Draft report

FISCAL INSTRUMENTS FOR SUSTAINABLE DEVELOPMENT

A Reform for Urban Water Utility Services and Environmental Pollution

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ABBREVIATIONS

AP	Andhra Pradesh
ADB	Asian Development Bank
ARM	Additional Resource Mobilisation
BOD	Biological Oxygen Demand measured in milligram per litre
BICP	Bureau of Industrial Cost & Prices
CETP	Common Effluent Treatment Plant
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
cum	Cubic metre equivalent to 1000 litres of liquid
CVM	Contingent Valuation Methods
DO	Dissolved Oxygen
DWSSU	Delhi Water Supply & Sewerage Undertaking
EC	European Countries
GW	Ground Water
GDP	Gross Domestic Product
HMWSSB	Hyderabad Metro Water Supply & Sewerage Board
HP	Himachal Pradesh
HT	High Tension electric line
HUDCO	Housing & Urban Development Corporation
ICWE	International Conference on Water & Environment
IIPA	Indian Institute of Public Administration
Kl	Kilo litre (1000 litres)
LIC	Life Insurance Corporation
lpd	litre per day (water consumption)
LT	Low Tension line
MBI	Market Based Instruments
MC	Municipal Corporation
MCD	Municipal Corporation of Delhi
MCH	Municipal Corporation of Hyderabad
MCM	Million Cubic Metres
MLD	Million Litres per Day
MMWSSB	Madras Metro Water Supply & Sewerage Board; Commonly known as Metro Water
MPN	Maximum Permissible Number
MT	Million Tonnes
na	not available
NA	Not Applicable
NIPFP	National Institute of Public Finance & Policy
OECD	Organisation of European Community Development
O & M	Operation and Maintenance cost
Rs.	Indian Rupees
RV	Annual Rateable Value of property
TPD	Tonnes per Day
USEPA	United States Environmental Administration
WB	World Bank
WHO	World Health Organisation
WSS	Water Supply and Sanitation
WTP	Willingness To Pay

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INTRODUCTION 1

The opening up of and jubilant liberalisation of the Indian economy in the nineties have brought to its fore the impressive growth of the economy. The growth of industrialisation and urbanisation have become sharper than before. But at the same time, it has begun to aggravate the threat to environmental damages. To counter the external effects of rapid growth, adequate investment on environmental protection has not yet been forthcoming. In the wake of the emerging problems of under-investment-led inefficiency of the environmental services, Indian policy makers are facing a dual challenge of designing suitable innovative instruments for achieving sustainable development and to plan for boosting the investment on environmental protection.

The problems of environmental pollution are more acute in the urban areas. Water scarcity and pollution, emission of hazardous chemicals and gases from automobiles and industries in and around cities are the major sources of urban pollution. Inefficient resource use and large scale abuse of air, water and natural resources are degrading the environmental quality in India in an unprecedented pace. Among these, the problems of water utility services are most serious. Existing control measures, regulation and fiscal instruments failed to contain the deteriorating level of water utility services and pollution abatement in the urban areas. To circumvent the deteriorating condition, policy makers must give adequate attention to identify appropriate economic instruments. The paper attempts to provide evidence that greater reliance on rationalisation of pricing policy yields enhanced finances for water supply, sanitation and solid waste management services, besides addressing the problems of environmental pollution. The instrument of user charge so designed have ample potential of environmental and economic benefits. Such a marginal cost based pricing structure is economically efficient and environmentally benign, besides promoting conservation of scarce water resources. The equity linked differential pricing (such as affordable prices for the urban poor and economic prices for the non poor) is welfare maximising and will help improve the general health of the urban population.

The prevailing practices of user charge are symbolic in several ways rather than based on the economic principle. Under-pricing and under-investment in water infrastructure induce wastage and over-use of scarce resources. Existing market based instruments are unable to provide incentives to conserve resources; consequently the regeneration capability of the natural resources are adversely affected. Urban water resources are the victim of such wasteful consumption. At the same time, the sources of water are becoming scarcer and its quality is deteriorating beyond permissive standards. Therefore, the choice of appropriate economic instruments becomes crucial to correct the distortion of the services, as one of the outcomes, viz, the distance-cost nexus is worsening the already strained fiscal crisis. Although, the theoretical principle of water pricing is important and often talked about, yet certain practical limitations such as financial inadequacy, providing basic services to the urban poor cannot be given the go-by, in setting the price of water. In other words, while emphasising economic efficiency, the consideration of social equity must be accommodated within a permissible deviation of water price from the level of economic price/marginal cost price, especially for the urban poor. Therefore, some subsidies are inevitable.

Unless investment on water supply infrastructure is sufficiently geared up and clean, safe water in adequate quantities is provided, people will suffer more because of environmental pollution. The suboptimal pricing of urban water not only induces inefficiency but also drastically erodes the revenue base of the municipalities. To garner the fiscal resources of the municipalities, market based instruments such as economic price, sewerage tax and effluent tax must be introduced. These instruments must be carefully designed so as to be acceptable by the people in conformity with their ability to pay. An optimal mix of human resoources, capital and knowledge will ensure sustainability and satisfy the social objectives of efficiency and equitable resource use.

In conformity with the terms of reference of the research project, the paper examines some issues of urban water utility services and the role of appropriate economic instruments to achieve the sustainable development of these services.

Urban water supply in India is confronting severe scarcity syndrome and quality deterioration in recent times. The resultant distortion to the water utility in terms of quantity as well as quality of clean domestic water directly affects the health and hygiene besides, creating environmental problems. Prominently, per capita availability of drinking water in several urban areas is declining fast and has been reduced to below the standard norm of the daily minimum requirement of 70 litres per capita. The distribution of water is also not equitous. The rich are appropriating more water than the urban poor. Over a billion slum population in the developing world are living in most deleterious conditions and are denied access to basic public services. This deprivation is also a potential threat of environmental damage. The poor suffer the most because they tend to be more susceptible to water related diseases and are the least able to pay the high price of water from private vendors. Unless the public utility services are improved in these areas, it will seriously affect the sustainability of the urban environment. The studies conducted internationally support the existence of a large differential that exists between the private price of urban water and the institutional prices (Crane Randall 1994 in Indonesia, Cairncross D 1988 in Khartoum, Water Demand Studies by the World Bank in six countries, Whittington D 1991 in Nigeria, Francey R 1990 in Nigeria, Saquee 1986 in Africa, Barah 1993 Groundwater Market in Indian Semi Arid Tropics etc.). Significantly the private vending price is as high as 120 times the public price in Khartoum (for example). Rapid growth of population, income levels, changing pattern of water consumption and other factors while influencing the level of the water utility service, tend to exert tremendous hidden pressure on the limited resources. At the same time, the scope for treating the existing price of water as an instrument of reform for correcting the market failure (more appropriately the institutional failure) in the sector is extremely inadequate. The under-pricing of piped water resulted in the municipalities and water boards heavily subsidising the water and sanitation services. The underpricing also has caused the failure of the local governments to meet the increasing demand for water.

The magnitude of the task of improving the utility service faced by the water supply agencies is immense. The fact that a decade after the proclamation of the International Drinking Water and Sanitation Decade 1981-1990 by the United Nations General Assembly, no significant change has taken place in the water supply sector only emphasises the gravity of the problem of water services. In other words, the problem of scarcity and its concomitant effects continues and is deepening. Adequate supply of safe water and basic sanitation are the keys to attain better health for all, but the existing policies have failed to address this vital objective. This requires an approach to understand the issues on sanitary environment in India in terms of the demographic, socio-economic, political and urbanisation context. With a population of 850 million, the rate of urbanisation of over 4% per year is growing faster than the demographic rate of growth of 2 per cent per year. In absolute terms, some 217 million people live in urban India in 1991. The urban population is expected to grow to 290-350 million by 2000 A.D. Obviously the growth of population alone puts enormous stress on the urban infrastructure. The United Nations has recently assessed the shortage of houses in India between 7 to 15 million compelling at least 30 per cent to 50 per cent urban inhabitants to live in slum hutments, 66 per cent houses without proper toilet facility, 37 per cent without electricity and over a fourth of the population without access to safe drinking water. In 1991, an estimated 20 million people in 23 million-plus cities in India live in slums and squatter settlements who are denied the basic needs of life such as food, shelter and safe drinking water. Among these, the need for water utility services is most important and urgent. The social and environmental costs of urban water scarcity in particular are extremely high.

Yet, water utility services are not given due importance in the Indian planning system. On the contrary, the plan outlay allocation for WSS in India, both at the centre and at State levels has been decreasing substantially. Total outlay allocation on WSS in the Seventh Five Year Plan (1985-90) by the central government is as low as 0.4 per cent of actual total plan outlay indicating that the entire financial onus is on the state government alone (Table 1 A and B). This creates a stringent fiscal imbalance as resources with the state are severely limited. To meet such a challenge for providing basic urban amenities, the local governments have very little of fiscal autonomy. In the absence of fiscal autonomy and a poor resource base, urban bodies become fully dependent on grants-in-aid, loans and other transfer from state and central government budgetary resources. This precarious situation causes further deterioration in the urban utility facilities. The governments have to accomplish more in future even in a tight fiscal environment, but given the existing budgetary resources, it will not be possible to continue financing the urban environmental pollution policies. Therefore, a clear, effective and efficient strategy of prioritised apparatus of appropriate economic instruments is sine qua non.

Interestingly, the Indian Constitution classifies water as a state subject, which actually makes it an obstacle to formulation of a national policy on drinking water supply. The central government however, influences this sector through approvals of state governments' development plans and the operation of the central level institutions such as Ministry of Urban Affairs, Housing and Urban Development Corporation, Central Water Commission etc. to provide technical guidance in matters of water resource development. The controversial issue of public impression that a democratic government must provide the basic water utility service, (being a public good), is another source of inefficiency of the sector. Despite the prime importance of efficiency, water utility services do not yet find priority in the overall national planning and policy analysis. This negligence has an expensive policy imperative in the future, in terms of environmental damages and health hazards. Therefore, an integrated approach to water resources is necessary towards planning for sustainable development which includes the planning for input use such as capital, labour, raw material, environmental resources, output delivery system, taxes, prices and other economic instruments.

Realising the importance of safe drinking water, the Government of India brought out a set of guidelines (Ministry of Water Resources 1987) which stresses that with the increasing scarcity of water, "optimal, economic, and equitable use has become a matter of utmost urgency". Consistent with these objectives, the Eighth Five Year Plan(1992-97) identified the following general strategies:

a. Management of water as a commodity as with any other resource;
b. Need to charge appropriate tariff to cover O&M and developmental cost where appropriate;
c. Encourage private sector to develop water supply projects;
d. Reduction of pollution by provision of appropriate treatment facilities for waste and sewage; and
e. Separation of the water supply and sanitation budget from general municipal budgets for better planning, monitoring and control.

However, in spite of the serious concern for management of water resources by the central government, there still exist several major gaps between strategy and practice on the ground.

The major lacunae for the development of urban water services are summerised as under the following premises:

(1) Inadequate and declining level of utility services affects the quality as well as the extent of population coverage.

(2) Depleting resource base (physical as well as financial) along with rampant market failure distorts the development policy.

(3) Existing practice of user charges for the services is unscientific and whereby the prices are fixed at a rate far below the optimal level. This actually causes erosion to the revenue base for the water supply agencies.

(4) The price signal not only does not serve any useful incentives for conserving scarce water but creates problems of pollution and environmental health hazard for the community.

In such a perplexed state of affairs, systematic social planning is required for a vibrant policy cushioning the effects of the random shocks and for sustainable development of water resources. The water supply services have the advantage of economies of scale which a single producer enjoys. But the urban authorities in India fail to encash the advantages to keep pace with the rising demand for the services. The urban bodies are also not equipped with adequate facilities to handle huge quantity of waste water and sewage. In this context, however, promoting the popular argument of the option of privatising the public services might defeat some of the basic social objectives. To throw open the entire water and sanitation services to private markets, may increase the transaction cost beyond the paying capacity of the consumer, specially disfavouring the urban poor. Water being a merit good, like primary health and education, a minimum supply of the basic need for water must be ensured by political process. Therefore, government intervention becomes inevitable in the provision of environmental amenities. But with the current practices, the quality and level of the services are deteriorating rapidly and the efforts of the governments to improve the level of services have rarely been successful.

In this context the main focus of the paper is to understand and explain the phenomenon of emerging fiscal crisis and deteriorating urban utility services. It is thus important to investigate the role of the economic and ecological instruments to accelerate the reform process in the sector effectively. The International Conference on Water and the Environment Development at Dublin has strongly recommended that a sustainable policy for water utility services should be based on the ecosystem principle, institutional principle and the economic instrument principle (ICWE 1992).

The paper examines the potential use of economic instruments to address the issues to improve the access to water utility services by all with special attention to the urban poor, including that of water pollution in the urban areas. The details of the following aspects are investigated

* the factors affecting the demand for water;
* the supply scenario and cost of urban water along with pattern of distribution of water among the consumers;
* the gap calculus of water tariff as well as of demand for urban water;
* pricing of water as an instrument for sustainability of urban water supply system and cost recovery;
* the role and estimation of subsidies for urban water along with the social welfare perspectives;
* problems of environmental pollution and social cost; and

* The paper finally proposes a couple of alternative scenarios to ensure sustainability.

The case for rationalising the pricing policy based on the principle of user cost, calls for detailed analysis of the investment scenario, demand for and supply of quality water, cost functions, optimal subsidies(or cross subsidisation) and their impact on environmental sustainability. To re-emphasise the need for a targeted policy to improve access to basic civic amenities to the urban poor, the consideration of equity and social justice, apart from the above policy for the sustainable path, demand careful interpretation of the subsidy issues. Because given the democratic set up, the zeroing subsidy is politically not feasible and socially undesirable. For the purposes of sustainable resource use, conservation and loss reduction are important considerations for baseline management of the water resource.

The rest of the paper is organised in the following sections -

Prevailing practices for the urban water supply sector and determinants of demand gap.
The role and significance of fiscal instruments and existing practices of user charges for water supply and sewerage with special reference to Indian cities.
The extent of fiscal distortions in the urban resource management and the role of user charge to rationalise the pricing of urban water supply.
The impact of water quality on environmental health and sanitation.

DATA BASE 2

The data base for the urban water supply and sanitation sector is highly heterogenous and complex. There is no uniform pattern for data base management not only across cities and towns, but even for a given city; the methods of data collection vary frequently over time. Lack of consistency of data set makes the generalisation less reliable, although, the diversity of pricing and modes of cost-recovery for urban water make the data set unique and enrich the coverage. For example, users are charged prices separately for metered and unmetered supply, slab rates, arbitrarily fixed rate per water connection irrespective of quantity consumed, and of course, free water to the urban poor through public stand posts. Sometimes, nominal water cess or pollution surcharge is levied along with water charge. Again, the sources and methods of water appropriation vary considerably depending on location of cities; there are cities which are endowed with rich local sources while others depend heavily on importation of water from far off sources. As a result the factor costs of production of water tend to vary.

India has the dubious distinction of having tried these diverse methods of extreme regional variation to improve the sanitary environment in urban areas but not with much success. Notwithstanding the difficulties in tackling the diverse systems, understanding of the various experimentations would provide useful policy parameters for generalisation. The diversity of the methods of public utility experiment in India has a historical dimension. The socio-cultural customs, locational factors including the nature of the sources of water supply contribute significantly to the variability of the methods and mode of the water supply system [1].

Given the binding constraints of the data base and methodological inadequacies, an attempt is made to identify appropriate analytical techniques and methodological modification to improve the value addition to the information base of the urban water supply system. The secondary information on water supply and sewage services are collected from a representative sample of Indian cities. The sources of data base are the annual budgets of the water boards and the municipalities. The sources of data on environmental variables are the Central Pollution Control Board and the Ministry of Environment and Forest, Government of India.

To capture the variability at a reasonable level, the sample consists of two distinct sets of larger cities representing organisational differences in the water supply set up. Such information give a comparative picture of various methods of resource management and the user charge mechanism besides helping us to rank the

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Barah B C; Traditional Water Harvesting Systems in India; New Age International Publisher, New Delhi 1996 municipalities or water boards in order of their efficiency. The first set consists of cities having independent undertakings/Boards for exclusive management of water supply and sewerage system such as Delhi, Hyderabad and Madras [2]. The second set consists of those cities where municipal corporations themselves perform the job of management of Water Supply Services. Bombay Municipal Corporation represents the metropolitan cities in this category.[3] The selected cities represent a wide geographical coverage across the country. (the spatial distribution of the selected cities is shown in the MAP as annexed).

Delhi has an independent set up for the management of water supply and sanitation named as Del Water Supply and Sewerage Undertaking (DWSSU). DWSSU was established in 1957. Delhi being the capital ci enjoys the highest level of infrastructural support for public utility services. However, the water supply a sewerage services in Delhi is highly subsidised. Owing to historical reasons and advantages of power equatio Delhi continues to enjoy the lowest water price. Delhi had a comfortable and easier source of surface water. B the rapid industrialisation and the growth of trade and commerce have destroyed the local sources. The Yamu river was the lifeline of Delhi. Unfortunately, this pristine source of water is continuously polluted as the Yamu is loaded daily with hazardous waste and a huge quantity of industrial effluent through a number of streams(Nala). Thus, the importation of water from far off sources becomes inescapable which adds to the cost of water significantly.

The capital of Andhra Pradesh, **Hyderabad** is situated in the drought prone area of the Deccan plateau. Owing to peculiar geological formation and difficult terrain, the natural water bodies are rare in the area. There is no perennial river in the vicinity of the city. Traditional sources of water have been a number of man-made water structures locally called South Indian Tank or Sagar. From the days of dynastic rule, Hyderabad is dependant on three major tanks viz; Osman sagar, Himayat sagar and Hussain sagar. Once again, rapid industrial growth in Hyderabad, has destroyed the sources of water(see the box insertion in the main text). The pollution of Hussain sagar has even endangered the aquatic biodiversity. Consequent to drying up of the local sources, the option left to the city agencies was to venture the importation of water from sources at least 100 kilometres away. This has increased the transmission cost of water manifold. However, despite several augmentation efforts in the recent years, the per capita water is decreasing drastically. As a result the Hyderabad Metro Water Supply and Sewerage Board is facing uphill tasks of providing the basic service to the population at reasonable level as well as controlling the escalating cost of production. The Hyderabad Metro Water Supply and Sewerage Board was established in 1989 to address these sectoral problems.

Madras is a coastal city of about 4 million population in peninsular India. The city suffers from a perennial shortage of drinking water. The source of surface water is limited and the ground water is unfit for domestic use owing to sea water intrusion. Most of the households invest heavily on private tube wells for water use in non essential domestic activities. The importation of drinking water has become a common practices in the recent times. The scarcity of raw water, inadequate pressure and intermittent supply compel the people and the agency to go for alternative but expensive sources. The revenue instrument in Madras is also not effective. Almost all the domestic connections in Madras are unmetered and the practice of charging is based on arbitrarily fixed flat rate of Rs.12 per month per connection. Such a method of charging flat rate is known to be an inefficient and potentially unviable practice. Established in 1979. the Madras Metro Water Supply and Sewerage Board is responsible for the management of water supply and sewerage system.

In contrast, the water and sewerage system in Bombay is one of the most efficiently managed systems of urban utility. The unique thing about Bombay, is that unlike Delhi, Madras and Hyderabad, the water utility is smoothly operated by the Bombay Municipal Corporation. Bombay has a number of local sources of water like Virar lake, Pawai lake etc. This local facilty has reduced the cost of water in Bombay substantially. However, in view of the growing urban population the scarcity of water still persists, necessitating future expansion of water supply from other sources. The cost recovery in Bombay is also satisfactory. The sewage disposal is also relatively inexpensive as the wastes are disposed of in the creeks and the Arabian sea.

BASIC STATISTICS OF SELECTED CITIES

CITY	STATE	LOCATION PARAMETERS	POPULATION (million)	AREA (sq km)
Delhi	Delhi UT	28.37N,77.20E MSL 220 m	10	653
Madras	Tamilnadu	13.05N, 80.18E	4	173
Bombay	Maharastra	18.56N, 72.51E	12	440
Hyderabad	Andhra Pradesh	17.22N, 78.26E	5	217

In accordance with the terms of reference of the research project, the study is restricted to secondary source of data and baseline studies. However, for the purposes of broader and realistic inferences, there is an urgent need for primary surveys. Certain caveats are inevitable in the use of secondary data set which are listed below. These caveats need to be kept in mind for the purposes of the inferences of the results.

: The data generation procedure and its recording methods are highly inconsistent and the data gaps are numerous.

: More often the physical information on water supply systems is weak and inadequate. However, financial data reporting is relatively better. For the purposes of comparison and generalisation, the interpolation methods are utilised to data fill.

: The variability in policy variables like water tariff, the quantity of water supply (due to augmentation limitation) is meagre. This makes the statistical relationship and parameters estimators less robust. For example, the water rates usually remain constant for a long period as against the volatile variables like cost of factors of production of water. In this situation, the cost and prices are seemingly unrelated, although both are logically interrelated.

: The accounting procedure for the cost of factors of production is diverse. For example, some include salary only for the staff cost or personnel cost while others include the administrative and establishment expenses also in it.

Similarly, the methods accounting the O&M cost vary significantly from place to place. The treatment of debt servicing and interest on borrowed capital also vary widely. In a majority of the cases, debt servicing is not included in the calculation of annual cost. The location specific characteristics are usually the non-marketed variables, as such the ordinary least square method of estimation can not explain them adequately. The modified method of pooled regression analysis helps in normalising the location specific and temporal effects. The purged data in this procedure yields pure residual error and the estimators are efficient and unbiased.

: The cost data of water supply and sanitation are often recorded jointly and hence it is difficult to separate out the investment expenditure for water supply and sewerage individually from the available combined data. The price of water and sewerage tax data, however, are straightforward and are available individually.

The details of the methodology employed in the analysis are discussed in the relevant sections.

3

GROWTH OF URBANISATION AND WATER UTILITY SERVICES:

A cause for environmental degradation

Consistent with the global trends in urbanisation, there is a spate of urban growth in India in recent times. During the recent decade or two the urban agglometrics are growing faster than the demographic growth of population. The urban population in 1991 was around 25 per cent of the total population of the country. Out of a total urban population of 217,177,625, the slum population in 28 major cities is

53,608,816 [4]. The Lakdawala Committee has recently estimated the number of urban poor in India at 80,000,000. The population of the metropolitan cities is growing faster with a rate more than double the all India rate. For instance, among the mega cities with over 5 million population, the individual decennial growth rate during 1981-91 in Delhi and Hyderabad are over 50 per cent (Table 2). The opening up of the economy and the liberalisation of the 1990s, which is basically urban centres biased, has further accelerated the growth of urban population. It has also given rise to an alarming and phenomenal growth of slums and urban poor. This growing population exerts tremendous stress on the limited public amenities and depletes the resources. As a result, the per capita availability of water is declining and service level shrinks. At least 25 per cent of the population in more than half of the Indian cities are deprived of safe drinking water supply. Table 3 shows that the average population coverage by piped water connection in India is around 83 per cent with a low of 40 per cent in Tamilnadu. Care should be taken that in the absence of the actual quantity of flow of water, the number of piped connection coverage is symptomatic only and do not reflect the true picture of the level of actual services. More seriously, the sewerage and sanitation system is the most neglected one whose externality effect has a severe consequences to the society.

