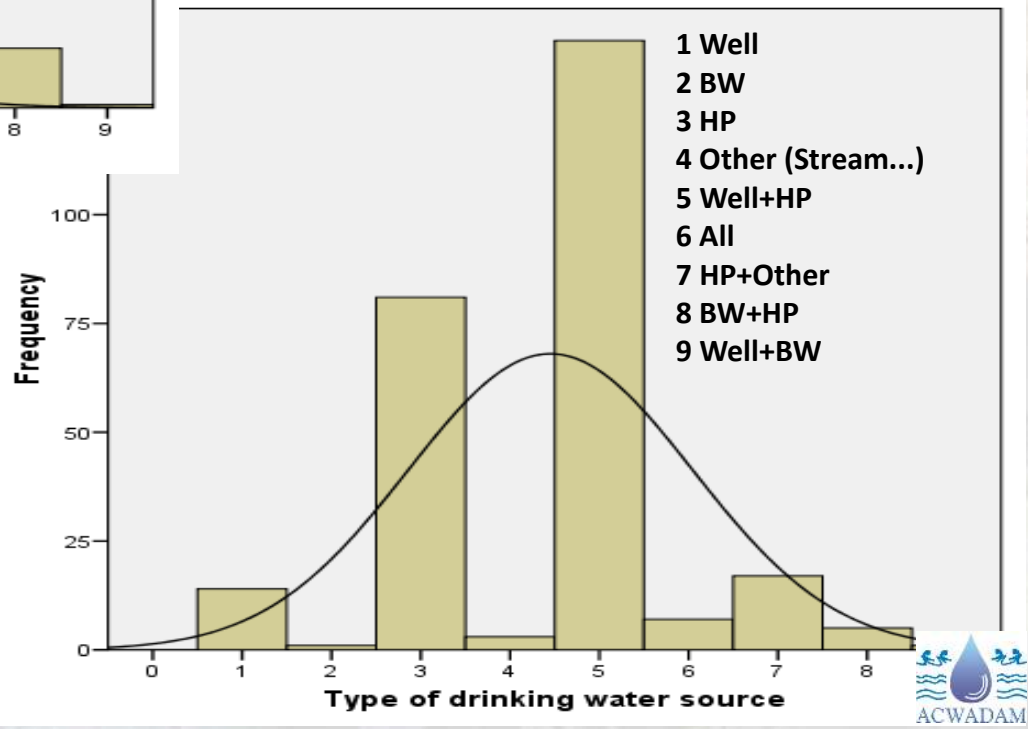
GROUNDWATER CONTRIBUTION TO 'IRRIGATION'



Indian Agricultural Statistics, various years

Local scenarios: 100 villages in Bagli tehsil from Dewas district





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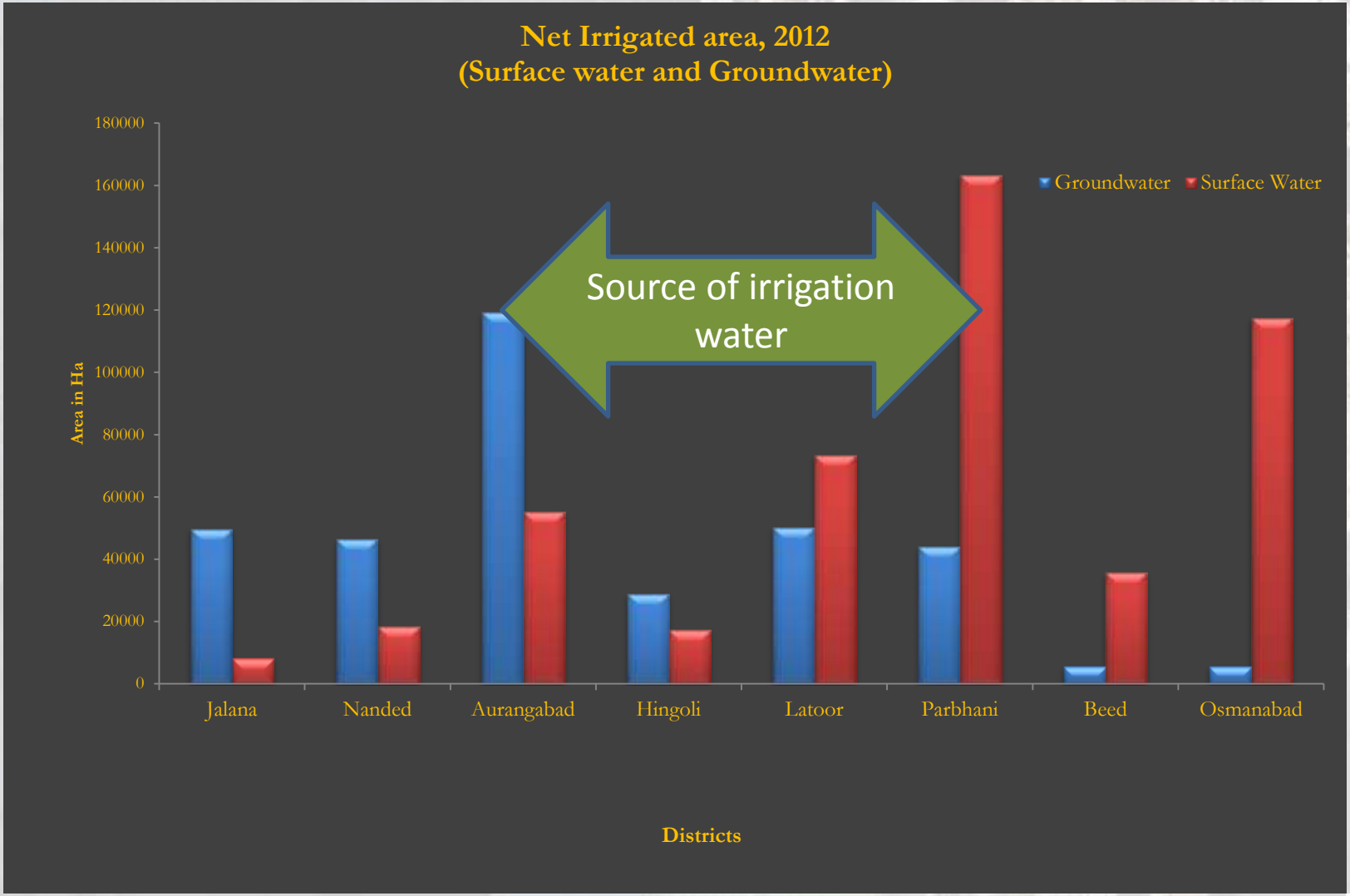
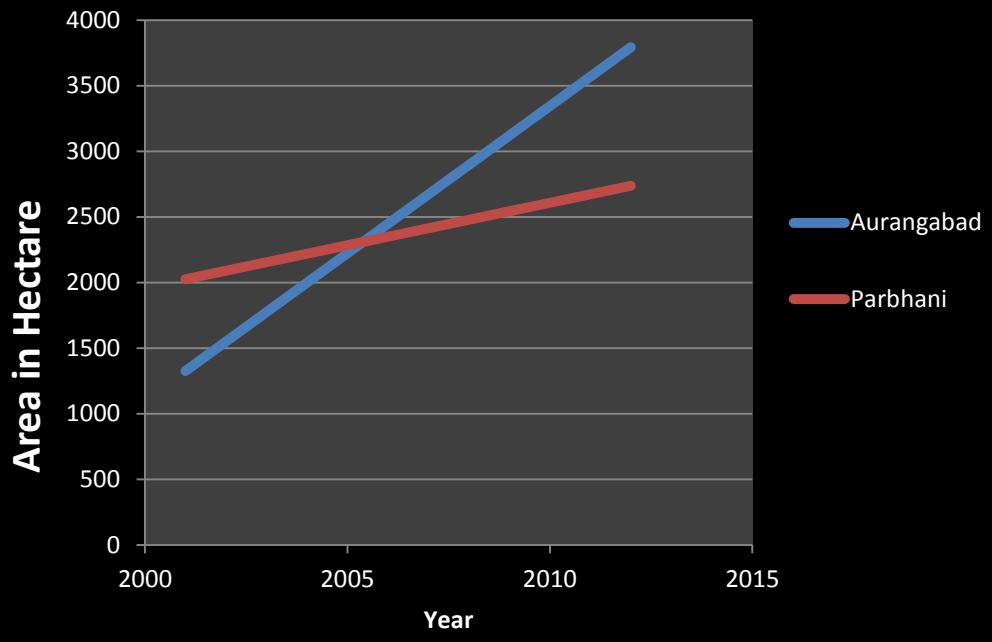
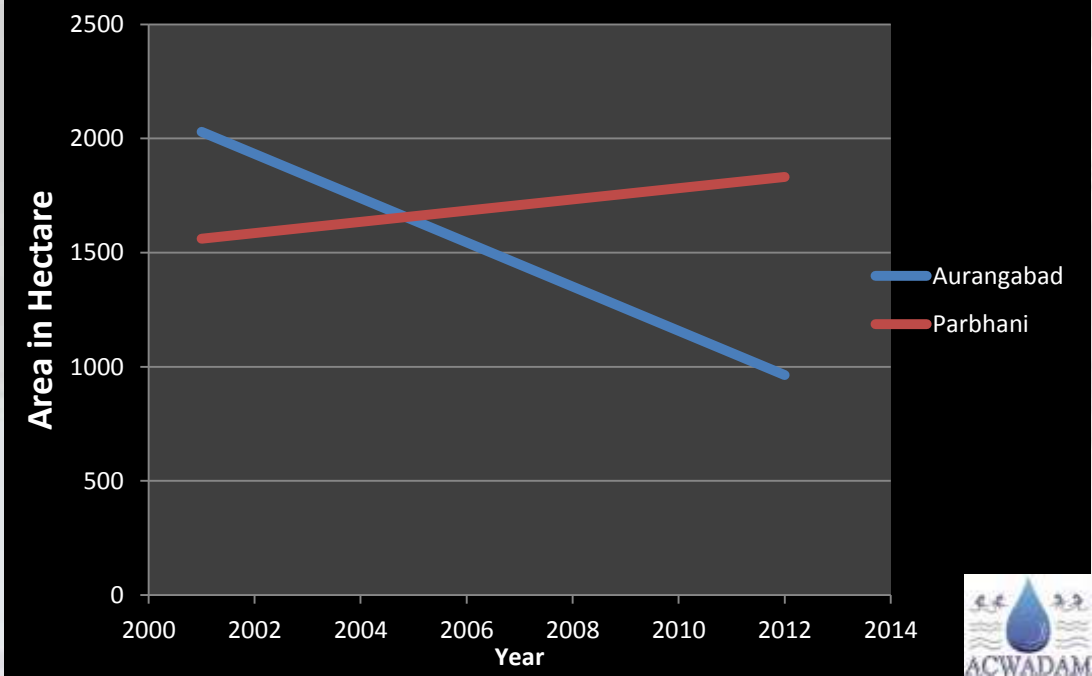
Regional Scenario: Case of Marathwada, Maharashtra



