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Pricing, Subsidies, and the Poor

Demand for Improved Water Services in Central America

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Evidence from Central America's publicly owned and managed water supply companies indicates that the urban poor are ill served by current subsidy policies. The best way to improve water services for the urban poor, this study concludes, is for tariffs to reflect system costs and for consumption to be metered. This permits each household to determine how much it wants to spend on water while ensuring sustainability of services across the network. The attitudes of poor communities toward metering are generally positive.

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Summary findings

Reformulating tariff and subsidy policies is central to improving water and sanitation services in developing countries. The traditional model of state enterprise service provision, coupled with residential tariffs set well below the cost of service, has generally delivered unsatisfactory results. Low internal generation of funds has impeded expansion of networks into poor communities and has resulted in very poor services there. Most of the subsidy has benefited higher-income groups. Reformers have proposed private provision to improve efficiency, cost-reflective tariffs to permit the systems to meet demand, and better-targeted subsidies.

But is there empirical evidence that existing subsidies are ineffective and that the poor could pay the full cost of water services? Analyzing household survey and water company data from cities of Central America and Venezuela, Walker, Ordoñez, Serrano, and Halpern confirm that:

- Households without piped connections pay a lot for small amounts of water from "coping sources."
- Most public water companies undercharge hugely, providing an implicit, generalized subsidy and accelerating their systems' decapitalization.
- There is little income-related differentiation in consumption and therefore in effective piped water tariffs. Volume-based tariffs would generate cross-subsidies from the rich to the poor if the rich consumed more water. But the data indicate that consumption of piped water varies little with income, so most of the water subsidy is captured by the nonpoor.
- Poor households that are not presently connected would clearly benefit from access to piped water supply. This would require increasing tariffs to cost-reflective levels. But where the urban poor already enjoy access, such tariff increases would have a disproportionate impact on this income group. This impact should be mitigated through better-targeted, temporary subsidies.
- The poor are often willing to pay much more than the present tariff for access to piped water but not necessarily the full cost of the monthly consumption assumed by planners (30 cubic meters). If tariffs were set to cover long-run financial costs, many poor households would consume much less. Improving the design of tariff structures and extending metering to such households would permit them to regulate their expenditures on water by controlling their consumption.

This paper—a product of the Finance, Private Sector, and Infrastructure Sector Unit, Latin America and the Caribbean Region—is part of a larger effort in the region to evaluate and disseminate lessons of experience in designing policies to improve the quality and sustainability of infrastructure services and to enhance the access of the poor to these basic services. Copies of this paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Silvia Delgado, room I5-196, telephone 202-473-7840, fax 202-676-1821, email address sdelgado@worldbank.org. Policy Research Working Papers are also posted on the Web at www.worldbank.org/research/workingpapers. The authors may be contacted at iwalker@esa.hn or jhalpern@worldbank.org. November 2000. (23 pages)

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Demand for Improved Water Services in Central America

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Abstract

The reformulation of tariffs and subsidy policies is central to the reform of water and sanitation services in developing countries. The traditional model of service provision has coupled public ownership with tariffs that are set well below the cost of the service, justifying this in terms of the importance of water services for the health status of the poor. However, results have often been unsatisfactory. Service quality and coverage remain inadequate in many countries, and subsidies directed at public water companies have often benefited the middle classes rather than the poor, who remain unconnected to the public network. Reformers have proposed to break out of this "low level equilibrium" through a combination of private sector provision (to improve efficiency), full-cost tariffs (to permit the expansion of the service in line with demand), and better targeting of subsidies (to ensure that reform does not have a negative impact on the poor). However, there is a scarcity of empirical evidence regarding the current distribution of subsidies and the demand for water services, so that the proposition that subsidies are poorly distributed and that the urban poor are willing to pay for efficient piped water services are often offered up as items of faith. This paper seeks to contribute to the discussion of sector reform through an empirical analysis of water tariffs, subsidies and water demand in Central American and Venezuelan cities, based on household survey data generated during 1995-98.

The analysis confirms that households without a piped connection pay large sums for small amounts of water from "coping sources". Few countries have explicit subsidy policies for piped water, but a comparison between existing tariffs and the estimated efficient cost of providing water shows that most public water companies undercharge hugely, leading to a generalized implicit subsidy and to accelerating de-capitalization of their systems. The study also shows that there is little income-related differentiation in effective piped water tariffs. Each of the cities studied had volume-based tariffs, which would generate cross subsidies from the rich to the poor if the rich were to consume more water. In fact, the consumption of piped water varies little with income. As a result, the richest 60% of households capture most of the implicit subsidy. The obvious way to favor the poor is to increase coverage, rather than to subsidize piped water. Nevertheless, in cities where piped water coverage is high, many relatively poor households at present do receive a significant subsidy. Since poorer households spend a higher proportion of their income on water services, raising tariffs to cost-reflective levels would affect these groups disproportionately. In this situation, the introduction of targeted subsidies could be used to avoid a negative impact on the poor of global tariff adjustments.

The second part of the paper analyzes the demand for water, drawing on both contingent valuation estimates generated by "willingness to pay" surveys and revealed preference data. Contingent valuation responses confirm that the poor are normally willing to pay much more that the present tariff for piped water. However, they also suggest that the poorest urban households are not always willing to pay for the full cost of the standard monthly consumption of $30m^3$ often assumed by planners. Revealed preference estimates confirm that if tariffs were set to cover long run financial costs, average demand in many cities would be below $30m^3$ a month. This reinforces the case basing the tariff on the system costs and using metering to allow households to determine how much water they consume and pay for. In Panama, metering lowered consumption by over 20% in four months. Across the region, survey and focus group findings show that attitudes to metering in poor communities are generally positive. It is regarded as the fairest way to charge for water and meters are also regarded as a proxy for tenure rights in informal settlements. Therefore, metering should be considered as part of service upgrading programs and should be promoted as a means of fostering fair distribution of costs.

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[1] ESA Consultores, Tegucigalpa, Honduras.

[2] LCSFP, World Bank.

1 Introduction

Ready access to clean and safe water is taken for granted in industrialized countries. But in poor countries, large proportions of both urban and rural households do not have access to safe water. In Central America, "potable" water coverage ranges from under 40 % to 70% in rural regions and the average national coverage in urban areas lies in the range 80% to 90%, although some individual cities have coverage of up to 100%. For those with access, the water is frequently not potable in the strict sense of the word and the quality of service (frequency, pressure and quality of the water supplied) is often poor (Walker and Velasquez, 1999).

The coverage and quality of the service is generally correlated with income and wealth and the poorer the country, the closer the correlation. Where there are not enough public resources to provide piped water for everyone, the better off have usually exercised political influence to ensure that their communities are included in the formal piped water network and receive a service superior to that available in lower income communities. The poor adopt coping strategies to compensate for the absence or inadequacy of the piped water supply, which include the purchase of water from trucks and hauling water from standpipes or domestic faucets in neighboring communities. Such strategies are normally extremely expensive in terms of money and time. In contrast, piped water normally is priced well below the marginal cost of provision.

The production and distribution of potable water has the characteristics of a natural monopoly, due to the costliness of moving raw water between river basins and of duplicating local distribution networks. At the same time, universal access to adequate water and sanitation services has long been recognized as a cornerstone of public health and an essential component of individual well being. The traditional response of governments to these twin concerns has been public ownership, management and financing of water companies and setting tariffs at levels deemed affordable to all households, both for distributional and public health motives. As these tariffs were on average below the level required to recover costs, implicit and explicit operational and investment subsidies were established to bolster the precarious financial position of the water companies. At the same time, there was a progressive accretion of complex and contradictory cross-subsidies, which aimed to redistribute income between social groups.

When the poorest households do not have access to piped water, the argument for subsidizing the tariff loses much of its force, since the resulting subsidy distribution is likely to be regressive. When the available resources are "captured" by better-off consumers or by system employees, low water prices may have perverse distributional consequences. They present a financial obstacle to the expansion of services into the low-income communities and condemn the poor to paying much more for an inferior, non-piped service, even though they may be able and willing to pay the full cost of a piped service.

Traditional tariff arrangements are also associated with limited household-level metering of consumption. For those without meters, the water charge is simply a fixed fee, not linked to the volume of consumption. This promotes inefficient consumer behavior, as those with a superior supply consume water up to the point where marginal utility is zero. In rationed systems (including most urban systems in Latin America) this prevents increased consumption by other households, which still have positive marginal utility.