INEFFICIENCY OF WATER USE PATTERN : 4
A reflection of wastage and over-use of water resources

At present, the per capita availability of water in Delhi is 237 lpd, 130 lpd in Bombay, Hyderabad 65 lpd and in Madras it is only 47 lpd. The availability of water has already decreased below the recommended standard norm of 70 lpd in several urban

Marty Rajandran; Habitat II- Urban Basic Services for the poor; UN Children Fund, New Delhi 1995.

areas including Hyderabad and Madras; a true reflection of the actual level of services. This declining trend is likely to continue as the local sources of water are declining faster and because of insufficient financial resources with the municipalities. Owing to decline of local water sources, the need for an efficient and holistic view of the management of water and incentives to consumers to use water efficiently increases. It is not creditable for the water agencies to show an efficient financial balance sheet without caring for the level of the services, because the financial efficiency alone, can not gauge the efficiency of the service. For example, the HWSSB claims to have an excellent balance sheet in 1994-95 by matching the user charges with the cost of production. But at the same time, the level of water utility service in Hyderabad is much below the standard norm. Moreover, the daily water supply level is likely to be reduced further to 82.58 mld in the year 2001 and to 61.98 mld in 2011 as compared to the present supply of level of 508 mld, if the supply is not augmented continuously by appropriating water from remote sources. On the supply-side, owing to scarcity problems, several other municipalities have reduced the duration of daily water supply to less than one hour to some consumers. This meagre quantity of water is also supplied intermittently and with inadequate pressure. The intermittent supply and insufficient pressure increases the chances of pollution by water contamination through the defective pipe system. Being centuries old walled cities, the water supply and drainage network systems are at least half a century old and many of them are already worn out.

With the growth of income, the consumption pattern for water undergoes changes. Table 5 shows a typical consumption pattern of water by income groups during 1991-92 in Delhi. It shows that the income effect on per capita consumption of water is prominent. The consumption of water by the affluent consumers is 313 lpd whereas the same by the lower income group is 140 lpd. The water use pattern, both for individual and for industrial consumers is changing radically. For purposes of comparison Table 6 gives the normative demand for water across the cities and the demand gaps thereupon for the selected cities. Detailed data on water consumption by income class is not available, however, Table sets 7 & 8 [5] give the extent overall availability of water for broader groups like domestic, industry and municipalities in the

Some tables are numbered as sets as these fall in the same main headings.

city fringe areas. Domestic consumers are the largest group and next important group is the industrial consumers. Being an industrial city, industrial consumption of water in Bombay is the highest at 28 per cent of total water supplied as compared to 12 per cent in Hyderabad and about 13 per cent in Delhi. While demand for water is increasing, the supply is lagging behind leaving the gap substantially wide. Hyderabad, might specifically, faces a serious problem when the augmented supply will be deficient to the extent of 60 per cent of the projected demand for water in 2011. In other cities also the water supply capacity drastically falls short of and leaves a gap of over a third of the demand for water.

Figure 1 shows a disaggregated picture of daily water consumption by the typical domestic consumer. The average daily per capita water use pattern of a hypothetical quantity of 150 litres is decomposed into six major consumption activities - toilet flushing 50 litres, washing and bathing 40 litres, laundry 20 litres, washing up 10 litres, car wash and garden 15 litres and drinking and cooking 15 litres. Apparently it indicates the possibility of technological solution to conservation of water. There is scope for economising water use to a substantial extent for the items such as toilet flushing and washing. If installed, the improved technology is capable of cutting down the quantity of filtered water used for toilet flushing by at least half. The water thus conserved from toilet flushing by a single individual could be supplied to an additional person for the entire daily requirement. Such a conservation effort is not pursued vigorously, perhaps owing to lack of resources for the capital investment for installing the new flush gadget. The important fact is that there are no incentives for the investment on equipment upgradation and replacement of old flush tank to conserve water, because the water charges paid by the consumer are very low. An appropriate policy of user charges induces an element of conservation of water. The conservation experiment in the developed countries show positive results (see Table 9).

Sandra (1985) estimated that by using efficient technologies for conservation, the indoor water can be saved for various activities to the extent of 52 per cent in toilet flushing, 21 per cent in bathing, 27 per cent in laundry and dishwashing (Table 9). The money thus saved by the conservation effort, can be invested for installation of water-saving technology and the cost of installation recovered within a year. Given the consumers' awareness about the water use economy, is the technology replacement expensive enough to deter them to upgrade the water use method ?

The resource requirement for improving the level of services in the circumstances is gigantic. For example, Delhi requires an additional 225 million litres of water per day to raise the average availability of water for nearly 4.5 million slum population, from the existing 16 lpd to the recommended a minimum of 70 lpd. The financial requirement would be an additional sum of Rs 12.7 million per year for the purposes in Delhi. Thus an enormous amount of resources are required to provide minimum level of basic civic services in the urban areas. Can this amount of water be provided adequately in the long run ? The present practice of serving the slums with free water through the public standpost or free hydrants needs careful review.

STATUS OF DEMAND FOR AND SUPPLY OF URBAN WATER 5

A basis for efficient policy imperatives for the water sector

Owing to historical reasons, research on the economics of water and specifically that of urban water supply is sparse. In particular, the studies on water policy and prices, consumer behaviour towards domestic water, subsidy, conservation, efficiency of resource allocation and on environmental problems etc. are relatively rare. However, in recent years, interest on research on water resources, has been evoked (Rogers 1992, Sarma 1988, OECD 1987, Howe and Linaweaver 1867, Young 1973, Munasinghe M 1990, 1992 and a series of recent World Bank studies). An attempt is made to address the issues of water utility services, using the baseline studies and to examine the implication of the demand gap for urban water in India.

As the demand for and supply of urban water are suspected to be interdependent, consideration of a simultaneous system model is appropriate. Demand for water involves a set of economic variables, personal characteristic variables, location and time variables, climate and surrounding environmental factors. The direct demand function may be written as

$$Y_d = f(\underline{X}, e)$$

where Y_d is the quantity of water consumed (as a proxy for the actual demand) and $\underline{X}$ is a vector consisting of the following factors:

x1: price of water,

x2: income level,

x3: family size,

x4: education status,

x5: water use pattern symbolising the asset possession,

x6: house type,

x7: location or time dummies, and

e: the general disturbance term.

The production function analysis for urban water helps us to make comparison of the factor productivity and efficiency across the cities. The production function is written as

$$Y_Q = f(\underline{X}, E)$$

where Y_Q is the quantity of production of water and $\underline{X}$ is a vector consisting of several factors of production:

X1: effective price including water tariff, surcharge and taxes,

X2: cost of electricity and other fuel,

X3: staff cost and other establishment expenses,

X4: total operational and maintenance expenses,

X5: expenditure on other materials like chemicals,

X6: debt servicing,

X7: locational dummies.

E: error or disturbance term.

Owing to lack of sufficient data, the demand supply system is approximated to a single equation by incorporating the supply side factors in the demand equation. The estimates may be of course, inefficient to some extent because of a simultaneity bias but may be corrected through add on information.

Table sets 10 and 11 show the pattern of trends for demand and supply of water supply in the selected cities. The demand is calculated based on the biological minimum need for water. Given the static supply of water, the consumers tend to adjust the consumption habit accordingly up to a limit, at which the scarcity of water below the biological requirement adversely affects the health and hygiene. The demand for water in Hyderabad was 1254 mld in 1991 and projected to rise to 2112 mld in 2011 as against the corresponding total supply of water of 508 and 920 mld respectively. The demand for water will be doubled in the next two decades, whereas the supply of water would grow barely at the annual rate of less than three percent. Delhi and Bombay also face similar situations if the expansion programmes are not undertaken continuously. In spite of massive investment to augment the water supply during 1986, 1991, 1995 in Bombay, the initial deficiency level of water could not be reduced rather the status quo maintained for the gap (Table 6 and see annexed figure of water gap). Will the consumers ever continue adjusting by cutting down the water requirement below the barest minimum ? The answer lies not only in the increased investment on water infrastructure on the supply-side, but also on efficient management on demand-side. If, the infrastructural investment is sufficient and the practice of conservation is implanted in the mind of the users, such drastic change of consumption of water may not be called for. This analysis confirms that increasing the investment on the capital intensive infrastructure augmentation alone can not solve the problem satisfactorily unless simultaneous analysis on the demand-side is emphasised. The study of the price signal as an instrument of efficient management of public water utility services is of paramount importance. This requires efficient estimation of elasticity of demand for water by using the effective price of water prevailing in a particular city.

Efficient estimate of demand function for urban water is rarely available, perhaps owing to the fact that the demand function is confounded by the supply function. The supply of water at half the demand not only indicates the miserable level of service of water supply but it also confirms that the truncated demand is the outcome of supply constraints(Table 11). The demand function in such a situation may not be a true reflection of actual demand for water but a partial one. The estimation of actual elasticities in this situation may be less accurate although it may add value to the existing knowledge. In these circumstances, the contingent valuation methods and willingness to pay (WTP) studies would be of good help to supplement the inferences. Studies on contingent valuation method (CVM) and WTP for water utility services are rarely available specially in the Indian context. Given the limitation, an attempt is made to estimate the elasticities using a unique set of panel data.

ESTIMATION OF REGRESSION MODEL FOR PANEL DATA
Dependent variable: Demand for water; Panel; N=2, T=8

Independent variables	Linear Model		Double logarithm equation			
			Model I		Model II	
	Pool	OLS	Pool	OLS	Pool	OLS
Constant	1646.3	1755.2	7.27	7.63	2.34	1.85
Effective price	-303.8 (2.58)	-35.4 (3.71)	-0.23 (1.73)	-0.38 (3.66)	-0.21 (1.17)	-0.36 (6.50)
Total Expenditure					0.459 (6.33)	0.52 (16.43)
R^2	0.48	0.49	0.40	0.47	0.93	0.97

Note: **Bracketed figures are the t-values. The Computational Tool is the PC LIMDEP package.** Locations(N): Hyderabad and Delhi; Time(T): 1999-90 to 1996-97.

In addition to the above panel data set for Hyderabad and Delhi, we have analysed an aggregate cross section (refer as cross section analysis) data for Rajasthan.

ESTIMATION OF REGRESSION MODEL FOR CROSS SECTION DATA

Independen t variable	Linear		Double logarithm			
	Model 1	Model 2	Model 1	Model 2	Model 3	Model 4
Price	-.129 (0.18)	-1.108 (2.70)	-0.109 (0.36)	-0.223 (0.71)	-0.087 (0.33)	-.010 (0.59)
Subsidy	0.45 (2.33)	0.0128 (0.11)				
Population		0.0023 (0.91)	0.217 (11.31)	0.225 (11.09)	0.593 (7.51)	0.382 (4.89)
Total Expenditur						0.024 (4.21)
# House hold		.00027 (2.04)		.00099 (1.12)		
Capacity Utilisation					-.053 (.71)	-.0005 (.09)
Population Coverage					-.054 (4.21)	-.031 (2.81)
R^2	0.91	0.97	0.34	0.72	0.68	0.82

Source: Reddy V R(1995); Personal communication. Data pertain to 27 districts of Rajasthan.

The cross section analysis for Rajasthan also confirms the findings of the above panel data analysis. The results further signify the impact of water scarcity and location factor on the estimation of elasticities. As expected the demand for water is inelastic and the value of the elasticities for Rajasthan are lower than that of the metropolitan cities. Rajasthan is known to have perenniel deficiency of water supply. In fact the value of the elasticity is as low as (-)0.10 which is half that of panel regression. Rajasthan has more than half of the total area as arid to semi arid where water is extremely scarce, where the existing suply of water is far below its demand. Therefore, it estimate of price elasticity truly reflects the inelastic behavior of the consumers. The arid districts in Rajasthan are Nagaur, Pali, Jalore, Jodhpur, Churu, Barmer, Bikaner and Jaisalmer. Even though the population coverge by the water connection has increased in the recent years, it fails to improve the supply of water owing to the exhaustion of designed capacity utilisation of water system. This implies that consumers are willing to pay more for improved services without adversely affecting the existing consumption level.

*** EFFICIENCY OF PRICING PRACTICES OF URBAN WATER:**
An Instrument For Sustainable Resource Use

This section introduces and explains the role of fiscal instruments for urban water utility services.

FISCAL INSTRUMENT

The fiscal instrument is defined as the mechanism to correct the imbalance of the fiscal system when implemented effectively. A variety of fiscal measures are used to correct the external effects of environmental services. The measures to address the environmental problems include a set of economic policy reforms (such as water tariff, sewerage tax etc.), specific environmental policy(new regulation for control of environmental pollution, pigouvian tax; polluters pay, tradeable permit, carbon tax) and targeted fiscal measures (affordable user charge for water use by urban poor and role of cross subsidisation). Against the backdrop of the failure of the command and control policy, the above market based instruments have a promising future. For the sake of sustainability of the services, it is necessary that the role of appropriate fiscal instruments should be studied with right earnest and also to know the future effects of these measures on the management of the water utility system.

The existing instruments have not been able to resolve the issues on water supply and sanitation. The prevailing price signal as a weapon to fight the distortionary situation is almost ineffective. The practice of under-pricing, if continued, would perpetuate the fiscal deficit of the urban local bodies. Therefore, under the circumstances, the user charge as an effective instrument requires careful attention. This necessitates a detailed examination of the role of economic instruments such as user charge, benefit cost analysis, Pigouvian tax, tradeable permits etc. It has been argued that the tax/user charge mechanism for dealing with systemic failure in market based incentive arises when individual are not confronted with full cost of their benefits

(Repetto et.al 1992). For example, when the financing of water supply and sewerage is linked to a small arbitrarily fixed portion of property tax, then the individual households pay the same amount, irrespective of their level of consumption of water, or polluting the environment through waste water and effluent generated by their activities. Because of this, there is very little incentive to conserve water or reduce the wastage, although increased water pollution may cost the society dearer. The case of incentives failure is a characteristic of environmental problems arising out of consideration of water as a common property. Unless efficient incentive based policies are implemented, the diffused social costs (even the financial cost) are hard to realise from those whose activities cause the damage.

On the choice of policy instrument, however, some argues that the economic explanation for the adoption of direct regulation (instead of effluent charge) is due to the fact that the market for such commodity is not characterised by perfect competition. Owing to the unclear status of water as public or private good, the informational advantages needed for policy on optimal charge is sparse. The market imperfection, of course, encourages the choice of a system of permit and effluent standard. Heavy polluters would prefer a pollution permit if the market determined fees are against the pollution charge. However, the failure of command and control policy, weakens this argument and the rent seeking strategy by the interest groups becomes handy in the circumstances. The market failure and consequent heavy pressure on subsidies add an additional dimension to the fiscal crisis faced by the urban bodies. The existing policy instruments are unable to correct the market failure satisfactorily.

Water is a good with economic value in all its competing uses. Considering water as an economic good, the consumers should be charged the prices that reflect the marginal cost of providing additional unit of water. The households should pay the user charges for the bulk of the cost of the service because the benefits of the service are of high value to the consumers. The pricing of water as an important instrument of management of the water resource must be based on the method of user charge. The prevailing practice of pricing and cost recovery, albeit, not based on economic principle, varies across the cities and among the consumer groups to a great extent. The consumers under the existing arrangement, pay a nominal price which is unlinked and unrelated to the financial and economic cost of water supply. The low water price encourages over-use, wastage and serve no incentive to the consumers to conserve, recycle or economise the water use. The water charges cover only a marginal proportion of O&M cost, leave alone the capital cost. This actually erodes the revenue base of the water supply agencies sharply. The revenue demand for water service thus, lags behind the corresponding expenditure to create a situation of permanent deficit budget for the local governments. On the other hand, to rationalise price incentives to consumers as an instrument of revenue management, the agencies lack knowledge about the willingness to pay by the consumers for improved services. The knowledge of WTP is a pre-requisite for effectively rationalising the user charges. Ineffective pricing policy on water supply service induces large scale under-investment on infrastructure. The under investment is an important source of inefficiency of the sector which further causes the level of swervices to deteriorate.

A simplistic argument that the public goods should be paid for by the public fund and private goods should be paid for by private sources/investment, does not fully hold good for the urban water system. A large number of the private consumers and sometimes, the government agencies escape full payment of user charge for water and sanitation by taking advantage of free-rider and inappropriate pricing policy. Industries often enjoy the benefits of private supplies and discharge untreated effluent without any pollution charge or penalty. On the contrary, the public funds for future expansion plan are becoming increasingly scarcer. The existing method of fiscal management for the sector has failed to provide the required resources. Water is a basic need of the consumers and a public goods, the management of the utility is therefore, subjected to contradictory objectives like efficiency and equity goals simultaneously. With a view to achieve these objectives, the urban water pricing policy in a developing economy like India must stress the following aspects.

Efficiency: Economic/marginal price of water.

Fairness and equity: Affordability and targeted subsidies.

Improved service level: Minimum and assured service must be provided.

Revenue objective: Revenue income should be at least at cost recovery level.

Consumer friendly tariff: The user charge should be simple and transparent to facilitate billing and consumers' acceptability.

The prevailing practices bring out the following observation on distribution and equity of urban water utility services :

1 The slum inhabitants are provided free but inadequate water through public stand posts or free hydrants. On average as many as 40 to 428 families share water from a single hydrant which supplies water up to maximum of two hours daily (NCU 1988). Currently, 40 per cent to 50 per cent of the urban population are living in the slum areas with suboptimal urban amenities. This works out to a daily per capita water supply to the slum population in the range of 15 to 20 litres. Such denial to provide the basic minimum urban utilities in slum areas creates health, hygiene and environmental problems.

2 Other domestic consumers avail themselves of a much higher quantity of piped water (for example in Delhi the average per capita availability of water is 237 litres) but pay a paltry sum compared to their income level towards the user charge for water. In other words, the pricing of water is not at all related to the paying capacity of its users.

The under-pricing of water has led to wastage and resource depletion and, of course the resultant huge uncovered costs. The inefficient resource use as a result of defective pricing policy is a deterrent to sustainability. The uncovered cost is usually compensated for by the State in the form of subsidies. Not surprisingly, a major portion of the benefits are reaped by the non poor urban affluent and middle income category of consumers. This has increased the burden of cumulative subsidy and causes the quality deterioration as well as distorted the prospects for sustainability of the service. The urban poor ends up paying a higher proportion of their meagre income for the inefficient services (by way of spending on water from private sources) compared to the non poor. The impact of the deficient service impinges upon the welfare of the society besides its adverse externalities on the health and environment. Therefore, the task of improving the level of basic minimum service as well as charging the services at affordable user prices is a major challenge to the urban agencies. In this context, it is important to examine the extent of cross subsidisation and differential pricing for water.

The urban poor whose average income level is less than a tenth of that of the non poor, do not have the ability to pay for the water utility at the cost-recovery level. Therefore, in a developing countries like India, with highly skewed income distribution, the uniform water pricing for all the sections of the society is Pareto inferior and not welfare maximising. Sankar (1992) has illustrated the importance of pricing of public utilities and its welfare implications. He has demonstrated that the uniform pricing is beneficial for the low income consumers including the urban poor (those who pay user charge for water). The higher consumers, on the other hand, prefer the two part tariff as it is Pareto superior.

To examine the issues on cost-recovery and to identify the appropriate economic instrument, the concept of prices requires further illustration which is given below.

Effective price (Pw): The effective price is the sum of per unit water tariff, surcharges, water tax and water cess actually paid by the consumer.

$$P_w = (R_1 + R_2 + R_3)/Y_c$$

where Y = Quantity of water actually consumed

R_1 = Total water charge including surcharges

R_2 = Total water tax . Usually the water tax is charged as a fixed percentage of rateable value of property(say 1 per cent). In some cases. there is also a water benefit tax charged as fixed percentage of rateable value of the property for the non metered water connections.

R_3 = Total water cess. A small amount of money per unit of water (currently 2 paise per kilolitre say P_e) is charged to enhance the resources for the sewerage and drainage services. This is also termed as pollution surcharge.

The official water rate (P_t) is the water charge per unit of consumption from the metered connection. This measure of water rate is comparable to actual domestic tariff or bulk water rate. A simplified ideal price may be derived by aggregating the prices defined above. The ideal price combines three important components of water related charges, that is the effective price, environmental cess and the metered water charge (official price). The resultant price approximates the true current accounting cost on water use. Assuming that defaulters pay penalty on water charges, and improved arrear collections are significant, the imputed price will be higher than the official rate:

$$P_w \geq P_t.$$

The water supply agencies seem to be adopting the variants of the above defined prices, although not efficiently. The existing water charges are substantially below the annual operation and maintenance expenditure in almost all the urban centres. In other words, the existing practice, neither follows the cost-recovery method nor the economic pricing. For the purposes of deriving at least cost-recovery pricing, it is essential to have unbiased estimate of costs of production of water. The extent of cost coverage by revenue collection from the water users is given in Table 12. Except in a few cases, the charges do not cover even the revenue expenditure leave alone the capital cost. For example, the current cost of production of water in Delhi is Rs.1.55 per kilolitre while its water tariff for the domestic consumers is as low as Rs.0.35 along with a 30 per cent surcharge. Marie (1995) has recently estimated that the actual monthly payment on water by the consumers in Delhi varies from a low of Rs.9.10 for 21,000 litres of water (i.e. an effective price of Rs.0.43 per kilolitre) to Rs.37.1 for the consumption of 60,000 litres of water by the higher consumer groups (@ Rs.0.61 per kilolitre). At current level of per capita income, the proportion of income spent on water by the urban non poor is a paltry amount of money and hence serves as no incentive for conserving water. This confirms that irrespective of the ability to pay, domestic water is heavily subsidised to the entire urban population. The proportion of net subsidy to O&M cost varies from 72 per cent for the lowest income consumers (in real terms: Rs 1.12 per unit) to 60 per cent to the upper income consumer groups (ie. Rs 0.94 per unit of water). It is interesting to observe that the water charge actually paid by consumer is lower than the official rate which happens to be below the cost of production of water (Vandana 1995). Table 22 gives the extent of variability of water prices. Correction for these price anomalies is essential for rationalising the water charges.

The efficiency of the ideal price (approximated to represent the average incremental cost) needs to be examined to reflect the true value of water in the long run. Recent literatures (Sarma 1992, Howe and Linaweaver 1967, Young 1973, Rogers 1992) indicate that the average incremental cost can be approximated to the marginal cost to justify the above cost-pricing as the true price.

It is worth noting that the existence of great diversity in the spatio-temporal dimension of water rates as well as the methods of charging the water users complicates the rationalisation of the price structure. Appendices 1-3 give the list of a diverse types of water rates charged from the water users in selected cities. As many as eight to nine different rates are found which are uniquely and unilaterally fixed by individual water agencies. Except for non-domestic uses, the water tariff is invariably fixed at a rate below the cost price. The variation in the modes of water charge is also significant among the cities. For example, Madras has a unique method of user charge which is based on a flat rate of Rs.12 per month per water connection irrespective of the quantity of water consumed. The domestic piped water supply in Madras is not metered. This method of water charge is devoid of the principle of economic costing and is known to have adverse effect on the revenue base, besides encouraging over-use of scarce water. This system of arbitrarily fixed flat rate is low revenue-yielding as the leakages in consumption go unnoticed. Bombay, in contrast, demonstrates the merits of the progressive pricing of water. Currently, Bombay raises more than 80 per cent of its total revenue water collection from the metered charges of which the major contribution (57 per cent) comes from the industrial consumers. There are other variants of the method of revenue collection such as mix of metered water charge on volumetric basis and/or monthly flat rate for non-metered or defective metered connection. Although locational factors are required to be adjusted for comparing the pricing practices, yet the above analysis is a pointer to the fact that in reality, the diversity of charging for water services exists on a large scale. In a situation of such diverse pricing, the policy parameters become highly complex and incomprehensible. Table set 14 shows the actual diversity of metered and non-metered connections in various cities and their revenue thereof. The percentage of metered revenue in Delhi is lower (74 per cent of total revenue) than that of Bombay. Loss of revenue as well as unaccounted for water loss due to non metered connection and the transmission losses need to be properly dealt with to improve the conservation strategy. An effective management to recover the lost revenue on account of unmetered water supply (more than 20 to 30 per cent revenue income) and of an equal proportion of water loss, would enhance the viability of the municipal water services.

