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Urban Environmental Services In Developing Countries

Jacqueline G. Coolidge,
Richard C. Porter
and
Z. John Zhang

Department of Economics
University of Michigan

No. 9 December 1993

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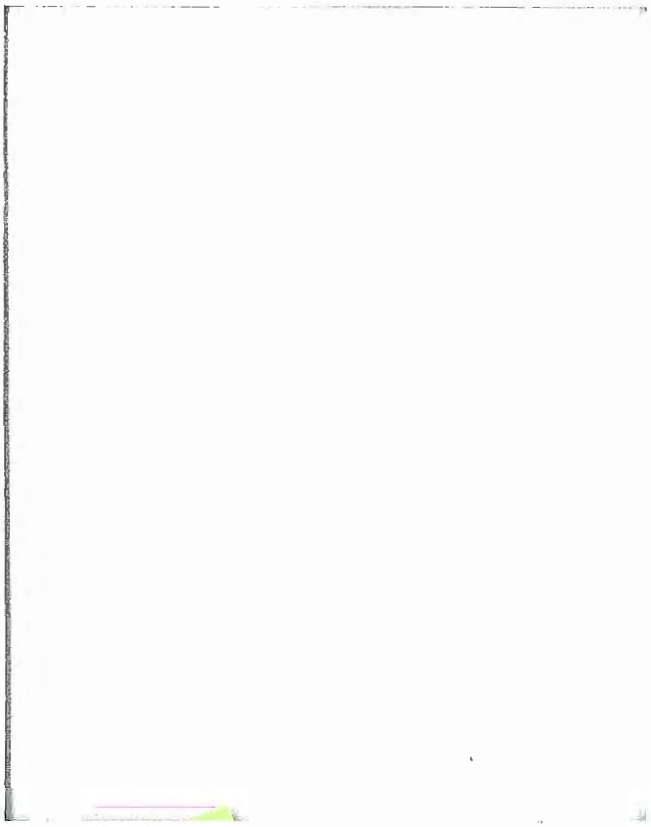

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By

Jacqueline G. Coolidge
Richard C. Porter
Z. John Zhang

For more information, contact:

Jacqueline G. Coolidge
Richard C. Porter
Z. John Zhang
Department of Economics
Lorch Hall
University of Michigan
Ann Arbor, MI 48109

Tel: (313) 764-2355
Fax: (313) 764-2769

For copies of this publication, contact:

Ellen Maurer
Communications Director
EPAT/MUCIA-Research & Training
University of Wisconsin-Madison
1003 WARF Office Building
610 Walnut Street
Madison, WI 53705

Tel: (608) 263-4781
Fax: (608) 262-0014

Layout by Sharon Graham and Lesa Langan
Design by Lesa Langan

Abstract

As cities in the developing world grow, their poor residents are being deprived of services, especially water, sewer, and solid waste collection, that can only be purchased expensively in private markets. But the inadequate provision of urban environmental services is not inevitable. A lack of will in this respect is partly due to an ambivalent attitude toward city growth and a widespread feeling that rural-urban migration is excessive. Provision of optimal urban environmental services is also expensive. While the budget problems are exacerbated by foolish pricing policies and cost inefficiencies, it may not be feasible for developing countries to provide all urban residents with optimal service levels. There are many ways to provide basic services to poor residents.

> Urbanization is ... expensive. The difference between the costs of urban development and rural development does not turn on the difference of capital required for factories and that required for farms. Each of these is a small part of total investment .... The difference turns on infrastructure ....
>
> Lewis 1978: 39

> Virtually all Third World governments have failed to ensure that rapid urban growth has been accompanied by investments in services, especially in the poorer areas.
>
> Cairncross, *et al.* 1990: 1

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Introduction

The rapidly growing cities of developing countries pose increasingly serious environmental problems for their residents. This paper looks at the policy choices that governments of the developing countries have made and can make to improve their environments, especially for their poor residents. It focuses on the provision of drinking water, sewage, and solid waste disposal services.

The word, "environment," is used here to mean those goods and services (hereafter, services) that affect an individual's welfare but whose consumption is largely outside the individual's control. Environmental services are not sold in the marketplace. There are four main reasons that free markets fail to provide certain environmental services to consumers:

1. Technically efficient provision of some services requires economies of scale and a single producer, precluding private competition. Examples: urban infrastructure, drinking water, and sewage.

2. The provision and consumption of some services generates externalities. If a provider's or consumer's actions directly increase the costs of other providers or decrease the well-being of other consumers, the potential efficiency of market activities is subverted.[1] Examples: waste generation -- solid, hazardous, nuclear -- and inappropriate waste disposal.

3. Some "goods" or services are, partially at least, collectively consumed. The decision to consume is not made by individuals through their market actions, the consumption of one individual does not preclude consumption by others, or it is costly to prevent consumption by people who will not pay for the service.[2] Examples: clean air and rivers, vermin-free and litter-free streets, sidewalks, and streetlights.

4. Many services are considered "merit goods" because a minimal supply of them is ensured through the political process rather than being left to the uncertainties of the marketplace.[3] Examples: minimal shelter, primary education, clean drinking water, basic sanitation, and access to basic health care.[4]

For many aspects of the environment, it makes little difference whether the context is urban or rural. For example, primary schooling and access to health care are just as much merit services for rural as for urban children. But environmental concerns are often much more acute in cities. Economies of scale in production and delivery are only important when the consuming population is sufficiently clustered to benefit. External costs are only imposed when there are many other consumers and providers in sufficiently close proximity to suffer from them. Collective consumption only becomes significant when people live densely. Cities produce -- that is the reason for their being -- but they also have high environmental costs.

Governments, therefore, have become involved in the provision of environmental amenities to their urban citizens. The extent and quality of service varies greatly across countries. It is not surprising that poorer countries provide less. But it is surprising that provision varies across countries with similar GDP per capita.

Municipal governments in developing countries provide services both directly by taxing and indirectly through subsidization and regulation of private providers. Pricing and cost recovery through user fees also vary across countries.

The efforts of these cities to provide basic environmental services to all residents have rarely been successful. Many cities provide excellent amenities to some residents and almost none at all to others. There are many explanations for this lack of success.

One explanation is that because the cities have grown so fast and large, immediate, universal provision of basic services is just too big a task for them to do with public resources. This paper argues that because the urban environment is highly valued by consumers and cannot be adequately serviced by the private sector, it must be a high priority for the use of public resources.

A second explanation is budgetary. The provision of urban amenities is usually the concern of municipal government finance; and municipal budgets, especially in developing countries, face inadequate and inelastic revenue bases. Therefore, everything dependent on city budgets suffers. The World Bank, 1988, puts it succinctly:

> Municipalities face tight budgetary constraints .... Traditional ways of raising revenue are becoming increasingly costly. Transfers from higher tiers of government are unreliable, and many local authorities have neither the authority nor the know-how to coax more out of the property tax. Services that depend heavily on general funding sources are therefore bound to suffer (: 144f).

A third explanation is political. Urban, as well as national, governments in developing countries are seen as "elitist" -- concerned primarily with providing amenities to those already relatively well off. Those very amenities that are badly provided to the poor are usually well provided to the rich. The pro-rich bias of public policies is an unfortunate fact.

A fourth explanation concerns the way in which the cities produce and distribute amenities. It sees municipal provision as rife with corruption and inefficiency, which means that the city's services are inadequate or high-cost. This leads to excessive demands for these services, causes huge operating deficits, and produces steadily deteriorating quality and quantity. The implication for equity is that new, often poor, neighborhoods are especially badly served, compared with established neighborhoods.

A final explanation sees urban migration in developing countries as excessive, as a dampening force on economic development that must be discouraged. Thus, the provision of services to new urban migrants simply makes it harder to discourage rural-urban migration. Improving the urban environment would suck new, unwanted, and unproductive migrants into the cities.

The view that rural-urban migration retards development stems from a naive application of the Todaro model of the late 1960s.[5] Urban wage levels are made artificially high by some combination of government minimum wage policies, labor union pressures, or oligopolistic rent-sharing.[6] This attracts migrants from the low-wage rural areas at a pace far in excess of the ability of the urban industrial sector to create jobs. The equilibrating force becomes urban unemployment, with equilibrium reached when the rural wage (or marginal or average product in agriculture) equals the average urban wage -- where that average is some weighted mixture of high wage rates for the modern-sector employed, low wage rates for the informal-sector underemployed, and zero wage rates for the urban unemployed.

An ingenious theory. But research over the last two decades has shown it to be largely wrong. Wages in the informal sector are not low, and labor there is not unproductive. Overt unemployment is rare, especially among the low-skilled new immigrants. And urban wages are not terribly high, once adjusted for greater education, higher costs, higher rents, congestion, and environmental disamenities.[7] There is indeed an "urban bias" to most developing country policy (Lipton 1976), but it is a bias against the rural population and a bias toward the better-off segments of the urban population. These biases are not corrected by adding a bias against the urban poor.[8]

The failure to provide basic environmental services to the urban poor is in itself the most vicious of all possible policy biases. For most services that the urban poor need, there are private-sector sources available, often at better quality or lower cost than the public sector can offer. But environmental necessities -- fraught as they are with elements of natural monopoly, public services, externalities, and merit services -- are badly provided by the private sector. If water, sewage, and refuse disposal are not made available by a public body, either they will not be made available at all or they will be too expensive for the poor to afford.

The ultimate irony of the developing country city is that its amenities, often thought to be equally available to all citizens, are generally better provided to the better-off -- sometimes even at subsidized prices for those who least need the subsidy:

> Urban poverty is not simply a matter of individual income; it is part of the spatial and physical organization of the cities .... Many city roads, especially on the outskirts, are unpaved; public water supply reaches low-income areas of the city through public hydrants serving a large number of families; and adequate sewage disposal systems serve only a small proportion of the urban population. Health facilities are unevenly concentrated in the richer areas ... (Roberts 1978: 137).

The rest of this paper is concerned with this irony, its sources, and possible meliorations.

The City and Growth in Theory and History

Developing country governments want economic growth but think their cities are too large.[9] Yet theory and history tell us that economic growth and city growth go together. This contradiction has tremendous implications for the urban environments of the developing countries, especially as they affect the poor.

Think of a small, very poor, developing country that is initially almost entirely agricultural. People are poor because they grow little or no surplus that they might sell to buy non-agricultural products. Because there is thus no demand for such production, people remain in farming. To develop, the country must generate an agricultural surplus.

Once surpluses appear, two possible development strategies emerge. The country could remain dominantly agricultural, export its surplus, and import newly demanded manufactures.[10] But distance, culture, and policy usually take it onto a different track. Labor no longer needed in agriculture for domestic food requirements moves into manufacturing, and the surplus is traded to the cities for manufactures. Manufacturing growth, needing the economies of scale and agglomeration effects that cities provide, has always meant urban growth.[11] Thus when its cities grow economically, a country grows and a shrinking proportion of the population is needed just to produce food.

City growth also accelerates overall economic growth whenever industrial productivity increases more rapidly than agricultural productivity -- as it usually has. Higher agricultural productivity not only releases labor for manufacturing, it releases that labor to a sector where productivity is greater and growing more rapidly.

There is, however, a downside to city growth. Congested cities have high welfare costs, which are passed on to manufacturing employers, who must pay higher wages in order to attract labor. And cities have higher living costs -- principally higher rents, as urban land becomes scarce, and higher prices for consumer services, as retailing and transport chains become more complex -- which are passed on as higher labor costs to employers. Finally, the greater need for public provision of environmental services involves higher costs.

Not all cities provide optimal environmental services; if they do not, the lack of services is a burden on employers, who must pay higher wages. This rise in wage rates will add more to the wage bill than the taxation needed to finance the optimal provision of amenities would have cost. Thus, the failure to provide optimal environmental amenities in cities not only causes personal hardship, it also retards industrial growth.

The linkage between economic growth and city growth is obvious. Why then do many developing countries not recognize their rapidly growing cities as a sign of the success, not failure, of their development strategies? The answer to this paradox is that these strategies have been largely anti-rural. They have depressed both the terms of trade of agriculture and the rural share of the government infrastructure and service budgets. And policies promoting import-substitution industrialization have encouraged excessively capital-intensive and import-intensive industry, which in turn has meant a slower growth of formal-sector employment in the cities.

Such policies excessively push labor from the rural areas and inadequately generate formal-sector jobs for urban migrants. In this sense, many developing countries are over-urbanized. And if informal jobs are seen as unproductive or cause underemployment, many developing countries may consider their rates of urbanization even more excessive. But it does seem an abomination that the urban poor should be made to pay for these bad policies and misconceptions by being forced to do without the very services and services that they cannot readily buy in the private marketplace. It is ironic that the very policies that are intended to lift the developing country out of poverty fail to extend much of that growth to the very poorest, in both the rural and urban areas.

Many developing country policies inefficiently slow growth rates and push labor from rural areas. Yet, in a net sense, urbanization still accompanies growth. Developing country cities are growing more rapidly in countries where the real GDP (and growth in real GDP) per capita is higher (Preston 1979: 203).

Furthermore, the rate of urbanization of developing cities is not high by historical standards. The percentage of the developing country population in cities grew from 17 to 28% between 1950 and 1975, almost exactly the percentage change that occurred in the now-industrialized countries between 1875 and 1900 (*ibid.*: 196). "... by the standards of the First Industrial Revolution, the urban transition associated with ongoing industrial revolution in the Third World hardly seems exceptional" (Williamson 1988: 430).

Yet, today's developing countries face different problems in providing their urban poor with environmental services.

First, population growth rates are much higher in developing countries than in the now-industrialized world a century ago. Comparable rates of urbanization mean much larger rates of growth in developing country cities. In turn, each year the numbers of newly born plus newly immigrated city-dwellers waiting for services is larger than the now-industrialized countries ever faced. If there are economies of scale in providing these amenities, this means a lower cost per capita, but it nonetheless means a higher total cost. Even if high population growth rates do not cause lower levels or growth rates of GDP per capita, they do deflect public expenditure away from investment in manufacturing and agriculture and toward investment in urban and rural infrastructure.[12]

Second, industrialization in the developing countries is occurring at a lower per capita income than in the now-industrialized countries. For example, while urbanization in Latin America (the richest part of the developing world) is roughly 30 years behind that of the United States, income per capita there approximates that in the United States in the latter half of the nineteenth century (Ingram and Carroll 1981: 269). Thus, the resources available in today's developing country cities -- for environmental services as well as for food and clothing -- are not as great, per capita, as they were in earlier industrializations.

Finally, nineteenth-century industrialization and urbanization were undertaken "on the cheap." Urban services were always provided belatedly and inadequately, especially in the working-class sections of town.[13] Hobsbawm, 1969, writes of British cities during the first half of the nineteenth century:

> Smoke hung over them and filth impregnated them ... the elementary public services -- water supply, sanitation, street-cleaning, open spaces, and so on -- could not keep pace with the mass migration of men into the cities, thus producing, especially after 1830, epidemics of cholera, typhoid .... New city populations ... pressed into overcrowded and bleak slums, whose very sight froze the heart of the observer (: 86).

