Estimating the Price of Water in Pondicherry, India: A Framework for Policy Analysis

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Abstract A rapid increase in the use of tubewells for irrigation has led to a falling water table, increasing levels of salinity and falling crop yields. The Tank Rehabilitation Project, Pondicherry (TRPP) aims to halt this process through a participatory rural development programme to rehabilitate all irrigation tanks in the region over a seven-year period. Recognising the vital importance of the policy framework, this paper outlines progress to date with a water pricing study that will make recommendations to achieve optimal use of surface and ground water. The present financial cost of water faced by tubewell owners is well below the economic cost because tubewell owners pay only a nominal flat rate fee for electricity and receive subsidised drilling and loan finance. Tubewell owners face a marginal cost of water that is close to zero but because of their market power are able to extract significant rent from water buyers. The present policy framework is inefficient (it encourages wasteful use of water and electricity), inequitable (it subsidises tubewell owners but not water buyers) and unsustainable (present policies will lead to saline intrusion and a falling water table). The challenge is to find policies that will ensure that groundwater extraction is kept at sustainable levels and to find ways to efficiently allocate water between different users. The emphasis must be on identification of policies that are realistic within the current political and institutional framework.

1. INTRODUCTION

Pondicherry region is one of four enclaves which constitute the Union Territory of Pondicherry a former French colony. Situated on the coast around 160 km south of Chennai (formerly Madras), it has one of the highest per capita incomes in India. This can in part be attributed to its low tax status which has encouraged a rapid rate of industrialisation and inward migration. The overall geographical area is 29,377 ha of which approximately 30 per cent was devoted to non-agricultural uses (urban and industrial) in 1993/4. The 1991 census recorded a population of 590,000 of whom around 68% lived in urban areas.

Historically most of the region was irrigated from tanks (reservoirs) which filled up during the monsoon season. Shallow wells were used only to provide pre-monsoon water for rice nurseries and land preparation and to supplement surface supplies during dry years (Tank Rehabilitation Project Pondicherry, 1996). However since the 1970s the government has heavily promoted the drilling of tubewells, by providing free electrical connections, subsidies for drilling and highly subsidised or free electricity supplies. By the 1990s there were over 7000 tubewells operating in the region resulting in a rapidly falling water table, intrusion of seawater into the groundwater aquifer and falling crop yields. The situation has been exacerbated by rapid increases in withdrawals for industrial and household use in the vulnerable coastal belt.

The Tank Rehabilitation Project, Pondicherry (TRPP) aims to preserve agricultural incomes from crop production in the Pondicherry region, diminish reliance on underground water resources and halt the process of salinisation of the aquifers (Tank Rehabilitation Project Pondicherry, 1996). This is to be achieved through a multi-disciplinary, participatory rural development programme to rehabilitate all irrigation tanks in the region over a seven-year period.

Recognising that these objectives can only be achieved under an appropriate policy framework, a study was commissioned to assess the financial and economic price of surface and groundwater under a range of conditions and to make recommendations for achieving optimal use of these resources. This paper outlines research methods, the progress which has been made on this study to date and some preliminary findings and policy implications.

2. THEORETICAL FRAMEWORK

The current consensus that water should be treated as an economic good can be dated back to the Dublin statement of the International Conference on Water and the Environment which stated that "water has an economic value in all its competing uses and should be recognized as an economic good" (World Meteorological Organization, 1992).

Briscoe (1996) provides a clear explanation of the theory of water as an economic good. "The idea of water as an economic good is simple. Like any other good, water has a value to users who are willing to pay for it. Like any other good, consumers will use water so long as the benefits from use of an additional cubic metre exceed the costs so incurred ... Welfare is maximized [for the group, or society as a whole] when:

- water is priced at its marginal cost; and
- water is used until the marginal cost is equal to the marginal benefit" (Briscoe, 1996).

