GROUNDWATER BASED RICE FARMING IN GANGLA BASIN- A SUSTAINABILITY STUDY

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River Ganga

River Bhagirathi (distributary of river Ganges)

Study areas in 5 districts of West Bengal in Lower Ganga Basin

The study areas in West Bengal under Lower Ganga Basin
Farming major source of livelihoods
(91% small farmers)

Pre-dominance of rice farming
(Staple food)

Groundwater based irrigated farming
(84% irrigated land)

Farming characters of the study areas
Arsenic pollution of aquifer

Depletion of groundwater table

Flood irrigation system
(30,000 m$^3$ water per hectare cultivation)

Highest water consumer
(3000-5000 lit water / kg rice production)

Flood irrigation in rice field
Challenges ahead

Sustainability

Resources

Food security

Environmental stability
Objectives

1. To analyze the trends of groundwater development *vis-a-vis* rice farming
2. To study environmental consequences
3. To address the issues towards sustainable management of water resources in lower Ganga basin of India
Methodology
## Primary Data Generation

<table>
<thead>
<tr>
<th>Field study area</th>
<th>75 Villages from 5 districts of West Bengal</th>
<th>Purposive selection from Lower Ganga Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm household survey</td>
<td>1500 respondents</td>
<td>Random selection &amp; questionnaire method</td>
</tr>
<tr>
<td>Water-table monitoring</td>
<td>45 hydrological points</td>
<td>‘Steel tape and chalk’ method</td>
</tr>
<tr>
<td>Arsenic analysis</td>
<td>3000 tube-well drinking water samples</td>
<td>Standard methods (AAS-FIAS 400-HG)</td>
</tr>
</tbody>
</table>

## Secondary Data Source

| Government literatures   | Minor Irrigation Reports, Central Ground Water Board Reports and Field Crops Statistical Abstracts | Compilation of data |
Findings
Development of irrigation facilities during 1986 -2010

- 80% growth in STW & DTW ground water irrigation
- Declining trends in surface irrigation (SL)

DW (Dug-well), STW (Shallow tube-well) & DTW (Deep tube-well) are groundwater irrigation sources.
SF (Surface flow) & SL (Surface lift) are surface water irrigation sources.
Groundwater irrigation development triggers summer rice cultivation (January to May)

Area expansion rate of summer rice about 300% during last two and half decades

Reduction of cultivated area of other low-water requiring crops, specially wheat and pulse crops
Environmental consequences
Periodical depletion of groundwater table

* Pre and post monsoons studies conduct in May and November months respectively

✓ Water-table is more or less declining due to exhaustive pumping without any efficient recharging system

* Pre and post monsoons studies conduct in May and November months respectively
## Effects of groundwater depletion and people awareness

<table>
<thead>
<tr>
<th>Effects in pre-moon period</th>
<th>Total observations</th>
<th>Number showing the effects</th>
<th>% showing the effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult to pump hand tube-wells for drinking water</td>
<td>900</td>
<td>576</td>
<td>64</td>
</tr>
<tr>
<td>Non-functioning of tube-wells</td>
<td>900</td>
<td>153</td>
<td>17</td>
</tr>
<tr>
<td>Shallow tube-wells replaced by deep submersible pumps</td>
<td>350</td>
<td>245</td>
<td>70</td>
</tr>
<tr>
<td>Drying up of dug-wells</td>
<td>80</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td>People aware of environmental consequences</td>
<td>1500</td>
<td>270</td>
<td>18</td>
</tr>
</tbody>
</table>
Arsenic contamination in groundwater

- Exhaustive pumping of groundwater for summer rice cultivation aggravates arsenic pollution in the basin region.

- 11 blocks out of 15 surveyed are exposed to arsenic toxicity beyond WHO permissible limit for drinking water 10µg/L.

- 53% of tube-well drinking water contains arsenic above 10 µg/L and 25% above 50 µg/L.

- 3000 tube-wells drinking water samples tested.
Mechanisms of Arsenic contamination in groundwater

- **Arsenopyrites** (Non-toxic form)
- **Oxidation**
- **Arsenite** [As (III)] & **Arsenate** [As (V)] (Toxic forms)
- **Arsenic leached to groundwater**

- Arsenopyrites – a **geogenic formation** from the underground rocks along the Ganga basin and it is present in **soils** (aquifer sediments in non-toxic forms)
- Excessive pumping of groundwater creates a **vacuum** by lowering water-table and causes entering of atmospheric oxygen into the underground aquifers
- Then **oxidation** of arsenopyrites to form toxic arsenite and arsenate, which are water soluble and leaching to groundwater
- **Arsenite is more toxic than arsenate**
Symptoms of chronic arsenic poisoning

Arsenicosis (Skin lesions and cancers)
Resources management for sustainability
Enactment of ‘Groundwater Regulation Laws 2004’

Strong institutional mechanisms in enforcing the regulatory laws

Collaboration of stakeholders and public agencies in decision making process

Building people awareness about mechanisms of water depletion and arsenic contamination

Empowering village administrations for issuing new permits for withdrawal of groundwater

Supply-side management strategies:
Supply-side management strategies:

- Development of surface water irrigation to reduce pressure on groundwater
- In-situ rainwater harvesting in village ponds and tanks
- Investment on River lift surface irrigation system

Development of surface water irrigation to reduce pressure on groundwater
Demand side management strategies

- Grow rice with less water
  - Adoption of water-saving SRI rice technology through training and incentives of farmers
  - Research on aerobic rice cultivation
- Switching over to low water requiring cropping pattern
  - Promote wheat, pulses and oilseeds crops by replacing summer rice
Conclusions

Considering the deleterious effects of groundwater based rice farming on environment of the river basin, the study calls for a paradigm shift in policy from further groundwater development to sustainable water resources management. The sustainability of water resources of the region will largely remain a function of the working of this integrated supply and demand side management regimes.
save water
save future
its your responsibility

Thank you