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1611 N. Kent Street, Room 1002
Arlington, VA 22209-2111 USA

Telephone: (703) 243-8200
Telex No. WUI 64552
Cable Address WASHAID

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WATER VENDING AND DEVELOPMENT: LESSONS FROM TWO COUNTRIES

WASH TECHNICAL REPORT NO. 45

MAY 1988

Prepared for
the Office of Health,
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Prepared for the Office of Health
Bureau for Science and Technology
U.S. Agency for International Development
under WASH Activity No. 185

by

Dale Whittington
Donald Lauria
Daniel A. Okun
and
Xinming Mu

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TABLE OF CONTENTS

CHAPTER		Page
	ACKNOWLEDGMENTS	iii
	EXECUTIVE SUMMARY	v
1.	INTRODUCTION AND OBJECTIVES OF THE STUDY	1
2.	DESCRIPTION OF WATER VENDING SYSTEMS	5
	2.1 Water Vending in Port-au-Prince, Haiti	12
	2.2 Water Vending in Surabaya, Indonesia	13
	2.3 Summary	14
3.	WATER VENDING IN UKUNDA, KENYA	15
	3.1 The Study Area	15
	3.2 Sources of Water and Patterns of Water Use	15
	3.3 Field Procedures	17
	3.4 The Water Vending Industry in Ukunda	21
	3.5 Analysis of Water Distribution	23
	3.6 The Demand for Vended Water: A Discrete Choice Model	23
	3.7 Is Vending an Appropriate Water Service Delivery System?	28
4.	A CASE STUDY OF WATER VENDING IN TEGUCIGALPA, HONDURAS	31
	4.1 The Study Area	31
	4.2 Field Study	32
	4.3 Vendor Supply Study	32
	4.4 Household Water Use Study	36
	4.5 Summary	39
5.	IMPROVING WATER VENDING SYSTEMS	41
	5.1 Justifications for Public Sector Intervention in Water Vending Activities	41
	5.2 Possible Public Sector Responses to Water Vending Activities	42
	5.3 Costs of Public Sector Actions	45
	5.4 Other Reasons for Public Sector Interest in Water Vending Activities	45

TABLE OF CONTENTS

CHAPTER		Page
6.	SUMMARY AND CONCLUSIONS	47
	6.1 Major Findings	47
	6.2 Recommendations	49
	6.3 Areas for Future Activity	49
BIBLIOGRAPHY		51

FIGURES

1.	Possible Water Distribution Systems	6
2.	Lima, Peru	7
3.	Lima, Peru	7
4.	Karachi, Pakistan	8
5.	Kenya	8
6.	Kenya	9
7.	Kenya	9
8.	Cali, Colombia	10
9.	Cali, Colombia	10
10.	Jakarta, Indonesia	11
11.	Surabaya, Indonesia	11
12.	Kenya	16
13.	Water Sources in Ukunda, Kenya	18
14.	Ukunda, Kenya	19
15.	Money and Water Transactions in Ukunda, Kenya Per Week	24
16.	Probability of Source Choice vs Travel Time	29

TABLES

1.	Comparison of Prices Charged by Water Vendors	1
2.	Distribution of Water in Port-Au-Prince	12
3.	A Representative Water Vendor's Weekly Budget	22
4.	Results of Discrete Choice Model (Ukunda, Kenya)	27
5.	Vendor Data, Seasonal	33
6.	Vendor Financial Data, Annual	34
7.	Household Water Use	37

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EXECUTIVE SUMMARY

Millions of people in developing countries obtain water from commercial vendors who deliver it to their houses. This water is very expensive, whether delivered by men, animals, or motorized vehicles. Households supplied by vendors generally pay more for 20 liters of water than those supplied 500 liters per day from a piped system. Despite the fact that water vending is ubiquitous in the Third World, it has received little attention and is not well understood. To address this problem, the WASH project and a research team from the University of North Carolina (UNC) at Chapel Hill conducted two in-depth studies, one in a village in Kenya and the other in a periurban area in Honduras, in order to understand how vending systems operate and how they can be improved.

Kenya Study

In June and July, 1986, the UNC research team conducted a study in Ukunda, a village of about 5,000 people 40 kilometers south of Mombasa. This research had three principal objectives: (a) to obtain detailed data in an area where water vendors provide a major portion of the community supply, (b) to examine the reasons why individuals purchase water from vendors when cheaper sources are available, and (c) to show how data on water vending can be used to improve water supply planning. The field work consisted of five different activities: (1) observation of water sources, (2) interviews with water vendors, (3) interviews with the owners of kiosks (taps where water is sold), (4) mapping the vendor delivery routes, and (5) household interviews.

The following are some of the main findings from this case study:

- The analysis of data from observing water sources shows that vendors sold more than 400,000 liters per week, 45 percent of the total consumed in the village.

- Households and businesses in Ukunda who use vendors enjoy good service; good quality water is delivered to their doorstep on demand and is perceived to be of good quality.

- People in Ukunda spend about US $150,000 annually for vended water (US $30 per capita), roughly nine percent of their income.

- The water vendors are not making exorbitant profits; the prices they charge are largely determined by market forces.

- Those households which use vended water tend to be farther from other sources and to have fewer women in them.

- The possibility that a household will choose a public tap for its water source falls dramatically as distance of the household from the tap increases. If a public tap is more than 500 meters from the household, almost no one in Ukunda will use it; instead, in Ukunda 75 percent of the households would choose a vendor while 25 percent would choose an open well. If the tap is within 100 meters of the household, over 80 percent of the households would choose it.

Honduras Study

Tegucigalpa was selected in part because 80,000 persons live there in shantytowns either without access to piped water or access only to public taps. These people obtain water from a variety of sources including vendors who sell from trucks at a price 35 times the official rate. The study had two main parts: (a) one concerned with supply focused primarily on vendors and (b) one which focused on demand for water, including the sources and quantities used by households.

Interviewers, assisted in the field by workers from SANAA, the national water agency, were sent to a shantytown served in part by public taps to collect data door-to-door. In addition, an interviewer was sent to the water source where vendors fill their trucks to obtain data on supply practices.

Some of the main findings of the Honduras study were as follows:

- The average age of the trucks used by water vendors was 18 years, and the average capacity was nine 55-gallon drums.

- During the 6-month rainy season, average monthly sales are 27 m^3, and vendors work on average 14 days per month.

- The average selling price during the rainy season is US $1.75 per drum (US $8.50 m^3), resulting in average monthly revenue per truck of US $230. This is only slightly more than the rainy season monthly cost of water, salaries, gasoline and oil.

- In the dry season, average monthly sales are eight times as much (210 m^3). The average revenue of a vendor is US $1,818 per month; average costs for water, salaries, gasoline and oil are about US $1,125.

- On an annual basis, vendors have average revenues of US $12,285 and total operating costs of US $10,425 (including tires and repairs). However, taking equipment costs into account, their profit margin is low.

- The average household spends US $14 per month for water in the rainy season (eight percent of household income) and US $21 in the dry season (12 percent of household income).

- Those households with higher incomes are more willing to pay the higher prices charged by vendors. Convenience is an important factor.

Conclusions

Both studies showed that vendors do not earn large profits, making government regulation to limit exploitation unnecessary. This research provides concrete evidence that households are able and willing to pay substantial amounts of money for water, much more than would be necessary for a piped distribution system with yard taps (a new piped system with yard taps could be built in Ukunda for an annual per capita cost of about US $10-15). This finding is important because funds from donor agencies and national governments are simply not sufficient to make grants for improved water services in developing countries. It is increasingly clear that consumers must bear a much larger share of the costs of water supply improvements. The studies demonstrate that a simple survey of vending can be a useful indicator of a community's ability and willingness to pay for a piped system.

This study also indicates that vending has several advantages in comparison to other water delivery systems:

- Vending systems can play a potentially valuable role in bridging the time from when a community can afford only a few improved water sources until the time when incomes increase to a level which can support a piped system with private yard taps or house connections.

