ELSEVIER

Energy Policy 35 (2007) 6413–6430

ENERGY POLICY

www.elsevier.com/locate/enpol

The energy-irrigation nexus and its impact on groundwater markets in eastern Indo-Gangetic basin: Evidence from West Bengal, India

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Received 9 April 2007; accepted 7 August 2007
Available online 3 October 2007

Abstract

South Asia in general and India in particular is heavily dependent on groundwater for supporting its largely agrarian population. Informal pump irrigation services markets have played an important role in providing access to irrigation to millions of small and marginal farmers and had positive equity, efficiency and sustainable impacts in water-abundant regions such as West Bengal. Quite predictably, in such pump lift-based economy, fortunes of energy and irrigation sectors are closely entwined. This has often been called the 'energy-irrigation' nexus. There are two major sources of energy for pumping groundwater, viz. electricity and diesel. Most of the current discourse in the field has looked only at the 'electricity-irrigation' nexus to the exclusion of the 'diesel-irrigation nexus'. This paper looks at both these aspects. In doing so, it makes two propositions. First, high flat-rate electricity tariff encourages development of water markets whereby the water buyers—who are mostly small and marginal farmers—benefit through access to irrigation. Second, low rate of rural electrification has forced majority of farmers to depend on diesel for groundwater pumping and the steep increase in diesel prices over the last few years has resulted in economic scarcity of groundwater. This in turn has had serious negative impacts on crop production and farm incomes. Using primary field data from West Bengal, India, this paper makes a case for rapid rural electrification and continuation of high flat-rate tariff, which would in turn support developed groundwater markets and provide access to irrigation to the poor and marginal farmers.

Keywords: Energy-irrigation nexus; Groundwater markets; India

1. Introduction

South Asia is heavily dependent on groundwater irrigation for supporting its largely agrarian economies. It is the world's largest user of groundwater, accounting for almost 210 km^3 of withdrawals every year (Mukherji and Shah, 2005). It is then no surprise that in such pump lift irrigation-based economies, fortunes of groundwater and energy sectors are closely entwined. This relationship between the two sectors has been often called the 'energy-irrigation nexus' (Shah et al., 2003; Shah, 2007a). This paper looks into two different aspects of the 'energy-irrigation nexus' viz. the electricity-irrigation nexus and the diesel-irrigation nexus.

Groundwater irrigated almost 60 per cent of India's net irrigated area of 56 million hectares during 2001–02 (GOI, 2003) and contributed more to agricultural output than all other sources of irrigation put together (Dains and Pawar, 1987; Deb Roy and Shah, 2003). It is generally considered to be the most productive irrigation source due to its reliability of supply and availability on demand. Rapid expansion in groundwater irrigation has been largely through the individual investment of millions of farmers scattered throughout the countryside. What makes the 'groundwater story' of South Asia even more interesting is the rise of ingenious institution of groundwater-based pump rental and irrigation services markets (referred henceforward as groundwater markets) whereby the owner of a pump sells water for a consideration—generally pecuniary. These markets have now become ubiquitous in South Asia. Data from India show that of the 82 million farm households in India, 21 million households owned

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doi:10.1016/j.enpol.2007.08.019

water-extraction mechanisms (WEMs) while another 24 million reported hiring of irrigation services from others (NSS0 1999). A large body of literature exists that discusses various dimensions of groundwater markets, such as their spread and extent, mode of functioning and the impact they have on agrarian economy (Shah, 1993; Janakarajan, 1994; Fujita and Hossain, 1995; Meinzen-Dick, 1996; Dubash, 2002; Prakash, 2005). The general consensus is that in regions of ample rainfall and alluvial aquifers such as in the eastern Indo-Gangetic basin (this includes eastern UP, Bihar, West Bengal and Bangladesh) these markets have positive equity and efficiency impacts (Shankar, 1992; Pant, 1992; Shah, 1993; Mukherji, 2004; Palmer-Jones, 2001; Fujita, 2004 and several others).

