Exploring the Potential of Water Rights and Energy Pricing for Sustainable Use of Groundwater for Irrigation in India

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Presented at IWRA XV World Water Congress
25-29 May 2015, Edinburgh, Scotland
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Introduction
Groundwater resources in India

- The net annual groundwater availability in India is estimated to be about 396 bcm.

- In 2009, the annual ground water draft was 243 bcm. Out of this, about 91% was for irrigation.

- Groundwater cater to about 85% of rural domestic water requirements, 50% of urban water requirements and more than 60% of irrigation requirements.

- Thus, groundwater has become a mainstay for providing water and food security to millions of people.
Emergence of groundwater irrigation in India

Diffusion of green revolution technologies- Mid 1970’s

Presently, groundwater sustains 60% of the irrigated area and 2/3rd of irrigated food production

Source: Government of India
Groundwater abstraction using energised wells

<table>
<thead>
<tr>
<th>Year</th>
<th>Electricity consumption in agriculture (GWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>4,470</td>
</tr>
<tr>
<td>1981</td>
<td>14,489</td>
</tr>
<tr>
<td>1991</td>
<td>50,321</td>
</tr>
<tr>
<td>2001</td>
<td>84,729</td>
</tr>
<tr>
<td>2011</td>
<td>131,967</td>
</tr>
<tr>
<td>2014</td>
<td>159,144</td>
</tr>
</tbody>
</table>

Source: Government of India
Annual replenishable groundwater resources

- Western and Peninsular India
  - Water scarce areas but high per capita arable land availability.
  - Groundwater abstraction through electrified tube wells/bore wells.
  - Electricity is highly subsidized.

- Eastern India
  - Water rich areas but low per capita arable land availability.
  - Groundwater is shallow, abstraction through diesel pumps (pump rental market).

Source: CGWB, India
Growing concerns related to groundwater resource
Status of groundwater development in India

<table>
<thead>
<tr>
<th>Category</th>
<th>2004</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe</td>
<td>71.3%</td>
<td>68.6%</td>
</tr>
<tr>
<td>SC</td>
<td>9.6%</td>
<td>10.5%</td>
</tr>
<tr>
<td>C</td>
<td>3.9%</td>
<td>3.3%</td>
</tr>
<tr>
<td>OE</td>
<td>14.7%</td>
<td>16.2%</td>
</tr>
<tr>
<td>S</td>
<td>0.5%</td>
<td>1.4%</td>
</tr>
</tbody>
</table>

Source: CGWB, India

Categorisation of the units (5723 assessed)

- Safe (< = 70%)
- Semi-critical (70-90%)
- Critical (90-100%)
- Over-exploited (>100%)
- Saline

Categorisation of units (6607 assessed)

- Safe (< = 70%)
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- Saline
Poor groundwater potential

- In India, 70% of the geographical area is underlain by hard rocks.

- In such areas, groundwater potential is poor. Its occurrence is confined to fractured zones as the formations do not have primary porosity.

- Thus, even a low level of groundwater development in such regions affects its availability and contribute to well failures.

Source: CGWB, India
Pervasive energy subsidy policies

- Policy of supplying free or highly subsidized power supply to farm sector is threatening both groundwater resources sustainability and power sector viability.

Source: Erstwhile Planning Commission, India
Institutional framework for groundwater management in India
Institutional arrangement

- Central Ground Water Board is the premier institution for the scientific and sustainable development and management of India's Ground Water Resources.

- 12 States/Provinces in India have an Act dealing with management of groundwater.

- Model Groundwater (Control and Regulation) bill which deals with well permits, water metering, and withdrawal limits is also proposed in 1970 and 1992.

- Institutional instruments such as: artificial recharge in areas of overdraft; local management by user group; and regulation on no. of wells, and promotion of water saving technologies.
Outcomes of the regulatory framework

- Most of the regulatory measures have been ineffective in arresting groundwater depletion.
  - groundwater recharge scheme in hard rock areas is not successful
  - legislations unable to restrict groundwater abstraction from existing wells
  - micro-irrigation technologies has enabled farmers to increase area under irrigation

- Model Groundwater Bill has not been properly adopted by any State so far.

