Groundwater Markets in Ganga-Meghna-Brahmaputra Basin

Theory and Evidence

Groundwater markets have emerged as an important rural institution in the GMB basin. This article reviews 13 papers (from 1974 to 2003) on groundwater markets in the region. First, various aspects of this market such as its evolution, spread, mode of functioning and impact are analysed. On the basis of these studies, it is concluded that groundwater markets have a beneficial impact in regions of abundant recharge, such as the GMB basin. Next, two broad strands of methodology used in groundwater market study are compared. Finally, the research gap in the way these markets have been studied are identified.

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I
Introduction

The Ganga-Meghna-Brahmaputra (GMB)[1] basin has fertile lands, a rich peasant tradition and huge groundwater potential, yet for a long time was locked up in an 'agrarian impasse' [Boyce 1987].[2] Most of the GMB basin has recently[3] emerged from the impasse. Two types of explanations have been given for this. One group has attributed this turnaround to a series of agrarian reforms, particularly in West Bengal [Adnan 1999; Gazdar and Sengupta 1999], while another group has claimed that much of it is related to market forces such as favourable input output ratios, cheaper boring technology, and a liberalised import policy [Hariss 1993; Palmer-Jones 1999]. Undisputed, however, has been the role of groundwater irrigation in this transformation. Yet, literature on groundwater irrigation and groundwater market in the GMB basin is scarce. This is all the more glaring because in the past decade groundwater markets have become very important in the region. For example, 88 per cent of pump owners in Bangladesh reported selling water. This figure was 60 per cent in Nepal and 48 per cent in West Bengal [Mukherji and Shah, in press]. Thus, informal groundwater markets have emerged as an important institution in the region, but their contribution to agrarian change remains understudied.[4] This paper reviews some of this literature.

II
Groundwater Markets in GMB Basin

In order to systematically review the existing evidence, I have formulated four questions. Each paper is scanned in terms of these four issues. However, not all papers necessarily cover all the four aspects that I have tried to unravel.

The four questions that I posit are:

(1) How and why groundwater markets do emerge?

(2) Who are the major actors in groundwater markets, and what is the extent of spread of such markets in rural areas?

(3) How do these markets operate? Can one find any overarching similarity in the way they function or are transactions so socially embedded as to defy any generalisation?

(4) What are the impacts and outcomes of groundwater markets in terms of productivity, equity and efficiency?

Very few researchers have so far analysed the emergence and evolution of groundwater markets from a historical perspective. Of the 13 studies reviewed here, only one captures the evolution of groundwater markets. During his period of study (1971-73) in the Kosi region of Bihar, Clay noted that

> …the high cost of a potentially profitable technology was inducing a process of technical innovation and the spontaneous development of a market in pumpset services, which involved novel transaction relationships [Clay 1974:129].

Clay's analysis shows that there were two immediate reasons why water markets emerged. First, bamboo boring made ownership of borewells affordable, but purchase of pumps remained a bulky investment, which only a few could undertake. Consequently, rental markets for pumps emerged. But this was neither automatic nor smooth. To begin with, potential water sellers were reluctant to participate in such a market.[6] Thus, selling water was a taboo for many early investors in water extraction mechanisms (WEMs), a finding very similar to that of Wood, according to whom

> …the whole idea of selling water was perceived to be immoral, to be admitted in extremis [Wood 1995:26].

Though this was the general scenario, in two of his study villages where water transactions were relatively well established, he found that much of the moral scruples on the part of the rich well-owners to hire out pumpsets were overcome, indicating that as markets matured, the economic logic of water selling superseded non-economic considerations. At present, it seems that selling water has largely become a norm rather than an exception in rural areas.

Three important characteristics of water buyers and sellers emerge from the papers reviewed. First, almost invariably, WEMs are individually owned. However, there are two notable exceptions. The first is the landless irrigation groups [Wood and Palmer-Jones 1991] where WEMs were managed by a group of landless people. Second, Palmer-Jones (2001) found that almost 52 per cent of WEMs in a Bangladeshi village were jointly owned by partners (p 15). It is difficult to understand the prevalence of joint ownership in this particular village, especially since the

cost of WEM is not prohibitively high as it is in north Gujarat, where informal tubewell companies are formed to take care of high initial investments [Shah and Bhattacharya 1993].

The second feature is the relatively skewed distribution of pump ownership. Thus, Clay found that the first investors in tubewell technology in the Kosi region were "…unequivocally members of the dominant economic group within the community" (1974:225).

Fujita and Hossain (1995) found that almost 73 per cent of WEMs in the village were owned by the largest landowners. Similarly, in Indian villages, upper caste farmers with large landholdings were more likely to own WEMs. On the other hand, water buyers were small and marginal farmers, generally belonging to lower castes, such as OBC and SC. Table 2 sums up the characteristics of water buyers and sellers in selected villages of Bihar, UP and West Bengal.

Third, in recent times, it seems that WEM ownership has become more diffused and is no longer the hegemony of the rich and upper caste farmers. Table 3, based on the findings of Ballabh et al (2002) shows that medium, small and marginal farmers taken together own as much as 82 per cent of pumps in the study villages. This seems to be quite different from what Clay (1974) had reported.

The extent of spread of the water market has been measured in terms of breadth and depth, which Shah and Ballabh (1997) define respectively as:

> ….proportion of farm and farm lands that come into beneficial ambit of the water market (p A-185) and …transactions are important in the household economies of the sellers and buyers… (p A-185).