- Vending systems permit households to adjust their water purchases to fit their cash flow. Households which use vendors do not have to meet fixed monthly payments when their incomes fluctuate. For example, in Ukunda income levels are very seasonal, increasing during the tourist season and decreasing in the off-season.

- Vending operates with low economies of scale and is flexible, with little unused capacity. During wet seasons, when demand may slacken, the vendors reduce their work load or find other employment. Vehicles can be used for other purposes; in any event their unused capacity represents a small portion of the total investment.

- Where alternate sources of water are available, a study of vending can indicate the extent to which convenience is valued. In both Ukunda and Tegucigalpa, people were willing to pay significant sums for having water delivered to their homes.

Recommendations

- Water vending studies should be carried out in most developing countries in order to provide information for improved water supply planning. Information from such studies may prove decisive in convincing policy makers that not only are people able and willing to pay for improved water services, but they are <u>already</u> paying more for vended water than it would cost to

construct a well-run, piped distribution system. Water vending studies can also assist with the design of tariffs and setting investment priorities (for example, among secondary cities).

- Universities in less-developed countries can carry out such water vending studies. USAID should support such groups by providing guidelines for the conduct of water vending studies and by providing reference materials.

Chapter 1

INTRODUCTION AND OBJECTIVES OF THE STUDY

Water supply projects in developing countries are traditionally based on either (a) piped systems with public taps or private household connections or both, or (b) wells with handpumps. Both of these approaches to improving water supplies 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 an available source and then deliver it in containers to households or fill household containers from tanks on their vehicles.

The distribution of water by vendors is expensive, whether it is carried by people, animals, or motor vehicles (see Table 1). Households which are served by vendors generally pay more per month for 20-40 liters of water per capita per day than those directly connected to a piped system pay for as much as 400-800 liters per capita per day. In addition, vendors sometimes sell water from polluted sources or fouled containers. Water vending can thus be a financial burden and a health threat to millions of people.

Table 1

Comparison of Prices Charged by Water Vendors

For 20-liter Container Delivered to Household (Rainy Season)

	US$ per 20 liters	Equivalent Price (US$) per m^3
Kenya	$0.10	$4.70
Tanzania	0.15-0.30	7.00-14.00
Nigeria	0.04-0.12	1.90-5.60
Haiti (1976)	0.02	1.00
Indonesia (1977)	0.05	2.40

For 55-gallon drum Container Delivered to Household (Rainy Season)

	US$ per 55 gallons	Equivalent Price (US$) per m^3
Nigeria	0.35-.50	1.70-2.40
Honduras	1.75	8.40

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 while plans are being made to expand the piped system, plans which may take years or decades to implement. In villages traditional water sources may still be available, but people may have enough money to buy water at least part of the time and thus obtain some relief from the daily burden of carrying it from a distant source. Water vending provides a needed commodity and permits a significant savings of time.

There are, however, other important social benefits of water vending. Vending is labor intensive. The principal cost of a water vending system is typically the labor of the vendors themselves, the social opportunity cost of which may be very low. The capital costs of 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 simple and can be maintained locally. Vending operations are thus less subject to breakdown than piped systems.

Despite the fact that water vendors serve millions of people in cities and villages throughout the developing world and may offer 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 literature. Most information is anecdotal. Professionals in the water resources field have ignored water vending in part because it is seen as an indication of the failure of water supply institutions to provide adequate service. Although this might be an accurate assessment, vending is worthy of study because:

- 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;
- vending may in some circumstances actually prove to be the most appropriate and economic for a community at certain levels of development;
- information on water vending practices, particularly costs and charges, may be useful for traditional water supply planning decisions; and
- The quality and economics of vending systems may be improved.

This WASH activity was initiated as a first step in providing information on water vending in developing countries. The project had several objectives:

- to provide a detailed description of water vending in two areas, one urban and one rural, where a major portion of a community's water supply comes from this source;

- to examine the reasons why individuals purchase water from vendors when other sources are available and to estimate statistically the factors which influence a household's decision to buy vended water.

- to identify the circumstances in which water vending is an appropriate water supply system; and

- to show how data on water vending can be used to improve water supply planning generally.

Studies were done in the rural community of Ukunda in Kenya, and in the periurban area of Tegucigalpa, the capital of Honduras.

Chapter 2 reviews the characteristics of water vending systems using examples from the literature on Port-au-Prince, Haiti and Surabaya, Indonesia. Chapter 3 presents the Ukunda case study. Ukunda is a small town in rural Kenya, but the water vending activities are typical of many urban fringe areas. Vendors in Ukunda collect their water from a piped distribution system running through the town and deliver it to households in handcarts. Chapter 4 describes water vending in periurban Tegucigalpa which is quite different from Ukunda.

The justification for public sector intervention for the purpose of improving vending systems and suggested improvements are presented in Chapter 5. The implications of the findings from the case studies for water supply planning, particularly as vending demonstrates willingness to pay, are presented in Chapter 6, along with conclusions and recommendations. Additional details of the case studies, including the questionnaires and data, are included in a background working paper (Whittington et al., 1987a).[1]

[1] WASH Working Paper No. 60, the case studies, includes the questionnaires and more detailed data. Copies can be obtained from the WASH Office, 1611 N. Kent St., Room 1001, Arlington, Virginia 22209.

Chapter 2

DESCRIPTION OF WATER VENDING SYSTEMS

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:

Wholesale vendors obtain water from some source and sell it to distributing vendors.

Distributing vendors obtain water from a source or a wholesale vendor and sell it to consumers door-to-door. The term vendor used alone refers to a distributing vendor.

Direct vendors sell water from a source to consumers coming to the source to purchase water.

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, to a direct vendor, or to the source.

Some distributing vendors obtain high-quality water from pipe distribution systems. Others obtain water directly from polluted surface sources. The distributing vendors transport the water to households and businesses by a variety of means. In Lima, Peru, tanker-trucks deliver water from the piped system to households throughout large parts of the city (Figures 2 and 3). In Tegucigalpa, Honduras, pick-up trucks carry 220-liter drums. In Karachi, a tank on a cart is pulled by a bullock (Figure 4), while in Kenya water containers are loaded on animals (Figure 5). In Kenya water from polluted sources is delivered in tins carried on carts (Figures 6 and 7). In Cali, Colombia, horses pull carts with water containers (Figures 8 and 9). In Nigeria, Kenya, Thailand, and Indonesia (Figures 10 and 11) water is carried by men either with a yoke of some sort or a handcart. Vendors use many different kinds of containers: plastic jerricans with covers, kerosene tins, wooden and steel barrels, and pottery jars.

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, or 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.

