Evolution of Irrigation Practices - Are Large Scale Irrigation Systems Still Relevant?

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Session 2: Evolution of Irrigation Services and Organizational Reform

Introduction

This paper traces the historical evolution of the irrigation sector in India. In doing so, it argues that the exact nature and form of irrigation and the way it is managed has changed over the years and these changes have wide implications for the overall agrarian economy. Irrigation development in the post-colonial times started with large scale public irrigation systems. Since the 1970s farmers have increasingly invested in groundwater wells and pumps. Relative share of surface irrigation (mostly in the public sector) has declined while that of private groundwater irrigation has increased. By early 1980s, groundwater irrigated area in India exceeded surface irrigated area. Groundwater over-exploitation, water quality deterioration and mounting electricity subsidies are among the problems which followed. However, recent trends in South Asia show signs of slowdown in groundwater use. This paper explores the implications of this slowdown in private informal irrigation on farmers who had earlier opted to fully or partially get out of public irrigation systems and shift to privately owned groundwater pumps. What does this entail for the irrigation bureaucracies who may now find farmers renewed interest in their services?

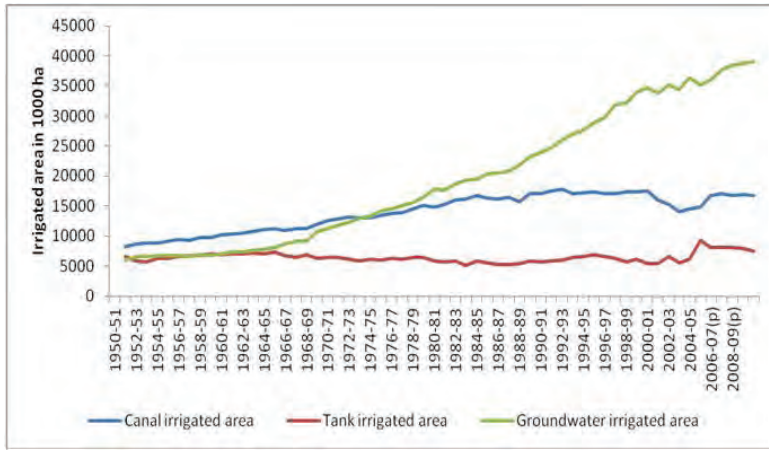
Issues and Challenges

Public investments drove irrigation expansion in the early years

Irrigation development in South Asia can be divided into at least 3 phases (Figure 1, Table 1). From 1950s to 1970s, there was a rapid increase in area under large public irrigation schemes. This development was partly in response to dire food situation in the 1960s, when it was feared that much of Asia was in imminent danger of falling into the Malthusian trap of high population growth and low agricultural productivities resulting in widespread food crisis and famines. Investments in large scale public irrigation systems were seen as a key to increase food agricultural production. The use of high yielding varieties of seeds, high doses of fertilizers and other complimentary inputs such as timely and adequate irrigation came to be known as the Green Revolution. In South Asia, cereal production rose by 93% from 1970 to 1995, using only 4% additional land and boosted per capita food supply from 2,105 to 2,361 calories per day (Rosegrant & Hazell, 2000). In East and South East Asia, gains were even more impressive where agricultural productivities more than tripled and rural poverty declined rapidly. In China, poverty incidence reduced from 33% to 3% between 1979 and 2001(Gulati et al. 2005), and in India, poverty incidence reduced from 44.5% in 1983 to 27.5% in 2004–05 (Bardhan

2007). In this Green Revolution, irrigation was the key instrument that unlocked the huge potential for agricultural productivities in Asia.

Figure 1. Irrigated area in India, by sources, 1951 to 2010



Source: Agricultural Statistics, Government of India, several years

Table 1. Percentage growth in canal and groundwater irrigated area

Year	% growth in canal irrigated area	Year	% growth in groundwater irrigated area
1950-51 to 1983-84	1.98	1950-51 to 1968-69	3.30
1984-85 to 1999-00	1.67	1969-70 to 1999-00	3.85
2000-01 to 2009-10	1.17	2000-01 to 2009-10	2.50
1950-51 to 2009-10	1.21	1950-51 to 2009-10	3.58

Source: Author's calculation based on Agricultural Statistics, Government of India

From 1970s private investments in groundwater irrigation took over

From late 1970 onwards, there has been a relative decline in share of area under canal and tank irrigation and a rapid increase in area under groundwater irrigation. Public irrigation systems have tended to be underutilized and over-capitalized, and typically serve only a fraction of the designed command. Small surface structures, notably tanks in southern India, karezes in Pakistan and Iran, kuhl's in the Himalayas, ahar-pyne systems in southern Bihar had been losing irrigated area since the 1950s. But during the 1990s, even large public irrigation systems have begun shrinking. For example, during the 7-year period between 1994 and 2001, India and Pakistan together lost over 5.5 million ha of canal irrigated areas despite massive investments in rehabilitation and new projects (Shah 2008).