Life expectancy for the urban poor thus was lower than that in the rural areas.[14] This is what led Engels to label British rural-urban migration as "social murder" (Engels 1987: 70).[15] Workers' wages, consumption, and welfare rose in the second half of the nineteenth century in Great Britain, but not because of any widespread provision of water, sewage, and refuse collection.[16] But this under-provision is no longer defensible. Developing country cities cannot "bury" their social problems until industrialization is further along.

The Provision of Urban Environmental Services

The basic urban services are clean drinking water, sanitary facilities, and solid waste collection.

Clean drinking water has been a concern of development thinking for three decades. The Twelfth World Health Assembly initiated the Community Water Supply Program in 1959. By the end of the 1970s, the United Nations (UN) called for continued international efforts to bring water and sanitation to all the people in developing countries. In November 1980, the UN General Assembly designated the 1980s as the International Drinking Water Supply and Sanitation Decade. In the 1980s, more than a billion and a half people were provided with access to safe drinking water, and nearly three-quarters of a billion were given access to sanitation (World Bank 1992b: 47; and Singh and Helweg 1990: 23).

Despite this impressive progress, the goal of providing safe water and sanitation to all people in the developing countries is far from being accomplished. In 1990, nearly one-quarter billion people in the urban areas of developing countries were still without potable water and more than one-quarter billion still had no sanitation (World Bank 1992b: 47; UNDP 1991: 136f; and Singh and Helweg 1990: 16).

The steady rise in the coverage rate in safe water for urban residents in developing countries is shown in figure 1. Despite decades of international efforts, 18% of the residents are still without safe water, 28% are without sanitation facilities, and 30-50% are without solid waste collection. The regional breakdown for the coverage rates in water and sanitation is summarized in table 1. At the current pace, universal coverage cannot be expected for another 40 years.

An illustration of the diversity of water and sewage service across households of different incomes and cities of different sizes comes from Malaysia (Meerman 1979) -- see table 2. Higher-income groups and larger cities have a higher proportion of both water and sewage connections, and sewage lags behind water.

The collection and disposal of solid waste in the developing countries have not received much attention. This lack of attention is not, however, an indication that the problem is less severe. The annual per capita generation of solid waste in the developing countries is between about 0.2 and 0.3 tons, less than half the rate in the industrialized countries (Cointreau-Levine 1991: 10). Table 3 shows generation for a number of large developing cities.

The magnitude of the problem is, however, only partially reflected in the astronomical amount of solid waste generated each year. Although the rate of per capita waste generation in developing countries is less than half that of industrialized countries, the income levels in these countries are a much lower percentage of income levels in industrialized countries. Contrary to popular belief, the volume of solid waste generated declines, as a percentage of output, as development proceeds.[17] This means that the developing countries: 1) are generating relatively more solid waste per unit of output than the industrialized countries; and 2) are relatively more constrained, with respect to their resources, in coping with solid waste collection and disposal.

Only 50% to 70% of urban residents in the developing countries receive collection service despite the fact that solid waste management typically absorbs 20% to 50% of municipal revenues (Cointreau-Levine 1991: 2); moreover, only 60% to 70% of the refuse is collected (Bartone *et al.* 1991: 495). Thus, each year, over 100 million tons of solid waste accumulate in the cities of developing countries. Even less attention is paid to waste disposal than to waste collection. On average, developing countries allocate less than 5% of municipal budgets for solid waste to disposal. The comparable percentage in the industrialized countries is 20% to 30%. In developing countries, open dumping is the most common means of disposal (Bartone 1990b: 1).

Why are these services so inadequately provided? It is widely believed that developing countries simply do not have sufficient economic resources for full provision. The coverage rates for water and sanitation do tend to be lower for those developing countries with lower GNP per capita, as indicated in figure 2, (see also Shafik and Bandyopadhyay 1992). The level and growth rate of GNP per capita are not, however, the only factors in the determination of a country's provision of urban services:

> Failure to achieve coverage targets in the 1980s has as much to do with the manner in which funding sources have been mobilized, allocated, and used as with the absolute level of resources available (UNDP-World Band and Sanitation Program 1990: 13).

For instance, each country's performance, as indicated by figure 2, clearly indicates that the dispersion in the coverage rates for individual nations is very large for any given level of GNP per capita. Many countries with a much smaller GNP per capita outperform the countries with a relatively higher one.[18] figure 3 shows that not only is the dispersion of coverage rates large for any given growth rate, but also that the distribution of the coverage rates over growth rates is essentially random.

Another factor that may determine coverage rates is the rapid population growth experienced by developing countries. In 1980, 3.3 billion people lived in developing countries; by 1990, 4.0 billion (Singh and Helweg 1990: 3). Rapid population growth in developing countries is usually thought to retard development, and hence limit a country's ability to devote resources to improved environmental service coverage. In sub-Saharan Africa, for instance, population growth was about 3% throughout the 1980s. Just to maintain the coverage rate of 1990 at the level of 1980, the service provision would have had to increase by more than 34% for that decade (Institution of Civil Engineers 1990: 1). However, as figure 4 indicates, there does not seem to be any simple monotonic relationship between water and sanitation coverage rates and population growth rates. The dispersion in the coverage rates for any given rate of population growth is also quite large. Some countries seem to accommodate population growth better than others in terms of coverage rates.

Figures 2 through 4 make it clear that there is a great deal of variance in water and sanitation effort among countries at similar levels of GNP per capita, of GNP per capita growth, and of population growth. This should not be surprising. A nation's expenditure on water and sanitation and, to a less extent, on solid waste is typically a very small fraction of its total output. Public investment in water and sanitation in the 1980s, for instance, accounted for only 10% of total public investment in the developing countries -- or roughly 0.6% of GDP (World Bank 1992b: 106). When the total is so small, investment priorities, rather than resource constraints, are the more important determinants of expenditure.

Urbanization has also been suggested as an adverse factor in the improvement of the coverage rates and waste management. In 1960, urban residents of the developing countries accounted for 22% of their total population; by 1990, 37% (UNDP 1991: 159). In Africa, for instance, urban population in the 1980s grew at an annual rate of roughly 5.5%; in comparison, population growth was 3.2%.[19] In the meantime, the urban water supply coverage rate in Africa dropped from 83% to 74% (Institution of Civil Engineers 1990: 1). The fast pace of urbanization in the developing countries is thought to have simply outgrown, so to speak, the ability to expand urban infrastructure.

Yet, a closer look at the cross-sectional data on the urbanization and coverage rates for water and sanitation seems to contradict this casual hypothesis. As figure 5 indicates, the countries with high percentages of urban population tend to have higher coverage rates.

While rapid urbanization stretches infrastructure, it could also provide an impetus for the rapid expansion of urban services. Urban centers in developing countries are frequently the centers of productive activities, where one-third of total population produces 60% of GNP (Bartone 1991: 412). Urbanization does not simply consume resources -- it also creates them. Further, rapid urbanization can focus public attention on the provision of services, increase popular awareness of urban problems, and generate greater political will to expand basic urban services.

Precisely how the various macroeconomic variables relate to the adequacy of urban water supply, sanitation, and waste management cannot be established by mere regression analysis. But regression relationships can be suggestive, as shown in table 4.[20] There are two things to especially note in the table:

1. The only statistically significant explanatory variable in any of the four regressions is the urbanization percentage. It is significant in all four regressions. And contrary to conventional wisdom, urbanization is positively related to coverage rates. The more urbanized the developing country, the more completely covered is its urban population with water and sewage service.

2. None of the first three explanatory variables has significant (or approximately significant) coefficients in any of the four regressions. There is, in short, no evidence in this sample of developing countries that the level of GNP per capita, its growth rate, or the growth rate of population have any consistent, cross-country impact on the extent to which the urban population is served with water or sanitation.

These regression results suggest that the macroeconomic constraints seem not to be binding when it comes to providing water and sanitation coverage to a developing country's urban population.[21] In retrospect, this is hardly surprising. Relative to GNP, or even relative to the total public investment budget, the investments are not large. These investments do, after all, stem from policy decisions that can vary. And urbanization itself seems to induce policy makers to better provide water and sanitation in cities.

Figure 1. Urban Developing Country Drinking Water Coverage Rate, 1970-1990

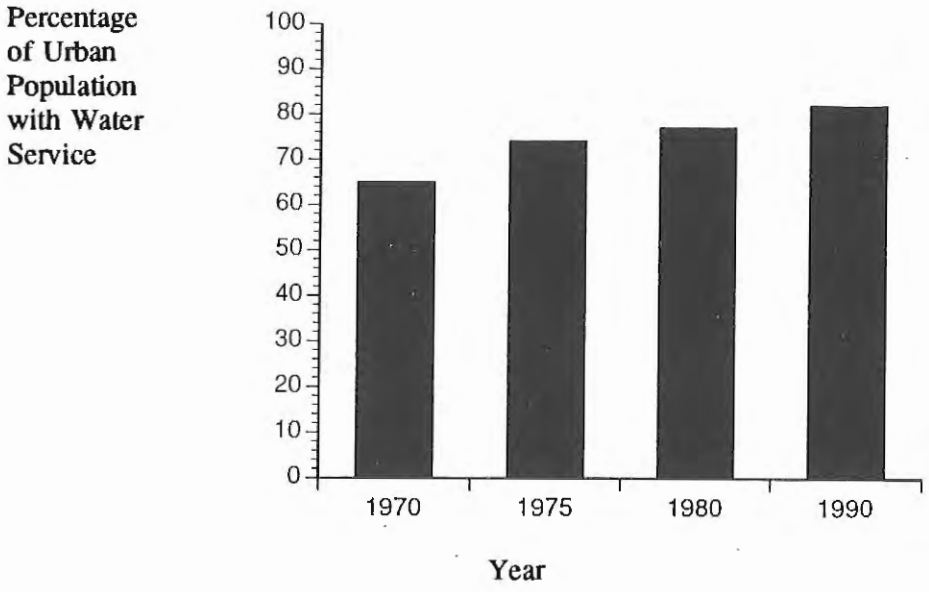


Table 1. Water Supply and Sanitation Coverage for Urban Residents in Developing Countries by Region, 1980 and 1990

	Percent Covered	
Region	1980	1990
Africa --		
Water	83%	87%
Sanitation	65	79
Latin America and the Caribbean --		
Water	82	87
Sanitation	78	79
Asia and the Pacific --		
Water	73	77
Sanitation	65	65
Western Asia and Middle East --		
Water	95	100
Sanitation	79	100

Source: Singh and Helweg 1990: 16.

Table 2. Households with Water and Sewage

(by income quintile and city size)

Households Served	Water[1]	Sewage[2]
By Income Quintile:		
Lowest	23%	3%
2nd	47	10
3rd	52	19
4th	68	29
Highest	83	56
By Size of City of Residence		
>75 Thousand	88%	62%
10-75 Thousand	58	28
1-10 Thousand	63	26
<1 Thousand	46	16

Notes:
1. Piped and treated water.
2. Flush sewage disposal.

Source: Meerman 1979: 624.

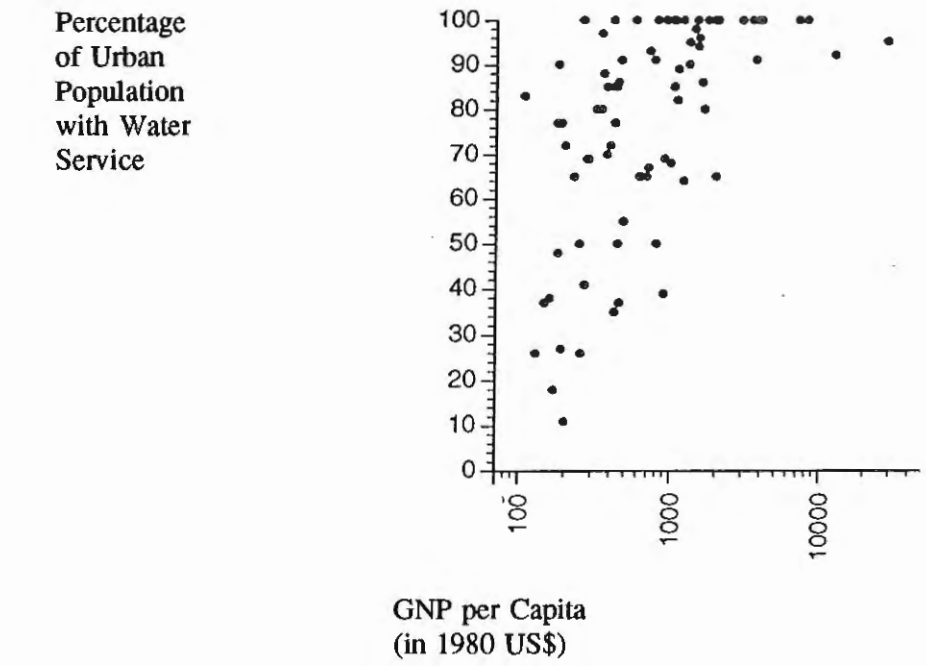
Table 3. Waste Generation in Some Large Developing Country Urban Centers

City	Population (millions)	Waste Generation (tons) Daily Total	Annual Per Capita
Abidjan (Ivory Coast)	1.7	1,400	0.300
Bangkok (Thailand)	6.0	2,500	0.152
Cairo (Egypt)	8.5	4,000	0.172
Colombo (Sri Lanka)	0.8	445	0.191
Douala (Cameroon)	0.8	1,120	0.499
Manila (Philippines)	8.0	2,700	0.123
Mexico City (Mexico)	17.0	6,510	0.140

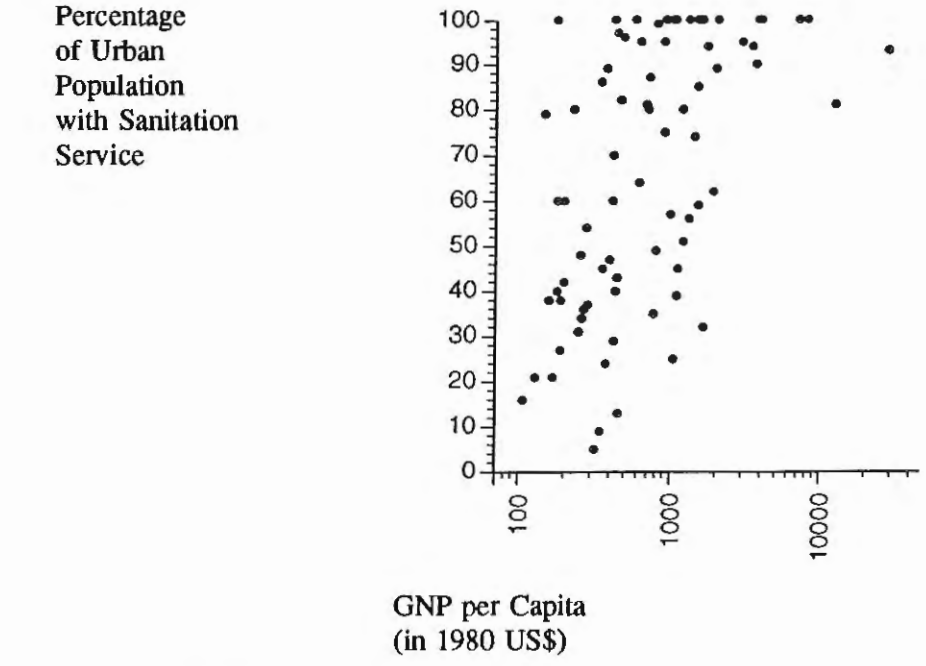
Source: Cointreau 1987, *passim.*

Figure 2. Developing Country Urban Coverage Rates and GNP per Capita

Water (a)