FIGURE 1

Possible Water Distribution Systems

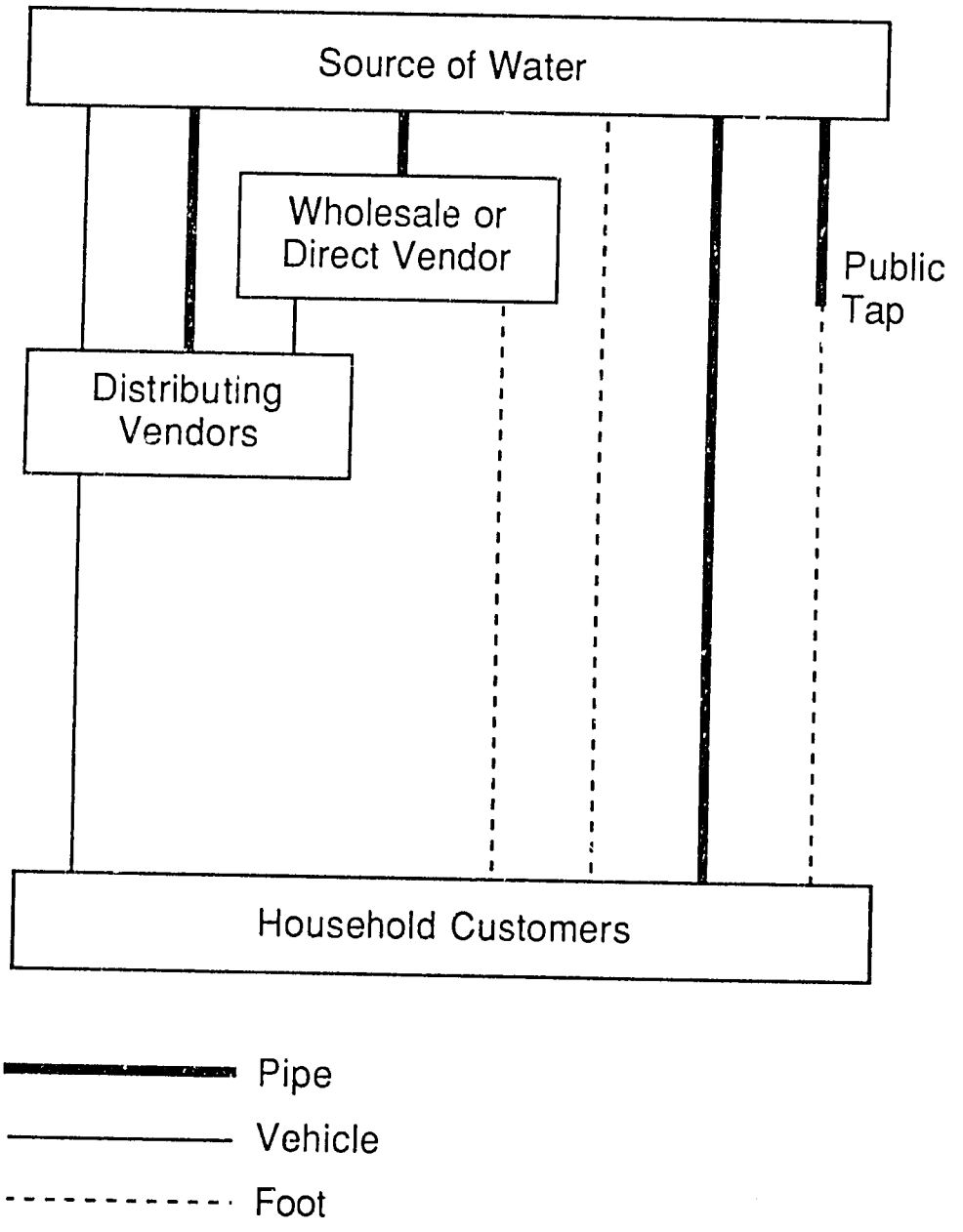


Figure 2: Lima, Peru

Figure 3: Lima, Peru

Figure 4: Karachi, Pakistan

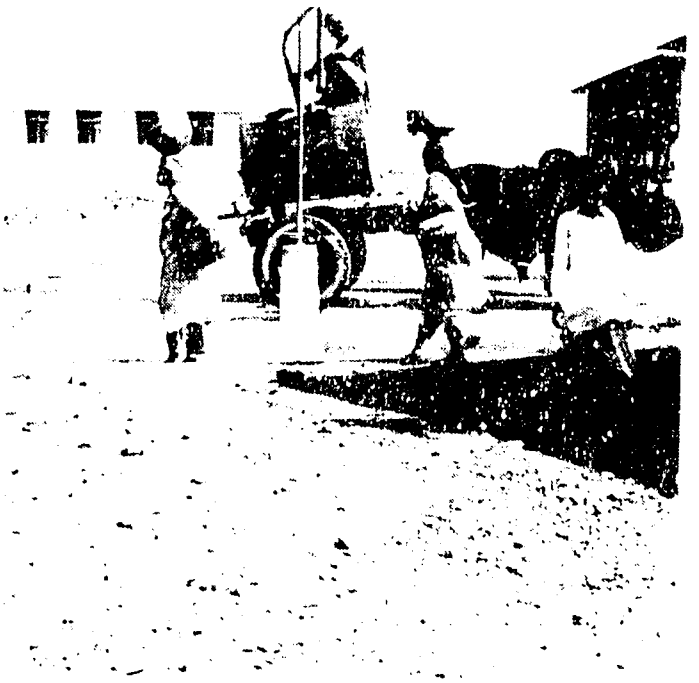


Figure 5: Kenya

Figures 6 and 7: Kenya

Figure 8 and 9: Cali, Colombia

Figure 10: Jakarta, Indonesia

Figure 11: Surabaya, Indonesia

2.1 Water Vending in Port-au-Prince, Haiti

Fass (1982) provides a detailed account of water vending activities in a major third world metropolitan area. Based on data collected in the mid-1970s, water vendors served the majority of the population of Port-au-Prince. The prices vendors charged were exceedingly high:

Rainy season	US \$0.001 per liter (US \$1.00 per m^3)
Dry season	US \$0.006 per liter (US \$6.00 per m^3)
Drought seasons	US \$0.01-0.06 per liter (US \$10-60 per m^3)

These prices are 4 to 250 times higher than the cost of piped water delivered inside the home in the U.S. The water consumption levels of most of the population (10 to 15 liters per capita per day) were extremely low.

Twenty-three percent of the population (or 150,000 individuals) in Port-au-Prince receives water through private connections. This accounts for 93 percent of the water distributed by the water authority. Seventy-seven percent of the population receive the remaining seven percent of the water through other means (see Table 2).

Table 2

Distribution of Water in Port-au-Prince
(after Fass, 1982)

Source of Water	Percent Population
From piped system connection	23
From household with piped connection, free	15
Purchased from household with piped connection or from one of the 14,000 distributing vendors	46
Purchased from tanker-truck vendors	1
Obtained from public taps	9
Obtained from leaks and breaks in system	6
TOTAL	100

The financial transactions for water in Port-au-Prince are equally extraordinary: 150,000 people served by piped water pay CAMEP US $1,800 per day, for 30 million liters. Some of these people sell water privately to people who have to carry it to their homes; these sales total US $5,100 per day. People who buy from vendors pay US $3,900 per day. The population with poor service (water from vendors or neighbors) pays substantially more for seven percent of the water than those with piped service.

2.2 Water Vending in Surabaya, Indonesia

In 1977 Surabaya had a population of about two million. St. Michel and Saleh (1977) and Suleiman (1977) provide descriptions of the water vending activities in Surabaya. Some 55 percent of the population obtained their water from poor quality shallow wells. The remaining 45 percent received water directly and indirectly from the piped distribution system, with about 18 percent having their own private connections; about 20 percent purchasing water from direct vendors; and about 7 percent purchasing water from distributing vendors.

The direct vendors sold to both individuals and distributing vendors at the same price: about US $0.01 per 20-liter container (US $0.53 per m^3). The distributing vendors usually operate in teams of two. One pushes a cart with a 220-liter drum, and the other uses a yoke with pails to carry water from the cart to the individual households. The price distributing vendors charge was US $1.30 to 2.60 per m^3, increasing with the distance the water must be carried.

St. Michel and Saleh offered the following reasons why people buy water from direct and distributing vendors respectively:

Direct Vendors

- Price is lower than that charged by distributing vendors;
- Household is close to the direct vendor (100-200 meters);
- Household has labor available to haul water.

Distributing Vendors

- Distance from direct vendor is more than 200 meters;
- Household does not have extra labor for hauling water;
- Shallow wells are not available.

People purchased vended water because it was of better quality than that available from many wells.

The 27 percent of the population of Surabaya who purchased water from vendors used only 8 percent of the total water sold by the city, but they paid more for their water than the water authority received from all its other customers combined. Households which purchase water from vendors paid two to six times the average monthly amount of households with private connections for one tenth as much water. Nevertheless, Suleiman concludes that, "The vendor system in its private sponsorship has filled a vacuum...and will continue for several years until facilities are expanded through the implementation of the Master Plan so that more people can be served through direct house connections." By that time, of course, additional people will have moved in and require vendor service.