- But of late, following have been increasingly advocated for managing groundwater demand:
  - direct institutional instruments such as establishment of tradable water rights and the effective enforcement of legislations
  - indirect economic instruments such as power rationing and pro-rata electricity pricing
Establishing water rights in groundwater
Water rights for sustainable groundwater use

- “Easement Act of 1882” grants landowners an unrestricted right to use the groundwater below the land.

- However, the land and well ownership is heavily skewed and there is an inherent inequality in access to groundwater.

- Researchers argue that a formal system of water rights can mitigate the inequity in groundwater access and promote its sustainable use.

- For water users to consider full opportunity cost of water, water rights has to be tradable.

<table>
<thead>
<tr>
<th></th>
<th>Small and Marginal Farmers</th>
<th>Large Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers owning wells and pump sets (%)</td>
<td>37</td>
<td>69</td>
</tr>
<tr>
<td>Area irrigated by wells (%)</td>
<td>14</td>
<td>29</td>
</tr>
</tbody>
</table>

Source: Kumar et al. 2013
How tradable water rights addresses the following?

| 1] Social tension & efficient groundwater use | □ Empower small and poor farmers  
□ Reduce monopoly power of large farmers  
□ Promote efficient use of groundwater as users would have an incentive to compare the opportunity costs of water |
| 2] Competition b/w agriculture & other sectors | □ Agriculture accounts for more than 80% of water use  
□ Modest transfers of water could meet growing urban and industrial demands |
| 3] Transaction cost | □ Buyers would attempt to find those trades which would minimize the total purchase price  
□ Conveyance infrastructure required for inter-sectoral water transfers would cost much less than the large hydraulic infrastructures planned to meet growing domestic and industrial water demand. |
Energy pricing as a viable option
Energy pricing is important in India where energy subsidies to agriculture are estimated between USD1.9 billion and USD6.5 billion per year.

These range from 80% in State of Madhya Pradesh and Haryana to 50% in Andhra Pradesh, Gujarat and Karnataka, and 40% in Rajasthan, Punjab and Tamil Nadu (Bhatia 2005).

These are also the States which are experiencing tremendous groundwater over-abstraction for irrigation.
Energy subsidies are turning out to be anti-poor

- The ‘pro poor’ subsidies regime has affected both groundwater situation and the state finances alike.
- It has already turned ‘anti-poor’ in several regions of Peninsular and Western India which are water scarce.

![Diagram showing comparison between small and large landowners in terms of mean number of wells per farmer, mean irrigated area per well, mean irrigated area per well owner, net return per well, and net return per farmer.](chart.png)
### Energy pricing debate in India

<table>
<thead>
<tr>
<th>Groundwater over-exploitation</th>
<th>Arguments</th>
<th>Counter-arguments</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Flat tariff regime with power supply rationing and supply management is the highly rationale, sophisticated and scientific pricing regime</td>
<td>• Field research suggests that power rationing with good quality supply but without metering and unit pricing has failed to arrest groundwater over-exploitation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<th>Counter-arguments</th>
</tr>
</thead>
<tbody>
<tr>
<td>• It is politically very difficult to return to energy prices that actually reflect the cost of energy to state</td>
<td>• Recent past has seen some remarkable success in introducing metering, and charging a power tariff based on actual consumption</td>
<td></td>
</tr>
</tbody>
</table>
## Energy pricing debate in India

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<thead>
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</thead>
<tbody>
<tr>
<td><strong>Economic viability</strong></td>
<td>- Increase in metered tariff required for elastic demand behavior are likely to be significantly higher than are acceptable to farmers</td>
<td>- Empirical studies established that the levels of pricing at which demand for electricity and groundwater becomes elastic to tariff are socio-economically viable</td>
</tr>
<tr>
<td><strong>Transaction cost</strong></td>
<td>- There is a question mark over feasibility of installing meters at such a large scale</td>
<td>- With the advent of pre-paid electronic meters and remotely-sensed meters, the transaction cost can be minimized</td>
</tr>
</tbody>
</table>
Conclusion

- Poor implementation of regulations has led to groundwater over-exploitation in India.

- Subsidized energy supply has provided incentives to resource rich large farmers to over-exploit the aquifers and use groundwater inefficiently.

- Enforcement of private and tradable water rights in groundwater can bring about more equitable access to, and control over, the water available from groundwater.

- This has to be complemented by the pro-rata pricing of electricity in the farm sector (especially in water scarce regions), with improved quality and reliability, to control groundwater and energy use in agriculture.