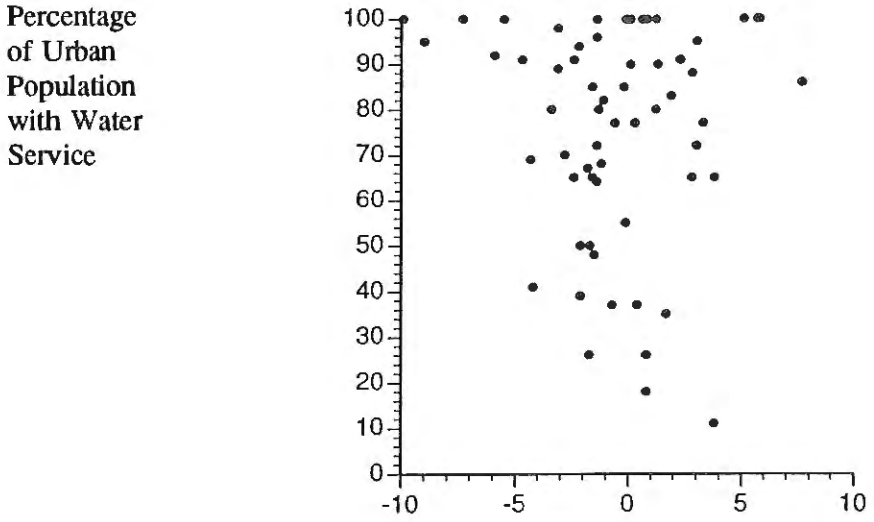
Sanitation (b)



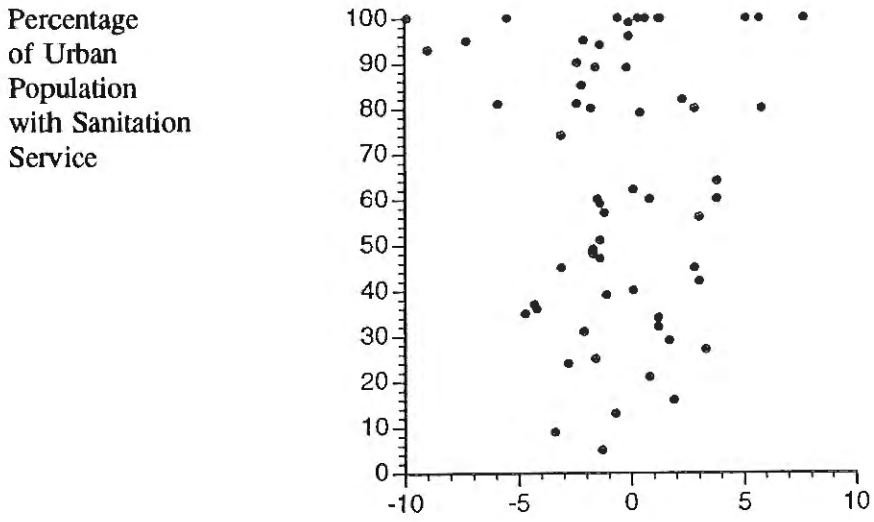
Source: WHO 1984; and UNDP 1991.

Figure 3. Developing Country Urban Coverage Rates and GNP per Capita Growth Rates

Water (a)



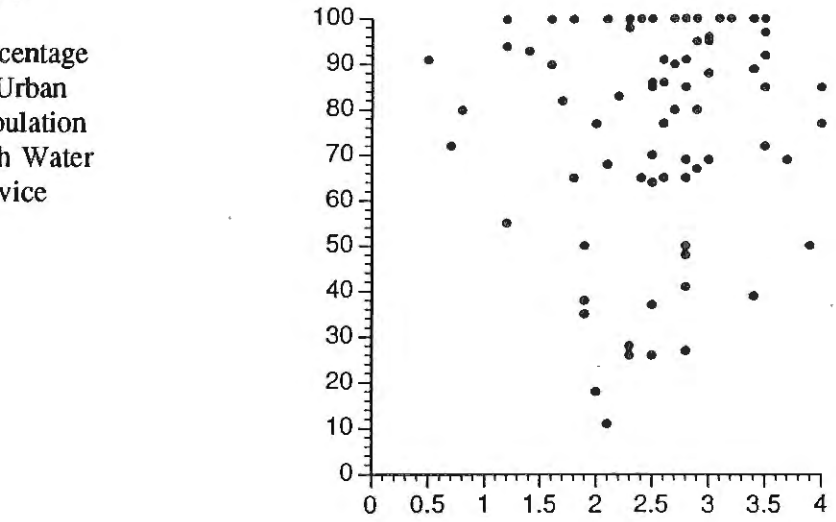
Sanitation (b)



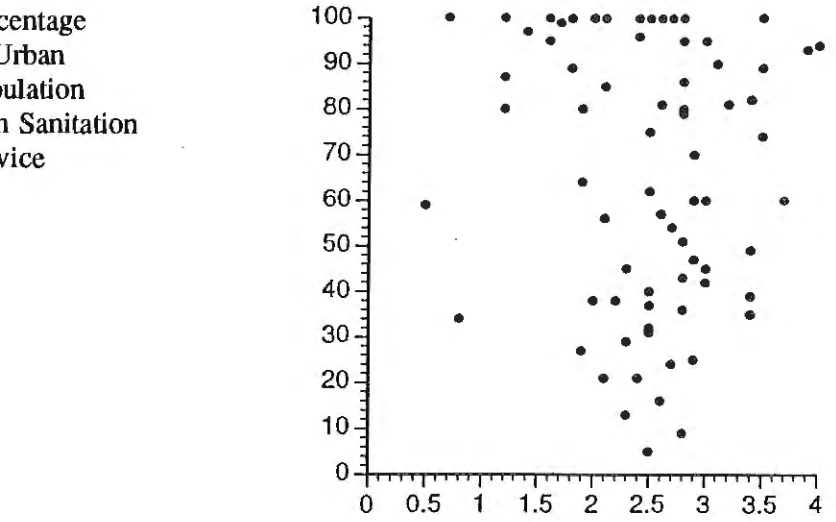
Source: WHO 1984; and UNDP 1991.

Figure 4. Developing Country Urban Coverage Rates and Population Growth Rates

Water (a)



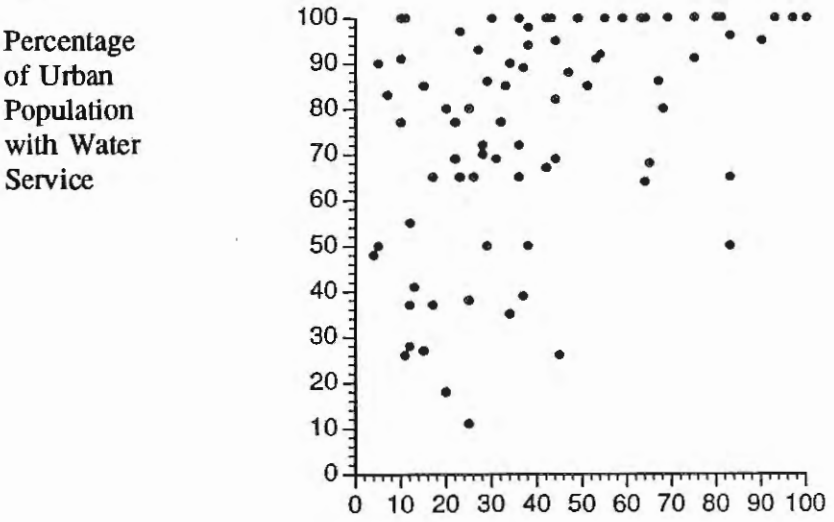
Sanitation (b)



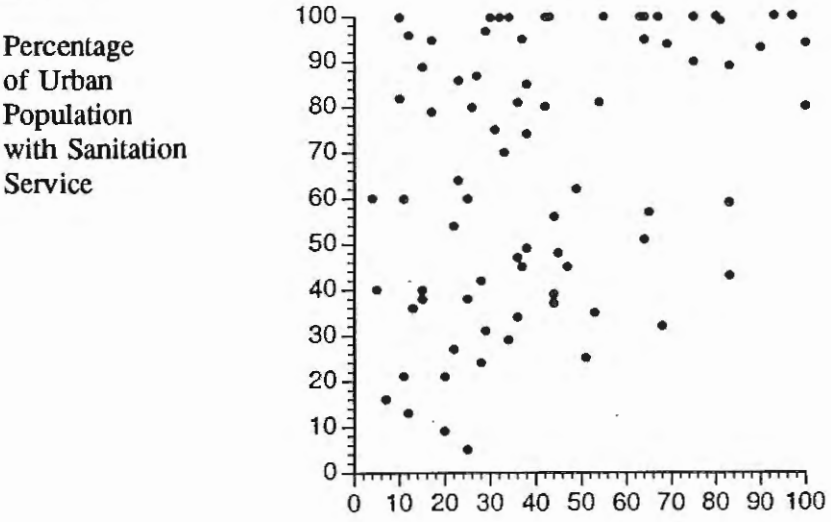
Source: WHO 1984; and UNDP 1991.

Figure 5. Developing Country Urban Coverage Rates and Urbanization

Water (a)



Sanitation (b)



Source: WHO 1984; and UNDP 1991.

Table 4. Water and Sanitation Coverage Regression Analysis

(a) Water Coverage (%, 1980):

Variable	Regression Coefficients: Tobit	Regression Coefficients: OLS
Constant Term	63.10 (3.29)	63.24 (4.25)
GNP Per Capita ($000s, 1980)	-0.07 (-0.07)	0.25 (0.28)
GNP/Pop Growth Rate (% p.a., 1980s)	-0.43 (-0.33)	-0.44 (-0.43)
Pop Growth Rate (% p.a., 1980s)	-3.92 (-0.68)	-2.60 (-0.54)
Urbanization (%, 1980)	0.63 (3.49)	0.43 (3.09)
		R^2=0.26

(b) Sanitation Coverage (%, 1980):

Variable	Regression Coefficients: Tobit	Regression Coefficients: OLS
Constant Term	31.07 (1.39)	29.31 (1.50)
GNP Per Capita ($000s, 1980)	0.85 (0.64)	0.71 (0.60)
GNP/Pop Growth Rate (% p.a., 1980s)	1.72 (1.07)	1.16 (0.86)
Pop Growth Rate (% p.a., 1980s)	4.41 (0.62)	4.99 (0.79)
Urbanization (%, 1980)	0.61 (2.78)	0.54 (2.89)
		R^2=0.22

Notes:
1. Figures in parentheses are t-statistics.
2. p.a. means per annum.
3. 1980s refers to 1980-88.

Cost and Price Structures

The next step after concern with service provision is attention to economics, more specifically, costs and prices. Prices determine both who gets the services and what revenues are available to cover costs. Revenues and budget constraints determine what costs can be afforded and eventually who can be provided with what kind of service. In all industries, revenue and cost are interrelated. But the interrelation is uniquely complex for urban environmental services.

The provision of infrastructure for water and sewage is a classic example of natural monopoly. There are large economies of scale and of contiguity -- that is, inefficiency in providing duplicate distribution networks in an area -- with high fixed cost and low marginal cost. Under these conditions, marginal cost pricing leads to financial loss, while pricing to fully recover all costs leads to inefficiently low levels of service. In solid waste management, there are fewer characteristics of natural monopoly, but the public-good nature of its benefits also tends to cause under-provision of the service.

Many developing country cities have erred on the low side in pricing decisions, causing financial losses that have led to inadequate coverage and deteriorating service. Even though many developing country cities have set the fees for public utilities below relevant costs, the results tend to be highly regressive. Wealthy households receive public amenities below cost, while poor families are unserved and must rely on costly, often low-quality, private alternatives or no service at all. How have cost structures and pricing criteria led to this inequity of service?

Costs

Water Costs

Capital cost in the water sector involves the cost of securing water supplies (*i.e.*, deep wells and pumps to acquire groundwater or large reservoirs to collect surface water), constructing treatment facilities, and laying out the distribution network. The costs of such systems vary widely, but World Bank economists (Garn 1987: 229) have estimated a general cost equation (for a water project with a design horizon of 10-15 years):

$$TCC = 4*Q^{0.67},$$

where TCC is the total capital cost (in millions of 1980 dollars) and Q is the expected quantity of water produced at capacity (in millions of cubic meters per year).[22] By this formula, a new water system for a city of 3 million people, consuming an average of 80 liters per capita per day, would incur a total capital cost amounting to $80 million or an average capital cost of $26 per capita. A similar system for a city of half a million people would require a total capital cost of $24 million or $48 per person. The higher per-person cost in the smaller city is a reflection of the economy-of-scale exponent of two-thirds.

Once a city has installed its fixed capital, the marginal cost of adding connections to individual houses or to standposts in neighborhoods is relatively low. Typically, individual household connections *(i.e.,* in-house taps for running water) cost more than $100 each; yard or neighborhood taps cost $30-50 each, depending on the spacing. World Bank economists have estimated that the incremental cost of increasing coverage through house connections to 90% of developing country urban populations (and through sewage connections to 70%) by the year 2000 amounts to only $8 per capita per year (Ringskog 1987: 233).[23]

However, trying to add many tertiary connections *(i.e.,* small-diameter pipes appropriate for servicing a sub-division) to an overburdened primary *(i.e.,* trunk) network often leads to substantial inefficiencies.

> [It] becomes more difficult and sometimes impossible to build trunk infrastructure after neighborhoods are fully established. The result is often an abundance of tertiary networks and a shortage of primary and secondary networks (World Bank 1992a: 48).

An inefficient mix of primary, secondary, and tertiary infrastructure increases per-unit cost. However, in slums and squatter settlements, many of the poor are not serviced at all, while others help themselves to illegal connections.

