Poor Provision of Household Water:
Environmental Impact & Private Response

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Abstract

Lack of funds, and generally poor municipal governance has contributed to a situation where much of urban India does not obtain 24 hour water. This has prompted individual households to undertake self-supply measures such as boring underground to access sub-surface water. This has contributed to the dramatic fall in sub-surface water levels and associated environmental damage.

In parallel, a large private sector is emerging in water supply though illegally. Indian laws, partly due to environmental considerations, do not allow private operators to undertake water supply using sub-surface water. In fact, policy has directly or indirectly, discouraged any type of private sector activity in water supply. However, these laws are proving to be un-enforceable due to inability of the local governments to satisfy the demand for water. If the private sector is included and not excluded from water supply and in a legal manner, both coverage and environment would benefit.

Key Words: Poor, Household, Provision, Water, Environment, Private, Response, Urban, 24 hours, India, Laws, Municipal, Sub-surface, Supply, Government, Local, Coverage, Perennial, LPCD, Usage, Kilolitre, Delhi, Public, Energy, Cost, Cities, Scarcity, Supply, Tap, Domestic, Demand, Tank, Tube well, Indicus Analytics, Laveesh Bhandari, Aarti Khare.

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1. Introduction

Provision of water in most countries has traditionally been in the hands of the government. Though water is not strictly a public good, it has been a convention that water supply be in the hands of the government. In India too this is the case.

India is blessed with some of the best natural water resources in the world. It has perennial rivers that are spread fairly evenly across the country, a large coastline, and (generally) high rainfall levels. Large population centers also tend to be spread according to the availability of water. However, much of urban Indian households do not have adequate water available for their daily requirements.

International organizations such as the U.S. Agency for International Development, the World Bank and the World Health Organization recommend between 20 and 40 LPCD (liters per capita daily). This excludes water for cooking, bathing, and basic cleaning. These figures are similar to recommended standards from the UN International Drinking Water Supply and Sanitation Decade and Agenda 21 of the Earth Summit.

Table 1: A Recommended Basic Water Requirement for Human Domestic Needs

Purpose	LPCD
Drinking Water$^{\alpha}$	5
Sanitation	20
Bathing	15
Food	10

Source: Gleik (2000). $^{\alpha}$ This is a true minimum to sustain life in moderate climatic conditions and average activity levels. In warm and hot climates the requirements would be somewhat higher.

Table 1 shows the estimates of per capita water requirements for a region with an average (moderate) climatic condition. However, for hot countries such as India, somewhat larger amounts are required – both for cleaning (better hygiene) and for consumption. The National Capital Territory of Delhi with its extreme climate provides a perfect example. The Master Plan of Delhi (MPD), 2001 recommends 70 GPCD (gallons per capita daily) (265 LPCD), while the Central Public Health Engineering and Environmental Organization's (CPHEEO) manual on water supply and treatment recommends 60 GPCD (227 LPCD) as the minimum requirement of water. According to these estimates, Delhi has a requirement of 827 or 965 MGD (million gallons daily) for 2001-2002 as against Delhi Jal Board's supply capacity of 650 MGD. As is discussed later, even this does not fully reach the consumers.

India therefore has adequate water resources. There is also a water supply mechanism (by way of municipal supply or local water boards) that does process and supply large amounts of water. However, the per capita requirement of water is extremely high – much higher than in most other countries. For instance most European cities supply in the region of 120 to 130 LPCD. Even countries with a similar climate and per capita incomes as India such as

Senegal and Ivory Coast supply in the region of 70 to 110 LPCD.[1] Most Indian cities on the other hand manage to process water at that level, and much more.

Then where is the problem? Take the case of Delhi, India's capital, that has relatively better water supply infrastructure than most Indian cities. Water is processed in the northern end of Delhi, from where it *flows* to the rest of the city. Unlike in most of the world, urban water supply is not pressurized in much of South Asia, its flows are a function of gravity and gradient. Though this is a cheap system to operate, it also creates a serious environmental problem.

Water requirements peak during certain times, typically mornings. During this time households draw the largest proportion of their daily requirements. But the gravity backed water flows are not adequate to service the needs *during this peak time*. Consequently, many households do not receive water. Later sections will reveal how many households as a consequence need a supplementary source of water.

[1] We would like to thank Dr. Vivek Srivastava of the Water and Sanitation Program, The World Bank, New Delhi, for this information.

Figure 1: Perennial rivers and cities of India

The problem is not limited to that of peak hour scarcity. Much of the water is not priced or priced very low.[2] The net revenues to the government of putting in water saving mechanisms are negative. As a result little is done towards this end.

Consequently investments in improving the water supply infrastructure have been very low. Theft and pilferage are rarely monitored and leakages are endemic. As a natural consequence a large percentage of water is 'lost'. Estimates of this loss range from 40 to 60 per cent of the total water processed in Delhi. A similar situation is faced in almost all other South Asian cities as well.[3]

Another associated problem is that of un-priced water in urban slums. These areas receive water at a common source from where it is collected by each household. In many places this source is not even tapped, and water flows and drains away freely whenever it is supplied.

The conditions therefore are such that while much of water is wasted, most households do not receive adequate water. Many households therefore resort to drawing sub-surface water. Many others find other ways of accessing it – such as illegally using pressurized pumps to draw water from the municipal pipes. These second best solutions are costly in many ways.

- First, they involve drawing of sub-surface water on a large scale. This, as we discuss in later sections, causes unobserved and irreversible harm to the environment.
- Second, they are highly energy inefficient, as many households have to draw water using their own motorized pump. Typically many large pumps drawing water require more energy than if water was adequately pressurized at a single point.
- Third, this requires households to store their own water. In the presence of low or no prices, there is inadequate incentive for households to prevent wastage.
- Fourth, poorer households purchase water from private or publicly subcontracted vendors. These vendors transport tankers of water to the neighborhood having scarcity. This leads to high unit cost of water, effort costs, and inconvenience for the poor.

Water supply in India differs from the rest of the world in another way. In no city in the country is water supplied for 24 hours a day. Almost all neighborhoods obtain water once or twice a day. Consequently they are forced to draw and store water for their *expected daily* requirements. And in this drawing and storing, water is lost.

The slow movement of water in its transmission and distribution, leaking pipes, and storage of water have another implication. In the tropical climate parasites multiply rapidly. When water moves slowly, or is stored, this process is further accelerated. When pipes leak,

[2] Generally the reasons ascribed to this are related to inability of the poor to pay. That the water service is poor also contributes to the inability of the government to charge higher prices. But low or no pricing also creates another problem.

impurities also enter the water. Consequently households have to filter and/or boil the water for drinking purposes. Electricity and cooking gas (or LPG) are used up as a result. And households that are unable to do so, have negative health consequences.

In the long term better supply and usage of water will require it to be priced appropriately. The prices in most Indian cities are in the range of Rs. 0.5 to Rs. 5 per kilolitre (if priced, much is non-priced). Experts tend to believe that at about Rs. 15 per kilolitre, households have adequate incentive to not waste the water and have the ability to pay for it. At these levels even the local government can overhaul the water supply infrastructure and undertake overall water saving measures.

