Water vending activities in developing countries

A case study of Ukunda, Kenya

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Millions of people in developing countries obtain water from commercial vendors who deliver it to their homes, yet this phenomenon has received little attention from professionals in the water resources field. This paper describes a water vending system which is in operation in Ukunda, Kenya, a town of about 5000 people south of Mombasa. In this community 45% for water consumed by households is obtained from water vendors who deliver water in carts directly to people's homes. The prices vendors charge for water are high, but vendors are not making exorbitant profits; hauling water manually is simply expensive. People in Ukunda spend about 9% of their income on vended water, which suggests that there are situations in which households are willing and able to pay substantial amounts of money for water even when traditional sources are readily available.

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Water supply projects in developing countries are traditionally based on either (a) piped systems, with public taps or private household services (or both), or (b) wells with handpumps. Both of these approaches to providing water services have been extensively studied; planning and design manuals for such systems abound. There is, however, a third approach to service delivery which is seldom explicitly recognized or incorporated in design or investment decisions: water vending. Millions of people in villages and cities throughout the developing world are, in fact, already being served by vendors who take water from a source that is available and then deliver it in containers to households or fill household containers from their vehicle tanks.

Water vending

The distribution of water by vendors is expensive, whether the vehicles are powered by people, animals or engines. Households which are served by vendors generally pay more per month for 20–40 litres per

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capita per day than those directly connected to a piped system who might use as much as 400 litres per capita per day. Households sometimes pay over 10% of their monthly income for vended water, as compared to 1–5% for most piped water systems (Whittington, Lauria and Mu, 1989; Zaroff and Okun, 1984). In addition, vendors somtimes sell water from polluted sources or fouled containers. Water vending can thus be a financial burden and a health threat to millions of people.

Nevertheless, vending is a valuable service for people in urban and rural areas who have no access to piped water; otherwise they would not choose to buy vended water. People moving into slums and squatter settlements on the fringes of rapidly expanding urban areas must often rely on vendors until the piped system is expanded, if ever. In villages traditional water sources may still be available, but people may have sufficient income to afford vended water at least part of the time and thus obtain some relief from the daily burden of carrying water from a distant source to the household. The principal benefit of water vending to the consumer is thus that it provides a significant saving of time compared to fetching water from other sources.

There are, however, other important social benefits of water vending. Vending is labour intensive. The principal cost of a simple water vending system (ie one without motorized vehicles) is typically the labour of the vendors themselves, the social opportunity cost of which may be very low. The capital costs of such water vending systems are much lower than for piped systems and usually require much less foreign exchange. Vending often provides significant employment in communities with few other opportunities (at least in the short term). The technology used in most vending systems is relatively simple and can be maintained locally. Vending operations are also robust; there are typically many vendors, and if the equipment of one breaks down, others still function.

While water vending is ubiquitous in developing countries, it takes many forms and is organized in many different ways. All systems have one or more of three types of vendors:

(1) *Wholesale vendors* obtain water from some source and sell it to distributing vendors.
(2) *Distributing vendors* obtain water from a source or a wholesale vendor and sell it to consumers door-to-door. (In this article we use the term *vendor* alone to refer to a *distributing vendor*.)
(3) *Direct vendors* sell water to consumers coming to the source to purchase water. In Kenya direct vendors sell water from kiosks where the water is dispersed from a distribution system.

An individual can be both a wholesale and a direct vendor, selling to distributing vendors and to customers directly as shown in Figure 1. A distributing, wholesale or direct vendor may obtain water directly from a source or a piped distribution system. A distributing vendor may in addition use a vehicle to get water from the source directly or from a wholesale vendor. Customers may get water by pipeline, from a distributing vendor, or by walking to a public tap, a direct vendor (kiosk) or a source.

Prices for water may be set competitively or controlled at any of several possible points in a vending system. Any of the three kinds of vendors may be formally or informally organized, or operate independently. The prices distributing vendors receive may be set in a competitive market, while they may buy water from wholesale vendors with monopoly power. Alternatively, wholesale vendors may compete freely, but distributing vendors may be organized to control prices. Water from a public tap is generally free, but, when attended, the direct vendor makes a charge.