At the regional level, water markets have acquired tremendous breadth as shown by multi-village studies conducted by Mukherji and Shah (in press) and Roy and Mainuddin (2003), such that in villages where groundwater irrigation is prevalent, groundwater market is all-pervasive. At the micro level, there is evidence to show that breadth of water markets has increased over time. Clay (1974:96) found that only around 8 per cent of total irrigated area was served through water sale. Fujita and Hossain (1995:447)[7] and Lewis (1989:222), working many years later in Bangladesh, found that almost 70 per cent of net irrigated area was accounted for by water sales. Based on several studies, Table 4 summarises the breadth of water markets in some villages in eastern India.

Several factors contribute to the breadth of water markets and it is seen to be generally inversely related to the existence of other modes of cheap irrigation, such as public tubewells and

Table 2: Land Owned by Water Sellers and Water Buyers in Eastern India

(In acres)

Location	Land owned		Sample Size	Source
	Water Sellers	Water Buyers		
3 villages in Nadia, West Bengal	6.13	6.28	17 STW owner, 3 water buyers	AERC (1988)
16 villages in eastern UP	4.35	4.25	231 water sellers and 1207 water buyers	Shankar (1992)
North Bihar (6 villages in Muzaffarpur district)	10.45	4.72	99 water sellers, 100 water buyers	Shah and Ballabh (1997)
Western UP (2 villages in Meerut and 4 villages in Moradabad district)	6.42	3.46	92 water sellers, 20 water buyers	Pant (2003)
Eastern UP (2 villages in Deoria and 4 villages in Jaunpur district)	4.45	2.22	88 water sellers, 25 water buyers	Pant (2003)

Table 3: Percentage Distribution of Pumps among Various Size Classes of Farmers in UP, Bihar and West Bengal

Location*	Large (> 7.5 acres)	Medium (2.5 to 7.49 acres)	Small and Marginal (0.01 to 2.49 acre)	Total Number of Pumps
Maharajganj, UP	21.50	41.25	37.25	51
Azamgarh, UP	34.93	31.74	33.33	63
Muzaffarpur, Bihar	4.75	41.85	53.40	43
Purnea, Bihar	15.0	34.0	51.0	47
Bardhhaman, WB	3.13	68.75	28.12	32
24 Parganas, WB	0	100	0	2
All	18.0	41.6	40.4	238

Note: * One village in each of the districts.
Source: Ballabh et al (2002:34).

Table 1: List of Studies Reviewed[5]

Author	Year	Location	Unit of Study	Nature of Study
Clay, E J	1974	Kosi region, Bihar	16-village pilot study in Purnea and Saharsa districts and 2 in-depth village case studies	Economics of tubewell irrigation in Kosi region, Bihar
AERC, Santiniketan	1988	Nadia district, West Bengal	7 villages in 2 blocks	Cropping pattern under shallow tubewell irrigation
Lewis, D J	1989	Comilla district, Bangladesh	1 village	Interaction between new technology and agrarian structure in Bangladesh
Wood, G D and Palmer-Jones, R W	1991	Various locations in Bangladesh	24 landless groups managing pumps and tubewells	Water selling by landless in Bangladesh – a review of programme by an NGO-Proshika
Shankar, K	1992	Phulpur tehsil, Allahabad district, UP	16 villages	Dynamics of groundwater irrigation
Fujita, K and Hossain, F	1995	Barind tract of north-west Bangladesh	1 village	Groundwater market
Wood, GD	1995	Muzzafarpur, North Bihar	1 village	Groundwater market
Shah, T and V Ballabh	1997	Muzzafarpur, North Bihar	6 villages	Groundwater market
Palmer-Jones, R W	2001	Tangail district, Bangladesh	1 village	Groundwater market
Ballabh, V et al	2002	Eastern UP, Bihar, West Bengal	6 villages, 2 each in each state	Groundwater development and agricultural production
Roy, K C and Moinuddin, M	2003	Bangladesh	40 villages	Groundwater socio-ecology study
Pant, N	2003	Eastern and Western UP	12 villages, 6 each in eastern and western UP	Groundwater development
Mukherji, A and Shah, T	In press	West Bengal and Bihar	6 villages in West Bengal, 5 villages in Bihar	Groundwater socio-ecology study

canals. Perhaps even more important than the breadth of markets is the intensity of water transactions, which is referred to as the depth of the market. Some of the oft-used indicators of depth of water markets are ratio of average hours of pumping in a year to hours of water sold, average hours of water purchased per buyer and average area of buyer served through water sale. The higher the value, more depth the groundwater market has. Table 5 shows some measure of depth in groundwater market in the region.

From Table 5, it is evident that the depth of water markets has increased considerably in North Bihar since the early 1970s and farmers in Bangladesh pump more for selling water than for self-cultivation. Thus, at the macro level, it would seem that Lewis's (1989) 'STW farmers' are increasingly becoming 'STW businessmen', with the possibility that quality of irrigation service has improved over time[8].

