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Trading in ground water: A source of power and accumulation

by

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Abstract

This paper examines the extent and the functioning of groundwater markets, their adaptation to the dropping water tables, and the extent to which commercial transactions in groundwater is competitive. The author argues that the trading in groundwater is quite extensive even where a water table has been falling steadily. The discussion also brings out the fact that the characteristics and the functioning of water markets have been undergoing transformation through their adjustment to the increasing scarcity of this precious resource.

Evidence provided in this paper indicates that the water markets are interlinked with other agrarian markets such as for labour and product. This is the reflection of unequal access to crucial productive resources and the poor bargaining capacity and the dependent status of the water purchasers vis a vis the water sellers. Therefore, it is clear that the market for water, at least in the context of the villages studied in the Vaigai basin, is far from being perfect and a few farmers emerge with power to exercise control over this precious resource and use this as a mechanism of surplus extraction.

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TRADING IN GROUNDWATER : A SOURCE OF POWER AND ACCUMULATION[1]

Section-1 Introduction

Commercial transactions in groundwater has been the topic of intellectual focus at least over the past one decade. By and large, the studies[2] which have probed into this issue convey two important points: One, the emergence of trading in groundwater has widened the scope of access to this precious resource across different sections of the agricultural population, thereby contributing to the total agricultural production; two, although the groundwater market has been functioning in an informal manner and although no precise estimates are available, the volume of transactions involved in the trade is no smaller than any other organized agrarian markets in a given village economy. However, the steady decline of the groundwater table poses a severe constraint on the effective functioning of this market. It appears to be quite obvious that a well owner would entertain a water purchaser only when there is surplus water in his well; if he himself faces water scarcity for his cultivation he may not sell water provided, the retums that he might get by way of selling water are more than or at least equal to what he might eam from his own cultivation using that water[3]. In other words, there is a critical minimum water level that a every well owner would try to maintain in his well beyond which the sale of water would fetch only a comparative loss. This is a peculiar situation (maybe a theoretical one) in which, although there is excess demand for water from water purchasers, the price of water cannot be pushed beyond a point too high at which it would not be profitable for water purchasers to buy water. Therefore, at a critical minimum (groundwater) level, normally one might not expect any water sale. Nevertheless, under such circumstances new forms of water deals / contracts may evolve to suit the emerging characteristics of groundwater conditions such as those discussed in this paper. Moreover, in reality, under competitive deepening conditions, a few well owners who have better access to resources and who are lucky enough to strike deeper aquifers, emerge successful and sell water. The terms and conditions of water transactions vary a great deal from one seller to another and from one village to another; there are several factors contributing to the differential terms and conditions such as the type and the power of the water extracting mechanism used, the relationship between the water seller and the buyer, the availability of water in the well, the distance between the well and the water buyer's plot of land and so on. Thus, competitiveness in the water market seems to be a proposition, which is far from reality. This is essentially the central theme of this paper discussed in the specific context of the low rainfall hard rock region, viz., Vaigal basin, in Southem Tamilnadu.

This paper is based upon two stage field survey conducted in the Vaigai Basin which is spread over Madural, Quaid-E-Millath, Pasumpon Thevar Thirumagan and Ramanathapuram districts of Southem Tamilnadu, during the years 1991-92. While the first phase survey was basically exploratory in nature which covered 27 villages spread over the entire basin, the second stage was a detailed one in which 7 of the 27 villages selected for the first round survey were studied[4].

The paper is organized in the following manner: Section-2 following the introduction discusses the agro-climatic characteristics of the study region; section-3 is devoted for a brief discussion on the secular lowering of the water table in the Vaigai Basin; while section-4 is devoted to presenting the facts about the extent of prevalence of the groundwater market and the emerging characteristics of water deals. The last section provides a summary and concluding observations.

Section-2 Agro-climatic Characteristics of the Study Region

The Vaigai river, which is one of the important rivers of Tamilnadu state, originates from the eastem slopes of westem ghats and enters into the sea after travelling a distance of 295 KM. The total area covered by this river basin is about 7031 sq.km.