Cropping pattern changes: Case of Aurangabad and Parbhani





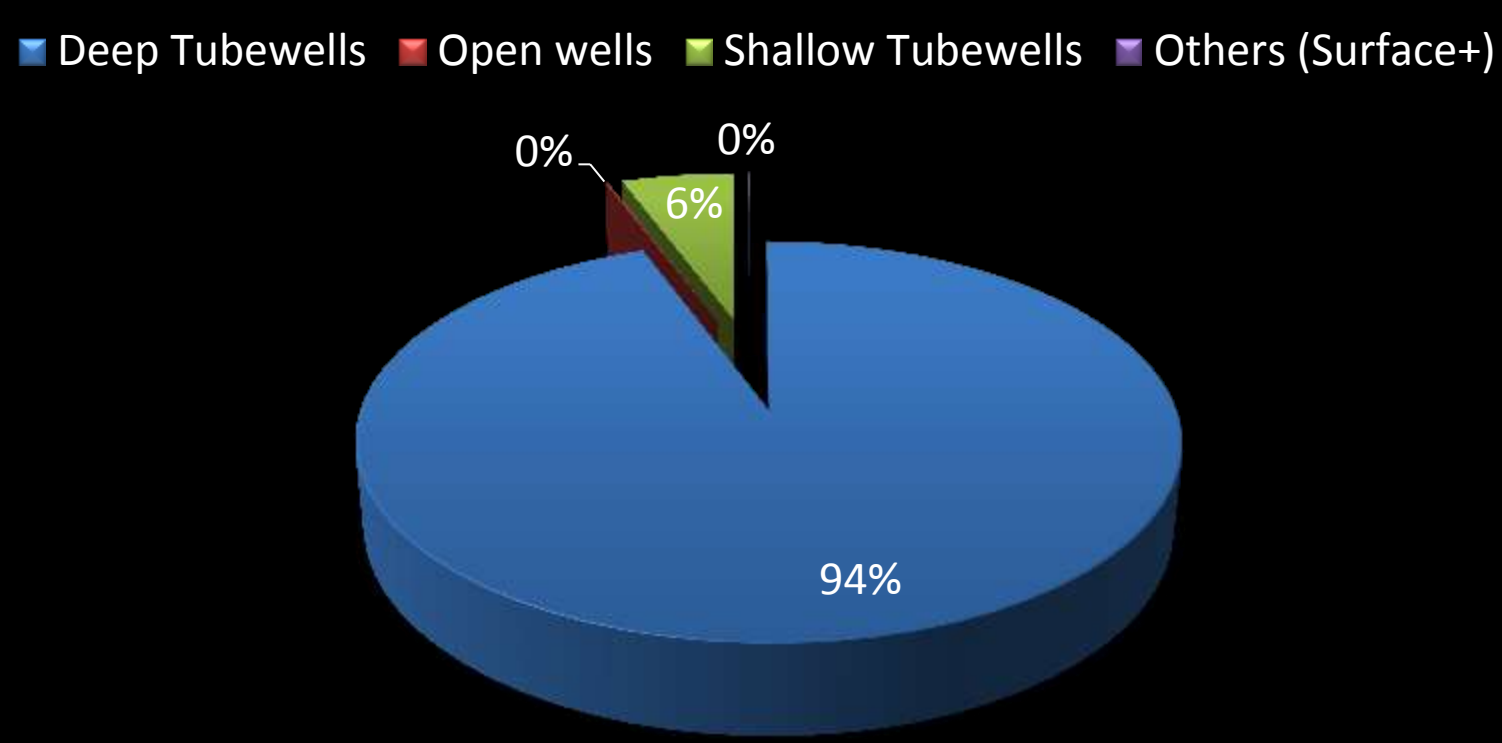
Drinking water dependency

Beed- Maharashtra

Madhubani- Bihar

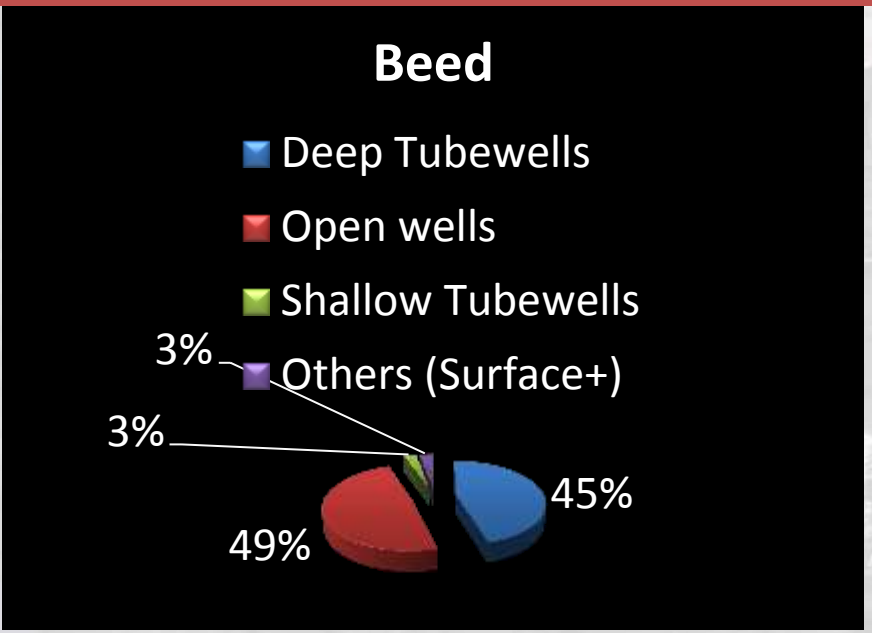
West Garo- Meghalaya

