WATER RESOURCE POLICIES AND THE URBAN POOR:

INNOVATIVE APPROACHES AND POLICY IMPERATIVES

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A Background Paper for the Working Group on "Water and Sustainable Urban Development", International Conference on Water and the Environment: Development Issues for the 21st Century

26-31 January 1992, Dublin, Ireland

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We are grateful to John Briscoe of the World Bank and Devendra Gupta of National Institute of Public Finance and Policy, New Delhi for their valuable comment on an earlier draft of this paper. Thanks are also due to Rita Cestti of the World Bank for research input and data analysis. Views expressed here are those of the authors and do not present the views of the organizations they represent.

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EXECUTIVE SUMMARY

The International Conference on Water and the Environment will discuss development issues for the 21st century with a view to developing coordinated intersectoral approaches towards managing water resources. This paper has been prepared as a background paper for the Working Group on "Water and Sustainable Urban Development", at the Dublin Conference.

Improved management of water resources is increasingly recognized as a key environmental and economic issue in many developing countries. This paper shows that most developing countries have not developed instruments (either regulations or incentives) for internalizing the externalities which arise when one user affects the quantity and quality of water available to another. As a result of the sub-sectoral policies in the management of water resources (e.g. subsidized tariffs ignoring the opportunity cost of water, no pollution taxes) excessive quantities of water are used in agriculture and industries and excessive pollution is produced .

In urban areas of developing countries, due to the quantity and quality problems, the costs of supplies of adequate quality are rising rapidly. Increasing unit costs imply that, for a given level of resources, those who are unserved or poorly served are the poor people "at the end of the line". Thus, a large number of urban poor depend on unreliable public supplies or use surface and groundwater sources often contaminated by microbiological, organic chemical and heavy metal pollutants resulting in health problems. Further, the poor have to either pay a high percentage of their income in obtaining water for basic needs or reduce their water consumption.

About 20% to 30% of the current water used in households and industries can be saved by adopting appropriate policy instruments such as regulations, water tariffs, quotas, and groundwater extraction charges. Further, twin benefits of clean water and reduced demand can be obtained if recycling/reuse of water is encouraged in industries through pollution control legislation and economic incentives (water tariffs based on economic costs, effluent charges and low-interest loans for effluent/sewage treatment plants). These conservation and recycling efforts would release enough water so that a significant proportion of the currently unserved urban poor can be given adequate and clean water supplies without incurring additional costs on distribution and treatment.

These savings, though important in providing immediate relief to those unserved at present, may be considered as short-term solutions to the problem. There is a need for a change from the present sub-sectoral piecemeal approach to a framework of analysis which incorporates the economic and environmental linkages among user sectors (including agriculture and forestry). A new awareness of the upstream/ downstream linkages in the river basin is required on the part of the scientific community, decision-makers and policy analysts. However, this would require institutional changes (both in terms of organizational structure and motivation of workers) so that regulatory mechanisms as well as economic incentives are effectively used to achieve economically efficient, socially equitable and environmentally sustainable use of water resources.

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I. INTRODUCTION

Improved management of water resources is increasingly recognized as a key environmental and economic issue in many developing countries. From the environmental perspective, the quality of both surface and groundwater resources is degrading rapidly in many developing countries. From the economic perspective, the most egregious problem is that of allocating large quantities of water to low-value uses in irrigation and inefficiencies in domestic and industrial sectors. The fiscal implications of subsidizing irrigation and domestic uses can be seen in budget deficits resulting in lack of funds for rehabilitation and new investments in water systems. Most developing countries have not developed instruments (either regulations or incentives) for internalizing the externalities which arise when one user affects the quantity and quality of water available to another. Industrial water tariffs are based on average cost pricing (rather than marginal cost pricing) and ignore the opportunity cost of water (i.e. benefit foregone in alternative use). Similarly, the effects of damages caused by pollution of surface and groundwater are ignored in determination of water tariffs. As a result, from an economic viewpoint excessive quantities of water are used, and excessive pollution produced.

In urban areas of developing countries, due to the quantity and quality problems the costs of supplies of adequate quality are rising rapidly (with the cost of a unit of water from "the next project" often 2-3 times the cost of a unit from "the current project"). Increasing unit costs imply that, for a given level of resources, those who are (a) unserved or (b) poorly served are the poor people who are "at the end of the line". Thus, a large number of urban poor depend on unreliable public supplies or use surface and groundwater sources often contaminated by both "old" (microbiological) and "new" (organic chemical and heavy metal) contaminants resulting in health problems and high mortality rates. Further, the poor (mainly in peri-urban areas), have to either pay a high percentage of their income in obtaining water for basic needs or reduce their consumption of water. The poor are also adversely affected when employment generation in small enterprises is reduced because these units are rarely able to provide funds for self-provisioning of water supply.

According to available estimates, the provision of water supply services in urban areas of developing countries will require an annual investment of around $11 to $14 billions per year over the next three decades. These investment requirements are about twice the estimated funds available for urban water supply during the International Water Supply and Sanitation Decade (1980-1990). As sector funding in this order of magnitude is not likely to be available, the result will be that provision of services to the needy (peri-urban poor) will be neglected.

Apart from mobilizing additional funds, it becomes necessary to implement policies which encourage conservation in households, industry and agriculture so that additional water supplies can be obtained without incurring additional costs for transport and treating water. Contrary to the general belief, regulatory policies and economic incentives can and do bring about significant savings in household water use and reductions in withdrawals for industrial use. There is scattered but compelling evidence that improved policies can have major impacts. In a number of cases in developed and developing countries, it has been demonstrated that regulation combined with pricing and tariff policies have resulted in savings of water ranging between 20% - 30% or more. Some of these experiences as well as potentials for further savings are documented in section V. The implications of these savings for the urban poor in developing countries are presented in section VI.

These savings, though important in providing immediate relief to those unserved at present, may be considered as short-term solutions to the problem. In the long-term there is a need for a change from the present sub-sectoral piecemeal approach to an analytical framework which incorporates the economic and environmental linkages among user sectors (as discussed in section VII). A new awareness of the upstream/downstream linkages in the river basin is required on the part of the scientific community, decision makers and policy analysts.

II. OBJECTIVES

The objectives of this paper are:

- To provide an analysis of the **key issues** affecting the use of water resource in developing countries;
- To identify **key policy instruments** (institutional changes, regulatory measures and economic incentives) and to provide **evidence**, both from developed and developing countries, where some of these instruments have been successful in encouraging conservation and recycling of water in industries/households; and
- To propose a **new approach** and an analytical framework which incorporates the economic and environmental linkages among user-sectors.

III. SYMPTOMS OF A MALFUNCTIONING SECTOR

The water resources sector in developing countries is characterized by misallocation among alternative uses and "wastage" in each use. Large quantities of water (over 80%) have been allocated to irrigation where benefits are low. This excessive use in irrigated agriculture has continued even though quantities of both surface and groundwater available for urban areas has declined. Further, water use in agriculture has been characterized by large subsidies where revenues cover only around 10 percent of the total operation, maintenance and capital costs. In the municipal and industrial (M&I) sector also prices have not reflected economic costs since these were based on average costs (rather than marginal costs) and have ignored the opportunity cost of water. These low prices have acted as disincentives for conservation and efficient use of water by households, industries and commercial establishments.

For both quantity and quality reasons, additional water supplies for urban areas had to be obtained from long distances (over 100 kilometers in many cases) resulting in increases in the costs of supplies (of acceptable quality) of the order of 100% to 200%. For given levels of investment funds for urban water supplies, rising costs have meant that the number of people served does not keep pace with the growth of urban population and the number of people who remain unserved by piped water supplies keep on rising. Since the poor people, particularly in peri-urban areas, are "at the end of the line" in receiving water services, they continue to depend on traditional sources of supply. Since access to traditional sources declines over time and these supplies (both surface and groundwater) become more and more contaminated due to lack of sanitation and/or discharge of industrial effluent, the poor have to purchase water to meet their basic needs. Thus, the poor have to bear the brunt of high costs and contaminated supplies which are the result of inefficient management of overall water resources in the developing countries. Some of these linkages between inefficient use of water in user sectors and their implications for the urban poor are explored in detail below.

A. Inefficiencies in the Use of Water Resources

The water resources sector in the developing countries has been characterized by inefficiencies in allocation among alternative uses as well as excessive wastage in individual sub-sectors. This mismanagement of water resources has major implications for economic performance, through both fiscal and real sector linkages. The principal fiscal linkage is through the huge subsidies- over billions of dollars as discussed below- which contribute to the ubiquitous national budget deficits. The real sector linkages arise because water resources are not used efficiently. The most egregious problem is that of allocating large quantities of water to low-value irrigation uses, but there are allocative problems within the M&I sector, too.

1. Wastage in Water Use

Water used in irrigated agriculture, which accounts for over 80% (of the total water withdrawals in developing countries) can be characterized as "high volume, low quality, and low value". Only a small fraction of water diverted in most large systems in developing countries is available for plant use, typically 25% to 30%, compared to 60% to 70% in advanced systems[1]. The remainder seeps or evaporates from unlined or obstructed canals and distributaries[2]. Farmers at the tail ends of distribution systems in large projects usually suffer from water shortages during critical period which reduce yields or encourage costly investments in groundwater extraction. In the urban water supply sector too, there is tremendous wastage of water in distribution systems and homes, commercial establishments and public facilities. For example, the average level of unaccounted-for water (UFW)[3] in Bank-supported projects is about 36%[4] UFW levels as high as 50% to 60% are observed in Cairo, Mexico City, Barranquilla, Lima, and Jakarta in comparison with 10% to 15% in well-managed public water supply systems. Although a part of

1/ Robert Repetto, "Skimming the Water: Rent-seeking and the Performance of Public Irrigation Systems," World Resources Institute, Research Report #4, December 1986.

2/ Although the quantity of water that seeps to become available via groundwater is not "waste" from the system perspective, this does result in additional costs of pumping water from the ground. Further, the quantity that comes back as "return flow" would be less than what seeped in because of losses in groundwater use.

3/ Unaccounted-for-water includes both physical losses of water and loss of revenues by the utility. This section will only make reference to reduction of the former because of the clear welfare implications.

4/ Harvey Garn, "Water Supply Investments in Developing Countries: Some Technical, Economic and Financial Implication of Experience," 1987.

the UFW is unreported water use by public agencies or unauthorized private use (sometimes by the poor), a large proportion of UFW represents leakage of water into the soil. In the case of Jakarta, for example, the order of magnitude of water loss by leakage has been reported as 41% of total water production[5]. Studies carried out in Indonesia show that physical losses can be reduced by 48% in a cost-effective manner[6].

2. Huge Subsidies in Irrigated Agriculture

According to one estimate, an equivalent of $250 billion (in current prices) has already been spent to create irrigation capacity in the Third World only[7]. A significant proportion of public investments in agriculture goes to irrigation in these countries. In Mexico, irrigation projects have taken up 80% of agricultural investments since 1940; in India, irrigation investments at over $2.0 billion account for about 30% of the total public investments; while in Pakistan, 10% of total public investment budget was allocated to irrigation in the current five-year plans. Development assistance agencies have also been heavy investors: irrigation has accounted for 28% of all World Bank agricultural lending during the 1980s, and commitments by all aid agencies exceeded $2.0 billion per year in the 1980s.

However, public irrigation investments have become an enormous drain on government budgets because cost recovery has fallen short of even modest targets. In Indonesia, Korea, India, Pakistan, Philippines and Bangladesh, irrigation receipts were less than the costs of operation and management (covering about 20% to 90% of O&M costs)[8]. Using a moderate estimate of capital costs in these countries, actual receipts averaged (in 1984) less than 10% of the full costs of irrigation services implying average subsidies of 90% on total costs of irrigation[9]. In Mexico, assumed cost recovery from users of public irrigation systems (created at the cost of $16 billion in 1981 prices) averages only around 11% of capital, operating and maintenance costs. In Pakistan, gross public revenues from irrigation services in 1984 were approximately Rs. 1.0 billion, compared to outlays for operation and maintenance of irrigation works of Rs. 2.0 billion and annualized capital charges on past irrigation investments of Rs. 5.9 billion. In India, in 1988-89, current revenues from water charges were Rs. 1.1 billion compared to Rs.15.0 billion on current expenditures on major and medium irrigation projects. Thus, annual irrigation subsidies were of the order of $0.6 billion in Pakistan and $1.2 billion in India. The estimated irrigation subsidies are of the order of over $5 billion per year in Egypt[10].

