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Universal (Non)service? Water Markets, Household Demand and the Poor in Urban Kenya

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Summary. Compared with the non-poor, just how inadequately are the urban poor served by the public utilities and private water providers? Based on a survey of 674 households, this paper examines current water use and unit costs in three Kenyan towns and also tests the willingness of the unconnected to pay for piped water or improved kiosk service. By examining the water use behaviour of poor and non-poor households, this study brings into question a long-standing notion in the literature—that only the poor are underserved, use little water and pay a lot for it. It also indicates that the standard prescription to 'price water and create water markets' is in itself insufficient to improve service delivery and that kiosks are not always a good solution for serving the poor.

1. Introduction

Access to safe water supply has been one of the top priorities in developing countries over the past three to four decades and billions of dollars have been invested to achieve the goal of 'universal service'. And yet, the general consensus at the 2002 United Nations (UN) conference on sustainable development was that the current reality and the situation expected in the near future are far from that goal (*The Economist*, 7–13 September 2002, pp. 13–14, 69–70). In fact, recent reports emphasise that the world 'is facing a serious water crisis' and that water access and services in the developing world need to be improved dramatically and urgently, especially if we are to make gains in the fight against poverty, hunger and disease (see, for example, United Nations, 2003). World leaders not only agree that water is an important part of the core development agenda but have also committed to ambitious targets for expanding access to water services. At the UN Millennium Summit in 2000, and subsequently at the Johannesburg Earth Summit in 2002, world leaders agreed to a set of time-bound, measurable and highly influential development targets—widely known as the Millennium Development Goals for 2015—which include a commitment to halve the proportion of people without access to safe drinking water (United Nations, 2003).[1]

Many experts seem to agree that the water crisis is essentially a result of mismanagement. There is, however, significant disagreement over the best approach to addressing

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the problem. In direct opposition to lobbies demanding that water be treated as a human right, experts at agencies such as the UN and the World Bank argue that a first or crucial step towards improving the water situation and its management is to treat water as an economic good (see, for example, World Bank, 2003b; UN, 2003). *The Economist* (2003) is even more emphatic and specific—it concurs that water has been "ill-governed" but argues that the problem "above all, [is that] it has been colossally underpriced". It concludes that, in meeting the ambitious water target of halving the proportion of people without access to clean water, "money will play a part. But ... greater reliance on pricing and markets are even more crucial".

A review of the academic literature reveals both a more sophisticated diagnosis of the problem and a more detailed prescription for addressing it. The literature clearly shows that public utilities in developing countries often serve only a fraction of the urban population, with the vast majority relying on alternate sources. Micro-studies in urban areas such as Port-au-Prince (Haiti), Jakarta (Indonesia) and Onitsha (Nigeria), show also that the urban poor are disproportionately underserved—poor households are almost never directly connected to the public utility, rely on vending systems, buy water by the bucket at very high unit prices and, hence, consume very little water (Fass, 1988; Crane, 1994; World Bank, 1994, 2003a). Poor households often pay vendors several times the unit price paid by connected non-poor households to the utility and they use only a fraction of the amount of water used by the connected. In many areas, water vending is no longer a fringe activity and it accounts for a large proportion of total water revenues. In Onitsha, for example, the water vending system collects 24 times as much revenue as the public utility during the dry season (Whittington *et al.*, 1991).

These findings strongly suggest that the widely used and well-intentioned public policy of keeping domestic water tariffs low is not benefiting many poor households. According to the World Bank, this policy has resulted in massive and poorly targeted subsidisation of service that has often helped the rich rather than the poor, hurt the financial viability of utilities, led to deterioration in service quality and, consequently, to low willingness to pay by users—most utilities are now caught in a low-price low-quality equilibrium (World Bank Water Demand Research Team, 1993).

To break out of this low-level equilibrium, World Bank experts contend that governments need to adopt a 'demand-driven approach' in which utilities 'deliver services that people want and for which they are willing to pay' (World Bank Water Demand Research Team, 1993). Two key ideas underpin the demand-driven approach (Gulyani, 2001). First, utilities can and should charge full costs for water and use the revenues to improve service and expand coverage—that is, they should move from a low-price, low-quality service for all households to a high-price, high-quality service for those who are willing to pay for it. Secondly, to do so, utilities and planners need to respond to demand—quantity, price and preferred service options—in each community they intend to serve because demand is highly location-specific. In other words, by pricing water right, effecting demand and then responding to effective demand for water, governments and planners are well on their way to solving the problem.

Designed as part of a larger enquiry into the problems in and potential solutions for the water sector in Kenya,[2] this study takes the preceding discussion as its starting-point and examines household demand for water in three Kenyan towns—Nairobi, Mombassa and Kakamega. Drawing on detailed household surveys, we take a closer look at service access, water use and prices, and disaggregate the data by welfare level to examine the following question: compared with the non-poor, how inadequately are the urban poor served by the public utilities and private water providers? In addition, to help design interventions for serving unconnected households in these Kenyan towns, we examine which, if any, of three differently priced improvement options they would choose and why.

Using the term 'water service' in its broadest sense to include water supplied by both public utilities and private providers (formal and informal), we find that neither the poor nor the non-poor are being well served. Damning evidence of poor service comes from the two most basic and important service variables—price and quantity. In direct contrast to the literature, we find that both the poor and non-poor are using little water and paying a lot for it. Not surprisingly, then, we also find that dissatisfaction levels are high across the board. This is a case of water mismanagement, but one where the problem is anything but underpricing (either by utilities or private providers) or lack of markets.

Overall, this study makes three contributions. First, it provides new policy-relevant empirical data on current water use and costs in these Kenyan towns. In addition, using multivariate statistical analyses and discrete choice models, it offers insights on which households are willing to pay for an improved system and also which of three options each would choose. Unlike most existing studies which focus on either the households' current water supply situation or their willingness to pay for hypothesised future improvements, this study does both. This allows us to investigate whether stated willingness to pay is backed by an ability to pay.

Secondly, this study contributes to the literature by showing that in some cities the poor may not be the only ones suffering from inadequate water service. Thirdly, it also contributes to the literature on demand-driven service delivery in the water sector and the larger discourse on utility reform, by showing that tariffs are, in themselves, a limited and partial tool for influencing service delivery. This is a case where utilities charge cost-recovery level tariffs but these have not automatically translated into financially solvent utilities that deliver a good service. And although utilities deliver water at a highly subsidised tariff to kiosks used by the poor, this has not translated into low purchase prices for the poor. While these observations regarding the limited potential of tariffs may seem like common sense, much of the current discourse on service and utility reform continues to place an extraordinary amount of faith in the power of 'correct' prices—this is evident, for example, in the advice emanating from *The Economist* (19–25 July 2003).

The paper is organised as follows. Section 2 outlines water supply arrangements and utility performance. Section 3 delineates the study design and data collected. Sections 4 and 5 analyse the actual water situation at the household level in terms of water use levels, prices and other service variables—broken down by household income level (section 4) and by type of water source (section 5). Section 6 investigates households' stated preferences and willingness to pay for improvements in their water system. Section 7 summarises and discusses policy implications.

2. Supply Arrangements and Performance of Urban Utilities

Responsibility for water supply and sanitation services in Kenya lies with three main institutions—the Ministry of Water Resources Management and Development (MWRMD), the parastatal National Water Conservation and Pipeline Corporation (NWCPC) and local authorities. Owing to deterioration in service provided by these institutions, many households rely on self-provision and/or on alternative services offered by community organisations, 'self-help' groups (registered with the Ministry of Gender, Sports, Culture and Social Services) and a burgeoning number of small size independent providers (SSIPs). In formal settlements, SSIPs typically finance and operate boreholes equipped with mechanised pumps, small distribution networks and water tankers; they obtain a water abstraction permit, but rarely a water vending licence. In informal settlements, SSIPs mostly operate water kiosks or hand carts and rely on municipal water supply.

Urban areas are home to 36 per cent of Kenya's total population of 32 million

(World Bank, 2004a). Of the 201 urban centres in the country, 109 have piped water systems of which 73 are managed by MWRMD, 26 by NWCPC and 10, including Nairobi, by local authorities. Although comprehensive supply-side data do not exist, known facts regarding the water supply situation in Nairobi, Mombasa and Kakamega, as reported by the World Bank (2001, 2004b), are summarised below.

In Nairobi, the capital city with a population of about 2.3 million in 2003, service is provided by the Water and Sewerage Department of the Nairobi City Council. Nairobi has an installed production capacity of 420 000 cubic metres per day and 182 295 legal connections of which 164 000 are domestic connections; often, water from a single connection is shared by multiple households and some domestic connections operate as kiosks. Although the production capacity is large and theoretically sufficient to meet demand, total water available for actual sale and use is significantly lower—unaccounted-for water (UfW) in the system is estimated at about 50 per cent. The UfW is attributable to technical losses (leakages, especially in older pipes) and commercial losses (unbilled and uncollected revenues and theft). Both bulk and client-level metering are highly inadequate and the data on water use and losses are unreliable. For households, bills are based on presumed consumption. The billings system is poor, collection efficiency—or revenues collected as a proportion of total billed—is 65 per cent and accounts receivable stand at more than 2 years of billings. Due to inadequate utility service and coverage, a large and mostly unregulated parallel water industry has emerged. There are an estimated 1500 individual boreholes in the city and water tankers are ubiquitous. Kiosks and vendors are prominent in informal settlements; for example, in Kibera—Nairobi's (and Africa's) largest slum with about 0.5 million residents—there are about 650 kiosks.