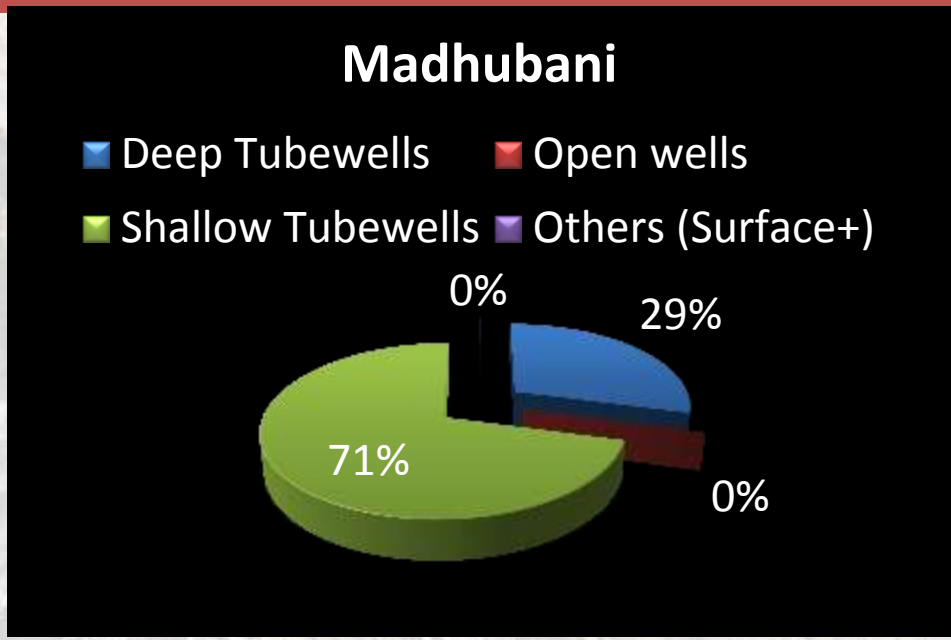
Patiala- Punjab

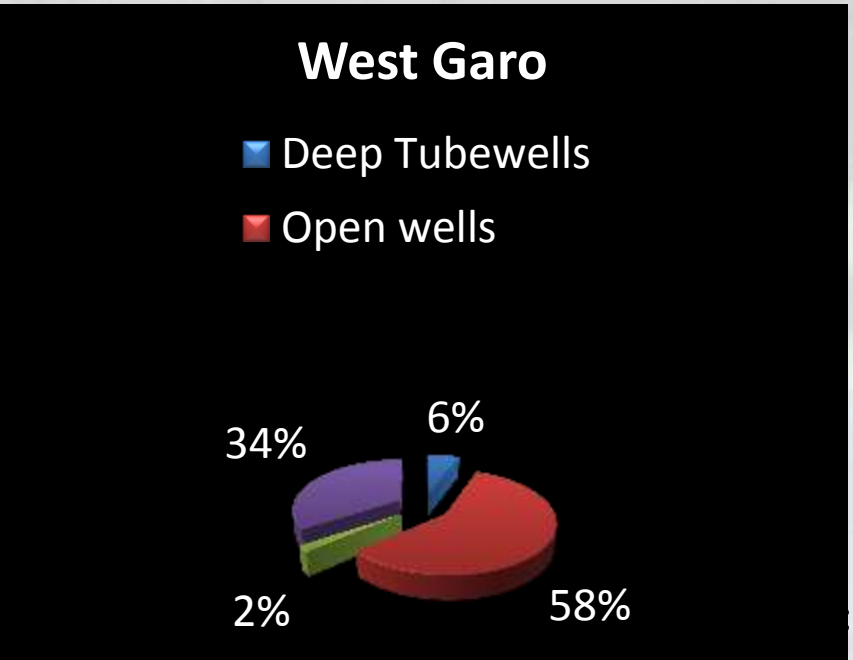


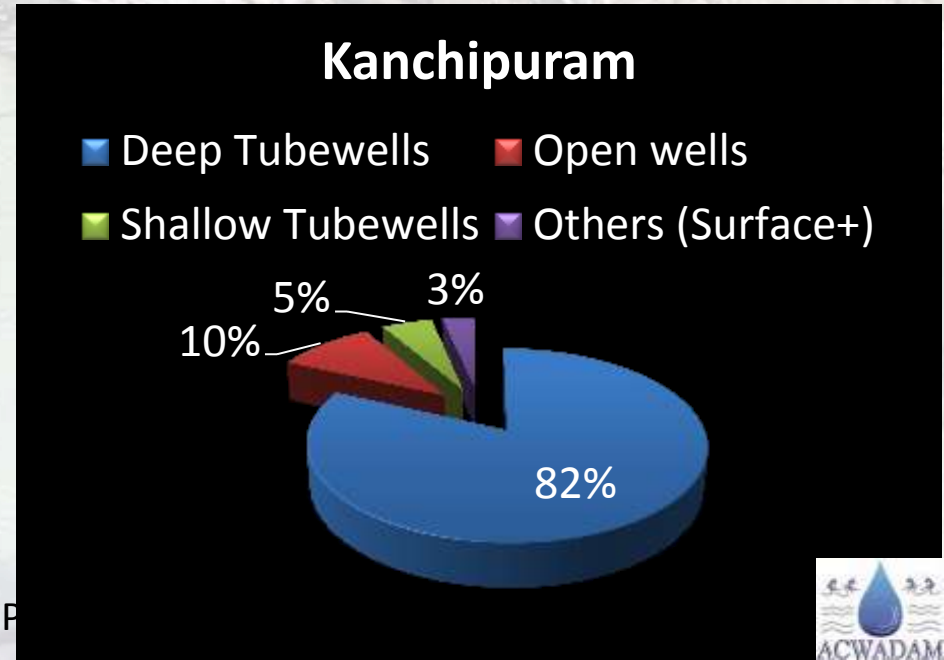
Source: NRDWP; 2015 (Format B-6: List of water sources in habitations)

