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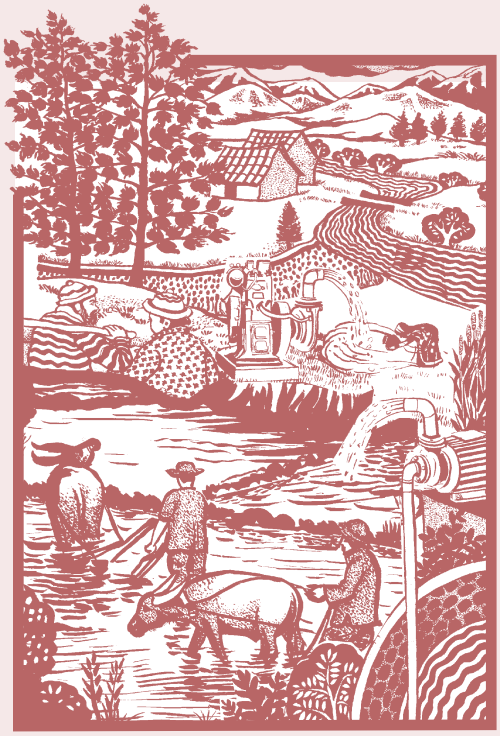

India is the world's largest user of groundwater. There are a few other countries like Mexico, Spain, Pakistan, Bangladesh and China which also make intensive use of groundwater. Can these countries offer useful lessons for India? This highlight reviews groundwater institutions and policies in these countries, with a special focus on the inter-linkages between energy and groundwater. It finds that while there are useful lessons from international experience, none of the other countries offer unmetered electricity to farmers as India does. It is this lack of energy accounting and resistance to metering that is at the heart of the invidious energy-irrigation nexus in India.

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HIGHLIGHT

A Review of International Experience in Managing Energy Irrigation Nexus

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A Review of International Experience in Managing Energy Irrigation Nexus[1,2]

Research highlight based on IWMI 2012[3]

Introduction

Around 1960, less than 1 million hectare of India's farmland was irrigated with groundwater - much less than most other countries in the world at that time. However, in the subsequent 50 years, India's groundwater use has grown at a much faster pace compared to US, Mexico and China. Many factors explain this extraordinarily rapid growth. However, arguably by far the most powerful factor is the regime of unmetered and highly subsidized power supply that India has evolved to support groundwater irrigation. Subsidized electricity for agriculture is not uncommon – it is found in several countries where intensive groundwater use is common such as in Mexico and Oman. In this Highlight, we review institutions and policies of groundwater governance with a special focus on energy-irrigation nexus with the view to draw lessons for India.

Groundwater Policies in India and China

Comparing groundwater institutions in India and North China is meaningful because of the similarities the two regions share in terms of high population densities, small landholdings and high dependence on groundwater. However, there are essential differences. China has all but 3.5 million agricultural wells, which withdraw 75 km^3 of groundwater annually, the figures for India are staggering at 20 million wells and 200 km^3 of water abstraction (Mukherji and Shah 2005).

In India, following the English law, groundwater rights are attached to the land. However, to be able to pump, an investment in pumping equipment is required, and not all farmers can afford it. In addition, high degree of land fragmentation means that even well owners cannot irrigate all their plots using a single pump. A major institutional response to this has been the emergence of informal groundwater markets. Water markets have been widely studied in the South Asian context. While reservations have been expressed about the markets negative impact on groundwater sustainability (Janakarajan 1994; Adnan 1999; Dubash 2002), there is a general consensus that the water markets give irrigation access to those who do not have their own source of irrigation and thereby helps to increase net irrigation surplus and thereby reduces poverty (Shah 1993; Fujita and Hossain 1995; Palmer-Jones 2001). However, these markets are totally informal, and the only point of contact between the groundwater water users and the government is through the electricity utility.

In China, before the agrarian reforms of the Deng administration in 1979, village collectives managed groundwater. After the reforms, a variety of institutional arrangements have been forged in Chinese villages (Shah 2003:5). The price of water is not left to be decided by free-market forces (as it is in most south Asian villages), but village leaders and party officials often fix the water price, which ensures that private contractors cannot earn super normal profits. The strong party presence in the Chinese countryside has also made the energy-irrigation nexus of South Asia a non-issue in China (Shah et al. 2004a) as we will see in a later section of this Highlight. In China, groundwater governance has changed from that of being highly fragmented to that of being more institutionalized and decentralized, with the roles of each agency been clearly demarcated. Yet certain loopholes remain, the most important being the tardy progress in issue of water extraction permits in many counties (Foster et al. 2004).