Water Pricing and Mode of Functioning of Water Markets

Clay (1974) found that payment for water was in cash at hourly rates. At that time (1971-73), groundwater markets were just emerging in the area. Therefore, the prevalence of cash transactions belies Shah's (1991) hypothesis that cash payment is indicative of a 'mature' stage of groundwater markets. Working in the same region 20 years later, Shah and Ballabh (1997) still found cash transaction was in vogue. However, working at around the same time in another region in neighbouring Bangladesh, Fujita and Hossain (1995) found that water sale through cash transaction accounted for only 3 per cent of the total area irrigated through water markets, while most was accounted for by tenancy contracts between landowners and WEM owners. Lewis (1989) found that seasonal cash contract was the most important mode of transaction in the water market in the village he surveyed in Bangladesh. Pant (2003), Ballabh et al (2002) found coexistence of hourly cash and kind payments in many of their study villages. Based on a review of all these studies, it emerges that there can be two types of transactions in the water market: one is outright sale of water (against cash, kind or a mix of both, either at hourly or seasonal rates), and the second is some kind of tenancy arrangement under which the WEM owner can either lease in land from other landowners or lease out land in lieu of certain return, either fixed (in terms of money or in kind) or share of the produce. Dubash (2002), Aggarwal (1996) and Kajisa (1999) have explained such multiplicity of arrangements in terms of risk sharing and reducing transaction costs while neoclassical economists have rejected these as a transitory phenomenon which they say will give way to cash transactions as markets mature.[9] Table 6 lists different modes of transactions and compares them against the stage of development of water markets and finds no particular relationship between the mode of payment and level of development of the groundwater market.

On the issue of water pricing, three types of concerns have been raised. First, whether or not water sellers exert monopoly powers to gain supernormal profits. Shah (1993) modelled groundwater markets as natural oligopolies, under which he hypothesised that the ratio of water charge (w) to total variable cost (c) is a fairly good indicator of the level of monopoly profit. He also hypothesised that as the markets became more competitive (due to introduction of more WEMs or change in power tariff), this ratio will fall steadily. In his and Ballabh's study of six villages in Muzaffarpur, they found that the water price was 2.5-3.0 times the incremental pumping costs. Clay, working in the same region roughly 30 years ago, found a w/c ratio of 2, which is more or less the same as reported by Shah. This temporal evidence questions Shah's hypothesis that as markets develop, the w/c ratio comes down. On the other hand, while both Fujita and Hossain (1995) and Palmer-Jones (2001)[10] found a fairly high w/c ratio in their study, unlike Shah they concluded that far from being monopolistic, water markets are competitive and a high w/c ratio merely reflects entrepreneurs' risk premium.

Table 4: Breadth of Groundwater Market in North Bihar, West Bengal, Eastern and Western UP

No	Village Name/District/State	Per Cent of Irrigated Area Served by Water Market
1	Birpur, Muzaffarpur, Bihar	23.5
2	Panapur, Muzaffarpur, Bihar	46.5
3	Morsandi, Muzaffarpur, Bihar	42.0
4	Barji, Muzaffarpur, Bihar	37.8
5	Ajana Court, Muzaffarpur, Bihar	27.3
6	Nariyar, Muzaffarpur, Bihar	46.0
7	Rampur, Maharajganj, UP	55.0
8	Khemaupur, Azamgarh, UP	81.0
9	Macchahi, Muzaffarpur, Bihar	90.0
10	Fariyani, Purnea, Bihar	33.0
11	Asonpur, Bardhhaman, WB	73.0
12	Hathberia, 24 Parganas, WB	100.0
13	Nagli Issa, Meerut, Western UP	33.3
14	Modkalan, Meerut, Western UP	24.4
15	Mundha Pande, Moradabad, Western UP	38.7
16	Dalpatpur, Moradabad, Western UP	50.0
17	Mohd. Pur Emma, Moradabad, Western UP	36.3
18	Singhpur Saini, Moradabad, Western UP	39.1
19	Chakra, Jaunpur, Eastern UP	69.7
20	Deolaspur, Jaunpur, Eastern UP	34.4
21	Purwa, Jaunpur, Eastern UP	20.8
22	Kurni, Jaunpur, Eastern UP	44.4
23	Kusmauni, Deoria, Eastern UP	21.4
24	Pakri Babu, Deoria, Eastern UP	44.8

Source: (1) No 1 to 6: Shah and Ballabh (1997: A-185, Table 2).(2) No 7 to 12: Ballabh et al (2002:21, Table 10). (3) No 13 to 24: Pant (2003, Appendix, Table 3.5).

Table 5: Depth of Groundwater Market in Bihar, Bangladesh and West Bengal

Location	Average Hours of Operation WEM/ Year	Average Hours of Water Sold/ Year	Measure of Depth of Water Market	Sample Size (No of WEMs	Source and Year
(1)	(2)	(3)	(4)= (3)/(2)	(5)	(6)
Kosi region, Bihar	183.3*	31.3**	0.17	18	Clay, 1974
16 villages, Allahabad, UP	592.69	216.10	0.36	140	Shankar, 1992
6 villages, Muzaffarpur, North Bihar	496.3#	248.5##	0.50	99	Shah and Ballabh, 1997
40 villages in Bangladesh	951.5	648	0.68	230	Roy and Moinuddin, 2003
6 villages in West Bengal	986.5	445.9	0.45	52	Mukherji and Shah, in press

Notes: * Weighted average of 6 electric tubewells running for an average of 214 hours, and 12 diesel tubewells running for an average of 168 hours [Clay 1974:71].

** Calculated on the basis of 15 buyers, mean irrigated area per buyer is 3.87 acres and mean hours of irrigation per buyer is 9.70 hours. This gives a total of 563 hours of purchased water from 18 WEMs, thus average per WEM is 31.3 hours [Clay 1974:225].

Average hours of operation of WEMs for 6 villages, based on Table 2, row (c), pp A-185, Shah and Ballabh (1997).

Average hours of water sale per WEM for 6 villages, based on Table 2, row (d), pp A-185, Shah and Ballabh (1997).