Drinking water dependency



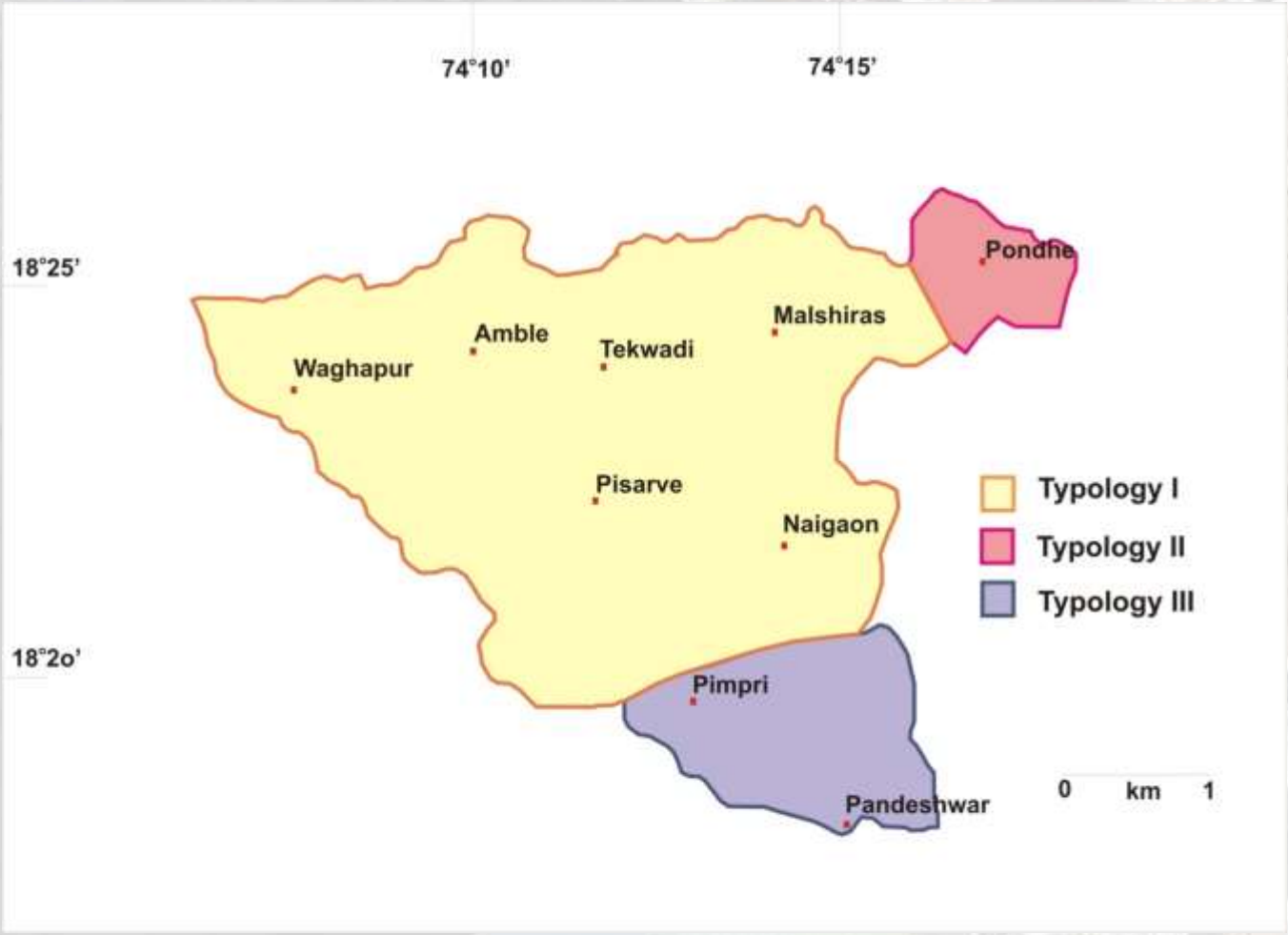






Diversity of problems

Eastern Purandar taluka of Pune district *(Area: 150 sq.km)*

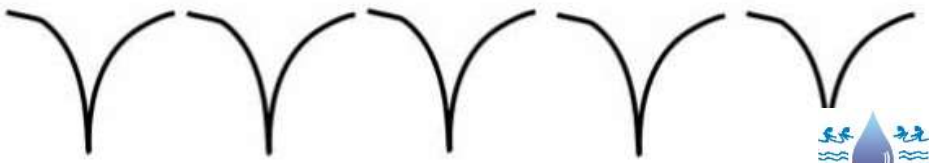


Groundwater Competition: No conflicts?

- Aquifer characteristics determine the nature of groundwater competition eg. Alluvial and hard rock aquifers
- It may also lead to local inequities in terms of access to groundwater, use of groundwater
- Arena for competition is so big that a period of intense competition resembles the conflict scenario
- The competition itself is so intense and overarching that it rarely transforms into an 'actual' conflict. Examples have been Coca cola case and Chennai water case (both over competing uses)

nature of competition in alluvial aquifers – drawdown is continuous

nature of competition in hard-rock aquifers: drawdowns are discrete



Groundwater governance in India-an overview

- Regulation
  - Legal framework doe
  - Mostly tied to land ow
  - Poor enforcement
  - High cost of implementation

In some states in Australia, if a 2 ha or less land is irrigated with gw, it is exempted from all types of regulation! What about India?

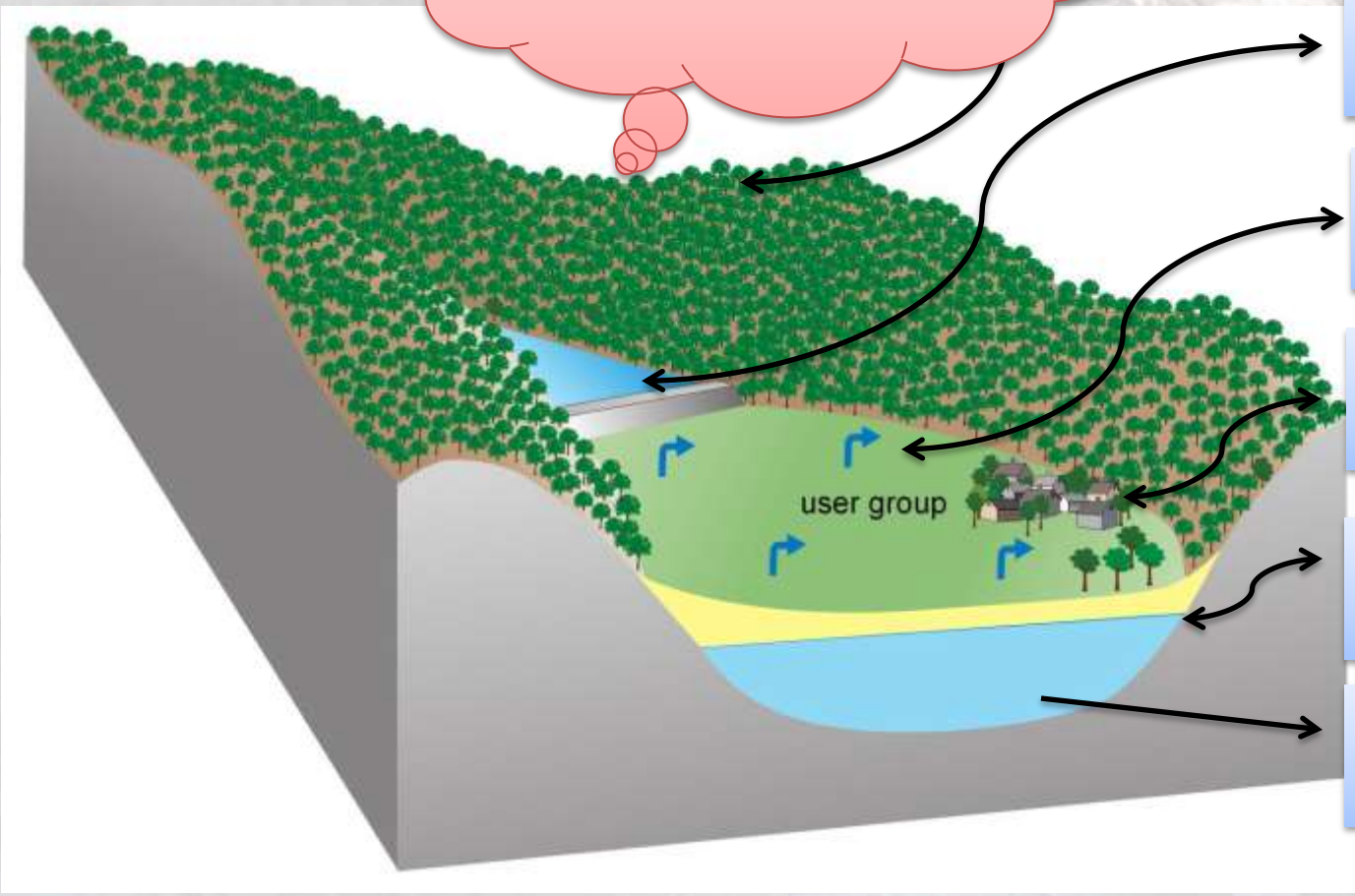
- Economy
  - Electricity is subsidized (free in some states)
  - No regulatory framework for groundwater markets
  - Political economy of groundwater limits actions

- Community initiative
  - No legal backing for community based action
  - Hiware Bazaar, Paani Panchayat: islands of success
  - Policy framework does not integrate these experiences

Groundwater:
A Common Pool Resource

Subtractable resource
Non excludable resource

Coordinating the effort: Challenge on the governance front



- Forest Department
- Minor Irrigation Department
- Agriculture Dept.
- Rural Development Dept.
- Drinking Water and Sanitation Dept.
- Groundwater Dept.

