

India's irrigation economy: In the throes of a transition

Tushaar Shah

Principal Scientists

International Water Management Institute, Colombo

1. Introduction

Stagnating agriculture has emerged, during recent years, as a speed breaker in India's otherwise splendid and enviable growth story. The failure of rapid economic growth to bring about poverty reduction in commensurate manner is also another major concern linked with stagnant agriculture. It has been widely thought that the slow down in public investment in agriculture, mainly irrigation development, is the main culprit behind the deceleration in agricultural growth. Government of India's Accelerated Irrigation Benefits Programme (AIBP) was conceived of as a response to the plea for increased public investment in irrigation. In recent budgets, the Union Finance Minister has been laying great stress on completing the "last mile irrigation projects" to step up the pace of irrigation development. Despite these initiatives, the area irrigated by public irrigation systems in India has remained stagnant for nearly a decade. In this paper, I want to argue that irrigation in India is in the throes of a major transition. The irrigation business model that India has followed since early decades of 19th century has rapidly changed, and public policies based on colonial model of irrigation development are no longer in sync with new developments in Indian agriculture. Neither the goals of India's irrigation policy, nor our irrigation development strategy, jives with the reality of our irrigation economy today.

Irrigation statistics compiled by the Government of India underestimate the scale of India's irrigation economy which is booming like never before. Official estimates of the net irrigated area in India based on land use surveys is 57 M ha and the gross irrigated area is around 90 M ha. Other sources, however, suggest that there is great deal more irrigation going on in India. The most striking have been new estimates of global irrigated area published recently the International Water Management Institute (IWMI). Based on the analysis of high resolution satellite imagery backed by extensive ground-truthing work, IWMI's estimate suggests that in 2004, India had 99 M ha of net irrigated area and 132 M ha of gross irrigated area. Both these estimates are over 50% higher than the official estimates. Infact, IWMI's estimates of irrigated area of today are nearest to what the government of India would like to achieve by 2020. Incredible as these new estimates may sound, recent rounds of national sample survey also suggests that India's irrigation economy may be considerably larger than reflected in the official estimates.

2. The Groundwater Revolution

At the heart of the transformation that India's irrigation economy has been undergoing is the wresting, by millions of small farmers, of the initiative for irrigation development from the hands of the State. Under the model of irrigation development that India followed since 1830's, the State has been the architect, entrepreneur, engineer and manager of irrigation systems. 'Command area' and 'duty' were the *mantra* of irrigation planning and

management. The Government was the provider of irrigation and the farmer a passive recipient. In this model of unbalanced irrigation development, command areas were created near hydraulically opportune sites where reservoirs or weirs could be built and downstream areas could be 'commanded' by gravity flow. Farmers in the rest of the country were left to fend for themselves. Post-Independence, India followed much the same strategy for irrigation development that created pockets of prosperous command areas, leaving other parts to rainfed farming.

By 1970, the population pressure on farm lands in many parts of India had become so inexorable that farmers everywhere felt compelled to work their small farm holdings twice, or even thrice every year. Population pressure on farm lands then flagged off India's tube well revolution. India—especially, in western and north-western parts-- had a centuries old tradition of irrigating with wells. Even in 1900, India had some 4 M ha under groundwater irrigation. At the time of independence, the areas irrigated by groundwater and surface water were evenly balanced. However, it was hardly expected by anybody that India would witness massive spread of tubewell irrigation in the surface-water-abundant Ganga-Brahmaputra basin or hardrock peninsular India. Such a pattern of irrigation development appeared wholly inconsistent with the country's hydro-geology.

At the onset of the 20th century, RC Dutt articulated the prevailing thinking about how irrigation should develop in different parts of India:

“Every province in India has its distinct irrigation requirements. In the alluvial basins of the Ganges and the Indus the most suitable irrigation works are canals from these rivers; while away from the rivers, wells are the most suitable. In Bengal with its copious rainfall, shallow ponds are the most suitable works and these were the numerous in the olden times, sometimes of very large dimensions. In Madras and Southern India, where the soil is undulating and the underlying rock retains the water, the most suitable irrigation works are reservoirs made by putting up large embankments and thus impounding the water descending from hill slopes. Such were the old reservoirs of Madras.” (Dutt 1989, vol. II, p 119, footnote 1).