These weaknesses result in two basic types of problems. The first is *inefficient resource allocation*. When marginal water tariffs are lower than the marginal cost of provision, there is little incentive for the water company to expand the service and fewer resources are allocated to potable water provision than would be optimal.[3] Moreover, incomplete networks and unreliable services result in the adoption of costly "coping mechanisms", such as water distribution by tanker trucks and by human haulage, and household investment in cisterns. The second basic problem is that of *distributional inequity,* as subsidies are regressively distributed when the poor do not have access to subsidized piped water service.

In recent years in Central America, the multilateral development banks have commissioned water demand surveys and willingness to pay studies, in order to document the underlying feasibility of a policy shift towards tariffs which reflect system costs, coupled with the introduction of targeted and transparent demand subsidies in place of the global supply subsidies implicit in generalized under pricing. Such studies have been undertaken by the consulting company ESA Consultores, in national and regional capitals in six countries in the region:

- Honduras (1995). Marginal *barrios* of Tegucigalpa and the intermediate cities of San Pedro Sula, Santa Rosa de Copán, Choluteca and Comayagua (World Bank and IADB).
- Nicaragua (1996). Marginal *barrios* of Managua (World Bank).

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[3] This is true so long as the users would, in fact, be prepared to pay a tariff equal to marginal cost.

- El Salvador (1996). The whole of the intermediate cities of Santa Ana, San Miguel and Sonsonate (IADB).
- Venezuela (1996). The whole of Caracas, Barquisimeto and Merida (World Bank and IADB).
- Venezuela (1997). Marginal *barrios* of Caracas (1997) (World Bank).
- Guatemala (1997). Marginal *barrios* of Guatemala City (World Bank).
- Panamá (1998). The whole of Panamá City and Colón (World Bank).

Details of the survey universes are presented in Annex 1.[4] The present paper brings together the results of these studies in a comparative framework, which seeks to amplify our understanding of the microeconomics and the political economy of water supply in low-income communities in the Latin America. The paper also highlights the policy implications of its findings. It is divided into four principal sections:

- **The distributional impact of tariffs for piped water services**

Section 2 analyzes subsidy elements of potable water tariffs. It estimates the subsidy households received by income quintile in six cities, to assess the degree to which poorer households benefit. The pattern of access to sewerage services is also analyzed. This section closes with a discussion of implications for the political economy of sector reform.

- **Analysis of water demand using revealed preference data and contingent valuation survey data**

Section 3 compares findings on water demand generated by two different methodologies. It first presents revealed preference data for water consumption and expenditure (in time and money) for households without a piped supply, which use "coping sources" and for those with a piped supply and metered consumption[5]. These data are used to generate household water demand curves for each of the cities studied. The revealed preference results are then compared with contingent valuation data on demand for improved water services, based on responses to survey questions. These findings on demand are then related to each system's costs and existing tariffs.

- **Attitudes towards metering**

Water metering is desirable in order to establish a positive marginal consumption price. It is economically rational to establish metering wherever the economic opportunity cost of water released by metering is greater

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[4] Further details on the data sets used for this study are available from the authors.

[5] The analysis in this section looks at households that are effectively metered, whose consumption will expand to the point where marginal utility is equal to the marginal tariff. Many households with a piped supply do not have effectively metered consumption. They will therefore consume water up to the point where marginal utility is zero. This is given by the intercept between the demand curve and the x axis.

than the cost of metering. This is likely to be the case in rationed systems[6]. But politicians are often reluctant to install meters, fearing the resistance of low-income communities. In some cases there have indeed been conflicts around metering. This section presents evidence on attitudes towards water metering taken from the household surveys and focus group exercises, which show a high potential for acceptance when metering is associated with service improvement.

- **Conclusions and policy recommendations**

The final section summarizes the main findings and their implications for sectoral policy.

[6] Formally, it is rational to introduce metering wherever the economic benefit derived by the households who will get more water when other users reduce their consumption due to metering is sufficient to offset the costs of installing and reading the meters plus the loss of economic benefit of the users whose consumption will be reduced by metering

2 The distributional impact of tariffs for piped water services

It is well known that households without access to a piped water connection spend a high proportion of their income on relatively small volumes of water provided by inefficient un-piped services. The benefit to these households from getting a household connection would be very high indeed. A recent case study of Honduras underlines this finding (Walker et al, 1999).

However, it is often also assumed that *within the scope of networked services*, the poor consumers lose out to the better off, because they receive services of inferior quality and/or because the tariff arrangements are regressive, due to high fixed charges that penalize households with lower consumption levels, which tend to be the poorer households. This hypothesis implicitly underlies the assumption that there will be political support from the poor for policy changes which combine tariff increases with service quality improvements. The present section analyses survey data on the consumption of and payment for piped water services by households that have a domestic connection, to see to what extent the poor lose out to the rich within the scope of the existing piped water systems.

Charges levied for the services are compared to the estimated cost of providing an efficient piped water service.[7] It is shown that tariffs are generally below the efficient financial cost, so the systems as a whole are subsidized.[8] Transfers between richer and poorer households are shown to be small, indicating a slight cross subsidy.

This is due to two factors. First, per-household consumption is similar across income groups. This, in turn, suggests *both* that there is little income elasticity in the demand for piped water in the cities studied; *and* that the amount of rationing faced by users at different levels of the income distribution is similar.

The second factor is the structure of tariffs in the cities studied (see text box). In each case, the main source of differentiation in payments was a stepped tariff, where the charge per cubic meter rises as consumption rises. In this type of system, the "progressivity " of the tariff structure depends in the main on the degree to which the rich consume more than the poor. However, water consumption is generally stable across income groups, so this mechanism does not result in differential charges for richer households in the cities studied. However, in some cities there are also "social" tariffs, which do lead to differences between the payment of the lowest quintile and other households.

There are, however, two clearly regressive distributive impacts of pricing piped water and sanitation services in the cities studied. First, where coverage is not universal, households without a connection are denied any subsidy and must resort to use more

Water tariffs in the systems studied

In the systems studied in the present paper, the structure of the domestic water tariff at the time of the survey had the following characteristics:

- There was a fixed minimum volume, which is charged for regardless of whether it is consumed. This is 15 m^3 *in most places; in Panama it is 30* m^3 *for* residential consumers and lower amounts for low-income areas.
- The marginal per-meter charge for consumption above the minimum is a progressive function of the total volume consumed. In El Salvador there were 3 ranges; in Nicaragua there were 9; in Panama, 5 and in Venezuela 4. The degree of progressiveness related to volume varies considerably from place to place.
- There are regional variations, which aim to capture differences in costs and / or in social conditions. These normally specify a higher tariff for the metropolitan system. In Venezuela there were seven "types" of tariff; in El Salvador there were two (metropolitan and other); in Nicaragua there were geographical distinctions within the capital city according to the distance from an historically important source and the regions paid less than the capital; in Panama there were four regional or spatial variants in the tariff.
- There was normally a special tariff for "social" cases. Sometimes this only applies to standpipes (El Salvador); in other cases it applies generally to informal settlements (Managua, Panama, Venezuela).
- In all these systems, the coverage of micro metering is relatively low; in some of them, it is simply none existent. In such conditions, the water company's discretionary estimates of each user's water consumption are crucial to tariff setting. This discretion is often used with the intention of trimming the bill to what the company thinks each part of the market will bear. As a result, the company's more or less arbitrary estimates of consumption and their decisions on zoning (where this is a factor in the tariff) turn out to be the key determinants of what people pay for water.

[7] For Merida and Panama, the cost data include the cost of wastewater collection and treatment .

[8] At present, in the systems analyzed, costs are above efficient levels. The present study uses as a benchmark estimated efficient costs based on forward-looking projection. See Section 2.1.1. for details.

costly sources. These households are much more likely to be poor than those with a piped water connection. Second, differential access to sewerage services results in a regressive transfer from poorer to richer households, because the poor are less likely to have a sewerage connection, but the water tariff is usually the same for those with or without a sewerage connection. However, in the absence of cross country data on sewerage costs, it was not possible to quantify this effect.

2.1 Data

In order to analyze the distributional impact of water tariffs it is necessary to have data for the amount of subsidy (positive or negative) received by each household and for the income of the household. The following paragraphs describe the methodology used to arrive at these estimates. This part of the paper is restricted to the cities where the survey universe covered the whole city population (not just marginal barrios) and where the registers allowed an estimate to be made of the volume of piped water consumed at a household level.

2.1.1 Cost and subsidy estimates

For each system, a benchmark tariff was estimated on the basis of cost projections including operation and maintenance and capital costs (financial charges plus depreciation). This tariff is set to generate a real rate of return of 12%. Table 2 summarizes the resulting estimates. This allows us to establish whether a given household is receiving a subsidy. Those who pay less than the benchmark tariff are defined as subsidized, while those who pay more are being over-charged. Using this framework, the paper explores the way that differential pricing redistributes resources between consumers.