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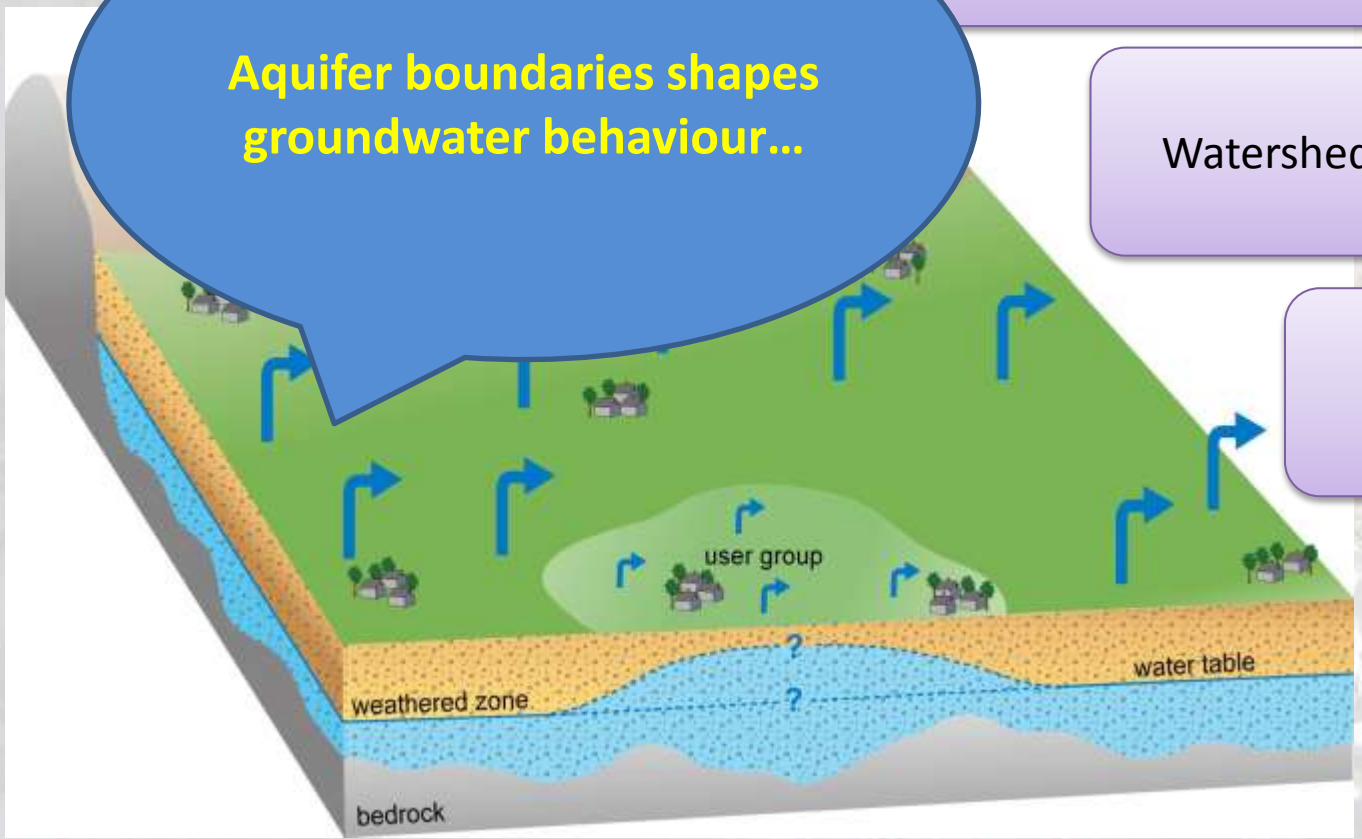
What defines groundwater behaviour? The question of boundaries

Aquifer boundaries shapes groundwater behaviour…

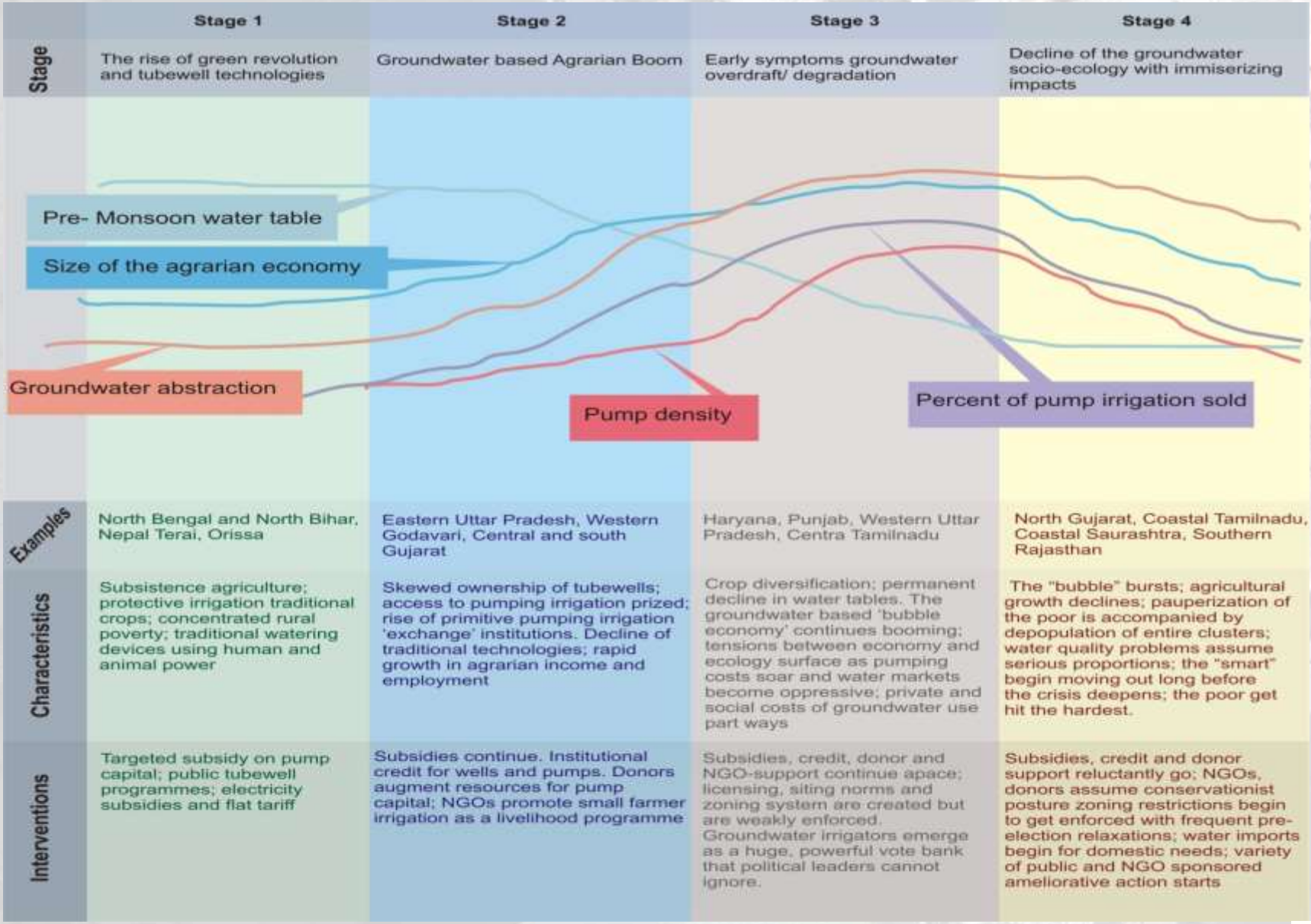
Administrative Boundaries?