There are several reasons for this decline. First, the surface irrigation schemes were never designed to support the kind of cropping intensities that are now commonplace in the sub-continent. For example, the Bhakra Nangal scheme in Punjab was designed for a cropping intensity of 75%, while the current cropping

intensity is close to 200%. Second, such high cropping intensity has been in turn a direct response to growing population and the imperative to produce more food on same land. Third, maintenance of public irrigation schemes has suffered because the modern welfare state's revenue interests in agriculture are minimal, unlike their colonial predecessor. The prime motive for irrigation investments was food security and poverty reduction, and not maximizing government income. Therefore, the governments have neither the will, nor the authority to collect irrigation fees needed to maintain systems. Fourth, and perhaps most importantly, technological innovations made pumping equipment cheap and affordable, while energy subsidies made groundwater pumping a far more attractive option to the farmers than relying on often unreliable public irrigation systems. Groundwater offers three things that public irrigation does not: reliability, flexibility and control. Farmers therefore opted out of inefficient public irrigation systems with own private investments supported by both cheap credit and energy subsidies (Mukherji et al. 2011).

Groundwater boom, while bestowing a large number of benefits, have created its own set of intractable problems in terms of over-exploitation and depletion of groundwater resources thereby putting in jeopardy the livelihoods of millions of farmers who depend on it. In India, agricultural electricity consumption increased more than 25-fold between 1970 and 2009, more than twice the pace of overall electricity consumption. Nine major Indian states are in a critical groundwater condition, where pumping exceeds the long-term recharge of the aquifers. Farm power subsidies are estimated at $9 billion annually, up from $6 billion a decade ago.

Is the groundwater juggernaut of India slowing down?

Just when it seemed that the groundwater juggernaut of South Asia was unstoppable, there are incipient signs of slowdown in the groundwater sector. Since early 2000s, groundwater irrigated area has grown at 2.5% per annum, while the long term average growth from 1950 t0 2009 has been 3.58% per annum (see Figure 1 and Table 1). That groundwater economy of India is slowing down is even more evident from the latest round of Minor Irrigation Census (Table 2 and Figures 2, 3, and 4). In most of India, growth in number of groundwater structures has slowed down, while some states in eastern India, like Bihar and West Bengal, absolute numbers of groundwater structures have also declined.

There could be several reasons for this decline. One, many places in India may have just run out of groundwater, in particular in peninsular India with hard rock aquifers. Tamil Nadu, one of the basket cases of over-exploitation is one such hard rock aquifer where number of groundwater structures has gone down from 1.90 million in 2000-01 to 1.86 million in 2006-07. However, absolute numbers have not declined in other hard rock aquifer states such as Andhra Pradesh and Karnataka, though rate of growth has declined. The same holds true for other states with over-exploitation problems such as Punjab, Haryana and Gujarat—here

absolute numbers of groundwater structures have increased, but have done so at a decreasing rate of growth. Second, many of these states depend on electricity for pumping and the deep crisis in the electricity sector meant severe rationing of electricity to farmers. For instance, in Gujarat, Punjab and Karnataka, farmers received 16–20 hours of electricity daily till early 1990s, since then electricity has been rationed gradually and now they receive not more than 6–8 hours per day. While most farmers have tried to get around this by switching to higher capacity pumps, restrictions posed by the electricity utilities on new connections has arrested run-away growth in number of wells and tubewells.

However, the fact that much of the decline in groundwater structures have come from eastern India where levels of development of groundwater is quite low (less than 40% of the renewable groundwater resources are tapped here) and rainfall and recharge are high, shows that decline in groundwater economy is more of a policy induced phenomena than a resource scarcity induced one. For example, eastern India has one of the lowest rates of pump electrification (only 20% pumps are electrified as against 66% national average), highest electricity tariffs and majority farmers use diesel pumps. All these have led to contraction of groundwater economy in eastern India. Almost similar story holds true in Bangladesh, though the government in Bangladesh, given its focus on food self-sufficiency, has been more pro-active in supporting its groundwater irrigators than governments in eastern India have.

