Circular Food Systems and Solutions: Addressing the Water-Energy-Food-Climate Nexus in South Asia

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Global mean temperature projected by CMIP5 multi-model ensemble

20–40% of the global human population live in regions that by the decade 2006–2015, had already experienced warming of more than 1.5°C above pre-industrial in at least one season.

CO₂ concentrations in RCPs (Representative Concentration Pathways)

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Greenhouse gas emissions pathways

- to limit warming to 1.5°C, CO2 emissions needs to fall by about 45% by 2030
- to limit warming to 1.5°C, CO2 emissions would need to reach ‘net zero’ around 2050
- limiting warming to 1.5°C would require massive changes
  - deep emissions cuts in all sectors
  - a range of technologies
  - behavioural change
  - increased investment in low carbon options
Agriculture, food production, and deforestation are major drivers of climate change.

Dietary change is an important route to reduce pressure on land and emissions, but production systems matters.

Coordinated action to tackle climate change can simultaneously improve land, food security and nutrition, and help to end hunger.
Risks to water in South Asia emanates from both climate and non-climatic drivers

Melting of glaciers and its impacts and risks on mountain people and downstream – entirely attributable to anthropogenic climate change

Groundwater over-exploitation – and its impacts on agriculture and cities, is mostly driven by non-climatic factors, though exacerbated by CC– and is largely a result of poor policies

Actions needed are different

- Saving our glaciers needs global community to adhere to their climate pledges;
- While sustainable use of groundwater needs more national and local action
Melting of Himalayan Glaciers

The Hindu Kush Himalaya
Global asset for food, energy, water, carbon, and cultural and biological diversity
In a 1.5°C world, glaciers in the HKH will lose 36% volume by 2100.

A 2°C global warming scenario implies a regional warming of around 2.7°C and a 49% loss of ice volume.

Snow covered areas and snow volumes will decrease and snowline elevations will rise;

Snow melt induced run-off peak will be stronger and occur earlier in the year.

Source: HIMAP climate change and cryosphere chapters and Kraaijenbrink et al. 2017, Nature
What do these changes mean for the region’s water resources?
Not running out of water, but…

Greater impact for those living closer to glaciers

Climate change is expected to drive consistent increases in total runoff of the Indus (due to increased glacier melt), Ganges and Brahmaputra (due to increased precipitation)

Contribution to total flow by (a) glacial melt, (b) snowmelt, and (c) rainfall-runoff for major streams during the reference period of 1998–2007. Line thickness indicates the average discharge during the reference period. Source: Lutz et al. (2014)
Mean relative change in 50 year return period of floods

Intensities of ‘once in 50 years’ flood events will increase:
- 40%–110% in upstream areas
- 115%–150% in downstream areas

Source: Wijngaard et al. 2017, PLOS
Unsustainable Groundwater Use and the Water-Energy-Food Nexus

Percentage of Electricity Operated Groundwater Structures to Total Mechanized Groundwater Structures, 1993-94*
Unsustainable Groundwater Use – A legacy of Green Revolution

Since 1970s, groundwater irrigated area has increased, as has number of wells and tubewells....

Number of Ground Water Structures, 2001

Legend
- 1 Dot = 5,000 Wells & Tubewells
- No data

Total Number of Groundwater Structures: 16.5 Million

Source: 3rd MI Census, 2001
Pace of growth in India’s groundwater structure is slowing down.

But number of deep wells is on the rise

There are deep regional divides

Rising contribution of groundwater in agriculture

1970-73

2000-03

BUT, depletion, scarcity and over-exploitation have emerged as serious problems.

However, groundwater over-exploitation in India has clear regional dimensions: Eastern India has ‘under-developed’ groundwater resources.

Source: Central Groundwater Board of India
Growth in electricity consumption in agriculture has outpaced growth in other sectors.

There has been 12 fold increase in overall electricity demand in India from 1950 to 2010, but 25 fold increase in agricultural electricity demand.
Electricity subsidy as percentage of state fiscal deficits is very high in some states

BRISCOE, 2005, Data pertains to 2002
But then, there is the energy divide: Farmers in eastern India depend pre-dominantly on diesel pumps, while rest of India has electric pumps.

So the food-energy-irrigation nexus is also different in east vs. rest of India.
Different groundwater-electricity regimes needs different solutions

Groundwater over-exploitation
In India is a result of

1) Its food policy – Green Revolution
2) Which stems from imperative back in the 1970s
3) Its energy policy – related to food self sufficiency
4) Both have become sticky
5) Leading to crisis in rural and urban areas

Electrified GW regime
GW is over-exploited
Current food basket of the nation

Dieselized GW regime
GW is under-utilized
Can become future food basket
Solar Irrigation Pumps (SIPs) as a solution?
~ 200,000 in the region (1% of all pumps)

Two concerns:
1. Equity, including gender inclusion
2. Impacts on groundwater sustainability
Can we do promote SIPs in an equitable manner?

- 77% of total demand came from women farmers
- To be awarded this discount, women will have to own land
- In 82% of the cases, land has been already transferred to women

Yes, if we provide the “correct” incentives
Result from a Randomized Control Trial Experiment in Nepal
Promoting grid connected solar irrigation can help farmers in groundwater over-exploited parts of India to reduce groundwater pumping, and sell solar electricity back to the grid – a win-win solution – reduced groundwater extraction, without compromising incomes
SPaRC: Solar Power as Remunerative Crop

- Incentivize farmers to become water and energy efficient
- Offer farmers an additional climate-proof income source
- Improve financial viability of Power Distribution companies
- Reduce the dead weight of farm power subsidies
- Curtail the carbon footprint of India’s agriculture economy
- Generate ‘green’ energy and contribute to India’s RE target
Results from IWMI’s experiment in Gujarat

If buy back tariffs are attractive, then farmers reduce water use, and sell electricity back to the grid.
SIPs and Energy-Irrigation Nexus

| Groundwater-scarce, Electricity-abundant | Northern, Western and Southern India |

- **Upscaling is happening**
  - Suryashakti Kisan Yojana (SKY), Gujarat
    - Already 70+ feeders, ~1000 farmers covered
    - Plan to cover 1000 feeders, 100,000 farmers in 2019
  - Grid Connected SIP Replication in other states
    - Rajasthan, Haryana, Maharashtra, Andhra Pradesh
  - A 4-year SDC-IWMI project in collaboration govt. agencies in Bangladesh, Nepal and Pakistan for grid connected SIP

- **Lets be aware and track the unintended consequences too**
  - Increased spikes in air pollution as a result of crop residue burning is a direct consequence of a policy that aimed at reducing groundwater use through delay in paddy transplantation....
Thank You...

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