

Sustainable Ground and Surface Water Management in South Asia: Challenges and Opportunities



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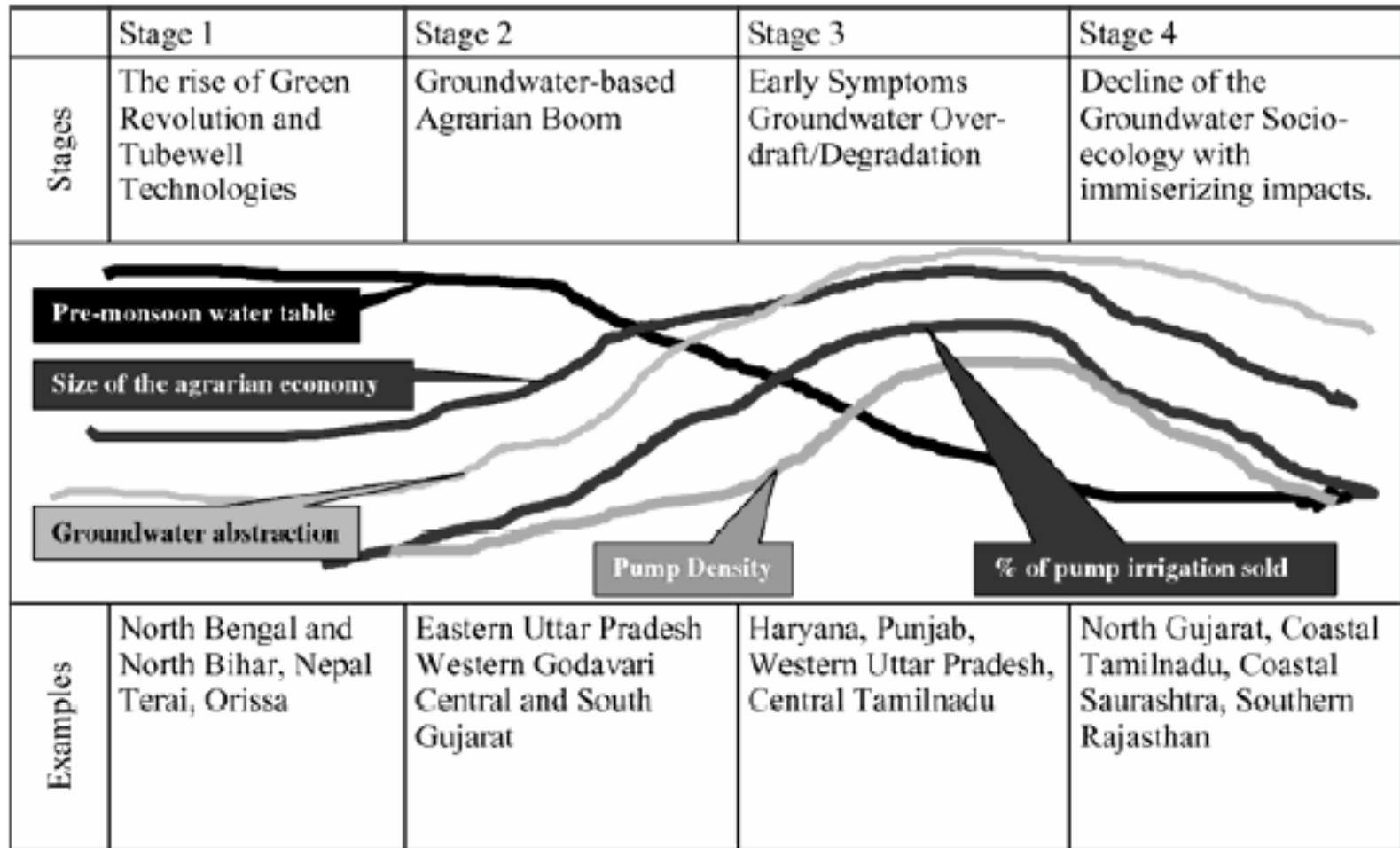
Preview

- **Groundwater Scenario**
- **Water-Energy nexus**
- **Sustainable GroundWater Management**
- **Political concerns**