Despite the fact that water vendors serve millions

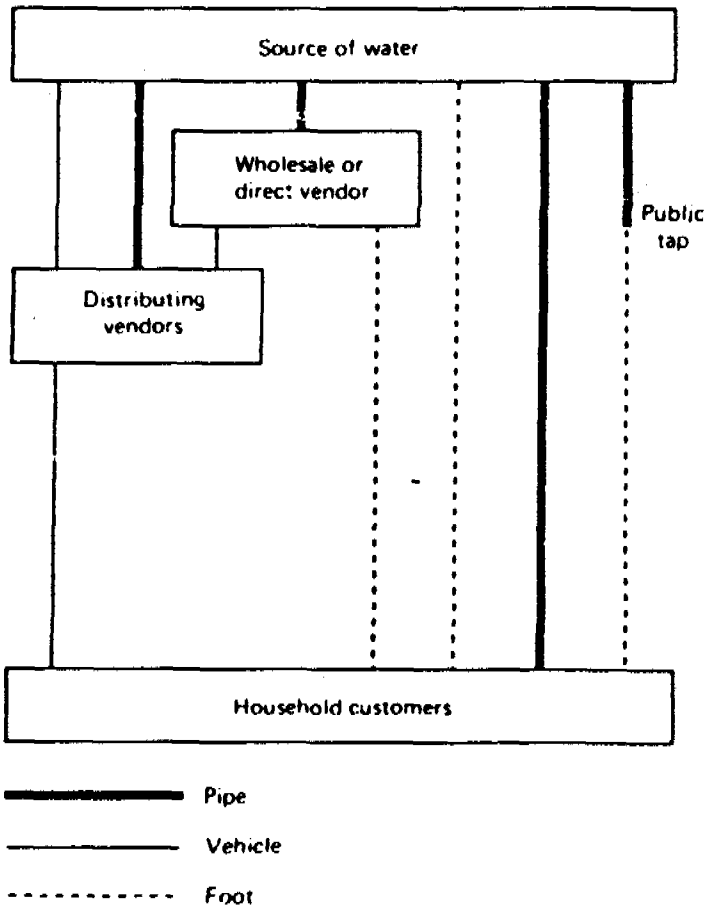

Figure 1. Possible water distribution systems.

of people in cities and villages throughout the developing world and may offer a more convenient service than is available from public handpumps or public taps (although at a high price), water vending has received little attention in the published literature (for exceptions see Adrianzen and Graham, 1974; Antoniou, 1979; Fass, 1982; Suleiman, 1977; and Zaroff and Okun, 1984). Most information is anecdotal. Professionals in the water resources field have ignored water vending in part because its existence is seen as an indication of the failure of water supply institutions to provide an adequate service. Although this is often an accurate assessment of the situation, vending is worthy of study for the following reasons:

(1) Vending will continue to exist in developing countries for the foreseeable future due to severe shortages of capital for piped systems or for wells and handpumps.
(2) Vending may in some circumstances actually prove to be an appropriate technology for a community at a given level of economic and social development because it is typically very reliable.
(3) Information on water vending practices, particularly costs and charges, may be useful for traditional water supply planning decisions.
(4) Vending systems may be improved in quality and economy.

The research reported in the remainder of this paper was initiated in order to take a first step towards providing detailed data on water vending in developing countries.

The study area

Ukunda is a village of about 5000 people located 40 km south of Mombasa in the Kwale district of Kenya. It is the largest population centre along the Kenyan South Coast between Mombasa and the Tanzanian border. The town lies alongside a paved highway which parallels the coastline and is about 3 km from the ocean. Ukunda's economy is representative of many small provincial centres in Africa which are being rapidly drawn into a national market economy. The economy of Ukunda is, however, heavily influenced by its proximity to the luxury tourist hotels at Diani Beach and Mombasa. Although the economy of the South Coast region is primarily based on agriculture and fishing, many people in Ukunda find jobs in tourist-related activities, particularly during the high season from November to March. This increased economic activity supports a petrol station, a handful of third-class hotels and restaurants, numerous bars and a few handicraft enterprises. There are also a few local offices for government organizations such as the Ministry of Water Development (MWD).

The majority of houses in Ukunda and surrounding villages are constructed of mud with thatched roofs, although corrugated metal roofs and masonry walls are becoming increasingly common. The agricultural areas around Ukunda are heavily populated, with over 200 people per km^2. Over 90% of the population along the South Coast is Wadigo, who are Moslems, but the percentage in Ukunda itself is somewhat less due to substantial in-migration. Education levels in the Kwale district are low; about three quarters of the population has never attended school. Per capita annual income in the region is in the order of US$200, although it is estimated at US$350 in Ukunda.

Rainfall along the South Coast is approximately 1200 mm per year. The rainy season lasts from April to October. Numerous small streams drain the Shimba Hills 30 km west of the coast; one small river passes 2 km north of the centre of Ukunda on its way to the sea.

Residents of Ukunda have numerous sources of water available in the village without walking to nearby rivers or ponds. The MWD operates a pipeline which was designed primarily to serve the resort hotels on Diani Beach (Figure 2). The source of water for this system is four boreholes 10 km north of Ukunda. The system's capacity is about 4000 m^3 per day, but it is subject to frequent breakdowns. There are only about 15 private house connections in Ukunda; most people in Ukunda obtain water from the system by purchasing it from direct vendors who are licensed operators (kiosks) or from distributing vendors who buy water from the kiosks (wholesale vendors). A kiosk is typically a small structure with a corrugated metal roof and walls surrounding a single tap which the operator controls by hand. All of the kiosks are used for direct vending to individuals; some of the kiosks also sell to distributing vendors who then deliver water to both households and small businesses.

The vendors carry water in 20 litre plastic jerricans, transported by either carts or bicycles. The carts have a single axle with two automobile tyres and are pushed by hand similar to a wheelbarrow. Most of the carts carry ten 20 litre jerricans weighing 200 kg. A bicycle outfitted for vending can carry three cans. The carts are more efficient for most types of terrain. The bicycles are used for more distant locations and on slopes which are difficult to reach with a fully loaded cart. The cart wheels are equipped with bells which jingle when the carts are

moving, and vendors make most of their sales while pushing their carts through the village looking for customers. The level of service which the vendors provide is quite extraordinary: almost anywhere in Ukunda a person can within minutes hear the bells and hail a vendor. Often several vendors appear.