The second issue of enquiry is on the existence of price discrimination in water markets. Clay (1974) found a consistent pattern of price discrimination along the line that closely followed near relations and others. So did Shah and Ballabh (1997), but they did not indicate if that had anything to do with the caste and status of the water buyer. But almost all others [Ballabh et al 2002; Pant 2003; Wood 1995] concede that discounts are generally given to kith and kin, though Lewis (1989) says that such discounts are not particularly common in the Bangladeshi village that he studied.

The third important issue is whether there is any causal relationship between monopoly rent, price discrimination and the level of development of groundwater markets. The neoclassical economists hypothesise that as markets develop and become more competitive, monopoly power of the water seller goes down. Table 7 compares the relationship between the extent of monopoly power and breadth and depth in six villages in north Bihar that Shah and Ballabh (1997) studied, and it finds no clear-cut relationship between the level of development of groundwater markets and degree of monopoly pricing.[11]

Literature is divided on the question of impact of groundwater markets, ranging from highly positive ones that declare groundwater markets as the 'vehicle of poverty alleviation' to that that accuse groundwater markets of 'creating water lords' and appropriating surplus from the poor. There are two major ways in which the impact of groundwater market is manifested; first, in changes in cropping pattern and cropping intensity among the buyers and sellers, and second, in terms of employment generation among the landless. The way these two variables are affected, in turn, affects the way net irrigation surplus (NIS)[12] is distributed among WEM owners and water buyers.

One of the central arguments of the neoclassical scholars [Shah 1993; Shah and Ballabh 1997] is that the difference in crop productivity and cropping pattern among water sellers and water buyers is a good indicator of the level of development of water markets. This is because cropping decision and the resulting crop productivity under green revolution technology is a function of reliability and adequacy of irrigation water. If, under such circumstances, the water buyers achieve as good output as WEM owners, then it indicates water markets deliver reliable and adequate water to the buyers. Shah and Ballabh (1997) find that in all the six villages cropping intensity of the WEM owners and that of the water buyers are comparable. They also find that water buyers invariably achieve higher yields than water sellers and in some crops, such as potato, water buyers achieve nearly twice the output of water sellers. An AERC (1988) study finds that while cropping intensity of water buyers was higher than that of well owners (228 per cent as against 205 per cent), cropping pattern of the latter had much more area under water-intensive and profitable 'boro' paddy (36 per cent) compared with water buyers, who could barely devote 7 per cent of their area to boro cultivation. Thus, in this case, water buyers were at a positive disadvantage vis-à-vis water sellers.

As far as labour employment is concerned, there is enough evidence to show that employment goes up with the introduction of irrigated agriculture, but none except Shah and Ballabh (1997) and AERC (1988) compare the difference in labour employed between water sellers and water buyers. Shah and Ballabh found that water buyers spent more per acre on labour during the rabi season – which is the main irrigation season in the study villages, while the AERC study found no such difference. Clay (1974) compared the use of labour in agriculture before and after investment in tubewell technology. He found, quite predictably, that labour use had gone up in the after-investment period as Table 8 shows.

Though there is not an iota of doubt that groundwater markets increase NIS, there is some controversy about the way this NIS is divided among the WEM owners, water buyers and labourers. Fujita and Hossain (1995) found that 20 per cent of NIS went

Table 7: Relationship between Breadth and Depth of Groundwater and Extent of Monopoly Pricing in Water

Village Name	Breadth of Water Market*	Depth of Water Market**	w/c Ratio***
Birpur	23.5	0.95	0.77
Panapur	46.5	0.33	1.23
Morsandi	42.0	0.27	1.04
Barji	37.8	0.78	1.91
Ajana Court	27.3	0.25	1.26
Nariyar	46.0	0.50	1.43

Notes: * Measured as per cent of area irrigated through purchased water (row b of Table 2)
** Measured as ratio of total hours of pumping to number of hours of water sold (row d/row b of Table 2)
*** Measured as ratio of water price (row g, Table 3) to that of average cost of extraction (row f, Table 3)
Source: Shah and Ballabh, calculated based on tables 2 and 3 (1997:A-185)

Table 6: Mode of Transaction in Water Markets

Location and year	Water Sale or Renting Out of Pumpsets				Tenancy Agreement		Level of Development of Groundwater Market
	Hourly Cash	Seasonal Cash Contract	Seasonal Crop Share Contract	Mix of Cash and Kind	Leasing in by WEM Owners	Leasing Out by WEM Owners	
Kosi region, Bihar, 1974	√	×	×	×	×	×	Very low
Muzaffarpur, North Bihar, 1997	√	×	×	×	×	×	Low to medium
Northwest Bangladesh, 1995	×	√	√	√	√	×	High
Comilla district, Bangladesh, 1991	×	√	√	√	√	×	Medium to high
Various regions in Bangladesh, 1990	√	√	√	√	×	×	Not enough information to deduce
Tangail district, Bangladesh, 2001	×	×	√	×	√	×	High
Maharajganj and Azamgarh, UP, 2003	√	×	×	√	×	×	High
Muzaffarpur and Purnea, Bihar, 2003	√	×	×	√	×	×	High in one village, low in another
Bardhaman and S. 24 Parganas, West Bengal, 2003	×	√	×	×	×	×	Medium in one and low in another
6 villages each in western and eastern UP, 2003	√	×	×	×	×	×	Varying levels, from low to high
27 villages from all over Bangladesh, 2003	√	√	√	×	×	×	Medium to very high
1 village in Bardhaman, West Bengal, 1999	×	×	×	×	√	×	Not enough information to deduce