Table 2. Growth in groundwater structures in India, 1986–97 to 2006–07

Year	Number of groundwater structures	CAGR of groundwater schemes in %
1986-87 (1st MI Census)	6193047	
1993-94 (2nd MI Census)	11526699	9.28
2000-01 (3rd MI Census)	18503267	6.99
2006-07 (4th MI Census)	19756217	1.10

Source: 1st to 4th Minor Irrigation Census, Government of India (1986, 1993, 2001 and 2006)

Implications of slowdown in groundwater economy for the public irrigation sector

While it is still early to take a call on whether groundwater economy of India is indeed slowing down, it may be timely to think through the implications of the same. Answering three questions, namely, why did groundwater economy expand so rapidly in the first place, why is it slowing down now and which parts of India is it slowing down faster than others will hold the key to understanding both policy implications of this trend and investment opportunities that it may offer.

The reason for unprecedented growth in groundwater irrigation was a combination of technological innovation in the form of cheap pumps and pumping equipment,

poor performance of public irrigation schemes, lack of service orientation of irrigation bureaucracy and the reliability and flexibility that pumps offered. However, with much of the groundwater resources now tapped, except in eastern India, and with severe crisis in the electricity sector, the unabated boom in groundwater sector has slowed down. This means that the exit option from public irrigation systems that farmers could easily exercise earlier is more constrained than before. However, this does not mean that farmers' demand or need for water is any less than before, nor does it mean that South Asia needs to grow less food in the future. In fact, it needs to grow more to support a burgeoning population. Thus, there is an unmet and latent demand for more irrigation. Groundwater economies, paradoxically, have contracted more severely in eastern India where groundwater resources are plentiful due to the nature of policies adopted by most eastern Indian states (Mukherji, 2006). It is in eastern India that further investments can be channeled to intensify cropping systems. Based on these, two broad streams of investment opportunities may be identified.

(1) Revitalizing canal irrigation in areas of groundwater overexploitation

In much of South Asia, particularly, those places which were traditionally dependent on canal irrigation, there is now a latent demand for surface water to supplement dwindling stocks of groundwater. This is especially true in states like Punjab, Haryana, Andhra Pradesh, Karnataka and Tamil Nadu. However, at a time when farmers have become used to on demand irrigation thanks to their tubewells, public irrigation systems needs to respond to farmers expectations. Just as innovation in pumping technology was a game changer in the 1960s and 1970s, rapid development in ICT technologies can be a game changer now. Use of mobile technologies for providing better information and quality of service has been tried out in many irrigation schemes, including in Andhra Pradesh and farmers seem to value and demand these services.

Better service orientation is the key and technology can assist in that to a large extent. However, what is needed even more is re-orientation of the irrigation bureaucracy from a supply driven agency to a demand driven one which can respond to their customer (farmers) demand with a modicum of efficiency and professionalism. At the heart of this new paradigm is the shift of focus from farmers as a "beneficiary" to farmers as a "client". Providing better service and bridging the credibility gap between the agency and farmers may even convince the farmers to pay reasonable service charges. Apart from investments in software, there is also need for hardware investments, especially to redesign some of the irrigation schemes of the yesteryears which were originally created for cereal cropping systems. Now, most farmers grow diversified crops and old designs do not cater to their needs. There is also a latent demand for micro-irrigation and precision irrigation technologies such as drips and sprinklers in these regions of physical water scarcity.

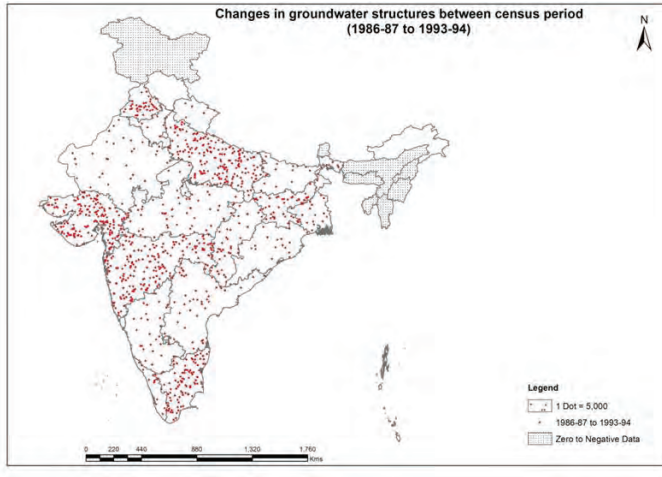
Therefore, an intervention package comprising of investments in redesign (and not just rehabilitation) of systems, re-orientation of irrigation bureaucracy, ICT and micro-irrigation technologies can potentially meet the unmet demand for water in these water scarce systems. Many of these systems are conjunctive use systems and policies which encourage planned conjunctive use, such as differential pricing of water and electricity in head vs. tail reaches of canal command have to be put in place to avoid some of the pitfalls of the past.