Watershed Boundaries?

Socio-economic boundaries?



GROUNDWATER TYPOLOGY: RISE AND FALL OF GROUNDWATER SOCIO-ECOLOGIES



Stage	Stage 1	Stage 2	Stage 3	Stage 4
Stage	The rise of green revolution and tubewell technologies	Groundwater based Agrarian Boom	Early symptoms groundwater overdraft/ degradation	Decline of the groundwater socio-ecology with immiserizing impacts
Examples	North Bengal and North Bihar, Nepal Terai, Orissa	Eastern Uttar Pradesh, Western Godavari, Central and south Gujarat	Haryana, Punjab, Western Uttar Pradesh, Centra Tamilnadu	North Gujarat, Coastal Tamilnadu, Coastal Saurashtra, Southern Rajasthan
Characteristics	Subsistence agriculture; protective irrigation traditional crops; concentrated rural poverty; traditional watering devices using human and animal power	Skewed ownership of tubewells; access to pumping irrigation prized; rise of primitive pumping irrigation 'exchange' institutions. Decline of traditional technologies; rapid growth in agrarian income and employment	Crop diversification; permanent decline in water tables. The groundwater based 'bubble economy' continues booming; tensions between economy and ecology surface as pumping costs soar and water markets become oppressive; private and social costs of groundwater use part ways	The "bubble" bursts; agricultural growth declines; pauperization of the poor is accompanied by depopulation of entire clusters; water quality problems assume serious proportions; the "smart" begin moving out long before the crisis deepens; the poor get hit the hardest.
Interventions	Targeted subsidy on pump capital; public tubewell programmes; electricity subsidies and flat tariff	Subsidies continue. Institutional credit for wells and pumps. Donors augment resources for pump capital; NGOs promote small farmer irrigation as a livelihood programme	Subsidies, credit, donor and NGO-support continue apace; licensing, siting norms and zoning system are created but are weakly enforced. Groundwater irrigators emerge as a huge, powerful vote bank that political leaders cannot ignore.	Subsidies, credit and donor support reluctantly go; NGOs, donors assume conservationist posture zoning restrictions begin to get enforced with frequent pre-election relaxations; water imports begin for domestic needs; variety of public and NGO sponsored ameliorative action starts

Source: Shah (2009)

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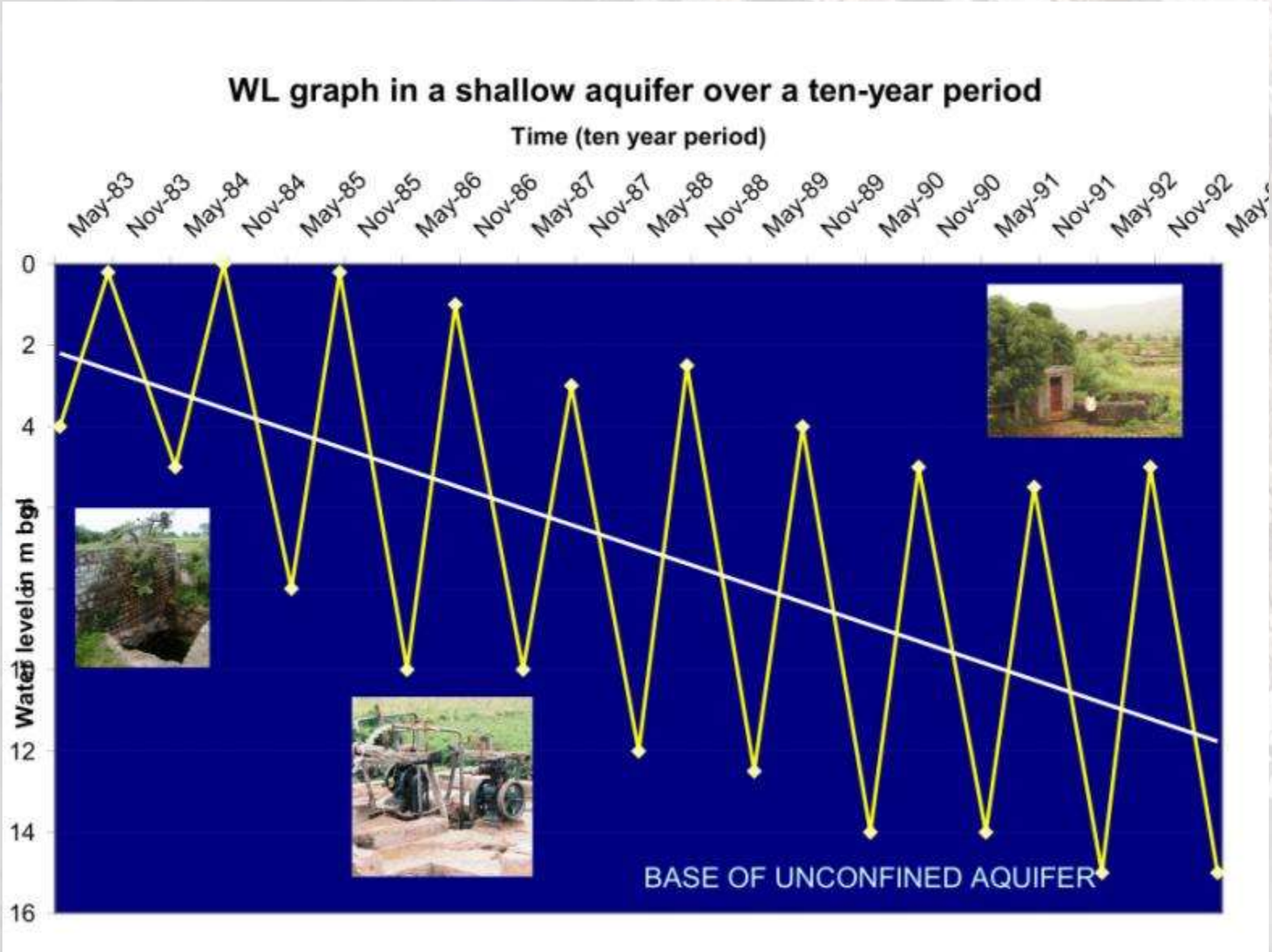
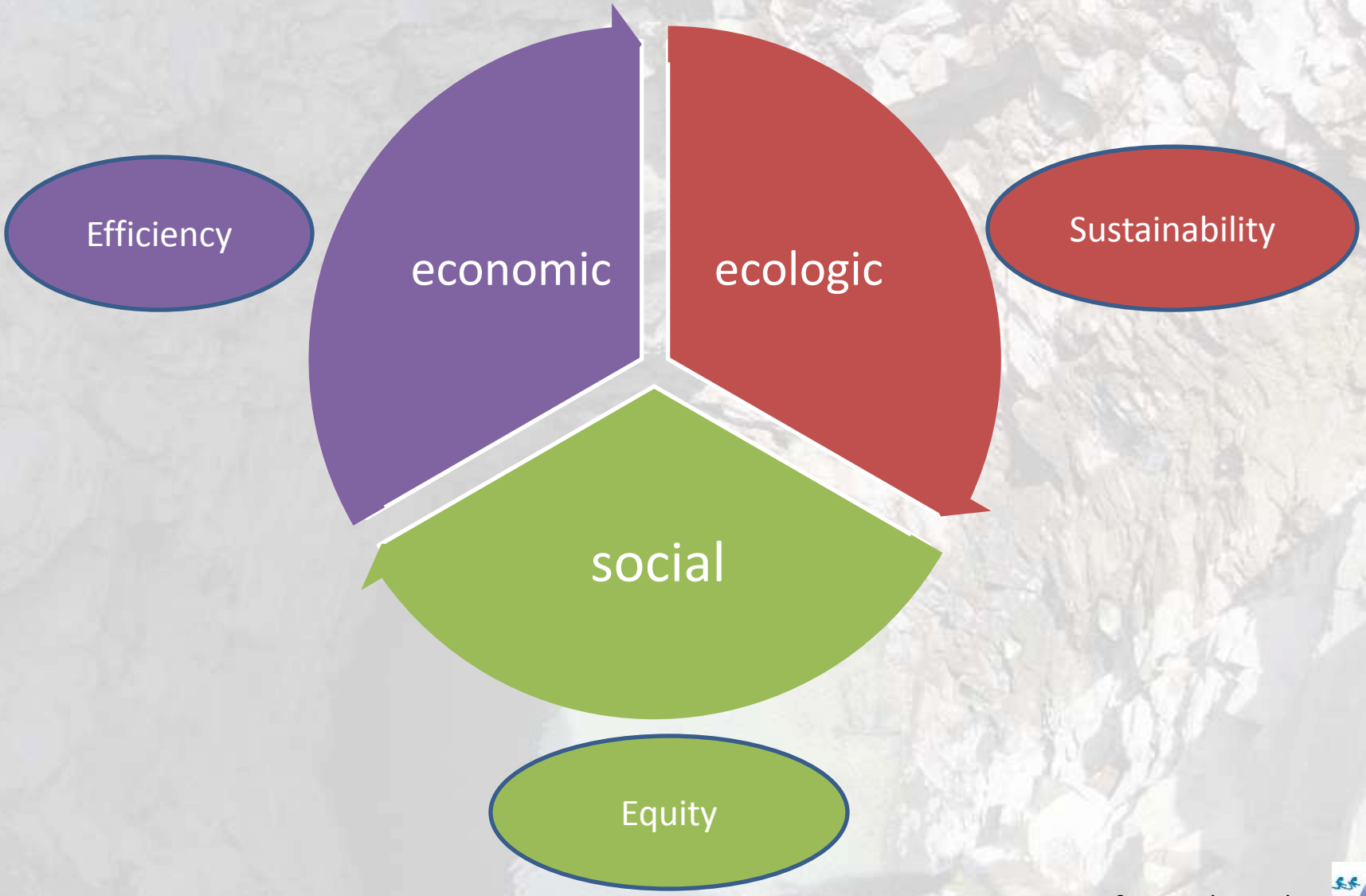
How is it reflected in one aquifer over time…