This thinking was endorsed 70 years later by the second Irrigation Commission¹. For millennia, irrigation in India had remained largely faithful to this dictum. Adaptive, minimalist, unobtrusive irrigation in India of 1800 was a reflection of this hydro-geologic make up of the sub-continental terrain. Constructive imperialism pioneered by Arthur Cotton in the south and Proby Cautley in the north took liberties with this ideal scheme. However, come 1970's, and this age-old wisdom lay in tatters as a new era of *atomistic irrigation* unfolded and engulfed South Asia with small-pump irrigation spreading everywhere like wildfire --in canal commands and outside, in arid, semi-arid and humid areas, upstream and downstream of river basins, in excellent alluvial aquifers as well as in poor, hard rock

¹ “The character of [irrigation] works was largely conditioned by the physiographical features of the area in which they were located. In the arid and semi-arid plains of North India, perennial rivers like the Indus and the Ganga made it relatively easy to divert flood flows through inundation channels. In the peninsula, where the rainfall is scanty, the practice of trapping storm water in large tanks for domestic and agricultural purposes was widespread. In areas where a high groundwater table permitted lift irrigation, wells were common.” (GoI 1972:61).

peninsular aquifers with limited storage potential. If the era of ‘constructive imperialism’ began tinkering with the hydrology of river basins, the recent era of atomistic irrigation with small wells and tubewells went about reconfiguring it totally.

The rise of groundwater irrigation also transformed the organization of irrigation at the local level. In pre-Colonial India, co-operation at the community level was the dominant irrigation institution. Under the colonial rule, collaboration between the State and the engineering profession was at the centre-stage of centralized, bureaucratic irrigation development and management. In this new era of atomistic irrigation, the State as well as science became onlookers in a ballgame whose rules and logic they did not understand, much less dictate. In an incipient atomistic irrigation economy of the 1980’s and later, neither the State nor the community was the entrepreneur, builder, or the manager of irrigation; it was the multitude of small-holders--Marx’s ‘millions of disconnected production units’--each with his tiny, captive irrigation system, ostensibly unconnected with the rest. Until now, crops had to wait for water to be released and flow through a network of canals before getting irrigated; now, water was scavenged on-demand and applied just-in-time when crops needed it most.

Between 1960 and 1985, India invested in irrigation projects many times more capital in real terms than the British had invested during the entire 110 year period between 1830 and 1940. Yet, even according to the government of India’s figures, over 60% of irrigated areas are today served by groundwater. Other indicators suggest even this may be a serious underestimate. Remote sensing data as well as national sample survey suggest that as much as 75%-80% of India’s irrigated area today is served by groundwater wells. Until 1960, Indian farmers owned just a few tens of thousands of mechanical pumps using diesel or electricity to pump water; today India has over 20 million modern water extraction structures. Every fourth cultivator household has a tube well; and two of the remaining three use purchased irrigation service supplied by tubewell owners (Shah, forthcoming).

3. Socio-economic impacts of the groundwater boom

Shallow tube wells have done to Indian irrigation what PCs have done to computing globally; they have democratized irrigation. They took irrigation away from command areas to the nook and corner of the country. Among several things, the booming pump irrigation economy has: [a] offered *some* irrigation access to an overwhelming majority, rather than concentrating *all* irrigation benefits on small privileged groups in command areas; [b] thereby, helped soften growing farmer unrest in the region’s vast dry-land areas, which would have otherwise destabilized social and political structures; [c] has come to account for over 60 percent of irrigated areas, and 80% of irrigated farm output and resultant incomes; [c] drought-proofed the region’s agriculture against at least one monsoon failure and made large-scale famines history; [e] improved farm wages and increased demand for farm labor year-round; [f] demonstrated a strong pro-poor, inclusive bias in irrigated agriculture; [g] supported a new drive towards intensive diversification to high value products such as milk, fruit and vegetables, especially in dry land areas in a scale-neutral format. These impacts have benefited—directly and indirectly, to lesser or greater extent--around half a billion rural people in South Asia. One can not say that the South Asian peasant is much better off in 2000 compared to 1975; but one can confidently say that, other things being the same, he would have been immensely worse off but for the pump irrigation boom.