(2) Expansion of the electricity grid in areas with high rainfall and groundwater potential

In eastern India, where much of the topography is flat, groundwater is relatively abundant and rainfall and recharge are high, investments in rural electrification, roads and markets will improve agricultural productivity. In these areas, rates of pump electrification is low and there is much potential to bring it up to national averages. The fact that farmers in eastern states of West Bengal, Bihar and Assam already pay for electricity means that power need not be subsidized anymore. Providing electricity together with investments in roads and market infrastructure will help increase agricultural production in this region. This will in turn take the pressure off regions like Punjab and Haryana which have been systematically over-exploiting their aquifers to feed the rest of India. Intensifying agriculture in eastern India is also in tune with the overall policy thrust of the government of India.

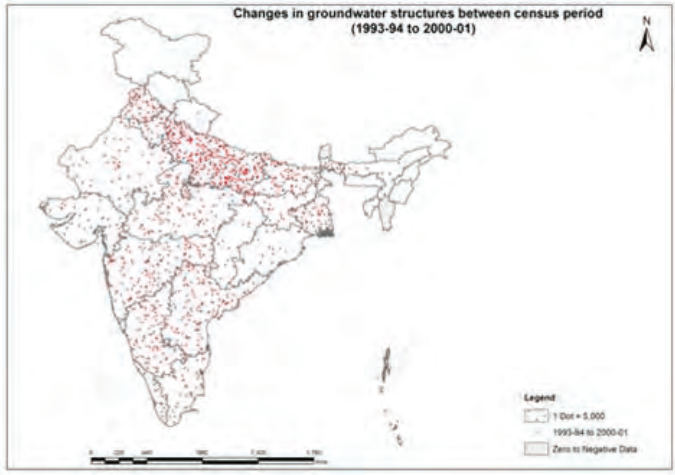
In sum, based on resources characteristics and recent trends in irrigation, two major investment portfolios may be tried—one targeted at regions of physical water scarcity and another where groundwater resources are plentiful. The first option will revitalize existing canal irrigation infrastructure, while the other will help boost groundwater use in agriculture. In implementing these options, lessons from the past must be taken into account and role of technology must be given due importance.

Figure 2. Number of groundwater structures added between 1986–87 and 1993–94



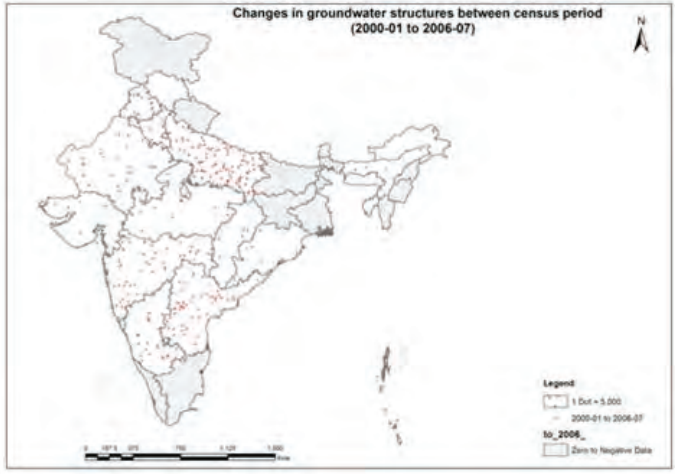
Source: 1st and 2nd Minor Irrigation Census, Government of India

Figure 3. Number of groundwater structures added between 1993–94 and 2000–01



Source: 2nd and 3rd Minor Irrigation Census, Government of India

Figure 4. Number of groundwater structures added between 2000–01 and 2006–07



Source: 3rd and 4th Minor Irrigation Census, Government of India

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