2.3 Summary

In both of these examples of water vending activities in large third world cities, owners of private connections are paying much less for water than those households which use vendors. Households with private connections selling water to distributing vendors and to other households are able to set high prices and make significant unearned profits. Households using vendors are often paying more for vended water than would be necessary to pay for the full costs of a yardtap or private connection.

Chapter 3

WATER VENDING IN UKUNDA, KENYA

3.1 The Study Area

Ukunda is a village of about 5,000 people located 40 kilometers south of Mombasa in the Kwale District of Kenya (see Figure 12). It is the largest population center along the South Coast of Kenya between Mombasa and the Tanzanian border. The town lies alongside a paved highway which parallels the coastline and is about three kilometers from the ocean. Ukunda's economy is representative of many small provincial centers in Africa which are being rapidly drawn into a national market economy. It is heavily influenced by its proximity to the luxury 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 gas 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).

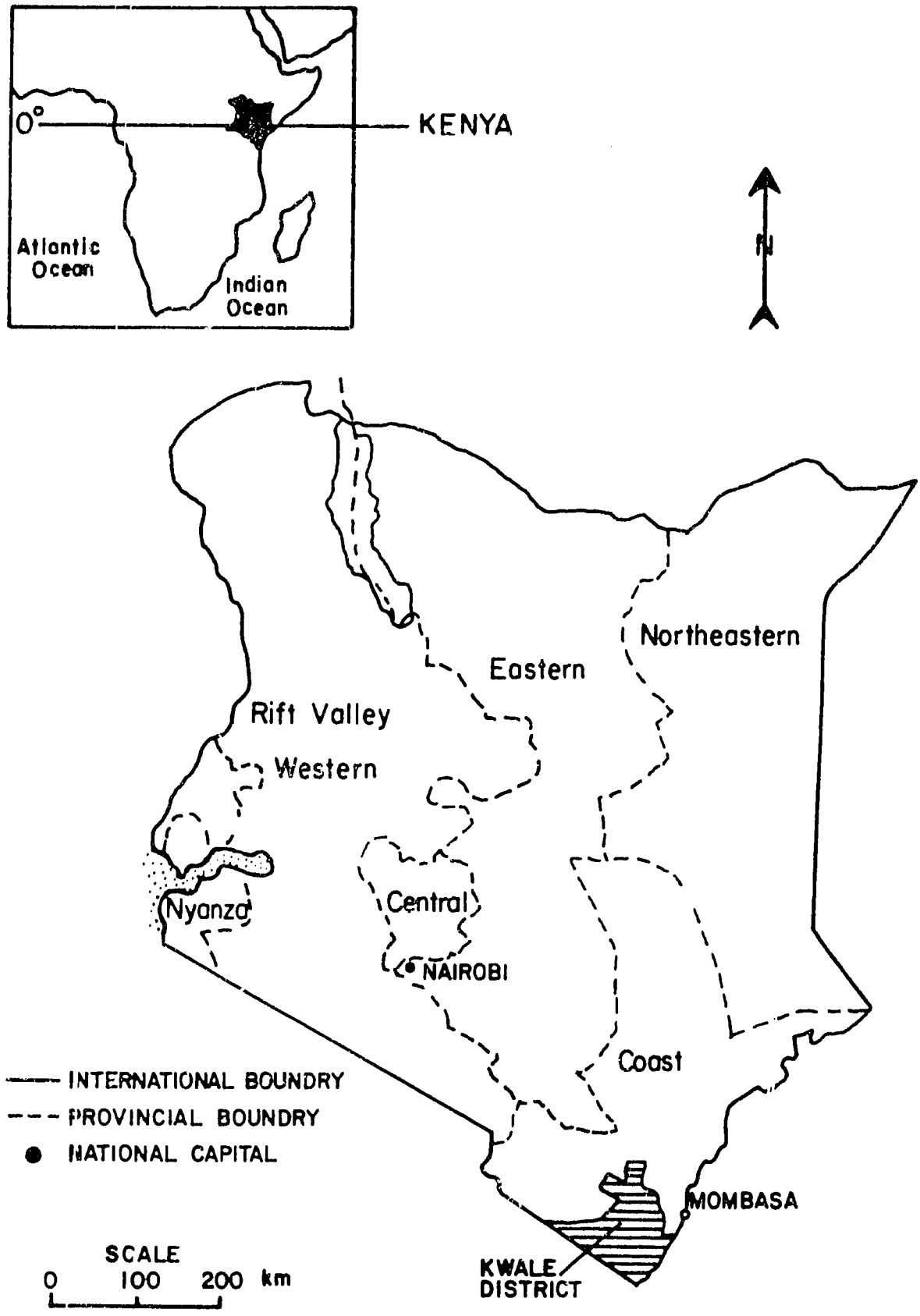
The majority of houses in Ukunda and surrounding villages are constructed of earth with thatched roofs, although tin roofs and masonry walls are becoming increasingly common. The agricultural areas around Ukunda are heavily populated, with over two hundred people per square kilometer. The main crops are coconuts, cashews, mangoes, cassava, and rice. Over 90 percent of the population along the south coast are Wadigo who are Moslems, but the percentage of Wadigo in Ukunda itself is somewhat less due to substantial in-migration by other groups. The other major ethnic group in the Kwale District is Waduruma. Education levels in the Kwale District are low; about three quarters of the population have never attended school. Per capita annual income in the region is on the order of US $200, although it is estimated at $350 in Ukunda.

3.2 Sources of Water and Patterns of Water Use

Rainfall along the South Coast is approximately 1,200 mm per year. The rainy season lasts from April to October; the hot, dry months from November through March correspond to the peak tourist season. Numerous small streams drain the Shimba Hills thirty kilometers west of the coast; one small river passes two kilometers north of the center of Ukunda on its way to the sea. The chemical quality of both surface and groundwater in the area is good.

Donors have been working in water supply on the South Coast of Kenya for a long time. UNDP started a handpump project in 1964. In 1978 the Australian government initiated a handpump project, and the Japanese International Cooperation Agency has constructed some wells. The UNDP/World Bank South Coast Handpumps Project, funded by the Swedish International Development Authority (SIDA), has been in operation in the area since 1983 and has drilled about 60 boreholes.

Figure 12: Kenya



Residents of Ukunda have numerous sources of water in the village without having to use rivers or ponds. The MWD operates a pipeline which was designed primarily to serve the resort hotels on Diani Beach. This system is served by four boreholes 10 kilometers north of Ukunda. The system's capacity is about 4,000 m^3 per day, but it is subject to frequent breakdowns. The system serves about 4,000 people between Waa and Ukunda. 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 (at water kiosks) who are licensed operators or from distributing water vendors who buy water from the kiosks (wholesale vendors). A kiosk is typically a small structure with a tin roof and tin walls surrounding a simple tap which the operator controls by hand. Figure 13 shows the location of the thirteen kiosks and other water sources in Ukunda. 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 water vendors carry water in 20-liter plastic jerricans, transported either by carts or bicycles (Figure 14). The carts have a single axle resting on two automobile tires and are pushed by hand. Most of the carts carry ten 20-liter jerricans. A full load thus weighs 200 kilograms. 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 30 meters deep and most provide water 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 two-liter tin container into the well. Several individuals can draw water simultaneously.

Several different brands of handpumps were installed in the community by various donors. 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, some of which appeared to be successful.