Table 2

Long run average financial cost for piped water/1

	Estimated average cost of water, US$ / cubic meter	
	Operation & Maintenance	Total
Managua	0.27	0.47
Merida, Ven [9]	0.09	0.13
Sonsonate, ES	0.11	0.18
Santa Ana ES	0.10	0.17
San Miguel, ES	0.12	0.21
Panamá & Colón	0.59	0.71

Note: 1/ These data in general reflect only the cost of piped water production and distribution and do not include that of wastewater collection and disposal, except in the case of Merida and Panama, where no separate data were available for water alone.

2.1.2 Household income estimates

The household surveys generated data for monthly household income based on the incomes of all household members from all sources.[10] These data permit ranking households by per capita income and grouping them by quintiles from poorest (1) to richest (5). This analysis could only be done where the survey universe covered the whole city population and not just marginal barrios, as in the latter case no data are available for the upper range of household incomes. Table 3 shows the percentage of households in each income quintile with a domestic connection for potable water.

Table 3

Who gets piped water services?

% of households in each quintile with a domestic connection

	1	2	3	4	5	All
Managua	93	97	98	97	98	97
Merida, Ven	100	100	100	100	100	100
Sonsonate, ES	71	80	84	93	94	84
Santa Ana ES	84	92	98	99	100	95
San Miguel, ES	54	65	67	79	86	70
Panamá and Colón	98	95	99	100	100	98

For Managua, Merida and Panama & Colon, coverage is very high (close to 100%) for all income groups. This means that low-income households are likely to receive an important share of any subsidy, unless they are

[9] For Mérida no data are available for capital costs. The full cost is estimated from the available data for O&M cost applying the average ratio between full and O&M cost reported for the other cases. A more recent study reported a somewhat higher figure for total financial cost for the Merida system, of $0.22 per cubic meter (OXERA, 1999). However, this relates to a later period. The above estimate for water costs have been used in order to maintain methodological consistency, because this number relates to the period when the survey data were gathered (1996). Note: even if the total average financial cost were higher than is here indicated, the pattern of cost distribution between income quintiles (which is the main focus of the present study) would not be affected

[10] Where the informant knew the job of a household member but not their income, income was imputed from the average value reported by other cases in the same database with the same type of job.

subject to disproportionate rationing or discriminatory pricing. In contrast, in the three Salvadoran cities of Sonsonate, Santa Ana and San Miguel coverage is lower, and is strongly correlated with income.

2.1.3 Water consumption and expenditure estimates

The surveys measured expenditure on piped water for all cases and registered the volume consumed where meters were installed (table 4a). For households without meters, consumption was imputed using regression analysis of the households with meters to identify the main independent variables (apart from price) linked to consumption. The determinants of water consumption varied from city to city. They included: the frequency of the piped water service, per capita household income, number of people in the household, geographical location, the size of the dwelling or plot, and storage capacity for water. The resulting coefficients were used to estimate piped water consumption for un-metered households. The analysis is restricted to the cities with sufficient observations of metered consumption to permit this imputation: Managua, Panama, Merida and the three cities in El Salvador.

Table 4a

Average household piped water consumption for metered households

M3 per month consumed by households in each quintile with a metered domestic connection

	1	2	3	4	5
Managua	25	57	29	31	28
Merida, Ven	49	35	37	43	40
Sonsonate, ES	35	26	34	27	28
Santa Ana ES	25	31	33	30	31
San Miguel, ES	30	34	27	29	26
Panamá and Colón	30	29	31	30	37

Note: There were sufficient observations in each case for the average to be statistically significant.

Based on this procedure, table 4b shows estimated consumption in all houses with a network connection, by household income quintile.[11] There is little evidence of discriminatory rationing in low-income areas. Average consumption is higher in the wealthier quintiles in only two cases (Panama and Santa Ana); in all the other cases, consumption is similar across income groups. This is consistent with the fact that Merida and Managua have relatively good coverage and service frequency across the whole network, while both Sonsonate and San Miguel are small cities where rationing is undertaken in a relatively uniform fashion.

Table 5 shows piped water expenditure for households with a domestic connection, and table 6 shows the implicit price per cubic meter, derived from tables 4 and 5. There is a significant cross subsidy from richer to poorer households only in Managua, where the richest quintile pays 53% more per cubic meter than the poorest (table 6). This reflects the failure of INAA (the operating company at the time of the survey) to collect more than symbolic fees in marginal barrios, which received a good service. In the other cities there is much less evidence of cross subsidy: in Merida the richest pay only 28% more per cubic meter than the poorest; in Sonsonate, 28% more; in San Miguel, 37%, in Panama, 13%, and in Santa Ana there is no difference at all.

Table 4b

Estimated average household piped water consumption for all households

M3 per month consumed by households in each quintile with a domestic connection, including imputed consumption for unmetered connections

	1	2	3	4	5
Managua	23	34	25	26	26
Merida, Ven	43	38	38	40	39
Sonsonate, ES	30	26	30	27	27
Santa Ana ES	25	29	30	31	34
San Miguel, ES	30	31	27	30	27
Panamá and Colón	28	28	30	31	36

Note: For households without water meters consumption is imputed. See text for explanation.

Table 5

Average expenditure on piped water

US$ per month spent on piped water by households in each quintile with a domestic connection

	1	2	3	4	5
Managua	3.5	4.0	3.9	5.0	5.8
Merida, Ven	2.9	1.7	2.1	2.0	3.5
Sonsonate, ES	5.6	4.7	7.4	5.3	6.2
Santa Ana ES	5.0	7.5	6.9	6.0	6.7
San Miguel, ES	5.7	7.4	5.3	6.3	7.0
Panamá and Colón	8.4	10.7	11.2	10.7	12.6

Note: For households without water meters consumption is imputed. See text for explanation.

[11] It might be argued that the procedure adopted for imputing consumption for un-metered households is likely to result in an underestimate, because the metered cases on which the imputation is based face positive marginal prices. In contrast, the un-metered households face a zero marginal price and are therefore likely – *ceteris paribus* – to consume more than a similar metered household. This effect is likely to be greatest when the supply is less rationed. In future work we propose to refine these estimates by developing a methodology to take account of these price and rationing effects when imputing consumption for un-metered households.

2.2 *The incidence of subsidies*

In this section, the data derived in Section 2.1 are used to analyze the distribution of subsidies. "Subsidy" is defined as the shortfall between the amount charged and the benchmark tariff, which reflects the estimated efficient cost of water service, while households paying more than the benchmark tariff are deemed to be "over charged". In order to assess distributive impact, the total subsidy received or over-charge paid by each quintile is estimated. In cities with high coverage, subsidies are distributed relatively evenly across income quintiles, with the result that the preponderance of benefits accrue to the non poor. Only in the two Salvadoran cities with relatively low coverage (Sonsonate and San Miguel) does a different pattern emerge. Since in these cases, the water users as a whole are being over charged to generate transfers to the national water company, ANDA, and the poorer households who are excluded from water coverage avoid paying this; the resulting distributive impact within the water system is progressive. The following sections detail the steps of the analysis.

Table 6

Average unit price of piped water by quintile US$/m^3

	1	2	3	4	5
Managua	0.15	0.12	0.16	0.19	0.23
Merida, Ven	0.07	0.05	0.06	0.05	0.09
Sonsonate, ES	0.18	0.18	0.25	0.19	0.23
Santa Ana ES	0.20	0.26	0.23	0.19	0.20
San Miguel, ES	0.19	0.24	0.19	0.21	0.26
Panamá & Colón	0.31	0.38	0.37	0.35	0.35

Note: Derived from tables 4 and 5.

2.2.1 Subsidies at the quintile level

Table 7 compares the price paid in each quintile (taken from table 6) with the benchmark tariff presented in table 2, to show the amount of implicit subsidy each quintile receives. In Managua and Panama all users are quite heavily subsidized and the level of subsidy is fairly uniform across quintiles. In Merida there is less subsidy but once again it is fairly even across quintiles. In Sonsonate the average price of water is very close to its real cost. Low-income users (the first two quintiles) are neither subsidized nor over charged, but higher income users pay a small surcharge. In San Miguel there is a small subsidy to the very poorest and a small surcharge on the richest. In Santa Ana everyone is overcharged, and at about the same rate.

The total amount of over charging or subsidy received is a function of the unit price of water per cubic meter, compared with its cost, and of the volume of water consumed in the quintile. This, in turn, depends on the average consumption for households with a domestic connection, and on the proportion of households with piped water.