Ground water scenario

- **Groundwater boom in South Asia**
India: < a million tubewells in 1960 and 19 million tubewells in 2000 (26 million wells). (Shah et.al, 2003)
- **North China plains: 3.5 million tubewells**
(Hebei Province: 730 wells in 1955 to over 840,000 in 1998)
- **South Asian extraction is around 400 cubic kilometers (India (215), Pakistan(54) and China(106))**
- **Investment by farmers is around 12 billion dollars in India alone**

Stages of Groundwater Exploitation



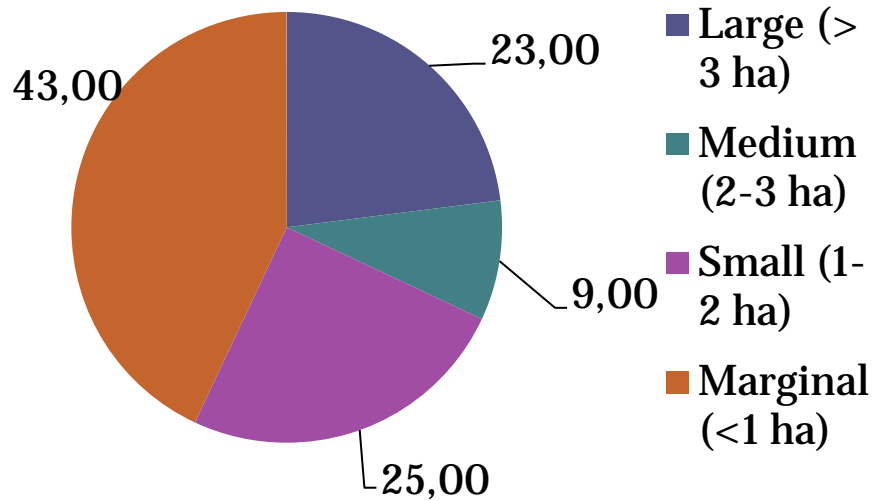
When the balloon bursts, untold anarchy will be the lot of rural India..

(Shah, 2007)

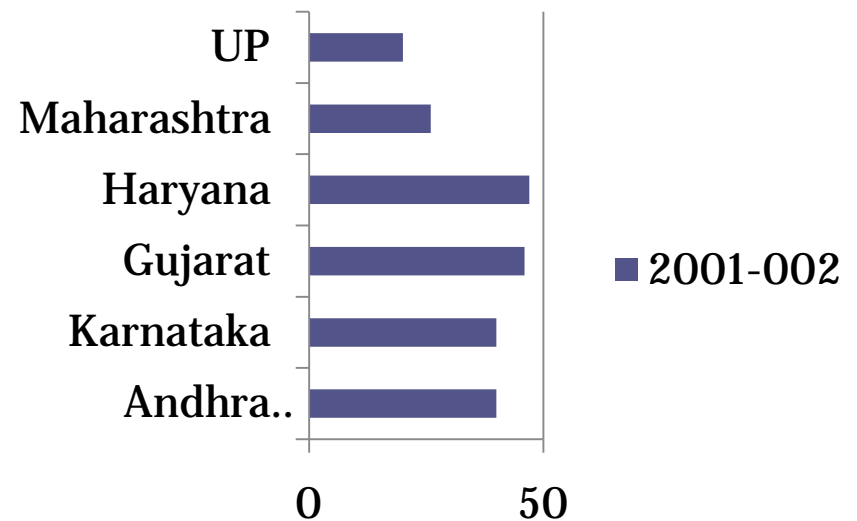
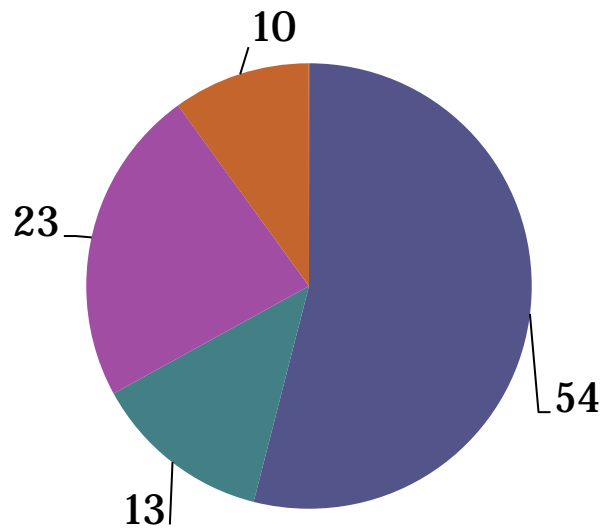
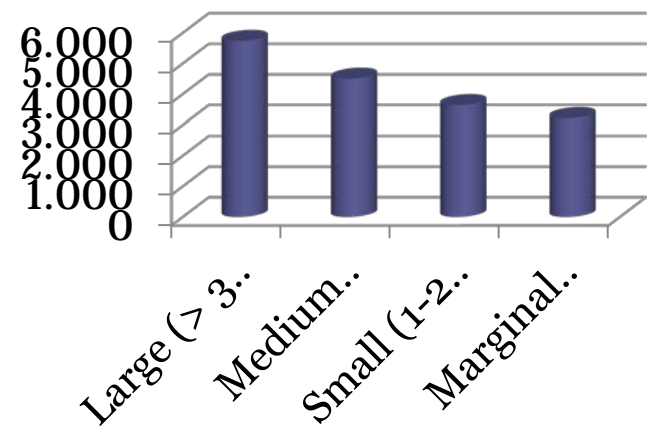
A deep open well