3.3 Field Procedures

The field work was conducted in June and July 1986, the rainy season. The field work consisted of five activities:

(1) source observations;

Figure 13: Water Sources in Ukunda, Kenya

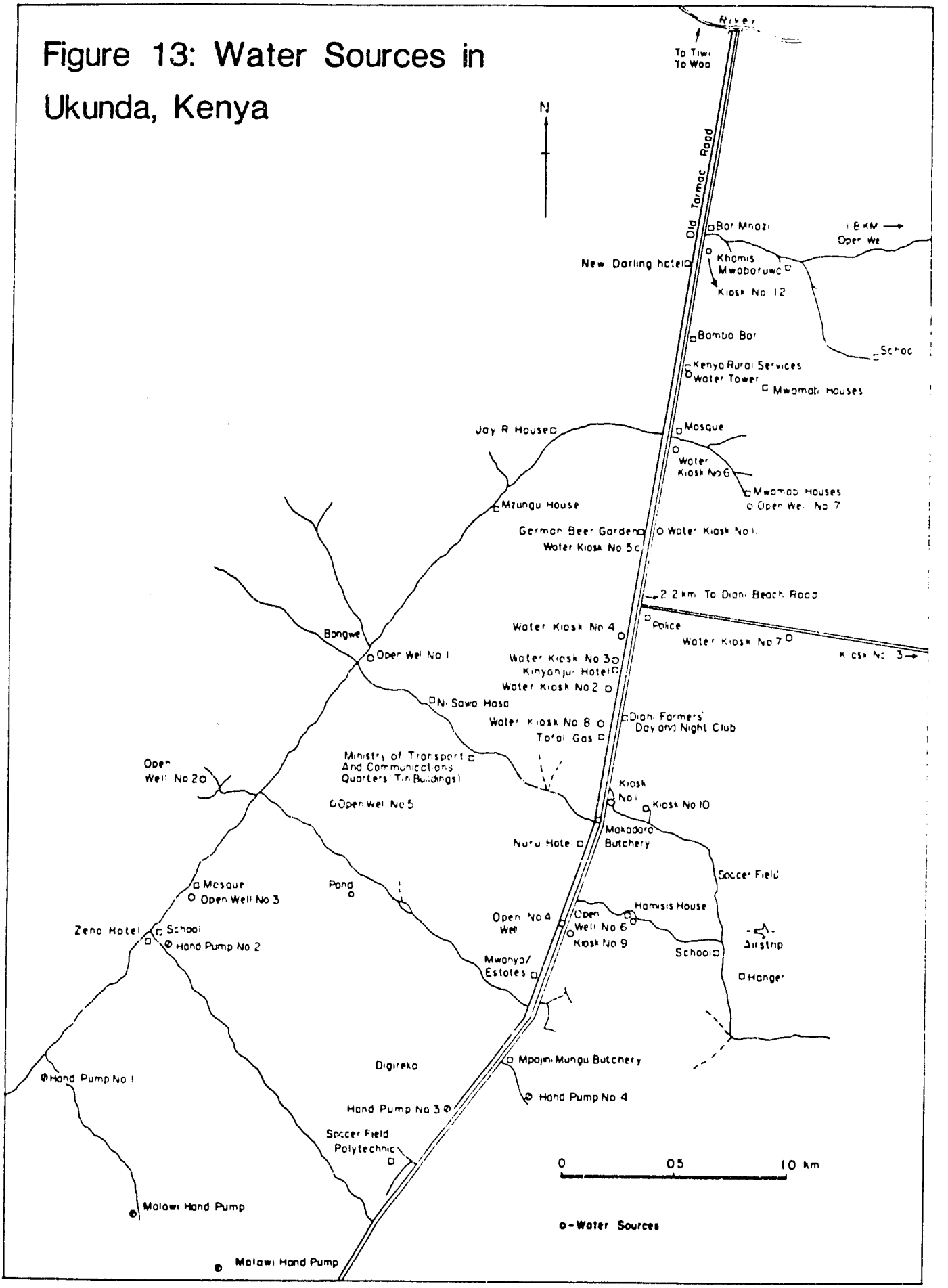


Figure 14: Ukunda, Kenya

(2) interviews with water vendors;

(3) interviews with kiosk owners;

(4) mapping out vendor routes;

(5) household interviews.

Observations at kiosks, handpumps, and open wells were conducted 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 in estimating volumes of containers and recording information and then were required to pass a test.

Distributing vendors in Ukunda only obtain water 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 were open for use for roughly the same period each day. Data were taken on 28,783 individuals' visits to collect water and on 3,605 visits by vendors.

Of a total of about 85 or 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.

Five enumerators followed vendors all day and recorded (a) the time, location, and volume of water collected at a kiosk each time, (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 and 887 actual sales were observed.

Sixty-nine households were selected randomly in one section of Ukunda for in-depth interviews. Households in this area had the most options for water sources, and thus the widest set of choices for deciding where to get their water. The household questionnaire consisted of three parts:

(1) Basic individual family demographic, occupational, and educational data;

(2) Questions on perceptions of the quality of water from different sources, the average number of times family members went to the source each day, the amount of water collected, the time spent collecting water, and the price paid;

(3) Questions about family income, livestock and agricultural production, and paid employment.

3.4 The Water Vending Industry in Ukunda

All of the vendors were male. Their average age was thirty years. For all but one, water vending was a full-time occupation. Most water vendors work throughout the year.

The prices charged for the 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 ks). The cost of a cart is about 1,000 ks. About 40 percent owned their equipment.

During both the rainy and dry seasons the vendors buy water from the kiosks for 0.15 ks per 20-liter jerrican. During the rainy season 90 percent of vendors' sales are at the rate of 1.5 ks per 20-liter jerrican (US $4.70 per m^3), increasing to 3 ks in the dry season. In the dry season the demand for vended water is high. In addition, because people are employed in the dry season in tourist-related activities, they have money to spend on vended water, 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 Tiwi (requiring a 10-kilometer round trip) and the price may increase to 6 ks per jerrican. During the rainy season higher prices were occasionally charged in outlying areas, and regular customers near kiosks sometimes received lower prices. Social pressures among the vendors appear to keep the price from falling much below 1.5 ks. During the dry season this system of zonal pricing is much more developed and widespread. The price increases the farther the vendor must go from the kiosks or from the paved road to deliver water.

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-liter jerrican for such reliable customers, and during periods of shortage, vendors will not charge the market price to regular customers.

Slightly less than 20 percent of the sales were made on credit. Most vendor household sales 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.

Because water vending in Ukunda is highly competitive, a vendor must be enterprising to be successful. As in many sales operations, there is great variation in individual performance, and it is thus difficult to characterize a typical vendor. Table 3 presents a weekly budget for both the rainy and dry seasons for an experienced vendor who rents his cart and jerricans.

Table 3

A Representative Water Vendor's Weekly Budget

Revenues

	Rainy Season		Dry Season	
Trips per day	3		6	
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	1.5	KS	3	KS
Total Weekly Sales	270	KS	1,170	KS
Costs				
Water				
Price per can	00.15	KS	00.15	KS
Cost per week	27	KS	5	KS
Equipment				
Rental of cart and jerricans	10	KS	15	KS
Total weekly expenses (excluding own labor)	37	KS	74	KS
Profits per week	233	KS	1,096	KS
Hours worked per week	37		54	
Implicit Wage Rate	6	KS/hr	20	KS/hr

There is a marked difference in profits 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, close to the market wage rate for unskilled labor. 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 $1,300-$2,100), about the average Ukunda household income.

3.5 Analysis of Water Distribution

Slightly more than 20,000 jerricans (400 m^3) of water were sold weekly in the wet season. Two of 13 kiosks supplied almost 50 percent 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. Average watering time at a kiosk is about ten minutes, being slightly longer at the busier kiosks (kiosk Nos. 1 and 2). Vendors still prefer these kiosks because their water pressure is reliable and they are well located. Waiting time at another kiosk (No. 8) are unusually long because of the low pressure at that point.

Individuals, as contrasted with vendors, collected about 480 m^3 of water per week in the rainy season; 79 percent by adult women, 13 percent by adult men, 7 percent by female children, and 1 percent by male children. Individuals obtained 64 percent of their water from kiosks. In addition, 18 percent collected water at no cost from handpumps, and 18 percent at no cost from open wells.