Source: (1) Clay (1974), (2) Shah and Ballabh (1997), (3) Fujita and Hossain (1995), (4) Lewis, (1989) (5) Wood and Palmer-Jones, (1991), (6) Palmer-Jones (2001), (7 to 9) Ballabh et al (2002), (10), Pant (2003), (11) Roy and Moinuddin (2003), (12) Webster (1999).

to the landowners who seasonally rented out land to tubewell owners under fixed tenancy arrangements, 15 per cent went to water buyers and the rest 65 per cent to WEM owners, while their respective landholding in the village was 42 per cent, 24 per cent and 35 per cent. Thus, it is clear that the WEM owners captured the lion's share of NIS generated in their study village. On the other hand, Palmer-Jones (2001) observed that "…most profits from irrigated agriculture accumulate to land owners rather than WEM owners" (p 13), but he gave no quantitative validation of his argument. Finally, Clay (1974) found that with tubewell irrigation, the factor share of labour went down, though in absolute terms labour employment increased (Table 9).[13]

On the whole, based on the literature reviewed so far, water markets in the GMB basin do not seem to have any deleterious effect. On the contrary, they increase NIS through higher crop productivity and cropping intensity, lead to higher labour employment and in regions of waterlogging, it helps to stabilise water tables.[14] Though formulation of water sellers as 'water lords' still remains quite popular, especially with the scholars of Marxian tradition [Wood 1995; Adnan 1999], no such concrete evidence is seen in any of the papers examined in this review. Given that much of eastern India has very small and fragmented landholdings, and that in order to break even, every WEM owner is dependent on the water buyer, and that the water seller in most instances is also a water buyer, tendencies leading to so called 'water lordism' are curbed. In addition, the shallow depths at which water is found and the relative ease with which tubewells can be sunk further limits the power of WEM owners.

III
Methodological Debate

Compared with other rural institutional arrangements such as land, labour and credit markets, the water market is a relatively recent field of enquiry. Since the mid 1980s, Shah (1985, 1988, 1991 and 1993), through his pioneering work has more or less moulded the shape of discourse on water markets. His approach has been that of a neoclassical economist (NCE). On the other hand, Dubash (2000, 2002), Kajisa (1999) and Palmer-Jones (1994) have charted a different path along the lines of new institutional economics (NIE). In this section, I will look at the origin and postulates of the two approaches and review the main grounds on which they have been criticised.

During the mid-1980s, when Shah stumbled upon the phenomenon of the groundwater market, there were increasing concerns about runaway growth in groundwater irrigation and inefficacy of any direct measures to regulate such growth. Given this background, he wanted to understand how indirect regulation could modify behaviour of water sellers (personal communication Shah 2004). In doing so, he modelled water markets as natural oligopolies and hypothesised that the mode of power tariff was the most important determinant of the level of vibrancy of water markets, and that a progressive flat tariff regime coupled with high quality power supply is conducive to the emergence of a competitive water market. His approach was highly policy-oriented.

But in recent years, this approach has come under increased criticism. For one, it is being questioned whether groundwater markets are indeed markets in neoclassical term.[15] The first condition of same price for same commodity does not apply; different water sellers charge different water prices by virtue of being located in different villages or even in the same village. Second, different buyers buy water at the same price, but they get differential quality of service. Third, freedom for purchasers and sellers is not respected, it is controlled by the technical factors such as command area that the tubewell can irrigate and whose land falls within that domain.[16] In addition to this basic methodological dilemma, two more criticisms have been levelled against this approach. For one, it is largely assumed that individual actions are not constrained by social institutions or alliances such as caste, gender, kinship, descent line or residence group and this assumption is not true in most cases. Second, the role of power in shaping water markets has been completely ignored.

The other approach of studying water markets is that of NIE. In interpreting groundwater markets, the NIE approach has tried to show how water markets have emerged to share risks inherent in irrigated agriculture, given that there is an absence of insurance markets. Dubash (2000, 2002) has shown that groundwater markets are 'socially and ecologically' embedded with a 'path dependent' history. Using this approach, one can indeed explain some of the unexplained facets, e g, the coexistence of different modes of water contracts as strategies to minimise or share risks or lower transaction costs. This approach also sheds light on why the same set of policy interventions gives rise to different sets of outcomes. The main drawback of this approach is that it fails to generalise.

NCEs and NIEs ask two different sets of questions vis-à-vis water markets. The NCE's central concern is how water markets can be used as a lever for managing groundwater economy, while the NIEs are more interested in understanding how water markets function as a social and economic institution. Then, are the approaches dichotomous? The so-called dichotomy, I believe, lies more in the scale of analysis. While the NCEs try to paint a macro-level picture, the NIEs are content with a micro-level image. Perhaps the reality lies midway. There are indeed certain core features of water markets that pervade across villages and regions, whereas there are other characteristics that are path dependent and hence vary from one village to another. Quite understandably, the best way to study water markets would be to combine both methods, which has not been done so far.

Table 8: Impact of Tubewell Investment on Employment of Permanent and Casual Labour on 69 Plots

Category	Before Investment*	After Investment**	Change	Per Cent Change
In '000 man days				
Farm servants	14.2	20.1	+5.9	+42
Casual labour	31.9	42.6	+10.7	+34
Total	46.1	62.7	+16.6	+36
Wages (Rs '000)				
Farm servants	29.0	40.3	+11.3	+39
Casual labour	70.7	105.2	+34.5	+49
Total	99.7	145.5	+45.8	+46

Notes: * Before investment data is based on recall of respondents.
** After investment data relates to 1970-71.
Source: Clay (1974:160).