Of central concern in the field of groundwater market studies has been the 'energy-irrigation' nexus, i.e. the way the motive power of WEMs and energy pricing affects the functioning of these markets (Shah et al., 2003). While the scope of the term energy is broad, the discussions in this field so far have been limited to the 'electricity-irrigation' nexus. The 'electricity-irrigation nexus' is of particular relevance to India where governments in many states have used electricity subsidy as a tool to stimulate groundwater use. This has led to a situation where 'the country's groundwater economy has boomed by bleeding the energy economy' (Shah, 2007a, p. 28). Within this, much of the debate has veered around the pros and cons of two different modes of electricity pricing, viz. rational flat tariff system and pro-rata metering and how these affect the functioning of groundwater markets. These markets, in the absence of widespread public provisioning of irrigation and failure of institutions such as public tubewells and cooperative tubewells (Cunningham, 1992; Brewer et al., 1999), have come to play an important role in providing access to irrigation to a large section of the rural population who would have otherwise remained outside the purview of irrigated agriculture.

The other major energy source for groundwater pumping, viz. diesel, remained outside the ambit of discussions in the field of the 'energy-irrigation nexus' so far.[1] This is because diesel prices were heavily subsidized till the late 1990s and in the 1980s and early 1990s, major parts of eastern India, which now make intensive use of groundwater and are overwhelmingly dependent on diesel-operated WEMs, made relatively less-intensive use of groundwater resources. Given the rapid rise in diesel prices over the past few years, there has emerged a serious energy squeeze in the region that has resulted in 'economic' water scarcity even though there is no physical scarcity of groundwater *per se*. Economic groundwater scarcity is defined as limited access to groundwater because of high costs of water extraction. As a result, the farmers' profit margins are under threat as is the overall agricultural economy in the state.

[1]Only very recently Shah (2007b) has looked into the aspect of rising diesel prices and its impacts on farming in eastern India.

This paper broadens the scope of 'energy-irrigation' nexus discussion by looking at both dimensions of the nexus viz. 'electricity-irrigation' and 'diesel-irrigation nexus'. In doing so, it draws empirical evidence based on a primary questionnaire survey carried out in 40 villages in West Bengal (Figs. 1(a) and (b)), India, during 2004–05. The paper is organized as follows. In Section 2 of the paper, the two propositions that this paper makes are elaborated. In Section 3, groundwater resource conditions and policies in West Bengal are discussed as a backdrop to the entire argument. In Section 4, the role of high flat-rate electricity tariff in sustaining groundwater markets is discussed. In Section 5 the impact of rising diesel prices on groundwater markets and the coping strategy adopted by farmers in face of rising pumping costs are discussed. Section 6 and the final section sums up the discussion by suggesting some policy options that might ease the pressures that farmers in West Bengal face at present due to high diesel prices and low rates of rural electrification.

2. Central propositions

This paper makes two propositions. First, high flat-rate electricity tariff encourages water markets, which in turn benefits the water buyers who happen to be mostly small and marginal farmers. Second, as a corollary to the first proposition, it argues that steep rise in diesel prices in recent years has led to a contraction in water markets and the water buyers have been hardest hit. Both these propositions have been validated with the help of primary data from West Bengal, India.

Electric WEM owners facing a high flat-rate tariff foster pro-active and competitive water markets in various ways. First, electric WEM owners facing high flat-rate tariff are more likely to sell water than diesel WEM owners and also sell a larger volume of their pumped water. Second, electric WEM owners also serve a larger number of water buyers and irrigate larger area per WEM than diesel WEM owners, and finally, given the very different economics of water extraction from electric and diesel WEMs, electric WEM owners are able to sell water at much lower rates than diesel WEM owners. This is because under a flat-rate electricity tariff, marginal cost of water extraction is almost zero. This provides an incentive to electric WEM owners to sell water, because by doing so they can recover their electricity bills and also make additional profits. This is not so in the case of either diesel WEMs or electric WEMs facing pro-rata tariff. This incentive for water-selling transforms to a pressure for selling water if the flat-rate tariff is set at sufficiently high levels because then self-use (given a small land holding size of most pump owners) no longer justifies the electricity bill. In the process, pump owners provide better service to the water buyers and that too at competitive prices. That the water buyers stand to benefit under such competitive water markets is fairly obvious. However, metering of electricity supply will in one stroke take away the incentive for water selling. Given that