5/ Japan International Cooperation Agency (JICA), "Jakarta Water Supply Development Project," 1985, Volume IV, p. M4-28.

6/ SAFEGE, BETURE SETAME & SOGREAH, "Jakarta Water Supply PDAM Java System Improvement Project," Implementation Report, Jakarta, pp. 78-79, 1989.

7/ Robert Repetto, op. cit., p. 3.

8/ L.E. Small, M.S. Adriano, E.D. Martin, R. Bhatia, Y. Shim and P. Pradhan, "Financing Irrigation Services: A Literature Review and Selected Case Studies from Asia," International Irrigation Management Institute, Colombo, 1989.

9/ R. Repetto, op.cit., p. 4.

10/ Personal communications with World Bank staff.

Irrigation subsidies in developing countries have been justified on a number of grounds[11]. Although some of these arguments may be correct, there is need to raise irrigation charges more as a means of "benefit recovery" rather than cost recovery since current charges are invariably less than 6 to 8% of the additional benefits from irrigation. Given the fact that farmers with irrigation are relatively better-off, there may be arguments for subsidies at the margin but there is no defense of such high levels of subsidies in irrigation.

In economic terms, the performance of large public irrigation systems has fallen short of expectations. Performance measures such as acreage irrigated, yield increase and efficiency in water use are typically less than projected when investments were made and less than attained by private irrigators who operate more controlled decentralized systems. In Mexico, a World Bank survey found, farmers still growing low-yield maize varieties in Irrigation Districts harvest only 2.5 tons per hectare[12]. In India, for example, production on canal-irrigated areas averages only 2.0 to 2.5 tons of food grains per hectare, much better than dry lands, but much less than the 5 to 6 tons attained under private tubewell irrigation[13].

3. Investments in Urban Water Supply Systems

In developing countries, on average, the shares of industry and households in total water withdrawals are around 10% and 5%, respectively[14]. However, in some river basins where metropolitan cities are located, the share of industrial and domestic uses is higher, ranging between 18% to 30%. For example, in Beijing and Tianjin, the share of industrial and domestic uses was 44% and 36% in 1984; in the Jabotabek region (including Jakarta) in Indonesia the share was 17% in 1987 and the estimated share of industrial and household use in Subernarekha river basin (which includes the steel city of Jamshedpur) in eastern India was 30% for 1990.

Due to rapid urbanization and industrialization, water demand for household, commercial and industrial uses in urban areas has been increasing fast and the share of industrial and domestic demands is estimated to rise in the future. These trends have given rise to situations where serious conflicts in water-use between agriculture and municipal uses have occurred. For example, the phenomenal growth in demand for water for domestic, commercial and industrial uses in a number of cities in India (Pune, Bombay, Hyderabad, Madras, and Vizag) has required that water be transported over long distances from its existing use in the irrigation sector to

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11/ Some of these points are: (a) volumetric measurement and pricing of water is possible only at main distribution points in view of the large number of farmers and the method of distribution of water (through gravity flow); (b) low income farmers cannot afford to pay for water if it is priced near its cost let alone marginal or even full economic costs (including opportunity cost); (c) even for large farmers, water charges will be between 30% to 40% of additional output from agriculture if both the capital and operation & maintenance costs are to be recovered; (d) there are indirect revenues collected by the state from incomes generated as a result of irrigation use; (e) there is an indirect taxation of the farm sector because the (administered) output prices for farm products are kept lower than the import prices as a matter of government policy; and (f) similar subsidies are available to farmers in the United States and other developed countries. See Small et al, op.cit.

12/ The World Bank, "Mexico:Irrigation Subsector Survey," Washington, D.C., Annex 3, p. 5.

13/ B.D. Dhawan, "Irrigation's Impact on the Farm Economy," Economic and Political Weekly, XX (39), 1985, pp. A124-128.

14/ The weighted average share of agriculture in a set of 18 countries including India was 87% in 1985; excluding India, the share was 79%. (World Bank calculations, 1989).

urban areas[15]. In the Jabotabek region in Indonesia the share of water requirement for drinking and industrial uses is estimated to increase from 17% in 1985 to 38% in 2015[16]. This increase (from 0.7 billion cubic meters in 1985 to 2 billion cubic meters in 2015) will mean that there will be a deficit of the order of 18% in the total estimated requirements of water in 2015 if future demands are not curtailed. In Beijing and Tianjin in China, also, the demand for water for domestic and industrial uses is expected to increase by 90% and 150% between 1984 and 2000, accounting for about 65% and 80% of total available supplies, respectively. This in turn will lead to a shortfall of about 20% and 45% of projected demands[17].

Public sector investments in municipal and industrial water supplies constitute a significant and rising component of overall investment in water resources. Investments in municipal water supplies are typically 5% to 6% of total public investment. Since the incremental costs of supplies are rising rapidly (due to quantity and quality problems as discussed below) these investments are not able to provide water supplies to the rising populations in urban areas.

As in the case of irrigation, the sales revenue in the urban water supply sector also falls short of the cost of providing supplies. Based on the data from projects initiated between 1966 and 1981, the incremental cost was estimated as around $0.49 (1988 prices) per cubic meter produced compared to the effective price realized was slightly over $0.17 per cubic meter produced (taking average unaccounted-for water as 35%) or only about a third of the incremental cost of produced water[18]. Here, as also in irrigation, pricing policies are not being used either for demand management or for allocation of scarce water resources.

The International Drinking Water Supply and Sanitation Decade of the 1980s made significant progress in extending water supply services in urban areas such that more than 368 million people were newly supplied with adequate water supply, with coverage over the decade increasing from about 77% to 82%[19]. However, even after the efforts of the decade, increase in urban population growth was such that it actually resulted in about a 15% increase in the unserved urban population. This means that in 1990, there were over 300 million urban dwellers who did not have access to safe drinking water supply. Assuming that the efforts of the Decade will continue, the number of unserved people will increase to around 520 million in the year 2000 and around 1.7 billion in the year 2020.

15/ M.A. Chitale, "Comprehensive Management of Water Resources: India's Achievements and Perspectives," June 1991, p. 22.

16/ INDEC & Associated Limited, "Cisadena River Basin Development Feasibility Study, Main Report", 1987.

17/ M.M. Hufschmidt, J. Dixon, L. Fallon, and Z. Zhu, "Water Management Policy Options for the Beijing-Tianjin Region of China," East-West Center, Hawaii, 1987, pp. VI-6-9.

18/ The World Bank, "Water Supply and Sanitation: FY90 Sector Review," Water and Sanitation Division, Infrastructure Department, December 1990.

19/ Joseph Christmas and Carel de Rooy, "The Decade and Beyond: at a Glance," Water International, 16, 1991, pp. 127-134.

B. Excessive Pollution is Created at Present

In the absence of a policy framework which takes account of externalities, cities cause and face closely-related water quantity and quality problems. Pollution of the Bogota river in Colombia is a typical example of this situation (see Box 1). With respect to water quality, the surface and groundwater supplies used by the city are often contaminated by both microbiological, organic chemical and heavy metal pollutants. In most cases the culprits include agriculture, industry and human settlements in the watershed, and homes and industries in the city itself.

BOX 1: EXCESSIVE POLLUTION IN THE BOGOTA RIVER, COLOMBIA

Presently there is no sewage treatment, so the untreated industrial and municipal wastewater flows reach the Bogota River, which discharges into the Magdalena River. Because a substantial portion of the flow is sewage, the Bogota River has been polluted. It has been estimated that the domestic and industrial organic pollution in the river produce a biochemical demand for oxygen on the order of 210 and 85 tons per day, respectively. The poor quality of the water has significantly affected the communities in the lower basin as well as rural areas, which depend on the Bogota River for water supply and fishing.

The problem of pollution is even more severe since the Magdalena River is also starting to be affected by the contamination of the Bogota (The Bogota River is a tributary of the Magdalena River). Because there are many cities and people depending on water from the Magdalena River, the risk of further pollution must be eliminated soon. Even though the flow of the Bogota River is only about 2% to 4% the flow of the Magdalena River, during some periods the Bogota River supplies up to 10% of the total flow of the Magdalena River at their confluence. The level of pollution of the Bogota River is such, that the 10% is enough to cause serious damage to the quality of the Magdalena River.

Pollution abatement of the Bogota River demands a regional approach by all agencies including all municipalities and users of the river. The different beneficial uses of the river (agriculture, water supply and electric generation) have implications on the required level of wastewater treatment (primary, secondary or tertiary) and therefore on the cost. Also, through a regional approach all beneficiaries from clean-up efforts could be included. For example, water diversion for irrigation downstream of Bogota may continue if efforts are made to clean-up the river, but a question arises, who is supposed to pay for those investments.

A regional approach will also help to address the issue of how to sustain the river flow. Fresh water reaches Bogota River from the upper basin and from excess water from the Chingaza scheme. Water from these sources is increasingly used for water supply, which afterward is converted into sewage. However, it is planned to collect the sewage in a interceptor and not reach the river. Therefore, flow in the river will decrease. In order to sustain the Bogota River, there are plans to develop new water resources further upstream. However, by following a strategy to reduce water demand for fresh water (water demand management), additional water may be available for sustaining the river flow.

Sources: Terence R. Lee, "Water Resources Management in Latin American and the Caribbean," 1990, pp. 63-90. Danilo Anton, "Urban Environmental and Water Supply in Latin America," Montevideo, 1990, pp. 89-94.

In Indonesia, the Ciliwung and Sunter rivers show similar symptoms. In the former river the average level of biochemical oxygen demand (BOD) was about 15 mg/liter[20], 150% higher than the norm, while in the latter one the level of BOD was about 28 mg/liter in 1985 at the

20/ E. Budirahardjo and C. Surjadi, "Environmental and Health Problems in Jakarta," Indonesia, 1990, Fig. 2.2.

confluence with the Cipinang[21]. Moreover, at the river mouths to the Jakarta Bay, the level of BOD in some rivers exceeds the value of 90 mg/liter[22]. In the case of Ciliwung River, the water quality in the upstream area is acceptable for all purposes except drinking, however, in the downstream area after the river has passed Jakarta, the water cannot be used for anything. The situation becomes even worse during the dry season when the flow is lower but the amount of discharge going into the river remains constant all year round. A review of the water pollution level in selected rivers in Java highlights that the level of fecal coliform is, in some cases, above 4,000 times of conventional standards. An alarmingly high level of heavy metals has been also reported in the Cisadena river near the Tangerang Industrial Zone. In one location, the level of mercury was registered as 100 times more than the allowable levels, and also excess levels of cadmium, chromium and selenium were observed[23] (see Box 2).

BOX 2: DEGRADATION OF WATER QUALITY AND IMPLICATIONS FOR THE COST OF WATER SUPPLY IN INDONESIA

In addition to the environmental damage, water pollution and excessive pumping have impacts on the costs of water supply. In order to improve water quality, there is a need to continuously increase chemical in the treatment process, which requires costly treatment. For example, in order to treat the increasingly polluted raw water of the Pulogadung water treatment plant in Jakarta, chlorine dosage has been increased from an average of 2.6 mg/l in 1982 to about 7 mg/l in 1984. Even with this increase of chlorine dosage (which increased treatment cost by Rp. 610 million per year in 1985 constant prices) which also decreased plant efficiency by 18% valued at Rp. 870 million per year, the finished drinking water frequently exceeded the drinking water standards on concentration of Ammonium, Organic Matter, Color and Fecal Coliform. In addition, there is the negative long-term effect of a high use of chlorine, since it produces carcinogenic chemical residuals such as chloroform.