Table 9: Income Shares of Product of 69 Tubewell Plots Before and After Investment in Tubewell

	Pre-investment		Post-Investment		Change	
	'000 Rs	Per Cent	'000 Rs	Per Cent	'000 Rs	Per Cent
Farmers' income	109	52	210	59	101	69
Agri labourer	100	48	145	41	45	31
Total	209	100	355	100	146	100

Source: Clay (1974:167).

IV
Research Gaps and Future Directions

Being a relatively new field of study, certain glaring gaps have remained in the way water markets have been studied. First, there has been a regional bias, in that groundwater markets have been better studied in water scarce regions than in water abundant regions. Now the focus needs to be shifted to water abundant regions such as the GMB basin. Second, there has been a lack of historical perspective in groundwater market research. Questions such as 'is there a stagewise progression in the development of groundwater markets from one of underdevelopment to that of competitive markets?', and 'if yes, is such a progression smooth and unilinear?' have at best remained hypothetical. Third, the relation between development of groundwater markets and level of agricultural development have remained imperfectly understood. Only Shah (1997) has presented a simplified stagewise linear model of groundwater-led agrarian transformation in eastern India, much along the contours suggested by Rostow (1961), but its main limitation is that it does not explicitly include agrarian relation as a constraining factor.[17] Fourth, the role of 'power'[18] has been widely used to formulate theories on labour and credit markets. However, in the study of water markets, not much attention has been paid to the question of power in rural society; if at all, the formulation has been very naïve and the water sellers have been depicted as 'water lords'– those who exert absolute power over water buyers [Wood 1995; Webster 1999]. Only Lewis (1989) observed that even water buyers can have power over the water sellers.[19] More work needs to be done in understanding the relative power of water sellers and water buyers and how this in turn shapes water markets. Finally, unlike other rural markets, such as labour and credit, there has so far been no attempt at formulating a general theory of groundwater markets. Thus, the current mode of functioning of groundwater market still leaves a lot of unanswered questions such as 'why do several modes of water contracts coexist under seemingly similar conditions and why do they respond differently to similar sets of incentives and disincentives?' If not a coherent theory of water markets, what is at least needed is a formulation of 'core features' of groundwater markets similar to the core features of the labour market outlined by Dreze and Mukherjee (1987). The best way to do so would be to combine both the NCE and NIE perspective.

Given that water markets have assumed increased importance in the GMB basin and that the entire basin is in the throes of a major agricultural transition, there is an urgent need to understand the role that groundwater markets can play in this transition. In doing so, some of the points mentioned in this section could be kept in mind for a fuller understanding of the remarkable phenomenon that is the groundwater market. EPW

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Notes

1 The GMB basin includes the eastern districts of Uttar Pradesh and the entire states of Assam, Bihar, West Bengal and that of Bangladesh.

2 The term 'agrarian impasse' got wide currency since the publication of Boyce's (1987) seminal work on Bengal. Three broad types of explanations have been used to account for this impasse and have been euphemistically referred to as problems of 'floods, feudals and Fabians' [Palmer-Jones 1999:125].

3 Indeed, in late 1990s, concerns have been raised about slowdown in agricultural growth in the region and thus have deflated much of the excitement of the late 1980s and early 1990s.

4 In fact, a careful sifting of literature will not yield more than a dozen or so studies on groundwater markets in eastern India, while case studies from more arid parts of India and Pakistan are rather large in number.

5 As the last column of the table shows, there are predominantly two types of studies, one that is entirely a study on groundwater market and another, though it has a much broader scope (such as, say, socio-ecology of groundwater irrigation in south Asia or role of new technology in agrarian change), does touch upon the topic of groundwater markets. Understandably, there are considerable variations in the depth and breadth of such studies. But the common binding feature of all these studies is that they relate to the eastern water abundant part of the GMB basin, which includes eastern Uttar Pradesh, Bihar, West Bengal and Bangladesh.

6 This had much to do with the novel nature of this type of transaction. For one, such a market was very different from the traditional factor markets such as the market for labour. In the labour market, the service (i e, labour) is invariably provided by the social inferior to the social superior. However, the nature of transaction in groundwater market was in the opposite direction, as the richer farmers with pumpsets were to provide service to poorer and socially inferior farmers in lieu of a consideration (usually monetary).

7 Fujita and Hossain (1995:447), in their study of a Bangladesh village find that of a total irrigated land of 310 acres in the village, some 24 per cent of the land is irrigated through 'pure' water sale. However, they find that almost 42 per cent of the irrigated area is rented in by the WEM owners under a local tenancy arrangement called 'chaunia' under which the WEM owner pay 3-4 maunds of paddy to the land owner.

8 Lewis (1989) found that motivation for investment in STW was the most important criterion for categorising WEM owners. He thus found two groups of STW owners. The first group was what he called the 'STW farmers' who were primarily interested in self-irrigation and not so much in water selling, while the second group consisting of 'STW businessmen' were motivated more by profits to be made out of water sale.

9 In fact, in hypothesising that as water markets developed, cash transactions would replace other types of transactions, the neoclassical economists quite paradoxically reiterate the Marxist view on agricultural transition from a feudal mode to capitalist mode. To quote Bharadwaj (1995:8-9), "A number of features of this particular transition was underlined by Marx as characterising growing commercialisation. For example, commutation of rent in terms of money, displacement of crop sharing tenancy by cash rents…".