Water service in Mombasa, a town of about 715 000 residents, is managed by the NWCPC's Coastal Region Operations office as part of a larger system that also covers 4 smaller towns (Voi, Malindi, Kilifi and Kwale). The Coastal Region's integrated water supply system has a combined source capacity of about 160 000 cubic metres per day but the total transmission capacity is only about 120 000 cubic metres per day. All of the 57 500 connections (53 000 domestic connections) are metered but about one-third of these meters do not work. UfW is estimated at 40 per cent. Billing efficiency is 62 per cent, collection efficiency is 67 per cent and accounts receivable represent more than 15 months of billings. In Kakamega, a town with about 61 000 residents, the NWCPC utility has 4000 connections and many residents rely on own or natural sources for water.

Towns such as Nairobi and Mombasa are caught in a downward spiral of declining investment, quality of service and financial returns characterised by: low coverage and unreliable service; high levels of unaccounted-for water (UfW) and of unpaid bills; revenues insufficient to cover operations and maintenance costs; and, poor financial and commercial management (World Bank, 2001, 2004b). To break this downward trend, the government has embarked on a series of water sector reforms which include institutional restructuring (for example, commercialisation of the Nairobi utility and separation of regulatory functions from service delivery) and a shift towards demand-based service delivery. However—as is evident from the observations regarding limited utility coverage and the acknowledged lack of adequate metering—there are currently no reliable data on demand, either on actual water use or on household preferences and willingness to pay. These data are required to help establish a baseline, facilitate design of interventions, inform tariff revisions and adjust policies and plans. This paper is an attempt to fill that gap.

3. The Data: Urban Areas Surveyed, Sample Design and Characteristics

The data were collected from a household-level survey conducted in November 2000 in Nairobi, Mombasa and Kakamega. In each of the three cities, surveys were conducted in 7–8 residential sites to ensure inclusion of a wide range of settlement and housing types, and diversity in the households' socioeconomic status and service access. Within each site, the households were randomly selected. The final sample covers 22 urban sites and includes 674 households: 300 in Nairobi, 199 in Mombasa and 175 in Kakamega. Out of these, 311 households (46 per cent of sample) who do not have private piped connections were also asked which, if any, of three improvement options they would choose if they had to pay for it. Overall, this is a stratified random sample and we believe that it is reasonably representative of urban households in these cities. In this paper we present the results for the three-city sample as a whole, except in cases where we find statistically significant differences across the cities or to allow for comparisons with city-level secondary data from earlier studies.

3.1 The Average Respondent and the 'Poor' in the Sample

On average, the respondent was 35 years of age, had a family size of 5 and had lived in his or her current residence for 8 years. The majority (86 per cent) had at least primary level education and about 35 per cent owned their home. Exactly half of the respondents were female.

We used self-reported total monthly household income as the measure of welfare to classify households as 'poor' versus 'non-poor'.[3] Specifically, households who reported monthly household incomes equal to or less than the threshold level for that city—Ksh10 000 in Nairobi and Mombasa and Ksh5000 in Kakamega—are designated as 'poor' and the rest are 'non-poor'. The poverty threshold for Kakamega was set lower than Nairobi and Mombasa to reflect the lower levels of income and expenditure, and lower cost of living, in this small town.[4] The sample proportion of poor households as defined by our welfare measure is 37 per cent.

Given the fact that households tend to underreport income relative to expenditure, this poverty threshold is broadly consistent with the 1997 official poverty line for urban Kenya which is set at a monthly *expenditure* of Ksh2648 per adult equivalent per month (Government of Kenya, 1999).[5] Further, those defined as poor using our welfare measure display characteristics that are consistent with expectations and findings from previous surveys. First, statistical analysis of socioeconomic characteristics of the two groups show that, compared with the non-poor, poor households in our sample are more likely to be in densely populated neighbourhoods (informal or peri-urban settlements), not own their homes, earn their living in daily wages and have household heads who are less educated and younger. Secondly, the neighbourhood-specific sample proportion of poor households is also consistent with *a priori* expectations—for example, neighbourhoods that are known to be poor have a high proportion of poor households as defined by our welfare measure and vice versa.

4. Understanding the Water Situation at the Household Level

4.1 Primary Water Sources

Households surveyed in the three cities use a wide array of primary water sources to meet their needs. Private in-house piped connections are the most important, with just under half (46 per cent) of the sample households using them as their primary source. An additional 15 per cent of households use yard taps as their primary source. In other words, 61 per cent of the households in the three cities have access to piped water supply either in their house or in their yard.

Water kiosks are, by far, the most important 'alternative' to piped supplies with 19 per cent of the households using them as their primary source. Ground and natural sources serve as the primary source for 10 per cent of the households, the overwhelming majority (94 per cent) of whom are in Kakamega. About 5 per cent of the households rely primarily on vendors, 2 per cent have their 'own source' (such as a well or borehole), another 2 per cent rely on neighbours, and the remaining 1 per cent report 'other' sources (including bottled water).

Utility coverage, or the proportion of households with access to piped water supply, in Nairobi—and even in Mombasa and Kakamega—appears to be higher than that in many of the other capital cities in Africa (Table 1). Specifically, we find that 71 per cent of the households in Nairobi, 50 per cent in Mombasa and 56 per cent in Kakamega have access to piped water supply either through a private in-house connection or a yard tap. By comparison, a study of water supply and independent providers in 10 African capital cities estimates that in 6 of these cities only 27–49 per cent of the households have access to piped supplies, with the rest of the households relying on independent providers or traditional sources (Collignon and Vézina, 2000).[6] In the other four capital cities, coverage is estimated to be higher—72–85 per cent of the households have access to piped supplies. In other words, Mombasa and even Kakamega, a small town, have a better utility coverage than 6 of the 10 African capital cities examined in the above study.

Although a significant proportion of households in Nairobi, Mombasa and Kakamega have access to piped supplies, the service that they receive is poor. As one would expect, the level of service provided by alternative sources such as kiosks is also very low. The evidence for poor service—and the argument that service is universally bad—emerges from the analysis presented in the rest of this section and the one that follows. In examining the level of service received by households, we use the term 'water service' in its broadest sense to include water supplied by the public utility as well as different private providers. Given that level of service is a function of several variables, we first examine the three most basic ones—price, quantity and time spent in collection (sections 4.2–4.4). We then examine additional service indicators such as hours of service, adequacy of the primary source and satisfaction rates (sections 4.5 and 5).

4.2 Per Capita Water Use

For the aggregate sample, we find that water use averages about 40 litres per capita per day (lcd) (Table 2). For households that have access to piped supply—either a private connection or a yard tap—average water use is 44 lcd as compared with 35 lcd in unpiped households. The median values for water use are even lower: 30 lcd for the sample as a whole, 33 lcd among households with piped supplies and 27 lcd among unpiped households. These water use levels are rather low given the fact that planners often design water systems based on average water use of about 100–200 lcd. But how much is 40 lcd? It is the amount of water dispensed in a 4.2 minute shower using an environmentally friendly reduced-flow shower head available in the US.[7]

These figures immediately raise questions about whether the data are credible, especially because the water use levels are self-reported by households rather than measured by a surveyor and/or a meter. Reassuringly, our estimate of average water use is remarkably similar to that reported in the Drawers of Water II (DOW II) study. The DOW II study uses the original Drawers of Water study conducted in 1967 as the baseline and examines changes in water use in 16 sites in eastern Africa between 1967 and 1997 (Thompson *et al.*, 2000a). Based on information collected from household surveys in which interviewers spent an entire day with each household observing water use, DOW II reports that average urban water use in Kenya is 45 lcd, with 47 lcd in piped households and 28 lcd in unpiped households (Table 2). Our estimate of average water use is somewhat lower than that in DOW II and there are at least two possible explanations. First, there was a water shortage in Nairobi at the time of the survey in November 2000. If we assume that the shortage in Nairobi reduced water use in that city by as much as 25 per cent, the 3-city average increases by 10 per cent to 44 lcd.[8]

Table 1. Proportion of households with access to piped supplies in urban Africa

	Ten cities study										Our (2000) survey		
	Abidjan (Cote d'Ivoire)	Nairobi (Kenya)	Dakar (Senegal)	Kampala (Uganda)	Dar es Salaam (Tanzania)	Conakry (Guinea)	Nouakchott (Mauritania)	Cotonou (Benin)	Ouagadougou (Bukina Faso)	Bamako (Mali)	Nairobi (Kenya)	Mombasa (Kenya)	Kakamega (Kenya)
Piped	78	72	85	41	31	32	49	27	72	36	71	50	56
Independent providers, traditional sources and other	22	27	15	59	69	68	51	73	28	64	29	50	44

Sources: 10 cities data from Collignon and Vézina (2000) and data for 3 Kenyan towns from our 2000 survey.
Note: 'Piped' includes in-home connection, yard tap, or standpipe with collection by household.