In the sphere of enacting groundwater laws, China has had more success than any of the South Asian countries. Starting with a significant 1988 National Water Law, China has enacted three more laws and enacted over 30 water management regulations during the last decade (Wang and Huang 2002). In India, though draft groundwater bills have been making the rounds for several decades, there is no will to make them into law, perhaps precisely because these will be difficult to implement. However, a phenomenon that is almost wholly missing in the North China Plains, but is quite significant in India, is the popular people's movement for groundwater recharge, especially in water-scarce states like Rajasthan and Gujarat (for details see Steenbergen and Shah 2003, Burke and Moench 2000). An interesting feature of such a people's initiative, however, is that rarely are these aimed at demand management.

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[2]The authors gratefully acknowledge the support received from Dr. Mohinder Gulati of World Bank.

[3]This paper is available on request from p.reghu@cgiar.org

Groundwater policies in Spain and Mexico

While Spain and Mexico are intensive groundwater users, just like South Asia and China, there are three essential differences. First, the scale of and dependence on groundwater is much less in these countries. Second, both Spanish and Mexican farmers have higher per capita incomes than Indian and Chinese farmers. Third, farmers' lobby is much stronger in these countries than either south Asia or China. This makes it possible for these countries to apply a wider repertoire of instruments to manage groundwater but in doing so these countries have to face stiff opposition from the farmers' lobby.

Spain, like many parts of the world, until 1985, bestowed private property rights over groundwater resources. However, the 1985 Water Act in response to intensive groundwater use changed the rules of the game. For one, groundwater was taken away from the private domain and ownership rights bestowed upon the state. Second, River Basin Management Agencies were given a role in managing groundwater, and finally, they were also vested with the power to grant permits for groundwater use that started after 1985. It also gave authority to the river basin agencies to declare an aquifer as overexploited, and once it was so declared, to formulate an aquifer management plan for recovery of the aquifer. In addition, all users of the aquifer were required to organize themselves into groundwater user associations in order to encourage user participation. So far, some 16 aquifers have been declared totally or partly overexploited (Hernandez-Mora et al.2003:398), while such user associations have been formed in only five and implemented in only two aquifer areas. Further amendments to the act were made in 1999 and 2001. An evaluation of the current implementation status of this law paints a rather gloomy picture. For one, even after more than 15 years, recording of groundwater rights still remain incomplete, and less than a quarter of all groundwater structures have been registered. Given Spain's long tradition of successful surface-water user's associations (some in Valencia are centuries old), the new water law has emphasized the formation of groundwater user's associations particularly for management of overexploited aquifers. Thus, while thousands of small groundwater user's associations have been formed, the majority of them are geared towards 'collective management of the irrigation network', and only a handful has a larger mandate of 'collective management of aquifers' and of these, only a few has been successful. In fact, in the Upper Guadiana Basin (a case of severe overexploitation), what has temporarily halted groundwater over-extraction is not positive collective action on the part of the irrigators, but the European Union's “Income Compensation Programme”, designed to reduce water abstractions with subsides up to 420 euro/ha (Hernandez-Mora et al. 2003; Lopez-Gunn 2003:370).

Mexico has reformed its water laws extensively since 1992. By the Law of Nation's Waters of 1992, National Water Commission (CNA- the Spanish acronym) was entrusted with responsibility of registering water use concessions. Quite like Spain, Mexico's water sector reforms declared water as a national property and made it mandatory for existing users to legitimize their rights through procuring concessions. In addition, the CNA was authorized to set up a regulatory structure to enforce and monitor these concessions granted and also to collect a volumetric water fee from all users, except small scale irrigators. COTAS or Aquifer Management Councils were promoted by CNA as user's organizations aimed at managing groundwater and in some provinces such as Guanajuato all water resources (Shah et al. 2004b; Sandoval 2004). In governing water, the CNA has essentially adopted three tools; regulatory tools, economic tools and participatory tools (Burke and Moench 2000). Response to the reforms so far has been at best mixed. The large water users (industrial and commercial users) have been quick to apply for concession and pay water fees. However, the real challenge has been registering water rights of the agricultural users who withdraw at least 80 percent of total volumes withdrawn and second, to monitor their withdrawals. Among the agricultural users, the tube well owners have responded to the law quite positively and have applied for water concessions. The major reason for such compliance has been the 'carrot' of subsidized electricity that has been promised to tube well owners who regularize their connection through registration of the wells with the CNAs as we shall see later in this paper.