Thanks to its myriad and widespread benefits, pump irrigation revolution, aided by irrigation service markets, has been amongst the most powerful rural poverty alleviation phenomena without which the region would arguably have been in the throes of massive social and political instability. Pump irrigation boom in India since 1975 has created more irrigation in 30 years than public investments in canal irrigation did in 170. Pump irrigation has also brought about greater spatial equality in irrigation; it is spread all over the country unlike canal projects which have created concentrated pockets of agrarian prosperity in canal commands. Vibrant local, informal markets for pump irrigation service have helped the 20 odd million WEM owners to reach irrigation benefits to another 40-60 million small holder families, covering a vast majority of the farming community with access to supplemental irrigation. Especially in north-western India, the rise of groundwater irrigation on private initiative has reduced water logging, which otherwise would have required massive public investment in drainage and salinity management. The pump irrigation economy has been the driving force behind national growth in food and agricultural economies, for example, transforming West Bengal (and Bangladesh) as the region's rice bowls. Pump irrigation farmers apply less water per hectare, achieve higher ratio of evapo-transpiration to consumptive fraction, and obtain higher yields/ha compared to flow irrigators. Across rural economic classes, the distribution of pump ownership is more equal than land holdings. In dry-land areas, supplemental pump irrigation has had a dramatic impact of stabilizing rain-fed yields and promoted agrarian diversification. The impact of a widespread drought on agricultural and food production today is much more muted compared to 1960's and before. Pump irrigation boom has been instrumental in all but banishing starvation deaths in the sub-continent. In effect, it has activated a sub-surface reservoir on a sub-continental scale—that always existed but remained largely unused—but which now captures and stores over 250-270 km³ of water in a normal year, creating on a massive scale space, time and form utility in agricultural water use, the object of any reservoir.

4. Sustaining the Groundwater Boom

Nothing is an unmixed blessing; and this is true about South Asia's pump irrigation revolution since 1970's which has been a prominent target of doomsday prophecies about an impending socio-ecological disaster (see, e.g., Seckler 2001; Postel 2003; Vaidyanathan 1996). There is much truth in this concern; however, tubewell irrigation has generated substantial socio-ecological dividends as well. In flood prone eastern India, it has helped mitigate the rapacity of floods and water logging by reducing 'rejected recharge' by creating more storage in the aquifers. In the Indus basin too, tubewell irrigation has reduced water logging and salinization, a task which would have taken hundreds of million dollars of investments in drainage.

Groundwater horror stories of India are however becoming increasingly frightening in arid alluvial and hard-rock aquifers. In some coastal plains along with arid alluvial plains facing overdraft, the central resource governance challenge is coping with salinization and depletion which, in a chronic form already visible in some parts, may seal the fate of agriculture, and of human settlement itself. Then, in hard rock areas of peninsular India, where tubewell irrigation expansion is way out of proportion to the limited storage offered by aquifers, resource depletion is a serious issue in itself but has also aided growing concentration of

fluoride and other salts in groundwater which is the main source of drinking water supply for rural as well as urban populations. Problems of geogenic contamination of groundwater—such as with arsenic in eastern Ganga basin and fluoride in much western and peninsular India are large and serious. The causal role of pump irrigation in mobilizing fluoride and other salts in groundwater is clearer than in arsenic contamination whose chemistry is still tenuous and disputed.

5. The Real Water Management Challenge

Although Indian irrigation planning by governments and international agencies is still steeped in harnessing rivers and developing surface water, the real challenge facing the country is managing its vast, informal groundwater irrigation economy. The role of the state as the sole provider of irrigation is passé, as farmers have taken the irrigation development initiative in their own hands. What the State needs to do is implement a strategy that will help sustain this informal irrigation economy. Key challenges of groundwater management are set out in table 1.

Table 1 Groundwater Management Challenges facing India

HYDRO- GEOLOGICAL SETTINGS		SOCIO-ECONOMIC AND MANAGEMENT CHALLENGES			
		<i>Resource Depletion</i>	<i>Optimizing Conjunctive Use</i>	<i>Secondary Salinization</i>	<i>Natural Groundwater Quality Concerns</i>
<i>A. Major Alluvial Plains</i>	<i>A.1. Arid</i>	●●	●●	●●●	●
	<i>A.2 Humid</i>	●	●●●		●●
<i>B. Coastal plains</i>		●●	●	●●●	●
<i>C Inter- Montane Valleys</i>		●	●●	●	●
<i>D. Hard-rock Areas</i>		●●●	●	●	●●●

Note: The number of dots suggest the scale and severity of a challenge.