10 This however, is quite in contrast with Palmer-Jones earlier 'club model' of water market, where he theorised that water sellers will co-operate and even collude amongst themselves to keep water prices at a certain level, thereby precluding competition [Palmer-Jones and Mandal 1988].

11 The correlation coefficient is in fact positive though insignificant in both the cases, the value being 0.388 in case of breadth vs w/c and 0.029 in case of depth vs w/c. For example, Nariyar village has one of the best spread of water markets and reasonably good depth, yet the monopoly power of water sellers is one of the highest. The neoclassical economists have not enquired into the reasons for this apparent anomaly, while the new institutional economists have pointed out that the assumptions behind modelling groundwater market as an oligopoly might be flawed and that it ignores the relative power (bargaining and moral) of the water buyers and sellers.

12 Net irrigation surplus is defined as the gross value added by irrigation less the nominal cost of irrigation [Shah 1993].

13 From Clay's (1974) evidence, it would seem that tubewell technology is a land-enhancing technology rather than a labour-enhancing one, because the share of labour in total NIS goes down. However, is this enough to condemn irrigation in general and water markets in particular as iniquitous? I shall argue it is not. Though relative share of labour might go down (more evidence is needed to assert this), in absolute terms, they are certainly better off under a water market than in a situation of no-water market.

14 A major benefit of enhanced groundwater extraction in regions of good quality alluvial aquifer and adequate recharge is the increase in induced recharge. Thus Roy (1989), using a simulation model for a small region in north-west Bangladesh, showed that with increased use of groundwater for irrigation, average yearly rejected recharge decreased from 590 mm under rainfed cropping to only 160 mm under three-season irrigated agriculture.

15 Rudra defines markets as following: "By a market we mean an institution

in which purchasers and sellers exchange a commodity at a standard price with full freedom. That is to say that there are no restrictions on who to sell the product and who can purchase it. Anybody who is ready to receive that price is ready to sell it. Conversely, who is not ready to sell a commodity for a price or to pay the price for that commodity cannot be coerced to do so" (1984:261).

16 Some might still characterise these markets as being fragmented, with each village a fragment or a segment. But then, it can be argued that tools of neoclassical economics will not operate even at the village level. For a perfect competitive model, the numbers would be too small, for an imperfect competition model the numbers would be too large.

17 Shah (1997) proposes that under 'initial' conditions of low groundwater development, the share of land in agricultural value added is very high, thereby precluding poor and landless farmers from benefiting substantially from agriculture. The next phase is characterised by accumulation of machine capital (particularly pump sets) by the rural elite. Water markets or lease market for other assets (except land) does not develop fully at this stage, because large farmers use all the water that their machines pump. However, in the later stages, even the small and medium farmers start investing in machine capital in general and pump capital in particular. Now water markets develop because they cannot use all the water on their own small fields. Close on the heel follows rental markets for other agricultural equipment such as tractors and threshers. Consequently, the share of land in agricultural value added goes down, while that of machine capital and labour goes up, and the rural economy stands transformed.

18 Rudra (1984) defines power as a "…social phenomena given rise to by such institutional factors as class division, caste hierarchy, distribution of wealth and income, occupational patterns, etc, and such ideological forces as customs, traditions, taboos, etc, affecting the process of decision-making by economic agents" (pp 250-51).

19 For example, buyers can choose not to cultivate water-intensive paddy and shift to potato, if the water sellers use their power unscrupulously. Thus, the ability to exit from the water market or to shift to a lower water-intensive crop, in a way checks the power of the water sellers.

References

Adnan, S (1999): 'Agrarian Structure and Agricultural Growth Trends in Bangladesh: The Political Economy of Technological Change and Policy Interventions' in B Rogaly, B Harriss-White and S Bose (eds), *Sonar Bangla? Agricultural Growth and Agrarian Change in West Bengal and Bangladesh*, Sage Publications, New Delhi.

AERC (1998), *Cropping Pattern Under the Irrigational Technology of Shallow Tubewell In the District of Nadia, West Bengal*, Agro-Economic Research Centre, Visva-Bharati, Santiniketan.

Aggarwal, R M (1996): 'Risk Sharing and Transaction Costs in Groundwater Contracts: Evidence from Rural India', University of Maryland, Department of Agricultural and Resources Economics, College Park, Md, USA, Mimeo.

Ballabh, V, K Choudhary, S Pandey and S Mishra (2002): 'Groundwater Development and Agricultural Production: A Comparative Study of Eastern Uttar Pradesh, Bihar and West Bengal', paper submitted to IWMI-Tata Water Policy Programme, Anand, Gujarat.

Bharadwaj, K (1995): 'A View on Commercialisation of Indian Agriculture and the Development of Capitalism', *Journal of Peasant Studies*, 12(4):7-25.

Boyce, K (1987): *Agrarian Impasse in Bengal: Agricultural Growth in Bangladesh and West Bengal 1949-1980*, Oxford University Press, New York.

Clay, E J (1974): 'Innovation, Inequality and Rural Planning: The Economics of Tubewell Irrigation in the Kosi Region', Bihar, India, PhD thesis, University of Sussex.

Dreze, J and A Mukherjee (1987): 'Labour Contract in Rural India: Theories and Evidence', Discussion paper series No 7, Development Research Programme, Suntory-Toyota International Centre for Economics and related disciplines, London School of Economics, London.

Dubash, N K (2000): 'Ecologically and Socially Embedded Exchange: Gujarat Model of Water Markets', *Economic and Political Weekly*, 35(16): 1376-85.