Ground water has two further characteristics. It is renewable and it is a common property resource. If rate of use exceeds natural replenishment then the water table will fall. As a common property resource it is characterised by overexploitation and dissipation of scarcity rent (Tietenberg, 1996, p. 51). However the precise effects of groundwater exploitation depend crucially on a range of factors. Janakarajan (1993) and Mosse (1996) emphasise institutions, culture and history in their explanations for the decline in tank irrigation. While Shah (1993) points out that tubewell ownership in India is highly skewed and allows owners to extract an economic surplus from what was once a common property resource.

The principles underlying the analysis of water as an economic good, and as a renewable common property resource have been clearly elucidated in the literature. The challenge is to apply these principles to the muddied waters of the real world in order to encourage optimal use of this increasingly scarce resource.

3. RESEARCH METHOD

Primary and secondary data will be collected and analysed in order to assess the financial and economic price of surface and groundwater under a range of conditions and to make recommendations for achieving optimal use of these resources. Data collection activities will include a baseline survey to provide information for project planning, monitoring and evaluation purposes. It will have two components: a detailed study covering agricultural, social and economic aspects of selected tanks and their associated communities and an inventory of all tanks in the region. Data from both components will be used in analysis of the cost and value of water.

The detailed study will be carried out in seven sample tanks. These have been selected based on characteristics such as cropping pattern, prevalent pumping system, groundwater availability, size of tank, degree of urbanisation etc. Formal survey methods will be supplemented by group discussions, discussion with key informants and participatory rural appraisal in order to gain a detailed understanding of the important issues for all stakeholders. Sample strata will include water buyers and water sellers in order to be able to compare responses relating to water prices and the prevalence of alternative contracts. Some tubewell and irrigation details will be recorded by direct observation – including direct measurement of yield (cubic metres per hour) and water use for a sample of wells.

The inventory of all tanks in the region will be based on compilation and review of all existing village level data and brief (1-3 day) visits to all of the 84 tanks covered under the project. The end product will consist of a database covering selected key variables and a brief profile for all tanks. This will cover social, agricultural, economic and technical aspects of the tank, the irrigated area and the communities who make use of these areas.

4. PRELIMINARY FINDINGS

The preliminary findings presented in this section are based on a review of secondary sources and preliminary field visits. They may be subject to substantial revision, as data from the baseline survey becomes available. All prices are reported in Indian Rupees (Rs) and paise (0.01 of a Rupee). In April 1999 the exchange rate was Rs 42 = US$1. Detailed calculations and assumptions have been omitted because of shortage of space but are available from the author on request.

4.1 Financial Cost of Groundwater

Preliminary estimates suggest that the financial cost of water faced by tubewells owners in Pondicherry is in the range of Rs 0.10 - 0.80/metre^3 metre. The wide range reflecting the difference in cost between installing a new submersible tubewell and projected maintenance and replacement costs for existing 'mortgage free' wells. The cost of water from these wells is Rs 0.10 – 0.12/metre^3.

Many farmers/cultivators do not own tubewells and depend on purchasing water from private tubewell owners. According to Shah (1993) payment for water in India takes a range of forms as markets become increasingly sophisticated and efficient:

i. labour contracts in which the buyer provides labour and draught power to the seller in return for water
ii. crop sharing contracts in which the seller provides only water
iii. crop and input sharing contracts in which the seller provides water and a share of other input costs
iv. cash contracts based on area irrigated of a particular crop, price per hour of pumping or per kWH of power used

Preliminary fieldwork suggests that crop sharing (category ii) is the predominant form of contract in Pondicherry. Most contracts are for a fixed quantity of paddy per area irrigated, rather than for a fixed proportion e.g. one third of the crop. A compilation of estimates of the price of groundwater in local water markets is presented in Table 1. It may be seen that all local estimates fall within the range of Rs 0.30- 0.50/metre[3].