Table 7

Average unit subsidy of piped water received by the quintile

US$ per M^3 of subsidy received by the households in each quintile with a domestic connection

	1	2	3	4	5
Managua	0.32	0.35	0.31	0.28	0.24
Merida, Ven	0.06	0.09	0.08	0.08	0.04
Sonsonate, ES	-0.005	0.00	-0.07	-0.01	-0.05
Santa Ana ES	-0.03	-0.09	-0.06	-0.02	-0.03
San Miguel, ES	0.02	-0.03	0.02	0.00	-0.05
Panamá and Colón	0.40	0.33	0.34	0.36	0.36

Note: Derived from tables 2 and 6.

Table 8 shows the average amount of subsidy received by each household with a water connection. In Managua the global average monthly subsidy is $8.08 per household and the amount received varies little by income level. In Panama the average is $10.88 per month and varies little across income groups. In Merida there is a lower subsidy of $2.72, again uniformly distributed. In the three Salvadoran cities studied there is considerable overcharging, ranging from US$0.24 per household/month in San Miguel to US$1.36 a month in Santa Ana. In San Miguel and Sonsonate the over charging for the lowest income groups is much lower than that for the higher income groups.

Table 8

Average monthly subsidy per household, by quintile, US$ · month

	1	2	3	4	5	Total
Managua	7.28	12.04	7.75	7.20	6.14	8.08
Merida	2.72	3.21	2.85	3.19	1.64	2.72
Sonsonate	-0.14	-0.01	-1.99	-0.35	-1.32	-0.76
Santa Ana	-0.75	-2.56	-1.80	-0.74	-0.94	-1.36
S. Miguel	0.49	-0.83	0.50	-0.06	-1.29	-0.24
Panamá & Col.	11.13	9.25	10.24	11.03	12.75	10.88

Source: Derived from tables 1 through 7.

Table 9

Total monthly subsidy received by all households in each quintile, US$ month

	1	2	3	4	5	Total
Managua	231,263	399,205	259,705	238,797	205,555	1,334,524
Merida	18,869	22,266	19,716	22,122	11,331	94,305
Sonsonate	-250	-13	-4,212	-814	-3,138	-8,427
Santa Ana	-3,784	-14,156	-10,587	-4,394	-5,656	-38,577
S. Miguel	1,120	-2,271	1,405	-202	-4,686	-4,635
Panamá & Col.	493,124	397,505	458,617	498,710	576,552	2,424,509

Source: Derived from tables 1 through 8.

Table 9 shows total monthly subsidy by quintile, taking account of the proportion of households connected to the system. The systems in Managua and Panama are both heavily subsidized, to the tune (respectively) of $1.3 million and $2.4 million per month. In each case, this subsidy is distributed fairly evenly across income groups, with rich and poor benefiting alike. In Merida the total subsidy is much lower ($94,000 per month), reflecting the smaller size of the city and the lower subsidy per cubic meter. In El Salvador, the water company ANDA is shown to be transferring a significant amount of resources from Santa Ana ($38,500 per month) and smaller amounts from the, other two cities, presumably to cover costs in San Salvador.

The estimates presented in tables 8 and 9 are based on a benchmark tariff that reflects the full cost that an efficient company ought to incurr , as reported in table 2. However, the water companies' cash expenditures are lower than this, because in general they make inadequate provision for asset depreciation and do not normally pay for capital finance, which is granted by the Government.

Table 10

Average monthly subsidy per household, by quintile, based only on Operation and Maintenance costs, US$ month

	1	2	3	4	5	Total
Managua	2.70	5.22	2.80	2.03	1.04	2.76
Merida	0.96	1.65	1.27	1.54	0.01	1.09
Sonsonate	-2.25	-1.83	-4.08	-2.27	-3.22	-2.73
Santa Ana	-2.49	-4.59	-3.88	-2.89	-3.30	-3.43
S. Miguel	-2.17	-3.66	-1.97	-2.75	-3.76	-2.86
Panamá & Col.	7.83	5.88	6.62	7.35	8.46	7.23

Source: Derived from tables 1 through 7.

Tables 10 and 11 repeat the same calculations as tables 8 and 9, but this time only the Operation and Maintenance costs are taken in account. The results show a much lower monthly subsidy per household in Mangaua, Merida and Panama, at $2.76, $1.09 and and $7.23 respectively, compared with the full cost estimates of $8.08, $2.72 and $10.88.

Table 11 shows the monthly total subsidy for each system, based only on operation and maintenance costs. Once again the subsidies in Managua, Merida and Panama are smaller than those reported in table 9. In both Managua and Panama, transfers from the central government finance part of the subsidy. The rest is accounted for by deferred maintenance: the company spends less than it should on programmed maintenance, which is likely to shorten the life of equipment. In El Salvador, when only O&M costs are taken into account, the small cities of Santa Ana, San Miguel and Sonsonate are shown to be veritable milch-cows. They generate surpluses ranging from $30,000 to $98,000 per month for the water company ANDA, to help offset deficits elsewhere.

Table 11

Total monthly subsidy received by all households in each quintile, based only on Operation and Maintenance costs, US$ month

	1	2	3	4	5	Total
Managua	85,841	172,932	93,904	67,227	34,729	454,634
Merida	6,623	11,460	8,795	10,682	93	37,653
Sonsonate	-4,031	-3,681	-8,627	-5,307	-7,630	-29,276
Santa Ana	-12,579	-25,375	-22,867	-17,216	-19,827	-97,865
S. Miguel	-4,944	-10,014	-5,559	-9,163	-13,625	-43,305
Panamá & Col.	346,849	252,614	296,341	332,624	382,785	1,611,214

Source: Derived from tables 1 through 8.

Table 12

Percentage of total subsidy received by each quintile, and progressivity index for each system, /1

	1	2	3	4	5	Index of progressiveness /2
Managua	17%	30%	19%	18%	15%	0.06
Merida	20%	24%	21%	23%	12%	0.06
Sonsonate /1	3%	0%	50%	10%	37%	0.31
Santa Ana /1	10%	37%	27%	11%	15%	-0.06
S. Miguel /1	-24%	49%	-30%	4%	101%	0.82
Panamá & Colón	20%	16%	19%	21%	24%	-0.04

Notes: 1/ For the three cities in El Salvador the table shows % of total implicit over-charging paid by the quintile. In these three cases, a negative figure implies a subsidy. In the other cases, the table shows the % of total subsidy received by the quintile. 2/ The progressiveness index is defined over a range of -1 to +1, with a zero value reflecting neutrality, -1 reflecting maximum regressiveness (all the subsidy goes to the richest quintile) and +1 maximum progressiveness (all the subsidy goes to the poorest quintile).

The estimates derived above can be used to calculate the distribution of total subsidy.[12] Table 12 summarizes the findings reported in tables 8-11. In Managua, Merida and Panama subsidies are distributed more or less uniformly across quintiles and the system is neither progressive (in the sense that it favors the poor more than the rich), nor is it regressive. In each case, the index number for the degree of progressivity is close to zero. In Santa Ana, the burden of over-charging is uniformly spread so this system is also neutral in distributive terms. The neutrality in the incidence of subsidies across income groups shown by these results contrasts with the stated goal of tariff/subsidy policies of protecting the poor. However, in both Sonsonate and San Miguel, the better off pay much more than an equal share of the excess charges levied, and are therefore progressive in a distributive sense. This arises because water coverage is low in the poorer quintiles and the rich pay a little more per meter than the poor.

2.2.2 Sewerage coverage and charges

It is clear from the foregoing analysis that where piped water supply coverage is high, subsidies appear to be relatively evenly distributed across income groups. However, an important element of regressivity arises from divergent sewerage connection rates across income groups. In all these cities, apart from Managua, the water tariff is the same for those with or without sewerage services, because sewerage coverage is supposed to be mandatory, and the charges are levied for a composite service. However, in practice, many poor households do not have sewerage connections (table 13).

Table 13

Percentage of households in each quintile with a sewerage connection

	1	2	3	4	5
Managua	38	49	53	66	78
Merida	96	97	100	100	98
Sonsonate	50	70	71	83	88
Santa Ana	57	76	80	84	92
S. Miguel	43	59	59	75	82
Panamá & Colón	42	41	67	69	80

At present, many of these systems are being prepared for privatization, with major investments slated for the collection and treatment of wastewater, in order to improve environmental conditions. This will mean significant tariff increases. In this context, priority should be given to increasing the sewerage connection rates of low-income households, which normally generate bigger environmental and health gains than the installation of wastewater treatment systems.[14] To ensure equity, only households that are physically able to connect to the sewerage system should be charged for this service[15]. This will also give the operator a clear incentive to extend

[12] This exercise has been done only for the full cost tariff and not for the Operation and Maintenance tariff.