Another large cost to the economy due to the high level of bacteriological contamination of raw water is the cost of boiling water to make it drinkable. The high level of pollution in combination with the poorly operated treatment and distribution facilities make the public water undrinkable, unless the water is boiled before use. For the DKI Jakarta (Jakarta Special Capital Province) area alone, this cost has been estimated at Rp. 96 billion per year (1987 prices) or US$ 52 million per year. Furthermore, this huge amount is equivalent to 1.1% of GDP generated in the DKI Jakarta. A surveys conducted in Jakarta revels that a household boils about 4.4 liters of water per capita per day, for drinking and cooking purpose, independent of the source. The water is boiled between 15 and 20 minutes and that requires about 200 kcal per liter; kerosene is the most used fuel, which provides about 8000 kcal per liter, and its unitary economic cost is Rp. 300. Thus the cost for boiling water before use can be estimated at Rp. 7.5 per liter.

Sources: Japan International Cooperation Agency, "Jakarta Water Supply Development Project," 1985, Vol. II, p. 4-20. The World Bank, "West Tarum Canal Improvement Project," Report 5429-IND, 1985, p. 35.

In Tianjin, China, only 21% of the total wastewater is being treated, while the rest is dumped untreated into the open water bodies. During 1988 the Haihe river stream channel was badly polluted with chemical oxygen demand (COD) levels exceeding standards 85% of the time,

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21/ Binnie & Partners, "Kali Sunter Purification Study," GOI, December 1986, p. 97.

22/ Giles Clarke, Suhadi Hadiwinoto and Josef Leitmann, "Environmental Profile of Jakarta," UNDP/World Bank/UNCHS, (Draft), 1991.

23/ The World Bank, "Industrial and the Environment: A Preliminary Assessment (Draft)," 1988, p. 5.

chlorides 24% and volatile phenol 5% of the time. As a result, surface and groundwater sources can not be used for domestic water supply. The cost involved in treating this water is higher than the cost of bringing water from other sources[24].

In Tunisia, the largest surface-water reservoir in the country which provides about half of the total mobilizable resources, Sidi Salem, is suffering from eutrophication. Sewage effluent and municipal waste are dumped directly into this water body and the nutrients carried out by the agricultural run-off are the causes for the reduction of depth penetration of solar rays and the quantity of oxygen and further eutrophication, which propagates parasites, viruses and bacteria, and endanger fish and bird species, as well as other living organisms[25].

As seen from a waste perspective the major part of the world pollution is generated in urban area. This makes the issue of sanitation and controlled waste handling a key issue of global concern. It raises the question as to what extent the present waste water treatment solutions are indeed realistic alternatives in Third World cities.

These environmental problems give rise to two distinct health problems. The "old" problems are the high rates of transmission of communicable diseases resulting from the use of inadequate quantities of water of poor quality. The "new" problems are the health risks arising from contamination of water sources by synthetic organic chemicals, heavy metals, pesticides and other modern pollutants. These risks--both old and new--are particularly high for the poor and constitute an important cause of the wide mortality differentials between the poor and rich in cities. The recent cholera epidemic in Peru[26], with an estimated death toll of more than a thousand and the negative economic consequences (such as the loss of exports estimated at about US$400 millions), is a typical case of what could happen to a country that lacks water and sanitation infrastructure and is exposed to extensive pollution[27].

C. Incremental Costs of Supply are Rising

In view of the conflicts in use of water, new supplies have to be obtained from long distances (ranging between 50 to 180 kilometers in metropolitan areas in many countries) involving high investments costs in pipeline transportation and pumping. Both the quantity and quality problems (pollution of surface and groundwater sources) mean that the costs of supplies of adequate quality are rising rapidly with the cost of a unit of water from "the next project" often being 2 to 3 times the cost of a unit from "the current project" (Box 3 and Figure 1).

Although public sector investments in municipal and industrial water supplies constitute a rising component of overall investment in water resources, these investments are already typically

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24/ J. Leitmann, "Tianjin Urban Environmental Profile," UNDP/World Bank/UNCHS, (Draft), 1991.

25/ P. Krause and H. Krist, "Eutrophication in Northern Tunisia," Aqua, No. 2, 1986, pp. 98-102.

26/ Pan American Health Organization, "Cholera Situation in the Americas," Epidemiological Bulletin, Vol. 12, No 1, 1991.

27/ In Peru, only 55% of the population has access to drinking water and 41% to sanitation services. Wastewater is discharge untreated into rivers and the ocean, resulting in extensive contamination from fecal matter and other elements.

about 5-6% of total public investment[28]. The share of public and private investments would have to increase substantially if supplies for the urban poor have to be increased simultaneously with those for households, commercial and industrial sectors.

BOX 3: INCREASING COSTS OF WATER SUPPLY

Figure 1 presents recent examples where supply costs are increasing due to water resources problems. These cases illustrate, on the one hand, that intense competition among water users create the necessity to transmit water over longer distance and make more extensive use of high-cost energy-using pumping. On the other hand, that environmental consequences of water use creates the necessity for additional treatment since lower quality sources are employed, or rejection of the source, because of the irreversible damage caused to its quality.

In the case of **Amman in Jordan** when the water supply system was based on groundwater the average incremental cost (AIC) was estimated at $0.41/m^3; however, chronic shortages of groundwater led to the use of surface water sources. This raised the AIC to $1.33/m^3. The most recent works involve pumping water up 1,200 mt. from a site about 40 km. from the city. Next scheme contemplates the construction of Unit Dam and the Northern Conveyor, which cost has been estimated at $1.5/m^3.

In **Shenyang**, a Chinese city, the cost of new water supplies would rise from $0.04 to $0.11, almost a 200% increase, between 1988 and 2000. The main reason is that groundwater from the Hun valley alluvium, which is the current water source, has to be rejected as an immediate means of supplying potable water for reasons of water quality. As a result, water will have to be conveyed to Shenyang by gravity from a surface source 51 km. away from the city. In **Yingkuo,** another Chinese city, the AIC of water diverted from the nearby Daliao river is about $0.16/m^3. However, because of the heavy pollution, this source cannot be used for domestic purpose. As a result, water is currently been supplied into the city from the Bi Liu river at a cost of $0.30/m^3.

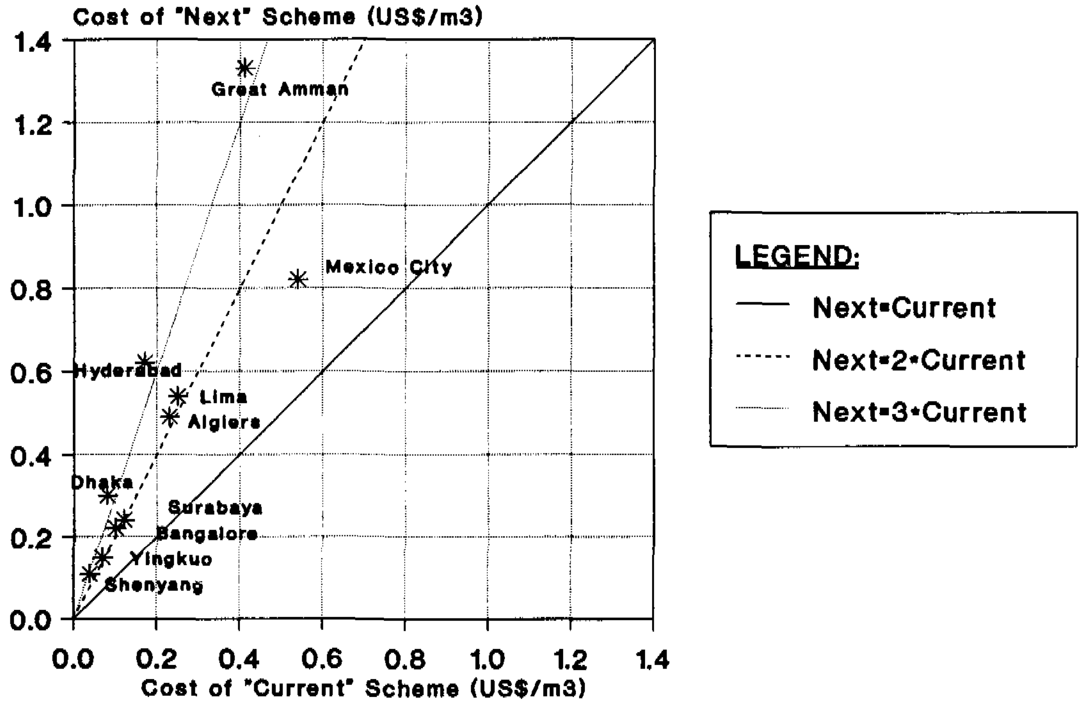
In the case of **Lima in Peru**, during 1981 the AIC of a project to meet short-to medium term needs, based in part on a surface source from the Rimac River and partly on groundwater supplies, was $0.25/m^3. Since the aquifer has been severely depleted, groundwater sources cannot be used any longer to satisfy needs beyond the early nineties. In order to meed long-term urban needs, a transfer of water from the Atlantic watershed is been planned, which AIC has been estimated at $0.53 per cubic meter.

The **Metropolitan Area of Mexico City in Mexico** water is currently been pumped over an elevation of 1000 meters into the valley of Mexico from the Cutzamala river through a pipeline of about 180 km. The AIC of water from this source is $0.82/m^3, almost 55% more expensive than the previous source, the Mexico Valley Aquifer. The former source has been restricted due to the problems of land subsidence, lowering of the water table and deterioration in water quality. The newly designed water supply project for the city is expected to be even more costly since it will have a longer transmission line and water will be pumped over an elevation of 2,000 meters to the city.

Source: "Water Resources: Problems and Issues for the Water Supply and Sanitation Sector (Draft)," Rita Cestti, The World Bank, 1989.

28/ The World Bank, "FY90 Sector Review Water Supply and Sanitation," Water and Sanitation Division (INUWS), 1990, p. 20.

Figure 1: Average Cost of Water Supply, Current Scheme Versus Next Scheme



Sources: INUWS calculations from Staff Appraisal Reports (SAR) and Feasibility Studies
Note: Prices are given in September 1988 dollars.

D. Urban Poor Bear the Brunt of Shortages and Quality Deterioration

In 1988, over 130 million of the developing world's poorest poor lived in urban areas about two-third of whom live in squatter settlements (62 million in Asia, 28 million in Latin America and 9 million in Sub-Saharan Africa)[29]. Most of these people depend on traditional sources of water supplies which are getting increasingly contaminated due to human waste, industrial effluent and agricultural pollutants. As a consequence, the poorest have to purchase safe household water for meeting their basic needs at exorbitant prices.

In a number of studies it has been shown that the urban poor pay much higher prices for water supplies as a result of which they spend a much higher proportion of their income (compared with those in higher income brackets) on water. For example, in Port-au-Prince, Haiti, it was found that the poorest households sometimes spend 20% of their income on water[30]; in Onitsha, Nigeria, the poor were estimated to be paying 18% of their income on water during the dry season versus 2% to 3% for the upper income households; in Addis Ababa, Ethiopia, and

29/ H. Jeffrey Leonard and contributors, "Environment and the Poor: Development Strategies for a Common Agenda," Overseas Development Council, 1989, pp. 20-21.

30/ D. Whittington, J. Briscoe and X. Mu, "Willingness to Pay for Water in Rural Areas: Methodological Approaches and an Application in Haiti," WASH Project, Field Report No 213, Washington, D.C., 1987.

Ukunda, Kenya, the urban poor spend up to 9% of their income on water[31]. In Jakarta, of the 7.9 million people only 14% of households received water through direct connections to the municipal system in 1988. Another 32% bought water from street vendors who charged around $1.5 to $5.2 per cubic meter depending on the distance from the public tap and in some cases households purchasing from vendors pay as much as 50 to 60 times more per unit of water than households connected to the municipal system[32]. (See Box 4).

BOX 4: HOW MUCH POOR URBAN POPULATIONS ARE PAYING FOR WATER

The problem of lack of water services is felt more pronounced by the poor and slum areas of the large cities in developing countries, accounting for between 30% to 70% of the population. Many times the only choice for those low-income households who can not afford a house connection is to buy water of substandard quality from private vendors at a relative high price, sometimes 100 times higher than that could be provided by public authorities. Some examples of this phenomenon are presented in the following table.