Besides the imperfection in water pricing, rent-seeking by various interest groups has also affected the rational pricing strategy for urban water. The dominance of the rent-seeking strategy is a well-known source of inefficiency in the revenue collection and cost-recovery mechanism. The price rigidity regime which holds the water rates in almost all the municipalities and prices remain static for a long period. For example, the water tariff structure in Delhi has not been updated since 1987, despite the escalating cost of production of water over time. Table 10 gives the cost of water calculated from revenue demand and total collection during 1988-89 to 1993-94 for Delhi. The average official water charges are found to be closer to the imputed effective price based on actual total collection of revenue. This implies that the prevailing water charges tend to be consistent with the historical prices and not related to current cost recovery. If the demand for revenue approximates the O&M cost recovery, the actual collection is found to be deficient by about 11 to 13 per cent of the revenue demand. The estimated average official price is Rs.0.69 whereas the imputed unit cost based on revenue collection varies from Rs 0.65 to Rs.1.35 . The same cost, based on the total revenue demand, ranges from Rs.0.73 to Rs.1.48 per unit. The empirical evidence supports the observation that existing cost calculus does not reflect the true picture of cost recovery.

The failure of the existing pricing mechanism to provide a sufficient incentive for economising water use, strengthens the argument for rationalisation of prices. The accurate measurement of water on a volumetric basis is an important requisite for an effective pricing policy. Therefore all water connections must be metered for full cost recovery. But in reality, non-metered water connections as well as non-functioning water meters exist simultaneously in large numbers, which is an obstacle to efficient planning for water resource. Non-functioning meters and non-metered connections offer a payoff to the household, as the connections are usually charged on the basis of an arbitrarily fixed constant monthly charge. But actually the installation of efficient meters to all the connections is cheaper in the long run besides helping conservation.

The modernisation of the entire water connections with tamper-proof meters of international standard for about 100,000 connection in Hyderabad cost Rs.1000 million. This amounts to a one time investment of Rs.10,000 per connection with a pay back period of about 10 years. But the cost of providing an additional unit of water from the Nagarjuna sagar dam is Rs.18,340 per kilolitre. Therefore, the cost of conservation of water is cheaper than producing an additional unit. As the water charges are low, there is no fiscal incentive even for upkeeping the water meter. This is typically a case of implicit free-rider for water use. As long as the problem of free-rider, unrealistic pricing, valuation of water utility and other externalities exist, the competitive pricing of water will not be feasible. Therefore, to correct the above mentioned factors, appropriate pricing (second best pricing) must be combined with relevant incentives or disincentives as the case may be, for efficient resource allocation. Such a policy would, of course, require reliable estimates of elasticities of consumer behaviour.

* ESTIMATES OF ELASTICITY OF DEMAND FOR WATER

A Measure of User-friendly Price Incentives

Studies on demand for water supply in India are extremely scarce. Lack of data on actual water demand, pricing of water have constrained the estimation of a realistic demand model and elasticity. Derived demand based on biological requirement is the basis for the projection of demand for water by the agencies. The available literature on the estimation of elasticity of demand for domestic water for developed countries does not provide information suitable to the Indian situation. However, it is useful as a broad spectrum of references and to incorporate necessary methodological modification in the estimation of a water demand model. Roger(1992) provides the estimation of elasticities for a number of states in the United States of America with a range of values from (-)0.30 to (-)0.80. The OECD study on pricing of water services(1987) also provides similar estimates for some of the OECD countries. These estimates do indicate a possible range of the values of estimation. Adjusting estimators for the differences in the economic condition, income level, existing pricing practices provide a meaningful comparison. As compared to the estimates of price elasticity of demand for water in the developed countries, the elasticities for Indian cities are expected to be smaller in magnitude as the demand in this case is largely supply determined and supply of water is limited. Moreover, water does not have any substitution possibility for its alternative uses, therefore, the supply constraints strain the actual demand for water. Unless, the supply of water is adequate, the consumer behaviour in response to changes in prices would be superficial. In these circumstances, the consumers mostly confront a supply-driven truncated demand situation making consumers less responsive to the price changes than when water supply is adequate. Therefore, improvement in the service along with the price rationalisation is a pre-requisite for true responsiveness of the consumers to the price change. However, with the limited information, a unique panel data are made available for regression analysis. The data consists of both supply-side as well as demand-side variables pertaining to Delhi and Hyderabad for a period of six years. The parameters of the regression models are estimated using a computation tool the LIMDEP: a versatile software package. The panel data estimation procedure is a significant improvement in the values of the elasticities as compared to that of the OLS procedures. The values of the estimates of the elasticities are lower as expected in the range of (-)0.087 to (-)0.223. The result provides a case for an alternative price policy akin to a conservation strategy. The unit increase in effective price has no significant influence on reduction of the consumption of water. That is to say, the price changes will not affect the consumption behavior pattern of water adversely. Thus the findings strongly support the case and the time is rife for correcting at least the cost recovery optimal price of water. The price revision up to the level of economic/marginal cost will not cause a significant setback to the consumption of water actually demanded. Rarely though, the available WTP studies also indicate that the consumer acceptance of the policy will be significant for assured and regular supply of water. The estimates, although not robust owing to insufficient degrees of freedom, nevertheless they provide important empirical policy parameters. These estimates confront the following limitation: firstly, the consumption of water, on average is below the potential demand level denoting a confounding effect, and secondly the water rates are so low that an initial change in price is not likely to have significant response to change in the consumption level. The panel data needs careful update for the variation of factors of production to ensure the efficacy of the estimates.

* ESCALATING COST OF PRODUCTION OF WATER:
A Guide to Price Rationalisation

The impression that water is a free good abundantly available and the provision of water utility services is the responsibility of the State, has caused enough harm to the efficiency of resource use. Water is a basic need of the consumers and a public good. Water exhibits several characteristics of public goods such as market failure, lack of property rights, problem of free rider etc. which distort the pricing mechanism. Specific aspects of water such as flood control is a characteristic of a public good, which can not clearly be charged for on the basis of use. Therefore, the state intervention in the market process is necessitated to address the problems of market failure and the environmental pollution. The simplistic logic that public goods should be paid for by the public fund and private goods should be paid for by the private fund raised from the user charge of the services could not be applied to water utility services. In reality the public funds are not sufficient even to cover the O&M cost.

The cost of water has two aspects - (i) private cost and (ii) social cost. The private cost or the accounting cost is primarily influenced by the nature of the sources of water and the distances between sources and destination. The debt servicing and the annualized capital cost compulsorily enter the private cost calculus. In contrast, the social cost is affected by a number of non-market variables including the environmental factors. Several non-marketed variables though not valued properly, significantly influnece the success of the economic decision making process. For example, the competitive digging of tube wells pushes the ground water table causing a large scale drying of the tube wells. Thus, the investors are exposed to larger risk of failure on tube well investment. The ground water may be contaminated owing to seepage of industrial effluent and sewage. The contaminated water causes a major health hazard which adds additional cost to the society. If valued properly, the total cost to the society attributed to the non marketed factors will be extremely high. This is one of the justifications for the consideration of the concept of user cost or scarcity rent for rationalisation of real water tariff. Besides the difficulties of assigning scarcity value to water resource, the estimation of the social cost also confronts the limitation of inadequate data base.

Often, the estimation of production function for domestic water is constrained by the data. The method of combining time series and cross section data for a multiple regression model is an appropriate and relevant technique which purge the data for locational disturbances and temporal shocks (Nerlove M 1971, Wallace & Hussain 1969 and Swamy P A V 1975). The estimates of pooled regression procedure facilitate the inter city comparison of the factor shares and elasticities. The regression analysis is carried out with the help of computer packages LIMDEP and RATS for panel data to enable cross checking of the results.

It has been observed that the total cost of water supply and sewerage works doubles every two years depending on the expansion programme. It is observed that, for example, the fund requirement for water supply works in Delhi has increased from Rs 34.50 million in 1972 to Rs 892.50 million in 1992 [6]. The expenditure trend on sewerage development works is also identical. The rising trend of the cost of water services must be internalised by the choice of user charge for water. However, understanding the complex cost matrix requires the examination of the nature and significance of various important factors affecting the cost.

The following factors are primarily responsible for the surging trend for cost of production of water:

* ERODING SOURCES OF WATER

Need for Restoring Traditional Systems to Improvise Modern Ones

Natural water bodies such as lakes, tanks and other water harvesting systems

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DWSSU; Annual Budgets, New Delhi.

create a symbiotic condition for sustainability of water resource and preserve the ecosystem. Traditionally, these water bodies provide a strong base for urban water supply in several cities. Unfortunately, most of these sources are declining because of over-exploitation for domestic as well as irrigation purposes [7]. This has created serious problems of scarcity of water and of water pollution. This scarcity syndrome has compelled several water supply agencies to move out of city limits to harness water. It is seen that twelve out of 23 cities have already exhausted the potential design capacity of water supply by as early as 1986-87 (Appendix 4). Except a few smaller size cities, others are also nearing the full capacity utilisation of water sources. As the possibility of replenishment and recharging the water sources with clean raw water is rather lean, therefore, the only way to the augmentation of a dependable supply is to go in for fresh investment on a new facility creation for water. The new expansion projects are expensive and importantly these projects interfere with the rural water and irrigation systems. Drawing of water from irrigation sources haphazardly is a source of potential rural-urban and interstate conflict. A series of interstate negotiations in the recent times on sharing of inter basin water is the manifestation of emerging social tension and failure of the social order. Table 20 shows the importance of distance as a cost-inducing factor which is reflected in the distance-cost relationship for water appropriation for urban water supply. Important metropolitan cities are already importing water from sources located over 100 kilometres away. The implication of the importation from a distant source is the manifold increase in the transportation cost of water. The consequent rate of capital cost on water works in Madras, for example, is as high as Rs.53.25 million per kilometre with the long term average incremental cost of Rs.14.39 kilolitre. This cost is many times higher as compared to the existing practice of a flat rate of Rs 30 per connection per month (after a long period the Madras Metro water rate was revised from Rs.12 to Rs,30 in 1994). Bombay has been enjoying cheap water from local sources so far, but the cost of future expansion of water supply from Bhatsai dam shows that total capital cost will be Rs.73.75 million per kilometre. This will increase the overall marginal cost of water. The distance-cost relation is a significant cost factor for urban water supply and an important relevant lesson for future expansion.

Barah B C et al; Decline of tank irrigation, Ind. Jr. of Ag. Econ 1993(March)

* INADEQUATE INVESTMENT ON WATER RESOURCE DEVELOPMENT.

Promoting Public-Private partnership

Investment pattern for water resource development in general and that for drinking water supply in India in particular is very disappointing. Only a niggardly importance is given to the allocation of plan outlay under the water supply and sanitation services during the entire planning era as elucidated in section one. With less than one per cent of central government contribution towards the planned budgeted outlay for WSS, one can hardly do justice to provide so called **ample and pure water** to the citizen and minimum basic services to the vast majority of deprived people termed as the urban poor. Therefore, a large investment fund is necessary for infrastructure building to enable improving the level for water supply and sewerage services. Table 17 presents a comparative picture of components of revenue expenditure for water supply in Hyderabad, Delhi and Bombay in order of rank of total cost. The unit cost of water Hyderabad is the highest and lowest in Bomaby. This has clearly shown that the declining local sources increases the transportation cost as the case in Hyderabad. Tables 18 & 19 give the total investment requirement for new projects in Bombay and Madras respectively. For the purposes of sustainability, this perhaps requires the participation of both private and public sources of funding.

* LOSS DUE TO UNACCOUNTED FOR WATER

A Scope for Water Conservation

Paradoxically, while the investment for water supply is inadequate, the proportion of unaccounted for water losses are increasing in almost all the cities. About 20-35 per cent of the total quantity of water is lost before it reaches the consumer. Table 8 gives the sources of loss of water in Bombay with 20 per cent distribution system loss and 2 per cent transmission loss. Lower transmission loss is due to the existence of reliable sources of water within the city limit. However, the transmission loss is a major source of water loss in Madras, Hyderabad and Delhi. The distance factor is also liable to render the water losses substantially high and therby influencing the cost escalation in several cities. The estimated loss of revenue due to system loss of water in Delhi has increased from Rs.179.57 million in 1988-89 to Rs.434.37 million in 1993-94 (Table 33). In a recent study, Marie (1995) shows that the value of unaccounted for water loss in Delhi is as high as 60 per cent of total revenue. It implies that the revenue collection may be effectively enhanced by 30 to 40 per cent by bettering the water management in the demand side. Sarma (1992, Appendix 5) shows that the proportions of unaccounted for water in several other cities are significantly high. The range of 20-35 per cent losses of filtered water before reaching the consumers, is a good target to improve the conservation.

*** COST OF POWER AS A DOMINANT FACTOR OF PRODUCTION OF WATER:**

The dominant factors responsible for the hike in cost are power/fuel and distance from the water sources to the destination consumers. Water is transported from distances in the range 100 to 400 kilometres away from the city limits which entails additional pumping cost, treatment cost and storage cost besides incurring a larger water loss. Although both the factors are exogenous and crucial to the pricing of water, efficient demand-side management may be helpful to control further cost escalation or even delay the process to some extent. The power costs are dependent on frequent upward revision of electricity tariff by the state electricity boards. The electricity prices in Hyderabad, for example, have undergone drastic upward revision up to 73 per cent in quick succession during August 1991 and January 1993 (Table 15). This revision of electricity rates increases the power cost raising its share up to 40 per cent of the total cost. The staff cost is the second highest component of total cost. At current level, power and staff cost together cover up to 75 per cent of the total cost. Can this regular hike in factor prices be absorbed in the user cost for water ?.

* DISTANCE - COST RELATIONSHIP

A Case Against Price Stabilisation

The sources of water in the vicinity of urban areas are rapidly getting exhausted and the deteriorating water quality creates pollution problems. Box 1 shows the source of water pollution and the impact of discharge of industrial effluent on water bodies in Hyderabad. The externality of the industrial effluent dumping is remarkable. The aesthetic value of the water body is reduced, ground water is contaminated and bio diversity destroyed.

> **BOX 1**
>
> The three centuries - old Hussain Sagar lake located in the centre of the city of Hyderabad is a victim of massive discharge of sewage from slums and effluent from the factories of the surrounding industrial estates. The lake has a catchment area of 250 square kilometres with a total spread of 450 hectares of land. It receives sewage and toxic effluent from 250 industries scattered in its vicinity through four natural streams. The daily discharge of effluent received from these streams at the lake is 43.3 million litres per day and 55 mld of sewage. There s are enough evidence to demonstrate that many such water bodies are polluted and destroyed in several cities in recent times.

The destruction of traditional sources of water has driven a large number of water supply agencies away from city limits to venture out to the sources of water withdrawal. The impact of the distance factor on the cost of tranportation of water is becoming dearer to the water supply agencies. It is a dominant cost push factor encompassing the entire range of factors of production thus affecting the overall price structure of the urban water supply. Madras Metro Water spends as much as Rs.29 million per kilometre for transporting water from Veeranam tank at a distance of 235 kilometres south of Madras city. Hyderabad is augmenting the water supply by transporting 500 mld of water from Nagarjunasagar at a cost of Rs.9170 million; an irrigation dam situated at a distance of 160 km away. The Nagarjunasagar water is expected to be at least four times costlier than the existing price when it arrives in Hyderabad by the year 2001 A.D.

INEFFECTIVE COST RECOVERY MECHANISM AND EROSION OF REVENUE BASE

6

An Obstacle to Garner Municipal Income and Resource Mobilisation

The scope of revenue mobilisation for expansion plans to augment the water utility services is inadequate owing to the lack of appropriate policy on user charge and the predominance of rent seeking strategy. Estimation of actual revenue gap is difficult, because the expenditure on capital account is often not included in the cost calculation. The reported expenditure data related to the revenue account and give only a partial cost of water. Certain factors such as project gestation lag, problem of non-starting and unexpected rise in input cost etc. make the accounting of capital cost difficult. The municipalities and the water boards have failed to raise the revenue even to cover the O&M cost so far. It must be kept in mind that the calculation based on the revenue account gives the lower bound of the revenue gap, which itself is highly significant. Table set 12 shows the extent of cost recovery based on existing pricing practices and gap thereof. It shows that the cost recovery in Delhi is gradually deteriorating from 64 per cent recovery in 1990-91 to 55 per cent during 1993-94. As mentioned earlier, Bombay has been successful in collecting revenue in excess of O&M cost during 1983-84 to 1987-88. The efficiency of the revenue collection machinery as well as contribution of industrial revenue for water use, cause the success story of Bombay. However, with rising costs of import of water in recent years, the current revenue position may be different. Data for recent years in Bombay are not available. In recent years, fresh attempts have been made in several cities to improve the cost recovery and water prices are revised upward, but these are done with a compromise on the reduced level of the services. Again, a caveat is that constitutionally public utility service agencies are expected to present at least a balanced budget if not a surplus one. Therefore, it is difficult to derive true gaps in revenue from the budget document, though this is an important source of data for utility services. At the same time, the financial requirement for operation and maintenance of existing facilities and augmenting the future capacity for water supply is enormous. The cost of capital works for development plans of water supply and sewerage, is doubled every year or two depending on the expansion programme and primarily owing to several exogenous factors. The arbitrary and frequent escalation of the prices of the exogenous factors, such as electricity, distort the cost structure and affect the stability of the water pricing policy. To counter the situation, unfortunately, the leverage on manipulating the user charge for water is less flexible as compared to the same for the exogenous factors of production of water. The price rigidity regime keeps prices of urban domestic water almost static for long periods (Zriliches 1967). More often, the rent-seeking strategy and public resistance thwart the plans for price revision. It is however, no reason for complacency. Whether price rationalisation as a measure to improve the services is possible or not (because of political reasons), in reality, a large number of cities in India are increasingly suffering due to scarcity of safe of drinking water. This implies that the political economy is important for evolving the pricing policy of water utility.

7

THREAT OF WATER POLLUTION AND ENVIRONMENTAL DEGRADATION :

Impact on Welfare Loss and Quality of Life

Under the circumstances, the issue related to the impact of water resource management on environmental health and pollution requires careful attention. The external effect of water quality, contamination and supply deficiencies is high. Compared to water supply, the sewerage service has a distinctly larger externality, as such the case for government intervention in the management of wastewater and sewerage needs more emphasis. The externalities associated with the sewerage service can be addressed only by the participation of public institutions like municipalities. The benefits of improved sanitation are defused at various levels. The individual households place high value on the on-site clean environment and improved sanitation facilities. There are also clear benefits that accrue at aggregate/ community level from clean environment and hence the externality of the sewerage system from the viewpoint of individual households. This provision and consumption of the service generate externalities which subvert the market activities (Coolidge J et al 1993). A huge quantity of domestic waste water and sewage (approximately 80 per cent of the total water use) are generated by the household consumers. Waste water heavily loaded with hazardous pollutants enters the water supply networks mostly during the monsoon and contaminates the drinking water. Toxic and hazardous pollutants in drinking water are a potential source of health and environmental hazards. There are several other sources of environmental pollution in urban areas including the industrial effluent, urban solid waste, faecal contaminated waste water, other residual refuses and the pollution caused by the slum dwellers and squatter population. The century old and worn out water supply and drainage system is a potential source of contamination. **(see the drawing of defective pipeline)**. The recurrence of a number of major water borne diseases in the form of epidemics and consequent loss of lives, specially in the monsoon season signifies the linkage between the quality of water supply and environmental health of the people. The social cost of environmental hazards is significant. The World Bank (WDR 1993) has recently assessed that roughly 30 per cent of India's loss of DALYs (Disease

Adjusted Life Years) can be attributed to environmental pollution. There are several subtle but significant benefits from improved sanitation and clean water supply, although, the measurement of benefits as well as appropriate financing arrangement are complex. Unfortunately the sewerage and sanitation aspects have long been neglected, as reflected from the fact that the current level of sewerage tax is very minimal and linked to a negligible proportion of property tax. The impacts of externality on welfare and quality of life need to be studied in detail in the context of management of wastewater and sewage treatment.

The problems of water pollution add an important dimension to the water supply system. Studies on pollution abatement in India are relatively scarce. Murty(1988), Gupta (1989), Gupta and Mundle(1989) have studied the problem of abatement cost in India on the industrial pollution covering air, water and effluent pollution. Murty(1993) studied the economics of Common Effluent Treatment Plant (CETP) based on a case study of Jedimetla CETP in Hyderabad. He suggested a second best pricing policy using the Ramsey technique. However, reliable estimation of abatement function as well as the damage function due to water pollution is still not available.

The problem of sewerage, waste water and effluent did not attract the attention of the early planners. A large number of cities are unable to provide the treatment facilities for waste water and effluent and hence allow the sewage to flow into the open drains. Tables 23-26 give the quantity of waste water generated, collected and the extent of treatment facilities for the individual cities as well as at aggregate level. Nearly, 80 per cent of total consumption of water is converted to waste water which is loaded with a large volume of toxic pollutants. The studies by CPCB and the GAP (Ganga Action Plan) of the Ministry of Environment and Forests have concluded that water from most of the perennial rivers and surface water bodies is not fit for drinking. Lack of sufficient treatment facilities at the polluting sources (like household as well as industry) is the main cause of water quality. Until recently Delhi for example, did not have any sewage treatment facility worth mentioning. The population coverage by the sewerage and drainage system is much lower varying from 10 to 60 per cent. For example, of the 1944 mld (432 mgd) of total waste water generated in Delhi, the treatment facilities are available only for 1260 mld. More than a third of the waste water heavily loaded with pollutants is disposed of in the open surface drains. Bombay does not have waste water treatment facilities as the waste water and sewage are disposed of in the creeks or the sea directly. More than half the waste water in Hyderabad flows through the open drains and streams untreated. Therefore, a huge public investment is needed for the management of the sewerage system and pollution abatement.

The untreated sewage and effluent have a direct impact on water pollution. Table 27 gives the extent of water quality deterioration of the important natural water bodies in India, measured in terms of BOD, COD and Coliform count. Owing to non-point pollution, all the major river systems are infected by the industrial effluent and sewerage. The National River Action Plan (1994) found that all the major water pollutants are present beyond the permissive level in large numbers in important locations on the bank of the river Ganga, which signifies the gravity of the situation. The raw water from all over the river basins is just not safe for drinking, necessitating heavy cost of treatment (Table 13).

The cost of the externalities of water pollution is enormous. Generally, water pollution occurs at two stages: a) at the raw water stage and b) at the distribution network. The water treatment plants clean the polluted water at raw water level and then transfer it to the distribution system. The pollution occurring at the distribution network is highly damaging to the consumers. The sources of water pollution in this context are:

a) Contamination through water distribution system pipes and sewer line;
b) Faecal contamination from the open latrines of the urban slums;
c) Ground water contamination;
d) Contamination owing to industrial effluent and solid waste which are susceptible to bio-vectors like flies, rodents and vermin; and finally
e) Contamination owing to untreated sewage.