Table 2. Per capita water use in Eastern Africa (lcd)

	All households		Piped households		Unpiped households		Non-poor households		Poor households	
	N	Mean (median)	*N*	Mean (median)	*N*	Mean (median)	*N*	Mean (median)	*N*	Mean (median)
Results from our study										
Kenya—all three towns	581	40.0 (30.0)	299	44.3 (33.3)	248	35.3 (28.6)	324	43.8 (33.3)	213	33.1 (26.7)
Nairobi	248	37.3 (30.0)	155	37.2 (30.0)	83	35.5 (26.7)	136	41.3 (33.3)	96	32.1 (24.0)
Mombasa	178	49.8 (37.5)	81	61.6 (42.9)	96	39.9 (33.3)	87	58.5 (40.0)	65	36.5 (33.3)
Kakamega	155	33.0 (25.0)	63	39.7 (30.0)	69	28.6 (22.5)	101	34.6 (24.0)	52	30.3 (26.3)
Results from DOW II										
Kenya—urban sites		45.2		47.4		27.7				
Tanzania—urban sites		70.5		76.5		25.1				
Uganda—urban sites		47.0		64.7		23.5				

Sources: Our 2000 survey and Thompson *et al.* (2000).

Secondly, our survey was conducted three years after the DOW II survey and it is possible that water use levels have fallen from the levels reported in 1997.

The minor differences in the results notwithstanding, our study and DOW II together provide strong empirical evidence that average per capita water use in urban households in Kenya is only about 40–45 lcd. Comparisons with other countries reveal the following. Although water use in urban Kenya is only marginally lower than the 47 lcd estimated for urban Uganda in the DOW II study, it is 60–70 per cent lower than the 71 lcd average in neighbouring Tanzania. And it is even lower when compared with water use levels reported for several non-African cities in the developing world (Table 3). For example, using metered consumption data, Yepes and Dianderas (1996) find per capita water use in 8 Latin American cities to be in the range of 143–237 lcd. Similarly, water use in 13 Asian cities was found to be in the range of 91–209 lcd (Asian Development Bank, 1997).

The current level of per capita water use in Kenya is low not only when compared with other countries, but also when compared with previous use levels in Kenya itself. Using baseline data from 1967, authors of DOW II argue that there has been a dramatic decline in domestic water use in urban Kenya—it has fallen from 105 lcd in 1967 to 45 lcd in 1997 (and 40 lcd in 2000 according to our study). This decline occurred despite the fact that unpiped households increased their water use from 11 lcd in 1967 to 28 lcd in 1997 (and 35 lcd in 2000 according to our study). It is attributable entirely to the sharp reduction in water use by piped households which fell from 117 lcd in 1967 to 47 lcd in 1997 (and 44 lcd in 2000 according to our study). Thompson *et al.* (2000a) suggest that piped households have been forced to cut back due to failing municipal supplies, an argument that our data, presented in section 5, support. As we will show, however, the reduction in water use is due not just to reduction in quantity available but to a *combination* of price and quantity factors.

Water use by poor and non-poor households. The literature conjures images of rich and connected households using—often wasting—water liberally for uses that include gardening, washing of cars and water for swimming pools. The poor, by contrast, are not connected, have to buy water by the bucket and pay exorbitant prices (see, for example, Fass, 1988; Whittington *et al.*, 1991; World Bank Water Demand Research Team, 1993; Crane, 1994). The result, as mentioned

Table 3. Per capita water use in Asian and Latin American cities

Asia			Latin America		
City	Water use (lcd)	Year	City	Water use metered (lcd)	Year
Kathmandu, Nepal	91	1995/96	Sta Catarina, Brazil	143	1990
Dhaka, Bangladesh	95	1995/96	Minas, Brazil	154	1990
Beijing, China	96	1995	Bogota, Colombia	167	1992
Mandalay, Myanmar	110	1995/96	Santiago, Chile	204	1994
Hong Kong, China	112	1996	Costa Rica	208	1991
Suva, Fiji	135	1995	Brasilia, Brazil	211	1989
Shanghai, China	143	1995	São Paulo, Brazil	237	1988
Colombo, Sri Lanka	165	1995			
Singapore	183	1995			
Kuala Lumpur, Malaysia	200	1996			
Manila, Philippines	202	1995			
Seoul, S. Korea	209	1995			
Delhi, India	209	1995/96			

Sources: Asian Development Bank (1997) and Yepes and Dianderas (1996).

earlier, is that the poor consume far less and pay far more per unit of water relative to their rich and connected counterparts. Previous studies in Jakarta and Port-au-Prince, for example, find that the non-poor use 2–14 times as much water as the poor. Specifically, in Port-au-Prince, Fass (1988) estimates that households with connections (mostly the rich) use 156 lcd compared with the 11 lcd used by poor households who rely on the vending system. The poor buy from vendors at prices ranging from US$1.1 to US$5.5 per cubic metre and thereby pay, according to Fass, 'some of the highest urban [water] prices in the world'. For Jakarta, Crane (1994) reports that households with private connections use 62.2 lcd as compared with the 27.5 lcd used by those relying on hydrants and 14.6 lcd for those relying on vendors. Crane also notes that vendors in Jakarta charge up to US$2.60 per cubic metre which he estimates is about 30 times the rate charged by the public utility; a different study finds the typical (as opposed to maximum) multiple in Jakarta to be about seven (Shugart, 1991).

We find that poor households do use less water than the non-poor, but the difference is nowhere near as large as the literature and conventional wisdom would suggest. Specifically, the poor use an average of 33 lcd compared with 44 lcd by non-poor households in these 3 Kenyan towns—that is, the non-poor use about 1.33 times (33 per cent) more water than the poor (Table 2). As one would expect, the sample distribution for poor households is more skewed to the left (lower usage level) than that of non-poor households (Figure 1).

4.3 *The Unit Cost of Water*

The unit cost of water was computed for *each household* in the sample by dividing the reported total expenditure on water by total water use.[9] Households are spending on an average Ksh260/cubic metre (US$3.5/cubic metre or UScents0.35/litre) for the water that they use (Table 4). The median cost is Ksh156/cubic metre (US$2.1/cubic metre)—that is, exactly half of the sample households are incurring unit costs that are higher than this value. If we assume that price inflation for vended water in Nairobi was about 25 per cent due to the water shortage at the time and recalculate the figures for a 'no shortage' scenario, we get an average unit cost of US$2.93/cubic metre, which is about 16 per cent lower. Even after the adjustment, these costs are remarkably high, both in relative and absolute terms. They are high, for example, relative to prevailing utility tariffs—the average tariff charged by Kenyan water utilities, from all categories of customers combined, is US$0.40/cubic metre (World Bank,

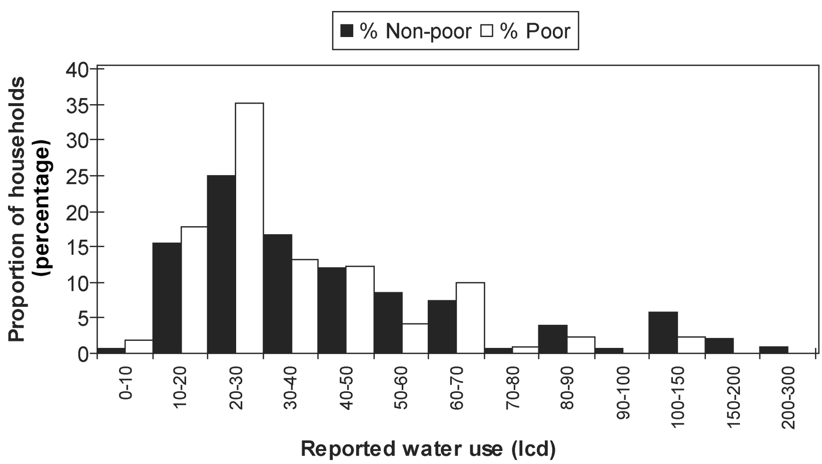

Figure 1. Self-reported water use (poor and non-poor households).

Table 4. Unit price of water in Kenya (US$ per cubic metre)

	All households		Piped households		Unpiped households		Non-poor households		Poor households	
	N	Mean (median)	*N*	Mean (median)	*N*	Mean (median)	*N*	Mean (median)	*N*	Mean (median)
Results from our study										
Kenya—all three towns	374	3.45 (2.11)	172	3.71 (1.80)	184	3.32 (2.59)	192	3.73 (2.00)	153	3.07 (2.40)
Nairobi	164	4.68 (3.33)	83	5.00 (2.21)	77	4.51 (3.33)	81	5.24 (2.37)	76	4.01 (3.33)
Mombasa	142	2.39 (1.67)	50	2.12 (1.21)	91	2.50 (1.77)	58	2.51 (1.40)	62	2.19 (1.67)
Kakamega	68	2.71 (1.75)	39	2.93 (2.00)	16	2.15 (1.17)	53	2.88 (1.77)	15	2.12 (1.67)

Source: Our 2000 survey (conversion rate: $1.00 = Ksh75).

2001).[10] They are also high in absolute terms given estimates, by the World Bank (2001), that full cost recovery of current water systems can be achieved at a fraction of these unit costs, if the water utilities are run efficiently.