Ratio Between Prices Charged by Vendor and Public Utilities

Country	City	Ratio	Source
Bangladesh	Dacca	12-25	1
Colombia	Cali	10	2
Ecuador	Guayaquil	20	2
Haiti	Port-au-Prince	17-100	1
Honduras	Tegucigalpa	16-34	1
Indonesia	DKI Jakarta	4-60	3
	Surabaya	20-60	1
Ivory Cost	Abidjan	5	1
Kenya	Nairobi	7-11	1
Mauritania	Nouakchott	100	2
Nigeria	Lagos	4-10	1
	Onitsha	6-38	4
Pakistan	Karachi	28-83	1
Peru	Lima	17	1
Togo	Lome	7-10	1
Turkey	Istanbul	10	1
Uganda	Kampala	4-9	1

Sources:

(1) "Urban Strategy Paper" (Draft), The World Bank, 1989.
(2) "FY89 Sector Review Urban Development Operations", The World Bank.
(3) "Indonesia: Foundations for Sustained Growth", The World Bank, 1990.
(4) "Paying for Urban Services" by D. Whittington, D. Lauria and X. Mu, 1989.

31/ D. Whittington, D. Lauria and X. Mu, "Paying for Urban Services: A Study of Water VEnding and Willingness to Pay for Water in Onitsha, Nigeria," The World Bank, Report INU 40, 1989.

32/ Laszlo Lovei and Dale Whittington, "Rent Seeking in Water Supply," The World Bank, Report INU 85, 1991.

E. High Costs of Water Supply Inhibit Growth of Small Firms

In Nigeria[33], a survey of 179 manufacturing firms in 1988 showed that the public water supply system provided only 55% of the total water usage and the firms had to purchase 10% of their requirements from private tankers and the remaining 35% was drawn from privately installed boreholes. Only 10% of the small firms (less than 49 employees) owned a borehole for self-provisioning of water supply while 75% of the larger firms (more than 500 employees) owned a private borehole. It was also found that the actual unit cot (0.52 naira per gallon) for small firms (0-19 employees) was much higher than the actual cost (0.02 naire per gallon) for large firms (500-999 employees). This shows that the existing cost structure subsidizes large firms at the expense of smaller firms and inhibits the growth and birth of new small firms. Further, higher incidence of deficient public supply has adverse impacts on employment and income distribution particularly in the Ambra-Imo region which has many small firms (which cannot afford self-provisioning through boreholes).

IV. MASSIVE URBAN POPULATIONS TO BE SUPPLIED IN NEXT FEW DECADES

The urban population growth process in developing countries is the result of population growth in the cities as well as urban migration. By 2000, there will be about 2,000 million people in urban areas in developing countries (compared with 1,000 million in developed countries) and there will be 45 metropolitan areas with more than 4 million inhabitants in each (with an aggregate population of over 400 million)[34]. The aggregate urban population in less developed countries by 2020 is projected to increase to over 3.5 billion (See Figure 2).

The International Drinking Water Supply and Sanitation Decade of the 1980s made significant progress[35] in extending water supply services in urban areas such that more than 360 million people were newly supplied with adequate water supply, with coverage over the decade increasing from about 77% to 82%. However, even after the efforts of the decade, increase in urban population growth was such that it actually resulted in about a 15% increase in the unserved urban population.

Assuming that the efforts of the Decade will continue at the same scale, the unserved urban population in the year 2000 will be about 520 million. If, on the other hand, no urban inhabitant should remain unserved by 2000, two and a half times as many new individuals would have to be served as during the preceding decade. If for the following 20-year period (2000 to 2020), water supply were to be organized to keep up with the urban population, then that would correspond to more than twice the rate of coverage during the Decade.

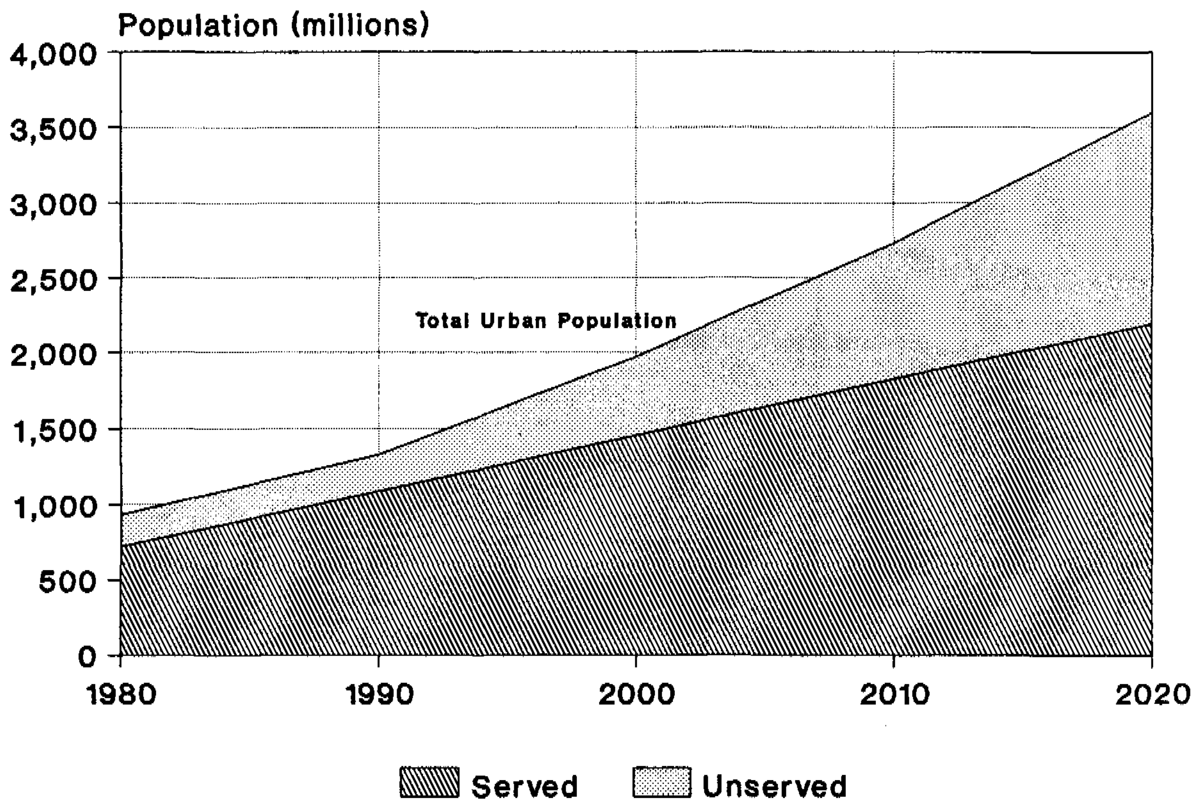
33/ Kyu Sik Lee and Alex Anas, "Impacts of Infrastructure Deficiencies on Nigerian Manufacturing: Private Alternatives and Policy Options", World Bank Publication, December, 1990.

34/ United Nations, "Prospects of World Urbanization," 1988, p. 8 and pp. 19-21.

35/ Joseph Christmas and Carel de Rooy, "The Decade and Beyond: at a Glance," Water International, 16, 1991, pp. 127-134.

If the investments made in urban water supply (excluding rural water supply and urban sanitation) during the Decade were estimated[36] to be of the order of $6 to 7 billions per year, the estimated investments required would be $117 billion during the Nineties in order to achieve 100 per cent coverage of urban population in the year 2000[37]. The provision of water supply services to an estimated 3.5 billion people in urban areas of developing countries would require $340 billion during 2000 to 2020 (assuming that unit real costs of water supply would increase by 67% over the next thirty years). Even when low-cost methods of water supply are found for one-third of the population, the total investments required would be of the order of $11 to $14 billions per year in the next three decades. These aggregate investments are about twice the investments made during 1980-1990.

Figure 2: Urban Population in Developing Countries and Water Supply Coverage



Assuming that the efforts of the Decade will continue.
Sources: "Decade Report Card" & "Prospect of Urbanization".

36/ This is assuming an average capita investment cost of US$ 120. (From "FY88 Annual Sector Review Water Supply and Sanitation," INUWS, Report INU 32, 1988, Annex 1).

37/ Urban population to be served by year 2000 in order to attain 100% coverage would be about 882 millions inhabitants, while the cost per capita is assumed at US$ 132 (assuming a 10% increase over current levels), which is a very conservative figure. Additional urban population to be served during the period 2000-2020 will be 1.5 billion.

As sector funding in this order of magnitude, $11 to $14 billion annually, is not likely to be available, the result will be that provision of services to the needy (peri-urban poor) will be neglected resulting in associated health implications (as in the case of cholera in Peru in 1991 summer). Hence, efforts would have to be made to increase resources both at the national and international levels. At the national level, water supply agencies would have to raise funds by providing adequate and reliable water supply so that a larger number of house connections could be given at higher tariffs. As pointed out[38] in a "Willingness-to-Pay" study in Kerala (India), by making a few critical policy changes--encouraging connections by financing connection charges, through higher tariffs and improved reliability--it is possible to raise revenues (by as much as 40 to 100 percent) by water supply agencies.

Apart from mobilizing additional funds, it becomes necessary to use existing resources more efficiently. In order to provide "correctives" for the current situation in the water resources sector, two things are required. First, implementation of policies which encourage conservation in households, industry and agriculture so that additional water supplies can be obtained without incurring additional costs on transportation, pumping and treatment of water. These savings, though important in providing immediate relief to those unserved at present, may be considered as short-term solutions to the problem. Second, and more important, a change from the present sub-sectoral piecemeal approach to a framework which incorporates the economic and environmental linkages among user sectors. This fundamental change in the approach to dealing with water resources issues is considered very important when a long-term view of the problems of water resources is taken.

V. POLICY OPTIONS AND KEY POLICY INSTRUMENTS

Apart from innovative approaches to the understanding of complex linkages in the water resources sector (as discussed later in section VII), it is also important to develop methodologies for analysis of various policy options (and related policy instruments) which will encourage demand management in all user sectors as well as allocation of water among competing sectors such that the objectives of economic efficiency and equity are achieved. This would require encouraging investments in conservation and recycling/reuse in households and industries. The costs and benefits of conserving water by improving the efficiency of use in irrigation and reducing the losses in urban water systems have to be evaluated and necessary investments for these improvements have to be encouraged.

One of the most obvious ways of extending the water resources base is by conserving water or by recycling it after use. However, each conservation measure may not be financially viable or economically appropriate. In many situations, conservation may be more cost-effective than investments in increasing water supply. From the viewpoint of an entrepreneur, investments in water-saving processes or in recycling would be worthwhile only if the cost of water saved is less than the cost of water supply. If water tariffs do not reflect the full costs of supply, firms or individuals do not invest in water-efficient technologies or appliances(such as shower-heads, flush systems, washers). From the viewpoint of society, improving water use efficiency would be economic only if the unit cost of water saved is less than the unit cost of water supply plus the

38/ B. Singh, R. Ramasubban, R. Bhatia, J.Briscoe, C. Griffin and C. Kim, "Rural Water Supply in Kerala, India: How to Emerge from a Low-Level Equilibrium Trap," World Bank, INUWS, April 1991.