The variable (*i.e.,* recurrent) costs of a water system are very low relative to the fixed cost. For a groundwater system, they include the energy cost of pumping the water and other operation and maintenance costs of the system. Usually, surface water requires more extensive treatment than does groundwater, but surface water does not incur the heavy pumping cost. The operation and maintenance costs for 54 urban water projects financed by the World Bank, which included both surface and groundwater sources, averaged less than $0.20 per cubic meter (as of 1980; Garn 1987: 232).[24]

Sewage Costs

A sewage system also has high fixed cost in the network of trunk sewers and in the facility for centralized treatment and discharge, while the capital cost of adding households to the system is relatively low. For example, the World Bank, 1992b, estimates that complete, standard sewage systems in the Developing World cost $300 to $1000 per connected household (: 107);[25] connecting up an existing sewer connection for a flush toilet costs about $200 (Linn 1983: 149).

A system for Taipei (Taiwan) designed in 1970, when the population was 3 million and growing at a rate of 5% per year, was estimated to take 36 years to complete, reaching 4.7 million people by time of completion. The construction cost was estimated at $300-500 million per year; operation and maintenance costs were expected to grow from about $10 million per year to almost $300 million per year by the end of the project (McGarry 1982b: 133).[26] For Kumasi (Ghana), a densely populated city of 600,000, capital cost (without treatment facilities) would amount to about $500 per household. Household connections and fixtures would add another $100-300 (Whittington *et al.* 1991a: 124).

Industrial sewage is more likely to contain hazardous or toxic wastes and higher concentrations of contaminants than is household sewage. Most municipalities either require industrial sewage to be "pre-treated" to established standards or make arrangements for individual firms to fully treat their

effluent before direct discharge into surface water. However, enforcement in developing countries is often lax, and sewage treatment plants (if they exist) may have to deal with effluents for which they are not equipped (Bernstein 1991: 35).

Solid Waste Costs

Solid waste collection and disposal service do not exhibit the massive economies of scale that water and sewage systems do. Private firms can profitably collect solid waste in free markets -- and the resulting prices may well approximate the lowest feasible per-unit cost. Recent estimates for urban areas in the industrialized countries suggest that there are significant economies of scale for a population of up to about 20-30,000 but not further above 50,000. Given the lower wages in developing countries, and the concomitantly more labor-intensive processes used there (*e.g.*, fewer and simpler vehicles staffed with more workers), economies of scale are likely to be exhausted at even lower population levels in developing countries (Schertenleib and Triche 1989: 13, 17).

Solid waste collection can be a very labor-intensive undertaking, with relatively small capital outlay. Most collection services in developing countries include a sizable crew of unskilled laborers, equipped with shovels and rakes, baskets or bins, wheelbarrows or push-carts, and a dump-truck or a cart with a draft animal. In larger urban areas, there will often be transfer stations where household garbage from an entire neighborhood will be collected and temporarily stored awaiting pickup for final disposal in an official dump site.

Even if there are few economies of scale, there are significant economies of contiguity. It is more efficient to have one firm or agency service a neighborhood than two or more wasting time and fuel leapfrogging each other. Thus, efficient collection, which requires monopoly, may be in conflict with efficient pricing, which requires competition. And efficient source-reduction efforts in solid waste, which require higher per-bag charges, may be in conflict with efficient litter-control (and "anti-midnight-dumping") efforts, which require low (or zero) per-bag or per-bin charges. These potential conflicts urge public, rather than private for-profit, provision of the solid waste collection system.

Furthermore, there may be significantly greater economies of scale at the level of secondary collection, processing, and disposal -- proper treatment of solid waste after its collection increasingly involves transfer stations, organized recycling, enclosed incineration, municipal composting areas, and sanitary landfills (with post-closure monitoring). In each of these areas, greater size means lower cost per unit of solid waste, which again suggests public involvement.

A final argument for public intervention in solid waste disposal is that many of the costs, while not technically externalities, are distant and uncertain and that such costs may be too easily escaped by private firms.[27] Especially in the case of landfills, the concepts and estimates of the true economic cost are particularly elusive:

> A particular landfill, once filled to capacity, is essentially unusable forever for further solid waste disposal ... a new landfill must be located, prepared, and opened. This process of closing and opening goes on again and again, periodically, and it comprises the major cost of the entire waste disposal operation .... [Disposal cost includes] not only all the handling costs at the landfill but also some part of this infinite sequence of closing and opening new landfills. What part, exactly? To find the marginal cost of, say, one extra ton of solid waste ..., we

would have to take account of the fact that the date of closing Phase I and opening Phase II would thereby have been accelerated a little bit, and that these earlier costs would have represented, in a 1990 present value sense, higher costs. But that same bit of 1960 solid waste would also have hastened the day when Phase II was closed and Phase III opened. Indeed, it would hasten the closings and openings of all future phases, forever after. So, finding the "cost" of a landfill for the purpose of discovering marginal cost and helping to set "tipping fees" theoretically requires us to look at all future closing-and-opening landfill costs (Bitar and Porter 1991: 4).

Landfills also pose administrative problems. Enforcing proper post-closure monitoring of private landfills almost certainly exceeds the abilities of developing country regulators -- just as in industrialized countries.

In poorer developing countries, however, urban solid waste usually gets dumped in ill-prepared landfills, which always contain considerable quantities of raw human waste and often contain hazardous toxic wastes which may leach into the groundwater and/or provide breeding ground for rats, flies, and mosquitoes. Open burning of garbage (as opposed to properly controlled incineration) exacerbates the air pollution problems of most developing country cities. Finally, many developing country cities allow uncontrolled dumping of garbage into nearby rivers and other bodies of water, with obvious consequences for public health.

The cost of solid waste disposal in developing country cities usually accounts for a very large part of municipal budgets, sometimes as high as 20-40%, with collection and transport accounting for three-fourths of that cost -- disposal costs make up the balance. But the range in the level of costs is tremendous, from $14 to $113 per metric ton of refuse collected (Cointreau 1982: 24, 33).

Pricing

Pricing Theory

The provision of water, sewage, and solid waste management services poses awkward choices for governments, given the interconnected problems created by elements of economic efficiency, natural monopoly, externalities, public services, and merit services. The conflicts can be seen from a list of possible pricing goals:

Cost recovery. The municipality should cover the full cost of the system's operation, maintenance, depreciation, and interest on capital, and perhaps even earn a surplus to help finance expansions that extend or maintain coverage of its growing population.

Economic efficiency. Prices should guide providers and consumers to that quantity of output where the benefit of consuming the last unit of output just equals the cost of providing the last unit of output.

Externality/public services. Clean drinking water and proper sanitation and waste disposal services yield public health externalities enjoyed by the entire population beyond just the private benefits, and prices should be low enough to reap these external benefits.

Merit services. Access to basic environmental services is a right of all citizens and should not be denied to the poor.

Obviously, no single price can reconcile these various criteria. And the usual, simple pricing formulas for public services inevitably fail on several of the criteria, especially when the service in question is a natural monopoly. Consider several possible pricing formulas:

1. Monopoly Pricing. The provider could charge a monopoly price (point A on figure 6) which would cover the full cost and yield a profit that could be used to finance expansion.[28] This price, however, brings about an inefficiently low level of output, and it ignores both the externality and merit good aspects.

2. Full Cost Pricing. The price could be set to cover average total cost (point B on figure 6). This price covers the cost of production, but it does not generate finance for expansion of the system[29] and is inefficient in that output is too low -- some potential consumers who are willing to pay the marginal cost of their consumption fail to receive the service. This price also ignores the externality and merit good aspects.

3. Marginal Cost Pricing. This has several different meanings:[30]

   3a. Short-run marginal cost pricing without a capacity constraint. Where capacity is not reached over the relevant market demand, setting price equal to short-run marginal cost (point C on figure 6) is efficient in that all potential consumers who are willing to cover the marginal cost of their own consumption receive the service. This price, however, fails to cover the average total cost of production, much less to generate a surplus for future expansion. This price also fails to take externalities into account, and it still might not be low enough for the very poor.

   3b. Short-run marginal cost pricing with a capacity constraint. Once capacity is reached, the marginal cost of additional output is essentially infinite. Marginal cost pricing in this situation simply means pricing to restrict demand to the capacity output available. In this case, short-run marginal cost pricing (point D on figure 7) is both efficient and (if demand is high enough relative to average total cost) capable of covering the full cost and of generating finance for system expansion. Ultimately, if the demand were unchanging, it would be possible to find that capacity at which a market-clearing price equaled capacity-constrained short-run marginal cost and also equaled average total cost. At that point, the optimal capacity would have been reached, short-run marginal cost pricing would be correctly practiced, and revenues would cover the full cost. Of course, externality and merit good issues would still exist.

   3c. Long-run marginal cost pricing. Technically, this means setting price equal to the cost of additional output when capacity must be added, as if fixed capital could be added in tiny increments.[31] In reality, however, investments in fixed capital are lumpy, and so any realistic picture of the cost of expanding output will exhibit steps, or discontinuities.

As a city grows, water and sewage capacity must be enlarged periodically in a series of discrete lumps (*e.g.*, larger or additional reservoirs, more or deeper wells, new treatment plants). "Long-run marginal cost pricing" has therefore come to mean that each buyer of the service must reimburse the system for the incremental capital cost (as well as the operating, or variable, cost) of expanding capacity to accommodate future users. This additional capacity may incur the same short-run marginal cost as the old capacity (in which case average total cost will eventually approach the long-run marginal cost), or it may incur higher costs.[32]

4. "Lifeline" Pricing. The price could be set low enough that most, maybe almost all, of the poorest members of society can afford the service (point E on figure 6). This price may be efficient, if the difference between the price and the marginal cost at the attained output represents external benefits of the service; even if the difference does not represent externalities, the below-marginal-cost price may be justifiable on merit good grounds. This lifeline price, of course, fails to cover marginal cost and hence requires a subsidy just for operation and maintenance cost. And needless to say, such pricing does not begin to generate funds for expansion.

Finally, there is the question whether to meter or not. On the one hand, metering allows for more precise pricing, which makes possible the achievement of efficiency and is necessary for well-targeted subsidies. On the other hand, meters -- and their associated administrative activities -- add to cost. Generally, in the poorest cities, where there are few household connections and piped-water usage is low, it makes sense to do without meters for households and to charge a monthly rate, either a flat rate or a rate graduated by property valuations. As cities grow in income, in number of piped-water connections, and in water usage, metering gradually becomes a cost-effective option.

Figure 6. Natural Monopoly without a Capacity Constraint

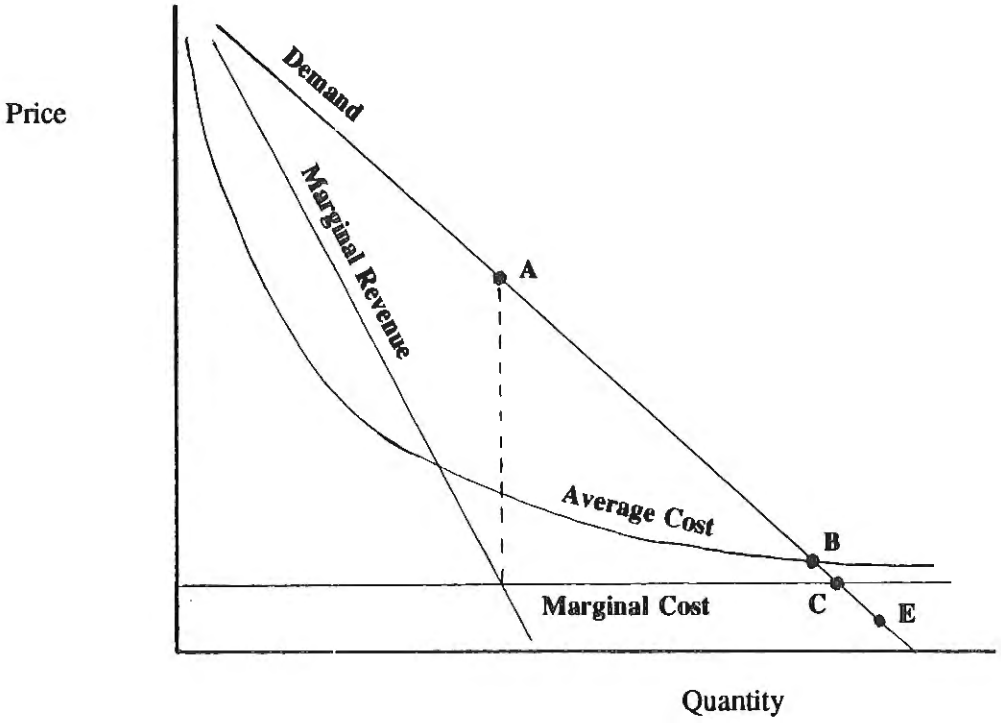
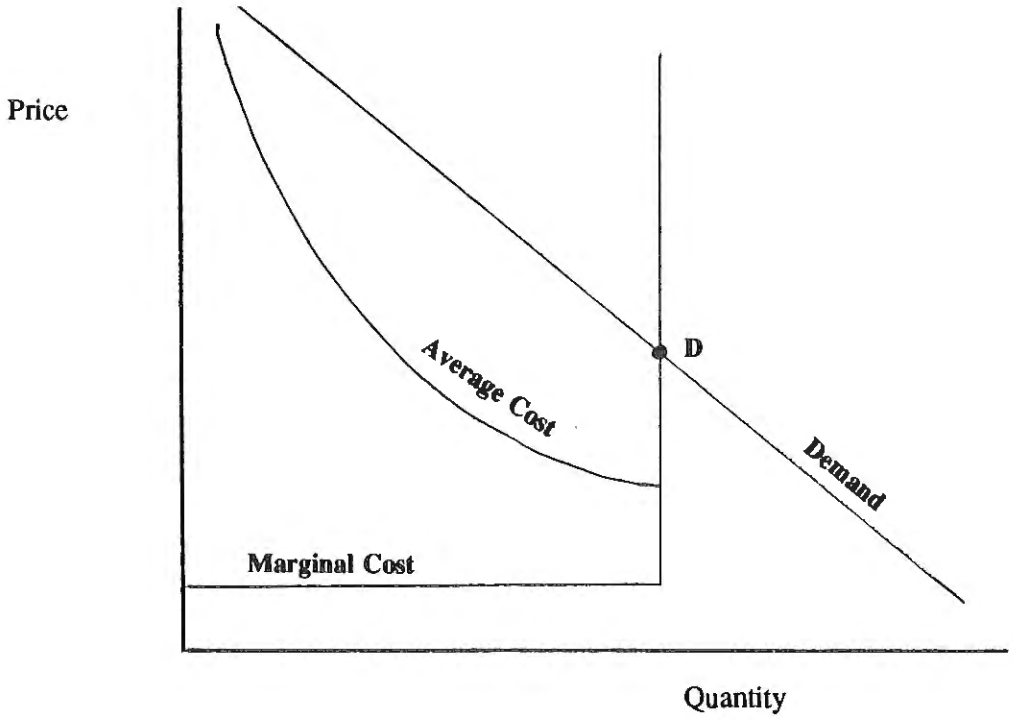


Figure 7. Natural Monopoly with a Capacity Constraint



Pricing Practice

In practice, many developing country municipalities have: 1) set prices so low, even below marginal cost, that service quality deteriorates; 2) not adjusted prices to keep up with inflation; 3) not collected fees regularly; and 4) not had a budget for expansion, even in areas where residents are willing to pay the full cost of service. Anderson describes the resulting ironies well:

> Physical infrastructure services are (or should be) inherently low risk investments. The technologies are well understood and proven; demand growth rates are high; demand, revenues, and costs can be projected with a reasonable degree of reliability; the investments have long lifetimes given good maintenance; and the authorities responsible for providing the services have the advantages of being public monopolies. As such, they should be ideal investments for attracting domestic and foreign finance .... However ... infrastructure services have often proven to be high risk investments in Africa, and have not attracted sufficient private finance, domestic or foreign ... undoubtedly one reason lies in the common failure of the authorities to adopt cost-reflecting pricing policies such that debts on commercial terms could be serviced (Anderson 1989: 531).