In addition, six open wells and five handpumps are scattered around the village. There is a long tradition of well ownership in Wadigo communities. Wells are typically dug by wealthier members of the community, but anyone in the community is free to use them without charge. The wells in Ukunda range from shallow to about 30 m deep, and most provide water all year round. Some of the wells in Ukunda are up to 2.5 m in diameter, with finely crafted rock walls. None are equipped with working pulleys; individuals collect water by dropping a 2 litre container into the well.

The handpumps in the community were installed by various donor agencies, and several different brands are used. The handpumps are located in the southern part of Ukunda, generally in less densely populated areas. The donors left various institutional arrangements for collecting funds to maintain the handpumps.

Field procedures

The fieldwork on water vending was conducted in June and July 1986, the rainy season, and consisted of four activities:

(1) observations at kiosks, handpumps and open wells;
(2) interviews with water vendors;
(3) interviews with kiosk owners;
(4) mapping out vendor routes.

Observations at kiosks, handpumps and open wells were conducted over the period from 23 June to 5 July 1986 by 17 individuals from the community, most with the equivalent of a secondary school education. All were given a day of training estimating volumes of containers and recording information; they were then required to pass a test to ensure that they could record information reliably.

Distributing vendors in Ukunda obtain water only from wholesale vendors at the kiosks; observers assigned to kiosks recorded the time each vendor arrived and departed and the amount of water purchased. Individuals obtain water directly from kiosks, open wells and handpumps; observers at all sources recorded the gender and age (adult/child) of each individual collecting water and the amount of water collected. The kiosks opened in the morning about 6.15 am. They closed for an hour or two early in the afternoon and then closed in the evening about 6.15 pm. Source observers stayed at their assigned posts for this entire period. Handpumps were generally locked at night and thus were open for use for roughly the same period each day. Data were taken on 28 783 trips by individuals to collect water and on 3605 trips by vendors.

Of a total of about 85–90 water vendors in Ukunda, 43 were interviewed. The questionnaire addressed the vendor's socioeconomic background, employment history, costs and sales, pricing and other business practices, and future developments in the vending business. Ten of the kiosk owners were interviewed to elicit information on their business and their opinions on water vending.

Some enumerators followed vendors all day and recorded (a) the time, location and volume of each fill-up at a kiosk, (b) the time, location and price of each sale, and (c) whether the sale was cash or credit. The enumerator also asked each buyer how much water was purchased on average each week. Over a six-day period vendors were followed for an entire day 50 times, and 887 actual sales were observed.

Description of the water vending industry

All of the vendors were male; their average age was 30 years. For all but one, water vending was a full-time occupation. Most vendors sell water throughout the entire year.

The prices charged for vended water are largely determined by free market forces. The vendors are not organized, and entry into the business is easy. Start-up costs are low because carts with jerricans are available for rent by the week from local merchants for as little as 10 ks (US$1 = 16 Kenyan shillings). The cost of a cart is about 1000 ks. About 40% of the vendors owned their equipment.

Kiosk owners pay the MWD 0.05 ks per 20 l (US$0.16 per m^3) for piped water. During both the rainy and dry seasons, the vendors buy water from the kiosks for 0.15 ks per 20 litre jerrican (US$0.47 per m^3). During the rainy season 90% of vendors' sales are at the rate of 1.5 ks per 20 litre jerrican (US$4.70 per m^3), increasing to 3 ks in the dry season when the demand for vended water is high because of the hot weather and the fact that, because people are employed in tourist-related activities, they have money to spend and little time for collecting water. The piped water system is unreliable and kiosk owners are without water about two days per week in the dry season. During such times of shortage, water vendors may have to collect water

from another town 5 km away, and the price may increase to 6 ks per jerrican. During the rainy season, higher prices are occasionally charged in outlying areas, and regular customers near kiosks sometimes receive lower prices. Social pressures among the vendors appear to keep the price from falling much below 1.5 ks. During the dry season a system of zonal pricing is much more developed and widespread. The price increases the farther the distance from the kiosks or from the paved road.

Some vendors have regular customers, highly valued because they provide a steady source of revenue, particularly during the rainy season. Vendors extend credit to regular customers and may charge lower prices. Prices in the rainy season may decrease to 1 ks per 20 litre jerrican for such reliable customers and, during periods of shortage, vendors do not increase the price charged regular customers to the market level.

Slightly less than 20% of the sales observed in this study were made on credit. Most vendor sales to households were for two jerricans. Businesses required larger deliveries. The average vendor made about 17 sales per day, requiring three to four trips to kiosks daily. Most vendors sell water in a relatively small portion of the village. Figure 2 shows the locations of water sales made by three vendors over the course of a single day's work.

Because water vending in Ukunda is highly competitive, a vendor must work hard to be successful. As in many sales operations, there is large variation in individual performance, and it is thus difficult to characterize a typical vendor. Table 1 presents a weekly budget for both the rainy and dry seasons for an experienced vendor who rents his cart and jerricans.

Table 1. A representative water vendor's weekly budget.