The normal average rainfall of Madurai and Ramanathapuram districts (erstwhile composite districts covered by this basin) are 902mm and 839mm respectively, which is 5 percent and 12 percent less than the

State's normal rainfall. In this region the north-east monsoon (October-November) fetches the bulk of the rainfall (about 50 per cent). The rainfall statistics from 1900 to 1984 show that it was below normal in 43 and 45 out of 84 years in Madurai and Ramanathapuram districts respectively. Moreover, the bulk of the rainfall is brought in a span of two or three days, resulting in heavy surface run-off. Therefore, only a part of the rainfall recharges the aqifer leaving a big margin between the extraction and recharge of sub-surface water. The problem of over extraction seems to be more acute in Ramanathapuram district. Potential evapo-transpiration rates (PET) are much higher than the rainfall in all the months except October and November during which period the monsoon is active in both the districts. The PET in both the districts varies from 164mm to 257mm during the months of January to August and in the same period the average rainfall varies from 9mm to 60mm. During September - December, the PET varies from 100 to 168mm and the rainfall from 46mm to 183mm.

The major sources of surface irrigation in the Vaigai basin have been canals and tanks. However, intensively irrigated crop land is concentrated in the upper reaches of the basin (such as the Cumbum valley, Bodi, parts of Periakulam and so on) where the Periyar-Vaigai Irrigation System supplies water. The major crops grown in this area are paddy, sugarcane and coconut. The sparsely irrigated crop land is distributed in the lower reaches of the basin, where the major surface source of irrigation is tanks. There are about 800 tanks located in this area, with a combined command area of 144 thousand acres. Although most of these tanks are system tanks, which are supposed to be fed by the Periyar-Vaigai System, one finds hardly any evidence of these tanks receiving supply through the system[5].

Both Madurai and Ramanathapuram districts which fall within the boundary of this basin, have been classified as hard rock regions and so the availability of groundwater pretty much depends upon the intensity and depth of the weathering and fracturing zones of rocks. The occurrence of groundwater seems to be very low in the tail end portion of the basin (mainly the area comprising of the erstwhile composite district, Ramanathapuram) compared to the other parts. A series of pump tests conducted in the various parts of the Vaigai basin shows that while the depth of wells varies from 21 to 58 meters in the head and central portion of the basin, in the tail portion of the basin the depth varies from 26 to as high as 86 meters[6]. The frequent occurrence of droughts in this region accentuates the problem of water availability and so the water table has been steadily falling in this region. Before getting into the main theme, viz., the water market, I shall discuss in the next section, rather briefly, the extent to which the water table has been falling in this region, with the supporting evidence from the village surveys conducted in various parts of this basin.

Section-3 Secular Lowering of the Water table in the Vaigai Basin

In the last three decades, the development of groundwater irrigation has been quite rapid in Tamil Nadu, both in wet and dry lands. The direct consequence is that in some places groundwater is over exploited resulting in the steep fall in the water table. Moreover, the yield of water from wells has been declining over a period of time. In our study region, farmers adopt several techniques to tap the available groundwater. The most common form of wells found in this region are dug-cum-bore wells, the depth of which goes unto 70 feet plus a 100+ feet bore. Farmers adopt the technology of not only vertical bores but also several side bores (horizontal) in different directions in the same well.

In the first round village survey, which covered 27 villages spread across different reaches of the basin, we addressed simple questions to each one of the sample well owners. The questions concered the original depth of the well[7] at the time the well was first dug, the year when dug the present depth of the well at the time of the survey. The data show that in all the villages the current depth has gone up tremendously, in particular in dry lands. The average time lag between the original and current depths was found to be about 30 years, as most of the wells were dug during the early sixties. For the purpose of this paper I shall present only a summary table (see Tables-1A and 1B)) of all the 27 villages, which covers the entire basin[8].

It may be seen from the table that of the total of 345 sample wells in the wet lands, while 72.4% reported less than 30 feet as their original depth, only 39.7% reported it as their current depth. This implies that about 33% of the total sample wells, whose original depth was less than 30 feet, have moved on to a higher depth range at the time of the survey. Again, the original depth of 20% of sample wells fell in the depth range of 30-50 feet, but as many as 42.3% of the sample wells lie in this depth range at present (current depth). This again implies that 22.3% of sample wells have moved unto this depth range whose original depth was less than 30 feet. Similarly, the percentage of sample wells reporting a depth range of 50-75 feet was 4.1% originally.This has gone unto 14.4% currently. This means that about 10% of sample wells have been deepened to 75 feet whose original depth was below 50 feet. Similar large variations as between original and current depths of wells are striking in the case of dry lands, in particular, in the 75+ feet depth range, which is suggestive of the pronounced possibility that the decline in the water table is much steeper in the dry lands than in wet lands.