[13] When the cumulative curve crosses the 45-degree line, this introduces a degree of ambiguity into the findings. For the calculation of the progressiveness index in table 12, this paper simply nets out the areas above and below the line to produce a global figure.

[14] However, it should be noted that the environmental and heath gains to be had from installing sewerage where good latrines already exist are normally small (ESA Consultores, 1999). It is always advisable to make a careful study of the cost-benefit relationship to be expected from imposing stricter environmental norms related to wastewater management on water system operators.

[15] Note that the proper criterion for levying the charge is *access* to the service, not *connection* to the service. If charges were only levied on households connected to the sewer mains, there would be a financial disincentive to connect.

coverage, as doing so will generate additional tariff revenue.

2.2.3 Implications for the political economy of tariff reform

The under pricing of water brings damaging long run consequences in the form of under investment and poor service quality. The pattern of subsidy distribution indicated above is also inefficient from the point of view of social policy, since a large proportion of the total subsidy goes to households who do not need it. However, the situation may be difficult to change. Unless financial performance is so weak as to require large current transfers, the Government's fiscal motive for reform may be limited . On the other hand, in many cases, if all subsidies were to be removed, poor households with piped connections would be negatively affected, facing increased tariffs and reduced real incomes. [16]

None of this removes the case for reform to increase efficiency and recover costs through the introduction of regulated private operators. However, it does suggest that, where coverage is already close to 100%, the political economy of reform is different. In cities with low coverage, the poor will gain unambiguously from improved coverage, and have little to lose from tariff adjustments, as they are presently excluded. However, where the poor already have access and receive a proportion of the existing subsidy, they stand to lose from tariff reform if it is not carefully designed. Opponents of reform might form alliances with low-income communities, who have a reasonable fear that they will be negatively affected by the tariff changes implicit in sector reform and private participation. The privatization program in Panama hit this sort of political obstacle in late 1998, and was put on hold as a result.

It may then be necessary for the political viability of reform to design subsidy mechanisms targeted to the poorest households and energetically to publicize this policy. Many commentators believe that the inclusion of a subsidy guarantee for the poorest households was crucial to the success of sector modernization in Chile in the 1990s. Another strategy to promote reform was developed in a World Bank project in Managua in 1996. Poor communities in informal settlements generally enjoyed relatively good service and were paying well below cost for water service. However, focus group consultations revealed dissatisfaction with the lack of formalization and with the failure to replace improvised local distribution networks with properly engineered systems, including meters (considered a symbol of tenure security). The community was willing to pay more in return for the correction of these problems. The water company therefore developed a program to link formalization and reengineering with tariff increases in the city's *asentamientos*. A similar program coupling formalization and physical upgrading with the initiation of charging for water services has been developed for the World Bank project, PROMUEBA Caracas.

Another finding is that centralized systems may be dogged by cross subsidies between cities. It is common for the metropolitan system to absorb resources from the smaller cities, whose political influence is less. This seems to be the case in El Salvador, where all three non-metropolitan systems were over-charged. As it happens, this over-charging is done in a relatively progressive way (i.e. it falls mainly on the wealthier households). Nevertheless, in such situations, secondary cities are likely to be strong supporters of decentralization, since they could operate sustainably with a lower tariff. It is striking that the momentum for decentralization has gathered force in El Salvador over the last year (Walker and Velzásquez, 1999).

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[16] This would be even more clearly the case in some other cities in the region, which were not included in this study for data reasons, and which have tariff systems that favor the lower income households. This is the case in Caracas, where the water company, HIDROCAPITAL, supplies water to the marginal barrios without charging. This is financed by a mixture of central government subsidy and cross subsidy from the richer areas of the city. The quality of the service in many marginal areas is very poor, partly due to deliberate rationing by the company, in response to the fact that it derives little or no income from such areas. Nevertheless, enough water is supplied to maintain the viability of these settlements.

17

3 The demand for improved services

Tariff adjustments to achieve cost recovery are central to water sector reform in Central America. As seen in the previous section, many systems run at a loss. They finance the shortfall between tariff revenue and costs through operating and capital subsidies from the government and through accelerated depreciation of capital. The result is a gradual deterioration of service quality as the system becomes trapped in a "low level equilibrium" characterized by low tariffs, poor service and limits on access, especially of poor households. This vicious circle has proven difficult to break, partly due to politicians' nervousness about the political impact of tariff hikes. Section 2 showed that in many systems, the poor receive part of the existing subsidy and argued that this adds to the political complexity of tariff reform. It suggested that the political sustainability of reform might be improved by focusing subsidies on assuring access of the poor. However, it is difficult to dimension tariff and subsidy proposals without more precise information about what people are willing to pay for water services.

This section presents evidence on the demand for improved water services. It first discusses two alternative ways of measuring willingness to pay: "revealed preference" estimates and contingent valuation surveys and then presents the findings of the Central American studies. For several of the cities, it is possible to compare the results of direct revealed preference and contingent valuation estimates. These are also compared with the benchmark tariff needed to cover average long run financial costs and with the tariff that prevailed at the time of the survey.

Definitional problems dog the discussion of willingness to pay. For economists, willingness to pay is a technical term referring to the area under the market demand curve, including *both* the amount paid to suppliers (market price times volume) *and* the triangle of "consumers surplus" which lies above this. The latter is not paid by the consumers, but reflects the fact that they would have been willing to pay more than the market price for the intra-marginal part of the total volume they are purchasing, since their marginal utility is a declining function of the volume of consumption. When a cost-benefit study reports "average willingness to pay" for water, it is referring to the amount an average consumer would freely pay for an average cubic meter of the water they consume, and NOT to what they would pay for the last (or marginal) cubic meter that they consume. This average will always be greater than the marginal price, due to the existence of consumer surplus. However, the term willingness to pay has also come to be widely used in a looser way in discussions about tariff setting for public services. Here, it usually refers to the price that the market (or some part of the market) will bear. This means the marginal price at which users would consume some specified volume of water. This is clearly different from the concept of willingness to pay as used in welfare economics. To avoid confusion, in this paper, the term willingness to pay is used exclusively to refer to "average willingness to pay". [18]

3.1 Empirical problems in the measurement of water demand

Demand curves should where possible be derived from revealed preference data. These can be taken from water companies' commercial databases (which hold data on metered consumption) and from specialized household surveys (which show what people pay for water from "coping" sources as well as household income and consumption data). These data have been used to derive demand curves.[19] In more elaborate studies ,

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[18] Both concepts of willingness to pay are distinct from the notion of *ability to pay,* which refers to the financial capacity of the household in relation to the cost of a benchmark quantity of water considered to be necessary for hygiene and cooking. The World Health Organization (WHO) has issued a widely used guideline suggesting that households should not be asked to surrender more than 3.5% of their monthly income to pay for basic water and 1.5% for sanitation services. It might be a goal of policy to ensure that the poor can buy a basic amount of water without sacrificing more than a certain proportion of their income. The policy maker might, for example, want to set up the tariff in such a way that an average household in the bottom quintile pays no more than 5% of their income for a basic supply of water and its sanitary disposal. If this is incompatible with the economically efficient tariff, a variety of possible mechanisms for subsidy or cross subsidy might be adopted to bridge the gap. However, many analysts believe that there is no good economic reason to limit expenditure on water to a given percentage of income. On this view, the amount spent on water should depend on the cost of water in a given place and on the preferences of the dwellers. In many cities with a stressed water supply, the efficient cost of supplying a basic service runs well above 5% of income and the households are clearly willing to pay such an amount, because they do so. It is not clear what the case would be for subsidizing this consumption through lower tariffs, especially if this were to lead to an increase in the volume demanded. If public resources are to be made available to increase household incomes in these places, it may be preferable to provide general income support.

[19] There are various empirical problems with this sort of analysis:

the demand curves are used jointly together with supply functions to estimate long run system equilibrium of supply and demand.[20] To generate a meaningful "revealed preference" demand curve for water, the minimum information needed is the following:

- Survey data on prices and consumption for households without a piped connection, who use "coping sources". Where there are various sources with different prices, there might be multiple observations.
- The average price-volume point for households with a piped service that is both un-rationed and metered.

This provides two or more points for a demand curve for the average household.[21] The curve can then be fitted so long as the general functional form can be inferred. Usually, a semi-log function is used.

An alternative approach is to apply contingent valuation methodologies, which were originally developed for the valuation of environmental "public" goods. The demand curve is inferred from the results of survey questions about what households would be prepared to pay for a specified service. This sort of work began to be done in the late 1980s, mainly to establish demand for rural water systems in Africa and Asia.