The argument that the poor cannot pay for water and therefore this necessity should not be priced is not based on the facts. The relatively poorer population *does* pay for water currently. It pays both monetarily and in terms of the effort required. In later sections we will discuss how poorer households in a slum in Delhi pay Rs. 200 per month for about 500 litres of piped water daily supplied twice a day. At 30 days per month this works out to be Rs. 13.33 per kilolitre. Add the convenience of 24 hour water and the Rs. 15 figure appears to be within reach of poor households. In any event, there are many better ways of subsidizing water than not to price it. This however is not the main focus of this paper.[4]

The point being made here is that if consumers can pay, it is possible to have private sector water supply. Private initiative in water supply has not been encouraged in the past (and even currently). Environmental considerations have perhaps been the key factors behind this orientation. Consequently, many private water supply activities are illegal. In many cases even if such activities are allowed, government functionaries require side payment for the 'privilege' of undertaking such supply activity. Despite such problems, private initiative is growing. And this is simply the result of demand unmet from public/government initiative, and the rapidity and flexibility with which entrepreneurs can respond to changing conditions.

We will later show how the private initiative, even when *not supported by public policy*, does not harm the environment any more than the government's inaction. And perhaps more importantly, it is able to service the poorer sections much better than government bodies. Moreover, private initiative is better at finding economically efficient ways of operations, *given exogenous conditions that are not in its control*. Good policy, therefore we will argue, is about allowing and promoting private initiative and not controlling it, but changing the conditions it functions under. By suitably structuring these conditions both efficiency and environmental goals can be achieved. We will also argue that these *conditions* do not require micro management or micro regulation of the water supply economy, but merely broad policy measures.

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[3] For instance Katmandu, which recently shifted to a pressurized system faced even higher loss, reportedly in the range of 70 per cent.

2. The public provision of water and existing scarcity

This section will hi-light the fact that water is under-supplied in India. The fact that water supply is almost wholly under public hands, only implies the governments' inability to provide this necessity.

Urban India is characterized by poor water supply infrastructure and worse services. Services are generally poor, both for the economically better and worse off. But for the lower economic segments conditions are worse because of their perceived inability to pay.[5] The government supplies water either by way of water boards or municipalities whose revenues are low; a direct impact of this are the lower levels of investments and expenditures on urban services in general. Problems in water supply are especially severe.

This section reports the general conditions of water access by urban Indian households. Provision of water to the people for meeting their daily water needs in Urban India can be deciphered using data from the National Sample Survey Organization's 54th round survey conducted in 1998. 110,313 rural and urban households were sampled in a representative manner in this survey.[6] The figures in the following table only pertain to urban India.

Penetration of municipal water – the tapped 70%

Results show that 70 percent of the urban households have tapped municipal water as their main source of water. The rest have to rely on other sources.

Table 2: Main Sources of Water

Source	No. of Households (Millions)	Percent
Tap	33.3	70.1
Tube-wells	10.2	21.4
Wells	3.2	6.7
Tank/ Pond Reserved for	0.1	0.2
Other Tanks/ Ponds	0.0	0.1
River, Canal, Lake	0.1	0.2
Spring	0.0	0.1
Tanker	0.5	1.0
Others	0.1	0.2
Not Available	0.1	0.1
Total	47.6	100.0

Source: NSSO 54th Round, as cited in Bajpai and Bhandari (2001)

Given that water processing centers have to be located close to the main source of surface water, processed water travels a long distance before reaching many areas. Proper flow of

[4] For a discussion on these issues see "New Designs for Water and Sanitation Transactions: Making Private Sector Participation Work for the Poor, Water and Sanitation Program, World Bank, Washington DC, May 2002".
[5] As in other poor countries a large part of urban India lives in slum like habitats where municipal services are almost non-existent. Moreover, this situation shows no signs of improving due to the generally poor financial health of urban local governments across India; also see Srivastava and Sen, 1997, and Khandwalla, 1999.
[6] See Bajpai and Bhandari, 2000 for further details.

available water is therefore crucial in determining water supply to the population. While the processing center/s may have the capacity to process enough water to cater to the entire city, they may not be able to do so. Water is unavailable to many due to (i) lack of adequate supply infrastructure, (ii) leakage and (iii) illegal access from existing water lines during transportation.[7]

Consider the case of Delhi, India's capital. In 1998-99 the total water processed and pumped by the Delhi Jal Board (DJB) was 545 MGD, i.e. 2475 MLD. Of this at-least 1082 MLD cannot be accounted for. That is 44 per cent of the water supplied by the DJB is lost during distribution (Economic Survey of Delhi, 2001). Water is lost when it goes unaccounted mainly due to leakage in main, communication and service pipes and leaking valves (Suresh V., 1998). According to one estimate about 82 percent of leakage (about 82 per cent) occurs in the house service connection, through service pipes and taps. The remaining 18 per cent is due to leakage in the main pipelines. Moreover, water supply is un-metered in many urban areas. Also significant proportion is supplied, particularly in low-income areas through stand posts resulting in unaccountable losses.[8]

Losses, whether due to leakage in ill-maintained pipes or due to pilferage by households and other institutions, impose two important costs. One cost is borne by the municipality, in terms of lower revenue and the other is borne by the household that has to use alternative sources of water to fulfill their water requirement or has to make do with little amounts.

Table 3: Supplementary Sources of water

Supplementary Source	Households with Principal Source of Drinking Water as Tap Water and Supplementing	Distribution of Households with Principal Source as Tap and Supplementing
Tap	614,564	1.8
Tube Wells/ hand pumps	3,992,515	12.0
Wells	1,521,794	4.6
Tank/ pond reserved for	47,425	0.1
Other tanks/ ponds	40,074	0.1
River, canal, lake	209,466	0.6
Spring	68,572	0.2
Tanker	295,128	0.9
Others	79,876	0.2
No supplementary source	26,396,988	79.3
Missing	1,779	0.0
Total	33,268,180	100
No tapped water	14,172,772	

Source: NSSO 54th Round, authors' calculations

Results from the survey (Refer to table 3) show that 20.5 percent (7 million) of the households that receive municipal tap water supplement their water supply with other

[7] Some consumers break into the water pipe and draw water free of cost, the municipal employees (and sometimes the police) are paid regular bribe for allowing this to continue.

[8] Stand posts are stand alone water pipes that are located in low income areas. Many are untapped. Even when tapped, they are rarely maintained properly. And as a result large amount of water is wasted.

sources. Loss of water during transportation reduces the amount of water received by the households who are paying for the water that they use.

Given that water supply from the municipality is already low priced, a tendency of the households to supplement their water sources only indicates insufficient amount of water received by the households. Especially when the cost of using alternate water supply source is very high. Approximately 12 per cent (4 million) of the households having municipal water as the main source use tube wells and hand pumps as a supplementary source of water. Of all the sources of water, installation of tube wells and hand pumps is the most expensive, requiring an initial lump sum expense (Rs. 1,00,000 for machine bore-wells and Rs. 90,000 for hand boring (including pumps)[9]) in addition to maintenance expenses. Another 1.5 million households rely on wells for supplementing municipal water supply.

The Untapped 30 percent

The thirty percent of the urban population that does not have access to municipal water is forced to obtain water from other sources (Refer to table 2). Underground water is the next most widely used principal source for water following municipal water supply. Sub-surface water accessed through wells, tube wells, and hand pumps, together accounts for more than 27 percent households' main water supply. A small percentage of the urban households depend on water tankers rather than piped municipal water supply. Other sources such as tanks, ponds, springs, rivers, canals, etc. are also used, although insignificantly. Another 13.4 million households rely on sub-surface water (wells, tube-wells/ hand-pumps) as a main source of water supply and another 4.5 million rely on it to supplement their main source of water supply.