TABLE 1A

Depth-wise distribution of sample wells in the Wet lands of the Vaigai basin, 1991-92

Depth Range	Original Depth		Current Depth		
	No of wells Reporting	Per-centage	No of wells Reporting	Per-centage	(4)-(2)
1	2	3	4	5	6
<30	250	72.4	137	39.7	(-) 113
30-50	69	20.0	146	42.3	77
50-75	14	4.1	49	14.4	35
75+	12	3.5	13	3.8	1
Total	345	100.0	345	100.0	

Table 1B

Depth-wise Distribution of Sample Wells in the Dry Lands of the Vaigai Basin, 1991-92

Depth Range (feet)	Original Depth		Current Depth		
	No of wells Reporting	Per-centage	No of wells Reporting	Per-centage	(4)-(2)
1	2	3	4	5	6
<30	334	66.1	159	31.5	(-) 175
30-50	127	25.1	202	40.0	75
50-75	31	6.2	82	16.2	51
75+	13	2.6	62	12.3	49
Total	505	100.0	505	100.0	

Notes for Tables 1A and 1B:

The total number of sample wells selected for the survey was 424 and 660 respectively for wet and dry lands; of these, original and current depths were available only for 345 and 505 wells respectively for wet and dry lands. Wet land refers to the area irrigated by the surface sources and dry land refers to the area which do not have access to the surface irrigation.

Source for Tables 1A and 1B: Survey, 1991-92

The implications of the secular lowering of the water table are manifold [9]. Although a detailed discussion on this subject is beyond the scope of the present paper, it is necessary to take note of certain salient features: First of all fixed investments in well digging and in subsequent improvements such as in well deepening etc go up. It implies that the operating cost of wells also goes up simultaneously. Secondly, a steady decline in the water table may result in the decline in the yield of water per well, the consequence of which is the rise in the unit cost of water pumped. Thirdly, the deepening activities in a well affect adjacent wells too. All the contiguous wells which are served by the same aquifer might need to be deepened in order to preserve their water yielding status. Therefore, what one encounters is a deepening and counter deepening race which eventually not only raises various cost components but also imposes a heavy burden on the new comer who wants to dig a well. Fourthly, the steady decline of water table imposes a heavy constraint on small farmers because, beyond a point they have to take a decision whether it is a rational proposition to dig or deepen the wells when the total cost involved is more than the value of land they own. Fifthly, it is important for the farmers to take a serious view of the fact that to what extent, the wells which are dug and deepened competitively are sustainable, in particular in a situation in which recharges do not match the pumping rates. This problem will be compounded during drought years. Sixthly, small and resource poor farmers, who were hitherto using traditional water lifting devices can no longer keep pace with the lowering of water table. The data collected as a part of the UNDP project in the Vaigai basin in the year 1980 by the Public Works Department, Govt. of Tamilnadu, indicates that there was a large number of animal driven lifts: Out of 27852 wells both in wet and dry lands put together in various villages spread across the Basin, (to which we had access to), as many as one-third were stated to be the wells fitted with animal driven lifts. Whereas, our survey carried out in the basin 11 years later, shows that only 10 out of 414 sample wells in the wet lands (2%) and 22 out of 665 sample wells in the dry lands (about 3%) reported animal powered lifts. It is interesting to note that as many as 92 sample wells in wet lands (22%) and 162 in dry lands (24%) reported no water extracting mechanism. Most of such wells had the signs of obsolescent water lifting devices. These are perhaps the resource poor farmers who have lost in the race of competitive deepening! This is the regime in which commercial transactions in groundwater has been quite extensive, the theme to which I shall turn to in the next couple of sections.

Section 4 The groundwater market in the Vaigai basin

4.1 The extent and prevalence of water market in the Vaigai Basin

In this section I shall present data to substantiate the fact that commercial transactions in groundwater is quite extensive even in a water scarce - low rainfall - hard rock region. Data that I shall present in this section pertains to the detailed study of seven villages - two in the head, two in the middle and three in the tail reaches - of the Vaigai basin.

Two types of information are used in this section: One is information collected through the village thalayari, the lowest grade revenue worker, who is most knowledgeable and the second is through a sample survey of well owners. The first source is almost a kind of census and the type of information collected include the name of each well owner, the name of the water purchasers to whom each well owner sells and the area to which water is sold, the rate for water and the crops grown. This information may be understated in the sense that not all the water purchasers could be perfectly covered in the survey. The data that we got through the sample survey of well owners covers much more detail: area irrigated, number of waterings supplied, number of hours of water supplied, crops grown, rate for water, input application and productivity. In this section I shall present information collected from the sample well owners, only to show the fact that groundwater sale is extensive (See Tables-2A and 2B which provide data on the extent of transactions in groundwater for sample wells).