Water Cost (Rs/m^3, 1999)	Source or Contract Type
0.33	Contract for one third of crop
0.39	Contract for 6-8 bags per *Khani* (local area unit)
0.40	Palanisami el al [1997 #630] survey in Tamilnadu
0.50	Copestake (1986) data for Madurai district of Tamilnadu

Table 1: Estimates of the Cost of Groundwater Traded in Local Water Markets

Mathevan Suresh (1996) studied the water markets in two coastal villages in Pondicherry Region in 1995/6. He presents some interesting data on the effect of well ownership on variables such as production and makes seven generalisations based on his field investigations:

i. groundwater markets are very localised, each farmer transacting with only a few other farmers;
ii. the number of sellers is few, and can be expected to drop as falling water tables force deepening of wells;
iii. unequal access to groundwater and poor bargaining capacity has created a dependent status of water buyers vis-à-vis water sellers;
iv. most of the water sellers are large land owners and water buyers are mainly small farmers and tenants;
v. the frequency of irrigation (which depends on the crop) determines the terms of water transactions – cash or crop share;
vi. tubewell owners have higher cropping intensity, higher yields and more crops under water intensive crops; and
vii. water buyers have no rewards or incentives for using water efficiently.

4.2 Financial Cost of Surface Water

The financial cost of surface water to farmers can be calculated by estimating annual surface water use and dividing it by a typical farmer's contribution both in cash and in kind. In Tamilnadu farmer contributions to annual tank maintenance are reported to be around Rs 150 per irrigated hectare per year. Such a level is likely to be below requirements if all regular maintenance works are to be carried out by farmers. Nonetheless it should be recognised that there will be strong resistance to payment of all maintenance costs by farmers. If we assume that farmer annual maintenance contributions in Pondicherry Region will be in the range Rs 150 to Rs 500 per irrigated hectare, then the price of surface water per cubic metre will be Rs 0.02 – Rs 0.05.

4.3 Financial Value of Water

In Pondicherry agricultural water markets exist in most places. Since water is becoming increasingly scarce it can reasonably be assumed that "the price at which water rights are sold more nearly reflect irrigation's productive value to the buyer than its cost to the seller which is often subsidised by the government" (Maass, 1976).

In other words water buyers will be willing to pay close to the value of water in terms of the extra production which they will gain. Water sellers would in theory be willing to sell for as little as their marginal cost of water, but since they face very little competition they are able to appropriate most of the benefits from use of extra water.

Based on this framework, the value of irrigation water can be assessed based on standard 'with/without' project appraisal techniques. This involves projection of net income from an optimal cropping pattern without extra water; and net income from an optimal cropping pattern with extra water. Assuming other factors are held constant, then the difference the between the two (the net benefit) may be attributed to water and a per unit value can be estimated. The value calculated in this way will be an *average* value and will vary depending on the crops grown productivity and other factors. In Pondicherry the value of irrigation water clearly exceeds Rs 0.33/metre since this is a price that all buyers are willing to pay (see Table 1).

Average value should be distinguished from marginal value i.e. what is the value of one more unit of water. The marginal value of irrigation water is very low or zero at times when farmers over irrigate. It is very high at times of water scarcity, particularly when these coincide with critical stages of plant growth. The value of water also depends on its source and reliability. Tubewell water has the highest value because it is reliable and under the farmers control. Tank water typically has a much lower value because it is less reliable and dependent on cooperation with other farmers.

4.4 Economic Cost of Water

In economic cost benefit analysis, we are interested in the price or return to the whole of society. The price of groundwater faced by tubewell owners does not reflect the real price paid by India as a whole for a number of reasons. The most obvious being that farmers do not have to pay the real cost of the energy which they consume, nor do they have to bear the cost which they impose on others by lowering the groundwater table and causing saline intrusion. The prices and incentives faced by Indian farmers are subject to a complex web of government subsidies, taxes, regulations and controls. In Pondicherry many farmers also receive a package of subsidies covering seeds, fertilisers and agro-chemicals. Assessment of the economic cost of groundwater should be based on the financial analysis but with the following adjustments:

- electricity should be valued at its economic cost;
- prices should be adjusted to remove the effect of government taxes and subsidies; and
- an attempt should be made to assess the cost of groundwater extraction on other users.

