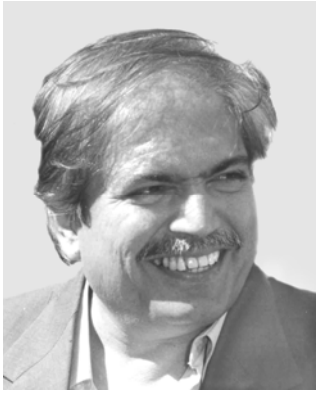
# The Irrigation Economy of the Indo-Gangetic Basin: In the Throes of a Transition

**Tushaar Shah**

***Paper prepared for presentation at the "Water For Irrigated Agriculture And The Environment: Finding a Flow for All" conference conducted by the Crawford Fund for International Agricultural Research, Parliament House, Canberra, Australia, 16 August 2006***



SESSION: BALANCING THE DEMANDS FOR AGRICULTURE AND THE ENVIRONMENT: WORLD BEST PRACTICES OR DISASTERS?

# The Irrigation Economy of the Indo-Gangetic Basin: In the Throes of a Transition

**TUSHAAR SHAH**

Principal Scientist
International Water Management Institute, Colombo
Email: t.shah@cgiar.org

## Introduction

Stagnating agriculture has emerged, during recent years, as a speed breaker in South Asia's otherwise splendid and enviable growth story. The failure of rapid economic growth to reduce poverty to a commensurate extent 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. In India, the government's Accelerated Irrigation Benefits Programme (AIBP) was conceived of as a response to the plea for increased public investment in irrigation. In Pakistan, too, plans to step up investment in the Indus Basin Irrigation System are afoot. Despite these initiatives, the area irrigated by public irrigation systems in South Asia — especially, the Indo-Gangetic Basin (IGB) — has remained stagnant for nearly a decade. In this paper, I argue that irrigation in the IGB is in the throes of a major transition. The irrigation business model that the region has followed since early decades of 19th century has rapidly changed, and public policies based on a colonial model of irrigation development are no longer in sync with new developments in South Asian agriculture. Neither the goals of the region's irrigation policy, nor its irrigation development strategy, jive with the reality of IGB's irrigation economy today.

TUSHAAR SHAH is currently a Principal Scientist in the Indian office of the Colombo-based International Water Management Institute. Trained as an economist and management specialist, his research interest lies in institutions and policies for water resources management. Over a research career spanning 25 years, Shah has worked extensively on water policy and institutions with a strong focus on the governance of groundwater economies of nations. Dr Shah was honoured with the Outstanding Scientist award of the Consultative Group on International Agricultural Research (CGIAR) in 2002.

Irrigation statistics compiled by government sources underestimate the scale of the basin's irrigation economy, which is booming like never before. The official estimate, based on land use surveys, of the net irrigated area in India 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 new estimates of global irrigated area are those 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. In fact, 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. There is similar evidence for Pakistan and Bangladesh as well.

## The groundwater revolution

At the heart of the transformation that IGB'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 Colonial India followed since 1830s, 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 region were left to fend for themselves. Post-Independence, too, India and Pakistan 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 farmlands in many parts of India, Pakistan Punjab, Bangladesh and terai of Nepal had become so inexorable that farmers everywhere felt compelled to work their small farm holdings twice, or even thrice, every year. Population pressure on farmlands then flagged off IGB's tubewell revolution. Pakistan and India — especially, in western and north-western parts — had a centuries-old tradition of irrigating with wells. Even in 1900, British 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 the region would witness a massive spread of tubewell irrigation in the canal-irrigated Indus Basin, surface-water-abundant Ganga-Brahmaputra Basin or hard-rock peninsular India. Such a pattern of irrigation development appeared wholly inconsistent with the country's hydrogeology.

At the onset of the 20th century, R.C. Dutt articulated the prevailing thinking about how irrigation should develop in different parts of British 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 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 Commission [6]. For millennia, irrigation in the Indian sub-continent 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 the 1970s, 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 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 organisation 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 centralised, bureaucratic irrigation development and management. In the new era of atomistic irrigation post-1975, the state as well as science became onlookers in a ballgame whose

[6] '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).

rules and logic they did not understand, much less dictate. In an incipient atomistic irrigation economy of the 1980s 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 and Pakistan 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, in India, even according to the government 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 tubewell; and two of the remaining three use purchased irrigation service supplied by tubewell owners (Shah, forthcoming). In Pakistan's Indus Basin Irrigation System, the world's largest continuous irrigation system commanding 16 M ha, government statistics show that flow irrigation from canals is rapidly giving way to pump irrigation from wells within and outside command areas.

## Socio-economic impacts of the groundwater boom

Shallow tubewells have done to irrigation in the Indo-Gangetic basin what PCs have done to computing globally; they have democratised irrigation. They took irrigation away from command areas to the nooks and corners of the basin. 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 destabilised social and political structures

(c) has come to account for over 60% 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 labour 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 cannot 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, the 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. The pump irrigation boom in the IGB 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 region, 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 21 odd million WEM (water extraction mechanism) owners to extend irrigation benefits to another 45–65 million small-holder families, covering a vast majority of the farming community with access to supplemental irrigation. Especially in north-western India and Pakistan Punjab and Sind, 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 a higher ratio of evapo-transpiration to the consumptive fraction, and obtain higher yields per hectare compared to flow irrigators. Across rural economic classes, the distribution of pump ownership is more equal than landholdings. In dry-land areas, supplemental pump irrigation has had a dramatic impact in stabilising rain-fed yields and promoting agrarian diversification. The impact of a widespread drought on agriculture and food production today is much more muted compared to 1960s and before. The pump irrigation boom has been instrumental in all but banishing starvation deaths in the sub-continent. In effect, it has activated a subsurface reservoir on a sub-continental scale — a reservoir that always existed but remained largely unused — but which now captures and stores over 250–270 $km^3$ of water in a normal year, creating on a massive scale space, time and form utility in agricultural water use, the objective of any reservoir.