	Rainy season	Dry season
Revenues		
Trips per day	3	3
Cans per trip	10	10
Cans sold per day	30	60
Days worked per week	6	6.5
Cans sold per week	180	390
Average price per can (ks)	1.5	3
Total weekly sales (ks)	270	1170
Costs		
Water		
Price per can (ks)	0.15	0.15
Cost per week (ks)	27	59
Equipment		
Rental of cart and jerricans (ks)	10	15
Total weekly expenses, excluding own labour (ks)	37	74
Profits per week (ks)	233	1096
Hours worked per week	37	54
Implicit wage rate (ks/hr)	6	20

There is a marked difference in the profitability of water vending in the rainy and dry seasons. In the dry season the water vendors work more hours per day, the price they receive per jerrican is doubled, and their weekly revenues are two to four times as great. The implicit wage rate in the rainy season is 6 ks/hr, about 50% higher than the market wage rate for unskilled labour. In the dry season the vendors earn about 20 ks/hr. Some vendors voluntarily reported that they are able to save money during the dry season. Net annual income varies from 20 000 to 35 000 ks (US$1300–2100), about the average household income in Ukunda.

Analysis of water distribution

Slightly more than 20 000 jerricans (400 m^3) were sold weekly in the rainy season. Two of 13 kiosks supplied almost 50% of the water sold to vendors. Vendors buy most of their water in the morning. After a slack period, activity picks up in the afternoon. The average vendor queue time at a kiosk is about ten minutes, being slightly longer at the busier kiosks. Vendors still prefer these kiosks because their water pressure is reliable and they are well located.

Individuals, as contrasted with vendors, collected about 480 m^3 per week in the rainy season: 79% by adult women, 13% by adult men, 7% by female children and 1% by male children. Of the water collected directly by individuals, 64% was obtained from kiosks, 18% from handpumps and 18% from open wells.

In all, kiosk owners sold about 700 m^3 per week during the study period, over half (57%) being sold to vendors. The kiosks received revenues of about 3000 ks per week from vendors and about 230 ks per week from individuals. At MWD's rate of 0.05 ks per 20 litres, its revenues from kiosks should have been about 1800 ks per week. In fact, the owners reported average weekly payments to the MWD totalling about 750 ks. The fact that several kiosk water meters were not functioning may have accounted for this difference. The kiosk owners' aggregate profits per week (not considering labour) were about 4500 ks (US$280). With 13 kiosks in operation 12 hours per day, it is clear that kiosk owners are not extracting significant monopoly profits from the existing water vending system in Ukunda.

Figure 3 summarizes estimates of the money and water transactions in Ukunda during the rainy season. Water vendors supplied 45% of the total