– (2002): *Tubewell Capitalism, Groundwater Development and Agrarian Change in Gujarat*, Oxford University Press, New Delhi.

Fujita, K and F Hossain (1995): 'Role of the Groundwater Market in Agricultural Development and Income Distribution: A Case Study in a North-West Bangladesh Village', *The Developing Economies*, 33(4): 442-63.

Gazdar, H and S Sengupta (1999): 'Agricultural Growth and Recent Trends in Well Being in Rural West Bengal' in B Rogaly, B Harriss-White and S Bose (eds), *Sonar Bangla? Agricultural Growth and Agrarian Change in West Bengal and Bangladesh*, Sage Publications, New Delhi.

Hariss, J (1993): 'What Is Happening in Rural West Bengal: Agrarian Reforms, Growth and Distributions', *Economic and Political Weekly*, 28(24):1237-47.

Kajisa, K (1999): 'Contract Theory and Its Application to Groundwater Markets in India', PhD thesis, Michigan State University.

Lewis, D J (1989): 'Technologies and Transactions: A Study of the Interaction Between New Technology and Agrarian Structure in Bangladesh', PhD thesis, University of Bath.

Mukherji, A and T Shah (in press): 'Socio-Ecology of Groundwater Irrigation in South Asia: An Overview of Issues and Evidence' in *Selected Papers of the Symposium on Intensive Use of Groundwater*, held at Valencia (Spain), December 10-14, 2002, IAH Hydrogeology Selected Papers, Balkema Publishers.

Palmer-Jones, R W (1994): 'Groundwater Markets in South Asia: A Discussion of Theory and Evidence' in M Moench (ed), *Selling Water: Conceptual and Policy Debates over Groundwater Markets in India*, VIKSAT, Pacific Institute and Natural Heritage Institute, Ahmedabad, Oakland, San Fransisco.

– (1999): 'Slowdown in Agricultural Growth in Bangladesh' in Ben Rogaly, Barbara Harriss-White and Sugata Bose (eds), *Sonar Bangla? Agricultural Growth and Agrarian Change in West Bengal and Bangladesh*, Sage Publications, New Delhi.

– (2001): 'Irrigation Service Markets in Bangladesh: Private Provision of Local Public Goods and Community Regulation', paper presented at Symposium on Managing Common Resources: What is the Solution? Held at Lund University, Sweden, September 10-11, 2001, http://www.sasnet.lu.se/palmer_jones.pdf

Palmer-Jones, R W and M A S Mandal (1988): *Irrigation Groups in Bangladesh*, Overseas Development Institute, London.

Pant, N (2003): 'Key Trends in Groundwater Irrigation in the Eastern and Western Regions of Uttar Pradesh', paper submitted to IWMI-Tata Water Policy Programme, Anand, Gujarat.

Rostow, W W (1961): *Stages of Economic Growth*, Cambridge University Press, Cambridge, UK.

Roy, K C (1989): 'Optimisation of Unconfined Shallow Aquifer Water Storage for Irrigation', PhD thesis, Utah State University.

Roy, K C and M Mainuddin (2003): 'Socio-ecology of Groundwater Irrigation in Bangladesh', paper submitted to IWMI-Tata Water Policy Programme, Anand, Gujarat.

Rudra, A (1984): 'Local Power and Farm Level Decision-Making' in M Desai, S H Rudolph and A Rudra (eds), *Agrarian Power and Agricultural Productivity in South Asia*, University of California Press, Berkeley, pp 250-80.

Shah, T (1985): 'Transforming Groundwater Markets into Powerful Instrument of Small Farmer Development', London, *ODI Irrigation Management Network Paper* No 11d.

– (1988): *Groundwater Grids in the Villages of Gujarat: Evolution, Structure, Working and Impacts*, Institute of Rural Management, Anand (IRMA).

– (1991): 'Water Markets and Irrigation Development in India', *Indian Journal of Agricultural Economics*, 46(3).

– (1993): *Water Markets an Irrigation Development: Political Economy and Practical Policy*, Oxford University Press, Bombay,.

– (1997): 'Pump Irrigation and Equity: Machine Reform and Agrarian Transformation in Water Abundant Eastern India', Policy School Working Paper # 6, The Policy School Project, Anand, India

Shah, T and S Bhattacharya (1993): *Farmers' Organisation for Lift Irrigation: Irrigation Companies and Tubewell Cooperatives of Gujara*, Overseas Development Institute, London.

Shah T and V Ballabh (1997): 'Water Markets in North Bihar: Six Village Studies in Muzaffarpur District', *Economic and Political Weekly*, 32(52): A183-A190

Shankar, K (1992): *Dynamics of Groundwater Irrigation*, Segment Books, New Delhi.

Webster, N (1999): 'Institutions, Actors and Strategies in West Bengal's Rural Development: A Study on Irrigation' in B Rogaly, B Harriss-White and S Bose (eds), *Sonar Bangla? Agricultural Growth and Agrarian Change in West Bengal and Bangladesh*, Sage Publications, New Delhi.

Wood, G D (1995): 'Private Provision after Public Neglect: Opting Out with Pumpsets in North Bihar', presented at the International Conference on Political Economy of Water in South Asia: Rural and urban action and interaction, held at Madras Institute of Development Studies, January 5-8.

Wood, G D and R W Palmer-Jones (1991): *The Water Sellers, a Cooperative Venture by the Rural Poor*, West Hartford, Kumarian Press, Wood 1994.