Since 1970's, at a rather low cost to the public exchequer, Indian farmers have opened up a vast reservoir—in the form of aquifers-- that we always had but for millennia, only sparingly used. Around 1950, India hardly used 15-20 billion cubic meters of groundwater; now, Indian farmers withdraw over 200 billion cubic meters of water from aquifers every year; and during every year of good monsoon, this reservoir gets replenished, without virtually any management effort invested by the government in it.

No reservoir anywhere in the world can keep delivering without proper management. The more intensively a reservoir is used, the more intensively it needs to be managed. Yet, India's groundwater aquifers—the country's largest reservoir-- are hardly managed, if at all.

India's irrigation officialdom do not even recognize aquifer management as a part of their responsibility. Indeed, one can assert that rural development programs in India—that support watershed development, tank improvement, rainwater harvesting, etc--do more to sustain India's groundwater irrigation economy than the irrigation bureaucracy does. The growing concern about groundwater depletion, falling water tables and salinization are a result of this lack of management of our biggest and most precious reservoir . In an average year, India receives 4,000 cubic KM of rain fall precipitation. Against this, farmers use only 200 Cubic KM of groundwater, barely 5% of our total water resources. All we need today to make the country's groundwater economically and environmentally sustainable is to ensure that 5% of our total water availability is recharged into groundwater aquifers. True, there is the big question of spatial variability. Punjab, Haryana and Rajasthan use a lot of groundwater but have little rainfall precipitation. But many of these regions have large volumes of canal water being spread on them; the first charge on this water needs to be for *managed* groundwater recharge rather than flow irrigation. If a tenth of the Himalayan water presently available in the Indian side of Indo-Gangetic basin were used for recharging aquifers in a managed manner, north-western India should never face groundwater stress it is experiencing now.

In sum, irrigation planners in India need to rewrite the country's mission in the water sector. In his "*Seeing Like the State*", James C Scott (1998) analyses how the official conception of forests in many colonized countries like India during the 19th century was shaped by the German foresters' obsession with the idea of revenue yield as the central objective of managing forests. This obsession encouraged single-minded conversion of natural forests into monoculture timber plantations. Scott argued that, long after colonialists withdrew, forest management for revenue yield stayed as the defining logic of local forest bureaucracies, themselves the product of the idea. Strikingly similar has been the evolutionary trajectory of official irrigation thinking in South Asia. Like revenue yield of forests, the *mantra* of irrigation planning during the colonial era were *command* and *duty* in flow irrigation systems. Myriad other ways that India's small-holders have now been figuring out to mobilize, store, scavenge, apply water to relieve moisture stress of plants were largely outside the purview of the mainstream irrigation thinking and practice.

To be effective in different circumstances, our irrigation planning needs to chuck this 'path-dependence' (North 1990), a phrase institutionalists use to describe the property of an institution to keep self-reinforcing itself, even at the risk of inviting irrelevance. We need to wake up to this new reality of agricultural water use in India. In this new reality, managing the vast underground reservoir that South Asia's farmers have created for free is the overarching priority to thrive in an anarchy that the state has neither the power nor wherewithal to tame.

References:

Shah, Tushaar, forthcoming, *Taming the Anarchy: Governing South Asia's Irrigation Economy*.

Brown, Lester R. 2005, *Outgrowing the Earth: The Food Security Challenge in an Age of Falling Water Tables and Rising Temperatures*, New York: W.W. Norton & Co..

North, Douglass C., (1990) *Institutions, Institutional Change, and Economic Performance*, New York: Cambridge University Press.

Postel, S. 1999. *Pillar of sand: Can the irrigation miracle last?* New York, NY, USA: W. W. Norton & Company. xvi, 313p. (Worldwatch book)

Vaidyanathan. A. 1996. "Depletion of Groundwater: Some Issues", *Indian Journal of Agricultural Economics*, cvol 51, No 1 &2, January-June