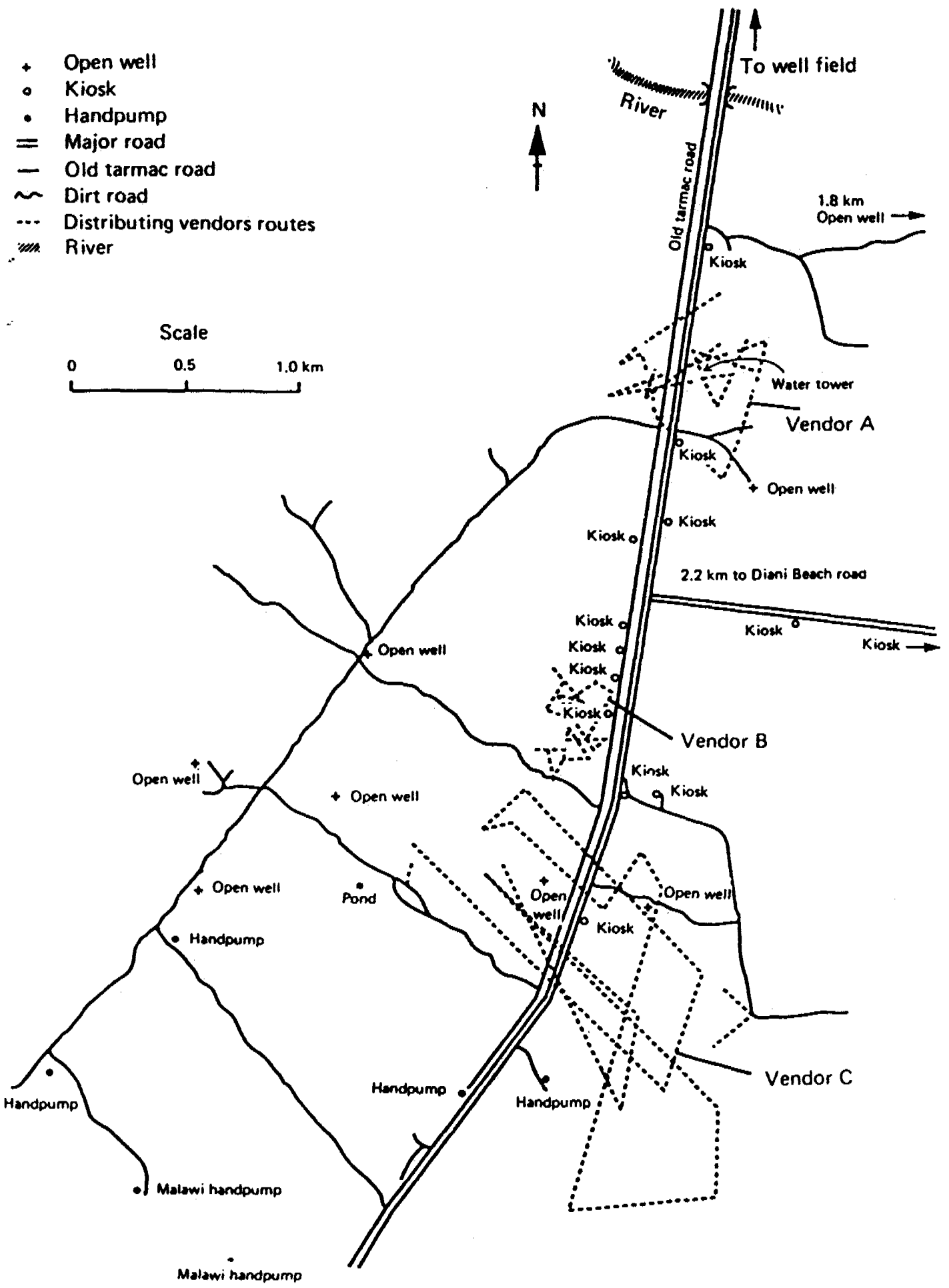

Figure 2. Water vendor routes in Ukunda, Kenya.

water consumed in Ukunda (excluding the water supplied from the few private connections). Conservatively estimating that weekly expenditures during the dry season are double this level, the annual expenditure by people in Ukunda on vended water is about 2.4 million ks (US$150 000), approximately 480 ks per capita per year (US$30). Of this total, 10% accrues to kiosk owners and 90% to the water vendors working in Ukunda for their labour. An average per capita expenditure of 480 ks per year for vended water is about 9% of the average annual per capita income in Ukunda.

Is vending an appropriate system?

Almost half of the water consumed in Ukunda is purchased from vendors. Those who use vendors enjoy a high level of service: good quality water is delivered to their doorstep on demand. Although vending does not provide a level of service comparable to house connections from a well-run piped distribution system, it is far superior to that available in most rural communities in Kenya.

This high level of service is, however, expensive. The operation of the vending system occupies approximately 100 people full time. Should either the water authority or the local community act to change this situation? Is water vending a 'problem', or is it an appropriate solution to the community's water needs? What should government policy be towards water vending such as exists in Ukunda?

Although significant resources are being expended in the operation of the water vending system, no one is making exorbitant profits. A relatively free market in water exists from the vendor's purchase at the kiosk to the point of delivery. Both the kiosk owners and the water vendors are receiving adequate incomes, but neither is extracting large monopoly rents. There are simply real labour costs involved in hauling 400 m^3 of water per week around the village in handcarts. Thus, if the water authority has established a reasonable price to be charged to and by the kiosk owners, there is little economic justification for (a) regulating either the price the distributing vendors charge their customers for water, or (b) licensing the distributing vendors or imposing other restrictions on entry into the vending business.

Although government regulation of vendors does not appear to be justified when there is a competitive market in vended water, improvement of a water system, such as an extension of a piped system, may be. In fact, it is obvious from the data on the magnitude of the money and water flows in the vending system in Ukunda that most people in Ukunda can afford yard taps or even house