The main reason behind the high unit cost of water is that the households, including many of those with piped private connections, are buying water from expensive sources such as kiosks and vendors. Households in our sample are paying, on average, Ksh4.1 per 20-litre jerrycan (Ksh205/cubic metre or US$2.7/cubic metre) for water from kiosks and Ksh12.6 per 20-litre jerrycan (Ksh630/ cubic metre or US$8.4/cubic metre) for water from vendors who deliver at home (including tankers of 8 cubic metres capacity). These prices for vended water are similar to those reported for Nairobi by Collignon and Vézina (2000) in their study of African capital cities; in addition, their data show that vended water costs more in Nairobi than in most of the other capital cities included in their 10-country sample.[11]

It is important to note that the average cost of water from kiosks is remarkably high, given that utilities in Kenya usually supply water to kiosks at a 'social' or bulk rate of about Ksh11/cubic metre (US$0.15). In other words, the kiosks owners are charging 18 times the price that they pay for the water. Even after taking into account the fact that kiosk owners have to incur initial costs for installation of kiosks as well as some recurrent overhead costs (including illegal payments), the difference in price paid to the utility and price charged for water by kiosk owners is large. In fact, Collignon and Vézina (2000) calculate the minimum gross profit margin of 'standpipe operators' (or kiosks) in Nairobi to be 80 per cent and the maximum to be 90 per cent—these profit margins were the highest among their 10-country sample. This suggests that much of the subsidy provided by the utility is not accruing to the poor for whom it is intended. Rather, these subsidies are accruing either to kiosk owners or to people collecting illegal payments from them or both.

Unlike for the price of water from a given vending source (a variable that has been examined in several studies), it is hard to find comparable data for the average unit cost borne by households for the water that they use from all sources combined. The DOW II study is one of few that calculates an average unit cost but, unlike in our study where we calculate only the monetary costs, the authors calculate the 'social cost of obtaining water' in which they include not just monetary expenditures on water but also a cash value for the amount of energy used by each (unpiped) household to fetch water.[12] While estimates of social cost are important for public policy, at the household level we find that it is important to separate monetary and non-monetary costs, especially in trying to understand household decision-making. As we will see in section 6, in our sample some households chose to trade off time savings in exchange for low monetary costs.

Unit cost of water for poor and non-poor households. In sharp contrast to the literature, we find that poor and non-poor households are, on average, paying very similar unit costs for their water. We do not find any statistical difference (at 5 per cent significance level) in average unit cost for water by welfare level. The median cost for the non-poor is US$2.0/cubic metre, compared with US$2.4/cubic metre for the poor and US$2.1/cubic metre for the sample as a whole. Although the difference in the median cost borne by the poor and non-poor is statistically significant, the difference is again not as large as one might expect.

There are at least three factors that help to explain the convergence in average unit costs borne by the poor and non-poor in our study. First, failing public water utilities do not provide adequate water to the connected non-poor households, forcing them to buy from vendors and tankers at prices that are significantly higher than the utility tariff. This raises their average unit cost for water. In theory, the connected non-poor do have access to water at the low and often subsidised utility tariff, but in practice they have to supplement this with water purchased from more expensive sources. Secondly, some of the non-poor (35 per cent of our sample) do not have private utility connections and this also raises the average cost borne by the non-poor as a group. Thirdly, the poor—especially, in small towns such as Kakamega—can and do still use water from natural sources such as streams and do not incur monetary costs for it; this lowers the average unit cost of the water that they use.

Although the average unit costs borne by poor and non-poor households are about the same, the costs borne by poor households are more 'concentrated' around this average value than the costs borne by the non-poor. This is evident from the standard deviation in the unit costs that they bear—we do find statistical difference (at the 5 per cent significance level) between non-poor (s.d. = 0.50) and poor households (s.d. = 0.18). A significant proportion of non-poor households fall in the two tails of the distribution—that is, they are more likely to bear the least as well as the highest unit cost for water. This is because non-poor households are likely to use both private piped connections (least unit price) as well as tankers and bottled water (high unit prices).

Price perception and demand elasticity. While the unit costs currently borne for water provide an important insight into households' ability to pay for future improvements, policy-makers are likely to be interested in knowing what tariff levels would be acceptable or politically feasible. To get the households' notion of a feasible or fair tariff, we asked them whether they perceived the current unit costs that they were bearing to be 'high', 'fair' or 'low'. Then we compared each household's current unit cost (reported in a separate section of the questionnaire) with their perception of its fairness. We find that households appear to have some distinct cost level corresponding to what they perceive as 'fair'. Typically, about Ksh200/cubic metre is perceived by households as a fair unit cost for water and, interestingly, it is similar for non-poor and poor households (although they do differ in their perception of 'low' and 'high'). This estimate of fair cost can be thought of as a 'proxy' measure for acceptability and has policy implications.

Another important policy question that arises is the price sensitivity of households and the extent to which it differs for the poor and non-poor. For example, if the tariff was increased by 10 per cent, would this have a differential impact on water use by the poor and the non-poor? To get insights into this issue, we used data collected in the survey to estimate a linear demand function, with total household water use as a function of unit cost incurred, household income level, household size, current city of residence and current primary water source (see Appendix for details).

The estimated multivariate linear demand model greatly increases our confidence in the data because it confirms that households' demand for water responds to key variables exactly in the manner predicted by economic theory. The quantity consumed is negatively correlated with price and positively correlated with income and household size, all with a high degree of statistical significance (at the 5 per cent level or less). In terms of elasticity, the estimation results indicate that household demand for water is relatively inelastic over the (realistic) price range of Ksh100–Ksh300/cubic metre (US$1.33–4.00). For example, using our sample means for household water use and unit price, the estimated point price elasticities are -0.12 for the sample as a whole, -0.16 for poor households and -0.10 for the non-poor.[13] It should be noted that while the *absolute* level of price sensitivity of all households is quite low, poor households are still *relatively* more sensitive than the non-poor.

It is important to note that our demand analysis is based on demand for water from *all* sources. It is thus expected to yield inherently lower price elasticity than in a source-specific (for example, piped water) analysis (as is the case with typical existing studies), since the latter analysis can capture the expected intersource demand substitution in response to any price change. Further, the

Table 5. Current water use and expenditure patterns

	Aggregate		Poor		Non-poor	
	N	Mean	*N*	Mean	*N*	Mean
Daily per capita water use (in litres)[a]	581	39.97	213	33.01	324	43.81
Unit cost of water used/procured						
From all sources (in Ksh per litre)[a]	374	0.26	153	0.23	192	0.28
From kiosk service (in Ksh per jerrycan)[b]	156	4.07	111	4.35	36	3.28
From vendor service (in Ksh per jerrycan)[b]	132	12.59	77	12.26	44	13.02
Time spent in collecting water (minutes per day)[b]	458	26.62	181	42.41	249	14.83
Per capita expenditure on water in Ksh per day [a]	409	9.06	155	7.63	220	10.35
Water storage capacity (litres)[b]	598	1058.00	205	377.00	347	1443.00
Investment in storage system (Ksh)[b]	549	5399.00	188	508.00	323	8519.00
Household size (persons)[b]	669	4.92	227	4.17	389	5.25
	N	Percentage	*N*	Percentage	*N*	Percentage
Households dissatisfied with primary source	592	49.80	203	58.13	343	43.15
Households who get all their water from a single source	610	65.90	201	55.20	357	73.40

Notes: Differences in means across poor versus non-poor households are statistically significant (at a 10 percent level or less) for all the variables except two: unit prices for water used/procured from all sources and from vendor service.

[a]Based on *computed* values derived *for each household* as follows: (i) daily per capita water use is daily household water use divided by household size; (ii) daily per capita expenditure on water is daily household expenditure on water divided by household size; (iii) unit cost of water used/procured from all sources is daily household expenditure on water divided by daily household water use.

[b]Based on direct responses of survey participants.

results of a water demand analysis using actual (as opposed to 'desired') water consumption data are implicitly contingent on supply-side constraints. The relatively low price elasticity of demand in the current analysis thus reflects and is consistent with the prevailing water supply constraints. With average use for a basic necessity such as water already at a low absolute level, and faced with limited availability and access to water, households have very little flexibility in terms of changing their current use level—either downwards in response to a price increase or upwards in response to a price decrease.

4.4 Collection Time

Households are spending an average of 30 minutes a day in collecting water. The poor spend an average of 42 minutes, or three times as long as the non-poor who spend 15 minutes on this activity (Table 5). As expected, collection time varies significantly by the primary source that households use. While those with private connections spend only about 5 minutes on water collection daily, those relying on yard taps spend about 15 minutes and those using kiosks spend 55 minutes per day on this task (Table 6). Households that rely on other alternatives, including own source and natural sources, spend an average of 37 minutes daily in collecting water.

4.5 Summarising the Water Situation of Poor and Non-poor Households

Overall, the results show that water use levels are low and both monetary costs and time

Table 6. Comparison of households currently with and without piped water service

Primary source	Private connection		Yard tap		Kiosk		Alternative sources[b]	
	N	Mean	*N*	Mean	*N*	Mean	*N*	Mean
Daily per capita water use (in litres)[a]	208	49.29	91	33.07	124	35.10	124	35.60
Cost in Ksh per litre for water used from all sources[a]	124	0.26	48	0.31	119	0.24	65	0.26
Cost in Ksh per jerrycan from kiosk service	3	2.33	15	5.87	119	3.92	18	3.97
Cost in Ksh per jerrycan from vendor service	22	12.45	22	13.63	44	13.39	43	11.53
Time spent on collection from primary source—minutes per day	166	5.30	65	14.50	122	54.70	99	37.40
Per capita expenditure on water in Ksh per day[a]	155	8.87	48	9.02	119	9.26	68	9.92
Water storage capacity in litres	251	1825	82	777	122	322	109	588
Investment in storage system (Ksh)	234	8994	80	1070	113	801	98	6883
Household size	275	5.50	100	4.40	125	4.20	134	5.10
	N	Percentage	*N*	Percentage	*N*	Percentage		
Percentage of households who are 'poor'	247	4.5	94	50.0	119	76.5	125	51.2
Percentage of households dissatisfied with service from primary source	269	44.0	77	45.0	123	63.0	123	53.0
Percentage of households stating 'water' as top priority	271	45.4	99	51.5	125	62.4	135	74.8
Percentage of households rating water from primary source as high quality	267	53.9	80	50.0	123	49.6	125	34.4
Percentage of households receiving less than 8 hours of service per day	239	35.0	77	44.0	119	32.0	n.a.	n.a.
Percentage of households who get all their water from a single water source	271	76.0	86	60.5	122	51.6	124	62.1

Notes: Differences in means across the three groups of households are statistically significant (at the 10 percent level or less) for all the variables except two: unit prices for water used/procured from all sources and from vendor service. The mean refers to values for the subset of households using a given primary source (and not, for example, to the cost or use of water from that source).