The agonizing sum of all these human-made problems is that usually the poor are the ones deprived of basic services. The urban poorest are new migrants who typically live in new neighborhoods. If faulty pricing and budgeting techniques prevent the expanded provision of basic services, they do without, even if they are willing to pay out of their low incomes.

Water Pricing

In practice, the pricing of piped water in most developing country cities has failed to cover cost, is inefficient, and is regressive. The World Bank, 1992b, estimated that:

> ... on average, households in developing countries pay only 35% of the cost of supplying water .... The proportion of total project financing generated by utilities points in the same direction .... Internal cash generation accounts for only 8% of project cost in Asia, 9% in sub-Saharan Africa, 21% in Latin America and the Caribbean, and 35% in the Middle East and North Africa" (:16, 104).

Often, the intention is to cover most of the fixed cost out of general funds, leaving water fees to cover recurrent cost. If cities could obtain sufficient general tax revenues without serious distortions elsewhere in the economy, there would be considerable logic to this structure of financing. However, in most developing countries, the general fund receipts simply have not been sufficient.

In addition, if a city targets subsidies to the poor while coverage is still incomplete, subsidized facilities may be taken over by the better-off:

> If [urban infrastructure] ... is in short supply, serviced residential plots acquire a scarcity premium, and thus housing becomes more expensive. Serviced land prices may be further elevated if, as is often the case in developing countries, infrastructure fees are inadequate to cover capital and operating cost, resulting in capitalization into land values some or all of the shortfall in infrastructure fees (World Bank 1992a: 14).

In this way, rising housing prices push the (renting) poor out, and the subsidy benefits whoever owned the property at the time of connection. In Kenya, for example, subsidized sites and services projects provided a windfall gain to the relatively small number of households selected to participate -- those with connections or luck. Low-income beneficiaries quickly sold out to middle-income home buyers, and took their cash with them to less well-serviced neighborhoods. In the end, serviced housing sites intended for the poor were occupied by the middle class and often owned by the wealthy.

The World Bank found that in the cities of Africa, Asia, and the Caribbean where urban infrastructure and services have a high rate of coverage and are priced and provided to be responsive to demand, "The price of serviced land is only slightly higher than the combined cost of raw land and infrastructure installation" (World Bank 1992a: 14). In other cities, however, where urban infrastructure is not provided to much of the population, the ratio of the prices of serviced land to raw land is of the order of ten or fifteen to one -- "far higher than consistent with the cost of installing infrastructure" (*ibid.*).

Most developing country cities simply cannot afford to extend optimal (household) connections to the entire population. Low-cost yard taps or neighborhood kiosks provide the poor with affordable access to clean water. Unfortunately, many developing country governments have resisted less than the optimum.

Financing connections (and covering capital cost) is more of a problem in developing country cities than in industrialized ones, where almost all houses are connected to water and sewer lines by law; connection fees for new housing are paid as a matter of course. In developing countries, many households must wait years to connect to city water (or sewage). And the fee is usually too high for a poor family to pay; in some cases, it is higher than the connection cost (Linn 1983: 165). Many cities provide financing. Sometimes this is financed with a separate "mortgage" and sometimes by increasing the water rates for new households.[33]

Where municipalities have been expanding coverage, there has been an additional pricing problem. Especially when the financing comes from multilateral agencies, governments have required utilities to cover cost from revenue. In these cases, new beneficiaries are charged the full cost *(i.e.*, the cost of operation, maintenance, interest, and depreciation) for connection to service, which is often financed by high monthly service fees. But households with established connections continue to pay the same rates, often much lower, than that being paid by the newly connected households (Meerman 1983: 508). This structure, is neither efficient nor does it recover cost.

Most utilities in developing countries either charge a flat rate per month (for non-metered systems) or charge a flat rate per unit of consumption (for metered systems). In a recent study, Garn, 1987, estimated that, while the unit cost of water averages about $0.30 per cubic meter, revenues in developing country utilities averaged only about $0.23 per cubic meter and had a tendency to fall in real terms over time as inflation outpaced price increases (*ibid.*: 232). Unfortunately, even these loss-making pricing schemes tend to be regressive. Wealthy households can fill swimming pools for a smaller fraction of their income than poor households pay for the bare minimum amounts of water needed for drinking.

Instead of flat rates, some utilities charge complex rates -- "two-part tariffs" or "block rates" -- which are different (and usually successively lower) prices on different units of consumption. If they are to conform to cost structures, such rates include a high up-front fee to cover connection, metering, and billing costs, and a low tariff for each unit delivered. There are two problems with such a pricing

system. One, the declining marginal prices are very regressive, with some of the poor, who buy relatively little water, paying only at the high initial prices. Two, the high initial prices deter many other poor households from even connecting up.

Alternatively, a "progressive block rate" charges a very low amount for the first few units consumed (a "lifeline" tariff) and higher rates for later units consumed.[34] This pricing structure solves externality and merit good problems and can even cover cost while cross-subsidizing the "lifeline" tariff.[35] However, it is not efficient.[36] More important, it can still lead to inequities. If the size of the "block" is kept low, a moderately well-off, small household that requires little water may pay less per unit than a poorer but much larger household. A more generously sized "block" may be too expensive for the system to finance internally.

Whatever the tariff structure established by a utility, and even if it was initially devised to cover recurrent cost, there has been a problem with inflation running ahead of price increases, eroding the ability of utilities to recover cost from revenue. Given that wealthy households are most likely to receive urban services, this inflation leads either to a subsidy for the wealthy from general revenues, or to a deterioration in service (or both).

Other problems frequently encountered include leakage, unauthorized connections, and low collection rates. There are often failures in metering or billing systems. Anderson, 1989, notes that illegal connections may account for losses of 20% or more of total output (: 528). Water that is unaccounted for (including leakage) constitutes some 40% of the piped-water supply in Latin America (World Bank 1992b: 16, 109). In many countries, particularly in Africa, low collection rates have even been exacerbated by non-paying government agencies and parastatals.

Sewage Fees

Sewage fees have proven even harder to set than water fees because it is difficult and not cost-effective to meter sewage production from households. Therefore, utilities usually assess sewage fees in proportion to water usage (where water use is metered), on the basis of estimates of the proportion of water usage that enters the sewage system.[37] In places where water is not metered, households are usually assessed a flat rate that appears with the water bill. In some cases, the fee may be added to city taxes. Sewage connection fees are usually financed in the same way as water connections. If not paid for in cash, some cities offer long-term financing or an increased monthly service charge that amortizes the investment.

Solid Waste Fees

Urban solid waste can be paid for in several different ways: 1) through the general fund, usually out of property taxes; 2) through a mandatory monthly fee to the municipality; or 3) through private operation and pricing. In some cities, residents are required by law to dispose of their garbage, and private firms compete to provide this service. More common is municipal collection or competitive bidding between firms for an exclusive contract for the entire city (or for sections of it). However, left to their own devices, the firms will take the "cream" of refuse -- *i.e.*, from households that generate a high proportion of recyclables and from easily accessible neighborhoods (Cointreau 1982: 25).

Therefore, if a municipality decides to contract the bulk of collection to firms, it must handle the rest or subsidize private collection from poorer sections.

Landfill site owners usually charge the dumper a "tipping fee." If the municipality owns a site, it can dump its garbage there at no cost and charge other users a tipping fee. But if, it does not own, it will be charged a tipping fee.

Can these costs be recovered? A sensible pricing structure for wealthy or well-organized municipalities may involve charging a user fee to the beneficiary households. However, reliance on user charges may drive poor households to dispose of their garbage illegally and unsafely. Similarly, user charges do not yet appear to deter waste generation (Cointreau 1982: 41). Furthermore, separate charges for each household are expensive to administer, monitor, and collect.

Ultimately, devising a workable, efficient structure of the availability and prices of urban environmental services depends on knowledge of what households are willing to pay for what different kinds of service at what costs.

Valuing Urban Environmental Services

Constructing an efficient supply and fee structure for water, sewage, and solid waste disposal services depends on estimates of their economic value that are not easy to make. Markets do not provide good estimates of consumers' willingness to pay nor of benefits from externalities.

In the past, many municipalities in developing countries have assumed that their residents' willingness to pay for such services was low. So they did not set prices high enough to cover costs, and utilities were unable to finance maintenance and expansion. In fact, the evidence speaks of a high willingness to pay. For water and sewage, for example, which have had the greatest number of studies, there is now consensus on three key points:

1. Most residents can pay the full cost of in-house water connections (although probably not sewer connections).

2. It is almost always feasible to raise the cost of water for most households to a point slightly above the full cost to finance expansion from revenues and provide some service to the poorest households.

3. Even in the poorest cities, it is economical to provide universal access to city water and even to subsidize water and sanitation for the poorest households (with yard taps or densely-spaced neighborhood kiosks), on the basis of external, public health benefits.

There are two sources of economic value for environmental services: 1) private willingness to pay for the service; and 2) external benefits from the service.

Willingness to Pay

Many different techniques have been used to derive estimates of willingness to pay. This paper now looks at briefly at seven.

Revealed Preference Techniques

"Revealed preference" simply means that information about willingness to pay can be inferred from the amounts households actually pay. In Onitsha (Nigeria), a city of about 700,000, only about 10% of the households are connected to the city water corporation (Whittington *et al.* 1991b). There are a score of private, independent boreholes in and around the city, which provide water to many privately owned large tanker trucks. These trucks sell most of their water to businesses or wealthy households who have large storage tanks, many of whom have become "small retail water vendors" (*ibid.*: 181). These vendors then sell water both to individuals, who come with buckets for their own use, and to "distributing vendors," who carry water from the retail vendors to households. Most households are within 50 meters of a retail vendor. This private system distributes about 13,000 cubic meters per day during the dry season. The city corporation distributes another 6,800 cubic meters. Finally, in a few parts of the city, households can get water free from shallow wells by the sidewalks (about 1,400 cubic meters).

Water prices in Onitsha vary tremendously.[38] Individuals pay about $50 per kiloliter for water from retail vendors and up to $130 per kiloliter for water from distributing vendors. Those who buy water directly from tankers pay about $15 per kiloliter if they buy over 1,000 gallons (4.5 cubic meters) or $40 per kiloliter if they fill only a 200 liter drum. The tankers, in turn, pay only about $3-4 per kiloliter at the boreholes, and the city corporation only manages to collect $3 per kiloliter on average.

This wide range of prices reveals a wide range of marginal willingness to pay. Moreover, since the poorest end up paying the highest prices, the study indicates a high willingness to pay for water by the poor.

There are fewer studies of demand for sewage systems than for water systems. One very detailed study (Whittington *et al.* 1991a) conducted in Kumasi (Ghana) revealed a wide variety of systems in use and willingness to pay. Current sanitation systems in Kumasi include flush toilets connected to septic tanks (usually shared by all households in an apartment building), private bucket latrines (usually also shared), and public latrines. Most of the public latrines are bucket latrines or aqua privies.[39] Some new ventilated, improved pit latrines (VIPs) are in use, both as public and private latrines.[40] A small proportion of the population uses simple pit latrines (or "the bush"); only a few buildings -- the hospital, the university, and some government buildings -- are connected to a sewage system. The study team surveyed usage of the public latrines:

- About one-fourth of the families use toilets connected to septic tanks; these households pay an average of $0.02 per capita per month for the desludging of septic tanks.[41]

- Another one-fourth of the households use bucket latrines; they pay an average of $0.11 per month per capita to have the buckets emptied a few times a week.

-- Nearly half the people use public latrines, and spend an average of $0.25 per capita per month.[42]

These figures can be compared to what the average Kumasi family pays for rent ($1.50 per month for a one-room apartment), for electricity ($1.63 per month), and for water ($1.13 per month), out of an average income of $15 per capita per month.

Contingent Valuation Techniques

"Contingent" valuation means the values people place on hypothetical services not currently offered. Obviously, such information is counterfactual. Whittington *et al.*, 1991b, surveyed households in Kumasi (Ghana), asking respondents: "Would you be willing to pay x amount per drum of water if you could get a household connection?" The surveyors varied the amount until they had determined a narrow band of prices for each household.[43] The study found that 86% of respondents were willing to pay $6 per kiloliter to be connected to city water; 60%, $10. At the $10 price, the city water corporation would maximize its total revenues.[44] These prices are much lower than most households are now paying for private water but at least twice as high as the city corporation now collects and substantially higher than the prices being discussed between the corporation and the World Bank (about $4-5 per kiloliter).

The World Bank project planned ultimately to serve 80% of the city's population through direct household connections. Whittington *et al.*, 1991b, calculated that households using the private vending system in Onitsha were paying $7 million per year, while the annual operation and maintenance cost of the new system would be $3.3 million, and total annual costs, including capital recovery (*i.e.*, interest and depreciation) would be $10 million. However, the household survey results suggest that the city water corporation would have to increase its reliability and water quality to entice such a large proportion of the population to pay. Further, it would have to improve its billing and collection to recover costs.

Unfortunately, the Whittington team did not report any detail on the relationship between willingness to pay (whether based on current expenditure or on survey responses) and household income.[45] The rich consume more water, but it is not known to what extent that extra consumption is due to the fact that they pay a lower price per unit and to what extent to their higher income. Useful estimates of total willingness to pay must make this distinction.

In addition, it is curious that households were unwilling to pay as much for city-provided, piped, running water as for private, vended water in containers. The most likely reason is the city water utility's reputation for unreliability. If householders believed that city service was unlikely to improve, they would feel they had to keep their tanks and vendors. Thus they would probably not be willing to pay as much for unreliable public service (requiring backups) as for their established system.

Another possibility -- that always haunts the contingent valuation method -- is that interviewees were responding strategically: If they believed that their responses would not affect the availability of water but would be used by the city to set prices, they would tend to understate their willingness to pay. However, "strategic" responses may run the other way, too. If they believed their responses would affect their availability of water but would not affect prices, they would tend to overstate their willingness to pay.