One way of measuring the economic cost of electricity in India is through the opportunity cost approach - what is the cost to the country of supplying one extra unit of electricity to rural tubewell owners? Pursell and Gulati of the World Bank (1993) estimated the long-run marginal cost of power generation and distribution at about Rs 2.8/kwh (adjusted to 1999 prices) and higher than this in rural areas owing to the higher cost of distributing there. They point out that the "true opportunity cost of electricity is best indicated by the cost of generation from the standby generators used by practically all large and medium Indian manufacturing firms. This is usually well in excess of the marginal cost of supplies from the grid."

Private power companies are reported to have entered into long-term contracts with the Government of India to supply electricity to the grid at at Rs 2.45 Rs 2.65 per kwh. While private sugar mills in Tamilnadu are paid Rs 2.48 for supplying electricity to the grid. Assuming a distribution cost of Rs1/kwh this indicates a long run marginal cost of supply of around Rs 3.5/kwh. Indicative analysis of the economic price of groundwater has been based on an electricity price of Rs 3.50 per kilowatt hour, economic values have so far been adjusted for some major distortions only e.g. the cost of electricity and the cost of drilling.

Based on the above, the economic cost of groundwater is of the order of Rs 0.65-2.45/metre^3. This value does not include an allowance for the cost of groundwater extraction on other users. The economic cost of surface water will be estimated once the cost of tank rehabilitation is known. Based on expenditure of Rs 25,000 per ha the price would be of the order of Rs 0.57 per cubic metre.

6. SOME POLICY IMPLICATIONS

The financial cost of water faced by tubewell owners is of the order of Rs 0.10-0.80/metre^3. This is well below the economic cost (Rs 0.65 – 2.45/metre^3) because tubewell owners pay only a nominal flat rate fee for electricity and receive subsidised drilling and loan finance (see Table 2). Tubewell owners face a marginal cost of water that is close to zero – because of the low flat rate charging system, but because of their market power they are able to extract rent from water buyers of around Rs 0.30-40 per cubic metre. The owner of a 15 horsepower submersible deep tubewell now pays an electricity bill of Rs 1125/year but may consume electricity with an economic cost of around Rs 70,000 – an annual subsidy to each deep tubewell owner of around Rs 69,000!

	Financial		Economic
	Cost	Value	Cost
Tubewell Owner	10 – 80	30 – 40 +	65 – 245
Groundwater Buyer	30 – 40	30 – 40+	65 – 245
Surface Water	2 – 5	Less	30 – 60

Table 2: Summary of the Cost and Value of Water (paise per cubic metre, 1999 Prices)

The existing pattern of ground and surface water use in the region is clearly not optimal at present:

- Tubewell owners pay a highly subsidised flat rate for electricity and so are encouraged to use water in a wasteful manner.

- water buyers (who are generally much poorer than tubewell owners) pay much more than the marginal cost faced by sellers. This results in significant net transfers from water buyers to sellers;
- water buyers generally buy water for a fixed rate per season; so they do not face any incentive for efficient use;
- use of costly groundwater is encouraged at the expense of cheap surface water; and
- there is no effective mechanism to make consumers face the real cost of excessive groundwater extraction in salinisation of the aquifer (and/or forcing other tubewell owners to deepen their wells).

The challenge is to find policies that will ensure that groundwater extraction is kept at sustainable levels and to find ways to efficiently allocate water between different users. The emphasis must be on identification of policies that are realistic within the current political and institutional framework. In the following section some preliminaries ideas are put forward in order to stimulate discussion.

In theory, the most efficient way of ensuring that consumers treat water as a scarce commodity is to introduce realistic volume based charges. This provides a strong incentive to conserve water and encourages the development of other options e.g. use of tank water (or recycling in the case of industry). Introduction of such charges will require considerable commitment if they are to be effectively implemented in the face of strong opposition.