Most cities suffer from these sources of pollution causing health hazards and loss of lives. The valuation of externalities effects are extremely difficult but essential for fiscal management of the pollution problem. The causal relationship of environmental health problems is multivariate in nature and is subject to measurement problems. As such it is difficult to establish a direct relationship of health and environment. It also requires long term experimentation which is beyond the scope of the paper. Therefore, the inference here is based on the indirect method. Tables 29,30 give the extent of incidence of water borne diseases and the number of deaths owing to water pollution related diseases in India. The income effect of the incidence of cholera, dysentery and gastro-enteritis is highly significant. It is found that although cholera seems to be under control during 1987-1990, dysentery and gastro enteritis have been occurring more frequently and affect large numbers of people. The occurrences take place mostly during the monsoon when the rain water gets mixed with faecal contamination enters the distribution system. The organism that causes cholera is called Vibrio cholerae 01 proliferate intensively in the rainy season through contaminated water. The seasonality of the health hazards also signifies the relationship between water quality and environmental hazards. Delhi had about 1500 cholera deaths and more than 30,000 cases of morbidity in the 1985 season. More recently, Delhi again had about 30937 cases of gastro enteritis during the first seven months of 1994 and 1099 deaths due to cholera. Strangely, the number of cases of these diseases is increasing gradually and regularly every year (Table 29). More than nine million people suffered from dysentery in 1989, whereas about the same number of cases of morbidity were found in 1987 due to both dysentery and gastro enteritis. More than 40 per cent untreated waste water in Delhi, freely helps spread of cholera and gastro enteritis every season. The uncollected residual garbage mixed with drinking water from hand pumps entering the water distribution system through the corroded water pipes is another toxic factor for spreading water borne diseases. The value of time, work loss and employment loss because of these water borne diseases is extremely high. The value, when superimposed on the existing subsidies, not only deepens the crisis but also sharpens the hypothesis of under-investment-led inefficiency and the erosion of public utilities becomes rampant. Can this level of under-investment convert the toxic factors to tonic one is question worth examination. The user charge such as sewerage tax need not conform to economic price as the sewerage services have more benefits at aggregate level than at individual level. The subsidies or the community payment should be earmarked to those services such as disposal of solid waste, maintenance of sewerage network and sewerage treatment. However, individuals should be charged to the extent of the proportion of individual benefits such as maintaining clean surroundings and household waste collection.

The fund requirement to contain the environmental pollution is massive. At the current prices, the cost of the sewerage system is substantial enough to be taken proper notice of. The HWSSB spends a colossal amount of Rs 5.0 million per month on operation and maintenance of the sewerage system. HWSSB also estimated an investment requirement for improving the sewerage system to the tune of Rs.5270 million at 1992 prices. Yet the major portion of waste water could not be treated for pollution. The existing practice of cost recovery is totally ineffective. The figures of cost recovery of sewerage services in table 12 are rather disappointing. The cost recovery was less than 25 per cent in 1990-91 which has slided down to 20 per cent of the total cost in 1993-94 in Delhi. Adding to the situation is the system of linking of sewerage tax to the property tax by the local governments as a certain per centage of the net annual value of the property. The historical value of the property is low and it is operationally difficult to update the net annual value to the current value. Therefore, the sewerage tax based on the historical value can not yield a reasonable income. A nominal pollution surcharge (called water cess) at the rate of Rs.02 per unit of water consumption is charged with a view to enhance the municipality resources. Negligible though, it is, the pollution surcharge seems to be progressive in nature. Thus as long as the user charge apparatus like water tax, sewerage tax or environmental surcharge is not delinked from the historically determined property tax, the cost-recovery for water works will remain deplorable. In other words, a rational policy would be to change the existing practice of property tax linked user charge for water supply and sewerage to a progressive system of charging the service based on the level of service (ie.quantity of water consumed).

8

STRATEGY FOR WATER CONSERVATION

A Step towards Sustainable Development and Delay in the Exhaustion of Resource

In view of the problems of scarcity and the under-pricing-led over-use and wastage, the issues on conservation of water are of paramount importance. A sizeable quantity of water is lost on the system before it reaches the consumers. Generally 20-30 per cent of water loss in quantitative terms is attributed to sources of loss such as transmission loss, processing loss, distribution system loss, pilferage and other malpractices, along with free distribution of water to the urban poor. The losses in revenue are absorbed to some extent by the State in the form of award of subsidies on the grounds of equity. The analysis of the sourcewise revenue losses and estimation of the burden of actual subsidies will provide baseline information and help identifying proper economic incentives. As for example, prevailing low prices of water become a disincentive to conserve by even the urban non-poor. On the other hand, a substantial proportion of existing subsidies enjoyed by the group whose ability to pay the user charge is high, should be done away with for the sake of better services to all including to that of the urban poor. The transfer of surplus from the industrial consumer along with subsidy withdrawal from the non-poor provides resources for social equity and environmental protection. It is found that currently an estimated annual surplus of Rs. 216 million from the industrial consumers is generated to cross subsidised the domestic consumers in Hyderabad. The scope of additional resource mobilisation can be broadened further by withdrawing the subsidies on the water supply to the colonies, households and multistoried buildings.

What are the available economic instruments and incentives for water conservation and reduction of waste generation ? Such economic instruments either are non existent or very meagre which conversely affect the over use and wastage of scarce resources. A successful economic incentive is one which corroborates the social responsibility and promotes conservation. People's awareness and participation backed by organisational support for technological upgradation are the key to conservation of water. The technological upgradation both at the domestic level and industry level is

Indian industries traditionally consume a large amount of water as compared to their counterparts in developed countries, because they use outdated and worn out technologies. For the water conservation strategy to be more effective there should be a quantitative change in capital mix (including man and machine) in the Indian industries. A number of industries have initiated action plans on modernisation and technological upgradation of old machinery with new and input-saving technology. For example, the fertilizer industries drastically reduce the consumption of water from 14 cum of water per tonne of urea to 6 cum for the same level of production without compromising on the quality. Similarly, Bhillai Steel Industries has demonstrated that it can save up to 83 per cent of water with appropriate technology and other means of conservation. Further, the estimate shows that if the entire Indian fertilizer industry modernises and upgrades its machinery, it potentially conserves/saves annually about 34 million cubic metres of water equivalent to Rs 23.915 million (at 1988-89 price). At the same time, the corresponding capital investment for all the modernisation schemes of the ferltiliser industries together is a sum of Rs 51.0 million with a pay back period of six months to 16 years. At the individual domestic level also there is a possibility of substantial water conservation. Assuming that the scarcity driven consumer adopts the ideal consumption of 150 lpd as depicted in figure 1, the per capita net saving of water in Delhi would be to the extent of 87 lpd. That is at least 37 per cent of total water could be conserved for the purposes of redistribution. Adding to it, a portion of the 40 per cent transmission and distribution loss of water, would improve the general service substantially.

9

EFFECTIVE MARKET BASED INSTRUMENT FOR URBAN WATER AND SUBSIDY NORMS:
Efficiency-Equity Tradeoff

Most critics argue that subsidies are regressive in character and promote inefficiency. The Indian experience shows that subsidies are also iniquitous. That is, a large benefit of subsidies are reaped by the rich rather than the targeted groups. To be equitable, the subsidy should be used for the purposes of redistribution of benefits to those who have the need. In this context the policy of cross subsidisation must be stressed which is believed to improve equity effectively. The quantum of subsidies for the urban water supply are estimated, based on an O&M cost. The actual quantum of subsidies would be mind boggling when the cross subsidisation from the non domestic consumers is withdrawn. Total subsidies can be divided into two parts:

a) A part of subsidies attributed to the free water supply to the urban poor through the public stand posts. There are a large number of beneficiaries of these subsidies who actually deserve it. It may be termed as Essential Subsidies (S_e).

b) The second part of the subsidies is avoidable (S_a), as it is enjoyed by the urban rich and must be substaintially reduced. The calculus of these subsidies is as follows:

$$S_e = Y_f.P_w,$$

where Y_f = quantity of water supplied through free hydrants or public stand post.

P_w = Cost price

$$S_a = (Y_Q - Y_f).P_w - \Pi : \quad \Pi = \text{total revenue collection.}$$

The size of S_a in reality is larger than that of the S_e. Thus a larger shares of the subsidies is reaped by the urban rich which helps deteriorate the fiscal crisis.

To examine the extent subsidies for urban water, it is found, for example, a typical household pays a water charge of Rs.18.20 per month to consume 30,000 litres of water , while the DWSSU spends Rs.46.50 to produce and supply the same quantity, leaving a subsidy to the extent of 60 per cent of cost of production per household. The cumulative subsidies over years is a staggering amount, inspite of the cross subsidisation from the non domestic sector. For example, of the net total revenue deficit of Rs. 296.3 million from the domestic consumers in Hyderabad, the industries provide a cross subsidy of Rs. 109.5 million. Bombay also generates substantial amount of cross-subsidies from the non domestic consumers. This of course is no reason for complacency. That is to say that the crisis persists.

10 A THEORY OF WATER PRICING: ALTERNATIVE PROPOSITIONS FOR REVENUE POTENTIAL

The analysis clearly brings out to its fore that the pricing of water supply in urban India is a notional one in character rather than based on sound economic principles. The under-pricing and consequent under investment are responsible for inefficiency of resource use and perpetuating fiscal crisis. Hence, there is an imminent need to rationalise the water pricing policies to ensure sustainable development and continued economic growth. Owing to the peculiar nature of water, being a quasi private and quasi public good in the economic sense of the term, a stringent economically efficient price can not practically be charged from the user. Therefore, despite strong theoretical argument for competitive pricing for water, the consideration for equity and financial adequacy must be kept in mind for setting the price for urban water. That is, the subsidisation of urban water, to some extent, is inevitable especially in the context of providing a basic need to the urban poor. Although further research is needed, nevertheless, we present below a set feasible recommendations for reform in the urban water utility sector.

A STRATEGY FOR REVENUE POTENTIAL UNDER ALTERNATIVE PROPOSITIONS

A Policy Imperative

The urban water supply agencies are responsible for the management of the Water Utility Services. The urban water supply system to be financially viable and functionally efficient, the consumers should pay for the services in accordance with the user charge principle. But, as the urban consumers consist of heterogeneous groups with varying ability to pay owing to extremely skewed income distribution [8], charging consumers with a uniform prices for water use in the urban areas leads to iniquitous distribution of the utility services. At the same time, the present practice of supplying free water through public stand posts to certain section of the consumers is also financially not feasible. At present, the urban poor are provided with free water through the public stand posts. On the other hand, the agencies are increasingly facing serious problems of resource crunch so much so that even the present level (less than a tenth of the average supply of the utility) of the services may not be available to the rapidly growing urban poor. For the sake of improving the services and the sustainability of fiscal system of water utility, we present two propositions of alternative scenario A and B as given below:

SCENARIO A :

The scenario A is based on the popular adage commonly used in Public Finance literature -

"BROADEST BACK SHOULD CARRY HEAVIEST BURDEN"

That is to say that users should be charged for public utility services based on ability to pay. The logic implies that the urban poor and non-poor should be charged for the basic water utility in accordance with their ability to pay. Thus is the case for government intervention through discriminatory prices for water aiming at achieving objectives of equity and social obligation. The first proposition viz, scenario A adopts the following basic conditionalities.

Mathur O P; State of India's poverty; NIPFP, New Delhi 1993.

1. Improving per capita water supply from existing suboptimal level to the basic minimum need level of 25 litres per day per capita to all. The limit of water supply of 25 litres is assumed to be necessary for the purposes of the most essential daily activities.
2. The basic minimum quantity of water supply targeted for the urban poor should be charged at 10 per cent of the marginal cost of water (a rate which is arrived at in accordance to the proportion to the difference of average income of the urban-poor from urban per capita income)[9].
3. The rest of the domestic consumers (urban non-poor) must be charged at least at O&M cost level.
4. Non-domestic consumers can afford to pay the economic price.

SCENARIO B :

In view of the prevailing practice of supplying free water to the slums and the poor, introducing user charge from the urban poor might arouse resistance in the first instance. Therefore, as a first step, in the direction of achieving dual objectives of cost-recovery and assured minimum services to the poor, the scenario B approximates the existing practice more closely. The primary assumptions are as following :

a) Free water allowance of 20 litres per day to all categories of consumers [10].
b) Consumption of water above (a) level must be charged at least at O&M cost price or marginal cost.
c) Non-domestic consumers have the ability to pay the economic cost.

The above propositions fulfill the objectives of cost recovery, enhancing the ARM and service to the poor and address the issues of environmental problems. The

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9 A number of studies (conducted by the World Bank; Demand for water) in Brazil, Haiti, Pakistan, India, Tanzania and Zimbabwe aptly underscore that "Poor people are willing to pay for services of a relatively high quality and they are willing to pay substantially more if the service is reliable"; Ref: Briscoe J; Poverty and Water Supply; Finance and Development, Dec 1992.

10 For example, Metro Water in Madras allows a free allowance water @ 200 litres per rupee of assessed value of water. The slum inhabitants, of course, universally, use free water from public hydrants.

gain (potential revenue yield) due to the application of proposition at scenario A and B is demonstrated by taking the recent data from Hyderabad and Delhi as shown in the Box entitled Application of Alternative Proposition for reforms in water sector.

BOX 2

EFFICIENCY GAIN DUE TO THE PROPOSITIONS IN THE WATER SECTOR :

The revenue calculation further assumes:

(a) Proportion of urban poor in Hyderabad is 25 per cent of total urban population. The enhanced level of per capita water supply from existing 11 litres per day to 25 litres would require additional 16.98 mld as against the existing supply of 14.27 mld. (i.e. 25 X 1.25 = 31.25)

(b) The urban poor are charged @ Rs 0.50 per kilolitre of water supply yielding Rs 4.75 lakh/month.

(c) Details break up of calculations are as given below:

Revenue Potential under Alternative A
Hyderabad 1992-93

	Urban poor	Non metered (# 5700)	Metered consumer					Total
			Slab 1	Slab 2	Slab 3	Bulk Supply	Non-domestic	
Water supply (mld)	31.25	5.70	66.37	71.08	49.37	69.64	71.23	399
Per Capita	11	200	166					79
Cost price (Rs/Kl)	0.5	5.06	5.06	5.06	5.06	5.06	10 (existing)	-
Total cost (Rs mill /pm)	4.744	0.865	10.076	10.794	7.494	10.572	10.813	55.35
Existing Revenue (Rs mill /pm)	0 (free)	0.342	3.988	5.629	6.37	71.52	22.097	45.598
Expected Revenue income	.475	.877	10.076	10.794	7.444	10.571	22.097	62.30

Scenario B: Details of the calculation of gain due scenario B:

(i) Total free allowance water requirement : 100 mld @ 20 lpd [11].

(ii) Remaining quantity of available water to be charged at cost recovery level : 228 mld (Total supply - free allowance - Industrial consumption). The revenue yield would be Rs.34.61 million/month (228 X 5.06).

(iii) Non-domestic sector revenue at existing level is Rs 22.094 million per month.

Box 2 ends

11 Providing 20 lpd improves the supply of basic need to urban poor to the extent of 45% from the existing level of 11 lpd. This also ensures basic minimum level of water available to everyone in the urban areas. However, while doing so, care must be taken that the cost recovery does not suffer.

BOX 3

Revenue Potential for the Water Supply Sector in Delhi under alternative pricing schemes 1992-93

	Consumer Category				
	Urban poor (1)	Domestic (2)	Non-domestic (3)	Industry & Institution (4)	Total
Population (million)	4.24[12] 16 lpd*	-	-	-	9.42
Water supply (mld)	70[13]	1119 (87.8%)	118 (9.3)	3.7 (2.9%)	1274 (100%)
Cost of Water (Rs mill./pm	3.3	52.76	5.26	0.174	61.49
Existing total Revenue	0 (free)	278.03 (annual)		381.0 (others)	659.03 54.9/month
Potential revenue under Scenario A	0.33[14] 0.18[15] ——	52.76	5.26	0.174	58.52 0.18 15.62 [16] —— 74.32

12 Percentage of urban poor in Hyderabad : 45%

13 14000 public stand posts supply free water @ 4000 - 5000 litres per day per PSP totalling 70 mld of water.

14 Urban poor are charged at 10% of the cost price; i.e. @ Rs.0.155 per kilolitre.

15 The existing per capita availability of water of 16 litres when enhanced to 25 lpd would require additional water supply of 38.16 mld. This would also yield an additional revenue of Rs.0.18 million.

16 At present 26% connections are unmetered which must be metered to charge the user efficiently with appropriate price. This would yield Rs.15.62 million per month. In 1992-93, there were 0.245 million unmetered pipe connections in Delhi.

Revenue Potential in Delhi : Scenario B:

(1) Free allowance water @20 lpd :188.4 mld (9.42 X 20)
Cost = Rs 8.76 million/month (188.4 X1.55)

(2) Rest of the water consumption to charge @ Rs 1.55/Kl
Metered Water 74 per cent = 1274 mld
Unmetered Water 26 per cent = 331 mld
Less free allowance = (-) 188 mld

1317

Total potential revenue: Rs 62.09 million per month (1317 X 1.55)

Impact of alternative propositions on per capita availability water:

Average per capita availability (lpd)	Existing level	Scenario	
		A	B
Hyderabad city	79	79	79
Urban non poor	102	77	98
Urban poor	11	25	25
Total Domestic water supply	399 mld	399	
Delhi			
City average	143	143	143
Non-poor : (70 mld)	246	238	243
Urban poor: (1274 mld)	16	25	20
Total water supply	1344 mld	1344	1344

Gain in Additional Resource Mobilisation and Cost Recovery

City	Existing Revenue (Re mil/pm)	Cost	Potential Revenue		Gain in ARM	
			Scenario A	Scenario B	Scenario A	Scenario B
Hyderabad	45.60	55.35	62.33	56.70	16.73	11.10
Delhi	54.90	61.49	74.32	62.09	19.42	7.19

Implementation policy:

The optimal implementation of policy prescriptions in an economy like India may be a rather difficult task. However, in view of the alarming situation of crisis of urban water utility, some stringent measures must be implemented with a greater seriousness. The necessary and sufficient conditions for the success of the implementation of the propositions made above, are as follows:

1 All piped water connections must be metered which is necessary for accurate volumetric measurement. The consumers of unmetered connections tend to over use and waste the piped water. Growing number of unmetered connections is a major source of leakage of water revenue. Actually, the practice of arbitrarily fixed monthly charge (usually lower than the actual water charge) is an incentive to temper with the meter and to neglect the up-keeping of the working meters. For instance, Delhi has as many as 0.245 million unmetered piped connections making up of the 60 per cent unaccounted for water. There are 5700 unmetered connections in Hyderabad supplying 5.70 mld of water which is charged at monthly flat rate. The existing revenue collection from the unmetered connections is Rs.0.345 million per month as against the revenue potential of Rs.0.877 million (an increase of 2.5 times the existing level). To be more effective, the private investment for the meter installation by the individual households needs to be encouraged along with the simultaneous involvement of the government in the form of loan or subsidy as the case may

be.

2 For the purposes of improve revenue collection machinery, the water billing should be regular. The existing procedure is highly irregular and the gestation lag between water use and billing ranges from a couple of months to years. This is how, the consumers sudenly face a burden of payment of large amounts of money at a time, thus is a potential source of evasion. To expedite the billing system, settlement of the public grievances for water services required to be made consumer friendly through computerisation of the water supply system. It is observed that the Rajkot Municipal Corporation has improved the revenue collection by about 60 per cent through on-line dialogue for consumers complaints. Such an Walk-in-Settlement and Done method is relatively easier and effective process for system reform.

3 As the existing revenue collection machinery in the slected cities is found to be weak and often understaffed, the lags in revenue collection increase and arrears accumulate. For example, the number of water connections between 1895 and 1994 in Delhi, have increased from 0.60 to 1.0 million, whereas the number of revenue collection personnel remained at the 1985 level. In such a situation, involving the consumer groups to help in revenue collection and in other decision making process is expected to improve the situation considerably. A large number of housing cooperative societies are already involved in the efficient management of in-house water supply systems. Such urban water societies may be encouraged to participate in the management of the piped water for the respective societies. Bulk quantity of water may be supplied to the societies by the apex water supply agencies. The societies in turn, should take the responsibility for distribution and charging the piped water use from the tertiary consumers. Such a method would improve the revenue collection and distribution as the communities have a stake in collective bargaining of the utility, and the societies are accountable to the overall management. Several non governmental organisations are already involved in performing a variety of similar activities in different areas which supplement the management of urban utility services such as primary collection of solid waste management. For

example, the involvement of EXNORA in Madras for activities like street beautification and community sanitation is worth mentioning in this context.