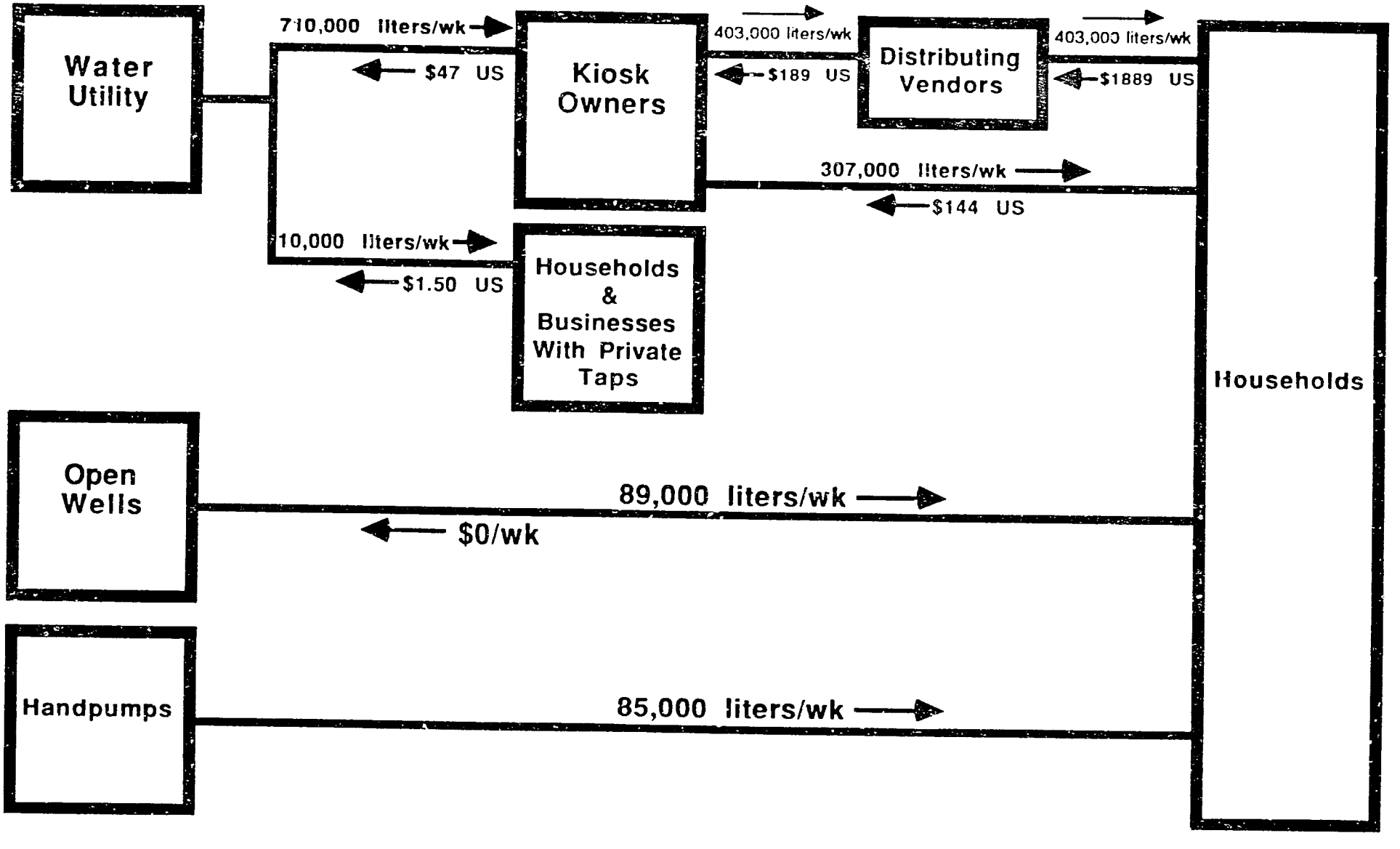
In all, kiosk owners sold about 710 m^3 of water per week during the study period, over half (57 percent) being sold to vendors. The kiosks received revenues of about 3,000 ks per week from vendors and about 2,300 ks per week from individuals. At the water authority's rate of 0.05 ks per 20 liters, the water authority's revenues should have been on the order of about 1,800 ks per week. In fact, kiosk owners reported average weekly payments to the MWD totaling about 750 ks. The fact that several kiosk water meters were not functioning may have accounted for this shortfall. The kiosk owners' aggregate profits per week (not considering labor) were about 4,500 ks ($280 US). With 13 kiosks in operation open 12 hours per day, it is clear that kiosk owners are not significantly monopolizing profits from the existing water vending system in Ukunda.

Figure 15 summarizes estimates of money and water transactions in Ukunda. Water vendors supplied 45 percent of the total 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 percent accrues to kiosk owners and 90 percent to the water vendors for their labor. An average per capita expenditure of 480 ks per year for vended water is about 8.5 percent of the average annual per capita income in Ukunda.

3.6 The Demand for Vended Water: A Discrete Choice Model

Why do some households in Ukunda buy water delivered at the house from distributing vendors at a high price, when they could, and many do, buy their water from kiosks at a much lower price, or collect it at open wells or handpumps at no charge? These questions are addressed by analyzing data collected from 69 household interviews.

Figure 15: Money and Water Transactions in Ukunda, Kenya Per Week
(Rainy Season-June 1986)



The survey was conducted in a part of Ukunda where households have access to several nearby water sources, and the decision as to which water source a household selects is not at all obvious. Numerous vendors work in this area, selling water door-to-door. There are two kiosks (nos. 1 and 9) and two open wells (nos. 2 and 6), but no handpumps. Each household is assumed to have three basic choices for its water source: a vendor (at 1.5 ks per 20-liter jerrican), the nearest kiosk (at 0.15 ks per 20-liter jerrican), and the nearest open well (at no cost). Most households chose a kiosk (62 percent), followed by vendors (25 percent), and open wells (13 percent).

The economic theory of consumer behavior would suggest that a household's choice of water source would depend upon two sets of factors: (1) characteristics of the water sources and (2) characteristics of the household. In the household survey, data were collected on:

(1) The round-trip travel time from a house to the kiosk or open well;

(2) The time spent queuing and filling water containers;

(3) The perception of the household about the taste, healthfulness, and quality of the water.

In theory, a household should be less likely to choose a particular water source if the travel, waiting, and filling time were longer, one must pay for the water, and the water is perceived to be of poor quality.

Enumerators walked from each household to each source to measure the travel time. Waiting and filling times were the same for each household for each kiosk and open well. The travel time and the waiting and filling time were added to obtain a measure of total collection time (TIME), which would be used as an explanatory variable in the water source choice. Enumerators asked households about both the taste and the "healthfulness" of water from different sources, but the answers for taste and healthfulness were almost perfectly correlated. The (TASTE) variable was used in the analysis as a single measure of the household's perception of the quality of water at a source. The taste variable was treated as a binary variable for which a "bad" response associated with a source is represented as one, and a good response is represented as zero. Since there was no variation in price across households, price was used as an intercept in the model (PRICE).

In the household survey particular attention was paid to developing estimates of all sources of income. Households with higher incomes would be expected to be more likely to buy vended water, other things being equal. Households with low incomes would be more likely to choose open wells. Household income enters the data set twice (as VINCM and WINCM) because it is necessary to determine whether the impact of income on the probability that a household will choose a vendor (VINCM) is different than the impact of income on the probability that it will choose a well (WINCM).

Because most water is collected by women, households with more women should be less likely to use vendors and more likely to use wells, because more people are available in the household unit to carry water. An explanatory variable (VWOMEN, WWOMEN) is used for the total number of adult women in the household. The number of years of formal education of the head of household is used as a measure of the household's educational status (VEDUCT, WEDUCT). A household with a higher educational level should be less likely to choose an open well because of its knowledge of the associated health risks.

Because the dependent variable, choice of source, is discrete rather than continuous, a multinomial logit model is used to describe the probability of a household's choosing each of the available water sources as a function of the source and household's characteristics:[2]

Probability of choosing each source = f(PRICE, TIME, TASTE, VWOMEN, WWOMEN, VEDUCT, WEDUCT, VINCM, WINCM)

The results, presented in Table 4, indicate that the overall model is highly significant. The findings were that:

- As collection time increases, the attractiveness of a source to a household decreases;
- Households would probably avoid using a source which they perceive to have poor quality water;
- Households with more women would be less likely to buy from distributing vendors and more likely to use wells;
- Better-educated households were less likely to use open wells.