***Good* water supply – ease of access**

Water supply can be rated as good if processed tap water is available for twenty-four hours a day, within the house and is meant for sole access. Efficient use of water then depends on the ease with which it is accessed and the pricing system that is imposed by the water provider. However, shared access to water imposes costs (since the main cost of a natural resource like water is in its transportation) in terms of time and effort invested by the household members in accessing it. Time costs and inefficiencies associated with long queues and limited water supply adds to the burden.

Many of the 70 per cent 'tapped' households have to share water from their main source. Of the 33 million households receiving municipal water only 15 million (46 percent) have exclusive access to it (Refer table 4). 18 million (54 percent) require some sharing.

[9] Refer to the Appendix A-1 for more details

Table 4: Right of use of tap water

Right of access	Number of Households (Millions)	Percent
Sole	15.2	45.6
Shared	8.7	26.1
Community	8.4	25.2
Others	1.0	3.1
Total	33.3	100

Source: NSSO 54th Round, authors' calculations

As mentioned, the amount of water used by each household is measurable if there is sole access to the water supplied. This not only makes imposing user charges possible it also facilitates differential pricing of water used. Any overuse and misuse of the water supplied can also be easily identified and penalized if the user responsible for overuse and wastage is traceable. While punishments may help, incentives solve the problem more amiably. Metered supply of water would mean that economic use of water would be rewarded since lesser use implies lower charge. Detection of leakages is easier. Also, planning is easier if gap in requirement and provision is precisely identified. However, if access to water is shared then additional costs accrue since it is difficult to measure usage by individual households and charge appropriately if they have shared access to water.

Much of the discussion on water supply and user charges is based on the presumption that the households have *sole* access. However, as we show, this is not the case for the bulk of urban Indian households. Another related problem is the distance between the dwelling and the source of water. That is, many households have to incur effort in obtaining water from the main source.

Table 5: Distance from principal source of drinking water: Households with taps

	No. of Households (Millions)	Percent
Within Dwelling	15.3	45.8
Outside Dwelling but within boundary (premises)	8.4	25.3
Others	9.6	28.8
Total	33.3	100.0

Source: NSSO 54th Round, authors' calculations

Only 46 percent of the households have the luxury of having the tap within the dwelling. The rest have to step out of their house and fetch the water. Another 25 percent manage to get it within the boundary surrounding their dwelling. But 30 percent still have to go

beyond the boundary of their dwelling. Household members from almost 10 million households have to go a long distance to access the tap water in urban India. The following table reveals the above discussion in totality.

Table 6: Right of use of water

Right of Access	Number of Households (Millions)	Percent
Sole	19.6	41.3
Shared	12.7	26.6
Community	13.6	28.6
Others	1.6	3.5
Not Available	0.0	0.0
Total	47.6	100.0

Source: NSSO 54th Round, authors' calculations

Of the 20 million odd households who have sole access to tap water as their principal source, only 11.3 million households have no supplementary source. We could conclude that these households are served the most efficiently; however that is not likely, it may also be true that they have no access to supplementary source of water, and 24 hour water is not supplied anywhere in the country.

In sum, not only is the penetration of municipal water supply low (about 70 per cent of total households), it is also quite poor in terms of access. Most households that depend on tap water have to either share it with their neighbors, or themselves transport it to their dwelling, or both.

The poor

Of all the other households that are not being serviced efficiently the worst hit are the households belonging to the lower economic stratum. Many a justifications for the prevalence of public provision of water are given that state that privatizing an essential good like water could lead to high prices that would not allow the poor to access water. However, the existing system is imposing additional burden on taxpayers while the poor still do not have good access to tap water.

For assessing the situation of the poor, a simple index representing the economic status of the households was created using ownership of certain amenities and certain lifestyle characteristics of the households (See Bajpai and Bhandari, 2001, and Appendix A2 of this paper). On the basis of this index the households were classified as belonging to the low, medium or high economic strata. Approximately 41 percent of the total households belonged to the low economic stratum. Another 13 percent belonged to the medium economic stratum and 23 percent to the high economic stratum. The remaining 23 percent could not be characterized into these categories since enough information was not available.

Table 7: Distribution of economic status as per principal source of water

Source	Economic Status of Household			Missing	Total
	Low	Medium	High		
Tap	65.6	74.4	79.7	65.9	70.1
Others	34.2	25.5	20.2	34.0	29.8
Missing	0.2	0.0	0.1	0.1	0.1
Total	100	100	100	100	100

Source: NSSO 54th Round, authors' calculations

A look across various economic classes of households shows that a high percentage of households receive tap water. When we look at the figures for all the households the distribution between tapped and untapped is 70 : 30. In case of low economic class the ratio is 66 : 35. In the case of medium and high economic class of household the ratio is 74 : 26 and 80 : 20 respectively.

The absolute numbers are more alarming than what the distribution suggest. Approximately 7 million households in urban India that belong to the lower economic stratum do not have access to tap water. This constitutes 14 percent of the urban households. Public provision of water has not managed to make tap water accessible to the urban poor. It has not even managed to provide good water supply to those households that have the ability to pay for tap water.

3. Environmental impact of poor provisioning: Overuse of sub-surface water[10]

The introductory section listed various energy overuse and water overdrawing impact of poor provisioning. This section focuses on subsurface water.

Of the 47.6 million households, 20 million extract water from underground sources. Of these 13.4 million rely on it as their principal source of water. The pressure on ground water use is not lessened by public provision of water. Even among those who use municipal tap water as their main source of water, there are many who use other sources to supplement it. A direct impact of the poor provision of water supply is that those who can

[10] See Leake, S. A. (1997): Land Subsidence Form Ground Water Pumping , U.S. Geological Survey, for a detailed discussion.

afford it access alternative sources, which in urban areas tend to be sub-surface water resources.

Ground water can prove to be an efficient source of water supply only if it is not *over-extracted*. As is well known, groundwater is *over-extracted* if it is extracted in excess of the groundwater recharge. Groundwater replenishment or recharge stems from rainwater infiltration. An aquifer can become extinct if water is extracted at a rate faster than the recharge rate.

Over exploitation of ground water has the following effect on the environment:

- Over exploitation of ground water is harmful to the environment since it causes water tables to recede to such low levels that the aquifer cannot replenish naturally. This causes the source of water to become extinct over time.

- In addition to this, pollution of fresh water increases. Ground water is available at shallow as well as deep levels. Deep ground water constitutes the fresh water system. Recharge from rainwater results in replenishment of the shallow aquifer by means of upward leakage from the deeper aquifer. The decline in groundwater level due to overexploitation changes the hydraulic gradient, thereby triggering the speedy movement of pollutants from above to the deeper groundwater system.

- Land subsidence results from changes taking place underground. Subsidence is the lowering of the land-surface and is generally permanent. This is permanent because even if the

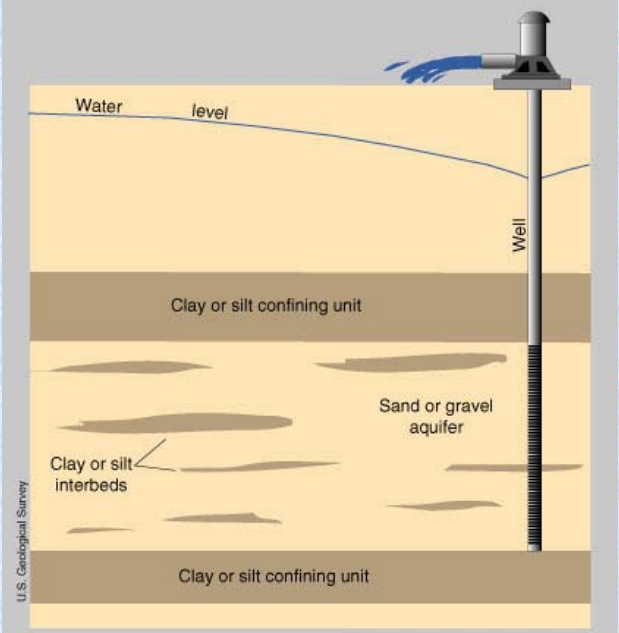


Figure 2. An aquifer system susceptible to compaction that results in land subsidence. Release of water from clay and silt confining units and interbeds causes a reduction in thickness of these compressible sediments.