CONCLUSION 11

The primary objectives of the reform in the urban water sector are to improve resource use efficiency and preserve environmental quality. The cost of reforms in a developing economy is usually apprehended to promote distributional problems at least in the short run. This is also true of the reforms in the urban water supply services which severely affects a large section of the urban poor. These services are rendered below the basic norm which has adversely affected the urban environment and deteriorate its quality. The externalities of the urban environmental pollution cost the society dearly. Therefore, equitable distribution of water utility should be an important objective along with efficiency of resource use for water resource planning. In other words, there is a need to examine the feasibility of the simultaneous existence of differential policies such as affordable price incentive as well as the market based economic instruments for water utility services. The economic instruments for sustainable development of water resources must address the issues related to environmental pollution and its impact on the quality of life. Such social objectives (equity and sustainability) are essential for rapid and deep reform process of the services at large. The paper has examined the broad objectives in the context of selected metropolitan cities in India where both poor level of basic civic amenities such as water supply as well as environmental pollution are raising serious questions to the policy makers. The analysis in the paper clearly brings out the following observations and recommendations:

OBSERVATIONS:

i) The service level for water supply and sewerage in a majority of the cities has been declining and are falling below the recommended standard norm. The rapid growth of population increases the demand for the utility while the declining sources of water affects the supply side. At the same time the existing infrastructure facilities for the public utility services have failed to match the increasing demand for the water utility. The design capacity for water supply is exhausted much faster, warranting fresher investment plans and reallocation of resources. The current status of per capita availability of water in several of the selected cities have already got reduced to half of the recommended level of 70 lpd, giving a signal on the alarming condition of basic civic utility services (for example, the present level of per capita daily supply of water in Madras and Hyderabad are already below the standard norm at 47 lpd and 65 lpd respectively). Of course, when confronted with the scarcity syndrome, the consumers seem to respond more to the supply situation and adjust their demand for water according to supply as a measure of crisis management. Therefore, the existing level of consumption reflects a situation of truncated demand for water rather than a real demand. Policy inferences on the price response behaviour of the consumers should take care of the situation accordingly.

ii) The gap between demand for and supply of urban water is increasing, despite the expansion plans and augmentation of water supply. The increasing gaps are the main causes of the reduction in the per capita availability of water in the recent times. Since the urban population is growing faster than that of the augmentation of water supply, the augmentaion efforts are rarely successful. For example, the augmentation efforts for the water supply in the Bombay Municipal Corporation from 2020 mld to 2930 mld could not reduce the existing demand gap of 18 per cent in Bombay, rather this gap is projected to go up to the extent of 33 per cent by the year 2001 A.D. The current trend of the gaps in other cities are found to be around 50 to 60 per cent of the demand for water. This has also affected the frequency and duration of water supply besides reducing the per capita availability. Residential water supply in several cities is restricted to a maximum of two to three hours once in two or three days; a kind of implicit rationing. Obviously, such a supply is also intermittent and of low pressure, which can make the ststem vulnerable to contamination attracting the pollutants.

iii) To counteract the situation of inadequate infrastructure as a technological means to improve the supply of water, the position of resource mobilisation is precarious. While the requirement of capital investment for replacement and relocation of the infrastructure for water supply and sewerage system is enormous, the prevailing low water charges failed to boost the additional resource mobilisation. A large segment of the urban population being poor, the pure competitative economic price can not be charged on them. Under the circumstances, neither the command and control instrument nor the pure market based instruments (MBI) could be effective. The failure of these instruments to tackle the problem of sanitary environment has adversely affected the quality of urban life in India. Thus a proper mix of MBI and government interventionis is a sine qua non for the water system. The proposed policy imperatives indicate that by rationalising the price structure for water supply and improving the collection machinery, the revenue potential of local governments can be enhanced considerably without compromising the objective of social equity.

iv) The cost of production of water is increasing sharply and is influenced by several exogenous factors. The dominant factors of the water cost escalation are the power/fuel and distance from the water sources to the destination consumers. At current price, the factor-share of total cost of electricity alone is around 40 per cent of the total cost. The combined cost of power and establishment is found to be more than three fourth of the total cost of the production of water. Thus in the changing situation, the existing rigid price regime has failed to recover the escalated cost of water. An effective set of management practices to recover the lost revenue on account of unmetered water supply (which is at least 20 to 30 per cent revenue income) and an equal proportion of revenue loss on account of water loss (such as transmission loss, loss due to defective distribution networks etc.), would enhance the viability of the municipal water services. The proposed "scenario A" demonstrates (without inviting the wrath of the potential critics), that an efficient fiscal management of a simple cost pricing has tremendous potential to garner the revenue base of the municipalities. The scenario is simple to comprehend by the policymakers and does not involve any radical departure from the existing system. For example, it is demonstrated that by carefully administering the cost recovery prices, existing regime is capable of yielding an additional revenue mobilisation of Rs.17.73 million (an increase of the existing revenue income of Rs.45.60 million to Rs.62.03 million per month) after meeting the cost of production of water in Hyderabad. In percentage terms, it provides 38.8 per cent ARM through the newly proposed initiative. The alternative at "scenario B" though, involves a sacrifice of a marginal amount of ARM with a view to achieve the objective of social equity, but satisfies the cost recovery mandate. It also generates a surplus of Rs.11.10 million as compared to Rs.17.73 million under scenario A. These alternatives ensure the additional advantage of providing basic minimum needs to all with a special emphasis on the urban poor. It enhances the supply of water to urban poor from the existing 11 lpd to 25 lpd under scenario A and a minimum of 20 lpd under scenario B. It clearly shows that the possibility of raising the water supply to double the existing level for the urban poor without seriously affecting the consumption of the non-poor. The redistributed per capita supply to the non-poor is estimated at 98 lpd against the existing 102 lpd (a marginal redistribution: about 4 per cent).

vi) The surplus so mobilised, can be reinvested to supplement the priority investment such as for the sewerage system. Owing to the negligence of the sewerage system, the urban environmental pollution is on the rise sharply. At presntly, on average more than half the untreated sewerage and waste water freely spreads the water borne diseases like cholera, gastroenteritis and typhoid etc. with a heavy toll of human lives every season. The fund requirement to contain the environmental pollution is massive. At the current prices, the cost of expansion of sewerage infrastructure is of substantial amount to be taken proper notice of. The HWSSB spends a colossal amount of Rs 5.0 million per month on operation and maintenance of sewerage system. Total investment requirement, for improving and expansion of the sewerage system in Hyderabad is estimated to the tune of Rs.5270 million at 1992 prices. Paradoxically, despite the massive investment, a major portion of city waste water would remain untreated to the detriment of the environmental quality. The existing pricing arrangement, instead of raising investible resources for sewerage improvement, shows a disappointing picture of cost recovery in the sector (Table 12). It is found that the average cost recovery is less than 25 per cent in 1990-91. The same has slided down to 20 per cent of the total cost in 1993-94 in Delhi. Adding to the situation, is the system of linking of sewerage tax to property tax as a negligible percentage of net annual value of the property. As the historical value of the property is used to be low and revision of property value is operationally difficult, therefore, sewerage tax based on the historical value does not yield a required income. In some cases a nominal pollution surcharge (also called water cess) at a rate of Rs.02 per unit of water consumption is charged with a view to enhance the municipality resources. Negligible though, the pollution surcharge seems to be progressive in nature. Thus as long as the user charge apparatus like water tax, sewerage tax is not delinked from the historically determined property tax, the cost-recovery for water works will remain deplorable. Therefore, the sustainability of the system demands a radical change in the existing practice of property tax-linked user charge for water supply and sewerage to a progressive one (ie. charging in relation to quantity of water consumed).

The prevailing practices of user charge as an economic instrument of reform is almost ineffecitve. The system is unscientific and unable to cover even the O&M cost. Moreover, there is a notable rigidity in the water prices. The water tariff in most cases are not revised for decades (see appendices 1-4). Among them the Delhi's case for water tariff is the atypical one. The revenue yield from the existing mode of user charge is at the lowest, which exacerbates the fiscal imbalance. Further, due to inefficiencies of revenue collection mechinary, the cost recovery has become unmanageable and the gap between revenue collection and expenditure is enlarging. Therefore, the inefficiency and suboptimal levels of services deepen the fiscal crisis and hence is the need for reform for the sustainability of the water supply sector. The practice of under-pricing of water entertains wastage and entails overuse of the scarce resource. To promote conservation of the scarce resources, the role of price signal must be understood carefully. However, further strengthening the effectiveness of the instrument of reform requires more empirical studies on the rather complex scenario.

One easily finds that under the influence of the said factors of water supply, and given the scarcity syndrome, the changing patten and increasing demand for water have superseded the expectation of the earlier investment planners. Thus, fresh investment of a larger magnitude on water works are needed which warrants drastic reallocation of resources. Once again, the findings of our analysis re-emphasise the importance of price rationalisation policy as a powerful economic instrument of reform. It has been clearly demonstrated that even without going deeper into the sophisticated models for water pricing, a simple cost recovery price alone, as a first step, is capable of improving the additional resource mobilisation of the municipalities siginificantly.

The impact of quality deterioration of water utility services on environmental pollution is crucial. Water creates environmental problems both under scarcity and excess condition. The narrow window of water beneficial (available) for mankind is also tempered with owing to over-use and wastage which creates problems of water pollution. The treatment facilities for the sewerage and waste water are extremely inadequate while the quantum of toxic sewage and wastewater generated in the selected cities are horrifying. In 1994, the sample cities have generated as much as 4984 mld of waste water per day (ie. 1819.542 billion litre per year). Existing designed capacity of the sewerage treatment plants is capable of treating hardly a 25 per cent (designed capacity of STP is 3830 mld) of these hazardous waste leaving the rest 75 per cent untreated. The untreated sewage and waste water are the potential sources of urban pollution. Discharge of industrial effluent and toxic waste water have polluted almost all the water bodies beyond the permissible standards. Important pollutants like biological oxygen demand(BOD) and faecal coliform counts are available in excess (CPCB norms) in the major water bodies and river basins. Unless, toxic contaminated water (even the ph values are high) is treated properly, the water from the river systems are not safe to drink. The other uses like bathing and washing etc. also create health and environmental problems. The domestic sewage, industrial effluent, hazardous solid waste and faecal contaminants enter the distribution network through the defective systems and are major sources of water pollution. The local governments, faced with severe resource crunch are unable to investment on the treatment machineries as their cost is doubling

every two to three years. As a consequence of the inadequate treatment facilities, the frequent occurrence of water borne diseases like cholera, dysentery and gastro-enteritis is causing serious health and welfare problems. Over nine million people in India suffered due to these water borne diseases during the mid eighties. The morbidity due to the water borne diseases is on the rise specially among the millions of slum dwellers. Loss of time, employment, income owing to environmental problems is highly significant. The value of the loss due to environmental degradation, when added to the existing subsidies, not only, deepens the crisis but also sharpens the under-investment hypothesis. Erosion of public utilities becomes rampant. To counter the crisis, the authorities are unable not to charge the individuals at full cost price of sewerage services (as a pure public good). Hence, the resources have to be raised from sources like grant-in-aid and transfer etc. The surplus generated at the proposed scenario A and B can be a supplement to such investment to an extent. The scenario A generates an ARM of Rs.153.96 million annually while the scenario B a sum of Rs. 7.2 million that help reducing the quantum of actual water subsidies in Delhi. Similarly, in Hyderabad, it can generate Rs.89.76 million and Rs.16.20 million respectively. The resultant effects are the perpetuation of the crisis, viz, short supply of public utilities, rising social conflicts owing to possible eruption of riparian famine like situation, and detriorating quality of life. Proposed scenario A proposes shows that there is hope for improving the situation to a great extent without depleting the resource base further. It only requires a radical change in the management philosophy on the demand side rather than encouraging overexploitation of water resources which is already on the brink of exhaustion. Rare though, the available WTP studies indicate that the consumers are willing to pay for assured and quality services as well as to boost private investment in water-saving technical innovation. Then question emerges - why are the policies delayed and implementation deferred ?
Perhaps, the political economy is the answer !

RECOMMENDATIONS

It is worthwhile mentioning that recognising the severity of the financial resource crunch faced by the urban governments, the seventy fourth amendment of the constitution of India (1992) has recommended some ways and means to upgrade the financial status in order to improve the quality of the urban utility services. The clause 243W and 243Y of the amendment empower the municipalities as " Subject to the provision of this Constitution the Legislature of State may, by law, endow _

> (a) The municipalities with such powers of authority as may be necessary to enable them to function as institutions of self-government and such law may contain provision for devolution of powers and responsibilities, subject to such conditions as may be specified therein....."[17]. Consequent upon the amendment, State Finance Commissions are set up and under the article 243 I of the Finance Commissions, the principles of financial devolutions are laid down to improve the financial positions of the municipalities. These functions of the self-local governments are also clearly recognised by the Tenth Finance Commission and coroborated in its report (1994), a substatial financial autonomy to these local bodies. [18]

However, to focus more sharply on the problems of sustainability of urban utility services, we present the following specific recommendations:

A **An efficient user charge for water utility services, based on the modified marginal cost price, should be implemented to raise at least the O&M cost in the first step.** The modification of said marginal cost is needed to achieve social equity especially for providing basic minimum civic amenities to the urban poor. This analysis has shown that a differential pricing policy enhances revenue base to the extent of more than 20 per cent of the existing revenue collection through improved management in the demand side only. This new initiative does not call for radical change in the existing practices to which the people are accustomed. The key contributing factors behind the Additional Resource Mobilisation are the efficiency of the

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17 Government of India (1992); THE CONSTITUTION SEVENTY FOURTH AMENDMENT ACT 1992 ON MUNICIPALITIES, Ministry of Urban Development, New Delhi, p4

18 **Governemt of India (1994) ; Grants for local bodies; Report of the Tenth Finance Commission for 1995-2000, New Delhi, p46**

cost recovery pricing policy and improvement in the revenue collection machinery along with adjustment for the social equity obligation. However, the infrastructural investment should be provided by the State.

B The existing low-revenue-yielding sewerage tax and dearth of resources for sanitary infrastructure are causing the services ineffective, creating serious environmental problems. In the context of the deteriorating urban environmental quality, the practice of charging sewerage tax as a proportion to property tax(as explained aerlier) is a toxic factor for the environment quality rather than a tonic one. To liberate the services from the trap of fiscal crisis, **the instrument of sewerage tax and effluent tax and the user charges** should be linked to quantity of water consumed by the household and the amount of effluent generated by the industries. However, government investment in the form of enhancing infrastructure facilities for sanitary environment is essential. Because it is well known that due to the properties of public goods, the entire sewerage charges can not be realised from the individual based on its use.

C The additional revenue for the environmental investment can be enhanced through **specific tax (speficific to the quantity of service consumed) such as pollution surcharge or water cess.** If properly implemented, such a charge, can promote environmental awareness and encourage conservation besides providing ARM for infrastructure expansion and maintenance.

D To achieve efficiency as well as equity, **New promotional tax or surcharge termed as EXPRESS SERVICES Rate for the rich and the AFFORDABLE WATER PRICE** for the poor within a permissible limit may be experimented. To make the system user-friendly, innovative methods of incentive to users may be pursued. Certain incentives like initial water tariff concession, fixed monthly concession or low interest soft loans etc. may be introduced as explained above. To ensure quality, stringent standards of the meter equipment such as temper proof test are recommended and rigorous supervision of the compulsory implementation must be followed by the agency. The failed meters or non metered connection should be discouraged and the water charges for such connection must be sufficiently higher to reflect the penalty element. The practice of such incentives are operatioanlly feasible yet no serious attention is paid. For example, Madras has already introduced a system of free allowance water at the rate of 200 litres per rupee of the assessed value for municipality water to the domestic consumer. Such a method can improve the ARM of the municipalities besides improving the supply of basic services to the poor and acting as a catalitic agent to promote conservation of water as well.

E **The effective participation of the community groups or societies goes a long way towards successful reform process and maintaining the viability of utility services.** This would imply that subsequent to the infrastructure building, the algorithm of Coasian negotiation would solve the problem of optimality by the cooperation of the polluters and pollutees together. That is, a successful reform process, must involve the participation of the users in the service decision. Bulk quantity of water should be supplied to the society at bulk water rate. These societies must be encouraged to take the responsibility of the tertiary distribution and collection of user charges. The process would improve the revenue collection and help correcting the distributional imbalances. In such a process of collective action, the individuals can effectively rectify their complaints in-house. This also reduces the bureaucratic hurdles considerably. Therefore, the motto of efficient economic instuments for sustainable resource use with improved level of services for basic needs can this way be satisfied.

F The successful adaptation of the above propositions has fair chances of the conservation of scarce resources and maintenance of proper environmental quality. However, further **studies on the consumers adjustment behaviour under the scarcity situation would be necessary to depict a real status of the services which can provide useful parameters for conservation strategy.** The hypothesis of under-investment-led inefficiency of the water supply and sewerage sector stresses the importance of the policy of conservation rather the expansion strategy for water appropriation. Because, saving (or conserving) a litre of wasteful consumption of water is cheaper than providing the same from a new source in the short run.

LIMITATIONS AND CONSTRAINTS OF THE STUDY:

Problem of measurement:

Historically, the access to water for domestic consumption was easy and the cost of providing it to the consumers by the water supply agencies was low. Therefore, the need for systematic studies on demand for urban domestic water did not evoke the serious attention in the past. The impression that water is a free good and should be supplied by the government, is making the archival data on water resources limited and currently available information base is rather weak.

Willingness to pay:

Absence of reliable estimates of consumption patterns for water has hampered the formulation of a meaningful pricing policy. If the political will and peoples' participation are favourable then it is easier to rationalise the principle of user cost to improve efficiency of resource allocation and promote conservation by using economic as well as ecological instruments. Fresh WTP studies may be conducted to ensure smooth operational success of rational pricing policy. Studies as such, on willingness to pay by the users for clean water and on the attitude of the consumers to pay for the use of water are sparse. A few studies, however, have shown that consumers are willing to pay for assured and improved services. The willingness to pay is sharper for those consumers who perennially suffer owing to lack adequate supply of water. As the current level of service is inadequate and the supply gap is more than 50 per cent of the demand, the WTP studies reflect an indication of the possibility of improving the service through appropriate economic instruments and ensuring sustainability.

It is generally believed that the development of water resources is constrained both by physical and fiscal constraints. These constraints should also be construed in the context of emerging socio-political milieu.

The difficulties faced in the courcse the investigation, which also also form a part of the constriants are listed below:

* Lack of a uniform system of budgeting and efficient accounting of costing for water supply and sanitation across the cities and over time.
* Lack of data on conjunctive use of water. It has its utility because the symbiotic relationship of various sources of water has many success stories which also ensures sustainability of the eco-system. Neglect of such practices has given rise to the problems of regeneration of resources. Lack of data on conjunctive use may give underestimates of the water supply.
* Involvement of multilayer decision makers and agencies for water supply infrastructure building and management is hard to come by, which hitherto affected the effectiveness of the policies. It is easy to prove that by not involving the people's participation, the authorities landed at great loss with mounting pressure on subsidies.

  Other socio-political limitations are:
* Power equation and urban services (rent-seeking strategy) is a deterrent to water planning.
* Problem of valuation of resources to reflect the social scarcity and depletion costs.
* The analysis of the role of water supply bodies as natural monopolists vis-a-vis the scope for privatisation.

TABLE 1A: Allocation of Plan Expenditure Under Water Supply and Sanitation (WSS) during the Seventh Five Year Plan (1985-90)

(Rs. in billion)

	Total Plan outlay	Total allocation for the WSS		Allocation on Urban WSS		Rural water supply allocation	
		Amount	% of total	Amount	%	Amount	%
Central government	1275.2	19.2	1.5	0.1	0.4	19.1	42.2
State government	915.1	51.7	5.6	25.5	99.6	26.2	57.8
Total	2195.3	70.9	-	25.6	100	45.3	100

Source : Seventh Five Year Plan, Planning Commission, Govt. of India 1984

TABLE 1B: Plan Outlay Allocation Under Water Supply and Sanitation Sector (WSS)

(Rs million)

Plan period	Total public sector outlay	% of total plan outlay	
		WSS	Urban water supply and sanitation
First Plan (1951-56)	33600	1.46	1.28
Second Plan (1956-61)	67500	1.07	0.65
Third Plan (1961-66)	85730	1.23	1.04
Fourth Plan (1969-74)	159020	2.75	1.77
Fifth Plan (1974-79)	393034	2.62	1.40
Sixth Plan (1980-85)	109291	3.20	1.20
Seventh Plan (1985-90)	180000	3.62	1.65
Eigth Plan (1990-95)	434100	3.84	-

Source: Five Year Plans, Planning Commission, Govt. of India New Delhi

TABLE 2 Growth of Population in Urban Agglometrics in India
(1981 to 1991)

[illegible]	Population in (millions)		[illegible]	[illegible]
	1981	1991		
Greater Bombay	8.24	12.60	52.80	4.33
Delhi	5.73	8.42	46.95	3.92
Madras	4.29	5.42	26.41	2.37
Hyderabad	2.55	4.25	67.09	5.27
Urban population	159.46	217.18	36.19	3.14
All India Population	683.33	844.32	23.56	2.14

Source: Census of India 1991., Census of India 1981 part 3A and part 3B (I), Registrar General and Census Commissioner, India.

Table 3: State Wise Population Coverage by Water Supply

Name of State/city	Est. urban population (mill)	Population coverage: water supply	
		Number	%
Andhra Pradesh (excl.Hybad)	13.430	8.400	62.54
Hyderabad	2.670	2.670	100.00
Maharashtra (excl Bombay)	28.046	27.968	99.72
Bombay	10.500	9.975	95.00
Tamil Nadu (excl Madras)	18.381	7.456	40.56
Madras	4.352	4.162	95.63
Delhi	8.081	7.965	98.56
All India Total	221.315	185.474	83.80

Note: Coverage figures denote piped water connections only. They do not indicate the quantity of water supply.

Source: Central Pollution Control Board (1988); Status of Water Supply and Waste Water Collection, Treatment and Disposal in Cities and Towns; New Delhi. (Ref: Ramasubban K S(1992))

TABLE 4 Population Covered by Water Supply(%)
(Population Size Class-wise)

Population served(%)	Range of city population (million)			Total	% to total
	0.35-0.50	0.50-0.60	Above 0.60		
Below 50%	0	2	1	3	11.54
50% - 75%	5	3	3	11	42.31
75% - 100%	5	1	5	11	42.31
100%	1	0	0	1	3.85
Total	11	6	9	26	100.00

Source: Calculated from Upgrading Municipal Finance, Vol. 2, National Institute of Urban Affairs, Research Study Series, No. 38, pp-c7-c11.

TABLE 5 Average Monthly Consumption of Water by Consumer Category: New Delhi (1992-93)

Consumer group	Water consumption (kilolitres)	Monthly water charge (Rs.)	Effective price (Rs.)
Affluent consumers	47 [313 lpd]*	34.14	0.726
Middle income	34 [227 lpd]	22.18	0.625
Lower income	25 [167 lpd]	13.90	0.556
Urban poor	21 [140 lpd]	10.22	0.486
Average			0.633

* [] bracketed figures indicate the daily per capita availability of water

Source: Personal communication with DWSSU 1995

Table 6: Trends in demand and Supply of water

Bombay	Demand	Supply	Gap (%)	Population (m)
1981	2488	2020	18	8.23
1986	3137	2425	21	9.40
1991	3588	2930	18	10.75
2001	4358	2930	33	12.79
Hyderabad				
1991	1408	508	63	4.25
2001	1734	920	47	5.00
2011	2330	920	60	
Delhi $				
1988-89	2998	1840	39	8.33
1990-91	3232	2083	35	8.98
1992-93	3391	2050	40	9.42
1993-94	3492	2176	37	9.70
1994-95	3780	2403	36	10.50
Madras				
1994	760	290	62	4.57

$ Total Water Supply figures in Delhi include the line losses and bulk supply. Per capita demand for water is assumed to be 360 lpd.

Madras: Consumption per capita: Domestic - 47 lpd
Industry - 23 lpd, Public stand post - 50 lpd
Normative demand at 200 lpd; Population figure for MMA

Source: Water Supply Boards for Delhi, Hyderabad, Madras.
Municipal Corporation of Bombay. World Bank, Bombay Water Supply Project II, p. 86.

TABLE 7: Per Capita Availability of Water in the Metropolitan cities

[illegible]	[illegible]	[illegible]
Bombay	137	180
Delhi	237	363
Hyderabad	65	120
Madras	47	200

Source: Individual Water Boards and Municipalities.

Distribution of Water supply:

Table 8A: Net availability of water and the distribution pattern in Bombay - 1991

Due to	Quantity of Water (mld)	Percent of total
Total production of water	2930	100
Transmission loss	59	2.0
Treatment plant loss	51	1.7
Quantity of water for distribution	2820	100
Distribution system loss	564	20.0
Industrial, commercial and government use	785	27.8
Net distribution for domestic use	1471	52.2
Per capita availability	137	

Source: WB report, Bomaby 1984

Table 8B: Distribution of water by consumer groups in Hyderabad 1991

Consumer groups	Supply of water		Population		Price (Rs/kl)
	mld	%	million	%	
Domestic (MCH)	314	62.8%	3.021	69%	3.25
Municipalities	116	23.2%	1.184	27%	3.00
Enroute village	10	2%	0.144	3%	2.00
Industry	60	12.0%	-		10.00
Total	116 lpd		4.349		-

Notes: Cost of production: Rs 5.00/kl.
Source: Barah B.C.: Scarcity Syndrome and Urban Water Supply, University of Hyderabad, 1994.

Table 8C: Distribution of Water supply in Delhi (1987-88 to 1990-91)

Consumer group	1988-89	1989-90	1990-91	1991-92
Domestic (MCD)	808 (85%)	968 (87%)	1099 (88%)	1109 (87%)
Industry, commercial & others	135 (15%)	144 (13%)	144 (12%)	157 (13%)
Unaccounted for water	1982 : 42.32% and 1992 : 39.9%			

Source: DWSSU New Delhi

Table 8D: Distribution by Consumer categories in Bombay 1982-83

	Supply		Demand		% Gap
Metered water					
	mld	Metered(%)	mld	%	
Industry	225	18	482.7	24	53.4
Commercial	15	0.4	30.57	1.5	50.9
GPR	130	10.6	242.45	12.1	46.4
Domestic	850	69.7	1243.23	62.2	31.6
Total metered water	1220		1998.93		38.9
Unmetered water					
Domestic	440		651.08		
Losses	300		791.57		
Enroute village	90				

Bracketed figure indicates the per centage distribution of metered water.