## Sustaining the groundwater boom

Nothing is an unmixed blessing; and this is true about South Asia's pump irrigation revolution since 1970s which has been a prominent target of doomsday prophecies about an impending socio-ecological disaster (see, e.g., Vaidyanathan 1996; Postel 1999; Seckler *et al.* 2001). While there is much truth in this concern, tubewell irrigation has generated substantial socio-ecological dividends. 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 salinisation, a task which would have taken hundreds of million dollars of investments in drainage.

Groundwater horror stories are, however, becoming increasingly frightening in arid alluvial and hard-rock aquifers of India. In some coastal plains, along with arid alluvial plains facing overdraft[7], the central resource governance challenge is coping with salinisation and depletion which, in a chronic form already visible in some parts, may seal the fate of agriculture, and of human settlement itself. 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. It has also concentrated fluoride and other salts in groundwater, which is the main source of drinking water for rural as well as urban populations. Problems of geogenic contamination of groundwater — such as with arsenic in the eastern Ganga Basin and fluoride in much of western and peninsular India — are large and serious. The causal role of pump irrigation in mobilising fluoride and other salts in groundwater is clearer than with arsenic contamination, whose chemistry is still tenuous and disputed.

## The real water management challenge

Although South Asian irrigation planning by governments and international agencies is still steeped in harnessing rivers and developing surface water, the real challenge facing the region 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.

Since 1970s, at a rather low cost to the public exchequer, South Asian farmers have opened up a vast reservoir — in the form of aquifers — that we always had but, for millennia, used only sparingly. Around 1950, the region hardly used 25–30 billion $m^3$ of groundwater; now, farmers in India, Pakistan, Nepal terai and Bangladesh withdraw over 270 billion $m^3$ of water from aquifers every year; and this reservoir is replenished every year when the monsoon is good, with virtually no investment by the government in management.

[7] Withdrawals exceeding long-term recharge resulting in sustained, long-term decline in the pre-monsoon water level.

**Table 1. Groundwater management challenges facing South Asia**

| Hydro-geological settings | | Socio-economic and management challenges | | | |
|---|---|---|---|---|---|
| | | Resource depletion | Optimising conjunctive use | Secondary salinisation | Natural groundwater quality concerns |
| A. Major alluvial plains | A.1 Arid | ●● | ●● | ●●● | ● |
| | A.2 Humid | ● | ●●● | | ●● |
| B. Coastal plains | | ●● | ● | ●●● | ● |
| C. Inter-montane valleys | | ● | ●● | ● | ● |
| D. Hard-rock areas | | ●●● | ● | ● | ●●● |

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

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, IGB's groundwater aquifers — the region's largest reservoir — are hardly managed, if at all. The region's irrigation officialdom does not even recognise aquifer management as a part of their responsibility. Indeed, one can assert that in India rural development programs — that support watershed development, tank improvement, rainwater harvesting, etc. — do more to sustain the country's groundwater irrigation economy than the irrigation bureaucracy does. The growing concern about groundwater depletion, falling water tables and salinisation are a result of this lack of management of our biggest and most precious reservoir. In an average year, the region receives 4800–5300 $km^3$ of rainfall and snowmelt. Against this, farmers use only 270 $km^3$ of groundwater, less than 5% of our total water resources. All we need today to make the South Asia's groundwater economically and environmentally sustainable is to ensure that 5% of our total available water is recharged into groundwater aquifers. True, there is the big question of spatial variability. The two Punjabs, Sind, Haryana and Rajasthan use a lot of groundwater but have little rainfall. Many of these regions, however, have large volumes of canal water 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 Indo-Gangetic Basin were used for recharging aquifers in a managed manner, IGB should never face the groundwater stress it is experiencing now.

In sum, irrigation planners in the IGB need to rewrite the basin'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 colonised countries like India during the 19th century was shaped by the German foresters' obsession with 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 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 from forests, the mantra of irrigation planning during the colonial era were *command* and *duty* in flow irrigation systems. The myriad other ways that South Asia's small-holders have now been figuring out how to mobilise, scavenge, store and apply water to relieve moisture stress of plants were largely outside the purview of mainstream irrigation thinking and practice.

To be effective in different circumstances, the region's 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 South Asia. 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


Dutt, R.C. 1989. *The Economic History of India.* Vol. I and II. Government of India, Ministry of Information and Broadcasting, New Delhi.

Government of India 1972. *Report of the Irrigation Commission.* Ministry of Irrigation and Power, Government of India, New Delhi.

North, D.C. 1990. *Institutions, Institutional Change and Economic Performance.* Cambridge University Press, New York.

Postel, S. 1999. *Pillar of Sand: Can the Irrigation Miracle Last?* W.W. Norton & Company, New York, NY, USA,. xvi, 313 pp. (A Worldwatch book).

Scott, J.C. 1998. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* Yale University Press, New Haven, 445 pp.

Seckler, D., Barker, R. and Amarasinghe, U. 1999. Water scarcity in the twenty-first century. *International Journal of Water Resources Development* **15,** 29–42.

Shah, T. Forthcoming, Taming the Anarchy: Governing South Asia's Irrigation Economy.

Vaidyanathan, A. 1996. Depletion of groundwater: some issues. *Indian Journal of Agricultural Economics* **51,** 184–192.