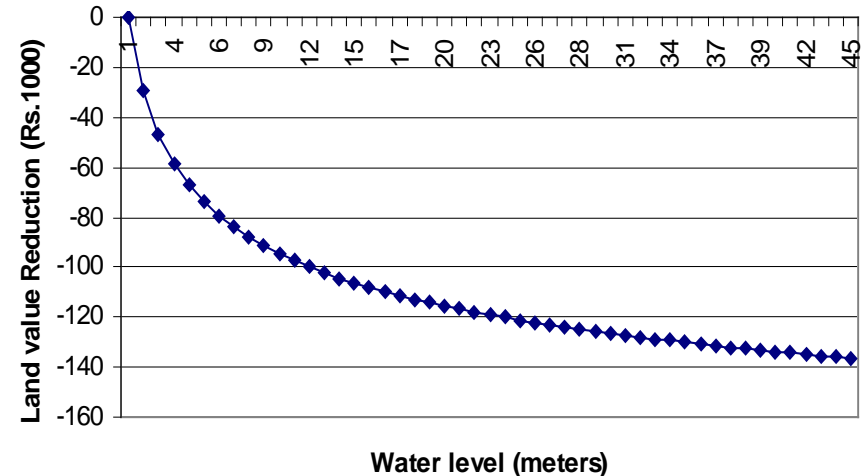
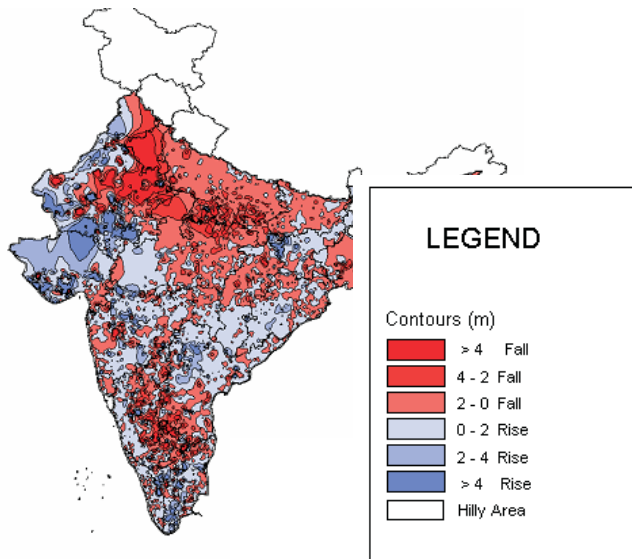
Water-Energy Nexus