TABLE 9: Water Use and Potential Saving Using various Conservation Measures in USA

[illegible]	% of total indoor water use	[illegible] (%)
Toilet flushing	38	52
Bathing	31	21
Laundry & dishes	20	27
Drinking & cooking	6	0
Brushing teeth & misc.	10	10

Source: USEPA, Flow Reduction, Methods, Analysis Procedures, Examples, Water Program, Washington DC 1981

TABLE 10: Trend of Consumption of Water and Effective Prices in Delhi

Consumption of water(%) by category in Delhi										Effective water tariff (based on aggregate)	
Year (1)	Cat.1 (%) (2)	Cat. 2 (%) (3)	Cat. 3 (%) (4)	Cat. 3 (SC1) (%) (5)	Total consumption MLD (6)	Revenue demand Rs. million (7)	Revenue collectRs. million (8)	Total collectinc debt charge	% collection (10)	Demand for revenue Rs./kl (7)/(6)	Total revenue (8/6)
1988-89	73.5	14.1	-	0.8	950	25.34	22.39	27.83	88.4	0.73	0.646
1989-90	86.5	9.0	3.9	0.6	1119	35.26	34.05	39.81	96.6	0.86	0.834
1990-91	87.9	8.1	3.4	0.6	1251	44.32	43.50	47.91	98.1	0.97	0.952
1991-92	87.6	8.8	3.2	0.4	1266	64.56	60.16	65.90	93.2	1.40	1.301
1992-93	87.8	9.3	2.7	0.2	1274	66.28	62.40	67.51	94.1	1.43	1.342
1993-94	87.0	9.0	3.7	0.2	1286	69.33	63.45	68.87	91.5	1.48	1.351

Note: Cat 1: Domestic and residential.
Cat 2: Non-domestic (shops, offices, household industries).
Cat 3: Non-domestic (cinema, Ice factories, clubs etc.)
Cat 3(SC1):Industries paying special environment tax.

TABLE 11A : Daily Normative Demand for Water

[illegible]	[illegible]
Domestic demand	225
Industry, commercial & community requirement @ 45000 litres/ha/day	47
Fire protection (1% of total demand)	4
Gardens based on 67 kl/hectare	35
Floating population & special use like embassy and hostels	52
Average	363 (litres)
Bombay	**1984**
Apartment (>100 sq.metre)	306
Apartment (<100 sq.metre)	220
Chawls #	146
Chawl with bath and shared tap	110
Slum	90
Aggregate domestic demand	180
Industrial and Commercial demand (28% of total demand)	50.4
Water Loss (20%)	46.0

Note: # A Chawl is a single story dwelling with private tap and facility.
Source: World Bank(1986) Bombay project; ADB Delhi project 1992

TABLE 11B : Demand for water in Hyderabad (Daily Per Capita)

	1991	2001	2011
Domestic			
MCH	150	160	170
Local Municipality	140	155	170
Enroute village	145	110	120
Non-domestic			
MCH	20	20	20
Local Municipality	20	20	20
Enroute village	14	14	14
Industry	49.4	78.2	110
Commercial	6	6	6
Total unaccounted water (20%)	198	304	425

Source: HWSSB (1993); A Nte on Revision of Water Rate, Hyderabad

COST RECOVERY AND REVENUE BASE

Table 12A: Cost Recovery and Revenue base in Delhi Rs. million

[illegible]	Water Supply [illegible]		Sewerage & Drainage		Total		[illegible]
	Expenditure	Income	Expt.	Income	Expt.	Income	[illegible]
1990-91	1565.02	1196.65	918.71	398.71	2483.74	1594.81	64.2
1991-92	2083.38	1475.59	1045.57	399.34	3128.95	1874.93	59.9
1992-93	2407.10	1635.69	1205.94	453.41	3613.04	2089.10	57.8
1993-94	2755.43	1796.56	1332.35	473.95	4087.77	2270.51	55.5

Source: Compiled from DWSSU budgets

Table 12B: Cost Recovery and Revenue base in Bombay

Rs. million

Year	Water Supply		Sewerage & Drainage		Total	
	Expt.	Income	Expt.	Income	Expt.	Income
1986-87	288.27	475.41	145.26	114.44	433.54	589.58
1987-88	440.19	672.76	223.31	280.84	663.50	953.60

Source: World Bank; Report on Bombay Water Supply

FINANCING WATER SUPPLY

Table 13: Trend of Funds for Development Works of Water Supply in Delhi (Capital Works only)

Year	Development fund (Rs. million)	Trend [illegible]
1967	19.6	100
1972	34.5	176
1977	89.8	458
1982	141.5	721
1987	228	1163
1992	892.5	4553

Source: Delhi Water Supply Study, ADB 1993.

COST OF FACTORS OF PRODUCTION OF WATER

Table 14A: Cost of factors of production in Delhi **(Rs millions)**

factor costs	1982	% of total	1992	% of total
Personnel	25.636	20.44	191.06	27.69
Power/fuel	49.004	39.08	239.457	36.15
Materials	12.113	9.66	106.869	15.49
Others	38.643	30.82	142.693	20.68
Net expenses	125.396		690.079	
Interest i/c debt charges	81.62		522.942	
Depreciation		-		-
Others		-		-
Gross expenses	207.016		1213.021	

Note: The depreciation cost in included.
Source: ADB Report, 1993, p. 76.

Table 14B: Cost of Factors of Production of Water in Hyderabad

Factor cost	1990-91	% of total	1994-95	% of total
Personnel	110.075	43.58	236.250	30.12
Power	81.445	32.25	277.380	35.37
Chemicals	2.940	1.16	31.680	4.04
Maintenance	36.533	14.47	67.620	8.62
Others	17.543	6.95	36.000	4.59
Interest	.072	0.03	139.156	17.74
Less capitalised	-	-	-44.488	-5.67
Depreciation	3.950	1.56	40.700	5.19
Total cost (O&M)	252.558		784.298	

Source: HWSSB(1993); A Note on Revision of Water Rates, Hyderabad.

TABLE 14C: Cost of Factors of Production of Water in Bombay

[illegible]	[illegible]	1982-83	[illegible]	[illegible]	[illegible]	[illegible]
Personnel	61.9	74.8	83.3	98.69	106.58	115.11
Power	50.8	71.6	85.1	91.91	99.27	196.06
Chemicals	0.4	1.6	10.8	11.66	12.6	13.6
Material, repair & maintenance	25.8	31.4	33.91	39.55	68.86	76.33
Transport & communication	11.6	11.9	15.9	17.17	18.55	20.03
Bulk water charges	0.7	0.7	0.7	0.7	0.7	0.7
Total direct cost	151.2	198	220.9	247.24	266.96	288.27
Administrative and general expenses (water & sewerage)	32	40.2	40.1	52.72	58.31	64.58

Source: World Bank (1984); Report on Bombay water supply.

TABLE 15: Typical Cost Escalating Factors

(Hyderabad Water Supply)

	Cost (Rs. per unit)		
POWER	Aug. 1991	Jan. 1993	% Increase
Demand charge (per Kva)	0.55	0.85	55
HT energy charge	1.15	1.85	61
LT-III charge	1.10	1.90	73
CHEMICALS			
Chlorine (per MT)	1650	4060	146
Alum. (per MT)	2250	2725	21
Staff cost (Rs. million/month)	12.1	16.9	40

Source: HMWSSB 1993 (ibid).

TABLE 17: Inter-city Comparison of Cost of Water Supply (Cost of Factor of Production : Rs/Kl)

Factor of production	Delhi[1] 1992-93	Hyderabad[2] 1992-93	Bombay[3] 1986-87
Staff cost (manpower)	255.30	964.4	127.4
Power/fuel	333.40	821.9	216.9
Chemicals	6.54	82.2	15.05
Maintenance	568.05	383.6	106.7
Interest + Depreciation	624.3	-	
Total water (mld)	2050	500	2475
Total revenue expenditure (Rs million)	1213.02	423.00	774.60

Source:
1. DWSSU Budgets.
2. HMWSSB, A Circular Note, Hyderabad 1993.
3. World Bank; Bombay Water Supply Project II, 1984.

TABLE 18 : Cost of New Project for Bombay Water Supply (Bhatsai dam 1984)

Expenditure head	Rs. million
Distribution system	222.5
Treatment capacity, pumping, storage	97.6
Sewer pumping	500.0
Sanitation	6.8
Technical assistance	14.9
Vehicle	20.0
Total project cost	395.6
Output (production of water)	455 mld

TABLE 19 : Cost of Veeranam Water Supply Project (Madras) 1994

Component	Cost (Rs million)	% of total cost
Source works	70.7	6.8
Transmission (235 km)	734.1	70.4 @
City distribution	104.0	10.0
Water conservation	100.8	9.7
Others	337.7	25.0
Total	1347.2	100
Output	108 mld	

@ Transimission cost per kilometre is Rs. 29 million

Source: World Bank(1995); Water Supply Project Madras.

TABLE 20: Expanding New Source of Water Supply in Urban Areas (Cost-Distance Relationship)

City	Deccaniel Population growth (%) (1981-91)	Local source	New source (unit cost: Rs./Kl)	Distance covered
Banga lore	77.5 (1981-90)	Exhausted	Cauvery river (Rs.4.63)	90 km (Rs.280 crore)
Ahmeda bad	27	Water level of 225 wells have gone down 4-5 meter per year	River Sabarmati	150 km upstream
Hydera bad	57	Local water sources are exhausting and polluted	River Godavari: Nagarjuna sagar reservoir (expected fourfold rise in prices)	160 km (Rs. 917 crores)
Delhi	46.86	Yamuna water flow reduced and highly polluted, ground water is depleting and contaminated (88% GW utilised)	Tehri Dam (Bhagirathi river):involve multi agency::268 MCM	250 km (project yet to start)
			Renuka dam (Giri river HP):460 MCM	Planning stage
			Kishau dam (Ton river) :616 MCM	Planning
Madras	4.35 mill (actual population)	Local sources highly inadequate and overused	Veeranam tank(Augmented supply 180 MLD)*	253 km (Rs. 1347.2 crores)
			Telegu Ganga (Interstate conflict not resolved)	400 kn
Bombay	50	Local sources functioning well: Vehar, Tulsi, Tansa, Vaitarana lakes	Bhatsai dam (augmented water supply 455 MLD)	53.65 km (rs. 395.65 crores)

* Long run average Incremental Cost = Rs. 14.39 per kilolitre

COST RECOVERY DETAILS AND REVENUE BASE

TABLE 21A: Sources of Revenue of Water Supply Bombay 1983-84

Rs. million

Water Supply	[illegible]	1987-88	% Total Water Revenue
Metered Domestic	93.08	98.69	79.7%
Industry	271.01	421.49	
Bulk			
Commercial	16.43	24.27	
GPR	94.90	128.91	
Non metered	122.16		20.3%
Sewerage			
Metered Domestic	23.93	35.89	
Industry	66.09	99.14	
Commercial	6.27	9.11	
GPR	18.15	27.22	
Non-metered	70.71		
Effective tariff (water) : Rs 1.9/kl.			
Average incremental cost : Rs 2.9/Kl.			

Source: World Bank(1984); Bombay Water Supply Project II,p36.

TABLE 21B: Source of Revenue of Water Supply in Delhi 1982-1992

[illegible]				
	[illegible]	%	1992	%
Domestic	63.52	41%	278.03	42%
Others	91.03	58.8%	381.00	57.8%
Total	154.564		659.033	

Source: DWSSB, Annual Budgets.

TABLE 21C: Source of Revenue of Water Supply in Hyderabad

	Water Supply	Populati on	Price	Cost	REVENUE (Rs. million)	
					collection	Potential
Domestic	314	3.021	3.25	32.99	32.986	47.66
Municipal	116	1.184	3.00	10.57	7.152	19.13
Village	10	0.184	2.00			
Industry	60	-	10.00	10.81	22.097	22.097

Source: Calculated

TABLE 22: Effective Price, Official Charge and Cost of Production and Domestic Water Rates

(Rs./Kl)

	Bombay	Delhi	Hyderabad	Madras
Effective price[1]	2.11[2]	0.89	2.32	2.92
Official water rates[3]	NA	0.87	3.00	2.99
Cost of production	0.95	1.70	5.00	2.94
Domestic water rate	0.30	0.35	3.00	12 pm per connection

Notes: 1 Effective rate includes sum of unit water charge plus water tax.
2 Includes water tax, water benefit tax, scavenging tax, surcharges apart from water charge, wherever applicable.
3 Official water rate is metered charge per unit of water. Official rate is calculated based on total collection of revenue from all consumers.

TABLE 23: State-wise Status of Waste Water Treatment Facilities

(In mld)

[illegible]	Waste water generated	Waste water collected	Waste water treatment capacity
Andhra Pradesh	780.60	163.40	171.54
Gujarat	814.99	220.30	463.00
Haryana	130.21	38.53	0.00
Karnataka	654.75	462.26	336.00
Maharashtra	2831.75	190.00	300.00
West Bengal	1107.42	27.30	19.80
Uttar Pradesh	1449.41	255.00	160.00
Delhi	1480.00	745.00	745.00

Source: CPCP; Status of Water Supply & Wastewater Collection Treatment and Disposal in Class I Cities - New Delhi, 1988.

TABLE 24: Water Supply, Wastewater and Treatment Capacity in Metropolitan Cities in India

City	Mode of disposal of waste water	Water supply (mld)			Waste water generated (mld)	Treat-ment capacity (mld)	Treat-ment of total waste water (%)
		Surface water	Ground water	Total			
Bombay	Creek, sea	2143	-	2143	1714	85	5
Delhi	River Yamuna agri. land	1680	168	1848	1480	745	50
Hyderabad	Land	508	-	508	406	140	35
Madras	-	-	-	290	230	-	-
				Total	3830	970	25%

Source: CPCB; Status of Water Supply, Waste Collection, Treatment and Disposal in Class I Cities, New Delhi, 1988.

TABLE 25: Class I Cities with Wastewater Treatment Plant Facilities

[illegible]	Total cities (number)	Cities with primary treatment only	Cities with secondary treatment only
Andhra Pradesh	17	2	-
Bihar	11	0	1
Gujarat	11	3	0
Haryana	9	0	0
Karnataka	14	4	1
Maharashtra	29	5	3
Madhya Pradesh	14	2	-
Punjab	7	-	-
Rajasthan	11	-	-
Tamil Nadu	19	3	2
Uttar Pradesh	29	-	1
West Bengal	21	-	1
Total	212	20	13

Source: CPCB, Status of Water Supply, Waste Collection Treatment and Disposal in Class I Cities, 1988.

TABLE 26: Waste Water and Effluent Generated Treatment Facility

City	Waste water and effluent (mld)				Remark
	Generated		Treated		
	Domestic	Industry	Domestic	Industry	
Delhi 1993	1714	81	12.71 (74%	Nil	
Bombay* 1987	2928	-	2635 (discharged to sea)	-	Drainage system is 135 yrs. old
Hyderabad 1992	405	43.3 mld (Effluent) 55 mld (sewage)	Negligible	2** CETP	Sewage system is old, and no improvement since 1931.

Notes:

* The Bombay sewerage system are redesigned to provide the facility up to 90% coverage. Out of the total waste water generated about 65% of the waste flow is discharged to the sea through five drainage areas (Colaba 42 mld, Malabar Hill and Worli 800 mld, Chembur 582 mld, Marve 411 mld and Mahim 800 mld) after screening and grit removal and the balance quantity to tidal creek after screening.

** There are two common Effluent Treatment Plants, one in the public sector, the other (cooperative) in the private sector (Jedimetla CETP). The CETPs when functioning properly could treat a fraction of the industrial effluent generated.

TABLE 28: Water Pollution Indicators at Selected Stations

Parameters: permissible limit	DO (>5mg/l)	BOD (< 2mg/l)	COD	Coliform count (< 50 (max) MPN/100ml)
Station				
Rishikesh - Haridwar	8.1	1.6	na	na
Kanpur	6.7	5.51	na	na
Allahabad	6.6	7.16	na	na
Varanasi	8.1	2.2	na	na
Patna	5.8	1.5	na	na
Delhi:				
- Upper segment (yamuna)	5.7-11.7	3.7	na	$460\text{-}13\times10^{3}$
- Delhi segment	0-49.5	7-39	na	5.4x10.5x10
Ahmedabad:				
- Upstream	8.3	1.4	na	4600
- Downstream	4.1	2.6	na	46000
Ludhiana:				
- at Budha Nela	na	3.5-12.4	8.6-24	11x1000
- Phillarum D/S	na	3.4-4.8	8.21-7.65	11x1000
Burhanpur MP:				
- Upstream	6.8	4.5	32	120
- Bathing Ghat	58	19	40	120
Srirangapatnam	13	2.9	na	55000

BOD : Biological oxygen demand. The BOD value is the amount of oxygen that micro organism require to break down organic matter in Water. The more the BOD less is the water-disposed oxygen available for higher species such as fishes. BOD is reliable measure of organic pollution of water body, ore of the important considerations for treatment of sewage or Waste water is to lower the BOD or COD values.

Note: 1. All the major water pollutants are available in all river basins beyond the permissive level. The raw water is not safe for drinking, necessitating heavy cost of treatment.

Source: National River Action Plan, Ministry of Environment & Forests, New Delhi, 1994.

TABLE 29: Impact of Water Pollution
(Incidence of Water Borne diseases in India)

State category	[illegible]				Dysentry				Gastro-enteritis		Total death (1987)
	#Cases		#Death		#Cases		#Death		#Cases	#Death	
	1987	1990	1987	1990	1987	1990	1987	1990	1987	1987	
High income state	1450	769	29	24	769698	678813	338	757	219078	789	1156
Middle income state	9930	2034	193	29	3466433	428230	550	4838	667606	1647	2390
Low income state	NA	893	1127	34	3271069	3753616	1063	5890	363146	1610	3800
Total	11467	3696	1349	87	7527200	8710659	1953	11485	1249830	4046	7348

Source: Ministry of Health, Health Information India, Government of India, New Delhi, 1989, 1991 (Reported cases and death due to diarrhoeal diseases).

TABLE 30: Impact of Water Pollution
(Occurrence of Gastro-Enteritis and Cholera in Delhi)

Year	Cholera cases	Gastro-enteritis cases
1988	1693	84792
1989	197	45959
1990	538	40601
1991	536	39361
1992	1070	43172
1993	698	53578

Source: Municipal Corporation of Delhi, Epidemiology Department, New Delhi, 1995.

TABLE 31: Consumption of Water and Conservation by Industry

[illegible]	Paper Industry	Fertilizer Industry	Steel Industry
Consumption of water per tonne of product	230-450 cum (1987-88)	9-40 cum (1988-89)	550 MCM of water to produce 13.7 MT of Steel (1993-94) @ 40.146 cum
Conservation due to upgradation with new generation of plant machinery	A substantial quantity of water	9 cum (=14-6) for urea	83% conservation of water by Bhillai Steel Plant (1987-93)

Source:: BICP, A Study on Industrial Water Audit by Selected Industries, 1987-1994, New Delhi.

TABLE 32: Estimate of Subsidies in Hyderabad - 1991

Rs. million

Consumers	Water supply (MLD)	Population (million)	Price (Rs./kl)	Subsidies Rs./kl	Total subsidies (yearly)
Domestic	314	3.021	3.25	-1.75	-200.6
Municipality	116	1.184	3.00	-2.00	-84.7
Enroute village	10	0.144	2.00	-3.00	-11.0
Industry	60		10.00	5.00	109.5
Total	116 lpd	4.349			189.5

Source: Barah BC: Scarcity syndrome & city water supply, University of Hyderabad 1994.

TABLE 33: Water Supply, Water Rate and Subsidies in Delhi

Year	Total quantity of water MLD	Line loss (18%) MLD	Free [illegible] (8%) MLD	[illegible]	Total revenue Rs. million	Unit cost of water	Subsidies (Rs. million)				Revenue loss due to [illegible]
							Essential	Other	Total	% of O&M	
1988-89	1726	311	138	997.6	320.0	1.58	79.81	597.84	678	68	179.57
1989-90	1938	349	155	1182.8	466.0	1.67	94.62	622.12	717	61	242.90
1990-91	2083	375	167	1476.4	591.2	1.94	118.11	767.10	885	60	265.75
1991-92	2114	381	169	1850.0	714.0	2.40	148.00	987.97	1136	61	333.00
1992-93	2050	369	164	2143.4	706.4	2.86	171.47	1265.52	1437	67	385.82
1993-94	2452	441	196	2413.1	764.8	2.70	193.05	1455.25	1648	68	434.37

Notes: 1. Essential Subsidies: Free hydrants supplies x unit cost.
2. Other Subsidies : (Total water production - free water) x unit cost - revenue (subsidies to non-poor).

TABLE 34: Estimates of Subsidies Per Month Due To Various Consumer Categories in Hyderabad. (1992-93)

Consumer category	Water supply MLD	Tariff Rs/kl	Total cost Rs. million	Revenue Rs. million	Subsidies Rs. million
Free public standpost (# 4788)	14.37	Free	2.181	0	2.181
Domestic					
- Unmetered (#5700 connections)	5.70	60/pm	0.864	0.342	0.520
- Metered (76600 + 85300 connections)					
Slab 1 (<15kl/m)	66.38	2.00	5.814	3.988	1.831
Slab 2 (15-25)	71.08	2.50	10.79	5.629	5.161
Slab 3 (>25)	4.937	3.00	7.494	6.370	1.124
Multi storey buildings	51.54	3.5	7.824	4.638	3.186
Domestic total	258.44	-	-	-	-
Bulk supply					
- Municipalities	-	2.25	-	-	-
- Enroute villages	-	1.75	-	-	-
- Housing colonies	-	2.25 (upto 300 kl/pm) 3.00 (above 300 kl/pm)			-
Total bulk supply	69.64	-	10.572	7.152	3.420
Sub-total	328.08	-	-	-	17.423
Non domestic	71.23	-	10.813	22.097	(-) 11.284
Grand total	399.31	-	-	-	6.146

Source: HMWSSB, 1993

APPENDIX 1

Water Tariff from 1970 to 1992, DWS & SDU (Delhi)

Sl. No.	Year	Category I Rs. per kl.	Category II Rs. per kl.	Category III Rs. per kl	Flat rates per connection per month Rs.
1.	1970-71 to 1974-75	0.17	0.34	0.78	(i) 4.50 upto 3 taps
					(ii) 1.00 for additional tap
2.	1975-76	0.17	0.80	2.00	-do-
3.	1976-77 & 1977-78				
	(i) Upto 20 Kl pm	0.20	1.20		(i) 9.00 upto 3 taps
	(ii) Addl. consumption	0.40			(ii) 2.00 for additional tap
4.	1978-79				
	(i) Upto 20 kl pm	0.25			-do-
	(ii) Addl. consumption	0.50			
5.	1979-80 to 1984-85				
	(i) Upto 20 kl pm	0.25	Upto 100 kl pm 1.50		-do-
	(ii) Addl. consumption	0.50	Addl. consumption 2.00		
6.	1985-86 to 1988-89				
	(i) Upto 25 kl pm	0.35	Upto 100 kl pm 2.00		9.00 upto 3 taps
	(ii) Addl. consumption	0.70	Addl. consumption 2.00		2.00 for additional taps
7.	1989-90				
	(i) Upto 20 kl pm	0.35	Upto 50 kl pm 2.00	(i) Upto 50 kl 3.00	-do-
				(ii) Upto 100 kl 4.00	-do-
				(iii) Addl. consumption 5.00	
8.	1990-91				
		-do	-do-	-do	(i) 12.00 upto 3 taps
	Plus 20% surcharge	Plus 20% surcharge	Plus 20% surcharge		(ii) 5.00 for additional taps
9.	1991-92	-do-	(i) Upto 50 kl pm 3.00	(i) Upto 50 kl pm 5.00	-do-
		Plus surcharge raised to 30%	(ii) Addl consumption pm 5.00 plus 30% surcharge	(ii)Upto 100 kl pm 6.50	Plus 30% surcharge

Note:
Category I. Domestic & residential
Category II. Non-Domestic (Shops, Offices, households Industries)
Category III. Non-Domestic (Cinemas, ice factories, Clubs, etc.).