TABLE 2A

Extent of transactions in groundwater in the selected villages of the Vaigai basin, for wells located in wet land, 1991-92

Name of the Village	Tot. No. wells	No. of sample wells	No. of Ws	No. of Wp	GCA (ac.)	Tot. No. Hours	Tot. Amt. Paid (Rs.)	Av. Amt. per acre (Rs.)
Thadicherry	31	20	1	2	5.30	366	7320	1381
Pudukkottai	15	15	3	5	10.20	118	1180	116
Viruveedu	15	14	1	2	1.00	34	340	340
V.Marudhur	14	14	4	10	8.25	325	5600	679
Munaivenry	22	20	8	29	22.30	2288	9292	417
Kalpiravu	17	17	4	58	120.82	933	3136	26
Kamudhakudi	10	9	7	55	34.13	2181	14650	429

Note : 1. Wa = water seller; Wp = water purchase; GCA = Gross cropped are

2. Number of water purchasers refer to those who transacted with the water sellers reported in the table

Source: Survey, 1991-91

TABLE 2B

Extent of transactions in groundwater in the selected villages of the Vaigai basin, for wells located in dry land, 1991-92

Name of the Village	Tot. No. wells	No. of sample wells	No. of Ws	No. of Wp	GCA (ac.)	Tot. No. Hours	Tot. Amt. Paid (Rs.)	Av. Amt. per acre (Rs.)
Thadicherry	141	20	1	1	2.00	80	600	300
Pudukkottai	135	20	1	1	2.50	40	400	160
Viruveedu	368	20	nil	nil	nil	nil	nil	nil
V.Marudhur	47	20	2	2	1.60	30	NA	NA
Munaivenry	20	18	6	25	21.65	2398	12071	558
Kalpiravu	23	20	4	33	36.00	950	3290	91
Kamudhakudi	25	20	7	87	104.40	9331	54132	519

Note : 1. Ws = water seller; Wp = water purchase; GCA = Gross cropped are; NA = Not available

2. Number of water purchasers refer to those who transacted with the water sellers reported in the table

Source: Survey, 1991-91

It may be seen from the table that the sale of water is quite extensive in the sample villages: There are altogether 28 water sellers who sell to a total nurnber of 161 farmers in wet lands and 21 selling to a total number of 149 in the dry lands. This constitutes 25% and 15% of the sample wells selected for the survey engaging in water sales[10]. The total gross area irrigated by purchased irrigation is 202 acres in wet lands and 154 acres in the dry lands. However, the most interesting information is the total amount transacted every year by way of water sales: In wet lands, in all the 7 villages together, the total amount

transacted in the year 1991-92 was Rs.41,518 and in the dry lands it amounts to Rs.70493 (excluding one village for which information is not available). The average amount paid per water purchaser varies from Rs.54 (Kalpiravu) to Rs.3660 (Tadicherry) in the wet lands and from Rs.100 (Kalpiravu) to Rs.622 (Kamudhakudi) in the dry lands. The value of water purchased per acre of gross cropped area varies from Rs.26 (Kalpiravu) to Rs.1381 (Tadicheny) in the wet lands and Rs.91 (Kalpiravu) to Rs.558 (Munaivenry) in the dry lands. This variation in the value of water purchased per acre is mainly because in some villages water is purchaaed for the entire crop season (eg. Munaivenri and Kamudhakudi), while in others, only a few waterings are purchased (eg. Kalpiravu and Vavidal Marudhur). Moreover it also varies according to the price charged for water. For instance, in Tadicherry the rate for water is Rs.10 per hour in wet lands and varies from Rs.15 to Rs.20 per hour in dry lands. In Kamudhakudi, the rate varies from Rs.6 to Rs.7 in both wet and dry lands. In Viruveedu, it varies from Rs.5 to 12 in both wet and dry lands; and in Munaivenri the rate varies from Rs.3 to Rs.5 in both wet and dry lands. In Kalpiravu, Pudukkottai and VavidalMarudhur, the rates charged are Rs.3, Rs.10 and Rs.15 respectively and one finds no intra-village variation in these villages. The inter-village and intra-village variation in the rate charged is likely to result from the differences in the type of water extracting mechanism installed or the availability and the delivery of water in a well, the type of water conveyance system constructed such as pipe lines, lined or earthen channels etc. In Munaivenry for instance, the delivery of water is so low that it takes several hours for each watering of one acre of land. Therefore, the rate charged is very low compared to other villages (Rs.3 to Rs.5 per hour). By contrast, the rate charged is Rs.15 to 20 per hour in Tadicherry, not only because the yield of water is good in this village but also because most of the water sellers have invested in a costly and modem water conveyance system (pipe lines) to convey water. Also,the rate for water in the wells fitted with oil engines is much more than those which are fitted with electric motors partly mainly because the price of diesel (fuel for running the oil engine) is substantially higher compared to the price of electricity and it goes without saying in a Tamilnadu state, where the farmers enjoy 100 percent subsidy in electricity.