From the foregoing section, we can draw three major conclusions. First, Mexico and Spain, and to a certain extent China, have viewed governing groundwater with seriousness and have made legal provisions for the same, while India is still grappling with basic issues such as enacting a groundwater law. Second, the experience of all these countries bring to the fore the fact that while making a law is not very difficult, enforcing one is a challenge, a challenge rarely met in any of the countries discussed above. This is in spite of the fact that conditions for law enforcement are more likely to happen in countries such as Spain and Mexico, where direct dependence on groundwater is low, economic conditions of farmers' better and political situations stable. However, more effective than direct regulatory measures have been the indirect measures, such as income compensation schemes in Spain or subsidy for electricity power meant to encourage well registration in Mexico. Third, current socio-economic and political structure in a country determines its ability to govern groundwater, a case clearly exemplified through case of India and China.

The Energy-irrigation Nexus: A Review of International Experience

The Non-Existent Energy-Irrigation Nexus in China

One of the main reasons for groundwater over-exploitation in India is the regime of electricity subsidy and unmetered supply. However, this is a non-issue in China. In China, the electricity distribution companies operate on twin principle of full cost recovery with minor concessions for technical losses and metered supply (Shah et al. 2004a). In China, unlike India, rural electricity was

charged at a higher rate than both domestic and urban electricity till recently (Wang et al. 2004). The village committee managed the task of maintaining village electricity infrastructure and collecting users' fee and they in turn hire a local village electrician for doing the same. The village electrician works for a rather modest salary, but he is strongly incentivized to collect user fees such that if he can collect more than 10 percent of line losses allowed, he can keep 40 percent of that additional amount as incentives. In implementing this system, China's unique advantage is its strong village level authority structure.

Electricity Pricing and Groundwater Use in Pakistan

The growth of groundwater followed a similar trajectory in Pakistan as in rest of north western India. Here use of electricity for groundwater pumping started in mid 1970s when the rural grid was expanded and government provided capital cost subsidy for tube wells. Much like India, initially all tube wells were metered and farmers were charged full cost of supply. By mid 1980s, number of electric tube wells had increased manifold and it was decided to change to a flat tariff system (Qureshi and Akhtar 2003) where tariffs were quite high. By mid 1990s, the government withdrew electricity subsidies in the Punjab and the Sindh provinces and later in early 2000s, Pakistan reverted to earlier metered tariff regime. As a result, large numbers of electric tube wells were replaced with diesel pump sets (GOP 2000). Therefore, attempts at managing the electricity groundwater nexus through full cost pricing of electricity and metering did help the electricity sector, but it could not to control groundwater use because given the relatively shallow pumping depths in Pakistan Punjab, most farmers shifted from electricity to diesel tube wells. Overall groundwater draft increased from 43 billion cubic meters (BCM) in 1990 to 48 BCM in 2000 (Qureshi and Akhtar 2003; Bhutta 2002) and further increased to 51 BCM in 2006 (World Bank 2007).

Subsidized Electricity for Groundwater in Oman

Oman is one of the most arid countries in the world and its dependence on groundwater is high. There are 1.27 lakh[4] wells in the Sultanate distributed over 128 catchment areas. New wells are subject to conditions of the Law on the Conservation of Water Resources, Royal Decree No. 29/2000. Licenses to drill new wells or deepen or replace existing wells are issued by the Ministry of Regional Municipalities, Environment and Water Resources. In some ways, Oman's groundwater pumping is closely monitored – much more so than most countries. However, all groundwater structures in the country run on electricity and all agricultural consumption is metered, but tariffs are heavily subsidized (Zekri 2008).

Innovations in Managing Energy-Irrigation Nexus in Mexico

Mexico, like India, provides electricity at a subsidized rate to farmers. The estimated power subsidy to agriculture in Mexico in 2000 was Mex$5.62 billion (US$592 million) which is almost equivalent to electricity subsidy in India at that time (Scott and Shah 2004). It is widely acknowledged that direct monitoring of groundwater extraction is beyond the administrative capacity of the water authorities. In response, Mexico has introduced a law called the Rural Energy Law in 2002 which caps an annual energy limit in kilowatt hours (kWh) which, based on the depth of the water table and constant electro-mechanical efficiency, yields an equivalent annual volume of groundwater concessioned for a particular well. This law also established subsidies for the energy consumption of the agricultural sector. The purpose of this law is to help Mexican farmers to remain competitive with their US counterparts, but at the same time, remain within their allocated quota of groundwater determined under the 1992 Mexican Water Law (Morgera et al. 2009). The impact of this law is yet unclear, but prima-facie, this seems to work better than direct monitoring of groundwater (personal communication with Christopher Scott of Arizona University).