Appendix 2

Existing and revised tariff rate for water supply and sewerage in Hyderabad.

From Aug. 1991

CATEGORY	Consumption Slab in Kilo Litres per month	Charge Rs. per Kilo Litre
1. Domestic Supply (Individual Connections) a) Unmetered Connection b) Metered Connections	 Fixed Charge Upto 15 15 - 25 above 25	 60.00 per connection 30.00 Minimum 2.50 3.00
2. Multi Storied Buildings a) 90% or more plinth area in domestic use b) 70% or more but less than 90% of plinth area in domestic use c) More than 30% of plinth area in non-domestic use	Upto 500 above 500 Above agreed Qty Above agreed Qty Upto 20 Upto 50 Above 50	2.50 3.00 5.00 4.00 5.00 100.00 Minimum 5.00 7.00
3. Bulk Supply (domestic) a) Enroute villages and Sangareddy Municipality b) Surrounding Municipalities & Contonment Board (if more than 10% used for non-domestic) c) Other Colonies	 Above agreed Qty Upto 500 above 500 Above agreed Qty	 1.75 2.25 5.00 7.00 on 10% 2.50 3.00 5.00
4. Industrial (including future connections) Industrial Housing Colonies (existing connections) Every year 20% of supply will be charged at Industrial rates, so that after 5 years full industrial tariff will be applied	Upto 26.67 Upto 500 above 500 Initially	200.00 Minimum 7.50 10.00 4.00
5. Construction purposes	upto 50 above 50	5.00 7.00
6. Commercial	Upto 20 Upto 50 above 50	100.00 Minimum 5.00 7.00
7. Institutional		4.00
8. Temp. Connections for Functions, etc.	1/2*dia conn 3/4*dia conn 1* dia conn	10.00 per day 20.00 per day 30.00 per day
9. Tankers	Per Tanker	50.00

* Sewerage cess @ 20% of the water charges is levied in respect of connections served by the sewerage system of the HMWSSB.

Appendix 3

WATER AND SEWERAGE TARIFFS IN BOMBAY

	Tariff/a	Percent of revenue yield
Water Metered charges Domestic Industrial and commercial	 Rs 3/10,000 litres Rs 20-60/10,000 litres	 14 42
Metred bulk supplies: Local Other government Trade and construction	 Rs 5/10,000 litres Rs 8/10,000 litres Rs 50/10,000 litres	 3
Non-metered charges: Tax on rateable value Water benefit tax	 9% of R.V. /b 6% of R.V. Percent of total revenue	 4 11 ---- 74 ----
Sewerage Metered charges: Domestic Industrial and commercial Non-measured charges: Tax on retable value Sewerage benefit tax	 50% of water charges 50% of water charges 5% of R.V. 4% of R.V. Percentage of total revenue	 4 12 3 7 --- 26 --- 100 ---

/a Effective FY84
/b R.V. = rateable value of real property

Appendix 4

Capacity Utilisation of Water Supply - 1986-87

City	Capacity of water supply (mld)		Water utilisation ratio (%)
	Designed#	Actual##	
Population between 0.35 - 0.50 million			
Guntur	27.25	27.00	99.08
Warangal	88.20	73.00	82.77
Bhavnagar	120.00	72.00	60.00
Calicut	40.50	40.50	100.00
Raipur	60.75	60.75	100.00
Kolhapur	81.90	75.08	91.67
Thane	0.00	113.00	*
Ajmer	8.50	5.50	64.71
Salem	0.00	45.00	*
Tiruchirapalli	50.00	45.00	90.00
Aligarh	0.00	3.47	*
Bareilly	71.50	52.50	73.43
Jalandhar	83.00	52.00	62.65
Population between 0.50 - 0.60 million			
Vijaywada	81.67	81.67	100.01
Rajkot	110.00	61.00	55.45
Mysore	95.34	95.34	100.00
Meerut	0.00	82.16	*
Cochin	30.00	30.00	100.00
Sholapur	135.00	120.43	89.21
Population above 0.60 million			
Vishakhapatnam	84.00	84.00	100.00
Srinagar	19.50	19.50	100.00
Hubli Dharwar	36.10	16.67	63.87
Amritsar	100.00	100.00	100.00
Jodhpur	94.10	71.00	75.45
Ludhiana	0.00	0.00	0.00
Agra	285.00	196.00	68.77
Allahabad	232.00	179.11	77.20
Vadodara	167.50	136.55	81.52

Notes: # Worked out with the total population, 1987.

Worked out with the population served, 1987.

* Water Supplied from source other than the municipality, hence water utilisation ratio is not relevant.

Source: Upgrading Municipal Finance, Vol-2, National Institute of Urban Affairs, Research Study Series, No.38, pp-c7-c11.

Appendix 5

Unaccounted Water and its Financial Implication

City	Unaccounted water as % total supply	Quantity (Kl/day)	Rev. potential (Rs/day)
Bangalore	17	51300	256.50
Jaipur	27	47000	42000.00
Lucknow	20	60000	54000.00
Jodhpur	28	35000	35000.00
Ajmer	15	4500	4500.00
Tiruchirapalli	6	3000	1500.00
Kolhapur	28	16400	20000.00
Aurangabad	15	7200	2549.00
Mangalore	8	2408	1204.00
Gulbarga	10	2000	4000.00
Muzaffarnagar	5	1400	500.00
Alwar	10	1950	1950.00
Kalyan	25	21000	23000.00
Bharatpur	10	1300	1250.00
Pollachi	11	500	150.00
Banda	10	1500	1400.00
Ballia	10	1260	277.00
Robertsonpet	23	1700	4250.00
Paramakudi	10	250	88.00
Barabanki	5	400	125.00
Ramanathapuram	5	20	20.00
Pusad	5	250	250.00
Jam-khandi	17	900	1053.00
Ranipet	5	100	75.00
Udupi	15	750	1125.00
Murudjanjira	5	50	71.00

Source: KSRN Sarma, Urban Water Supply Tariffs, IIPA, 1988.

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MAP OF INDIA
(Selected cities encircled)

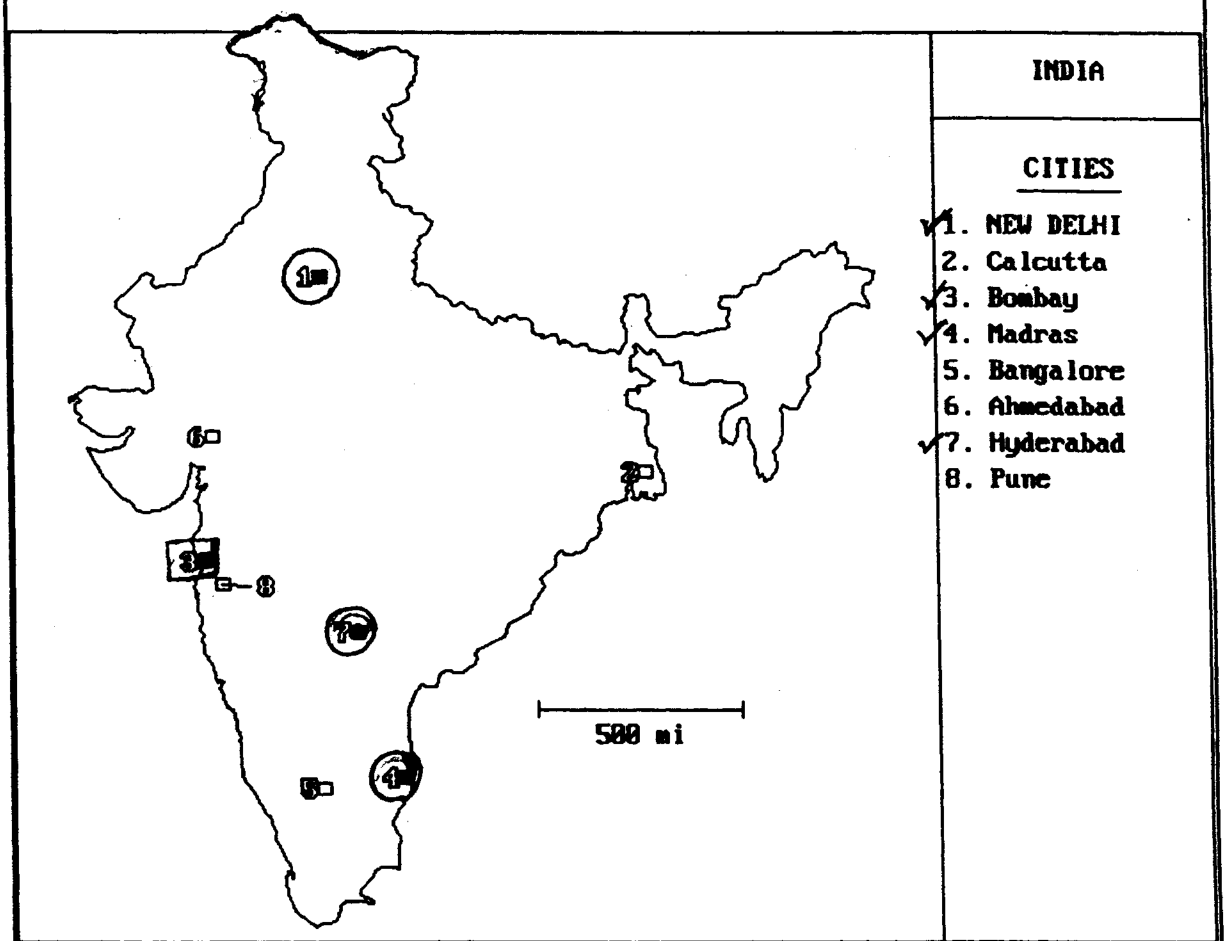


Figure 1

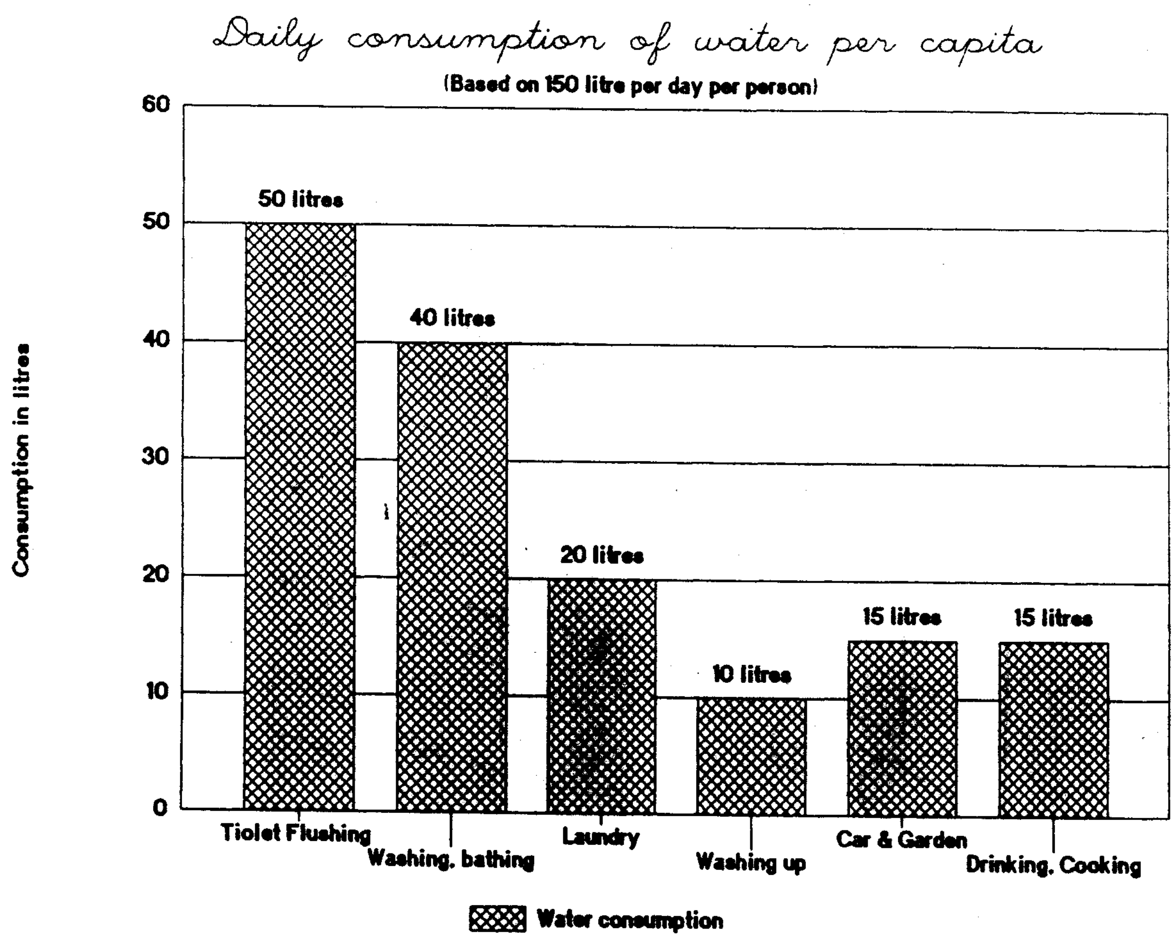

Daily consumption of water per capita
(Based on 150 litre per day per person)
Consumption in litres
60
50
40
30
20
10
0
50 litres
40 litres
20 litres
10 litres
15 litres
15 litres
Tiolet Flushing
Washing, bathing
Laundry
Washing up
Car & Garden
Drinking, Cooking
Water consumption

Figure 2

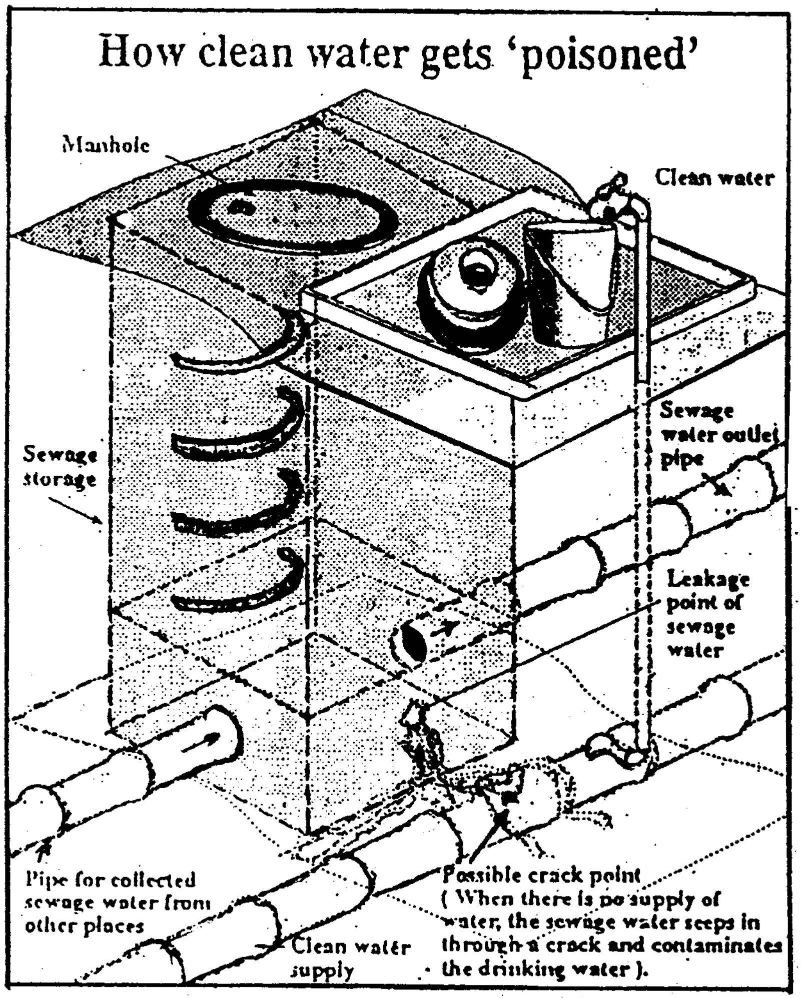


Figure 1 2: Contamination of drinking water.

Source: The Hindustan Times, July 4, 1993.