LAND SUBSIDENCE

In many aquifers, ground water is pumped from pore spaces between grains of sand and gravel. If an aquifer has beds of clay or silt within or next to it, the lowered water pressure in the sand and gravel causes slow drainage of water from the clay and silt beds. The reduced water pressure is a loss of support for the clay and silt beds. Because these beds are compressible, they compact (become thinner), and the effects are seen as a lowering of the land surface. The lowering of land surface elevation from this

aquifer is recharged to original levels it would not lead to land surface elevation.[11] Land subsidence causes many problems:

(1) Slope of streams, canals and drains get altered;

(2) Bridges, roads, railroads, storm drains, sanitary sewers, canals, and levees as well as public and private buildings may get damaged;

(3) Forces generated by compaction of fine-grained materials in aquifer systems may cause failure of well casings;

(4) In some coastal areas, subsidence may cause tides to move into low-lying areas that were previously above high-tide levels.

(5) Earth fissures are also associated with land subsidence. When ground water is pumped it causes horizontal movement in the sediments. This leads to narrow cracks of an inch or less in width. Overtime these cracks can expand and develop into large fissures of widths of tens of feet. This is due to erosion, as they intercept surface drainage.

Groundwater is a mineral resource and has a dynamic character, with both stock and flow aspects. If only the flow of the resource is utilized then it is possible to sustain the use of ground water over time. If however we utilize the stock as well then over time the resource tends to diminish causing environmental damages along the way. Generally if the subsurface water table is falling, it indicates over-extraction of groundwater.

For environmentally sustainable and friendly use of ground water a constant monitoring and control over ground water utilization is required. This requires knowledge of the situation of the existing ground water resources. There are two different nationwide groundwater statistics available. Irrigated area statistics and volumetric data on ground water use. However adequate assessment of groundwater use for non-irrigation purposes is still lacking (Dhawan, 1995). The Central Ground Water Authority (CGWA) has some estimates.

As a reply to a question raised in the parliament (Lok Sabha, Unstarred Question No. 2792) in 2000 a State-wise list of over-exploited and dark blocks was obtained from the Ministry of Water Resources (Refer to Appendix A-3). According to these figures, of the 5711 blocks, *taluks*, *mandals* (administrative units) and watersheds, 310 were categorized as dark and 160 were marked as over-exploited. A dark block is one that is on the verge of being over-exploited. Over exploitation is defined as extraction in excess of recharge.

In India the biggest damage caused by receding ground water levels is the increased scarcity of potable water to the masses. Evidence specifically from the cities is not well documented. However, the impact of depleting ground water levels is obvious from various rural areas of India where ground water is drawn by hand-pumps and recently by means of tube-wells.

[11] Leake, S. A. (1997) : Land Subsidence Form Ground Water Pumping , U.S. Geological Survey

The Center for Science and Environment (CSE) has also noted that over pumping, lack of groundwater recharge and a gradual destruction of the local traditional systems of water harvesting have contributed to water shortages. Some of the evidence cited by them in this respect is discussed below.[12]

According to the CSE, in Chennai overexploitation of groundwater caused water tables to fall and regions around the sea experienced ingress of seawater. This led to extreme soil salinity and saline water ingress. This is true of Junagarh district in Gujarat as well where over exploitation of ground water has led to the falling ground water levels and therefore seawater ingress.

Over the years, groundwater contamination has caused many deaths in India. The fact remains that most areas with contaminated water at present had earlier depended exclusively on groundwater. The resultant fall in their levels has led to a water crisis. And as these areas were already rich in certain metals or compounds, dipping groundwater levels meant increasing contamination. Mandla in Madhya Pradesh is an example of such a case where consumption of ground water leads to Fluorosis. Nearly 93.5 per cent of the 157 villages in the Dungarpur district of Rajasthan suffer from dental Fluorosis and an abnormally high 32.5 per cent of them have skeletal Fluorosis. About a hundred thousand of the state's population is affected by it.

Arsenic pollution cases are also being noted, particularly in West Bengal where ground water in many of the State's small towns and villages is now contaminated with it. In Bichhri, a village in Rajasthan, the water pouring out of the bore-wells is brown in colour. The 90-odd wells once meant for irrigation and domestic needs lie unused now.[13]

As population increases in urban India and public provision becomes scarcer, ground water use has increased. The effects are beginning to show. Take for instance Delhi. Long term observations made by the Central Ground Water Board (CGWB) have shown that ground water levels have declined drastically in many parts in the nineties.

Table 8: Groundwater decline over ten years in Delhi

Blocks In Delhi	Decline (Meters)
Mehrauli	4 - 10
City	4 - 8
Njafgarh	4 - 7
Kanjhawala	4 - 5
Alipur	4 - 5

Source: Lok Sabha question, May 2000, Ministry of Water Resources.

[12] CSE, Down to Earth, February 1999
[13] CSE, Down to Earth, February 1999

The maximum range of decline is 4 to 10 meters in the NCT of Delhi during the last ten years. The situation is similar for other cities that do not have good access to processed tap water. The inability of the local governments to provide water (a duty of the local government by law) and the need for water has led to the emergence of alternative means of obtaining water. Such means generally target ground water. The inability of the governments to enforce the poorly defined groundwater laws is clearly visible from the emergence of the private water suppliers.

4. Private sector responses

Poor provision therefore has had two effects. One, poor coverage of households and the denying of a basic necessity. And two, environmental damage, much of it unaccounted. Poor coverage and quality of water supply has led to unmet demand for water. The economically better off have constructed their own tube wells – an activity that is not strictly illegal. However, the poor are unable to even afford that either. A part of this requirement is being met by private (informal) sector. This activity occurs in two ways:

(a) Tankers operated by private individuals supply the water either from surface water sources (and is legal) or from subsurface (illegal). Water is priced according to the volume drawn from each water tanker; and

(b) Water is supplied from sub-surface sources and transported by way of pipes to within the household premises. This activity is strictly illegal.

4.1 Private Water Tankers:

The Delhi Jal Board (DJB) is the government's water supply arm. The DJB itself has water tankers for distribution of water. However, these tankers are only used in the following cases:

- Non-availability if water due to leakages/ bursts in water lines or any other faults in the system. In such a case the water tanker is to be supplied within three hours of complaint, subject to availability of water tanker. This service is free of cost.
- For private functions such as marriages and religious functions. The water tanker can be supplied on any working day, however only if the booking is done 15 days in advance. The charges of booking (filling and stationary) depend on the distance of the house from the DJB water storage area.

Table 9: Tanker rates from Delhi Jal Board

Distance	Stationary	Filling
Upto 5 Kms.	Rs.400/-	Rs.225/-
5 Kms. to 10 Kms.	Rs.600/-	Rs.325/-
Beyond 10 Kms.	Rs.1000/-	Upto 15 Kms. Rs.425/-
		Beyond 15 Kms. Rs.450/-

Source: Delhi Jal Board, 2002

It is not possible to buy water from the DJB on short notice. An advance booking is essential. This leaves the people, who may or may not have a municipal water connection without any recourse when they are stranded with no water to drink. However an option that has emerged is the private water tankers that supply water. This water is accessed either from a surface water source or a sub-surface water source. Many private water tankers also supply municipal water.