One further point is in order. The incidence of trading in groundwater for irrigation appears to be low and seems to be even insignificant in some villages. It was reported during our village survey that the incidence of water sale would have been much higher than what in fact was observed, had there been sufficient surplus water available for sale. A majority of non-well owners and those whose wells have dried up, had expressed the desire and need to purchase water, but there were only a few (well owners with surplus water) to sell. What follows next is the brief village case studies to introduce the emerging forms of water contracts in the context of the secular lowering of the water table.

4.2 New Forma of Transactions in Groundwater - Brief Village Case Studies

It has been pointed out in the introduction that it would not be profitable for a water seller to sell water beyond a critical minimum of water reserve, because at that point to make the water deal profitable, a water seller might have to pitch the price in such a way that it at least matches the income that he might generate from his own land by using that minimum available water. At that price on the other hand, it might not be a profitable deal for a water purchaser, since the price of water would be too high, that he might have to part with his (at least) entire farm income generated by using the purchased water. Thus, logically it follows that water sale might not take place under such circumstances, although one may face a situation in which there is excess demand over supply.

At the surface, the problem appears to be as explained above in the study villages; but a deeper look at the study villages brings out the fact that a few have recouped investment costs and proved successful and have also started gaining control over the village economy by means of greater access to this precious resource. It is also fascinating to note that in the changing groundwater conditions, characterized by steady decline in the water table, low yield of water from wells and so on, new forms of water transactions have

emerged. Moreover, as a water conservation measure, concrete pipelines or hose pipes are extensively used for conveying water. It has been reported that farmers have resorted to this technique of using pipelines on an extensive scale only since the 80s and until then only earthen channels were used for conveying water. Another mechanism by which farmers have overcome the problem of low yield of groundwater is by way of joint use of water from more than one well at a time. In other words, adjacent well owners, who perhaps share the same aquifer and face more or less a similar situation, jointly channel their waters to irrigate a plot of land of either their own or plots of non-well farmers - water purchasers). What follows next is the empirical evidence by way of brief case study of individual villages:

1. Tadicherry (Head Reach) :

As per the sample survey (see Tables-2A and 2B), the incidence of water sale in this village appears to be insignificant; one reason why our samples did not capture the incidence of water sale is due to the fact that the respondents were extremely reluctant and afraid that the intention of the survey is to reintroduce the electricity tariff. Therefore we resorted to get information also from the village thalayaris (lowest grade revenue workers) and the knowledgeable village farmers, with a view to get a somewhat total picture of the village. As per the information provided by the thalayaris there are altogether 16 water sellers, selling to a total of 62 water purchasers and the total area benefitted was 31 acres in wet lands and 81 acres in dry lands; by and large, water is purchased for paddy in both wet and dry lands.

This is an unique village, where farmers have laid extensive pipelines, linking wells located in the wet lands and far off dry lands where the majority of wells have stopped yielding water. As per our own count, there were at least 16 farmers who have laid pipe lines to a total length of 38 km; of this, one person alone (a powerful local politician) has laid to a length of 11.5 km, connecting a well dug close to the Vaigai river and his lands in the village. The availability of groundwater in the wet lands and the potential demand for water from non-well owners have prompted farmers to invest in such costly projects. Most of these farmers pump water from the wells located in the wet land and store the same in their wells located in the dry land and pump again for irrigating the plots of land close to that well. Note that such farmers' energy consumption is doubled, since water is pumped twice for irrigation. The rate at which water is transacted in this village varies from Rs.15 to Rs.20 per hour, depending upon the distance of the well which supplies water from the plot of land which requires irrigation and the length of the pipe line. These rich farmers (water sellers) have also gained a high social status and take all major decisions concerning the village.