Figure 3

Who Uses the water

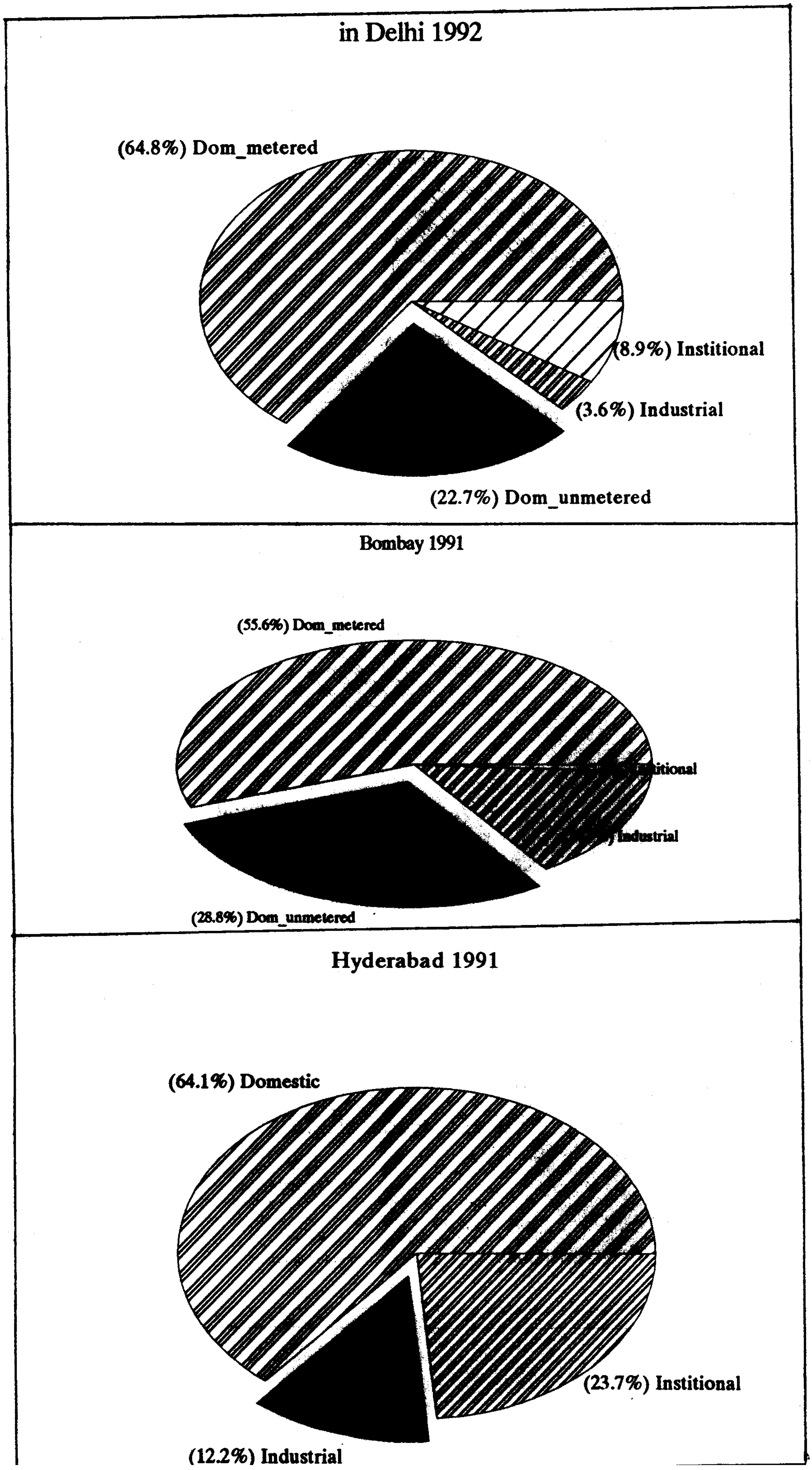


Figure 4

What costs water

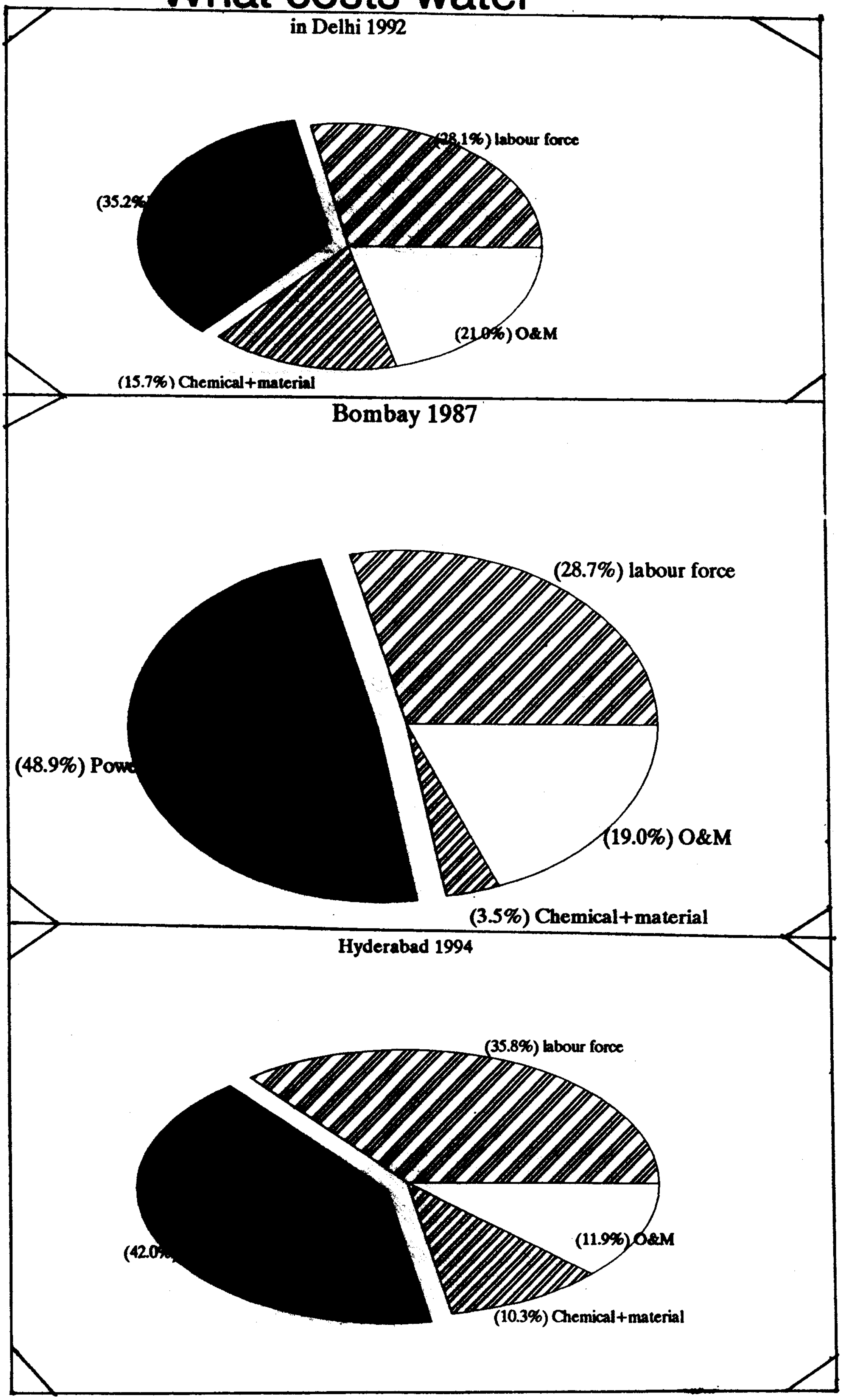


Figure 4A

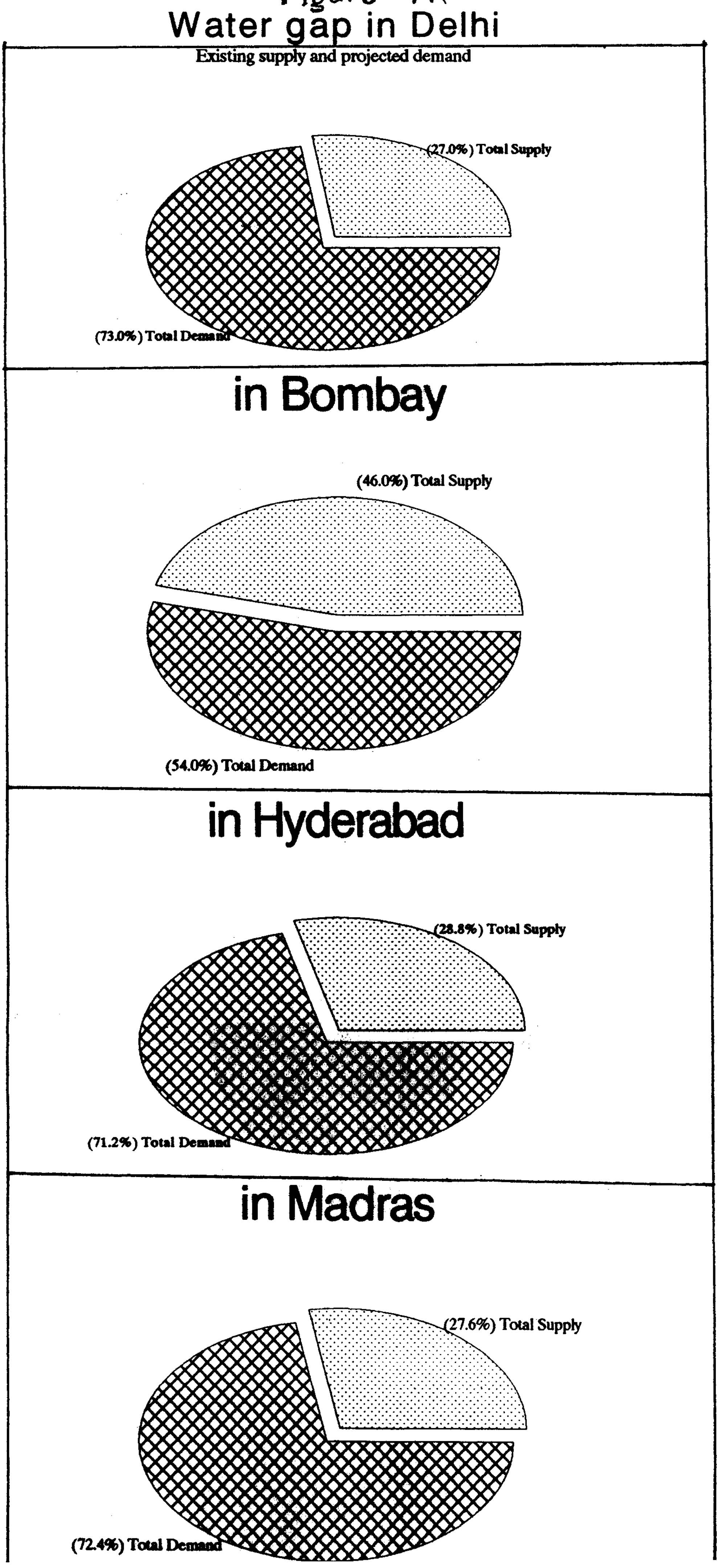

Water gap in Delhi
Existing supply and projected demand
(27.0%) Total Supply
(73.0%) Total Demand
in Bombay
(46.0%) Total Supply
(54.0%) Total Demand
in Hyderabad
(28.8%) Total Supply
(71.2%) Total Demand
in Madras
(27.6%) Total Supply
(72.4%) Total Demand

Figure 5

Who pays for water

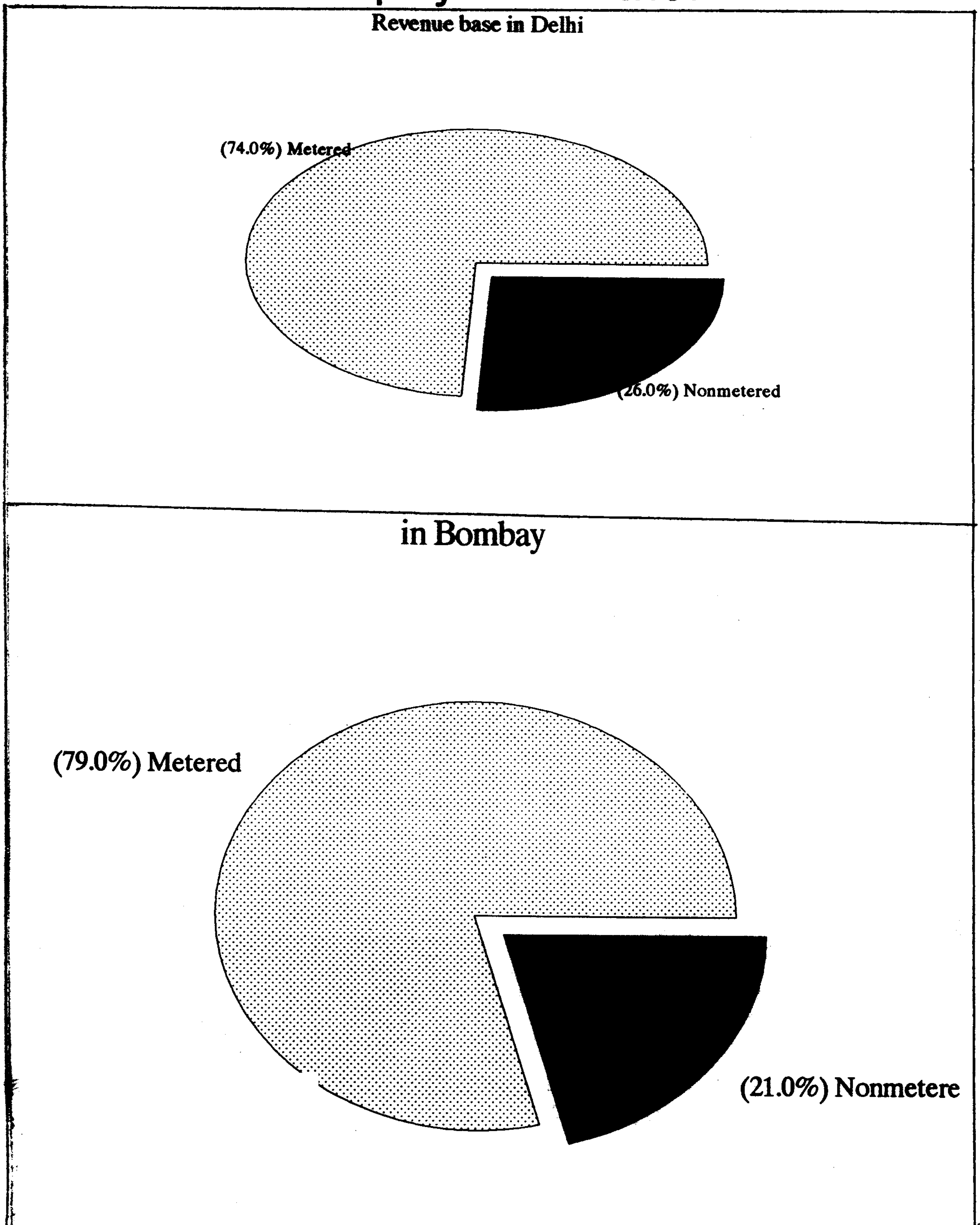
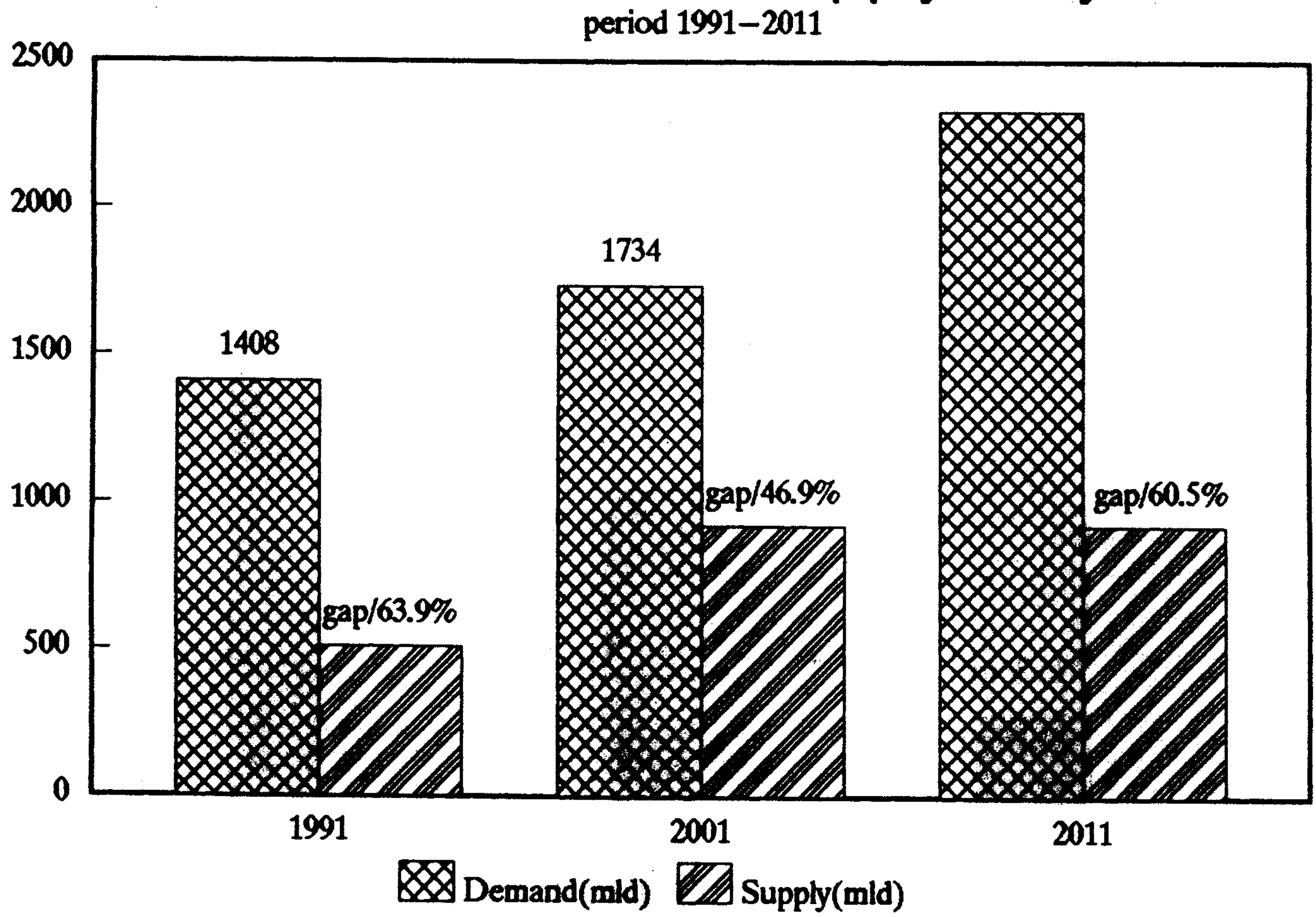


Figure 6

Gap Calculation for Water Supply in Hyderabad

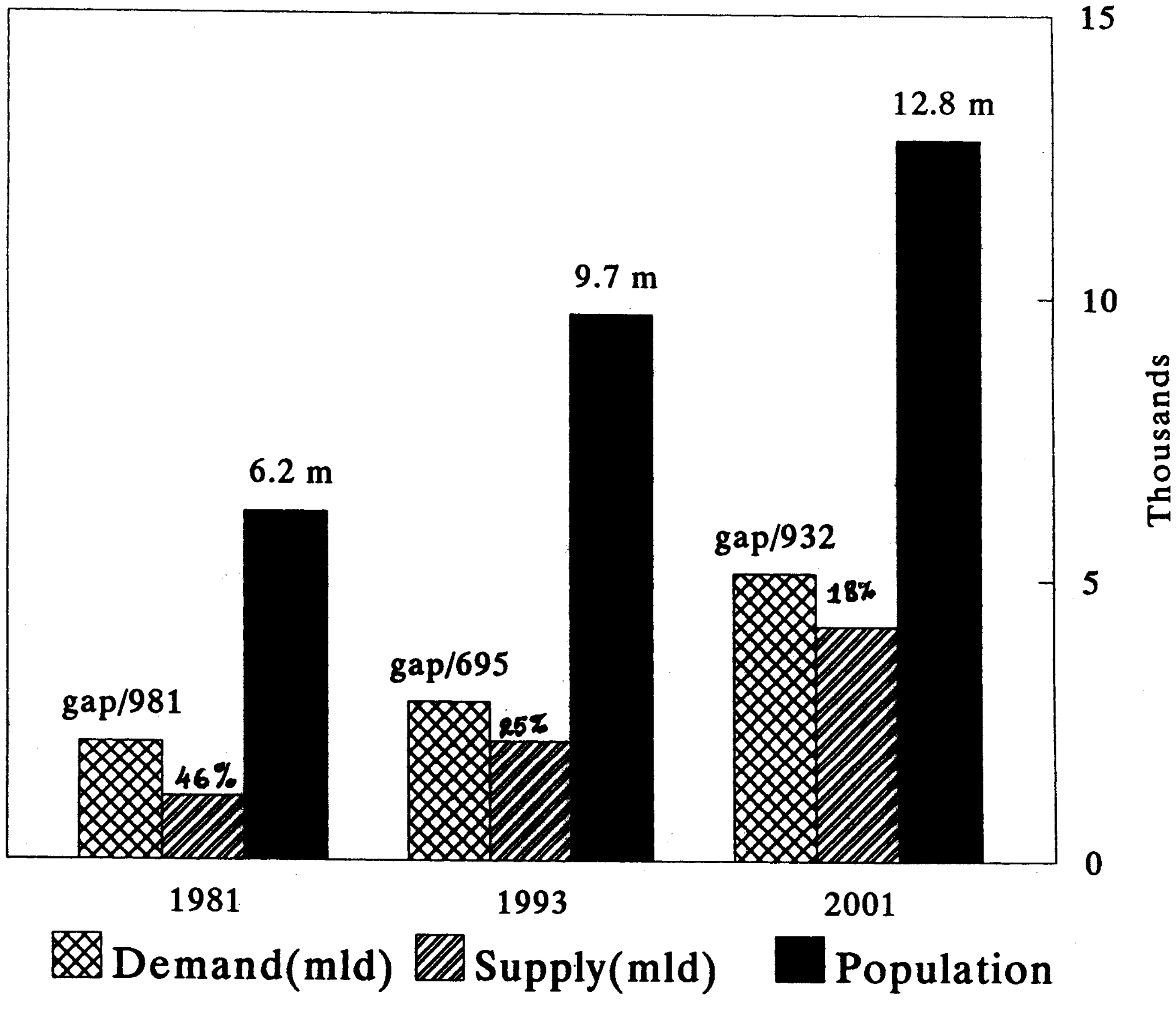


Source: HWSSB; A note on price revision 1993

Figure 7

Gap Calculation for Water Supply in Delhi

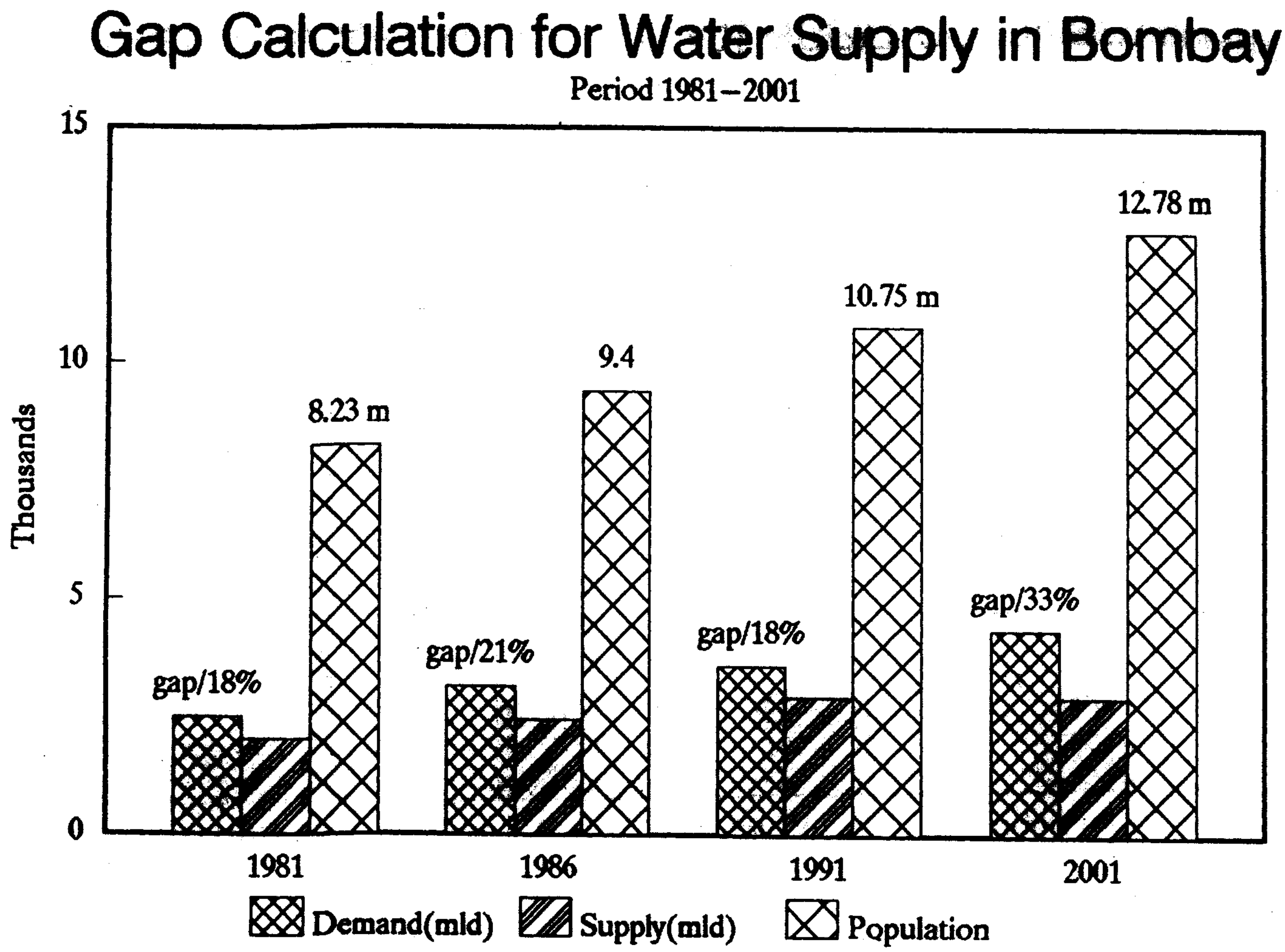
Period 1981 – 2001



Source: Ghosh R; Delhi's Water Needs, CWC 1994

INSTACON

Figure 8

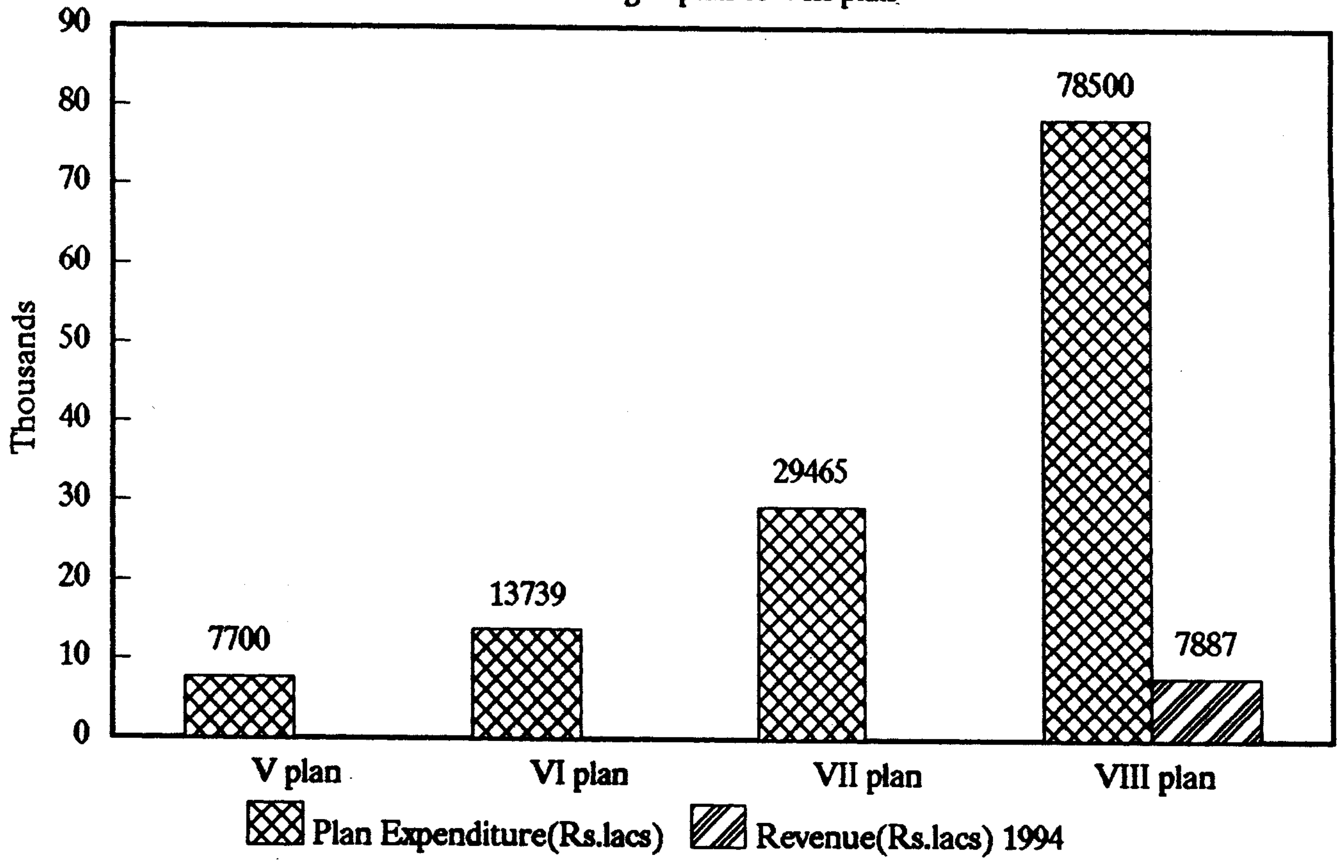


Source: World Bank: Bombay water supply project 1986

Figure 9

Resource Base for Water Supply in Delhi

During V plan to VIII plan



Total revenue figure is for 1994
Source: DWSSU brochure 1994