In case of private water tankers, there are standard charges as per the quantity of the water supplied. The water tankers generally have a capacity of 3000 liters or 6000 liters. The charge is Rs. 300 for 3000 liters and Rs. 500 for 6000 liters. Since the private suppliers are present in almost all the neighborhoods the prices are generally not quoted according to the distance. The private water tanker suppliers transport the water to the house and fill it into the storage tank. There is no requirement of an advance booking.

Often groups of people collectively call for a tanker. These are generally households belonging to lower or lower-middle class, who do not have very large storage tanks to accommodate 6000 or even 3000 liters. They call for these water tankers and share the cost of water by paying by the bucket or some other terms of sharing as per quantity used.

Most private suppliers access water from other sources that include surface as well as sub-surface water. There is little or no processing that the water undergoes. However, there is no difference in the price level for the different sources of water. Some private suppliers are also known to supply processed (DJB) water; they are subcontracted by the DJB to do so.

4.2 Private Piped Water Supply:

The case study is from an illegal (squatter) settlement (slum or *basti*) situated in South Delhi. This section of Delhi faces acute water shortages and the situation is especially bad in the hot and parched summers of Delhi. All of the four water processing centers of Delhi are located in its northern part and by the time the water reaches the southern part of the city, much of it is lost.

The residents of this *basti* and many such *bastis* in Delhi form a major portion of the labor force for the service industry of this city. While the government is 'charitable' enough to provide water by means of occasional tankers, this water is not provided to them as a right, a service for which they are willing to pay.

The supply network of the DJB is in place in most of the neighborhood with high and middle-income families. While these households also suffer from water shortages, the situation of the residents of illegal or squatter settlements is much worse. In the *basti* studied by us there is no provision of piped water from the DJB. There are hand-pumps drawing sub-

surface water that have been installed by the DJB. Most of the households in this *basti* rely on these hand-pumps for their daily water needs.

The ratio of hand-pumps to the number of users is very small. This leads to long queues and waiting times. Also water has to be carried in many vessels at one time, for avoiding queuing up many times. Water is stored in small vessels in the house and households are able to use it only minimally. Since the hand pump is not very deep the water available is also not very pure. The deep ground water aquifer is the source of fresh water. And in summer months when the water tables fall further the hand pumps do not provide adequate water. In case of extreme scarcity of water the local politicians are approached who provided for some water tankers from the DJB to be sent to the *basti*.

In order to avoid the trouble and the uncertainty associated with accessing water from the hand-pumps many residents of this *basti* have started to buy water from private piped water suppliers. Piped water supply provided by some of the residents has provided the perfect solution to many households in this locality who have the willingness and ability to pay a certain price for water.

In one particular part of this *basti* piped water is supplied to approximately 80 - 90 households by a private set-up. This water is obtained from the ground by means of a pump. The water is accessed from a depth of around 150 to 160 feet. The boring for extraction of water was done mechanically. The cost of boring was approximately Rs. 40,000, a cost impossible for any household in the area to bear on its own. Hand boring is a slightly cheaper option, but after digging to a certain depth it is impossible to dig any lower without the means of machines since there is a layer of rocks. An average pump for pumping out the water is available in the market for Rs. 25,000. The total starting cost was therefore about Rs. 65,000.

For access to this service the households were required to pay Rs. 500 as a security deposit. The terms of the informal agreement are simple. If the household wishes to discontinue taking water from the supplier then they are not returned their security money. On the other hand if the supplier decides to discontinue supply then he would have to return the same amount to the households. Rs. 500 is a sufficient amount as security money. Many households in this *basti* are not connected by this water supply because they are unable to pay such a lump sum amount. In addition to this the households had to bear the cost of the initial supply network of pipes. This amounted to another Rs. 500. The households were free to get the pipes for the water supply fitted on their own. The arrangement for the maintenance of the pipes is also very simple. The main pipe that runs through the road connecting the household is the responsibility of the suppliers. They repair any harm to that. From the main pipe to the house the pipe is the responsibility of the respective households.

Water is provided twice a day for half an hour per household. Seven to eight households receive water at one time. At the time water is being supplied the owners of the water supply are watchful of pilferers. Half an hour supply of water is enough for filling a storage tank of 500 liters capacity. In case the tank does not fill up during this time then the suppliers continue for a little longer on request. A storage tank of this size costs approximately Rs. 1,000 to 2,000. It is up to the household to choose their own means of storage. The agreement is for a supply for half an hour, twice a day, at a good pressure of water. There is no way for measuring the amount of water supplied. Neither the suppliers nor the households have a meter installed.

For this water the households make an advance payment of Rs. 200 per month. However, the terms of payment are not very severe. A month's delay is accepted depending on circumstances of the household, which the private suppliers are generally aware of since they live in the same neighborhood.

The cost of this water supply to the supplier is mainly in running the pump. Though electricity connection is available the pump is run by means of a diesel generator. The pump is run for 7 hours daily. This costs approximately Rs. 9000 per month[14]. Since water is supplied to 83 households, a surplus of Rs. 6,400 per month is generated. In addition to this, on occasions households that are connected by pipes buy water from them at the rate of Rs. 30 for 100 liters. These households generally rely on the hand-pumps but when they need a lot of water for some special event they choose to buy it from these suppliers.

Water supply systems like this one connect approximately 40 percent of the households in this *basti*. All the water suppliers in this area have an understanding of supplying water at the same rates.

Earlier the households would spend significant amount of time and effort in obtaining small amounts of water from the hand pumps. In summer when the hand-pumps would dry up then they would have to go to hand pumps in other areas that were further away that still had some water. The last resort was a plea to the local politician who would then ask for a tanker to be sent to the *basti* by the DJB. Fights early in the morning when people were leaving for work was added hassle to be faced by these households. In place of this cost the households have chosen to pay Rs 200 per month and get a tap directly into their home. (This works out to be approximately 6.6 per cent of the average monthly salary of the households in the neighborhood.) Water quality is also better since the water is drawn from deeper into the ground than the hand-pump.

Significantly, water is not priced, but the access to water is. The lump sum charge of Rs 200 includes access to as much water as the household can draw during the time when

[14] An amount (not revealed) must also be given to the police.

water is made available. And since the pipes have limited capacity, households' consumption is also limited due to this capacity constraint.