Ideally all consumers should be metered; this would include domestic drinking water, industrial use, and groundwater for irrigation. In practice the costs of metering small consumers can exceed the benefits so some exemptions may be appropriate. Opposition to metering and realistic water charges is often based on the idea that water is a basic right and so should be provided at a cheap price. One way of reducing any adverse impacts on poor households is through the use of increasing block tariffs. It should also be remembered that the poor generally suffer more than the rich from the failure of policy to address the problems of over-exploitation of the water resource. The problem with projects that aim to introduce water or electricity metering is that the meters often break down or are tampered with. Strong rules will be required if a metering programme is to be effective.

Shah (1993) includes a thorough analysis of the many complex issues relating to public policy and the selection of an optimal system for charging for groundwater. He highlights many of the disadvantages of pro-rata as compared to flat rate tariffs. Under a pro-rata tariff the monopoly position of water buyers tends to be strengthened leading to increasing charges for water buyers. Under flat rate systems this monopoly position tends to be contained and water sellers have very low marginal costs, thus leading to lower water prices. Flat rate systems avoid all of the costs associated with metering and the incentives to pilfer power which strengthen as pro-rata tariffs increase.

Shah (1993, p. 213) concludes that the most equitable method of containing over-exploitation in ecologically fragile areas is through judicious rationing of power supply and moderately high flat rates. The rationed power supply should be of high quality, this implies: uninterrupted, reliable power supply supplied on schedules announced well in advance and targeted to periods of peak irrigation needs. Rationing of power supply is reported to be used to control water use (or at least the cost of the electricity subsidy) in Tamilnadu. The design of the distribution system allows the three phase supply to be cut while leaving two phase supply to domestic users unaffected. In Pondicherry it is reported that separate control of the two systems is not possible. However if power rationing is felt to be a worthwhile policy option then it would be worth investigating the cost of modifying the Pondicherry distribution system to allow separate control of three phase supply to tubewells.

Tradable water rights have many advantages as a mechanism for achieving optimal use of limited water resources. They have been used successfully in a number of countries including the USA and Australia. Pursell and Gulati reported that "By far the most promising method of achieving [efficient allocation between users in Indian agriculture] would be to create conditions which would allow the existence of efficient markets in tradable water rights"(1993).

Establishment of a 'simple' regime of tradable water permits in Pondicherry could involve the following main steps:

- Determine the sustainable level of groundwater use in different parts of the Pondicherry Region (based on groundwater modelling).
- Carry out a broad-based consultation process to agree upon an appropriate division of the groundwater resource between agriculture, domestic and industrial use.

- Estimate the sustainable number of tubewell connections in each village (based on typical HP and hours of pumping).
- Issue this number of tradable permits to holders of existing connections (or based on some other criteria)
- A tradable permit gives the holder the right to one electrical connection in a certain geographic area (probably a revenue village).
- Use of diesel pumpsets would have to be controlled in order to prevent those without permits from extracting water.
- If there are too many connections then government would 'buy them back' – at the free market price.
- If anyone wants a new connection, then they would have to buy one of these permits from an existing holder – at the prevailing free market price. A system would need to be set up to facilitate such transfers.
- A similar system could be used to work towards optimal use of water by medium and large industry. In this case the tradable permit would give an industry the right to extract a certain volume of water in a certain area. Any new or existing industry wanting to extract more water would have to buy permits from other users.
- This would mean that industry would face the real cost of water and so would have considerable incentives to invest in water saving technology. It would also mean that industries which rely on large volumes of cheap water would decide not to locate in the region.

7. CONCLUSION

The present policy framework is inefficient (it encourages wasteful use of water and electricity), inequitable (it subsidises tubewell owners but not water buyers) and unsustainable (present policies will lead to saline intrusion and a falling water table).

The challenge is to find policies that will ensure that groundwater extraction is kept at sustainable levels and to find ways to efficiently allocate water between different users. The emphasis must be on identification of policies that are realistic within the current political and institutional framework. Three policy options have been discussed; realistic pro-rata power tariffs, power supply rationing and transferable water permits. A broad based dialogue should be encouraged in order to assess these and other policies. One thing is certain, policy improvements will be required if serious environmental and economic effects are to be avoided.

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