Introduction
IMPORTANCE OF GROUNDWATER
Global Groundwater Situation
Sources for presentation

- ACWADAM’s database
- CGWB, *various publications*
- FAO-database
- Various United Nations publications.
- UN World Water Development Report 2, 2006
- Comprehensive Assessment of Water Management in Agriculture (Earthscan 2007)
- *Falling Water Tables, Falling Harvests* by Lester R. Brown in [http://www.earth-policy.org/Books/Seg/PB3ch04_ss2.htm](http://www.earth-policy.org/Books/Seg/PB3ch04_ss2.htm)
- *Personal communication* with various researchers from all over the world.
Some glaring global facts

- Countries that contain more than half of the world’s people are also dominantly groundwater dependent.

- These countries include the three big *grain producers*: China, India & USA.

- Most of these countries are *overpumping* their groundwater to satisfy their ever-growing water demand.
Consequences of groundwater overuse – global examples

• CHINA: When the North China Aquifer is depleted, the grain harvest will drop by 40 million tons - enough to feed 120 million Chinese.

• INDIA: Some 175 million Indians are fed with grain produced with water from irrigation wells that will soon go dry.

• USA: Wells have gone dry on thousands of farms in the Southern Great Plains, forcing farmers to return to lower-yielding dryland farming.

Uses of groundwater

• Drinking and domestic purposes

• Agriculture

• Livestock

• Industry

• Maintaining the ecological balance
Rainfed agriculture
Irrigated agriculture
Area under irrigation - 2002

India, Pakistan and Bangladesh
90
30%

WORLD
210
70%

Figures in million hectares and percentages

T. Shah, 2009
Groundwater irrigation: India’s unique story
India is the world’s largest user of groundwater for agriculture...

India has over 20 million irrigation wells. We add 0.8 million/year.

Every fourth cultivator owns an irrigation well; non-owners depend on groundwater markets.

T. Shah, 2009
NIA, surface water & groundwater

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’

Close fit between NIA from groundwater and total NIA.
## Status of groundwater use: 1995 vs 2004

<table>
<thead>
<tr>
<th>Level of Groundwater Development</th>
<th>% of Total Districts</th>
<th>% of Total Area</th>
<th>% of Total Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50% (“Safe”)</td>
<td>82</td>
<td>55</td>
<td>89</td>
</tr>
<tr>
<td>50-70% (“Safe”)</td>
<td>10</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>70-90% (“Semi-Critical”)</td>
<td>4</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>90-100% (“Critical”)</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>&gt;100% (“Overexploited”)</td>
<td>4</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*CGWB, 2006*
Trends: dug wells vs tube wells

Number of Dugwells and Tubewells, 1986-2001

GW access: community sources to individual ones

Bore wells have caught up with dug well, in numbers

Minor Irrigation Census, 2001
India’s groundwater economy

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Groundwater Structures</td>
<td>Million</td>
<td>17.5</td>
</tr>
<tr>
<td>Average Output of Groundwater Structures</td>
<td>m(^3)/hr</td>
<td>30</td>
</tr>
<tr>
<td>Average Hours of Operation per Well per Year</td>
<td>Hours</td>
<td>360</td>
</tr>
<tr>
<td>Estimated Groundwater Use</td>
<td>km(^3)</td>
<td>210</td>
</tr>
<tr>
<td>Imputed Value of Groundwater Used per year</td>
<td>Rs. (crores)</td>
<td>42000</td>
</tr>
</tbody>
</table>