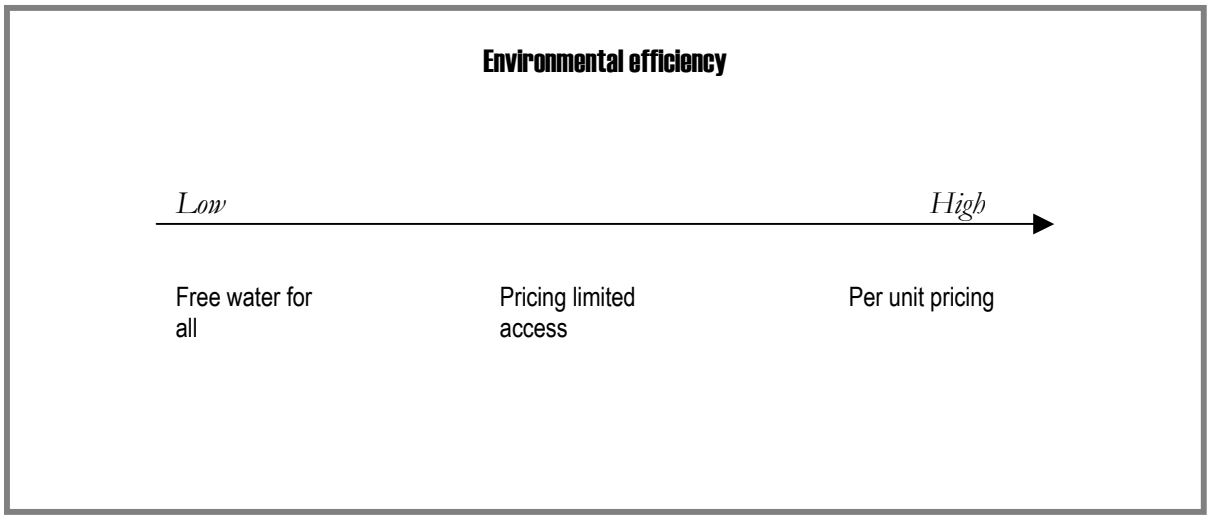
Many have pointed out about the efficacy of marginal cost pricing in water supply, that is considered to be a system that has the right incentives for producers to supply optimal levels, consumers to appropriately use water, and as a consequence have minimal negative impact on the environment. However, this system of priced access and not priced supply is somewhat removed from the marginal cost principal.

The key question, of course, is why has it emerged in this manner in this unregulated environment. First economic principals would indicate that a completely free system would tend to move towards a marginal cost based pricing system. That it is not so, means other forces, technical or otherwise, are playing a strong role in this market.

The cost at the margin deals with two related issues: one is the cost of extra per unit of water and the second is the extra cost per unit of time. We will argue that the extra cost per unit is zero within a certain range. And the extra cost per unit of time is significant in this market. Consequently, it is in the interest of the supplier to price access and not price water. And to base this pricing on time (half an hour's supply).

First, water has to be extracted and supplied at pre-determined minimum pressure levels – otherwise it does not reach the households located on higher floors, elevations, or distance. The diameter of the pipe through which the water passes is also fixed. Consequently, water has to be supplied at the given pressure levels, or not al all. Less cannot be supplied by reducing the pressure levels. Second, and this is a corollary to the above, sub-surface water extraction cannot be below a minimum pressure level. And after it is extracted it is costly to store. If water were stored not only would storage costs be incurred, but also costs of re-pressurizing it to supply to households. The most energy (and cost) efficient system therefore is one of extracting and supplying simultaneously, and using the same motor. Third, pricing on the basis of units of water requires the installation of water meters in each household. These are costly, and can also be tampered.

This system is not the most efficient in terms of the environment. Environmental considerations would require pricing water per unit quantity. In this case of pricing access there is some incentive to draw and use later as much as a household is able to. There is no counterbalancing force for its mis-use. However, this system is much better than that effectively followed by the government – of not supplying adequately, and not pricing it adequately.



But environmental efficiency is not the only objective of public policy. Coverage is as, if not more, important. We however find that the government is not aware that water can be supplied to those who the government has been unable to, by private initiative.
Current laws in Delhi, for instance, allow the following to access sub-surface water (see Appendix 4):

- Households for their own individual requirements
- Manufacturing units manufacturing drinking (bottled) water

Both these activities are effectively only for the economically better off. They can afford to spend large amounts for their private water needs, and are also the primary consumers of bottled drinking water. Poorer sections can only access sub-surface water through an entity that can would supply them on a commercial basis. However that option is closed by law.

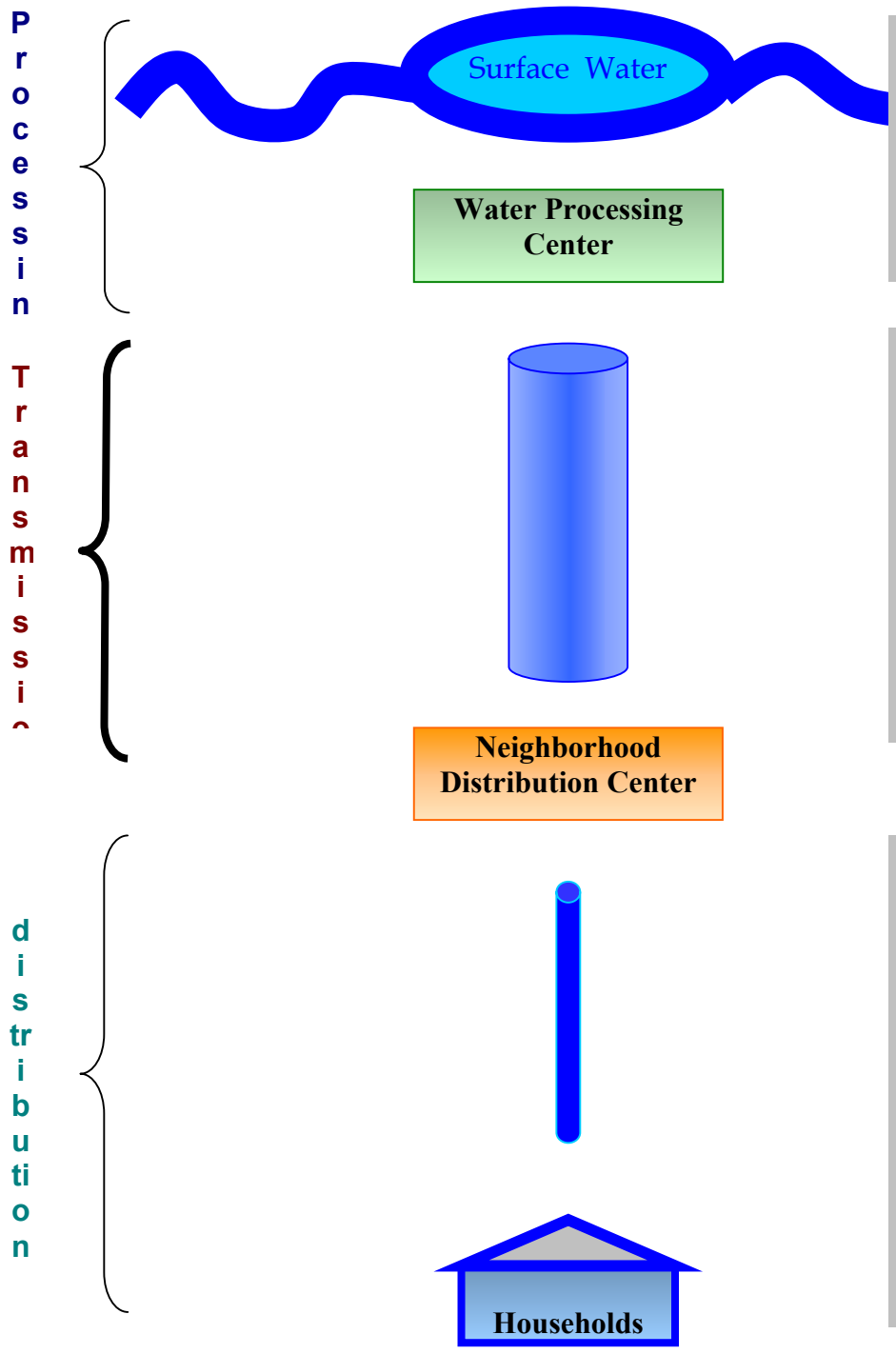
Regulations and controls such as this are intended to reduce the burden on the environment. (How effective they are is another matter). However, they have a perverse impact on the poor. And good policy would have to be one that is able to find a good middle ground. These issues are discussed in the next section.