The one surprise was that household income did not appear to affect significantly the decision to buy more expensive water from distributing vendors rather than buying from kiosks.

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[2] See Moshe Ben-Akiva and Steven R. Lerman (1985) for a detailed discussion of the discrete choice modeling. See Whittington et al. (1987a) for a complete presentation of the results of the application of this methodology to household water source choice in Ukunda.

Table 4

Results of Discrete Choice Model (Ukunda, Kenya)

Independent Variable	Parameter Estimate	T-statistic
PRICE (intercept)	-3.52	-2.67
TIME	-0.27	-3.45
TASTE	-0.50	-0.84
VINCM (Effect of Income on the Probability of Choosing a Vendor)	0.02	0.78
VWOMEN (Effect of Number of Women in Household on the Probability of Choosing a Vendor)	-1.14	-2.24
VEDUCT (Effect of Number of Years of Education of Head of Household on the Probability of Choosing a Vendor)	0.008	-0.19
WINCM (Effect of Income on the Probability of Choosing a Well)	0.03	0.71
WWOMEN (Effect of Number of Women in Household on the Probability of Choosing a Well)	0.42	1.08
WEDUCT (Effect of Number of Years of Education of Head of Household on the Probability of Choosing a Vendor)	-0.94	-1.52

X -Squared = 60.8 with 7 degrees of freedom
Log Likelihood Ratio = -45.4

From a policy perspective, the results indicate that a household's choice to use vendors is systematically related to source and household characteristics (except income). This model can be used to develop predictions of the consequences of policy decisions in water supply planning. For example, the results summarized in Figure 16 show that the probability that a household will choose a public tap (kiosk) for its water supply, other things being equal, falls dramatically as round-trip travel time increases. If round-trip travel time to the tap is more than 30 minutes (500 meters), almost no one will use it if there is an alternative. If the tap is as far as 500 meters away, 75 percent of the households in Ukunda would choose a vendor; 25 percent would choose an open well. If the tap is within 100 meters of the household, over 80 percent of the households would choose it.

These results suggest that water supply planners need to pay particularly careful attention to the spacing of facilities such as public taps. In Ukunda additional public taps will only be utilized if they are located within 100 to 200 meters of the target population. If public taps were installed within 100 meters of every household, most water vending would be eliminated.

This model can be used to forecast the number of households in a village which will use an improved source if it is made available, a matter of crucial importance for determining whether a new system is justified, and, if so, how large it should be.

There are two kinds of situations in which the model could be employed in forecasting the demand for a particular water supply service. First, the model could be based on data collected in a village where a water service is already operating. If data were collected on the independent variables in a second similar village where the service is not yet available, the model could be used to forecast the number of households in the second village that would use the service if it were initiated.

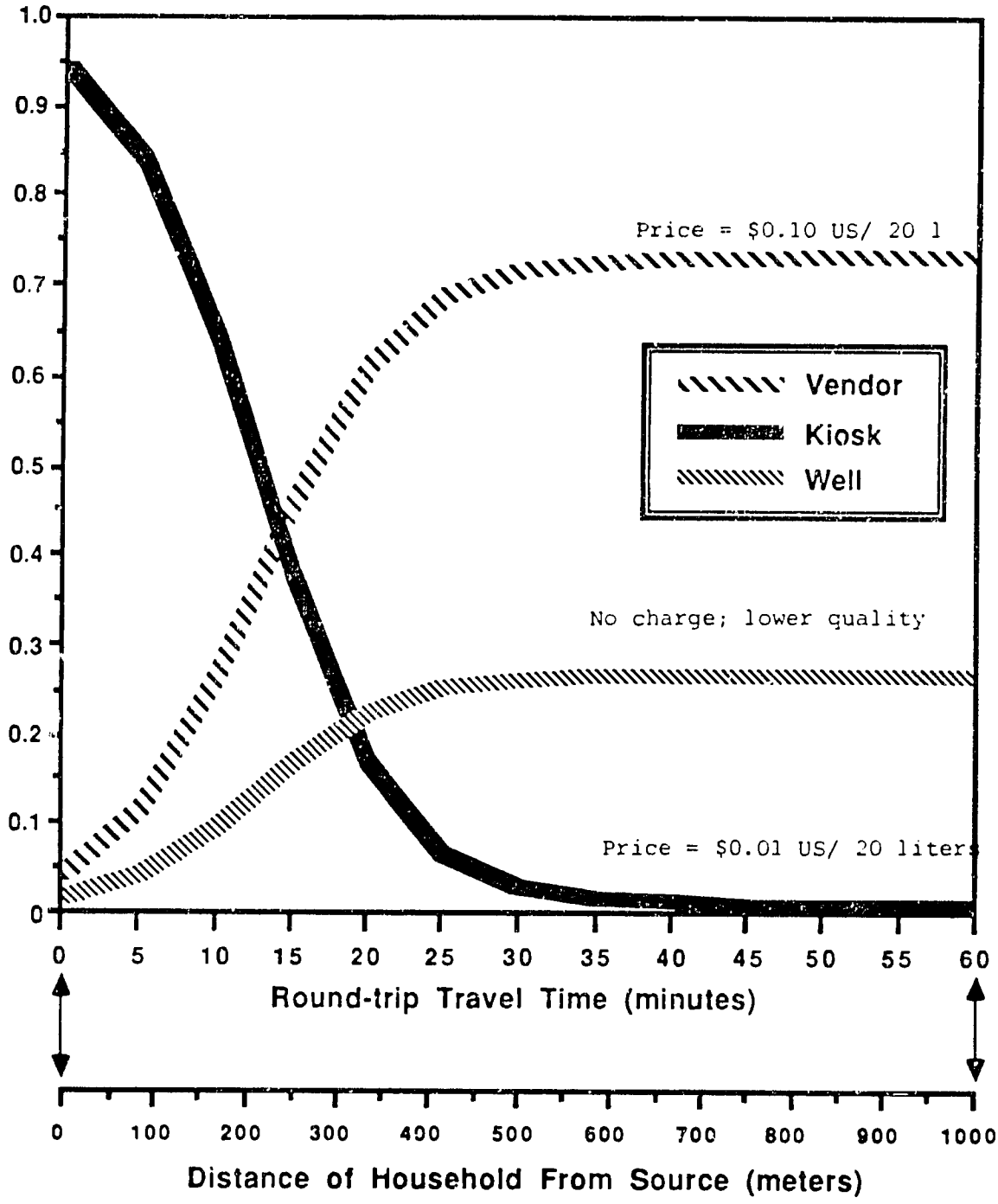
Secondly, the model could be used where a planner wanted to generalize from a sample population in a village to the entire population of the same community.

3.7 Is Vending an Appropriate Water Service Delivery 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 provided at a substantial cost. About 4,000 people in Ukunda are spending about US $150,000 annually on vended water, roughly 8.5 percent of their income. The operation of the vending system occupies approximately 85 to 90 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 toward water vending such as exists in Ukunda?

Figure 16: Probability of Source Choice vs Travel Time (Ukunda, Kenya)



Although significant resources are being expended in the operation of the water vending system, no one is making exorbitant profits. A 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 monopoly unit prices. There are simply real labor 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 vendors charge their customers for water or (b) licensing the vendors or imposing other restrictions on 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 flow of money and water in the vending system in Ukunda that many people in Ukunda can afford yardtaps. 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 including capital and operation and maintenance costs. Average annual per capita expenses in Ukunda on vended water alone are now about US $30. Under such conditions, 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 yardtaps 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 to pay for the cost of the improved service.

The study permitted vending systems to be compared with improvements such as handpumps and piped systems with yard taps. Whittington et al. (1987a) found that as vending becomes more extensive and as the value of the time of residents increases, the benefits of handpumps are likely to decrease generally, although their value may be justified in specific locations.