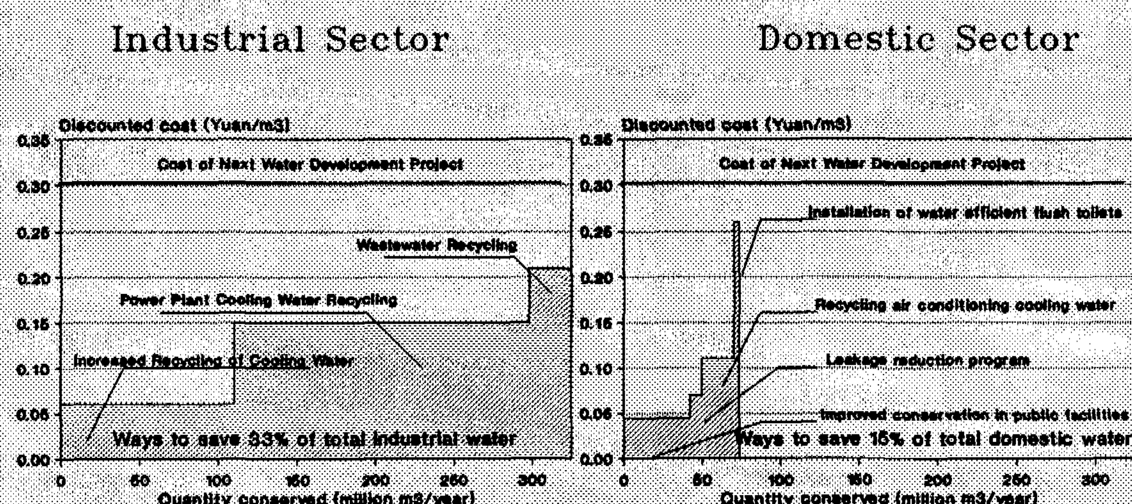
opportunity cost of water. When comparing against supply alternatives, it is economic to implement all conservation measures whose "cost of conserved water" (CCW) is less than the marginal cost of new supplies (including the opportunity cost of water or economic return from alternative use of water). When a number of different conservation schemes are to be evaluated, a tabulation of the CCW for each measure ranked in increasing order will provide a supply curve for conserved water. The supply curve is a graph of the cumulative volume of water saved versus the cost of conserved water. Based on this approach and using available data, supply curves for the industrial and domestic sectors have been prepared for Beijing (Box 5).

BOX 5: THE COST OF CONSERVING WATER IN BEIJING

The supply curve, which is presented below, is a graph of the accumulative water saving versus the discounted cost of conserved water. This analysis shows that the cheapest way of increasing water supply is through more efficient management of existing water supply systems. **Domestic water demand** could be reduced (through leakages reduction programs, water conservation in public facilities and installation of water-efficient flush toilets) by about 15% at a cost which would be lower than the marginal cost of new water supplies. **Industrial water demand** could also be reduced by one-third by recycling of industrial water and reuse of municipal wastewater at a cost substantially lower than the cost of new supplies.

The Supply Curve for Conserved Water in Beijing

(Quantity Conserved vs. Discounted Cost of Conserved Water)



Source: M.M. Hufschmidt, J. Dixon, L. Fallon, and Z. Zhu, "Water Management Policy Options for the Beijing-Tianjin Region of China," East-West Center, Hawaii, 1987.

The potential for conservation varies from one user sector to another. Hence, demand management issues are studied for each individual sector such as household, industries and agriculture. (See Table 1 for an overview of various policy instruments and their effects on reductions in water demand).

Table 1: Effects of Water Tariffs, Pollution Control, Water Market, and Conservation Programs on Demand for Water

Policy Option/ Instruments	Status	Household Demand	Industrial Demand	Overall Demand
A. WATER TARIFFS				
Bogor, Indonesia	Actual	30% decrease after tariff increase from $0.15 to $0.42 per cubic meter.		
Fertilizer Factory Goa, India	Actual		50% reduction in 6 years; from designed 22,000 cubic meters per day to 11,000 cubic meters per day.	
B. POLLUTION CONTROL/RECYCLING				
Tata Iron and Steel Co., TISCO, India	Projected		40% reduction through recycling of industrial effluent and sewage.	
Sao Paulo, Brazil (Three industries)	Actual		As a result of effluent charge 40-60% reduction in unit consumption.	
C. WATER MARKET				
California, USA	Actual			Purchased 10% of M&I demand from farmers through "Water Bank".
D. CONSERVATION PROGRAMS				
East Bay Municipal District, California, USA	Actual			27% to 30% reduction in overall demand.
Tin Plant Co. India	Projected		75% reduction through process change.	
Metropolitan Water District, Southern California, USA	Actual			50% reduction in cost of urban water obtained by financing conservation in irrigation.
Tianjin, China	Actual		60% reduction in unit consumption.	
Beijing, China	Actual		17% reduction per unit of output.	
Israel	Actual		70% reduction in unit consumption (1962-1982).	
TISCO, India	Proposed		20% reduction in demand	
Istanbul, Turkey	Projected	6% additional supply as result of 10% reduction of UFW.	17% industrial demand reduced through reuse of wastewater.	
Mexico City, Mexico	Projected	10% reduction if water-saving flush systems are used	14% reduction in demand as a result of reuse of wastewater.	

A. Managing Household Demand

In a number of developed countries--Israel, Canada, United States, Australia and Great Britain--researchers have found that household water demand drops by 3% to 7% when prices rise by 10%. In developing countries, there is a myth that prices do not play a significant role because water bill is a small percentage of the total household expenditure. However, there are no studies of household water demand in developing countries which have supported this belief. Since water tariffs have been traditionally low, the incentives for efficient use in households have been rather low. It is difficult to estimate elasticity of demand where there is no metering of consumption and price changes have not been significant. However, where sharp increases in prices were made and consumers had to pay higher prices for additional quantities (increasing block rates) consumers did respond by reducing consumption (as in Bogor, discussed later).

To the extent that tariffs have been low and people have not been conscious of conserving water, the potential for savings is considerable if the correct tariff policies are put in place. If water for domestic users were priced at the marginal cost of providing it (including the opportunity cost of water), consumers would respond by eliminating and reducing some uses[39]. As long as there is a "downward sloping demand curve", prices will reduce demand even though the impact would vary from one group of households to another.

In addition to prices, other methods have been used to reduce water demand in the household sector. Some of these cases have been described below:

- The case of the East Bay Municipal Utility District (EBMUD), California, illustrates the role of a comprehensive water conservation program for improving efficiency of municipal water use and reducing water demand during 1988 and 1989 drought years. A drought program was implemented with mandatory conservation goals by customer group (single-family residential, multifamily residential, industrial, commercial, and irrigation), strict ordinances on water use, an increasing block rate structure, and an extensive public relations program. Large reductions in water use were achieved. The overall conservation target of 25% during the summer of 1988 over 1986 was exceeded with an actual reduction level of 30%. Similarly, during 1989, the actual reduction was 27% as against the target of 15%[40].

- As a result of the tariff increase ranging between 200% and 300% in different consumption blocks of June 1988 a household with a monthly consumption of more than 30 m^3 had to pay $0.42 for the last cubic meter of water consumed instead of $0.15. This resulted in significant reductions (around 30%) in water-use for domestic and commercial connections. (See Box 6).

39/ As pointed out by Peter Rogers, some municipalities including Tucson, Santa Fe, and Denver, have saved significant amounts of water by increasing domestic water charges somewhat above the average cost of supplying it. See his paper, "Water: Not as Cheap as You Think," Technology Review, Vol. 89, #8, 1986, pp. 30-43.

40/ J. Gilbert, W. Bishop and J. Weber, "Reducing Water Demand During Drought Years," Journal of the American Water Works Association," May 1990, pp. 34-39.

BOX 6: IMPACT OF PRICE INCREASE AND WATER CONSERVATION CAMPAIGN, BOGOR

On the basis that in the near future the Water Supply Enterprise of Bogor, PDAM, in Indonesia would face high investment costs (the relationship between average incremental costs of current scheme and next scheme was 1 to 2) a decision was made to combine the augmentation of water supplies with other non-structural measures in order to bring down the average water consumption to rational levels (maximum consumption level was fixed at 30 cubic meters per month), so the surplus would be used to supply water to those people who are waiting for a connection. In order to ration water and balance demands with supplies, the water utility introduces both price and non-price policy instruments.

The Tariff Increase of June 1988: As a result of the tariff increase (ranging between 200 and 300 per cent in different consumption blocs) of June 1988, water use in Bogor has decreased significantly, especially for domestic connections (household and yard connections). Their average monthly consumption decreased from 39 m^3 to about 28 m^3 for household and from 37 m^3 to 26 m^3 for yard connections between June 1988 and April 1989. These represent a 28% and 30% reduction in water use, respectively. Commercial connections have also responded to the price increase by decreasing their consumption by about 29% on average. While in April 1988 the average water use was around 59 m^3, after one year that consumption was reduced to about 42 m^3. The features of the new water rate were the following: (a) increased progressivity of the water rate structure; (b) increase of water rates; and (c) higher fixed service charges.

Consumption Level Evaluation Programme: In spite of the favorable impacts of the new tariff on water consumption, not all customers achieved the desired consumption target of 30 m^3 per month. About 33% of household connections were using more than that. On that basis, in March 1989 PDAM initiated a campaign to reduce water use intended specially for customers with a consumption above 100 m^3 per month. The campaign has twofold objective: (a) to make customers aware of their water use habits; (b) to give advice on how to change those habits; and (c) to provide customers with the necessary tools to reduce consumption. PDAM employees visited customer's homes to look for leakages inside the house. And in the event leakages were found, then an estimate of repair costs and total savings were provided to customers. After three months the programme started, the average water use decreased by 29%, from 159 m^3 per month in February 1989 to 113 m^3 in May 1989.

Sources: IWACO-WASECO, "The Impact of the Price Increase of June 1988 on the Water Demand in Bogor (Special Report 17) and Consumption Level Evaluation Programmer (Special Report 19)," 1989.

B. Managing Industrial Water Demand

In industrialized countries, demand for water does not increase with industrial output due to changes in processes, technology, mix of industrial output and increased recycling of effluent water. In some OECD countries, industrial water use in the year 2000 will often be 50% less than it was twenty five years earlier.[41] However, in developing countries, in many industrial units and thermal power plants, low water tariffs and easy availability (these plants are either located on river banks or sea shores) have encouraged "once-through" processes and cooling ponds (instead of cooling towers) which do not economize on water withdrawals or consumptive use. Further, since pollution control regulations are either non-existent or not stringent, there is no incentive for industrial units or thermal power plants to treat their industrial effluent and sewage for recycling water in their plants. To the extent that they have to meet some effluent quality

41/ World Resources Institute, "World Resources 1986," Washington, D.C., p. 131.

standards, the industrial units/thermal plants find it convenient (and economic due to low tariffs) to dilute their pollutants rather than treat their effluent.

However, the above description does not indicate that conservation is not possible or not achievable if the right policy environment is created. In fact, there is scattered but compelling evidence that regulatory measures and economic incentives (mainly water tariffs) have resulted in significant reductions in water demand in industrial units. There are a number of examples where administrative and legislative measures such as licenses, quotas on water use and effluent discharge and introduction of water-saving technologies have resulted in savings ranging between 40% to 70% in industrial water consumption. A number of economic incentives can used for promoting efficient use of water such as water tariffs; tax/subsidy policy regarding equipment; interest rate subsidy or soft loan for water-saving and/or effluent treatment equipment; and effluent charges.

Some examples where these instruments have been used are the following:

- In India, in a fertilizer plant (Zuari Agro-Chemical Limited, ZACL) at Goa, over a six-year period (1982 to 1988), water consumption was reduced by 50% (i.e. from designed 22,000 m^3 per day to 11,000 m^3 per day) as a response to high price of raw water (about \$0.10 per m^3)[42] and government pressure regarding reducing industrial effluent discharged in the sea (which has been reduced from 132,000 m^3 per day to almost zero). (Box 7).

BOX 7: WATER PRICES AND POLLUTION CONTROL REDUCE WATER CONSUMPTION IN A FERTILIZER PLANT IN INDIA

In India, in a fertilizer plant (Zuari Agro-Chemical Limited, ZACL) at Goa, over a six-year period (1982 to 1988), water consumption was reduced by 50% (i.e. from designed 22,000 cubic meters per day to 11,000 cubic meters per day) as a response to high price of water and governments pressure regarding reducing industrial effluent discharged in the sea. As a result of these measures, water consumption in ZACL in 1990 was 10.3 cubic meters per ton of nutrient. This unit consumption was only 40% of the water consumed in another fertilizer unit, Indian Explosives Limited (IEL) unit at Kanpur (24.35 cubic meters per ton of nutrient). This significantly lower consumption in ZACL is mainly as a response to (i) higher price of water (12 cents per cubic meter) charged by the PWD (Public Works Department) compared with the cost incurred (1 cent per cubic meter) by the IEL in self-provisioning.