5. Policy Implications

The last three sections reveal that the government has been unable to price water adequately, and this has resulted in its inability to finance service and water supply infrastructure improvements. Apart from an artificial water scarcity for some it has also encouraged misuse and wastage of water. Current efforts to reform the sector will be limited on two accounts:

- The poor quality of current services and infrastructure
- Perception that poor cannot or should not pay for water
- Inability of government functionaries to recover dues even for water that is priced

Broad Stages of Water Supply



- Mainly surface sources of water
- Scarcity in long hot and dry summer
- Large reservoirs missing

- Not Pressurized and old pipes
- Poor maintenance
- Leakages, wastage
- Theft
- System cannot handle peak load
- Local governments revenue starved

- May be pressurized
- Poor Maintenance
- Meters tampered
- System cannot handle peak load
- Water priced low or free
- Leakages, wastage
- Theft
- Rationing & scarcity

Each of these contributes to the inability of the government bodies from collecting adequate charges for the water.

However without per unit charges imposed on water it is unlikely that water would not be misused or wasted. Moreover, without the ability to generate funds from within the sector would also prevent cash strapped local and state governments from improving infrastructure and services, leave alone expanding them to meet the increasing requirements of a growing urban population. A Catch-22 like situation exists in almost all cities in India.

In some of the larger cities, external agencies have stepped in to provide concession-al finance and advice. However such cities are in the single digits (there are 5000 odd cities and towns in India), and cannot be expected to grow much more.

Any infrastructure and service improvement would require capital, and this capital can be accessed from commercial sources. To do that a revenue stream from water charges would be essential. And this revenue stream is possible, as we show in the next sub-section.

How to break the vicious circle: Good Water Policy

Water supply can be divided into three broad stages: Processing, transmission, and distribution (as shown in the accompanying figure). Currently all three are in the hands of the government. A pricing system can be put in place only if the input and output can be monitored. If they are then either the government can directly undertake these activities or the private sector can. Financing and pricing then becomes much easier. Simple subsidy mechanisms also then become possible.

We first start with the last stage – the distribution stage. This is so because revenues are recovered at this stage, and if water supply mechanism operates smoothly at this stage, then the rest will follow. However we do not go into specific policy recommendations, instead we suggest a broad framework for policy to follow. The specific policy aspects are highly dependent on case specific factors, and should only be developed on a case-by-case basis.

The Distribution Stage

The key problem here has to do with the inability and unwillingness to recover charges. This stage should be wholly in private hands. The water can be supplied to them at a price for which the distributor can charge a mark-up from the consumer. The amount of water supplied to the distributor can easily be measured by the transmission agent (which may or may not be a government entity); and since there are relatively fewer distributors than consumers, it also becomes much simpler for the transmission agent to monitor.

The distributor in turn would supply the water to the consumer. Lack of water meters is an extremely important issue. Water meters can be subsidized by the government or provided free to the distributor. Based on the water units consumed the distributor can recover revenues from the consumers.

In the case of the poor water can be subsidized, and there are many ways of doing so. Some examples are:

- Water stamps
- Direct subsidies
- Area specific rates of water (urban households tend to be clustered according to their economic status)

There are many advantages to this system

1. The costs of any water losses in the distribution stage are automatically borne by the distributor, and she has a strong incentive to prevent wastage or theft (as we also noted in the case of the private water supplier in Section 3).
2. Water is not given free, and whoever wastes the water pays for it.
3. The consumer pays to the distributor. The distributor therefore has an incentive to collect the charges from the consumer as her returns are dependent upon the revenues received.
4. Moreover, as the case in Section 3 shows, a private distributor has the incentive to show some flexibility in payments terms – something that bureaucratic systems rarely have.
5. Subsidies can be directed to those who need them the most. And more importantly, subsidies need not be unlimited.
6. A public distributor implies that government employees man the system, and such wage based personnel cannot have the same incentive as returns based private entrepreneur.
7. Since the entrepreneur is charging a per unit mark-up, it is in his interest to supply adequate quantities of water, but not to waste it. Similarly, it is in the interest of the households to not waste water.
8. No large scale investments are required to straightaway shift to this system. The distribution stage can be privatized as it currently is.
9. It is in the interest of the distributor to provide 24 hour water at the correct pressure levels. And therefore, it is in her interest to invest in quality improvements.
10. Depending upon the particular system being followed by the government, it may not even be necessary for detailed account-keeping and regulation. Transactions can be merely on the basis of amount of water sold. This implies that the distribution stage need not have formal private sector distribution companies. Informal (unorganized) private entrepreneurs can be given the task of reselling the water. This in turn implies that we do not even require local water distribution monopolies, a market for private distribution of water can develop.

In general disassociating water distribution from transmission and production has many advantages. The most important one is that of flexibility. Depending upon the conditions of the locality/neighborhood different systems can be followed.

As mentioned before, if the distribution stage works smoothly, the rest will follow. In the following space we briefly discuss the policy issues at a very broad level. In both transmission and processing stages, large investments are required; these can be undertaken either in the private or public ambit; however it is likely that some government support would be required. In cases where many sellers are not feasible a market cannot develop and some regulatory oversight over private water supply would be essential.

The Transmission stage

The transmission stage essentially requires a transmission agent, that may or may not be a government entity. The primary task of this entity would be to devise ways that prevent water from leaking and being stolen. In the long term, as Indian cities also shift to pressurized water supply, almost all the infrastructure in this stage would need to be overhauled. Since the input (from the processing stage) and the output (sold to the distributor) are both measurable commodities the problem of transmission is a simple one in economic terms. However the process of improving the system, preventing leakages and theft, and overhauling the infrastructure is operationally a very complex one.

The key issue however has to do with adequate revenue generation. It is not clear whether only revenues would enable the capital requirements for the large scale overhaul. In case they are not, government subsidies would be essential. These would have to be judged on a case by case basis. In any event, a monitored system that generates revenues would be an essential first step for their overhaul.

Processing Stage

The source of water has to be such that adequate amounts are available throughout the year. This is broadly possible, as most cities are located close to perennial rivers or large lakes. However, in the long summer months the water levels in many rivers reduce and the water levels in reservoirs or lakes go down (and sometimes even dry-up). This requires an extension of the lakes, tanks, or reservoirs. Minor dams on rivers that trap the surplus water during non-summer months would also help. All of these require capital. Water processing plants in many cases are quite old and need to be improved and their capacity expanded. This also requires some investment.

As in the case of the transmission stage, the processing stage can also be in the private sector. There is nothing preventing it from being so. The only problem is that of a city-wide monopoly being created.

Regulation and markets

It is generally considered that if the private sector were to provide water supply services some regulation would be essential to prevent monopoly exploitation. However, this is not necessary. The private sector has the ability to provide quality services at a low price *provided there are large number of sellers.* For very large cities in India, it is possible to have more than one or two water processing and transmission entities. In the case of distribution, this would be possible in most cities. And private water supply need not be equated with regulation. At the same time, in the case of transmission and processing there would be many cases where only one or two companies are feasible – and here price and quality regulation may be the only way if private sector is to play a role.

6. Conclusion

This paper deals with the problem of poor public water supply and its impact on the environment. It shows that there is a private sector response, that is not necessarily bad for the environment. More importantly, it argues that given the right conditions, private (formal or informal) mechanisms can have an environmentally and economically efficient role to play. Moreover, given enough freedom to operate and public support, they would also have a positive on inequality of service provision and the coverage over the poor.