T. Shah, 2009
Talukas/Blocks: stage of GW development

Legend:
- Safe
- Semi-Critical
- Critical
- Over Exploited
- Saline

CGWB, 2006
## Status of groundwater use: 1995 vs 2004

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<td>82 / 55</td>
<td>89 / 52</td>
<td>80 / 45</td>
</tr>
<tr>
<td>50-70% (“Safe”)</td>
<td>10 / 15</td>
<td>7 / 16</td>
<td>13 / 20</td>
</tr>
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<td>4 / 13</td>
<td>2 / 14</td>
<td>3 / 17</td>
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<td>TOTAL</td>
<td>100 / 100</td>
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CGWB, 2006
### SA groundwater typology: rise and fall of groundwater socio-ecologies (T. Shah, 2009)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Characteristics</th>
<th>Examples</th>
<th>Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>The rise of green revolution and tubewell technologies</td>
<td>North Bengal and North Bihar, Nepal Terai, Orissa</td>
<td>Targeted subsidy on pump capital; public tubewell programmes; electricity subsidies and flat tariff</td>
</tr>
<tr>
<td>Stage 2</td>
<td>Groundwater based Agrarian Boom</td>
<td>Eastern Uttar Pradesh, Western Godavari, Central and south Gujarat</td>
<td>Subsidies continue. Institutional credit for wells and pumps. Donors augment resources for pump capital; NGOs promote small farmer irrigation as a livelihood programme</td>
</tr>
<tr>
<td>Stage 3</td>
<td>Early symptoms groundwater overdraft/ degradation</td>
<td>Haryana, Punjab, Western Uttar Pradesh, Centra Tamilnadu</td>
<td>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.</td>
</tr>
<tr>
<td>Stage 4</td>
<td>Decline of the groundwater socio-ecology with immiserizing impacts</td>
<td>North Gujarat, Coastal Tamilnadu, Coastal Saurashtra, Southern Rajasthan</td>
<td>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</td>
</tr>
</tbody>
</table>

- **Pre-Monsoon water table**
- **Size of the agrarian economy**
- **Groundwater abstraction**
- **Pump density**
- **Percent of pump irrigation sold**
Lessons from the past?
# Groundwater vulnerability

<table>
<thead>
<tr>
<th>Description</th>
<th>Number of Districts</th>
<th>% to Total Districts</th>
<th>States where these Districts are Located</th>
</tr>
</thead>
<tbody>
<tr>
<td>Districts with High Level of Groundwater Development (GD&gt;70%) (“Unsafe” districts)</td>
<td>173</td>
<td>30%</td>
<td>Punjab, Haryana, Rajasthan, UP, Gujarat, Tamil Nadu</td>
</tr>
<tr>
<td>Districts with at least one of the 3 most serious quality problems (Arsenic or Fluoride or Salinity)</td>
<td>169</td>
<td>29%</td>
<td>Assam, Gujarat, Haryana, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, West Bengal</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>342</strong></td>
<td><strong>59%</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Kulkarni, Shankar & Krishnan, 2009*
...the importance of geology
Potential Groundwater Pollution

RAINFALL

OPEN DEFECATION

CATTLE WASTE

POLLUTION

FERTILISER And PESTICIDES
Hydrogeology is most important in watershed management projects

- Harvesting
- Conservation
- Recharge

*Is this a percolation tank or an irrigation dam?*

*Where to do what???
...a watershed...
...geology...
Groundwater resources in Neemkheda are hosted by the shallow aquifer constituted by a layered sequence of the fine grained Kanar sandstone, the coarse, calcareous Katkut sandstone and a part of the overlying fractured basalt. The base of the aquifer is marked by the impermeable chert breccia sitting atop the Lohar dolomite.
Understanding groundwater...
Hydrogeological diversity in India

The Himalaya

The Gangetic Plains

The Western Ghats
GEOLOGY plays a very important role in the formation of aquifers, and consequently, on the accumulation and movement of groundwater.

Geological conditions tend to vary, both laterally and vertically…
Therefore, the need to *understand* groundwater...
Hydrological processes...
Watershed geology: a clearer perception of groundwater in the watershed

• Geology: rock types, their interrelationship and structures in the rocks.

• First step in understanding groundwater resources in the watershed.

• A useful tool for planning watershed development structures.

• Hydrogeology: going from geology to understanding groundwater
ACWADAM’s small effort in groundwater management...
ACWADAM’s goal

To help achieve scientifically based, sustainable management of water resources, especially groundwater, in different settings –

- Geographically diverse locations.
- Rural & urban
- Domestic, agricultural & industrial
Our approach

- Action research
- Education and training
- Customisation

Partnerships and collaborations based on mutual strengths

e.g. ACWADAM’s scientific capabilities often combined with social skills or engineering capacities of partner organisations.
Locations of our interventions

- Began with sites in Maharashtra
- Currently, working with different partners in other parts of India
- Spreading our work to newer areas
Our small effort at fighting groundwater problems

- Research: To new levels, with possible experimentation of groundwater management models.
- Training: Widening and deepening of “training” inputs.
- Dissemination of research and education in groundwater to wider audiences.

Advanced Center for Water Resources Development and Management (ACWADAM)
Plot 4, Lenyadri society, Sus road, Pashan, Pune-411021.
☎ 020-25871539;
Email: acwadam@vsnl.net;
Website: www.acwadam.org