The cost of water in the Kanpur unit is low because it pumps its water from the lower Ganges Canal where the irrigation department charges a nominal fee of 0.2 cents per cubic meter. Further, in the case of Goa where effluent water is to be discharge into the sea, it is expected to adversely affect fish, cattle and plant life in the area. In the early stages (1969) of the setting up of the plant, the ZACL management had to pay about \$2,000 to 50 farmers as compensation. At that time a waste water treatment plant was installed under the control of the Central Pollution Control Board. Subsequently, the management made investments in pollution control and reuse facilities as a result of which liquid generation has been reduced from 13,200 cubic meters per day to almost zero (implying 100% recycling of liquid effluent). As a contrast to this, in the IEL, Kanpur, the quantity of wastewater discharged into the river and sewage is about 6,000 cubic meters per day.

Source: D.B. Gupta, M.N. Murty and R. Pandey, "Water Conservation and Pollution Abatement in Indian Industry," National Institute of Public Finance and Policy, New Delhi, April 1989.

42/ This is about fifteen times the cost incurred by another fertilizer factory, the India Explosives Limited (IEL), at Kanpur, which gets its water from the lower Ganges Canal and tubewells.

- In Israel, between 1962 and 1982, average amount of water consumption steadily declined from 20 m^3 per thousand Israeli Pounds (IL) of production output at fixed prices to about 6 m^3. This means that an expansion of 300% in the output of the industrial product was achieved with only 20% rise in water consumption.

  The increasing efficiency in industrial water use can be attributed to the following policies adopted by the Water Commission: (a) license of water supply (water is supplied to industrial firms under license, and the quantity allocated is calculated on a normative basis which depend on: nature of the end product, production processes, existing equipment, and raw material; etc.; (b) introduction of water saving technologies; and (c) subsidized financing for investment in water saving processes/appliances[43].

- Conservation and reuse of water in many Chinese cities have become increasingly important in view of the water shortage. By means of propaganda, education, and various kinds of economic, administrative and legislative measures Tianjin, for example, has decreased industrial water use per 10,000 Yuan of gross production value from 360 m^3 in 1981 to 145 m^3 in 1988, which represents a reduction of about 60% of the industrial water consumption per unit of industrial output value. In Beijing also, between 1978 and 1984, the decrease was from 880 m^3 per 10,000 Yuan of production value to about 335 m^3. Thus, the annual water consumption was reduced at an average rate of 17% over the six-year period[44].

  The measures been applied include the following: (a) a strict water quota and effluent quota per production unit; (b) a progressive water price system under which those consumers who exceed their water allocation have to pay between 10 and 50 times the normal charge; (c) a progressive fee for pollutant discharge exceeding the limits; and (d) water audit program and water flow surveys on a regular basis under which industrial enterprises are inspected for leakages and effectiveness of water saving measures[45].

C. The Effects of Pollution Control on Water Demand

- In Sao Paulo, Brazil, after effluent charges were levied three plants reduced the amounts of water used (reducing unit consumption ranging from 42% to 62% in 1982 over 1980) in their processes. (See Box 8).

43/ Saul Arlosoroff, "Water Management in Arid Zones," presented at the Conference of the IBM African Institute, Ivory Coast, 1985.

44/ Wang Zhenhui, "Countermeasures for Industrial Water Conservation in China," UNEP Industry and ENvironment, July-December 1990, pp. 13-14.

45/ Zhu Zhongjie, "Pollution Control of Water Resources in China."

BOX 8: EFFLUENT CHARGES ENCOURAGE REDUCTION IN EFFLUENT AND WATER-USE IN SAO-PAULO, BRAZIL

In Sao Paulo, Brazil, three industrial plants that were asked to pay effluent charges to the central effluent treatment facility, the management in these firms decided to economize large amounts of water in their processes. These savings were achieved through change in process, substitution of inputs, use of more efficient equipment (reducing double washing to single washing) or use of mechanical washing (insted of manual washing). In the pharmaceutical industry, volume of effluent (and of water consumption) per unit of output in 1982 was 49% less than in 1980. In the food processing industry case, the volume of effluent and water consumption were lower by 42% per unit of output in 1982 compared with 1980 and the main reasons for this reduction were due to changes in washing processes, effluent recycling and modifications in cleaning process. In the dairy industry , the unitary coefficients of volume of effluent and water-use were lower by 62% due to improvements in washing process and expansion of in-site treatment plant.

Source: Luis Caetano Miglino, "Industrial Wastewater Management in Metropolitan Sao Paulo," Harvard University, Massachusetts, 1984.

- In Jamshedpur, India, there are a number of industrial units which are currently discharging their industrial effluent, almost untreated, in the river Subernarekha. Although a part of the municipal sewage is treated, it is not recycled for industrial uses because fresh water is available at low cost (without paying any abstraction charges for pumping water from the river). Since the Irrigation Department is constructing a reservoir on the river, it is feared by the managements of industrial units that they will have to pay for water in the future and there may also be shortage of water in the dry season. In response to this, the management of the steel company, Tata Iron and Steel Company (TISCO) (which accounts for 90% of the total industrial demand of 55 MCM), are preparing plans for water conservation and recycling of treated industrial effluent and sewage in their plant. If 50% of effluent water is treated and recycled, it would reduce intake(withdrawal) of freshwater by 13 MCM or about 30% of the total intake of the factory. However, as presented in Box 9, the cost of treated water would be about 110% more than the industrial water tariff if tariff was based on financial (marginal) costs of water supply. Even when tariff is fixed on the basis of economic cost (including the opportunity cost of water), the financial cost of recycling will be higher than the water tariff.

  Under this situation, there is no incentive for the enterprise to invest in treatment and recycling of water just because it helps the society by avoiding the damages caused to downstream users. In this classic case of externalities, the enterprise will continue to dump industrial waste in the river and will not invest in treating the sewage wastewater unless (i) the regulatory authority (pollution control board) becomes effective in checking pollution if incentives are provided to the entrepreneur to invest in treatment plants.

  If the damages caused by industrial pollution and waste water discharge are considered serious enough, the society should either force the enterprise to comply with pollution control regulations or make it worthwhile for the entrepreneur to invest in treatment plants by using policy instruments such as soft loans or investment subsidies for individual or community effluent treatment plants.

Given the administrative difficulties of enforcing pollution control regulations on rich and politically powerful industrialists by low-paid government officials, it would be necessary to find ways in which economic incentives are used to make it worthwhile for them to treat and recycle municipal and industrial waste. One of these incentives would be to provide a soft loan at low interest rates or to provide investment support which would be much less than the investment that would have to be made to supply fresh water to the industries[46]. (See Box 9).

The above examples show that the twin benefits of environment improvement and reduced costs will be available to the society if appropriate policy instruments are used. These may be a mix of regulation, effluent charges, water tariffs and tax/subsidy policies including low-interest loans.

D. Conservation as a Capacity Augmentation Option

- The Metropolitan Water District of Southern California expects to develop additional supplies by financing water conservation projects (especially improvements in irrigation efficiency) within the Imperial Irrigation District in exchange for rights to use conserved water. The cost per cubic meter so obtained was at the most half the cost of a cubic meter from the next available undeveloped source[47].

E. Better Management of Existing Resources

- By doing three sensible things (requiring three utilities to cooperate, devising more refined reservoir operating rules, and reducing the planned frequency of shortfalls from 1 to 100 years to 1 to 10 years) the Washington DC Metropolitan Areas was able to reduce the number of reservoirs required from 16 to 1, and the cost of investments from $400 million to $31 million[48].

- In order to control direct abstractions France has imposed a comprehensive charging system. Charges are differentiated by: zone, surface or groundwater, season (winter and summer), quantity of water abstracted, and quantity of water consumed. The imposition of charges by the Picardy Agence de Bassin in 1970 led to industrial water consumption falling by 50% over a ten-year period[49].

46/ Data collected during field study in Jamshedpur, September 1991.

47/ Michael Lawson, "Water Projects Face Quandary," ENR, August 1990, pp. 26-30.
M. El-Ashery and D. Gibbons, "Water and Arid Land of the Western United States," pp. 233-279.

48/ Robert McGarry, "Negotiating Water Supply Management Agreements for the National Capital Region," Maryland, 1982.

49/ OECD, "Pricing of Water Services," Paris, 1987, pp. 82-83.

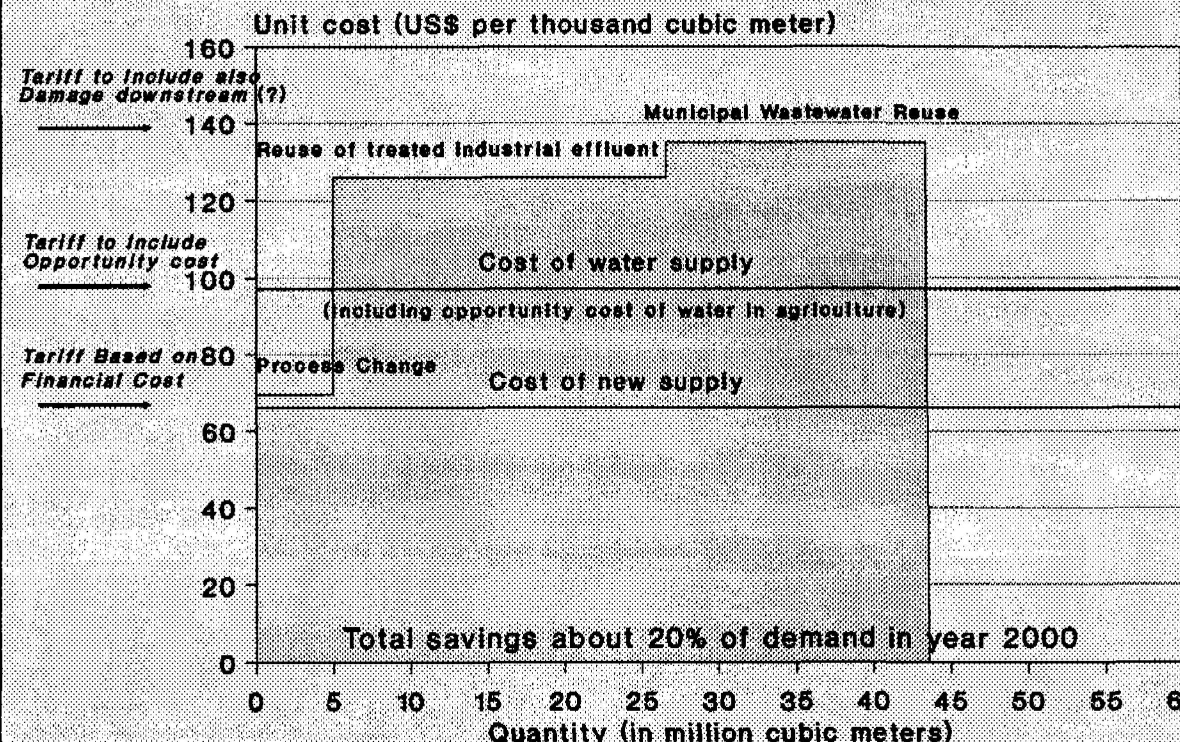
BOX 9: POLICIES TO ENCOURAGE CONSERVATION AND RECYCLING/REUSE

Preliminary results from one the case study in Jamshedpur (India) show the significance of water pricing and tax/subsidy policies in encouraging water conservation and recycling/reuse. As shown in the figure below, about 5 million cubic meter (MCM) per year could be saved in an industrial unit (Tin Plate Co) at a unit cost of $ 65 per thousand cubic meter (TCM). If average tariff for water supply to this industrial unit is fixed to cover the financial cost of new supplies, the tariff will be less than the unit cost of water conservation indicating that from the viewpoint of the enterprise it would not be financially viable to invest in process change technology which saves water. However, if the tariff is fixed to reflect the economic cost inclusive of the opportunity cost of water in alternative use (i.e. agriculture), then it would be financially worthwhile for the firm to invest in water-saving technology. This shows that if tariff are fixed to reflect the true economic cost of water supply to the industry, it would encourage these units to invest in water-savings technologies.