Permeable

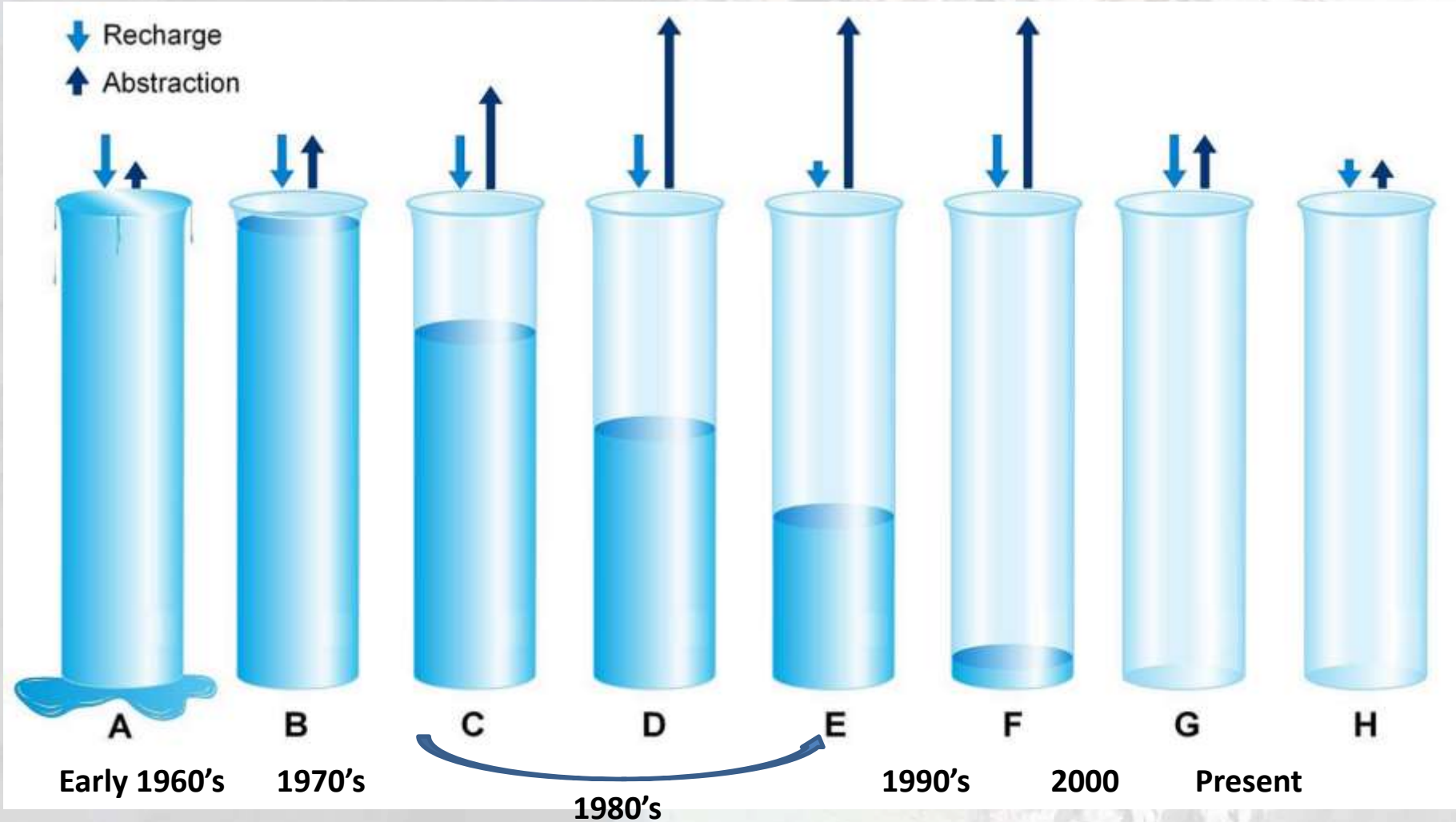
Source: Kulkarni (2005)

Textbook definition of sustainable governance



Source: Our common future (1987)

Stages of groundwater development in India



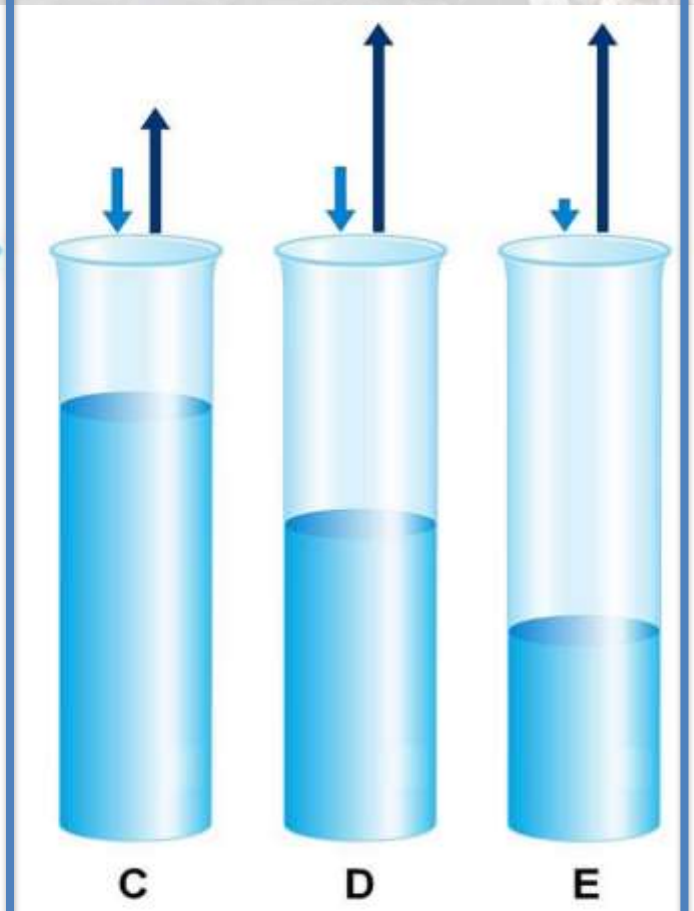
Source: Kulkarni and Vijayshankar (2009)