[a]Based on *computed* values derived *for each household* as follows: (i) daily per capita water use is daily household water use divided by household size; (ii) daily per capita expenditure on water is daily household expenditure on water divided by household size; (iii) unit cost water used/procured from all sources is daily household expenditure on water divided by daily household water use.

[b]'Alternative sources' cover use of vendors, neighbours, own source (well, borehole), ground/natural sources and other miscellaneous sources (including bottled water) as primary water sources.

spent on collection are high for sample households. When disaggregated by welfare level, the data on these three level-of-service indicators—water use, unit cost and collection time—show, as expected, that the non-poor are better off than the poor. The differences in mean values for the poor and non-poor are statistically significant for most variables, except the unit cost of water used from all sources. However, many of these differences among the poor and non-poor are far smaller than previous studies suggest. In particular, the finding that the non-poor use (only) about 33 per cent more water than the poor, combined with the finding that the two groups bear similar unit costs for their water, suggests that *both* the poor and the non-poor—with the possible exception of the richest 7–10 per cent of the population—are suffering under the current water supply system in urban Kenya.

To explore further the differences in the water situation of the poor and non-poor, we examined several additional service variables. These results, summarised in Table 5, show, for example, that 58 per cent of the poor are dissatisfied with their primary source compared with 43 per cent of the non-poor. Compared with the non-poor, a smaller proportion of the poor get their water from a single source and they get a smaller proportion of their water from their primary source. These data provide additional evidence that the non-poor are better off than the poor but not dramatically so.

5. Comparing the Level of Service from Different Systems

In this section, we comparatively analyse the three most used primary sources of water—private connections, yard taps and kiosks—and 'other alternative sources' (such as vendors, neighbours, wells, natural sources) combined. We examine who these systems serve and the level of service that they provide, using some service indicators related to price, quantity, quality, reliability and convenience offered by each system (Table 6). Overall, this section shows that all households receive water for only a few hours a day from their primary source, as many as 42–44 per cent are forced to rely on multiple sources and water storage is ubiquitous. As a result, half of all households—piped and unpiped, poor and non-poor—are dissatisfied with their current water supply situation.

5.1 Which Systems Serve the Poor?

About 50 per cent of the households using yard taps and 77 per cent of those using kiosks are poor. Similarly, 52 per cent of the households relying on other alternative sources are also poor. By contrast, poor households account for a mere 5 per cent of those with private piped connections. Although almost all of the households with private connections are non-poor, many of the non-poor are not connected and have to rely on other sources including boreholes, tankers and to some extent kiosks.

5.2 Water Availability by Source

Previous studies of water use in Kenya report that households tend to rely on one source to meet most of their water needs but reliance on additional sources has increased (see, for example, Thompson *et al.*, 2000b). In our sample, households report that their primary source accounts, on average, for 66 per cent of their total water use. At the same time, as many as 42 per cent of the households in our sample report that they use two or more sources to meet their water needs. As one would expect, the non-poor households get a higher percentage of their total water needs from the primary source than poor households. Households need to use multiple sources because their primary source is not fully reliable and does not provide the level of service that they require.

One indicator of the level of service of a system is the proportion of households that rely exclusively on that system to meet their water needs. We find that 76 per cent of households with private piped connections, 61 per cent of those with yard connections, 62 per cent of households using alternative sources and 52 per cent of those using kiosks get their water exclusively from their primary source (Table 6). In relative terms then, a piped connection provides better service than a yard connection and that from all other sources combined. However, neither the 'gap' between the private and yard connection nor that between the yard tap and alternative sources is as large as one might expect.

Another indicator of service level is the number of hours that water is available from a given system. Our data show that 36 per cent of the households with private connections, 36 per cent of those relying on kiosks and 47 per cent of those with yard taps report that water is available for *less than 8 hours per day*. Only about one-third of households that have private connections usually get water for more than 16 hours a day. Taken together, limited water availability and the highly curtailed hours of service offer one explanation for why overall water use, by poor and non-poor alike, has fallen and is at surprisingly low levels. In addition to cutting water use, households are coping with the intermittent water supply by storing water. Indeed, almost all households report that they store water. The average storage capacity is about 1058 litres and average investment is about Ksh5399 (US$72). As one would expect, storage capacity and investment vary by income and type of storage system—the poor rely on portable low-cost and low-capacity storage options such as jerrycans, whereas the non-poor use higher-cost options such as overhead tanks.

5.3 *Customer Satisfaction*

Our survey shows that half of the households are dissatisfied with their current primary water source. The groups dissatisfied include: 44 per cent of those using piped water as their primary source, 45 per cent of yard taps users, 53 per cent of those depending on alternative sources and 63 per cent of those relying on kiosks (Table 6). Disaggregating the data by welfare level shows, as mentioned earlier, that about 58 per cent of the poor and 43 per cent of the non-poor are dissatisfied (Table 5). The fact that service and availability, apart from easy access, strongly influence household satisfaction is evident from the 56 per cent satisfaction level for private piped connections in contrast to the 100 per cent satisfaction for own sources. The highest levels of household dissatisfaction are associated with water kiosks and vendor services—although people are forced to rely on them, they do not like them as options for their water supply. Not surprisingly then, 56 per cent of all households also rate 'improvement in water supply' as their top development priority.

6. Household Preferences and Willingness to Pay for Improvements

Of the 674 sample households, those 311 who did not have private piped connections were asked additional questions on their preferred option for improving their current water supply system. This section reports the findings from these 311 responses (Nairobi 117, Mombasa 91 and Kakamega 103). About 65 per cent of these 311 households are 'poor' based on our welfare measure. In this part of the survey each participating household was given the following options regarding the water supply system: (1) private piped connection; (2) yard tap connection; (3) improved kiosk services; and (4) *status quo* or 'no change' to the current system.

The improvement offered in the kiosk service entailed building additional kiosks so that households would have access to a kiosk within 50 metres of their residence. The unit price for this improved kiosk service was set at Ksh250/cubic metre for all households surveyed. For the private piped and yard tap connection options, different tariff structures, based on deposit fee and unit price, were used across households. Specifically, each household surveyed was offered one of the following 8 tariff combinations of an upfront deposit (Ksh) and unit price (Ksh/cubic metre): (2500; 50); (2500; 75); (2500; 100); (2500; 125); (5000; 50); (5000; 75); (5000; 100); (5000; 125).

Unlike most previous willingness-to-pay studies that use a very wide range of prices to allow an estimation of the limits of the demand function, in this survey we chose a range of 'pragmatic' tariffs around a level estimated to allow cost recovery. A team of water experts had estimated that a price of approximately Ksh75 or US$1 per cubic metre combined with an upfront deposit of Ksh5000 or US$67 would be sufficient to recover costs for a system such as Nairobi—indeed, at such a price, private providers would be willing to enter the market (World Bank, 2001; and personal communication with Bank staff). These experts also noted that the unit tariff would need to be somewhat higher in Mombasa given the higher cost of supply in that city. Accordingly, we offered the respondents one of two deposit fees (Ksh 2500 or Ksh 5000) and units prices ranging from Ksh50–125 per cubic metre. For each household, based on its size, we estimated the monthly bill associated with the offered price for each of the three options. Based on these prices and its preferences, each unconnected household chose the improvement option, if any, for which it was willing to pay.

From the analysis presented in earlier sections of this paper we now know—in hindsight—that the prices we offered are lower than the average and median unit costs (Ksh260 and Ksh156 percubic metre, respectively) that households are currently bearing (section 4). Indeed, the prices are also lower than the Ksh200/cubic metre cost that the households deem as 'fair'. The result, not surprisingly, is that the majority (76 per cent) of the unconnected households chose to pay cost-recovery-level prices for one of the three improvements rather than maintain their current water system.

In its simplest form, the above result is no different from what many other studies have found in the now-vast literature on willingness to pay for water—that is, households want improved water service and they are willing to pay a lot for these improvements. One difference, perhaps, is that we can show that the households' willingness to pay is backed by an ability to pay and that they consider these prices to be fair. In the next two sub-sections, we use our data to go beyond these broad conclusions and examine the following questions. Which households opted for *status quo* versus an improved system and why? Of those opting for an improvement, which households are likely to select a private connection versus a yard tap versus kiosks and why?

6.1 Demand for Change versus No Change

Of the 311 households responding to the contingent valuation questions, 72 (23 per cent) opted for the 'no change' or *status quo* option rather than pay for improvement and 4 households (1 per cent) remained unsure. All of the rest—235 households (76 per cent)—opted to pay for change indicating that there is quite a bit of 'latent' demand for some type of improvement in the current water system.