The standard approach in contingent valuation is to use "referendum" survey questions. The interviewee is asked how he would vote on a specified change in the service, having first been told what change in cost this would imply. People who would vote in favor are considered to have a willingness to pay for the improved service, at least as great as the cost stipulated in the questionnaire. Normally, only one cost is put to each respondent, but alternative costs are postulated to other respondents, so the impact of different prices (or tariffs) on the proportion of positive responses can be analyzed.

This approach has its own set of difficulties. The training of the survey workers is a delicate matter, due to the need to avoid the interviewer influencing the response. CV data may be "contaminated" by strategic bidding. If the interviewee believes the response may have an impact on the tariff, they may deliberately under-bid in order to procure a lower tariff. If, on the other hand, they think their response may affect the decision to implement a project that will benefit them, they may deliberately over-bid, in order to ensure that the project is approved. Properly applied, the "referendum" method should reduce this type of risk, but it cannot eliminate it.

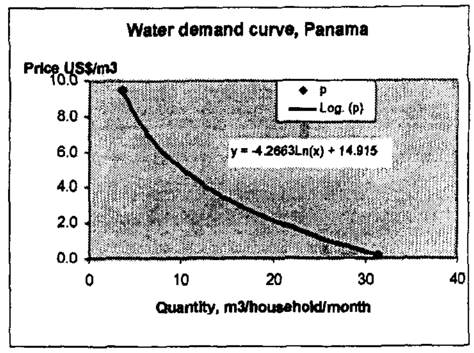
The use of contingent valuation techniques to determine the demand for piped water is especially difficult. The technique was originally developed for valuing categorical changes (eg the value of the existence of a forest, compared with its disappearance). It lends itself less well to valuing continuous variables, such as the volume of water consumed in a piped service. It is difficult to address volume in a survey questionnaire. It is meaningless to ask the question: "If the price per meter were $0.30, what volume would you purchase monthly?" as users often have little notion of volume.

- Where a new piped water system is to be constructed, *ex ante,* only the demand for non-piped water can be observed (through survey work). However, consumption of non-piped water usually falls into a range that is distant from that relevant to piped water. Demand for a piped supply must be inferred from other systems.
- Metering is needed to generate observations on household water consumption. Estimated consumption (which often appears in the water company's database as the legal basis for the tariff calculation) is meaningless for economic analysis.
- Where consumption is rationed, we cannot observe points on the demand curve from individuals' behavior, as they will be consuming less than they would wish to consume at the existing price.
- Where tariffs are levied without reference to the volume consumed, they constitute a lump sum service charge and the marginal price is zero.
- In most tariff systems there is only one marginal price per type of consumer so there are insufficient observations to derive the elasticity of demand empirically. The analyst has to guess the elasticity and use sensitivity analysis to show that his results are robust. An alternative way of generating sufficient price-demand observations is to trace changes in the real tariff through time due to either inflation or nominal tariff changes, and see how volume responds. However this begs many questions about the effect of money illusion and of changes in other unknown independent variables (the time trend), so the empirical validity of the results will always be questionable.

[20] The program SIMOP generates this sort of estimation.

[21] It might be objected that piped water and un-piped water are two different products, so that it is not legitimate to derive a single market demand curve from observations on "coping" sources and piped water consumption. However, the two can be regarded as essentially similar products if the following conditions hold: 1) neither source is strictly potable; 2) the piped source is not continuous (so that the use of either service requires a storage system in the household); 3) the coping source delivers water to the household and the full cost of this (including household labor) is accounted for. The first two conditions hold for the systems covered by the present study, and the estimates of the price for water from coping sources include the full cost of delivering the water to the house, including the imputed cost of household labor.

Rather, the usual type of question is the following: "If the price were $10 per month for an average consumption of 30 cubic meters a month, variable in accordance with the real metered consumption of each household, would you vote in favor of the system improvement I have described?" As a result, the survey can only be used to estimate one point on the demand curve, reflecting the average amount that respondents would be prepared to pay for the stipulated volume. If the questionnaire were to postulate a variety of quantities with different respondents, it would in theory be possible to observe more than one point on the demand curve. But this is rarely done, due to the difficulty of concretizing the notion of volume for the respondent.



3.2 *Water demand data generated by the Central American water studies*

The surveys on which the present article is based generated demand data of both the aforementioned types: revealed preference estimates and contingent valuation estimates. This section summarizes the findings and comments on their significance.

3.2.1 Revealed preference estimates

All the surveys gathered data on household water consumption and expenditure. These are used to estimate the average price per meter and the average volume consumed per month for a) households without a piped service, who use coping sources such a wells and water trucks; and b) households with metered piped services[22].

Table 14

Demand for water of households with and without a piped service

	Without piped service		With piped service	
	M3 / month	US$ / m3	M3 / month	US$ / m3
San Pedro Sula, Hon	3.55	2.46	39.50	0.24
Intermediate cities, Hon /2	2.73	1.18	33.50	0.09
Managua	6.30	0.71	33.70	0.19
Sonsonate, ES	5.30	1.65	29.40	0.18
Santa Ana ES	8.80	1.48	30.40	0.18
San Miguel, ES	11.40	0.41	28.60	0.18
Panamá & Colón	3.55	9.51	31.40	0.21
Unweighted average	**5.95**	**2.49**	**32.36**	**0.18**

Table 14 shows the average price paid and quantity consumed for households with and without a piped service in each city. Those without a piped service pay between $0.41 (in San Miguel) and $9.51 (in Panama) per cubic meter of water consumed, including both the cash spent and the imputed value of the time used for hauling the water.[23] Consumption varies inversely with this price, ranging from 2.73 meters per month in Comayagua, up to 11.4 meters in San Miguel. On average, these households consume 5.95 meters at a price of $2.49 a meter, spending $14.8 per month.

The households with piped water face more uniform tariffs, ranging from $0.09 per meter in Comayagua to $0.24 in San Pedro Sula. Their consumption ranges from 28.6 meters in San Miguel up to 39.5 meters in San Pedro Sula. On average they consume 32.4 meters a month at a price of $0.18 per meter, spending in total $5.82. It is obvious that there would be large economic gains for the households without piped water if they were to be given a piped service on these terms.

These two points were used to derive a simple household demand curve, by fitting a semi-log function.[24] This was used together with the benchmark tariff reported in Section 2 to determine the equilibrium price and quantity.[25] An example is shown here for Panama.

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[22] Theoretically one should use the measurement of *unrationed* consumption. However an analysis of consumption of metered clients with different service frequencies in all cases revealed an insignificant difference between the overall average consumed and the average consumed by those with an unrationed service. This suggests that households develop storage capacity to meet their consumption goal, regardless of the frequency of the service.

[23] The opportunity cost of the time used carrying water was valued at 40% of the average hourly income found in the income data in the survey.

[24] Strictly speaking this procedure is only valid so long as it is assumed that the households with and without domestic connections are otherwise similar. In fact, those without piped water are generally poorer. However, this is unlikely to cause

These curves were used to estimate willingness to pay (WTP), based on the area under the curve (table 15)[26]. The WTP for 30 cubic meters varies from $12.5 a month in San Miguel up to $140 per month in Panama. WTP per meter ranges from $0.42 in San Miguel to $4.67 in Panama. The estimate for Panama reflects the high value imputed to the household labor time used to carry water, which in turn reflects labor market conditions in Panama City.[27]

Table 15
Revealed preference estimates of Willingness to Pay, US$

		WTP per month	WTP per meter/1
San Pedro Sula, Hon	Marg. barrios	42.5	1.42
Intermediate cities, Hon	City wide	17.2	0.57
Managua	City wide	16.1	0.54
Sonsonate, ES	City wide	30.7	1.02
Santa Ana ES	City wide	37.3	1.24
San Miguel, ES	City wide	12.5	0.42
Panama and Colon	City wide	140.1	4.67

1/ The per meter estimates reflect estimated average household consumption in each city, derived from applying the estimated full cost tariff to the household demand curve.

3.2.2 Contingent valuation estimates

In each of the cities, the surveys asked contingent valuation questions to establish WTP for an improved service with monthly consumption of 30 cubic meters. In all cases, the institutional scenario postulated metered service with delivery at least once per day. Where households already enjoyed an "ideal" scenario (formalized service with a 24 hour supply every day) they were asked about their willingness to pay a higher tariff to avoid deterioration in this service. This was done in Caracas, Merida and Panama.