However, even when the tariff incorporates opportunity cost of water, it does not "internalize" another important externality namely the cost of damages done by industries and households in contaminating the water supplies. It is empirically difficult to estimate "damage functions" for deterioration of quality since this would require quantifying the effects of various contaminants on a large number of downstream users. Nevertheless, it is important to recognize that water tariff should include an estimate of the likely adverse impact of water quality on members of society. If water tariff does not reflect this, there is no incentive for the enterprise to treat water before it is added to the already polluted river.

Under these circumstances, it would be necessary to induce the industrial units to treat the effluent before discharge , particularly if the likely damages are high and the (marginal) economic value of water is higher than the cost of effluent treatment. In this case it is found that the cost of treatment for water for recycling were about 30 to 35% higher than the economic cost of water (inclusive of opportunity cost) and hence, there is no incentive for the enterprise to treat water for recycling even if tariffs were increased to reflect economic costs. If water tariff can not be raised by 35% or higher due to political reasons or due to lack of information regarding damage costs, an alternative solution would have to be found to ensure that polluted water is not discharged into the river.

Cost of Conserved Water in Industry and Water Supply



(Continuation on Box 9)

This could be done in two ways: first, to enforce legislation regarding treatment of effluent water and second by providing soft loans and/or subsidies or investment support towards meeting the initial cost of effluent/sewage treatment plants. In the case of developing countries such as India, there is no experience of implementing pollution control legislation and it is difficult to visualize the extent to which such a regulatory measure could be enforced legally and administratively.

Given the administrative difficulties of enforcing pollution control regulations on powerful (and rich) industrialists by low-paid government officials, it would be necessary to find ways in which economic incentives are used to make it worthwhile for the industrial unit to treat and recycle effluent water for its own plant. Since the industrial unit will be re-using its own treated water, this will provide necessary incentive to operate the effluent treatment plant rather than discharge untreated effluent in the river.

One of these incentives would be to provide soft loans at low interest rates or to provide investment support or subsidy in investment cost. In the case of Jamshedpur, the required subsidy levels would be of the order of 25% to 30 % of the investment cost i.e. of about $4.5 million. This level of subsidy is about one-third of the estimated investment cost of treatment and distribution of 40 MCM of water supply using conventional surface sources if recycled water was not available.

By this approach it would be possible to ensure that the industrial unit has to treat effluent for its own use so that contamination of river water can be avoided. Apart from ensuring that water quality does not deteriorate due to industrial pollution, this will release fresh water supplies which will not be required because the unit is recycling effluent water.

Source: Field Study, The World Bank, INUWS, 1991.

F. Trading of Water Among Sectors

There are a number of institutional changes which can be used for re-allocation of water supplies among users. The most significant ones are trading of water rights, water banks and auctions of water. Some of these have been tried successfully to re-allocate water from "low value" uses to "high value" uses as discussed below:

- During the 1991 drought year, California purchased approximately 920 million cubic meters of water from farmers in order to meet critical urban and agricultural needs. This volume represents about 10% of municipal and industrial demand of the state in normal conditions. The Department of Water Resources, through the newly formed "Water Bank", acquired water at $0.10 per cubic meter and then sold it at an average price of $0.14. (See Box 10).

BOX 10: WATER REALLOCATION THROUGH WATER BANK, CALIFORNIA, U.S.A.

Water transfers and exchanges are playing an important role in the management of water resources in California. There are many forms of water transfer incentives, and the governmental action to facilitate transfers has focused mainly on establishing the appropriate legal and institutional framework to allow all kind of transfers. In order to cope with the drought of 1987-1991, the Department of Water Resources established a Water Bank in order to facilitate water transfers. Through this mechanisms water could be allocated for critical urban and agricultural needs, fish and wildlife needs, as well as available for 1992 carryover storage. Approximately 920 million cubic meters (about 11% of state wide consumption for domestic and industrial uses) were purchased from farmers on voluntary basis. The offered price was high enough to compensate rice, corn and tomato farmers. For example, a rice grower was offered $925 for every hectare not planted, an amount that is 25% higher than the benefit the farmer could get otherwise. Since each hectare of rice uses about 9,100 m^3 of water a year, the farmer received $0.10 for a cubic meter of water. Water thus obtained was sold at an average price of US$ 0.14 per cubic meter, of which about 80% went to satisfy critical urban needs and the remaining 20% was used for critical agricultural needs.

Source: David N. Kennedy, "Allocating California's Water Supplies During the Current Drought," Presented at the World Bank International Workshop on Comprehensive Water Resources Management Polices, Washington, D.C., 1991.

VI. PROVISION OF MORE AND SAFE WATER TO THE POOR

As discussed earlier, there is compelling evidence that conservation can increase supplies by 20 to 30 percent in the household sector by a judicious use of tariff policies and institutional changes. In industry also, water-saving processes/technologies can result in substantial (10%-25%) decrease in water withdrawals by industry. Further, encouraging industries/power plants to treat their industrial effluent and sewage water and recycle or reuse it in their own processes has twin benefits of environmental improvement and additional economic gain. It reduces the withdrawals of water for industrial use since a part of its requirements are now met from recycled water. This reduction provides a net economic benefit if water at this withdrawal point has a higher economic value than if it is used downstream or pumped from the ground[50]. It also provides an environmental benefit by improving the quality of water in the river/pond (where effluent/sewage was being dumped) for downstream users. In this sense, the environmental objective of improving water quality of receiving bodies complements the economic efficiency objective of higher net benefit from water available for other uses.

In view of the weak regulatory apparatus in developing countries, it would be necessary to use water tariff policies in conjunction with subsidies and soft loans for treatment plants so that entrepreneurs find it worthwhile to treat industrial effluent/ sewage for recycling in their own plants(rather than dump these untreated in rivers/ponds. The quantum of savings in each use

50/ Although the net economic benefit would be rather location specific, it would be correct to assume that economic benefits of using water in agriculture(which is diverted from industry) in the upper reaches will be higher than when it "returns" to the system. This is because a part of this water would have either evaporated from the river after its return or would involve pumping costs if it seeps into the ground. If the marginal benefit from water in the upper reaches is the same as at downstream location (where water returns) the net benefit would be positive in using it upstream.

and its implications for the urban poor will depend on the volume of water saved in households and/or industries and the number of people who remain unserved in a particular setting. To illustrate these implications in quantitative terms, a few cases have been selected to indicate:

- The extent of savings in the household sector;
- The extent of savings in the industrial sector as a result of conservation achieved through a changeover to new processes/technologies;
- The extent of reduction in withdrawals of water for industries as a consequence of recycling/reuse of treated effluent/sewage;
- The number of people who could be provided with piped water supply (as a result of the above measures) without substantial additional cost of storage, transportation or treatment; and
- The extent of savings which will be required in the agriculture sector to release water for providing 100% coverage to the urban population.

Four cases selected for illustrative purposes are: Jamshedpur, a city of around 1.0 million people in Eastern India; Istanbul, Turkey, a city with a population of around 6.6 million; Mexico City Metropolitan area with an estimated population of over 19 million; and Jakarta, Indonesia, a city with an estimated population of 8.5 million in 1988. Table 2 provides an overview of the additional water supplies available as a result of conservation and recycling in four metropolitan areas. It may be noted that in Jamshedpur and Mexico City, additional supplies would be adequate to provide 150 lcd of water to the entire unserved population (at present) without incurring additional costs. In the case of Istanbul, additional supplies would be sufficient for about 80% of the unserved population, while in Jakarta these would provide water to a quarter of the population currently unserved.

A. Jamshedpur, India

As discussed in Box 9, there is considerable scope for conservation and recycling and the industries would implement these plans only if (a) water tariff is set to reflect the economic cost which includes the opportunity cost of water; and (b) if soft loans or investments subsidy is given for making worthwhile for the industries to treat effluent and sewage water and recycle it for industrial process. The volumes of water saved through these methods are shown in Table 2, if two major consumers of water TISCO and Tin Plate Co., invested in new technologies/process to save water, these could save as mush as 15 MCM (about 25% of the total industrial use) of water without affecting the output or employment levels. Further, if 50% of effluent water is treated and recycled, it would reduce withdrawals by about 20 MCM. The additional supplies would be sufficient for a few new industrial units and for domestic supplies (150 lcd) to the entire unserved population of Jamshedpur and neighboring areas. However, apart from additional water supplies, there will be a need to bring about necessary institutional changes through which these additional supplies are, in fact, available to the poor.

Table 2: Additional Water Supplies Available As a Result of Conservation and Recycling in Four Metropolitan Areas
(In Million Cubic Meters per Year)

	Jamshedpur INDIA	Istanbul TURKEY	MCMA MEXICO	Jakarta[a] INDONESIA
Total Household Demand	65	276	1160	210
Total Industrial Demand	60	213	390	56
Extent of Savings in Household Sector	N.A.	18	110	45
Savings from Conservation in industries	15	N.A.	N.A.	N.A.
Effects of Recycling/Re-use in Industries	20	36	55	N.A.
Total Estimated Savings	35	54	165	45
Number of persons who could be provided additional supplies (million)[b]	0.5	1.0	3.0	0.8
Total Population (million)	1.0	6.6	19.0	5.1
Population without Piped Supply	0.5	1.3	2.8	3.6

Notes:
N.A. means not available
a/ Only the service area of PDAM.
b/ Assuming an average consumption of 150 lcd (liters per capita per day)

Sources:
- For Jamshedpur: Field Study
- For Istanbul: "Istanbul Water Supply and Sewerage Project," SAR 6985-TU, 1987.
- For Mexico City: "Mexico City Metropolitan Area Water Supply and Sewerage Sector Overview" (Draft), Report 8150-ME, 1989.
- For Jakarta: "Jakarta Water Supply PDAM Jaya System Improvement Project," Safege, Beture, Satame & Sooreah, 1988-89; and "Second Jabotabek Urban Development Project (JUDP II), Report #8339-IND, 1990.

B. Istanbul, Turkey

The city of Istanbul has a population of around 6.6 million, about 80 percent of whom have access to piped water supply. If the level of Unaccounted-for Water (UFW) is reduced by 5 points (from 30% to 25%, assuming leakages of 10%) in the total consumption of households and commercial activities, there will be a saving of 17.5 MCM which could be used for extending water supply to other areas. There are plans to build wastewater treatment facilities that will produce high quality secondary effluent. If 30% of currently collected domestic wastewater is treated and reused in the industrial sector, industrial water withdrawals can be reduced by 36 MCM. Thus, the additional volume of water released could be around 54 MCM enough to provide 150 lcd to 1.0 million people (Table 2).

C. Mexico City Metropolitan Area, Mexico

Total population in Mexico City Metropolitan Area was estimated to be around 18.7 millions (in 1986) of which about 85% have access to piped water supply and about 71% have access to sanitation services. Average gross domestic per capita consumption is about 200 lcd (15% of the population consume on average 350 lcd, 25% about 250 lcd and the rest 140 lcd). If traditional water closets (flush systems) that use 16 liters per flush are replaced by more efficient ones that use only 7 liters, domestic and commercial demands would be reduced by 10%. This will result in a total saving of about 110 MCM. If just 20% of currently collected domestic wastewater is treated and reused in the industrial sector, industrial water requirement will be reduced by 55 MCM. As a result of the above conservation measures, about 3 million inhabitants could be served at a gross rate of about 150 lcd (Table 2). Thus, 100% of the currently unserved would be served without incurring huge investments to develop new supplies.

D. Jakarta, Indonesia

In 1988, only 28.4% of the households (in the service area of PDAM) or 1.45 million inhabitants in Jakarta received water through direct connection to the municipal water system (house connections 21% and public standpipe 7.4%). The rest of the population relied either on private well or bought water from street vendors. Per capita consumption figures for piped water varies from 250 liters per capita per day (lcd) in high income group to 150 lcd in middle income group. Consumption from standpipes is estimated as 30 lcd. Unfortunately accurate data on the volume of water extracted from groundwater sources do not exist. For the industrial sector, it has been estimated that only one-eighth of its water demand is met from public piped water, while the rest is met from private groundwater abstraction. Regarding the domestic sector, it has been assumed that the rest of the population have to rely largely on this source and the consumption rate is about 120 lcd. If UFW is reduced by 20 points (from the current level of 51%), the PDAM (urban water supply authority) could save about 45 MCM. This volume may provide additional water to about 0.8 million people (at 150 lcd).