2. Pudukkottai (Head reach) :

Water sale has been reported to be a recent phenomenon in this village, which came to be practiced around the late 70s. As groundwater table has dropped very deep in the dry land and since very few well owners have surplus water to sell, the incidence of water sale is relatively seen more in the wet than in dry land. Water is purchased for paddy and sugarcane in the wet land and for cotton and vegetables in the dry land. The price for water varies according to the horse power (HP) of the electric motor or the type of water extracting mechanism installed. If an oil engine is installed in a well, a water purchaser has to pay Rs.15 per hour of water supplied in addition to meeting the cost of diesel (fuel for running the engine). In the case of electric motors, while 5 hp fetches a price of Rs.10 per hour, 7.5 hp fetches Rs.15 per hour.

3. Vavidalmarudhur (Middle reach)

Water sale in this village is slightly more prevalent in the wet than in dry lands. Most of the water purchasers are non-well owners who resort to purchase of a few waterings towards the end of the second season when the tank water is exhausted. The rate for water varies from Rs.12 to Rs.20, depending upon

the type of water extracting mechanism installed and distance of a well and water a purchaser's plot of land: We found in one particular case in dry land, a water purchaser was charged as high a rate of Rs.40 per hour; in this case, water has to be conveyed to a distance of about 500 meters and moreover, the water seller has installed oil engine to pump water.

The most striking, however, is the case of a water seller, who has dug a well in the poromboke land (govemment land). This well yields very good water and is pumped almost round the clock. A few sugarcane growing non-well farmers (whose total extent of land is 10 acres and the gross area cultivated in a year is 30 acres) entirely depend upon this well water for the entire period of crop growth. This well owner has been supplying water to these small sugarcane growers for the past 5 years at the rate of Rs.15 per hour. In fact, it is interesting to note that the sugar mill (located close to this village) which gives permits and advances loan to buy necessary inputs, warrants assurance from this water seller (before advancing loan to these small farmers) that he would supply (sell) water throughout crop period. Moreover, at the beginning of each season, the sugarcane inspector (from the mill) visits the village and inspects the water availability in the well.

4. Munaivenri (Tail reach) :

This is a very interesting village, where three types of water sale were found: a) Selling water to well owning farmers, whose wells yield inadequate water; b) joint sale of water at a time by more than one well owner to a single water purchaser and c) sale of water by a single well owner. The first is the case in which one well owner sells water to another, whose well yields insufficient water. The water purchasing well owner, either pays for water at the rate of Rs.10 per hour or compensates by way of supplying water from his own well as desired by the water seller. The majority of well owning farmers resort to purchasing water in this manner towards the end of a crop season. The second is a non-typical case in which more than one well owner supply water at a time to a water purchaser; in this case a water purchaser is either a non-well owning farmer or a well owner. Very often a well owning purchaser is also a seller in the same way as he purchases. In other words, several wells which are contiguous, yield very little water, that it is not possible to irrigate a plot of land. In order to make use of the available water in a meaningful manner, such adjacent well owners join together and pump water at a time from their wells to irrigate a plot of land. Very rarely well owners exchange water in this case, for requirement of water varies according to season and the type of crop grown. Therefore, in a majority of the cases, water is transacted for cash at the rate of Rs.3 per hour. The rate for water appears to be very low but note that the quantum of water delivered from a well is also relatively low; moreover, a water purchaser has to pay to more than one well owner at a time - very often to three well owners, and in which case the rate for one hour of water supply is Rs.9. It was reported that in this type of irrigation, at least three wells have to pump water roughly for about ten hours for each watering (it depends upon the size and distance of the plot that receives irrigation and sometimes it takes even more time). This means that totally 30 hours of electrical energy is consumed to irrigate a plot of land once, and the price paid by a water purchaser is Rs.90 per watering. But, since the electricity is supplied free, water sellers pay practically nothing for the energy consumed. And note also that the most vulnerable section is the non-well owning purchasers.

The third type is the most generally observed one in which one well owner sells water to non-well owning water purchasers, at a high rate of Rs.15 per hour. As a general rule (applicable in all three types), payments for water should be settled before purchasing the next watering.

In this village, as is the case in many other villages, water is not conveyed through open cut earthen channels; with a view to conserve precious water, hose pipes are used for conveyance. If a water purchaser does not have a pipe, water seller hires out one, at a rate of Re.1 per hour. Very often, the hose pipes are hired-in for the whole day, so that the rent for pipe is reduced to Rs.20 (for 24 hours) and also they

have the flexibility of using the same pipe for purchasing water from more than one water seller. We found absolutely no difference between the wells located in the wet and dry lands and the crops grown depend upon the availability of water; if adequate water is available, paddy is preferred to any other crop; otherwise vegetables, chilly, groundnut and cotton are grown.