KWh/Year

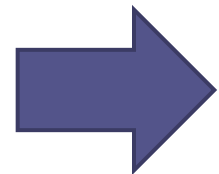


Impacts

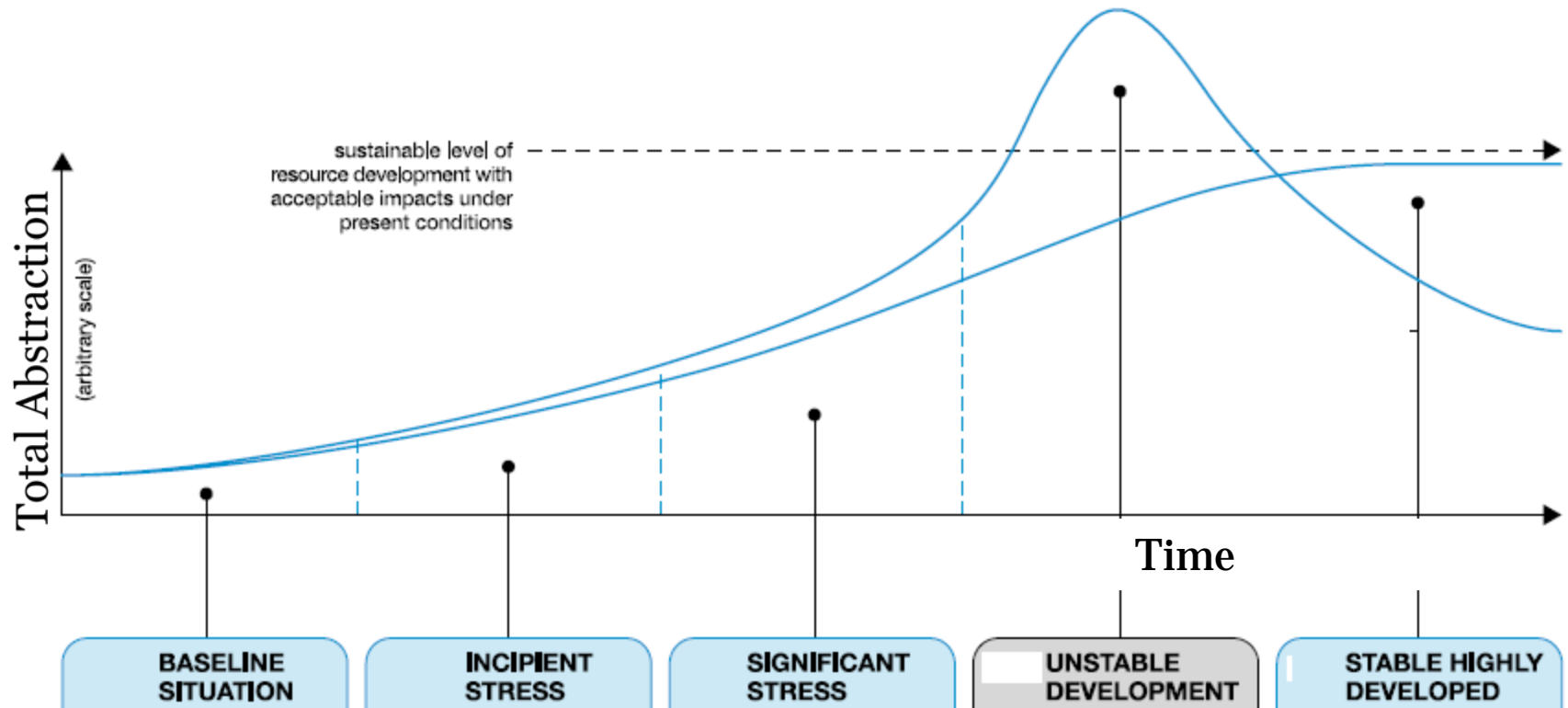


16–25 million mt of carbon emissions, 4–6% of India's total emissions from groundwater pumping. (Shah, 2009)

Huge fiscal deficit of state governments due to power subsidies (18000 million rupees for Karnataka state in 2001)



Sustainable Groundwater management



(World Bank, 2006)

Modelling sustainable groundwater use

Basic Model

- maximizing the discounted profits over time of all farmers sharing a common aquifer
- **By optimising**
- Water Extraction
- Energy costs
- Groundwater recharge
- Land use
- **Restrictions on**
- Land
- Labour
- Water

Policy tools

- Energy cap and water trade
- Energy pricing
- Treating aquifer as a community property and charging of water extraction of the farmers
- Landuse restrictions/Licensing
- Partnership solution

Surfacewater purchases through Water Markets

Limitation

Water rights needs to be assigned to each farmer
Water has to be quantitatively allocated to each plot
Very small size of plots
Very high transaction costs

Solution

Restricting the property rights assignment to water user community level

Model

Coordination among users in a water user association.