Only one price was put to each subject. The various prices under investigation were distributed randomly between different subjects. The analysis is based on the percentage of "yes" and "no" answers to each price. In most cases, the question was put in the referendum format. In a few cases for households without a piped service, it was formulated in terms of the decision to connect to a new service. The resulting estimates are presented in Table 16. They were derived from logistical regressions, using standard methodology. In each case the estimates were made using a linear function (for estimates of both the average and the median value) and a logarithmic function (for the median only)[28]. The estimates can be used to infer average household WTP for 30 cubic meters of water per month. This is a single point on the household demand curve for water, analogous to the point for "with piped water" in table 14, but with volume fixed in each case at 30 meters per month. [29] Since existing service conditions might affect responses, the results are shown separately for households who already had a piped service and those who had none. In general, those without a formal piped connection are prepared to pay more than households who have one.

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a major distortion, due to the low income-elasticity of water demand. The validity of the procedure also depends on the two commodities "piped water" and "un-piped water" being essentially the same. (see footnote 21).

[25] For the present study, no iteration was undertaken between the demand and supply functions. Implicitly, it is assumed that the long run cost curve is flat. Section 3.2.5 discusses the implications of this assumption not holding.

[26] See footnote 18 for a discussion of the definition of *willingness to pay*.

[27] The proportion of families without piped water in Panama is very low and the number of observations for such households in the dataset is also correspondingly low. This figure should therefore be treated with circumspection.

[28] The regression outputs and estimation procedures are available from the authors.

[29] The contingent valuation results do not permit inferences about the shape of the demand curve for lesser volumes. As mentioned in section 3.1, this would only be possible if the surveys had solicited responses for a range of volumes. Absent that, one cannot ascertain willingness to pay in its full sense from contingent valuation, while one can from the revealed preference data (Table 15). The contingent valuation data in table 16 reflect only the area of the rectangle formed by the price-volume pair for 30 meters per month, and do not capture the triangle of consumer surplus, which lies above it.

Table 16
Contingent valuation of the amount households would pay for 30 cubic meters
$US per month for a formalized connection with meter, daily service, consumption of 30 m3 / month

		Linear estimate (average and median)		Logarithmic estimate (median)	
	Scenario:	a) Improved or maintained service	b) New formal connection/1	a) Improved or maintained service	b) New formal connection/1
Tegucigalpa, Hon	Marg. Barrios	4.7	5.0	4.4	5.3
San Pedro Sula, Hon	Marg. Barrios	n/a	4.1	n/a	3.8
Intermed. cities, Hon	City wide	3.1	n/a	3.1	n/a
Guatemala	Marg. Barrios	12.0	21.8	11.1	30.7
Managua	City wide	5.3	6.3	4.7	5.7
Caracas, Ven: Petare	Marg. Barrios	n/a	14.0	n/a	11.3
Caracas, Ven: La Vega	Marg. barrios	n/a	13.1	n/a	10.6
Caracas, Ven: Cotiza	Marg. barrios	n/a	6.3	n/a	5.6
Sonsonate, ES	City wide	10.0	10.8	9.7	10.6
Santa Ana ES	City wide	9.6	17.4	9.2	20.0
San Miguel, ES	City wide	13.7	10.8	14.7	10.6
Panama and Colon	City wide	16.0	31.2	15.2	43.2

1/ In all but two cases, these are households without a domestic connection at the time of the survey. The exceptions are Managua and Panama. In Managua these are households connected illegally to the system, which were asked their WTP for a formalized and improved service. In Panama they are households with a poor service, which pay nothing as they are classified as "social cases", who were asked about their WTP for an improved service.

3.2.3 The impact of income on the responses to contingent valuation questions

The surveys also permit the analysis of the impact of income on payment intention. The survey responses indicate that the poor are willing to pay similar amounts to the non-poor for water (Table 17).

The average willingness to pay of the poorest quintile for a metered, piped service of 30 m^3 per month is estimated at US$8.9 per month, compared with between $10.2 and $10.9 for the second, third and fourth quintiles.

However, there is a more divergence between the WTP of the poor and non-poor for households without a piped connection. In this case (when the service offered is a new connection) the average WTP for the poorest quintile is $7.7 per month compared with between $10.2 and $11.2 for the second, third and fourth quintiles.

Table 17
The impact of income on demand for water
Average willingness to pay for a service of 30 m^3 per month, linear estimate, US$.

City and scenario	Quintile 1	2	3	4	5	Cases
New connection						
Tegucigalpa	3.9	4.5	6.2	10.5	5.0	471
San Pedro Sula	4.1	5.5	3.4	3.8	3.5	117
Guatemala	19.5	22.3	22.4	25.9	27.9	701
Sonsonate, ES	9.4	13.5	13.7	6.9	8.2	221
Santa Ana, ES	n.a.	19.1	13.8	13.5	16.0	140
San Miguel, ES	8.6	n.a.	9.1	10.5	10.7	193
Average	***7.7***	***11.2***	***10.2***	***10.7***	***10.9***	
Improved service						
Tegucigalpa	3.9	4.9	5.4	3.7	5.3	304
Guatemala	9.2	12.0	10.2	12.9	14.1	820
Managua	4.4	4.8	5.4	6.6	10.1	942
Sonsonate, ES	8.8	7.2	7.8	12.0	29.5	108
Santa Ana, ES	8.1	9.4	9.2	9.9	10.2	236
San Miguel, ES	10.2	12.7	10.4	n.a.	28.6	248
Average	***7.4***	***8.5***	***8.1***	***9.0***	***16.3***	
Maintained service						
Panama & Colón	16.4	14.5	15.7	15.0	19.9	1191
Global Average	***8.9***	***10.9***	***10.2***	***10.9***	***14.5***	

n.a. = not available

3.2.4 Revealed preference and contingent valuation estimates compared to benchmark and current tariffs

Table 18 compares the demand estimates yielded by the revealed preference and contingent valuation for the cities where both estimates are available. The estimates of the price at which demand would be 30 cubic meters a month are broadly commensurate (columns 3 and 4). Only in two cases do the two estimates differ by more than 100%; in 3 cases they differ by less than 50% and in two cases, by between 50% and 100%. The contingent valuation methodology does not appear systematically to distort the estimate upwards or downwards compared with the revealed preference estimate. In three cases, the revealed preference estimate is the higher of the two; in four cases the contingent valuation estimate is higher. Nevertheless, the divergences are in general too great to conclude that contingent valuation is an acceptable substitute for good revealed preference data.

Table 18

Comparison of the present tariff and the full-cost tariff with the contingent valuation price and the revealed preference price at which demand would be 30 m³. *(US$ per m³)*

	Present tariff	Bench-mark full cost tariff	Contingent valuation estimate of price at which average consumption would be 30 m^3/1	Revealed preference estimate of price at which average consumption would be 30 m^3
Tegucigalpa, Hon	0.11	0.22	0.15	n/a
San Pedro Sula, Hon	0.13	0.26	0.13	0.49
Intermediate cities, Hon /2	0.07	0.35	0.10	0.14
Managua	0.25	0.47	0.16	0.23
Sonsonate, ES	0.18	0.18	0.32	0.16
Santa Ana ES	0.18	0.17	0.31	0.19
San Miguel, ES	0.18	0.21	0.49	0.17
Panamá and Colón	0.25	0.71	0.51	0.40

Table 18 also compares the demand data with the existing tariff and with the benchmark tariff estimated to reflect long run cost. With the exception of the three Salvadoran cities, the average tariff is at present less than half of the benchmark tariff, indicating the need for a sharp tariff rise across the board if these systems are to reach financial sustainability.

3.2.5 Estimation of demand response to raising tariffs

Table 19 estimates the average consumption that would result if water meters were installed and the price was set at the benchmark tariff. This would vary from 13.7 cubic meters per month in Managua up to 38.7 meters in San Pedro Sula. We can conclude that in most cases, although people are willing to pay more for water, they would not consume 30 cubic meters per month at the full cost tariff. Only in San Pedro Sula and Santa Ana would average consumption be above 30 cubic meters at the benchmark tariff, and in four cases, it would be significantly lower. Within those averages, the demand for the poorer households would tend to be lower than the rest. These findings should serve as a warning to planners not to assume consumption of 200 liters per person per day as the minimum service standard, which is the volume consistent with 30 cubic meters per month for households with 5 members.

Table 19

Average consumption when the price is set at the benchmark tariff, reflecting long run cost

	Price per meter, US$	Cubic meters per month, from revealed preference demand curve
San Pedro Sula, Hon	0.26	38.7
Intermediate cities, Hon	0.35	25.4
Managua	0.47	13.7
Sonsonate, ES	0.18	29.4
Santa Ana ES	0.17	30.1
San Miguel, ES	0.21	25.3
Panamá and Colón	0.71	27.9

In many Central American water studies, this number is used as a standard planning parameter, in conjunction with population projections, in order to determine system investment requirements. The results presented here together with the fact that 30 m^3 is at least three times more than is needed for basic hygiene purposes in most situations suggest that service standards should be more flexible.