5. Kalpiravu (Tail reach)

In this village there are six water sellers who sell to as many as 140 water purchasers as per the information provided by the village thalayari. Power centers around these six water sellers in the village as may be evident from the fact that most of the decisions conceming the village affairs are taken only in consultation with them. One of the water sellers is also a foodgrain trader, who sells water and get paid in kind after the harvest and moreover purchases output from his water purchasers. The interviews with the water purchasers revealed that the price paid is always less than what is prevalent in the market but have no option as that would mean antagonizing the water seller. This is a classic case of water market getting interlocked with product market[11]

The water sellers in this village seem to be much more systematic in so far as maintaining records for each individual water purchaser. The type of information recorded are date of purchase, plot which received irrigation, number of hours purchased, crop irrigated and so on. Most of the water purchasers make the payment for water only after the harvest and some of them also pay the equivalent of cash in kind (paddy). However, the most interesting point to note is that as an informal rule, those who defer the payment until harvest have got to render some 'small' services to water sellers which are not clearly defined. Quite apart from this, there are some water purchasers who have small plots of land, work in the water seller's land for various agricultural operations in order to adjust labour services against the payments for water that they owe to water sellers. These water purchasers have to work whenever the water sellers require their services. These are again the cases where the labour market is interlocked with the water market. We could not ascertain more on this issue as water sale has been one of the most sensitive issues in the rural Tamilnadu, particularly since electricity is supplied free. It is also fascinating to note that the plots of land situated close to these six wells fetch better price and are highly demanded. This is in contrast to earlier days, when a plot of land situated close to a tank sluice used to command a higher price.

The rate for water also differs according to the quality of water: out of six wells, three supply good water suitable for paddy cultivation and charge a rate of Rs.10 per hour; water from other three wells is somewhat saline and is suitable only for chilly and sugarcane; the price charged is Rs.5 per hour.

6. Kamudhakudi (Tail reach) :

This is another village where water sale is quite in prevalence. There are a few water sellers, whose wells yield good water and who sell to a large number of non-well farmers. As per the infonmation collected from the thalayari there are about 200 water purchasers and the rate for water range from Rs.6 to Rs.12, depending upon the distance of the plot, lifting mode used and horse power of the motor installed. It is interesting that most of the water purchasers possess their own hose pipes for conveying water to their plots, as otherwise water sellers will not supply water.

Quite a few water purchasers exchange their labour service for water mainly for ploughing operation. It was reported that during peak season or whenever there is rainfall, water sellers would call the water purchasers (who opt for setting the dues by way of working) to bring their ploughs and bullocks for ploughing operations. That will be at precisely the time when they themselves have to undertake that operation in their land. But water purchasers cannot deny this form of repayment, as that would mean water will be ceased in the subsequent seasons.

On the whole, a series of brief village case studies may help one to understand the emerging forms of water contracts and the intricacies involved in the water deals and wide variations in water transactions, not only across villages but even within a village.

5. Summary and Conclusion :

The central issues addressed in this paper are: The extent of functioning of groundwater market and its changing characteristics in a regime which has witnessed secular lowering of water table; and the extent to which the commercial transactions in groundwater are competitive. The evidence provided in this paper indicate that trading in groundwater is quite extensive even though water table has been falling steadily. It also brings out the fact that the institutional characteristics and functioning of water markets have been undergoing a transformation in such a way to adjust to the increasing scarcity conditions of this precious resource. For instance, it has been noted that in most of the survey villages, water is conveyed from wells to different plots of land by way of pipe lines (permanent structures) or hose pipes in contrast to earlier days when water was conveyed through open cut earthen channels. This has also facilitated well to do farmers to convey groundwater to a distance of several kilometers, to transfer water from wells located in the wet land to dry land and so on, not only to irrigate their own land but also to sell water. In some villages since yield of water is very low, contiguous well owners adopt the technique of joint pumping of water from their wells at a time, to irrigate one plot of land. They settle the transaction either by way of exchange of water or for cash. In effect, under the changing conditions, each electric motor has to run for several hours more to pump a given quantum of water; in some cases, as we have observed, electric motors are run twice to pump the same water, as water from one well is pumped to be saved in another well only to be pumped again for irrigation the next day. It is one thing to appreciate the efficiency with which farmers / well owners handle the scarcity conditions. But it is another to measure the social cost involved in the matter. In fact, one of the serious implications of the changing characteristics of groundwater irrigation in this region has been the manifold increase in the energy consumption. But well owners keep pumping water oblivious of the energy cost involved, precisely because they pay practically nothing towards the electricity tariff and enjoy a one hundred per cent subsidy.