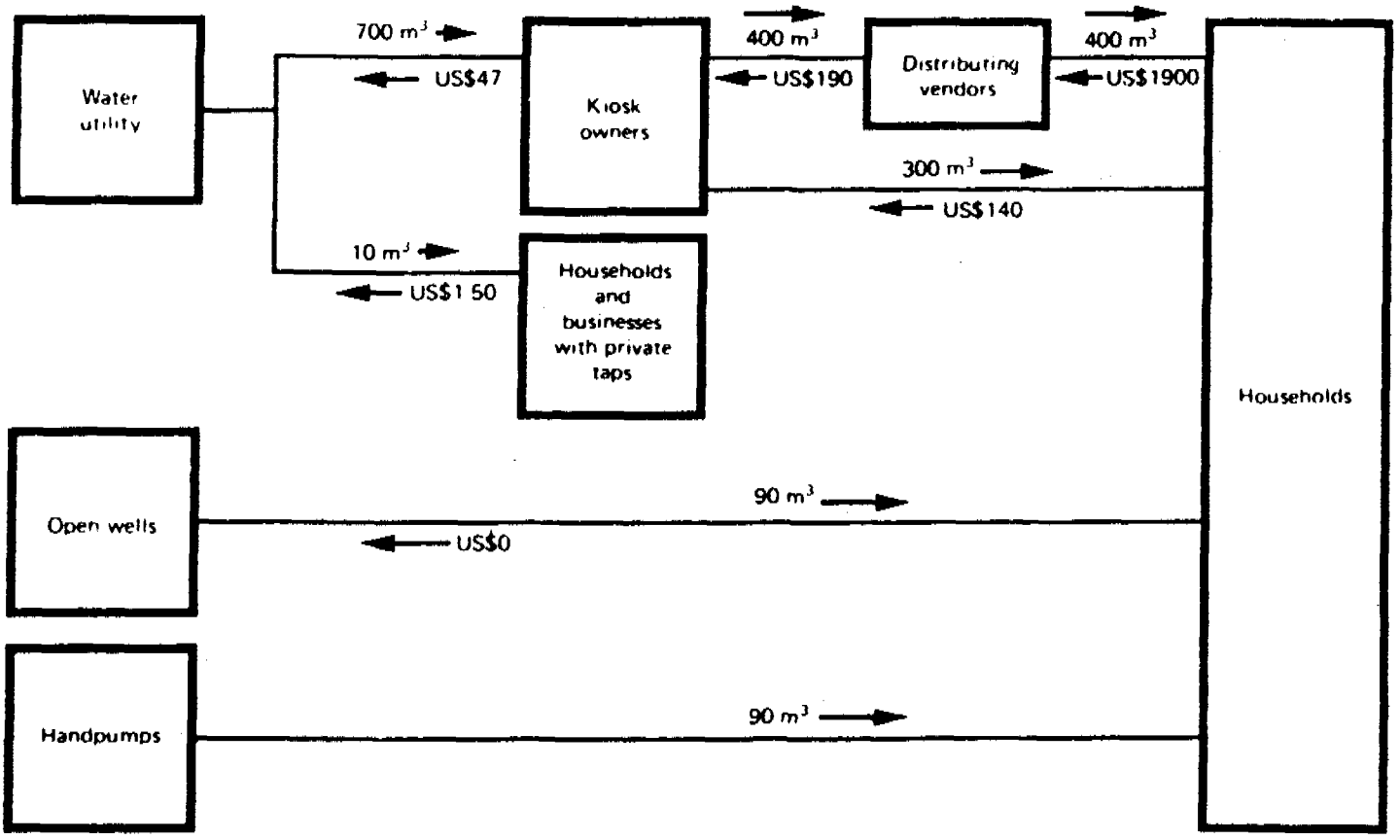

Figure 3. Weekly money and water transactions in Ukunda (rainy season, June 1986).

connections. Even assuming that the existing water system was completely reserved for the beach hotels, the people of Ukunda could build *a totally new system*, for an annual per capita cost of about US$10–20 including capital and operation and maintenance costs. Average annual per capita expenses in Ukunda *on vended water alone* are now about US$30. In situations such as this the information on the water vending system can serve as a useful indicator of a community's ability and willingness to pay for a piped distribution system. The fact that yard taps do not already exist throughout Ukunda indicates an inability on the part of the community or water authority to mobilize resources, not an inability or unwillingness of the population to pay for the cost of the improved service.

In other situations where vending exists, the choice of the appropriate level of service may be more complicated, and a more detailed analysis of the service options will be required. Such an analysis will require an understanding of why households choose different water sources, including vendors. In another article we have examined the determinants of households' water source choice decisions in Ukunda using a discrete choice econometric model (see Mu, Whittington and Briscoe, 1990). In the remainder of this article we assume that it is possible to model households' decisions regarding which water source to use, and we consider the question of whether it is justified to install additional handpumps in a village such as Ukunda which already has a water vending system.

Vending *v* handpumps

Consider a village with an extensive vending system like that of Ukunda. Should either the water authority or a donor agency install additional handpumps? This decision could arise in Ukunda, for example, if political or institutional constraints made the widespread provision of private connections impossible. Are the benefits of an additional handpump greater than its costs? The benefits of the handpump depend on how many households elect to use it and which sources these households are currently utilizing. It is assumed that the number of households which will choose to use the new handpump can be predicted and that the quantity of water households consume is independent of the source they choose. For purposes of this analysis, the households which will choose to use the new handpump are divided into three groups:

(1) households previously using distributing vendors (Group A);
(2) households previously collecting water from kiosks (Group B);
(3) households previously using open wells or other handpumps (Group C).

For those households previously using distributing vendors (Group A), their principal benefits (not considering health issues) will be the difference between (a) the money they would no longer have to pay vendors and (b) the value of the time which they would have to spend hauling water from the new handpump. For those households previously collecting water from kiosks (Group B), their benefits will be both (a) the money they no longer have to pay kiosk owners and (b) the value of any time saved (or lost) by having the handpump closer to (or farther from) their home than the kiosk. For those households previously using open wells or other handpumps (Group C), their benefits will be the value of the time savings associated with having a new water source closer to their home. Against the benefits to each of these three groups must be weighed both the capital and the operation and maintenance costs of the handpump.

Individuals in the community have both higher and lower levels of service open to them, and the additional handpump thus serves less of a need than if it were the highest level of service available. Viewed from this perspective, it is easy to see why the existence of widespread vending fundamentally alters the investment decision regarding the additional handpump. Vending offers a superior level of service for those individuals who place high value on their time, and they are unlikely to choose the new handpump since they have the alternative of having water delivered to their doorstep. For those people in Group A, the net benefits are likely to be low if they have to spend any significant amount of time collecting water from the handpump. Although they save the money previously spent on vended water, they incur the time costs of hauling water, and the value of their time is high relative to others in the community because they previously chose to buy water from vendors rather than collect it for themselves. For those individuals in Groups B and C, their value of time cannot exceed the price per litre of vended water divided by the time they spend collecting a litre of water; otherwise they would already be buying water from vendors. An upper bound on their benefits can thus be calculated.