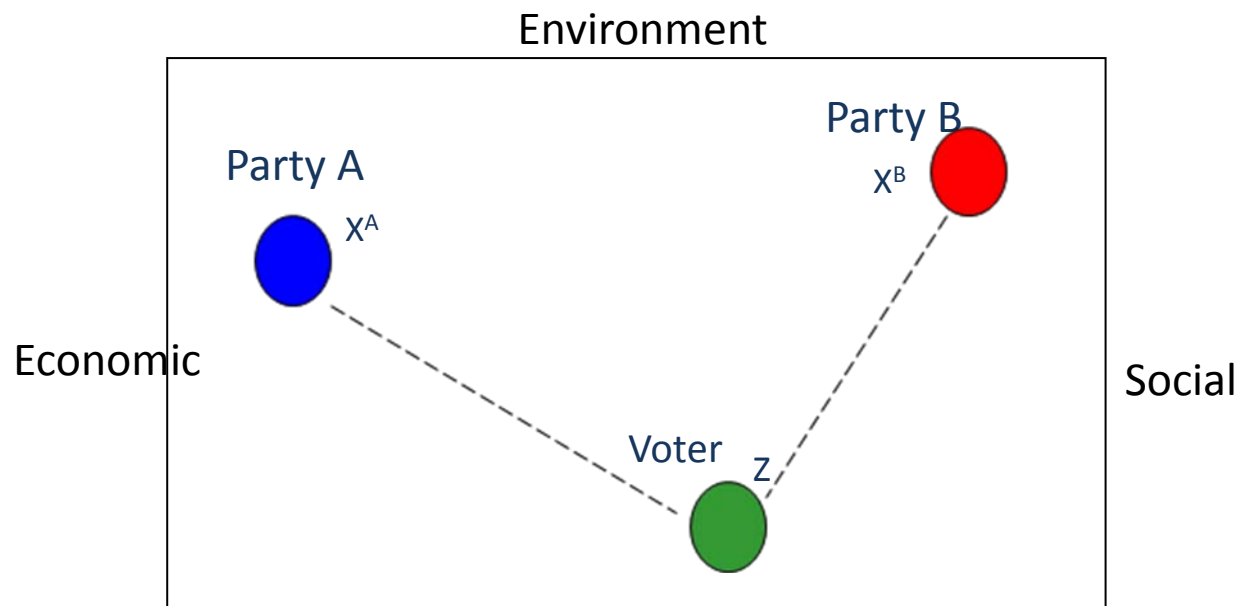
Principal-agent model

Principal (Manager)

Agent (Farmer)

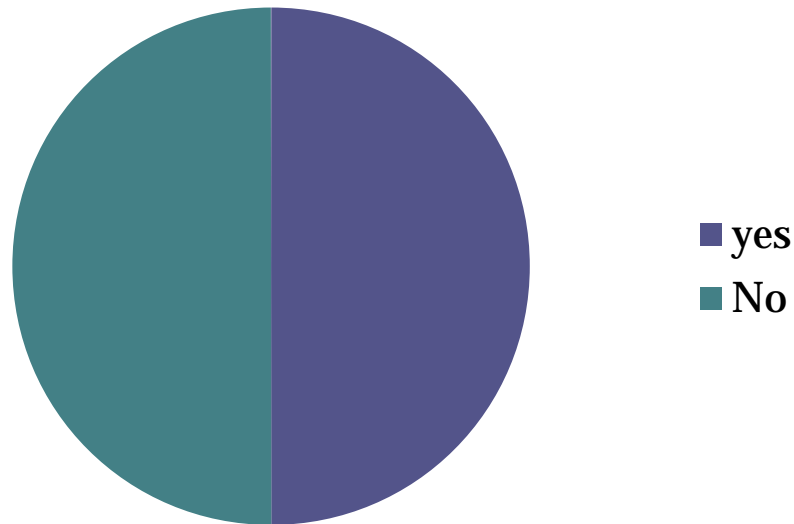
Optimal incentive scheme (Profit sharing) that maximizes the water trade is devised

Political Dilemma



Voting behaviour: Free electricity

Will you vote for a political party offering free electricity to farmers (irrespective of their current party affiliation) ?



THANKS FOR LISTENING



Further Contact
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Policy Basket

- **Voluntary restrictions**
- **Credit restrictions**
- **Increasing energy prices**
- **Encouraging water saving/Energy saving measures**