We find that the households preferring the *status quo* option are likely to be least satisfied with their current primary water sources (Table 7). They are also likely to be poor, to pay a lower unit cost for water consumed, to have lower per capita expenditures on water and to spend more time collecting water than those households who opted for change. The lower income level and the relatively long time spent daily on water collection by these households suggest they have low opportunity cost of time, which is likely to be the result of both low wage rates of earning members and the presence of non-earning members in households. In their source selection, then, they appear to be trading off their time in exchange for low monetary expenditures on water.

When asked their reasons for not choosing any of the proposed improvements, these households responded as follows: 53 (74 per cent) households cited financial reasons, that is, the unit price and/or deposit fee for the proposed improvement options was high; 8 (11 per cent) gave both financial and 'physical' ('house too small' or 'rent only one room') reasons; 9 (13 per cent) said they were satisfied with their current supply system; and 2

Table 7. Profile of unconnected households selecting a particular option (by option)

	Private connection		Yard tap		Kiosks		*Status quo*	
Option preferred	*N*	Mean	*N*	Mean	*N*	Mean	*N*	Mean
Household water use in litres per day	94	139	80	128	49	93	70	119
Daily per capita water use (in litres)[a]	93	34.9	80	34.2	49	27.9	69	30.9
Cost in Ksh per litre for water used/procured from all sources[a]	59	0.27	66	0.25	28	0.24	51	0.21
Time spent on collection from the primary source in minutes per day	77	35.4	68	38.3	47	26.9	66	61.4
Household expenditure on water in Ksh per day	61	31.4	66	28.7	28	29.4	51	27.0
Per capita expenditure on water in Ksh per day[a]	60	10.5	66	8.6	28	7.0	51	6.6
Number of rooms in current residence	102	2.5	80	1.9	51	1.7	71	1.9
Household size	101	4.7	81	4.3	52	4.2	71	4.5
	N	Percentage	*N*	Percentage	*N*	Percentage	*N*	Percentage
Percentage of households who are 'poor'	98	46.9	57	73.1	48	75.0	69	75.4
Percentage of male respondents	102	46.1	81	45.7	52	36.5	72	40.3
Percentage of respondents with at least primary level education	102	50.0	80	36.3	51	31.4	72	43.1
Percentage of households who own their current residence	95	34.7	79	17.7	52	17.3	64	23.4
Percentage of households travelling more than 200 metres to primary source	89	34.8	72	33.3	45	8.9	69	40.6
Percentage of households not satisfied with service from primary source	97	51.6	76	61.8	49	51.0	70	64.3
Percentage of households very satisfied with service from primary source	97	5.2	76	0.0	49	4.1	70	1.4

[a]Based on *computed* values derived *for each household* as follows: (i) daily per capita water use is daily household water use divided by household size; (ii) daily per capita expenditure on water is daily household expenditure on water divided by household size; (iii) unit cost water used/procured from all sources is daily household expenditure on water divided by daily household water use.

(3 per cent) did not cite a reason. These findings suggest that most of these households prefer to maintain the *status quo* not because they are satisfied with their current water sources, but rather because they see little economic benefit (combination of monetary costs and opportunity cost of time) in switching from current sources and/or that is the best they can afford even if it entails a long collection time and an unsatisfactory service experience.

Next, we conducted a multivariate statistical analysis in the form of binomial logit model. This allows us, first, to test the statistical significance of the findings of the descriptive, univariate analysis above and, secondly, simultaneously to control for the effects of all potential factors, to identify which of these multiple factors are truly the 'drivers' behind households' preferences. The literature identifies a multitude of socioeconomic factors that can influence a household's decision regarding change versus no change (see, for example, World Bank Water Demand Research Team, 1993). In our logit model, we analysed several variables drawn from the literature, including household size, income level, gender of respondent, education level of household respondent, current water use and unit costs (see Table 8). We also controlled for the city of residence and the tariffs for private and yard options used in the survey. Results of the binomial logistic regression analysis are presented in Table 8.

Table 8. Results of binomial logistic regression analysis—dependent variable: probability of opting for 'change' relative to 'no change' ($N = 221$)

Independent variable	Coefficient estimate	T-statistic
Intercept	−0.45365	−0.26
Option characteristics		
Connection fee for private/yard tap options	0.00003	0.30
Unit price for private/yard tap options	0.00090	0.12
Household characteristics		
Male respondent	−0.07932	−0.15
Education level of respondent	−0.87327	−1.67
Poor household	−0.65677	−1.52
Household size	0.00873	0.07
Per capita daily water use	0.01767**	2.38
Unit price currently paid for water	5.87584**	3.70
Own residence	−0.95518	−1.72
Number of rooms in residence	0.23416	1.13
Time spent daily in collecting water	−0.00868**	−2.75
Overall satisfaction level with primary water source	0.30604	0.60
City of residence[a]		
Mombasa	−0.06182	−0.19
Kakamega	0.46857	0.24
Current primary water source[b]		
Yard tap	0.04937	0.05
Own source (well, borehole)	−2.30138	−1.86
Kiosk	0.27770	0.21
Ground and natural sources	0.08514	0.68
Adjusted R^2	0.37	
Log-likelihood	−74.9	

[a]'Nairobi' is used as the base/comparison level.

[b]'Neighbours/vendors/others' is used as the base/comparison level.

**indicates statistical significance at the 0.05 level or less.

The results show that, when controlling for all potential socioeconomic factors simultaneously, only three factors exhibit a statistically significant (at the 5 per cent level or less) influence on a household's preference for change versus no change in their current water supply system. These are: current unit cost for water; current per capita water use; and, time spent daily in collecting water. We find that a household is *more* likely to maintain its current water system, the *lower* the unit cost it bears for water, the *lower* is its per capita water use or the *longer* the time it spends daily on collecting water. The negative relationship between the preference for the *status quo* and the first two variables is easy to understand—a household that currently bears a low unit cost for water or has low per capita water use, will see little economic incentive in switching from its current water system.

Regarding collection time, *a priori*, we would expect that households spending a lot of time in getting their water would be more (not less) likely to opt for a change. In this case, however, there is a positive relationship between daily time spent by a household on water collection and its preference for the *status quo*. One possible explanation, mentioned earlier, is that these households place a very low value on the opportunity cost of their time, reflecting perhaps low wage rates and/or availability of non-working members who can collect water. A low opportunity cost of time combined with the indication that they have financial constraints, suggests that these households perceive the economic incentives of switching from their current sources to be low, despite the longer collection time.

We find that all other potential factors used in our analysis reveal *no* statistically significant (at the 5 per cent level or less) influence on a household's preference for change versus no change. The statistically insignificant factors, many of which other studies find to be relevant, include: household size, welfare category, gender and education level of respondent, home-ownership, current primary water source, overall satisfaction level with the primary source, the city of residence and the tariff for the private and yard improvement options used in the survey.

Overall, our results indicate that, within the subset of the unconnected, neither current economic welfare category (poor vs non-poor) nor their stated dissatisfaction with their current source plays a decisive role in a household's decision to change its current water system. What really decides whether a household is likely to agree to pay for a proposed improvement option is whether it expects the switch to result in tangible economic benefits—implicitly defined by respondents themselves as some combination of just three factors: cost, quantity and collection time. For instance, a poor household with a high level of satisfaction with its current water supply situation can still prefer a proposed improvement option as long as it sees economic benefit in such a switch. Conversely, a non-poor household with a low level of satisfaction with its current water system can still prefer the *status quo* over all of the proposed improvement options if it sees no economic benefit (either in terms of direct monetary savings or indirect savings associated with time reduction) from such a switch.

The results suggest that these urban households in Kenya use an implicit economic cost–benefit framework to guide their decision on change versus no change in their current water system. Coupled with the finding that 76 per cent of sampled households prefer one of the three proposed improvement options, this study indicates that the majority of Kenyan urban households perceive clear economic benefits from the proposed improvement options and are thus more likely to be willing to pay for them. The policy implication is that the economic and financial viability of future improvements is high. The key constraints to the introduction and success of improved water services are, hence, more likely to be political and institutional. We return to this point in the concluding section.

6.2 *Demand for Types of Change*

Of the 235 households who opted to pay for a change, 33 per cent selected private connections (51 per cent of non-poor and 24 per cent of poor), 26 per cent selected yard connections (21 per cent of non-poor and 30 per cent of poor) and 17 per cent (12 per cent of non-poor and 19 per cent of poor) opted for improved kiosk services. Kiosks were the least-preferred improvement option among both the non-poor and the poor. This result is consistent with our earlier finding that the dissatisfaction rate of households who *currently* use kiosk services is high (section 5).

For our multivariate analysis, we use the McFadden discrete choice model because in our survey the households choose among three improvement options and one option characteristic (the tariff structure) varies across households (see Mu *et al.*, 1990). The improvement option characteristics used in the analysis are the proposed connection fee and unit price. The socioeconomic variables included are the same as those used in the analysis of 'change versus no change' in the previous section. Estimation results of the McFadden discrete choice model are presented in Table 9.

The results show that, when controlling for various household and option characteristics simultaneously, only three variables are statistically significant (at the 5 per cent significance level) in explaining households' preferences among the three options: current unit cost of water; current per capita water use; and, number of rooms in current residence. We find that a household is *more* likely to prefer the private piped connection option as compared with the improved kiosk option, the *higher* the unit cost it currently incurs for water, the *higher* is its current per capita water use level, or the *more* numerous the rooms in its current residence. These three statistically significant factors suggest that non-poor households are more likely to have a higher preference for private piped connections and they support the descriptive results in Table 7. The strong influence of the size of a household's current residence suggests that housing (and, by extension, settlement) characteristics play an important role in determining household preferences among service options.