The investment analysis suggested above can be best illustrated with some specific numbers:

n_1 = number of households that choose to carry water from the new handpump that currently buy their water from vendors (Group A)

n_2 = number of households that choose to use the new handpump that currently buy their water from kiosks (Group B)
n_3 = number of households that choose to use the new handpump that currently use an open well or another handpump (Group C)
p_1 = price of vended water (US$/litre)
p_2 = price of water sold at kiosk (US$/litre)
h_1 = hours per day spent collecting water from the new handpump
h_2 = hours per day spent collecting water from the old source (equal to zero for households currently using vendors)
q = average quantity of water consumed per capita per day in the village (assumed equal for all households)
m = average number of individuals per household
v_1 = value of time spent hauling water for households in Group A
v_2 = value of time spent hauling water for households in Group B
v_3 = value of time spent hauling water for households in Group C
C = annual costs of additional handpump (including capital, operation and maintenance)

The annual net benefits of the additional handpump (NB) are given by:

$$NB = 365[n_1(p_1*q*m - v_1*h_1) + n_2(p_2*q*m + v_2*(h_2 - h_1)) + n_3(v_3*(h_2 - h_1))] - C$$

The table at the bottom of Figure 4 presents some values of these parameters characteristic of the situation in Ukunda. The values for individual parameters can be varied and combined in different ways to characterize many villages in developing countries. Figure 4 presents the annual net benefits for households in Groups A, B and C for different values of time spent hauling water for households in Group A. For purposes of illustration, the value of time of households in Groups B and C is assumed to be half of that of households in Group A (see Whittington, Mu and Roche, 1989, for empirical support for this assumption).

As the value of time spent hauling water increases, the net benefits of the new handpump to households in Group A decrease, and the net benefits to households in Groups B and C increase, which is evident from the signs of v_1, v_2 and v_3 in the net benefit equation. Because the quantity consumed per capita per day is assumed to be independent of the source, the money savings to households in Groups A and B from the new handpump depend only on the price of water

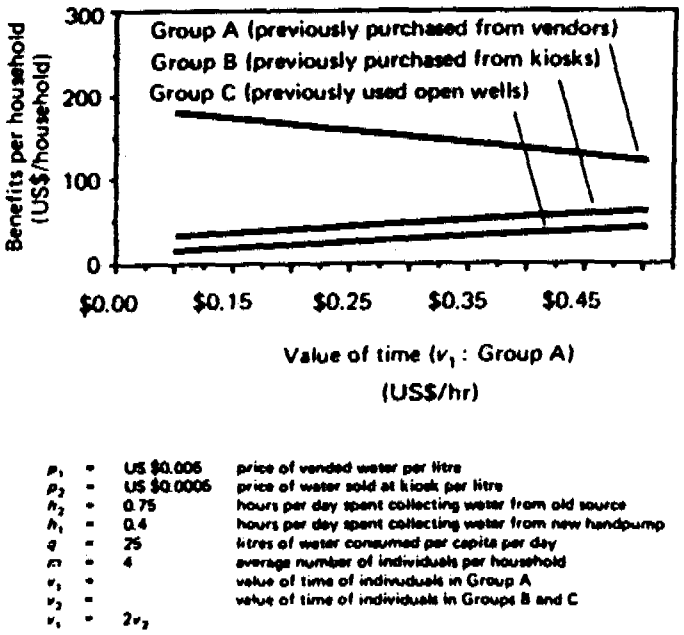

Figure 4. Annual benefits per household from the installation of handpumps.

charged by vendors and kiosks respectively, the per capita consumption and the size of the household (and are positively related to all three). The benefits to households in Group A decrease as the time spent collecting water from the new handpump increases. The benefits to households in Groups B and C increase as the *difference* between the time spent hauling water from the old source and the new handpump increases.

Total annual costs (capital and operation and maintenance) of a well and handpump in Ukunda would be in the order of US$500. Thus, if the value of time savings is the primary benefit of the handpump investment (ie water quality considerations are not important), the results of these calculations show that a well-located handpump can be very beneficial to households in (a) Group A if their value of time is low and if the distance they have to walk to the new handpump is short, and (b) Groups B and C under most circumstances. If the time savings are significant (eg an hour per day), only a relatively small number of households in Groups B and C would be required to justify the investment for most values of time saved and per capita consumption. Only a handful of households in Group A are necessary to justify the investment if the handpump is located very close to them so that the time spent hauling water is minimal (less than 30 minutes per day). The benefits of a handpump to a household in Group A are, however, negative if the household would have to spend an hour per day collecting water and their value of time is greater than US$0.40 per hour.

There is evidence that households using vendors value their time at a higher rate than the current market wage for unskilled labour (US$0.25 per hour; see Whittington, Mu and Roche, 1989). Referring to the information in Figure 4 on the annual benefits per household *versus* the value of time, it can be seen that at a value of time of US$0.50 per hour annual benefits to households in Group A are on the order of US$110. If households in Groups B and C have average values of time of US$0.25 per hour, their annual benefits are about US$50 and US$30, respectively. It is thus important for the economic justification of the project that any handpumps be located in an area where several households currently using vendors are likely to switch to the new handpump.

These calculations illustrate that as vending becomes more extensive in a village or town and the value of time increases due to increased economic activity and wage employment, the benefits from additional investments in handpumps are likely to decrease. There may, however, still be particular locations where a handpump is needed because the benefits to only a few households may be enough to justify the investment. Similar calculations could be carried out for a comparison between vending and yard taps, although in this case the consumer surplus associated with the increased consumption of water resulting from the installation of yard taps would need to be estimated (Powers, 1978; Churchill *et al.*, 1987).