Whittington *et al.*, 1991a, also surveyed Kumasi (Ghana) households about their satisfaction with their current sanitation systems, about their interest in either a toilet with a sewage connection or in a ventilated pit latrine (VIP), and about their willingness to pay for either. Most households with private (apartment-shared) sanitation systems were generally satisfied; but there was considerable dissatisfaction with the public latrines -- which were considered lacking in privacy and convenience.[46] Without taking cost into account, the households showed roughly equal interest in toilets and VIPs. Those who preferred the toilets perceived them as cleaner; those who preferred the VIPs perceived them as simpler and more reliable (in part because there is irregularity in the city's water supply).

The survey also included direct questions on willingness to pay for WCs (*i.e.*, toilets) and VIPs with the following results:

> Households without a WC on average said that they were willing to pay about the same amount per month for a WC as for a ... VIP ($1.43 vs. $1.47). Households with a WC said they were willing to pay slightly less than this for a connection to a sewer ($1.32). On average, households without water connections said that they were willing to pay $1.56 for a ... VIP and $2.53 per month for both a water connection and a WC (Whittington *et al.* 1991a: 121).

Hedonic Pricing Techniques

"Hedonic" pricing econometrically estimates the value of specific individual attributes of a good that is sold only as a bundle of these attributes. This technique has been used most extensively to break housing prices down into values of square meters of floor space, number of bathrooms, quality of the air, degree of police security, *etc.* Access to, or quality of, water, sewage, and solid waste service are also attributes of a house. Where it is difficult to estimate the contribution to a house's price of its various "bundled" attributes, regressions across a large sample can yield regression-coefficient estimates of these implicit prices (and hence "market" values).

Kaufmann and Quigley, 1987, examined housing conditions, housing prices (rent or mortgage), and in-kind (primarily labor) contributions to a housing development project for low-income families in Santa Anna (El Salvador). The study examined a sample of poor families who participated in a "sites and services" project and a matched sample who were not project participants.

The study included a very detailed survey of housing conditions and amenities. For example, water service is described by means of five binary variables and four continuous variables. The binary variables indicate whether or not basic types of service are provided: private piped water, public piped water, water purchased from vendors, water carried from streams or wells, and well water. Three continuous variables measure the number of hours per day water is available for the first three types of service. A final continuous variable measures the distance water must be carried. Analogously, the information describing sanitary services consists of four binary variables and two continuous measures.

Total housing expenditure is written as a function of a vector of the housing attributes. This equation is known as a "hedonic price function" and is estimated econometrically. Then, partial differentiation of the function with respect, in turn, to each variable yields the marginal price of each attribute. Estimates of the hedonic price function, combined with estimates of household income and expenditure

and estimates of the private costs imposed on program participants (usually self-help labor), provide estimates of demand for the various housing attributes (including water and sewage service) as a function of the attribute's implicit price and the household income.

Kaufmann and Quigley's analysis includes an index of water service ranging from 0 (very poor -- presumably no access to safe water and a considerable distance to unsafe water) to 3 (very good -- presumably an in-house water connection and a reliable supply of safe water). The analysis estimates that a unit increase in the index of water quality (*e.g.*, from 1 to 2) is worth an extra $2 per month in rent or mortgage payments to the average low-income household (Kaufmann and Quigley 1987: 272). Note that this value is placed on improved access to water alone (*e.g.*, running water in the house vs. a hand pump down the street or perhaps a shallow well in the yard) as a housing attribute; it does not include the cost of the water itself.

Similarly, the index of sanitary service ranged from 0 (very poor -- presumably reliance on the bush) to 10 (very good -- presumably a flush toilet with a reliable sewage connection). This larger range reflects more options than for water service. The value of a unit increase in service to an average house is estimated at about $0.50 per month. Again, this measures only improved service.

Unfortunately, the study's use of indices precludes valuation of specific amenities. Yet it concludes that the direct benefits of sites-and-services projects (not limited to improved water and sewage service) significantly outweighed costs.

Opportunity Cost-of-Time Techniques

This fourth measure focuses on the time spent fetching water and the value of that time were it to become available for other activities. In most developing countries, households without running water (or at least a large storage tank) must send members (usually women) to gather water. A large urban household may need two or more trips per day, involving both walking and waiting time.

Many studies have simply assumed that the value of such time is substantially less than that of unskilled labor, usually on the basis of time valuation from transport studies. But passengers in transit, or waiting, can read, sell, knit, sew, or study -- things people going for water cannot do. Whittington *et al.*, 1990, determined that households value time spent gathering water at approximately the going wage rate.

Whittington's team studied household water source decisions in the town of Ukundu (Kenya), where the vast majority of households not connected to city water can choose several private sources: vendors who deliver water, kiosks that sell water, and open wells. The differences in water quality are not great, so the household's choice of water source depends primarily on price and collection time. Well water is free, but involves the highest collection time for most households (10 to 25 minutes). Water from the kiosk is sold at a fixed price of $0.50 per kiloliter ($0.01 for a 20 liter container), and usually requires 5-15 minutes. Water from vendors costs $5 per kiloliter ($0.10 for a 20 liter container) but requires no household time. Household decisions on where to obtain water thus yield upper and/or lower bounds on the value of their time.

The market wage rate for unskilled labor in the area is about $0.25 per hour. Of the households in the study, 62% chose a kiosk. On average, these households value their time (estimated as the mean of

the midpoints between upper and lower bounds on time valuation) higher than the market wage rate, namely, at $0.38 per hour. Twenty-five percent of the households chose water vendors. The lower bound of the value of time is at $0.57 per hour -- more than twice the minimum wage. Thirteen percent use open wells; but for over half of these, a kiosk is further away than a well. The upper bound for the remaining few households is about $0.37 per hour.[47]

As expected, there is a distinct correlation between household income and choice of water source. Households choosing a vendor have an average annual income of $2,000; a kiosk, $1,250. And households with fewer adult women are more likely to choose a vendor. The study econometrically estimates that -- for an average household, holding income, other demographic characteristics, and prices constant -- the value of time spent hauling water is about $0.31 per hour, one-fourth higher than the market wage rate.

Thus, families getting their water from kiosks pay $0.50 per kiloliter of water, and, if they value their time at $0.38 per hour and spend ten minutes per trip gathering 20 liters at a time, the opportunity cost of their time and effort adds almost $3.20 per kiloliter -- more than six times the cash price of the water.

Techniques for Calculating Costs of Averting and Treating Disease

Families without access to basic environmental services can sometimes avert the worst effects of this lack by private expenditures. For example, if people lack publicly-provided safe drinking water, they must boil water to reduce their vulnerability to disease. But this extremely expensive recourse costs, for example, about 11% of the income of the lowest quartile of the population in Bangladesh, and almost 30% of the income of a squatter family in Peru (World Bank 1992b: 100). Chemical treatment is even more expensive.

The costs of disease treatment are more straightforwardly apparent, once the relationship between services and disease have been established; they include the opportunity cost of the time of health-care workers as well as the costs of drugs, equipment, hospital space, *etc.*

Techniques for Calculating Lost Output from Morbidity and Mortality

The valuation of the opportunity cost of foregone production resulting from sickness or premature death usually makes use of the "human capital" approach, which considers the present discounted value of the lost income of the victim. For morbidity (*i.e.*, an illness of specific duration), this is conceptually straightforward, although it can be difficult to estimate.

Valuing a change in mortality, or risk of mortality, is much more problematic -- how does one value life? Some studies use as a lower bound the present discounted value of the income of an individual's expected remaining working life.[48] Other studies use hedonic estimates of the difference in wages for occupations with different risks of death (for instance, a mine worker must be paid more than a factory assembly-line worker to compensate for the added risk of accidental death or injury). Some studies use contingent valuation, and simply ask respondents: "How much would you demand in compensation for a one in 100,000 increase in the risk of death?" However, there seems to be a big difference

between perceived voluntary risks (*e.g.*, smoking cigarettes or working in a mine) and involuntary ones (*e.g.*, a nuclear power plant built near one's house). There is also a distinction between sudden, accidental death, and death occurring after a long illness (Cropper and Oates 1991: 714).

Most of these studies, which have been undertaken in the developed world, where productivity and incomes are much higher than in developing countries,[49] estimate a higher value of life for the wealthy than for the poor. Most economists escape the dilemma of this morally repugnant differential by describing such estimates of the value of a "statistical life" as lower bound estimates (Cropper and Oases 1992: 713).

Techniques to Account for Pain and Suffering

Many studies of the costs of pollution and disease go beyond averting and treatment expenditures and values of foregone outputs and attempt to add a value for individual willingness to pay for a specific improvement in health.[50] Such studies are, clearly, fraught with practical and ethical difficulties.

The subject of willingness to pay for municipal environmental services has two final complications. First, one often finds a vicious cycle of low reliability of water supplies and low willingness to pay for them. This can lead to misleading estimates of willingness to pay for reliable service. Many studies show that households are willing to pay much more for reliable service. A study in the Punjab, Pakistan, revealed that connections increased dramatically when reliability improved so did revenue (World Bank 1992b: 105).

Second, matching willingness to pay with the right kind of service can be a problem. In a poor region of Thailand, a water project installed neighborhood hand pumps with access to safe groundwater (World Bank 1992b: 106). After five years, most of the pumps had broken due to lack of maintenance; others were disused. A follow-up project installed motorized pumps for neighborhood standpipes. Five years later, the majority of pumps had broken down, and most others functioned only intermittently. The community seemed unwilling to pay for the operation and maintenance cost of these systems and resorted to hauling buckets to and from traditional wells. However, because many households expressed an interest in individual yard taps, the project began to allow them to buy yard taps with meters. Five years later, 80% of the population had opted for yard taps, 90% of which were functioning reliably. Thus most of the community were willing to pay for a higher level of service than project designers had supposed.

Another study, however, found the exact converse (Romm 1987). A community in Bolivia was offered only patio connections, with no possibility of cheaper yard or neighborhood taps. Many households refused (or were unable) to pay, and the project suffered financial losses.

The difference in outcomes suggests that if only kiosks are offered, they will be considered inadequate by households as their incomes rise (*i.e.*, the Thailand problem) yet if only household connections are offered, the currently poor households will not be able to afford them (*i.e.*, the Bolivia problem). Accordingly, water projects should be flexibility designed for level of service (and prices), to ensure that households can upgrade as when they can afford to.

In summary, these studies show a high willingness to pay. The World Bank, 1992b, has concluded that the "vast majority of urban residents ... are willing to pay the full cost" (: 16) of their water

supplies. Ringskog, 1987, cites one persistent myth that is hampering progress: "the belief that consumers cannot afford to pay the higher tariffs which it would take to make the sector financially autonomous" (: 225).

External Benefits

Cities in developing countries must consider, in addition a household's willingness to pay for environmental services, any external benefits of such services for other households. These external benefits fall into three categories: 1) public health benefits (a large portion is the benefit counted under private willingness to pay); 2) benefits of reduced pollution; and 3) benefits of reduced direct damage to a community's welfare.

Such external benefits are gained because one household's decision to utilize clean water, sanitation, or proper waste disposal services will also benefit its neighbors. Yet rational, self-interested households will not fully consider these benefits when deciding to pay for services. These benefits are "public services" in two senses: 1) the neighbors cannot easily be excluded from them even if they do not contribute to the cost of providing them (*i.e.*, non-excludability); and 2) socially, there is no reason to exclude the neighbors from them since their enjoyment uses up no resources that could be used elsewhere (*i.e.*, non-rivalness).

Since these benefits are "external," the market provides no data on their economic value Cropper and Oases, 1992, describe the steps required to value the benefits of reducing pollution:

> (1) the emissions reduction ... must be related to changes in ambient air or water quality; (2) the change in ambient environmental quality must be related to health or other outcomes through a dose-response function; [and] (3) the health or nonhealth outcomes must be valued (: 722).

The first two steps are difficult enough, requiring large amounts of data and sophisticated analysis. The third step, particularly for public health, is even more daunting, being fraught with such imponderables as the appropriate compensation for pain and suffering and, indeed, the very value of life itself.

Public Health Externalities

Although it is impossible to value external public health benefits with any precision, there is abundant evidence that they can be very large. After installation of water and sewage systems in Western cities, life expectancy shot up from the low 30s to almost 50 years.[51] The lost income in Peru during the first 10 weeks of its cholera epidemic -- measured as foregone earnings from agriculture, fisheries, and tourism -- was three times the nation's investment in water and sanitation infrastructure for the previous 10 years (World Bank 1992b: 100).

The World Bank estimates that well over 1 billion episodes of diarrheal and water-born parasitic diseases result each year from unclean water, and that diarrhea alone causes the death of about 3 million people per year. If poor people had access to safe water and adequate sanitation, annually there would be 2 million fewer deaths from diarrhea among children under five years of age, 200 million fewer episodes of diarrheal illness, 300 million fewer with roundworm infection, 150 million fewer with schistosomiasis, and 2 million fewer with guinea worm (World Bank 1992b: 49).

Public health benefits must be ascertained before they can be valued. It is, however, not enough to simply look at before-and-after data for cities making various improvements in environmental services. Experts have shown it is not valid to ascribe too many health benefits to the provision of clean water and sanitation service alone. Their provision usually coincides with other improvements in health infrastructure -- health care, housing, education, and nutrition (Koenigsberger *et al.* 1971: 30-34). To separate the different sources of improvement would require a very careful study. Data are not available on whether the emphasis should be on quantity of water or quality of water, nor on the relationship between the type of sewage system and the incidence of any disease, nor even on what type of benefits can be ascribed to solid waste removal. Even after public health benefits are ascertained, valuing them is difficult. Such valuation can be built up from a number of often overlapping sources similar to those discussed under revealed preference techniques.

But to estimate these external benefits, private valuations must be separated from external or public valuations. Consider a household without access to safe water. If the household boils its water to avoid illness, this incurs a private cost; similarly, if it fails to boil its water, contracts illness, and incurs medical costs and loss of income, these are still private costs. However, if its neighbors lack access to clean water, get sick, and somehow pass the illness to them, the resulting cost is "external" and would not be captured by any assessment of private costs. Thus, some of the value of the benefits is not captured in the value of private willingness to pay.[52]

Production Externalities

Many of the measurable external economic costs of poor sanitation are those imposed on providers -- for instance, raw sewage and solid waste dumped into rivers kill fish and other marine life and adversely affect the outputs and incomes of fishers. This is conceptually straightforward but very difficult to measure. Consider the cholera epidemic in Peru. There was a huge loss in revenue from fishing -- many people stopped buying fish for fear of contamination and fishermen were too sick to work. There are, however, two problems with using this gross output loss to measure the potential benefit of change: 1) the total loss in revenue grossly overstates the net loss to the economy -- whenever fishing boats do not work, there are savings in fuel and other production costs; and 2) gross output and revenue might not fall because fishers compensate for their changed circumstances, devoting more resources (more time spent out fishing, more fuel, bigger nets) to production. The costs of pollution should be measured by the value of the extra inputs, rather than by any loss of output.