6.3 Kiosks as a Strategy for Serving the Poor: Success or Failure?

Many water-sector experts believe that kiosks and private (as opposed to public) standpipes are an appropriate and financially sustainable solution for providing water to poor households (for example, Whittington *et al.*, 1990; Collignon and Vézina, 2000; Kariuki *et al.*, 2003). These experts argue that private connections are usually inappropriate for the poor. First, connections costs tend to be too high for the poor to afford. Secondly, even if they are connected, the poor often cannot pay the lump-sum monthly bills, especially because their income tends to be irregular. The result is high disconnection rates and/or large arrears and both the utility and the poor consumers are left worse off.

By contrast, kiosks provide a service that works better for the poor and is a technically and financially feasible option. Specifically, kiosks: allow users to buy in quantities and at times that they can pay; entail lower capital costs per household served compared with private and yard connections (allowing, among other things, coverage rates to be increased significantly and faster, and presumably lowering the unit cost to the user); and, permit (better) cost recovery by the utilities because the kiosk operators ensure that the users pay for the water.

In other words, kiosks provide a flexible, desirable and 'good' service to the poor by allowing them to purchase in small quantities, as and when they have money (as opposed—for example, to a lumpy monthly bill which is due on a fixed date each month). The poor get a service that they can afford and the utility recovers most of the costs of providing such a service. Further, given that most customers of kiosks tend to be poor, any subsidies directed to the kiosk system are better targeted.

At least in the case of Kenya, this well-intentioned approach is not working well. Although kiosks do seem to have improved access for thousands of unconnected and poor households, they are not seen as a desirable solution by users and they are hurting the

Table 9. Estimation results of the McFadden discrete choice model for household preferences among proposed improvement options ($N = 221$)

			Dependent variable: relative to the 'improved kiosk service' option, probability of opting for			
			Private connection		Yard tap	
Independent variable	Coefficient estimate	*T*-statistic	Coefficient estimate	*T*-statistic	Coefficient estimate	*T*-statistic
Intercept			2.82979	0.67	2.97466	0.71
Option characteristics						
Connection fee	−0.00016	−0.69				
Unit price	2.25893	0.19				
Household characteristics						
Male respondent			0.33352	0.49	0.57949	0.89
Education level of respondent			0.90920	1.19	−0.01566	−0.02
Poor household			−0.96432	−1.25	−0.61993	−0.81
Household size			−0.10386	−0.64	−0.18524	−1.16
Per capita daily water use			0.02523**	2.41	0.01719**	2.32
Unit price currently paid for water			0.99265**	1.97	3.10373**	1.99
Own residence			−0.50863	−0.38	−1.21824	−0.92
Number of rooms in residence			1.47847**	1.98	1.46556**	1.98
Time spent daily in collecting water			0.00869	0.86	0.01261	1.30
Overall satisfaction level with primary water source			−0.58083	−0.82	0.02283	0.03
City of residence[a]						
Mombasa			−0.81608	−0.50	0.96586	0.57
Kakamega			−1.64079	−0.93	−1.49329	−0.84
Current primary water source[b]						
Yard tap			−2.18028	−1.29	−2.77830	−1.69
Own source (well, borehole)			−12.58227	0.00	26.04710	0.00
Kiosk			−1.29486	−0.92	−1.83151	−1.32
Ground and natural sources			−1.12005	−0.50	−2.04493	−0.94
Adjusted R^2	0.31					
Log-likelihood	−97.6					

[a]'Nairobi' is used as the base/comparison level.
[b]'Neighbours/vendors/others' is used as the base/comparison level.
**indicates statistical significance at the 0.05 level or less.

utilities' bottom line. From our price analysis in section 4, we know that kiosk owners charge, on average, a price that is 18 times higher than the subsidised prices at which they receive water from the utility. That is, the utility loses money on water it supplies to kiosks but none of the subsidy reaches the users, the majority of whom are indeed poor. As mentioned earlier, the Collignon and Vézina (2000) study notes that kiosk operators in Nairobi have gross profit margins of about 80–90 per cent but suggests that these *may* be a reflection of the high costs of connecting to distant water trunk lines and/or illegal payments that they are forced to make.

In their study of vending in Jakarta, Lovei and Whittington (1993) show how the system can generate substantial monopoly rents that can be appropriated by public and private agents. In our case, the question of whether the kiosk system indeed results in extraordinary *net* profits (i.e. monopoly rents) and to whom these profits accrue requires additional research. It is clear, however, that the kiosk system and the design of the subsidy are not working as intended in these Kenyan towns. The significant gap between purchase and sales prices of kiosk water also provides evidence for the argument that tariffs in themselves are a limited tool for targeting and/or influencing service delivery and that the intermediating institutional arrangements are crucial for determining the outcome.

What is the practical implication of these findings? One approach—a pragmatic and optimistic one—is to try and fix the problem and the options for doing so include: bringing trunk infrastructure closer to low-income areas; increasing private, yard and kiosk connections in these areas, perhaps by subsidising connections but not the water itself; and, supporting the establishment of kiosks with regulated or fixed prices to put downward pressure on the price charged by other kiosks—there is evidence, for example, that NGO-run kiosks in Nairobi and government-owned kiosks in Mombasa charging fixed prices have helped to lower water prices in their area. A second and dramatically different approach is to acknowledge failure and rethink the strategies for serving the poor—empirical assessments may well reveal that options such as subsidised private or yard connections with innovative payment arrangements are economically and financially superior (or at least not inferior) to the current kiosk system in Kenya.

7. Conclusions

This study finds that the current water supply situation in Nairobi, Mombasa and Kakamega is dismal. Although about half of the sampled households have access to private piped water connections, only 5 per cent of those connected are poor. The poor households are thus overwhelmingly dependent on alternative water sources and end up spending an average of 42 minutes in collecting water (compared with 15 minutes spent by non-poor households). These findings are not surprising. Indeed, stories of underserved poor households are legion in the literature which shows that the urban poor are not likely to have a private water connection, are likely to be paying high unit prices for water that they purchase and are likely to spend a significant amount of time in collecting water.

The surprise is that the non-poor in the sample are not that much better-off. The mean per capita daily water use is 33 and 44 litres for poor and non-poor households respectively and the median water use values for both groups are lower. These water use levels are rather low in absolute terms and, when compared with baseline data from earlier studies, represent a sharp decline in usage by the connected non-poor households. In addition, the unit costs incurred by both the poor and the non-poor are very high and there is no statistically significant difference in the mean unit costs that they incur for their water. On average, the households are spending Ksh260 per cubic metre (US$3.5) and the median unit cost for the sample is Ksh156 per cubic metre (US$2.1). Overall, both the poor and non-poor are consuming little water and incurring high unit costs for it—this is due to a failing public water supply system and the emergence of an unregulated private market for water in which prices and gross profit margins are high. The result is that half the households sampled—piped and unpiped, poor and non-poor—are dissatisfied with their current water supply situation and the majority rate improvement in water systems as their top development priority. In other words, water service is universally bad.

When presented with improvement options and associated tariffs, the majority (76 per cent) of the 311 unconnected households opted to pay for an improvement—kiosk, yard tap or a private connection—rather than maintain the *status quo*. Of these, 43 per cent opted for private connections, 35 per cent for yard connections and 22 per cent for improved kiosk service. Multivariate statistical analysis shows that only three variables are statistically significant in explaining households' preferences among the three options: the current unit cost of water; current per capita water use; and, the number of rooms in current residence. We find, for example, that a household is more likely to prefer the private connection option, the higher the unit cost it incurs for water, the higher its per capita water use or the greater the number of rooms in its current residence.

Regarding the household decision on whether or not to opt and pay for a change from their current system, again only three variables are statistically significant: the current unit cost of water; current per capita water use; and, time spent daily in collecting water. We find that a household is more likely to maintain its current water supply status, the lower its unit cost for water, the lower its per capita water use or the longer the time spent daily on collecting water.

The results indicate that households in these urban areas are acting largely as informed and rational economic decision-makers, that there is a well-established private market for water and it is similar in nature to the market for a consumption good—it works on price and quantity, all else being equal. Survey respondents—poor and non-poor, educated and uneducated, male and female—understand the value of water, treat it as an economic good and have moved away from any erstwhile notions that it will be available from a public source at low or no cost.

It is much to our own surprise and in contrast to some of the earlier studies on demand (albeit rural demand),[14] that economic factors such as price and quantity, rather than socioeconomic variables such as education level and gender, help to explain much of the variation in households' decision on whether or not to connect and which option to choose. One possible explanation is that, in cities such as Nairobi and Mombasa, failing public supply combined with the emergence of a poorly functioning and unregulated market for water has transformed basic user perceptions regarding water, its availability, price and options for supply. In such cities—which we speculate would include the likes of Dar-es-Salaam and Lagos—the demand for improvements in water supply and households' willingness to pay for them are likely to be very high.