Other investment considerations

There are three other but important aspects of the decision on whether to install additional handpumps in a village where water vending is being practised. The first concerns the dynamic character of water system capacity expansion. Even if the handpump appears to be a good investment using the economic model described above, if incomes in the village are rising it may not be long before the community can afford a piped water system (if it cannot already do so). Because the operation (or expansion) of the vending system does not entail significant capital costs, it is much more flexible and adaptable than a policy of installing additional handpumps. An investment in a handpump needs to provide benefits over an extended period of time in order for its high initial capital costs to be justified, and it therefore may quickly become obsolete. A vending system can potentially play a valuable role in bridging the period from when the community can only afford a few improved sources until incomes are at a level which can support a piped system with private yard taps or house connections. Vending can eliminate the need to overinvest in a system such as handpumps which provides a low level of service.

Second, it is not simply the total average income which determines whether a household can afford the monthly costs generally associated with a house connection from a piped system; the reliability and variation in household income are also important. In Ukunda the incomes of many households are tied to the tourist industry, which is highly seasonal. The water vending system permits households to adjust their water purchases to fit their cash flow situation. Households are not locked into fixed monthly commitments which they are not sure they can pay.

Third, in the investment calculation it is assumed that the price vendors charge for their water is an accurate measure of its social value. As shown in this study, the price of vended water is largely determined by the implicit wage rate associated with the vendors' time. This cost-benefit calculation thus assumes that the opportunity cost of the vendors' time to society is roughly equal to the market wage for unskilled labour (in the rainy season). Whether this is a reasonable assumption depends upon whether in fact the vendors could find other employment if they were not vendors. This is an empirical question, but it is crucial to a proper appraisal of water vending *vis-à-vis* alternative water delivery systems. If the shadow value of labour of water vendors is very low, water vending becomes much more socially attractive. As a first order approximation, the question of the shadow value of labour depends upon what the roughly 100 people in Ukunda currently engaged in water vending would do if a piped system were installed. In many vending situations they would probably serve another location where piped water is not yet available.

Conclusions

The findings from this study have important implications for water supply planning in developing countries, not only with respect to water vending, but also with regard to (1) willingness to pay for improved water services, (2) choice of technology, and (3) level of service. First, people in some rural villages are willing and able to pay substantial amounts of money for water, even when traditional sources are readily available. In Ukunda 64% of the water used in the village *in the rainy season* was sold by kiosks to distributing vendors and individuals. Distributing vendors in Ukunda sold more than 45% of the total water consumed in the village. People in Ukunda spend about 9% of their income on vended water.

Second, households are paying much more for vended water than would be necessary to provide and sustain a piped distribution system with yard taps. Such information is important because grants from donor agencies and national governments are not sufficient to meet the huge demands for piped water in developing countries. A survey of vending practices in an area can be a useful indicator of a community's ability and willingness to pay for a piped system.

Third, the case study shows that the prices vendors charge for water are high because hauling water manually is expensive. In Ukunda vendors were making a fair return on their labour and capital investment, but they were not making exorbitant profits. This suggests that government regulation of distributing vendors may not be necessary or advisable.

References

Adrianzen, T. Blanca, and George Graham (1974). 'The High Cost of Being Poor', *Archives of Environmental Health*, Vol 28, June, pp 312–315.

Antoniou, James (1979). *Sudan: Khartoum-El Obeid Water Supply Project Urban Poverty Review*, World Bank, Washington, DC.

Churchill, Anthony, A., with the assistance of David de Ferranti, Robert Roche, Carolyn Tager, Alan A. Walters and Anthony Yazer (1987). *Rural Water Supply and Sanitation: A Time for Change*, World Bank Discussion Paper 18, Washington, DC.

Fass, Simon (1982). 'Water and Politics: The Process of Meeting a Basic Need in Haiti', *Development and Change*, Vol 13, pp 347–364.

Mu, Xinming, Dale Whittington and John Briscoe (1989). 'Modeling Village Water Demand Behavior: A Discrete Choice Approach', *Water Resources Research*, forthcoming.

Powers, Terry A (1978). 'Benefit-Cost Analysis of Urban Water Projects', pp 371–385 in *Water Supply and Management*, Vol 1, Pergamon Press, Oxford, UK.

Suleiman, M. S. (1977). *A Study of the Vendor Water Distribution System in Surabaya, Indonesia*, World Health Organization, Geneva.

White, Gilbert F., David J. Bradley and Anne U. White (1972). *Drawers of Water: Domestic Water Use in East Africa*, University of Chicago Press, Chicago, IL.

Whittington, Dale, John Briscoe and Xinming Mu (1987). *Willingness to Pay for Water in Rural Areas: Methodological Approaches and An Application in Haiti*, Field Report No 213, WASH, USAID, Washington, DC.

Whittington, Dale, Donald T. Lauria and Xinming Mu (1989). *Paying for Urban Services: A Study of Water Vending and Willingness to Pay for Water in Onitsha, Nigeria*, Report INU 40, Infrastructure and Urban Development Department, The World Bank, Washington, DC.

Whittington, Dale, Donald Lauria, Daniel A. Okun and Xinming Mu (1988). *Water Vending and Development*, Technical Report No 45, WASH USAID, Washington, DC.

Whittington, Dale, Xinming Mu and Robert Roche (1989). The Value of Time Spent on Collecting Water: Some Estimates for Ukunda, Kenya', Report INU 46, Infrastructure and Urban Development Department, The World Bank, Washington, DC.

Zaroff, Barbara, and Daniel A. Okun (1984). 'Water Vending in Developing Countries', *Aqua*, No 5, pp 289–295.