Recreational and Aesthetic Externalities

This final category of external benefits is perhaps the most difficult to value. Suffice it to say that there are externalities involved, because people are not only willing to pay to have their own garbage removed and their own septic tanks maintained -- they want their neighbors' garbage removed and

their neighbors' septic tanks maintained as well. This shows up in the willingness of families to pay more to live in a neighborhood that doesn't have garbage lying around and that doesn't smell like an open sewer. These aspects of willingness to pay need also, in principle at least, to be added in.

An important thread runs through this analysis of the economic valuation of basic urban environmental services. People, even poor people, are very willing to pay. But an economic valuation of this individual willingness to pay must be added to, for two reasons. First, since the amenities are not usually sold directly through well-functioning markets, non-market methods of estimating willingness to pay must be examined. In the process, it is more likely that willingness to pay will be under- rather than over-valued. Second, a variety of external benefits is involved, which impinge on a possibly large number of people in multifarious ways. Actual valuation of these benefits will almost certainly miss many of them.

Appropriate Technologies

There is generally high private demand for urban amenities, and social (*i.e.*, externality) considerations urge their provision even more. Yet there is nevertheless a great diversity in willingness to pay among urban residents of different incomes, which suggests a need for flexibility in providing different levels and qualities of service.

In developing country cities, low-cost technologies can help give this flexibility, especially in providing services to the poor. Clearly, given the financial constraints that most developing countries face:

> ... there will be little expansion of service in the 1990s unless sector professionals learn how to incorporate more realistic estimates of effective demand into investment plans and service level choices (Institution of Civil Engineers 1990: 3).

Appropriate technologies are, however, only one imperative. In the past decade, the international efforts to increase the coverage of water supply and sanitation for urban residents in developing countries have taught the importance of encouraging community participation; building local institutions to train personnel to construct, manage, operate, and maintain service systems; and educating the public about of a healthy urban environment. Most important, technologies must also be appropriate both culturally and institutionally.

In the past decade, civil engineers have developed a wide array of low-cost technologies to provide services while innovatively using local institutional and cultural inputs. These technologies, which prove that "quantum leaps" are not necessary to build a healthy urban environment, probably hold the key to sustainable service expansion.

Water Supply and Sanitation

A wide spectrum of technologies is available for the provision of potable water and hygienic sanitation services, ranging from full-scale and centralized piped-water and sewage systems with mostly individual house connections to hand pumps and dry or waterborne on-site sewers. The choice of technology to a large extent determines the cost of the services.

Conventional service systems in the urban areas of developing countries involve city-wide service planning. Cities typically provide households with individual house connections for piped water and sewage. Although these full-scale technologies, adopted from industrialized countries, are routinely constructed and have proven most beneficial to residents, they are very costly (see table 5).

Full-scale technologies are especially costly in the case of sanitation (see table 6). These conventional systems can frequently be prohibitively expensive as the result of high design and service standards.

Costs of service facilities can often be reduced by scaling down the design of these conventional systems and using simpler standards. A survey of World Bank sites-and-services projects carried out in 1974 showed that the use of communal standpipes for water supply, instead of individual plot connections, reduced average costs from $80 to $30-50 per connection (Linn 1983: 149). Often, cost reductions can be achieved by emphasizing quantity of water rather than quality:

> In the last two decades ... an increasing amount of evidence has accumulated for the importance of access to water in adequate quantities as a means of improving health ... water quantity appears to be more important than water quality ... (Cairncross 1990: 111).

Low-cost options for water supply may be constrained by the availability of uncontaminated groundwater. However, low-cost technologies -- such as hand pumps -- can also be used in urban settings. In Epworth (Zimbabwe), locally produced hand pumps supply potable water to 30,000 people who used to rely on contaminated open wells (Morgan 1987: 57). The cost of installation is less than $20 per head. According to a World Bank assessment, "In the areas where groundwater is readily available at moderate depth, constructing a number of wells fitted with hand pumps is by far the cheapest means of providing a good water supply" (McJunkin and Hofkes 1982: 37).

Indeed, many developing countries have taken an innovative approach in scaling down the conventional service systems to achieve economies. In Cochabamba (Bolivia) new design criteria reduce the needed sewer diameters, slopes, and manholes. By also integrating waste treatment with irrigation, the service reaches conventional quality standards at greatly reduced cost (Bartone 1990c: 9). The same principle is also applied in Brazil, where simplified sewage was developed that allows smaller, shallower, flatter sewers with fewer manholes. In combination with low-volume flush toilets (using only one-third the water per flush as conventional toilets), this system reduces costs by as much as 33-46% while providing the same level of service as conventional sewage (World Bank 1992b: 108; Bartone 1990c: 9). In Natal (South Africa), simplified sewage in squatter settlements resulted in an unprecedented connection rate of 97% and full-cost recovery through a 40% surcharge on water bills. To accomplish the same result, a conventional system would have required a surcharge of 100% on a much higher water bill and government subsidies (Bernstein 1992: 75). In Karachi (Pakistan), simplified sewage provides service to the poor. With extensive community participation in

construction and financing, the cost reductions can be dramatic, from $1,000 per household for sanitation facilities to less than $50 in the Orangi Pilot Project. As a result, "600,000 people in Orangi are now served with self-financed sewers" (World Bank 1992b: 108).

There have also been innovative adaptations of conventional sewage to the constraints of developing countries' budgets. Small-bore sewers are used in combination with septic tanks or interceptor tanks to convey solid-free sewage. The cost of such a hybrid sewage system, without diminishing service, is often only half of that for the conventional system (Bartone 1990c: 9; World Bank 1992b: 108). In Brazil, a new sewage design, called "condominial," features a shorter grid of smaller and shallower sewers as feeders to the main system. Costs are reduced 20-30% from those for a conventional system (World Bank 1992b: 107).

Cost savings are the largest if decentralized on-site sanitation can be used. This type of low-cost system is most suitable to urban areas with low population density, well-drained soil, and low water consumption rates. Two systems have been widely adopted in developing countries over the past decade: 1) pour-flush toilets, first developed in India; and 2) the ventilated improved pit (VIP) latrine, first developed in Zimbabwe.

The pour-flush toilet is a waterborne, on-site sanitation system. By using hand-poured water to flush the toilet, a water seal is provided between the household and the excreta storage pit, so that odors, flies, and insects are kept out of the latrine enclosure (McGarry 1982b: 150). The system also suits the local customs of many developing countries, where water is used for anal cleaning. The construction cost is only about $100 per private latrine. This system has enjoyed great success in India since its introduction in 1970s. In Delhi, for instance, public systems expanded quickly, supported by government subsidies, by appropriate user fees, and by community involvement. By November 1990, 68 complexes have been put in place, patronized by 290,000 men and women daily, and another 61 are in the process of completion (Bernstein 1992: 77).

Nineteen other countries throughout South Asia, Africa, and Latin America have adopted a slightly modified system with significant cost advantages. In Jakarta (Indonesia), for instance, the total investment cost for a pour-flush system is only one-fourth that of conventional off-site sewage, while operation and maintenance costs are also lower (De Kruijff 1987: 53).

VIP latrines are designed to reduce the problems of smell and flies typical of conventional pit latrines. The technology is sufficiently simple and in tune with customs of many developing countries to allow wide community participation. Community self-help labor greatly reduces the financial costs of the system. A study on sanitation in Kumasi (Ghana) indicates that a VIP system can significantly reduce the costs of sanitation in comparison with the conventional sewered water closets (Whittington *et al.* 1991a: 124). The system has also been demonstrated in the slums of Guayaquil (Ecuador), where sewers are not economically and technologically feasible (Bartone 1990c: 10).

In Mozambique, the improvement in sanitation is achieved by upgrading traditional "bush" latrines (*i.e.*, a fenced-off corner on the plot with a pit covered with poles, scrap material, and soil). The introduction of composting and VIP latrines, though relatively low-cost, turned out to be unsuccessful because people do not like the idea of emptying latrines and defecating in a roofed house, and construction materials are not all available locally. As a result, engineers developed an innovative design to upgrade traditional latrines by means of a safe and hygienic latrine slab. Families can simply dig a pit and put the slab on. The slab can be manufactured with local materials and costs less than $10.

The household response to the innovative design has been tremendous. Thirty thousand slabs were quickly sold in Maputo alone, and half a dozen other urban centers in Mozambique also adopted the design (Brandberg 1987: 529).

Table 5. Unit Costs of Construction

(median values of national averages)

	Urban Water Supply		Urban Sanitation	
Region	H.C.	S.P.	S.C.	Other
Africa	$100	$4	$150	$53
South America	125	62	165	62
Southeast Asia	55	4	63	15
Europe	100	77	150	50
East Mediterranean	250	102	530	365
West Pacific	80	20	220	50

Notes:
1. H.C. = house connection.
2. S.P. = stand-post.
3. S.C. = sewer connection.
4. Figures are dollars per capita, 1980.

Source: WHO 1984: 32.

Table 6. Cost and Affordability of Alternative Sanitation Techniques

Technology	Mean Annual Cost[2] (1978 $)	Percent of Income of Average Poor Household[2]
Low Cost[1]--		
Pour-flush toilet	$19	2%
Pit latrine	28	3
Communal toilet	34	9
Vacuum-truck cartage[3]	38	4
Low-cost septic tank[3]	52	6
Composting toilet	55	10
Bucket cartage	65	6
Medium Cost[1]--		
Sewered aqua privy[3]	159	11
Aqua privy	168	16
Japanese vacuum-truck cart	188	15
High Cost[1] --		
Septic tank[3]	369	29
Sewage[3]	400	26

Notes:

1. Costs include appropriate shadow prices for unskilled labor, foreign exchange, and capital.
2. Assuming average annual per capita income of $180 and six persons per household.
3. Suitable for urban areas.

Source: Linn 1983: 151.

Solid Waste Collection and Disposal

In developing countries, labor is less expensive relative to capital than in the industrialized countries. Hence, low-cost provision of municipal solid waste services usually involves the use of labor-intensive technology. Reduction in costs requires the judicious choice of solid waste collection and disposal equipment -- units that are designed to suit local geographical characteristics, waste composition, and labor availability. This frequently means that instead of full-scale collection trucks, mechanized compactor vehicles, and street sweepers, small trucks and hand-pulled or animal-drawn carts may be appropriate, except in the largest metropolitan centers.

There is ample evidence that government agencies can provide solid waste services efficiently. For example, the Shanghai (China) municipal government runs a profitable network of recovery stations and waste utilization plants (Cointreau 1987: 43-55). However, private participation can often reduce costs. Private participation through contracting, franchising, competitive bidding, and equipment leasing can sometimes greatly lower costs. In Bangkok (Thailand), contracted municipal solid waste management service appears to have lowered costs. In Seoul (Korea), Jakarta (Indonesia), and Bogota (Colombia), private collections command a substantial cost advantage in labor, wages, and benefits (Cointreau-Levine 1991: 3, 15). In Kuala Lumpur (Malaysia), private firms make more trips per vehicle per day and collect more waste on each trip, and hence are nearly 50% more productive than the public service (*ibid.*: 17). Evidence from Latin American cities also points to lower costs and higher productivity for the private sector (Bartone *et al.* 1991).

This does not imply, however, that privatization is a panacea for the general inadequacy of solid waste service in developing countries, especially in serving the urban poor. Not only are the poor least able to support waste collection with their own tax base or user fees, they also generate the least valuable garbage and the highest collection cost for private providers. The low-cost solution there calls for creative service provision and extensive mobilization of community members to clean up their own neighborhoods. In the slums of Curitiba (Brazil), which cannot be reached by collection trucks, the municipal government motivates people to dispose of their garbage by exchanging food for bags of garbage. The food is drawn from the state's agricultural surplus (Brooke 1992: A4). In Indonesia:

> ... cities commonly work with the local leader of low-income neighborhoods to organize community efforts for self-delivery of waste to a communal depot or to hire and manage the neighborhood's workers who provide door-to-door collection by push cart (Cointreau-Levine 1991: 20).

Many cities in China also rely on community leaders to organize neighborhood cleanups.

Many developing countries have a long tradition of the informal sector participating in the collection and recycling of municipal waste. Armies of scavengers work daily on the streets and in the landfills for recyclable refuse. In Manila (Philippines), about 20,000 people live around a dump known as "Smokey Mountain." A few thousand scavengers live in Bangkok (Thailand) (Cointreau-Levine 1991: 90). In Cairo (Egypt), nearly 4,000 scavengers, known as wahis and zabbaleen, haul over 50% of collected municipal refuse with their donkey carts (Cointreau 1987: 22 and Neamatalla *et al.* 1985: 20). Low-cost waste collection often calls for the integration of this informal sector. In Ciudad Juarez (Mexico), "Landfill scavengers were organized into a recycling cooperative which obtained

a concession arrangement to operate the city landfill;" in Medellin (Colombia), scavengers were organized into "small firms for collecting commercial wastes and for purchasing recyclable materials door-to-door" (Bartone 1991: 507). Thus, the improvement in refuse collection creates the least social dislocation and best utilizes scarce skilled labor when it encourages the informal participation of low-opportunity-cost labor.

This integration of the informal sector can greatly facilitate service expansion at low cost. For example, in 1980 Cairo (Egypt) initiated a pilot solid waste upgrading program to expand service and fully recover costs. From the start, Cairo took a comprehensive approach to improving the wahi-zabbaleen system and to increasing its capacity to handle growing waste generation. The city began to organize the wahis and zabbaleen with modern management and technology. In the meantime, the government offered incentives for them to invest in their trade and to increase their productivity, such as granting land tenure to the zabbaleen living in squatter settlements and providing them with water and sewer services and paved roads. By 1983, the service provided by the traditional sector improved for the upper-income communities with the addition of modern equipment and improved donkey carts, and "more than 150,000 low-income Cairenes were receiving regular household solid waste collection service for the first time" (Neamatalla *et al.* 1985: 51). Moreover, the wahi-zabbaleen system provided equivalent levels of service to a newly trained labor force, with costs reduced by 25 to 30%.

The trend in the now-industrialized countries is rapidly toward highly mechanized, highly safeguarded sanitary landfills. It is very possible that the developed countries are wasting resources in becoming excessively careful with their landfills. But it is very certain that developing countries should not follow their lead. Solid waste is to a great extent not now collected and disposed of at all in developing countries. Simply getting it out of residential areas, and especially congested residential areas, would be a large step forward. Simply "dumping" it in "old-fashioned" landfills may be a very cost-effective way of improving the solid waste situation. In short, if resources are adequate only for collection or for disposal, collection is the clear choice.