Policy conclusions are then discussed. The point being made is that it is possible to have a unit priced based system of water supply. This system would save water, and enable quality water supply to all. However, given Indian conditions, this is only possible if water supply is in private hands at the distribution stage.

The paper does not aim at a detailed analysis of the economies of scale, or financial implications of such a system. That, indeed, would be essential before such a system is put in place. It purely puts forth the view that such systems are possible, and not too difficult to put up.

Appendix A-1: Groundwater use

Machine drilling of borewells is possible (illegally) at a cost of Rs. 60,000. This is the cost of drilling up to 250 feet. Beyond this the cost increases another Rs. 3000 or Rs. 4000 until a depth of 300 feet is reached. At a depth of 300 feet water is generally available. In addition to this there are bribes to be paid to the police (Rs. 5000 to Rs 10,000) given the current ban on installation of new bore-wells and tube-wells. Pumps that are installed for extracting the water cost approximately Rs. 25,000. Cost of drilling seems to alter as per the area in which it is to be done. In a economically well off locality the total cost can reach to around a hundred thousand rupees. The bribes are also higher. (may depend on the level of risk to be undertaken)

Hand-boring is a cheaper alternative, though it has its shortcomings as against a machine which can bore even in the presence of difficult to penetrate layers of the earth. The actual cost of hand-boring is Rs. 50,000. This does not include bribes to be given to the police.

Appendix A-2: Index of economic status

Since the data-set did not contain any information on aspects such as per capita monthly expenditure of households, Bajpai and Bhandari used the following amenities to create an index of economic status:

1) TV ownership: Whether household owns no television, black and white or color television.

2) Newspaper Subscription: Number of newspapers subscribed by the household.

3) Mode of regular commuting: Whether travel to work is by foot, cycle, animal drawn transport, public transport, taxi, autos, two- and four-wheelers.

At the first stage of creating the index, each household was given a rating of 1, 2, or 3 for each of the three lifestyle categories. In the next stage, a consolidated rating was given to each urban household by summing these value ratings.

Step 1:Rating each household for each category

Lifestyle Category	Rating
TV	
No television	1
Black and White	2
Colour TV	3
Mode of commuting	
Foot or bicycle	1
Public transport, rickshaw	2
Owned car, two wheelers,	3
Newspapers subscribed	
0	1
1	2
>=2	3

Source: Bajpai and Bhandari, 2001

Step 2: Final rating for each household

Consolidated Rating	No. of households (Millions)	Per cent of Total	Economic Status
3	9.0	19.0	Low
4	10.3	21.6	
5	6.3	13.2	Medium
6	4.3	9.0	High
7	4.0	8.4	
8	2.3	4.8	
9	0.4	0.9	
Unavailable	11.0	23.1	
Total	47.6	100	

Source: Bajpai and Bhandari, 2001

Appendix A-3: State-wise list of block, mandals, taluks and watersheds categorized as dark or overexploited on all- India basis:

	States	Number of districts	Number of blocks/ mandals/ taluks/ watersheds	Number of blocks/ mandals/ taluks/ watersheds			
				Dark		Over exploited	
				No.	%	No.	%
1	Andhra Pradesh	22	1104	12	1.09	14	1.27
2	Arunachal Pradesh	3		0	0	0	0
3	Assam	23	134	0	0	0	0
4	Bihar	42	589	3	0.51	9	1.53
5	Goa	3	12	0	0	0	0
6	Gujarat	19	184	13	7.07	15	8.15
7	Haryana	17	108	33	30.56	8	7.41
8	Himachal	12	69	0	0	0	0
9	Jammu & Kashmir	14	123	0	0	0	0
10	Karnataka	19	175	7	4	9	5.14
11	Kerala	14	154	0	0	0	0
12	Madhya	45	459	2	0.44	1	0.22
13	Maharashtra	29	231	2	0.87	6	2.6
14	Manipur	6	26	0	0	0	0
15	Meghalaya	5	29	0	0	0	0
16	Mizoram	3	20			Not Assessed	
17	Nagaland	7	21	0	0	0	0
18	Orissa	30	314	4	1.27	4	1.27
19	Punjab	17	138	72	52.17	11	7.97
20	Rajasthan	32	236	74	31.36	20	8.47
21	Sikkim	4	4			Not Assessed	
22	Tamil Nadu	27	384	64	16.67	39	10.16
23	Tripura	3	17	0	0	0	0
24	Uttar Pradesh	58	819	19	2.32	21	2.56
25	West Bengal	16	341	0	0	1	0.29
26	Andaman & Nicobar						
27	Chandigarh						
28	Dadra & Nagar Haveli						
29	Daman & Diu		2	1	50	1	50
30	NCT Delhi		5	3	60	1	20
31	Lakshadweep		9	0	0	0	0
32	Pondicherry		4	1	25	-	0
	Total		5711	310		160	

Note - Andhra Pradesh - Mandal - Gujarat, Karnataka, Maharashtra - Taluks/Tehsils

Appendix A-4: Special provision for unauthorized colonies by DJB

UNAUTHORIZED UNREGULARISED COLONIES

- Rates for water development charges for provision of water lines in unauthorized unregularised colonies has been revised from the existing Rs. 55/- per sq. meter to Rs. 110/- per sq. meter. If the payment of full amount of development charges is made within three months of the receipt of Ist bill, 10% rebate will be given.
- Water lines will be laid on payment of first advance installment of Rs. 25/- per sq. meter of the plotted area.
- The tender will be called only on receipt of 50% of the first installment and work will be executed only after receipt of 75% of the first advance installment from the colony [neighborhood] as a whole.

After execution of the scheme water connections will be released on payment of another Rs. 25/- per Sq. Mt. and the balance will be payable in 20 equated quarterly installment.

Source: Delhi Jal Board

Recently, the DJB has given the people in unauthorized colonies an option to access municipal water. The terms of obtaining water from the municipality are presented in the adjoining box.

Any such arrangement would require all the residents to contribute otherwise it will not materialize. Once the infrastructure is set into place it might be a cheaper option, but the efficiency may still be questionable.

The Central Ground Water Authority was created under the Environment (Protection) Act, 1986 to regulate and control ground water management and development. In September 2001 the CGWA declared the entire Yamuna Flood Plain area as "notified area" and prohibited the construction, installation and drilling of any new structure for extraction of ground water resources for purposes ***other than drinking and domestic.*** In addition to this any scheme/ project of ground water development and management in the region was not to be done without the prior permission of CGWA. Any violation of this was to be penalised under the provision of section 15 of the Environment (Protection) Act, 1986. Drilling contractors were also instructed not to drill unless permission was available from the CGWA.

A later notice issued in 2001 imposed a ban on the abstraction of ground water for sale and supply by private agencies/ persons who were engaged in its sale and supply in the earlier notified areas (except for the flood plain area) in Delhi. A violation of this notice could lead to "sealing of tubewell/borewell by the concerned Deputy Commissioner/District Magistrate, disconnection of electric supply to the energised well and/or seizure of any other equipment being used to facilitate the abstraction of ground water for sale and supply and will also attract the penal provisions under section 15 of the Environment (Protection) Act, 1986". This notice appears to target these private suppliers of piped ground water.

A notice following this however allowed large businesses to continue, however on a few terms). They were asked to register themselves with the CGWA (an activity they had been conducting since February 2000. The intention of this exercise was cited as the generation of a database on goundwater based mineral/ drinking water industries. April 2002 was cited as the last date for registration beyond which the industries could be penalized under section 15 of Environment (Protection) Act, 1986.

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