Diesel Subsidy and Pre-Paid Electricity Cards in Bangladesh

Bangladesh has emerged as a major groundwater user in South Asia and currently has over 15 lakh pump sets, of which almost 95 percent run on diesel. Goal of rice self-sufficiency is high on the policy agenda of the government, especially after the food price shock of 2008. In response, government of Bangladesh has designed an innovative subsidy scheme for farmers called the Agricultural Input Assistance Card (AIAC). This scheme provides direct delivery of cash to the farmers' bank account which can then be used for purchase of diesel. Small farmers operating the LLPs (Low Lift Pumps) and STWs (Shallow Tube Well) are a major beneficiary of this program. Farmers eligible for receiving the cash subsidies under the program are given a pre-determined amount based on their land holding, which is then transferred directly to their bank account. Barind Multipurpose Development Authority (BMDA)—a government owned Irrigation Company has also introduced a pre-paid metering system for farmers using electric tube wells. Under this system, an electronic pre-paid card is provided to the farmers. The farmer inserts his card in the meter slot and selects the number of hours of watering; it automatically opens the valves related to farmer's field and starts watering for chosen duration. The meter takes a record of energy consumption and debits the amount as per power tariff from the farmer's card.

Uniqueness of energy-irrigation nexus in India

Our review shows that there are a host of countries which make intensive groundwater use, and most of these countries provide electricity subsidy to farmers. However, none provide unmetered electricity to their farmers as is the practice in most states in India. The genesis of unique energy-irrigation nexus in India is the policy decision in many states to supply unmetered power to the agricultural

[4]One lakh = 0.1 million

sector. Thus, it is the lack of energy accounting due to unmetered supply that is at the heart of this unique energy-irrigation nexus in India. While there are lessons from international experiences, none of these can be applied unless Indian states decide to meter its agricultural consumers and therein lies the real challenge.

References

Adnan, S. 1999. Agrarian structure and agricultural growth trends in Bangladesh: The political economy of technological change and policy interventions. In: Rogaly B, Harriss-White B. and Bose S (eds) *Sonar Bangla? Agricultural growth and agrarian change in West Bengal and Bangladesh*. New Delhi, Sage Publication, pp.177–228.

Bhutta, M.N. 2002. Sustainable management of groundwater in the Indus basin. Paper presented at second South Asia water forum, Pakistan Water Partnership, Islamabad, Pakistan, 14–16 December 2002

Burke, J and Moench, M. 2000. Groundwater and society: Resources, tensions and opportunities. New York, United Nations.

Dubash, N.K. 2002. Tube well capitalism, groundwater development and agrarian change in Gujarat. New Delhi, Oxford University Press.

Foster, S., Garduno, H., Evans, R., Olson, D., Tian, Y., Zhang, W. and Han, Z. 2004. Quaternary aquifer of North China plain - assessing and achieving groundwater resource sustainability. *Hydrogeology Journal*, 12(1): 81–93.

Fujita, K. and Hossain, F. 1995. Role of the groundwater market in agricultural development and income distribution: a case study in a northwest Bangladesh village. *Developing Economies,* 33(4): 442–463.

Government of Pakistan. 2000. Agricultural statistics of Pakistan. Ministry of Food, Agriculture and Livestock, Economics Division, and Government of Pakistan, Islamabad

Hernandez-Mora, N. and Martinez Cortina, L. and Fornes, J. 2003. Intensive groundwater use in Spain. In: Llamas M.R. and Custodio, E. (eds) *Intensive use of groundwater: Challenges and opportunities*. The Netherlands, Balkema, pp.387-414.

IWMI. 2012. Direct Delivery of Power Subsidy to Agriculture: India Case Study, Report submitted by IWMI to ESMAP, July 2012

Janakarajan, S. 1994. Trading in groundwater: A source of power and accumulation. In: Moench M (ed) *Selling water: conceptual and policy debates over groundwater markets in India*. Ahmedabad, VIKSAT, pp.47-58

Lopez-Gunn, E. 2003. The role of collective action in water governance: a comparative study of groundwater user associations in La Mancha aquifers in Spain. *Water International*, 28(3): 367–378.

Morgera, E., Kulovesi, K. and Gobena, A. 2009. Case studies on bioenergy policy and law: options for sustainability. Bulletin FAO Legislative Study 2009 No. 102 pp. vii + 395 pp.