In contrast to the supply-side penchant for pushing kiosks as the affordable and desirable strategy for serving the poor, we find kiosks are the least-preferred 'improvement' option among unconnected urban households in Kenya. Our data also suggest that current users of kiosks continue to use them only because they have no choice and/or no ability to pay for a better alternative. Arguably, one reason that households do not like kiosks is that kiosk operators charge high mark-ups resulting in very high prices—they sell water at an average of Ksh4.1 per 20-litre jerrycan or US$2.7 per cubic metre even though they receive water from the utilities at a 'social' tariff of US$0.15 per cubic metre. Thus, not only are the kiosks hurting the bottom line of the utilities, but also none of the subsidies intended for the customers of these kiosks—77 per cent of whom are poor—is actually reaching them. This finding highlights the limitations of using tariffs as a targeting tool and the importance of getting the subsidy mechanisms right. We speculate that this particular failure seen in the Kenyan kiosk system is not unique—that is, it is highly likely that utilities in several other countries are also failing to recover costs from kiosks even though users are likely to be paying cost-recovery-level prices for water from these systems. This contention needs to be tested through additional empirical research. Further, it is worth conducting research on the scale, scope and functioning of the parallel water industry in these Kenyan towns and also, perhaps, on whether private water providers—who often deliver a valuable and desirable service—are indeed extracting extraordinary profits.

What are the broader implications of this study for the water sector in Kenya? The study indicates that there is broad constituency for reform in the water sector in urban Kenya—a constituency that includes, unlike perhaps in many Asian and Latin American cities, both poor and non-poor consumers. The low levels of water use have at least one positive implication—the size of the systems and investments required to meet demand and the Millennium Goals is smaller. Despite low water use, the existing water budget of the population is large indicating that households' willingness to pay for improvements is backed by an ability to pay. In other words, this is a situation where user support for, and the financial and economic viability of, an improvement programme are high. There are no major supply constraints either—water production and water treatment capacity exist; but they need to be complemented by improvements and expansions in the transmission and distribution networks (World Bank, 2001). We also know that the utilities are losing money and service provision is deteriorating despite the fact that the tariffs are technically sufficient to allow cost recovery (World Bank, 2001). This means that the low-level equilibrium cannot be attributed to low tariffs and, hence, the standard prescription of 'raising prices and using the increased revenues to improve service' has little value and credibility in this situation. The key challenges, it seems to us, are political and institutional. They include: the political will to build broad support for and move forward with a reform programme; dramatically altering the institutional and governance arrangements for service delivery and enhancing incentives for performance (which some practitioners believe boils down to the ideologically difficult decision regarding public versus private or commercial operation of utilities); and designing mechanisms for incorporating independent water providers and current utility staff into the reform programme in a manner that reduces the threat of their jeopardising potential institutional reforms in the sector as a whole.

Notes

1. These time-bound and measurable targets are aimed at reducing poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women (see UN, 2003, and http://www.un.org/milleniumgoals/). Although the target of reducing the proportion of people without access to safe water is technically included under the category of 'environmental sustainability', it is widely acknowledged that many of the other goals—such as reduction of poverty and lowering of infant mortality rates—require improvements in water supply and sanitation.
2. The 'larger enquiry' refers to a joint review of the water and sanitation sector in Kenya by several bilateral and multilateral agencies, including the AFD, KfW, GTZ, DfID, and the World Bank. This study of household demand was one of several analyses and background papers commissioned for the review.
3. To reduce survey response bias in income reporting, we relied on a technique that is well-tested and commonly used in the marketing and management literature (see, for example, Ratchford *et al.*, 2003). Instead of asking for a precise income figure, households were asked to indicate which of the following 9 income brackets they were in: less than and equal to Ksh5000; Ksh5001–10 000; Ksh10 001–15 000; Ksh15 001–20 000; Ksh20 001–25 000; Ksh25 001–30 000; Ksh30 001–35 000; Ksh35 001–40 000; more than Ksh40 000.
4. We tested the sensitivity of the primary findings reported in this study with respect to: (a) using a common poverty threshold of Ksh10 000 for all the 3 cities; and (b) excluding Kakamega from our sample altogether. In either case, the substantive findings were quite similar to the findings reported here.
5. The urban food poverty line was estimated at Ksh1254 per adult equivalent per month. To calculate adult equivalency, the Kenya

report (1999) reweighted household size as follows: 0.24 for age-groups 0–4; 0.65 for age-groups 5–14; and 1 for adults (15 and above). For example, for a family of 2 adults and 3 children in the 5–14 age-group, the adult equivalent would be 3.89 and the poverty threshold would be monthly expenditures of Ksh10 300 (3.89 * Ksh2648).

6. In this 10-city study, the households were categorised as: those with an in-home connection; those that collect water themselves from standpipes; and, those that depend on independent providers (trucks, vendors, kiosks, etc.) or traditional sources. For our purposes, the first two groups can be reclassified as those that have access to piped supply in-house or through standpipes/yard taps.
7. This showerhead dispenses water at 2.5 gallons per minute (9.46 litres per minute) and is rated by its manufacturer as a 'reduced flow' showerhead.
8. To investigate the extent of potential bias that could have been introduced in our findings due to the drought-induced shortage in Nairobi during our survey, we recomputed the average water usage level and unit price paid for the aggregate sample under various scenarios: (i) without shortage, each Nairobi city household would have been using 10–25 per cent more than the amount reported in our survey; and (ii) without shortage, Nairobi households would have been paying 10–25 per cent less than that reported. The resulting reduction in the mean values for water use and costs are noted in the text.
9. Although unit cost usually refers to the costs of production, in this paper we use the term to indicate the costs incurred by households per unit of water that they use.
10. Utilities in most Kenyan towns, including Mombassa and Kakamega, follow a standardised increasing block tariff which ranges from Ksh20–100 per cubic metre (US$0.27–1.33) depending on total use (World Bank 2001). In Nariobi, the tariffs for domestic use are somewhat lower and range from Ksh12–60 per cubic metre (US$0.16–0.80).
11. For Nairobi, Collignon and Vézina (2000) report that the cost of water from standpipes ranges (min–max) from US$1.0–2.5/cubic metre. For water delivered to homes, the range of prices in the 10 cities is US$2–8/ cubic metre, with that in Nairobi being US$6–8/cubic metre.
12. DOW II reports an average unit cost of water of US$1.02/cubic metre for piped supplies and US$1.4/cubic metre for unpiped supplies. These estimates are significantly lower than ours and appear to reflect different assumptions—for example, they appear to be assuming that the piped households are able to buy *all* of their water at the relatively low utility rates, an assumption that our study directly refutes. Our cost data and those from the DOW II study provide a basis for future discussion and debate on the appropriate methodology for calculating the private cost of water and help to establish some sort of a baseline for future analyses.
13. As price enters in linear form in the estimated demand function, price elasticity of demand is not constant over the function—it depends on the 'point' at which it is computed and can be expressed as $\beta P/Q$, where β is the estimated demand function coefficient at price P and corresponding demand Q. The sample mean household water use levels (in litres per day) are 186.4, 118.9 and 226.0 for 'all', poor and non-poor households respectively. The sample mean unit costs incurred (in Ksh per litre) are 0.26, 0.23 and 0.28 for all, poor and non-poor households respectively.
14. Several studies on demand for water in rural areas, published in the early 1990s, suggest that socioeconomic factors such as education levels and the gender of the respondent have a large role to play in determining the demand for water and the source choice (see, for example, Briscoe *et al.*, 1990; World Bank Water Demand Research Team, 1993).

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Appendix. Estimation of Household Demand Function for Water Use

To gain insights into sample households' price elasticity of demand for water, we used regression analysis to estimate a linear demand function of total household water use (in litres per day) in terms of unit water price paid (Ksh per litre), household income level (Ksh per month), household size (number of persons currently in residence), current city of residence (indicator variable with *Nairobi* as the 'base/comparison' level) and current primary source of water (indicator variable with *private piped connection* as the 'base/comparison' level). It should be noted that the objective of our demand model analysis is not to develop a *predictive* model of household water use, but to test for any systematic empirical relationship between the use level and unit price paid across households. This makes the inherent problem of 'missing variables' in any reduced-form empirical model analysis, as is the case with our demand function model estimation here, less of an issue.

The model was estimated using GLM (generalised linear model) regression analysis with robust standard errors clustered on neighbourhood sites (used as the stratifying unit for our survey data collection) to account for possible lack of independence across individual household observations within these clusters. The GLM estimation technique thus relaxes the two critical assumptions (i.e. equal variance and independent random errors across observations) underlying the usual OLS (ordinary least square) regression analysis and should lead to more appropriate significance tests for the model coefficients. The estimation results are shown in Table A1.

Table A1. Estimation results for the linear demand function—dependent variable: household water use (litres per day) ($N = 340$)

Independent variables	Coefficient estimate	T-statistic
Intercept	32.23310	0.78
Unit price paid (Ksh per litre)	−83.28066**	−2.24
Household income (Ksh per month)	0.00281**	3.70
Household size (number of persons)	31.52073**	4.34
Current city of residence[a]		
Mombasa	87.30729**	3.18
Kakamega	−27.44817	−1.14
Current primary source of water[b]		
Yard tap	−60.70484**	−2.48
Own source (well, borehole)	91.36908	0.45
Water kiosk	−78.06063**	−3.07
Water vendors	−80.13046**	−2.20
Neighbours	−67.69434**	−2.12
Ground and natural sources	−59.11138	−1.81
Others (including bottled water)	−126.6406**	−4.94
Adjusted R^2	0.34	

[a]'Nairobi' is used as the base/comparison level.
[b]'Private piped connection' is used as the base/comparison level.
**indicates statistical significance at the 0.05 level or less.