Issue of Equity, Efficiency and Sustainability: the three pillars of sustainable governance

Stage 1

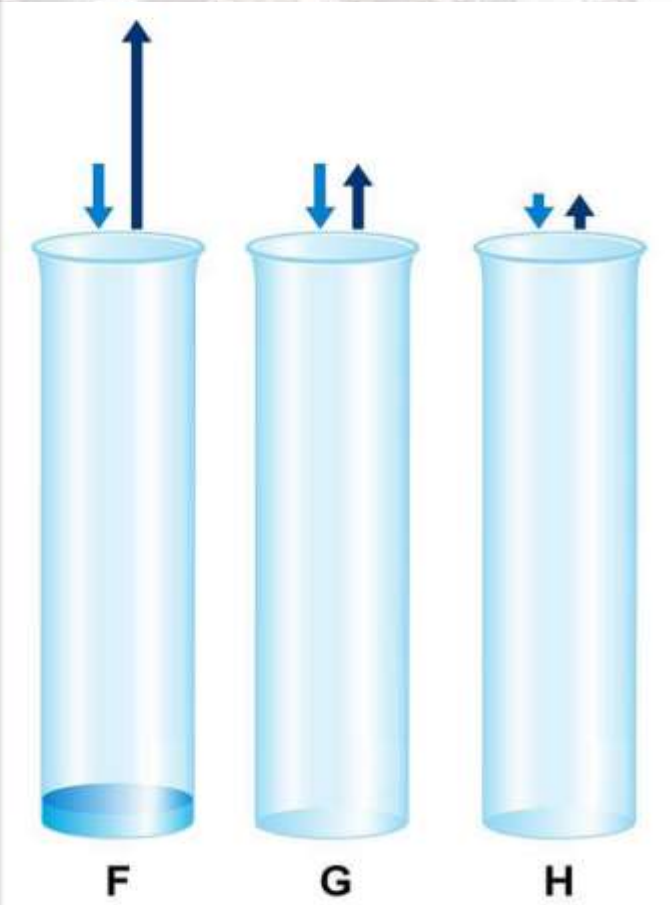
Sustainability
Equity
Efficiency

Stage 2



Equity
Efficiency
Sustainability

Stage 3



Efficiency
Equity?
Sustainability?

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Introducing GW protocols (for wells) in different phases of GW use

Protocols	Stage 1	Stage 2	Stage 3	Stage 4
Geo-hydrology in WSD		✓	✓	✓
Protection of recharge areas	✓	✓	✓	✓
Efficient well use		✓	✓	✓
Pump capacity re				✓
Distance (wrt drinki regulation				✓
Depth Regulation (wrt drinking well)			✓	✓
Regulation of Agricultural water use				✓
Groundwater management through sharing		✓	✓	✓

Diverse problems, diverse responses

Introducing GW protocols (for springs) in different phases of GW use

Protocols	Stage 1	Stage 2	Stage 3	Stage 4
Geology in Spring shed development		✓	✓	✓
Identification of recharge area, its protection and recharge enhancement	✓	✓	✓	✓
Water quality protection (specifically in recharge areas)		✓	✓	✓
Community use of springs		✓	✓	✓
Agreement between recharge area and discharge area communities			✓	✓

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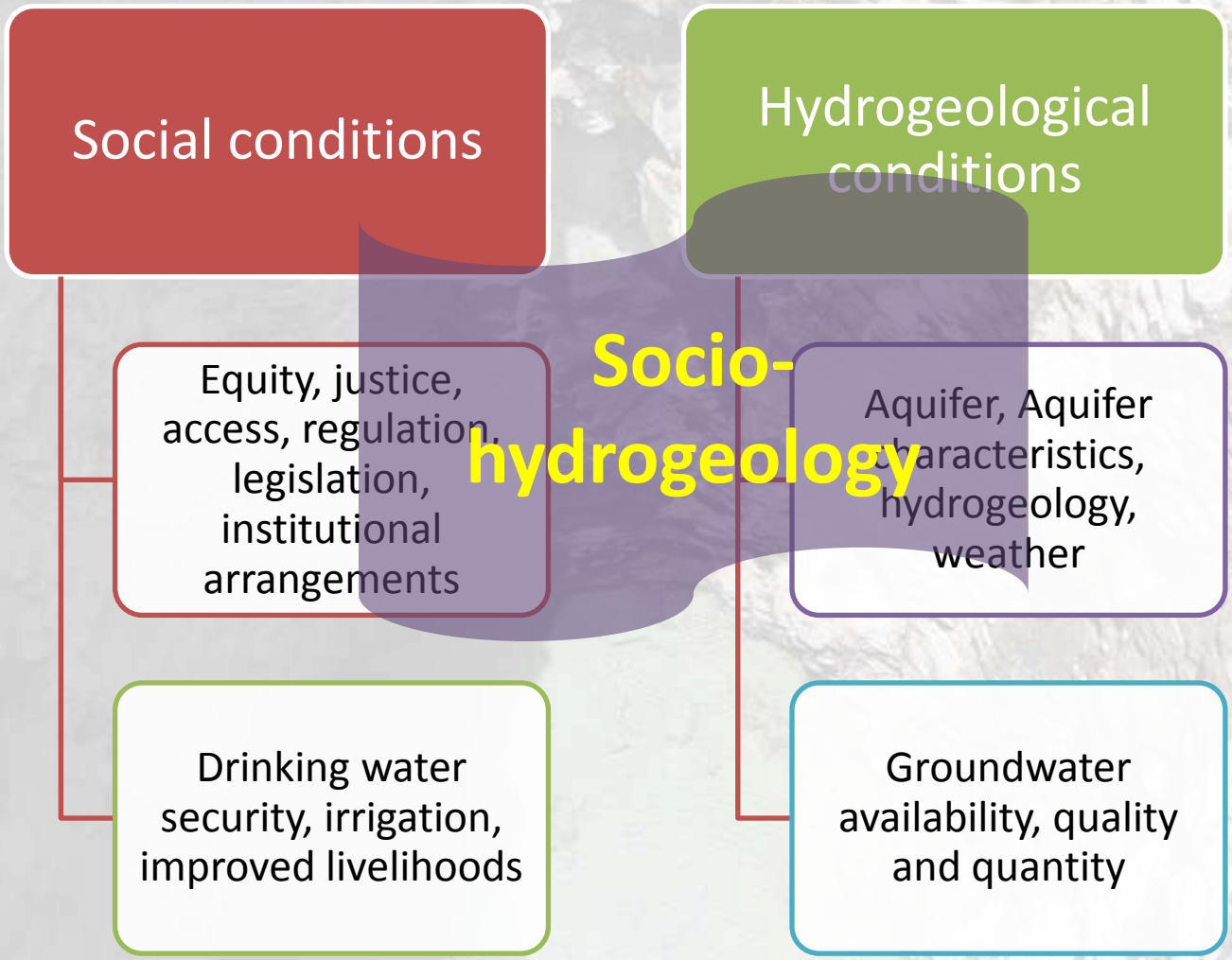
Linking social and hydrogeological realities….



Thank You!

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