These savings, though important in providing immediate relief to those unserved at present may be considered as short-term solutions to the problem. There is a need for change from the present sub-sectoral piecemeal approach to a framework of analysis which incorporates the economic and environmental linkages among user sectors. Since this is considered very crucial for policy analysis, this is discussed in detail in the next section.

VII. IMPERATIVES FOR A NEW APPROACH

Some of the problems mentioned in section III regarding the malfunctioning of the water resources sector arise because water-related decisions are taken without recognizing that water is a unitary resource[51]. Rain, surface water in rivers and lakes, groundwater, and polluted water are all part of the same resource base. They are all one and the same resource, although in different manifestations, occurring in different parts of the hydrologic cycle. Actions taken in one part of the system often have significant impacts upon other parts of the system (i.e. the presence of

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51/ Peter Rogers, "Concept Paper for World Bank Comprehensive Water Resources Management Policy Paper," Harvard University, Cambridge Massachusetts, July 1990.

externalities). Hence, these linkages must be taken into account when assessing the costs and benefits of specific actions.

The externalities of both water quantity and water quality are experienced in the spatial sense between upstream and downstream users, and in a temporal senses between different seasonal releases of stored water, common pool effects on groundwater, and the export of pollution. These externalities can be broadly classified as economic and environmental in order to assess the effects of various policy instruments.

A. Economic Externalities

As a unitary resource, water in the basin can be used for different purposes and in sequential uses. Each use implies withdrawal of a given volume of water of a certain specified quality (e.g. quality specifications vary for water for drinking or industrial cooling). When a certain volume is being withdrawn for one particular use (say, industry), this quantity of water is not available (at the same time and location) for other uses such as irrigation or drinking water supply. At this point in time and at this location the water is said to have an "opportunity cost" since the continued abstraction by one user reduces the amount available to another there is a loss of the opportunity to use the water by one user[52]. This lost opportunity costs the affected user the amount he values these units of water. At this point the "value" of the water should reflect the willingness-to-pay of the user who is losing water. If total water is in short supply and water is allocated to an industrial unit, the relevant opportunity cost would be the farmer's willingness-to-pay for irrigation water. If there are well-established markets for water then the market price would itself reflect the opportunity cost of water. However, in most countries such markets do not exist and it becomes necessary to estimate the opportunity cost in indirect ways.

Estimation of opportunity cost of water used in an industrial plant requires an estimate of the benefits foregone in an alternative use, often agriculture. This could be estimated by calculating the economic value of water in irrigating a crop.

The estimates of opportunity cost (economic value in alternative use) are useful in setting water prices or tariffs in different sectors. For example, in Jamshedpur, (see Box 9), the inclusion of the opportunity cost of water may result in a 25% increase in water tariff for industrial users. This has implications for the financial viability of investments in water-saving processes/technologies as detailed in Box 9. If the tariff is fixed to cover only the financial costs of new water supply, there is no incentive for the entrepreneur to invest in water-saving process. However, if the tariff is fixed to reflect the economic cost inclusive of the opportunity cost of water, then it would be financially worthwhile to conserve water.

B. Extended Environmental Analysis

In addition to incorporating economic linkages in the use of water, a new awareness of the upstream/downstream linkages in the river basin is required on the part of the scientific community, decision-makers and policy analysts. This would require that the general development problem is defined in the larger environmental perspective of the basin population as a whole.

52/ Ibid, p. 7.

On the one hand, the basin population depends on the rainfall over the basin for the water-consuming biomass production in agriculture and forestry, and, on the other hand, depends on the remaining water surplus that does not return to the atmosphere but goes to recharge aquifers and water courses and is accessible for various water-dependent uses. As vegetation management will be influencing the return flow to the atmosphere, and, therefore, the amount that remains to recharge aquifers and rivers, land use and water will have to integrated. This level of analysis not only considers multiple-uses of water simultaneously it goes a step further and integrates all water-consuming activities in the basin and therefore also vegetation, i. e. biomass production, both natural and anthropogenic for meeting basic needs as well as market requirements.

Such an Extended Environmental Analysis should encourage planning so that upstream and intracity-generated threats to urban water supply can be taken into account and that downstream impacts from the urban activities can be minimized. These would be:

- Threats induced by upstream activities to the sustainability of the city system: (a) from upstream land use (agriculture, forestry) and upstream diversions influencing the long-term water availability in the city surroundings, and from upstream land management, influencing the silt transport and therefore the sustainability of city reservoirs; and (b) from upstream cities and industries influencing the quality of the surface water in the city neighborhood;

- Threats induced by city activities to other city activities and particularly related to groundwater level and quality;

- Threats induced by the city system to downstream basin activities: to downstream surface water and therefore to both irrigation possibilities, fish edibility and human health impacts from contact with the polluted water from urban waste water; and

- The potential for sequential reuse along the river if wastewater treatment is made operational.

Table 3 gives an overview of the relationships among the various threats and risks to be included in a long-term environmental study of the urban water supply system as seen in its regional context. Such a study would indicate the approaches to:

- Avoid pollution of peri-urban aquifers by acceptable waste handling in the city and the industries;

- Avoid pollution of surface water by acceptable waste water treatment; and

- Plan for changes in upstream conditions that might influence the future reliability of the water supply system: its quantity due to reforestation or irrigated agriculture; its quality by upstream industry and urban waste water.

At the project level, the following environmental impacts of water development projects would have to be considered: water pollution caused by water-use in agriculture, industry and households; social and environmental impacts of large reservoirs in terms of loss of forests/wildlife and welfare losses of resettlement of populations; and waterlogging, salinity and diseases caused by irrigation of land.

Table 3: Relationships Between Threats and Risks to be Included in Analysis

	CITY		DOWNSTREAM			
RISKS TO	**Water Availability**	**Water Quality & Health**	**Irrigated Agriculture Supply & Land Fertility**	**City Water Supply**	**Industrial Water Supply**	**Fishery**
THREATS FROM						
Upstream						
. Reforestation	*					
. Irrigation	*	*				
. City Pollution		*	*	*	*	*
. Industrial Pollution		*	*	*	*	*
. Diversion Out	*		*	*	*	
City						
. Municipal Waste	-	*	*	*	*	*
. Industrial Waste	-	*	*	*	*	*

C. Integrated Water Resources Planning and Management

Integrated Water Resources Planning (IWRP) is the conceptual approach which can take into account the geophysical relationships in the hydrological cycle, the value of water to different users, and national policy objectives. This approach can provide linkages between economic and environmental issues in the use of water resources. The approach uses the water in the basin as an economic good, and to assesses the "economically optimal" use of this resource, and the "economically optimal" instruments to achieve this. Using an optimization framework, "near optimal" solutions can be evaluated under a variety of scenarios reflecting demand and price options.

The systems analysis approach, IWRP, may however be extended so that the integration would go further and include also the water-consuming biomass production in the basin. There is a very good reason for doing so in poor countries in the semi-arid region where water and land availability act as serious constraints to income generation. Such an approach would include ,on the one hand, a water-balance based planning of land use and water use with due attention to quantity and quality linkages between upstream, city and downstream land and water uses; on the other a broad-based cost awareness which includes the benefits forgone (opportunity costs) of any particular water use, including biomass production. In areas where afforestation is taking place or being planned, future water supplies may be threatened by the increased water consumption by the additional biomass. In areas where most of the rainwater returns to the atmosphere due to high evaporation losses, and only a very limited amount goes to recharge aquifers and rivers, this limited return flow may produce significant runoff changes.

VIII. CONCLUSIONS

The conclusions of this paper are summarized as follows:

- As a result of the present sub-sectoral policies in the management of water resources (e.g. subsidized tariffs ignoring the opportunity cost of water, no pollution taxes), excessive quantities of water are used, excessive pollution is produced and the urban poor have to bear the brunt of shortages by paying high prices or through adverse health effects;

- There is compelling evidence that at least 20% to 30% of the current water used in households and industries can be saved by adopting the appropriate regulatory and policy instruments (such as tariffs, quotas, groundwater extraction charges) in developing countries. Similar savings are also possible in irrigated agriculture by investments in canal lining, encouraging less-water-intensive crops (through relative output prices) and raising irrigation rates.

- Twin benefits of clean water and reduced demand (up to 20%) can be obtained if recycling/reuse of water is encouraged in industries through pollution control legislation and economic incentives(water tariffs based on economic costs, effluent charges and low-interest loans for effluent/sewage treatment plants.

- These conservation and recycling efforts would release enough water that a significant proportion of the currently unserved urban poor can be given adequate and clean water supply without incurring addition cost on distribution and treatment of water.

- However, this would require necessary institutional changes(both organizational changes and incentive systems for motivating people) so that both the regulatory mechanisms and economic incentives are effectively used to achieve desired objectives.

- There is a need to change the approach of analyzing water resources issues in developing countries. Analysis of environmental linkages requires a new awareness of the upstream/downstream linkages in the river basin. The approach suggested here integrates all water-consuming activities in the basin and includes all forms of vegetation, i. e. biomass production. Such an analysis should encourage planning in such a way that upstream and intracity- generated threats to urban water supply can be taken into account and that downstream impacts from the urban activities can be minimized.

Annex A: Discussion Points for the Working Group

In view of the massive urban population growth , increasing costs of new supplies and excessive pollution (both "old" microbiological and "new" organic chemical and heavy metal pollutants), the number of urban poor bearing the brunt of shortages and quality deterioration is expected to increase in the next three decades and beyond. To mitigate the health problems arising out of inadequate and contaminated water supplies and to avoid the productivity and welfare losses associated with unreliable water provisioning (to manufacturing units as well as households) would require new thinking and approaches as well as concerted efforts at the national and international levels. The delegates to the Dublin Conference may, therefore, discuss actions needed on the following key points:

- Efforts needed for accelerating rural development, better income distribution in the country side and child-spacing in urban areas with a view to **reducing the growth of urban population**;

- The **role of international community** (governmental, multilateral, scientific, NGOs) in developing a new thinking regarding spatial pattern of urban growth (more medium-size cities); in supporting the national efforts through human resources development (training networks), R&D in technology and new approaches in pollution-avoidance (waste treatment and water re-use); water conservation and integrated plans for upstream/downstream land and water-use;

- Defining the situations under which **international funding** can stimulate local efforts (including private sector and community actions) in provisioning of water supplies to target populations;

- At the national level, this requires comprehensive **integrated land and water-use plans** (using systems approach) for river basins containing urban areas. Such plans should explicitly consider all sources of water supply and pollution (from agriculture, industries and city-dwellers) and suggest methods for improving and protecting water quality;

- The role of key policy instruments in encouraging efficient, equitable and sustainable use of water resources in developing countries. These policy instruments may be grouped under (a) **institutional changes and regulatory measures** such as water quality standards, groundwater regulation legislation, pollution control legislation, water rights, water markets, private sector participation, etc.; and (b) **economic incentives** such as tariffs, tax/subsidy policies, interest rate policies (soft loans), groundwater extraction charges, effluent charges, etc.

Annex B: Main Messages

- There is compelling evidence in both developed and developing countries that a mix of regulatory and economic incentives (tariffs, fiscal incentives) have resulted in 20 to 30% (or more) reduction in water use in industry, thermal power plants,and households. Hence, demand management should be a major component of investment and pricing policies for the water sub-sectors.

- Encouraging the treatment of industrial effluent/sewage for recycling within the industrial units reduces the demand for raw water and makes it available for other uses without incurring investment costs on new projects. This **complementarily rather than conflict in the environmental and economic objectives** can be obtained by a judicious mix of water tariffs, pollution taxes and fiscal incentives (tax concessions, soft loans, subsidies).

- There is a need for a new approach which takes into account the economic linkages among various users of the unitary resource, incorporates environmental linkages among upstream/downstream users and includes interactions between land-use and water resources supplies/demand.