Let me tum to the second issue: To what extent the market for water is competitive? The basic theoretical requirements which may designate a market perfectly competitive are; a) clear demarcation and definition of goods and services exchanged in the market; b) prevalence of many buyers and sellers; c) homogeneity of the product; and d) prevalence of single price in the market.

As far as the first condition is concemed, it is a known fact that the property rights in groundwater are ambiguous, in particular because this resource has been recognized as one of the crucial common property resources. It is difficult to define property rights on groundwater in tems of a "bundle entitlement" comprising an owner's privileges in use as well as in selling. The second condition that there should be many buyers and sellers in the market only indicate that no single seller or buyer can alter the price. The village case studies presented in this paper bring out the fact that while one finds a large number of buyers, the sellers of water are but few. This is particularly important in the context of a steady decline in the groundwater table in which well owners are involved in competitive deepening. Eventually, only a few who have better access to resources sustain the race and also emerge as potential water sellers. c) The third condition, homogeneity of the product perhaps, requires some laboratory tests; but, at least in one village we have witnessed a large variation in the quality of water. This is not uncommon. d) The last one, viz., 'prevalence of single price in the market,' needs no substantiation as it has been made clear in this paper that rate for water varies not only across villages but even within a village. The rate for water depends upon several factors such as the speed and the extent of delivery of water from a well, type of water extracting mechanism and the horse power of the motor installed, the distance of the well from the plot which requires irrigation, the type of water conveyance method used, quality of water,

personal relationship between the agents involved in the trade and so on. In several cases we also witnessed payments due for water is adjusted against the labour services of the water purchasers and also their output. In the process, water market is interlocked with other agrarian markets such as labour and product markets. This is the reflection of unequal access to resources and the poor bargaining capacity and dependent status of water purchasers vis-a-vis water sellers /water lords[12]. Therefore, it is undoubtedly clear that the market for water, at least in the context of the villages studied in the Vaigai basin, is far from being competitive and a few emerge powerful to exercise control over this precious resource and use this as a mechanism of surplus extraction[13].

NOTES

1. This is a part of the larger study on "Costs and Productivity of Irrigation in Tamil Nadu", funded by the Union Planning Commission.

2. For instance see, Boyce,1986, Palmer-Jones and Mandal,1987, Shah and Vengamaraju,1988, Vaidyanathan and Janakarajan,1989, Kolavalli and Chicoine,1989, Ruth Meinzen-Dick and Martha Sullins,1993).

3. Farmers around Tiruppur town and in the adjacent villages in Tamil Nadu - the area which is well known for steep falling in the water table - find it lucrative to sell water to the urban consumption. In fact, many of them have almost stopped their cultivation and engaged in the water selling as a full time occupation.

4. For details on the methodology of village and sample wells selection, see, Janakarajan,1992a.

5. For more details, see, Janakarajan,1992a.

6. Water Resources Assignment of the Vaigai Basin , Institute of Water Studies, Public Works Department, Government of Tamil Nadu, Madras.

7. "Depth to water table" instead of "depth of wells" would have been a useful indicator for analyzing the lowering of water table. However, there were practical difficulties in collecting reliable data on "depth to water table" in particular because, water is constantly pumped from wells and so it is subject to a lot of fluctuations within any given day. Therefore, depth of wells have been used for this analysis.

8. For a disaggregated level information, see, Janakarajan,1992a.

9. See also in this context for an elaborate discussion on the management of aquifer over-exploitation and its environmental consequences, Young,1993 and Todd,1992.

10. In fact, the incidence of water sale captured through our sample survey is somewhat understated; many of them were reluctant to answer as there was a general fear that the motivation of the survey is to reintroduce the electricity tariff. Tamil Nadu is a state, where, farmers are enjoying hundred percent subsidy in the use of electricity for agricultural purposes.

11. See Janakarajan,1992b, for evidence on interlinkage of water market with other agrarian markets.

12. See for a detailed discussion on this issue, Janakarajan,1986 and Ruth Meinzen-Dick and Martha Sullins,1993.

13. See in this context, Brajer,et al.,1989, and Bowlen etal.,1991.

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