A wide range of technological choices is thus available for the provision of water, sanitation, and solid waste services. Moreover, the most appropriate choice is often the low-cost technology that takes advantage of widely available unskilled labor and provides a kind of service that matches both the limited ability to pay and cultural traditions of poor neighborhoods. Since developing countries' investment in these sectors is always constrained, low-cost technologies may prove essential to alleviating the inadequate delivery of these services to the urban poor. By using low-cost technologies in water supply and sanitation over the next 10 years, some 80% of the now unserved population could be served at only one-third of the total cost that would be needed to provide 100% coverage with a mixture of high, intermediate, and low technologies (Christmas 1990: 27).

Summary and Recommendations

By the year 2000, 20 of the 25 largest cities on earth will be in developing countries (Hamer and Linn 1987: 1256). These cities may be growing too rapidly, due to anti-rural and pro-industrial biases in developing countries' development policies, but urban growth is the inevitable by-product of economic growth. Provision of environmental amenities in these developing country cities has not kept pace with urbanization. Basic services, such as water, sewage, and waste disposal, are poorly provided in most of these cities and are especially poorly provided to the poorest segments of the population.

The poor, everywhere, are poorly provided with many things. Why should one worry especially about the provision of water, sewage, and waste disposal? For two reasons. First, the declining-cost technology of these services makes them particularly badly handled by the private sector, so that the poor have few market substitutes to fall back on if public provision fails, and those few market substitutes are likely to be monopoly-priced. Second, these services have important externalities, particularly in the area of public health, so that even a well-functioning private market would underprovide them. "Privatization" of their provision may be appropriate, but only if it is publicly planned -- and possibly subsidized.

It is not as if cities must thrust these services down the throats of the poor. The poor, as well as the rich, in developing country cities place a substantial value on access to these services and, in fact, are willing to pay high prices for private alternatives when public provision fails. Non-market data also suggest a high willingness to pay for water, sewage, and refuse collection. External benefits, though more difficult to quantify, are also substantial.

Where budgetary constraints preclude provision of "first class" service to all urban residents, usually alternatives can be provided. Urban amenity provision is not an all-or-nothing issue.

Furthermore, pricing is not an all-or-nothing proposition. It is not necessary that every person serviced by an urban amenity cover the full cost (*i.e.*, the marginal cost plus that person's share of the interest and depreciation on the capital), nor is it necessary that the poor be provided with optimal service at zero cost. Pricing systems can charge different amounts to various people and still cover costs. Pricing systems can lose money and need subsidy from the general funds of the government because they are justified by externality, public good, and merit good arguments. And gradations of service can be supplied to different people within the same municipal jurisdiction.

The search for such differential pricing and provision schemes has begun. Prakash, 1987, recommends pricing residential water in developing country cities -- and the idea is readily extended to sewage and solid waste collection -- with lifeline tariffs in the form of progressive block tariffs, where the first 20-40 liters per capita per day incur only a very low charge (:260). High block tariffs for heavy water users could then recoup the losses on the lifeline prices. Linn, 1983, has pointed out that it is primarily the large, once-and-for-all, initial connection fee -- rather than the ongoing water service prices -- that deters most of the poor from connecting up to city water, where it is available. Linn's point suggests a sequential, three-part strategy: 1) start by providing long-term, commercial financing for connection fees where households want them; 2) if many families cannot afford connections even with this financing, subsidize the remaining household connections; and 3) if the city cannot afford

subsidies of this magnitude, target affordable subsidies to standpipes in poor neighborhoods (: 166). In short, one can picture the urban poor in developing countries as consisting of three groups:

1. People not now receiving adequate services who are quite willing to pay their full costs.

2. People who can come close to paying the full costs. For these, externality and merit good arguments justify the provision of basic services; and cross-subsidization, either from wealthier recipients or from the general fund, can make such provision practical.

3. The very poor, who are able to pay very little. For these, there are alternative, low-cost technologies.

There are compelling arguments for providing basic urban environmental services in developing country cities, perhaps even on a subsidized basis, to everyone -- including the very poor. Does this mean further increasing the "urban bias" of development strategy? It need not. The urban poor need public provision of water, sewage, and waste disposal services more than the rural poor; the total cost of minimal provision of these services is higher in urban than in rural areas; and the external benefits of their provision are greater in urban than in rural areas. These three facts make such provision a higher priority in urban than in rural areas. An urban-rural balance in the provision of public services does not mean an identical public expenditure on identical services in the two areas. To offset the greater expenditure on water, sewage, and waste disposal appropriate for the urban poor, developing countries should stand ready to incur the greater expenses required to provide other services to the rural poor, such as education, health, and transport. The urban poor should not benefit at the expense of the rural poor, but the urban poor should benefit by receiving a more appropriate mix of public and private services.

Notes

1. Note the word, "directly." Actions of consumers and providers that affect others through their effects on market quantities and prices (*i.e.* "pecuniary externalities") do not cause market failures.

2. In environmental applications, public "bads" are simply the mirror image of public "goods" or services. Cleaner air, or the abatement of air pollution, is a public good; dirtier air, or the creation of air pollution, is a public bad.

3. There are also environmental "demerit services," where the political process chooses a maximum level of consumption that a person may enjoy -- or that a person must endure -- for services deemed harmful or where society, by some collective political process, interferes to prevent individuals from irrational overconsumption.

4. Sometimes a distinction is made between two kinds of "merit services," those that will not be consumed by the poor because they cannot afford them and those that are not consumed by certain citizens because they are irrational (Besley 1988). Our use of the term implies the former.

5. See Todaro 1969, and Harris and Todaro 1970.

6. Sometimes policies are also noted that keep rural wages (or rural labor opportunities) artificially low.

7. The persistent misunderstanding of the structure and activities of urban squatter settlements in the developing countries has been labeled by Perlman, 1976, as "the myth of marginality."

8. For lengthy documentation of anti-poor urban policies in the developing countries, see Hardoy and Satterthwaite 1989, Chapter 2.

9. A 1983 United Nations survey of 126 developing countries' governments found that only three countries considered the rural-urban distribution of their populations to be "appropriate" and that three-fourths of the countries were pursuing policies to reduce or reverse the rate of rural-urban migration (Shukla and Stark 1985: 297).

10. Throughout, the theory being discussed depends upon the assumption that the income elasticity of demand for agricultural products is less than one. Evidence supporting this assumption -- called Engel's Law -- has been accumulating for well over a century.

11. As the 21st century approaches, improvements in transportation and communication may be making the city -- or at least the very large city -- less essential to manufacturing growth, but such speculation is irrelevant here.

12. This costly by-product of rapid population growth has long been noted (Coale and Hoover 1958). It is worth noting that rapid population growth, in itself, ought to lead to a slower, not a faster,

rate of growth of cities both by shifting demand toward agricultural products and by providing greater labor for the labor-intensive agricultural sector (*i.e.*, the Rybczynski effect).

13. The phrase, "on the cheap," is from Williamson 1990: 270. He continues, "Investment in housing and public works simply failed to keep pace with the rest of Britain's economy in the first half of the nineteenth century" (: 272).

14. Through much of the nineteenth century, it was known that "people die more rapidly in cities than in rural districts," that there was "no inherent reason for the relatively high urban mortality," and that the differential rate of mortality disappeared with "sanitary improvements" (Weber 1899: 343, 367).

15. Nor was the United States very fast to provide urban environmental services (Melosi 1981, Ch.1).

16. See Rosenberg and Birdzell 1986: 175ff, and Williamson 1990, Chapters 9 and 10. Wohl 1983, argues that this neglect of environmental services was due to two forces: 1) capital-market failure, which made it difficult for cities to borrow for the capital investment in urban infrastructure; and 2) public-sector failure, which gave heavy voting weight to the groups who would have been most heavily taxed to pay for such infrastructure investment. Also see Brown 1988. Kearns 1989, argues that "environmentalism required interventionism" (: 120), and interventionism was something nineteenth-century European cities were slow to accept.

17. Using the regression of solid waste per capita on GNP per capita estimated by Shafik and Bandyopadhyay 1992: 27, one can derive the additional solid waste produced by each additional dollar of GNP. For countries at GNP per capita of US$100, each additional GNP dollar generates 0.21 kilograms of solid waste; at GNP per capita of US$10,000, 0.01 kilograms. (Hereafter, the $ sign always refers to the US$.)

18. Simple regressions of (the logs of) various measures of developing countries' environmental welfare on (the log of) per capita GDP (for example, Shafik and Bandyopadhyay 1992: 27) confirm both the slight positive relation and the high variance:

Dependent Variable	Income Elasticity	R^2
Percent with Safe Water	0.12	0.43
Percent with Sanitation	0.14	0.22
Solid Waste Collected	0.38	0.60

The safe-water regression reported in the above table is actually the percent without safe water, adjusted by us to estimate the above elasticity. The safe water regression is for the rural as well as the urban population; the bottom two regressions are for urban only. The top two income elasticity estimates are calculated at 80% coverage for water and sanitation. The R^2 figures are adjusted.

19. This means the percentage of the African population that is urbanized has been growing at 2.3% during the 1980s.

20. The regression analysis uses cross-section data for 56 developing countries, all those for which we could find complete data in WHO 1983, and UNDP 1991. The dependent variables are the 1980 urban percentage coverage rates for water supply and for sanitation. The exact definitions of the four independent variables are as follows: GNP per capita (in 1980, in thousands of dollars); GNP per capita growth rate (real, during 1980-88, in percent per annum); population growth rate (in 1980, in percent per annum); and the percentage of the population living in urban areas (in 1980, in percent). Since the dependent variables are bounded by 0 and 100, and the lower bound is not actually binding, a Tobit regression model is used to estimate the coefficients; the ordinary least-squares (OLS) regressions are also reported.

21. The results are reasonably robust. Replicating the above regressions using a different data set (World Bank 1922b and UNDP 1991) yields similar conclusions. There, GNP per capita becomes a more significant determinant and the urbanization percentage a less significant determinant (though still a strong positive force on coverage).

22. One cubic meter equals one kiloliter (*i.e.*, 1000 liters). The exponential is just another example of "the rule of two thirds" that often appears in the cost functions of processes that treat or transport fluids.

23. The cost of water without sewage is not estimated in this source.

24. Depreciation and interest costs added another $0.10 per cubic meter.

25. The wide range in cost reflects differential technical factors, particularly of terrain and soil.

26. In this project, however, sewage treatment was expected to be minimal.

27. It is difficult to "bond" private firms for distant obligations, and it is impractical to make them carry insurance or form "contingency funds" when the potential amounts are so large and so uncertain.

28. The monopoly price could, in principle, fail to cover the full cost, but we will not further consider this.

29. Full-cost pricing, (*i.e.*, pricing at average total cost) refers to both the operation and maintenance cost (*i.e.*, average variable cost) and the interest and depreciation cost (*i.e.*, average fixed cost).

30. The concept of marginal cost (or incremental cost) is clear enough -- it is the cost of producing one additional unit of output. The shadings of meaning to the criterion of "marginal cost pricing" derive from the question, <u>marginal what cost</u>?

31. In practice, what is called "long-run marginal cost" is usually an estimate of the per-unit cost of operation, maintenance, depreciation, and interest in the next planned stage of expansion.

32. Such expansion cost, and hence the long-run marginal cost that incorporates it can be very high indeed:

> In Mexico City [Mexico] ... the city has to contemplate pumping water over an elevation exceeding 1,000 meters ... in Lima [Peru] upstream pollution has increased treatment costs by about 30%; in Shanghai [China] water intakes have already been moved upstream more than 40 kilometers, at a cost of about $300 million; and in Amman [Jordan] the most recent works involve pumping water up 1,200 meters from a site about 40 kilometers from the city (World Bank 1922b: 101).

33. Either way, many utilities then find that inflation seriously erodes the value of these "mortgage" assets. Such random redistribution serves no sensible policy goal.

34. The World Bank has been encouraging this kind of pricing for several years; as of 1977, it had been implemented in 21 of the 36 developing countries that had borrowed from the World Bank for water projects and that had metered connections (Linn 1983: 189).

35. A cross-subsidy refers to the system of pricing where profit is earned on the sale of some services in order to cover losses on the sale of others.

36. Efficiency arguments, for water especially, can be exaggerated. Over most relevant ranges, price elasticity of demand for water is so low -- usually -0.3 to -0.6 (Gomez 1983: 2) -- that the deadweight loss associated with inefficient prices represents only a small fraction of the total value of consumption.

37. Most household water in developing cities is used for drinking, cooking, and watering vegetable gardens; a much greater percentage of industrial water winds up in the sewage system. However, the proportion of water assumed to enter the sewage system may be a "political" estimate, that is, not necessarily an accurate estimate of reality but one intended to reallocate the burden of support for the sewage system from households to businesses.

38. These prices seem very high, but this is due to our conversion to dollars at the over-valued exchange rate.

39. Bucket latrines and aqua privies are relatively simple, temporary storage systems that must be emptied regularly. Bucket latrines utilize open storage and must be emptied at least twice a week; aqua privies utilize a compartmentalized, water-filled storage tank and may be left for longer intervals.

40. For a fuller description of these VIP systems, see the Appropriate Technologies section.

41. Only about 60% of the septic tanks, however, are desludged on a regular basis. The rest "routinely overflow and discharge to street drains and ditches, making WCs [*i.e.*, toilets] one of the most poorly operated sanitation systems in the city" (Whittington *et al.* 1991a: 120).

42. The public latrines charge a fee of $0.02 per visit for most adults; children and the elderly are admitted free.

43. The 200 liter drum is the well-understood standard unit of measure for water in Onitsha. To avoid "starting point bias," the survey randomly offered respondents either a relatively high proposed starting bid or a relatively low one.

44. *i.e.*, raising prices beyond that level would lead to falling revenues due to the loss of large numbers of potential customers.

45. Only price is needed to estimate marginal willingness to pay, but, to estimate the total benefit of a large water project, one needs estimates of consumers' willingness to pay.

46. Interestingly, respondents did not complain about the lack of cleanliness of the public toilets.

47. A calculation error in the article incorrectly specifies $0.53 per hour (: 273).

48. While this method is widely utilized by the legal profession, it runs into serious logical and ethical objections. For example, is the value of a retired or disabled person's life zero? Or for another example, where women earn less than men because of occupational or wage discrimination, does this mean that their deaths are socially of lower cost?

49. For studies undertaken in Asia, see Shin *et al.* 1992.

50. Alternatively, one estimates the willingness to accept (WTA) compensation for a specific worsening in health status. In theory, at the margin, most WTP and WTA valuations should be very close. Any discrepancy between WTP and WTA is brought about by income effects when we are dealing with outcomes without good substitutes. Public services with no close substitutes may display a large discrepancy between WTP and WTA; and in practice, many studies have turned up considerable discrepancies between WTP and WTA estimates, with WTA valuations sometimes many times higher than WTP valuations (Cropper and Oases 1993: 702, 711).

51. *i.e.*, life expectancy at birth.

52. On the other hand, simply adding all the value of the health-related benefits to the value of private willingness to pay would involve extensive double-counting of the benefits.

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