Mukherji, A. and Shah, T. 2005. Groundwater socio-ecology and governance: a review of institutions and policies in selected countries. *Hydrogeology Journal*, 13(1): 328–345.

Palmer-Jones, R.W. 2001. Irrigation service markets in Bangladesh: private provision of local public goods and community regulation. In: Paper presented at symposium on managing common resources: what is the solution? Held at Lund University, Sweden, 10–11 September 2001. http://www.sasnet.lu.se/palmer_jones.pdf

Qureshi, A.S. and Akhtar, M. 2003. Effect of electricity pricing policies on groundwater management in Pakistan. *Pakistan Journal of Water Resources*, 7(2):1-9.

Sandoval, R. 2004. A participatory approach to integrated aquifer management: the case of Guanajuato State, Mexico. *Hydrogeology Journal*, 12(1): 6–13.

Scott, C.A. and Shah, T. 2004. Groundwater overdraft reduction through agricultural energy policy: Insights from India and Mexico, *Water Resources Development,* 20(2): 149–164.

Shah, T. 1993. Groundwater markets and irrigation development: Political economy and practical policy. Bombay, Oxford University Press.

Shah, T. 2003. Governing the groundwater economy: Comparative analysis of national institutions and policies in South Asia, China and Mexico. *Water Perspectives*, 1(1): 2–27.

Shah, T., Giordano M. and Wang, J. 2004a. Water institutions in a dynamic economy: What is China doing differently from India? *Economic and Political Weekly*, 39(31): 3452–3461.

Shah, T., Scott, C. and Buechler, S. 2004b. Water sector reforms in Mexico: Lessons for India's new water policy. *Economic and Political Weekly*, 39(11):361–370

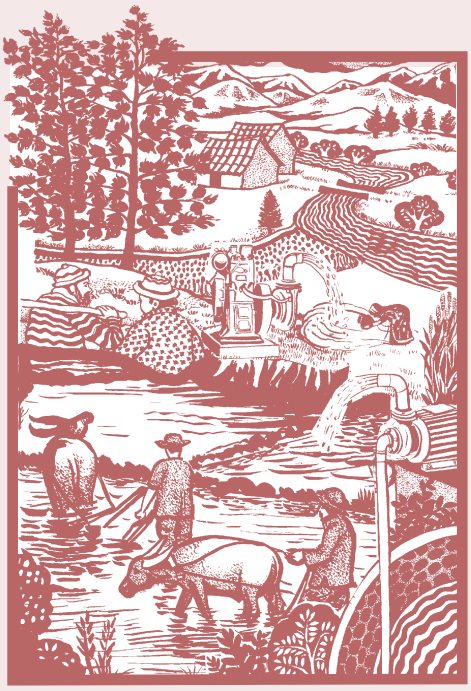
van Steenbergen, F. and Shah, T. 2003. Rules rather than rights: self-regulation in intensively used groundwater systems. In: Llamas, M.R and Custodio, E. (eds) *Intensive use of groundwater: Challenges and opportunities*. The Netherlands, Balkema, pp. 241-256.

Wang, J. and Huang, J. 2002. Water institutional and management system at national and river basin level in China, Beijing. Centre for Chinese Agricultural Policy (internal paper)

Wang, J., Zhang, L. and Cai, S. 2004. Assessing the use of pre-paid electricity cards for the irrigation tube wells in Liaoning Province, China. IWMI Tata Water Policy Programme, Anand and Chinese Centre for Agricultural Policy, Beijing.

World Bank. 2007. Punjab groundwater policy - Mission Report. WB-SA-PK-Punjab GW Mission report. http://www.worldbank.org/gwmate. Accessed June 2007

Zekri, S. 2008. Using economic incentives and regulations to reduce seawater intrusion in the Batinah coastal area of Oman. *Agricultural Water Management*, 95(3): 243–252.



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The IWMI-Tata Water Policy Program (ITP) was launched in 2000 as a co-equal partnership between the International Water Management Institute (IWMI), Colombo and Sir Ratan Tata Trust (SRTT), Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations. Through this program, IWMI collaborates with a range of partners across India to identify, analyze and document relevant water-management approaches and current practices. These practices are assessed and synthesized for maximum policy impact in the series on Water Policy Highlights and IWMI-Tata Comments.

Water Policy Highlights are pre-publication discussion papers developed primarily as the basis for discussion during ITP's Annual Partners' Meet. The research underlying these Highlights was funded with support from IWMI, Colombo and SRTT, Mumbai. However, the Highlights are not externally peer-reviewed and the views expressed are of the author/s alone and not of ITP or either of its funding partners.

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