The best way of achieving flexibility is to remit to the consumer the decision about how much water they want to consume and how much they want to spend rather than being required to pay for amounts that they would not otherwise choose to consume.

4 The impact of water meters and attitudes towards their installation

Section 3 concluded that individual metering may be used to manage demand and thereby avoid over-dimensioning investment schemes and inflating costs. It is also attractive because it allows households to determine how much water they are prepared to pay for. In contrast, if they are automatically billed for a fixed estimated consumption volume and pay a marginal tariff of zero, this will tend to stimulate demand..

How much difference can metering make in practice? In Panama, an estimate was made of the impact of metering by tracing measured consumption over the first four months of metering. It was assumed that the consumption in the first month reflected un-metered consumption and that after four months behavior had adjusted to the reality of paying a positive marginal price for water.

The exercise revealed that metering reduced consumption of normal residential clients by 22%. In contrast, low-income clients and small town users, whose consumption was already lower on average than the residential group, registered increases, which probably reflect the fact that prior to the installation of meters they experienced rationing (table 20 and graph).

However, there remains much nervousness in policymaking circles about the public's reaction to water meters, and apocryphal stories abound of violent resistance to their installation. Each survey addressed attitudes to water metering (table 21).

The effect of metering on water consumption in Panamá City

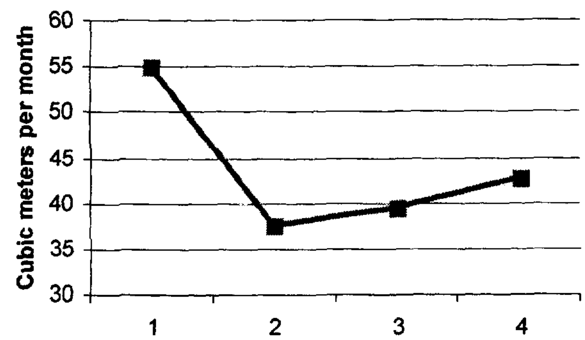

Table 20

How metering affects water consumption

Average metered monthly consumption of newly metered households in Panamá between May 1997 and April 1998

	Months since metering began 1	2	3	4	% change
Residential, Panama city	55.1	37.6	39.5	42.8	-22%
Special (low income)	27.0	29.3	30.3	28.7	6%
Interior (small town)	36.1	39.8	38.2	40.4	12%

Source: Commercial database of IDAAN

The surveys encountered an overwhelmingly positive reaction to metering as the fairest way to distribute the costs of the water service. However, in cities with poor service quality, skepticism was expressed about the accuracy of the meters. The studies also found that informal communities on land with disputed title often welcomed metering coupled with the formalization of the water service, as a proxy for tenure. Table 22 summarizes the proportion of informal users who favored obtaining a formalized metered connection; in no city was this below 74%.

Table 21

Attitudes towards water meters

Which of the following is the fairest way to decide the charge for water?

% with each opinion	Managua	Caracas	Barquisimeto, Ven.	Mérida, Ven.	Panama City and Colon	Guatemala City
Metered volume of consumption	55	66	59	67	54	76
Number of people in household	14	4	4	9	n/a	n/a
Zone of the city	n/a	5	7	7	n/a	n/a
Ability to pay	25	14	21	14	39	11
All should pay the same	7	6	7	3	7	11
No opinion	0	5	2	0	0	2

One conclusion that can be drawn from these findings is that the installation of metering should be considered as a component of programs to upgrade service quality rather than being pursued in isolation, as has often been the case in publicly managed water systems. Metering should be promoted on the basis of fairness and as a means of improving operating efficiency and lowering costs. Care should be taken to allow a couple of months of "shadow billing" to give users time to adjust consumption behavior. The provision of technical assistance to help to identify and correct intra-domiciliary leaks can also help to ameliorate potential consumer apprehension.

Table 22

Proportion of illegal users of water services who would like a formalized connection

	%
Managua	88
Caracas	74
Barquisimeto	81
Merida, Ven	n/a
Panama	92
Guatemala City	94

5 Conclusions

This paper has reviewed evidence generated by household surveys across Central America on water use and demand. It used the resulting data to analyze the distribution of subsidies and to compare demand estimates generated by revealed preference and contingent valuation methodologies.

5.1 *Summary of principal findings*

- Survey data confirm that across the region, households without a piped water connection spend significant amounts of time and money to get relatively small amounts for water with which they can satisfy only their most basic hygiene needs. Investments to expand the coverage of potable water to such communities are likely to have a very high economic rate of return.
- The poor are generally ill served by the current system of global subsidies and incomplete coverage common to many publicly managed water systems. However, where low-income communities do have household connections, they are normally the beneficiaries of a significant amount of the total subsidy.
- The disparity of sewerage connection rates among income groups when the water tariff automatically includes charges for sewerage services is a considerable source of regressivity.
- Contingent valuation survey responses show that the poorest urban households are willing to pay much more per cubic meter for a piped service than is charged at present by the water company. However, they also suggest that poor households have lower WTP for a service of 30 m^3 / month than other households.
- Revealed preference estimates confirm that in many cities, if tariffs are set to recover cost, households' monthly demand (especially that of poorer households) would fall below the standard planning volume of 30 cubic meters a month per household, which is widely used in the region.
- Water metering is not as unpopular as is often thought. Faced with the choice of alternative ways of distributing the cost of the service between users, most chose meters over other possible options.

5.2 *Implications for tariff and subsidy policy*

- Poor households without a piped water connection currently pay much more for water from coping sources than those with access and contingent valuation data suggest that most households are willing to pay substantially more than the current tariff for an improved piped water service. Policy makers should therefore assess, rather than assume, the need for subsidies. The poor are better served by gaining access to piped water rather than by the continuation of global subsidies.
- Tariffs should be gradually raised to levels that reflect costs in order to permit sustained expansion of coverage and improvements in service quality.
- Tariff structures should be as simple as possible, with a standard flat rate per cubic meter consumed, reflecting the total financial cost of the system's operation. One-off connection charges may impede access, so these costs should be recovered through monthly charges. Any subsidy should be targeted to the poor and should focus on increasing access. Rising block tariffs are an ineffective means of targeting subsidies, because the income elasticity of household water demand is low.
- Low-income households should be given the freedom to decide their level of water consumption and expenditure, rather than being required to pay for amounts that they would not otherwise choose to consume. This would militate for expanding metering and reducing minimum consumption blocks in the tariff structure. Metering should be promoted on the basis of "fairness" and as a means of enhancing operating efficiency (identifying leaks and discouraging wastage). But meters should not be installed in isolation: they are useless unless the service quality is improved and appropriate tariff structures are put in place.
- Tariffs should not be charged for sewerage unless there is a sewer line adjacent to the dwelling; programs should be developed to help poor households finance the connection to the sewer; and investment programs should include plans to increase sewerage connection in low-income areas.

- Raising tariffs to cost-reflective levels will have a disproportionate impact on the real income of the poor, for whom water comprises a larger share of their consumption basket than for the non-poor. This, in turn, may serve as a pretext for mobilizing political opposition to tariff reform. Therefore, in cities where the poor already have access to piped water service, policy makers should consider the inclusion of temporary targeted subsidies for the poorest households to ameliorate the negative impact of tariff adjustments.

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Annex 1: Survey data used in this study

Table A.1.1 provides an overview of the survey data used in the present paper. The surveys used similar methodologies, including rigorous sampling procedures based on the best available cartography, and were subjected to strict quality control. They generated largely comparable data for household income and wealth, the coverage and quality of water and sanitation services, expenditures on and consumption of water from different sources and willingness to pay for improved services. The executed sample sizes range from 227 to 2,163 households.

Table A.1.1

Survey data used in this study

		Survey data			Exchange rate
	Universe	Date	Sample size (executed)	Universe size (households)	Local currency units/US$
Tegucigalpa, Hon	Marginal barrios	Mar-95	1273	30121	9.13
San Pedro Sula, Hon	Marginal barrios	Mar-95	236	2528	9.13
Comayagua, Hon	City wide	Mar-95	227	6399	9.13
Guatemala	Marginal barrios	Oct-97	2163	42104	6.1
Managua	City wide	Nov-95	1639	170894	8.43
Merida, Ven	City wide	May-96	980	34637	290
Sonsonate, ES	City wide	Jun-96	444	12596	8.77
Santa Ana ES	City wide	Jun-96	502	30036	8.77
San Miguel, ES	City wide	Jun-96	347	21075	8.77
Panamá and Colón	City wide	Sep-98	1613	226152	1

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