Based on an estimated value of time of US $0.25 per hour, Whittington et al. (1987b) found that annual benefits of $100 to $175 would accrue to individual households in Ukunda if a piped system with yard taps was installed and that households would have a strong incentive to request yard-taps.

Vending serves a useful function in Ukunda in that it is an interim system and requires little capital investment pending the installation of a piped system. Given that yard taps are financially feasible, vending provides a more appropriate interim service than handpumps. Vending also allows the householder flexibility in purchase. During busy seasons, such as the tourist season in Ukunda (the harvest season elsewhere), the household can purchase water from vendors while fetching water from kiosks during slack seasons.

Lastly, this case study demonstrates that the price of vended water is determined by the implicit wage rate. Where wage rates are low, vending is more socially attractive. If a piped system were to make vendors redundant, they might find a place for their services in a nearby community without piped water.

Chapter 4

A CASE STUDY OF WATER VENDING IN TEGUCIGALPA, HONDURAS

4.1 The Study Area

Tegucigalpa is the capital city of Honduras with a present population of about 520,000. The annual growth rate is 5.5 percent. Of the 30,000 new inhabitants each year, it is estimated that at least 20,000 settle in shantytowns, called "barrios marginales," on the fringes of the city. Tegucigalpa has about 150 of these barrios with a total population of 250,000. SANAA,[3] the national water supply agency, provides water to part of the population of Tegucigalpa.

About 80,000 persons in the barrios have either no access to potable water facilities or access only to public taps, which on the average serve about 1,400 persons each. About 25,000 persons live in barrios that are only partially served with house connections. Those without connections bought water from their neighbors, from public taps, or from vendors. The remaining barrio population had connections, but the quality of service was poor, with fewer than six hours of positive pressure in the water network per day. In January 1986, the Pan American Health Organization (PAHO) commissioned Donald Lauria to conduct a study of water supply conditions in Tegucigalpa, including vending. The PAHO study was done in the middle of the dry season (October to May) when potable water was scarce. It was found that people in barrios without facilities were purchasing water from private vendors at a price of Lps 0.017/liter (US $8.30/m^3), 34 times higher than the official government price of Lps 0.0005/liter (US $0.25/m^3).[4] Assuming a minimum demand of 10 liters per capita per day (lcd), these people would be spending about US $0.5 million during the six months of the dry season.

Those living in barrios with public taps purchased water from them when possible at a price of US $0.004/liter, 16 times the official price. At a demand of 10 lcd, these people would also be paying about US $0.5 million during the dry season. Hence, at least $1 million US was being spent on purchased water during the dry season by the 80,000 persons in just these two types of barrios, and only a tiny fraction of these funds reached the water supply agency. The majority went to private entrepreneurs. The total amount expended by all barrio dwellers for the entire year (not just the dry season) was estimated to be several million US dollars.

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[3] SANAA is the acronym for Servicio Autonomo Nacional de Acueductos y Alcantarillado (National Autonomous Service of Aqueducts and Sewerage).

[4] Lps (lempiras) 2.0 = $1.0 US.

4.2 Field Study

SANAA cooperated in the study described below, which was conducted from June 5 to 14, 1986 during the wet season to complement the data collected during the previous PAHO study. The study focused on the private vendors with trucks who go door-to-door selling water from barrels. In contrast with the Ukunda study, no effort was made to study other sources of household supply such as public taps, neighbors, and natural sources, nor were the wholesale vendors who supply water to truck vendors studied in detail. However, data were collected on where households in barrios obtain their water, the quantities collected from the various sources, and the costs incurred.

The field work was conducted with the help of Octavio Cordón, a private consulting engineer from Guatemala, seven field workers provided by SANAA, and supporting personnel such as drivers. Six of the field workers were assigned to study household water demand and one to study vendors. Draft questionnaires had been prepared and field tested during the PAHO study in January and modified in the June study. Final questionnaire forms are included in Whittington et al. (1987a).

Vendors were interviewed as they came to fill their trucks at major water sources. The sources were mainly privately-owned wells. June is the rainy season when the demand for water from vendors is reduced. Consequently, the vendors made fewer trips each day, reducing the opportunity to collect data. In general, the workday for vendors (and the interviewer) started about 4:00 am. A total of 21 vendors were interviewed.

For the household study a barrio with widely varying water sources (including public taps, private wells, nearby natural sources, and no easy access to potable water) was selected. Interviews were door-to-door, with the interviewers convening regularly to discuss their experiences and turn in their questionnaires to the project leaders who checked each form. When errors, missing data, or inconsistencies were found, the interviewer returned for clarification.

The household study was conducted in the barrio of Villa Nueva, with more than 6,000 inhabitants. The households were selected for study each day which were farther away each day from the principal access road and which were more remote and at higher elevations where access was more difficult and potable water increasingly scarce. A total of 214 households, about 20 percent of the total number of the households in the barrio, were interviewed.

4.3 Vendor Supply Study

The average age of the trucks of the 21 vendors was 18 years with an average market value estimated by the driver or owner at Lps 6,150 (US $3,075). Trucks on the average carry about nine 55-gallon drums with a total capacity of 2 m^3.

The study revealed distinctively different vending practices in the rainy and dry seasons (see Table 5). In the rainy season, trucks travel 250 km per month, compared to 1,250 km/mo in the dry season. Rainy and dry season monthly sales average 27 m^3 and 217 m^3 per truck, respectively. Although the

trucks are not fully occupied with water vending during the rainy season, only 2 of 21 vendors said that their trucks were used for purposes other than vending water. The sense was that vendors work very hard during the dry season and are content to be less occupied in the rainy period.

Table 5

Vendor Data, Seasonal

	Rainy Season	Dry Season
Sales m^3/month	27	217
Trips, no./mo	14	110
Trip length, km	18	11
Distance, km/mo	250	1,250
Length/sales, km/m^3	9.3	5.8
Revenues, Lps/mo	460	3,640
Costs, Lps/mo	90	890
Water	90	890
Labor	180	680
Fuel	110	600
Oil	30	80
Operative, subtotal	410	2,250
Tires	130	130
Repairs	280	280
Maintenance, subtotal	410	410
TOTAL O&M COSTS	820	2,660
Net Income Per Month, Lps	-360	980
Net Income Per Month, $US	-180	490

The average selling price of water from 55-gal barrels in rainy and dry seasons was US $1.75 each (US $8.50 m^3), which resulted in average monthly revenue per truck during the rainy and dry periods of US $230 and US $1,820 respectively. Monthly operating cost was US $205/truck in the rainy season and US $1,125/truck in the dry. The revenue from sales just about covers operating costs in the rainy season but not maintenance costs. In the dry season, revenues exceed costs, with a net income annually of about US $1,850, not including rental or fixed charges for the trucks. If true, the income is surprisingly low and suggests that the price charged by vendors of US $1.75 per 55-gal drum is not excessive.

The profit margin for truck vendors is even smaller if capital costs are taken into account. If a vendor could buy a used truck for US $3,500 and use it for five years, financed at 10 percent annual interest over a five-year life, the corresponding annual costs would be US $950 which, as shown in Table 6, results in a total annual cost of US $11,400. Compared to total annual revenue of US $12,350, the annual profit would be only US $956, or eight percent of the annual total cost.

Table 6

Vendor Financial Data, Annual

Revenues	24,700 Lps
Costs	
Operating	16,000 Lps
Maintenance	5,000 Lps
	21,000 Lps
Capital fixed charges Lps 7000, 10%, 5 years	1,800 Lps
Net income	3,700 Lps
Net profit, Lps/year	1,900 Lps
(Net profit, US$/year	$950 US)

These figures suggest that truck vendors are not exploiting their customers, despite their high prices. In the rainy and dry seasons, the vendors purchase water for about US $1.70 and US $2.10/m^3 respectively, and they sell it for US $8.50/m^3. Hence, the value added by the vendors is on the order of US $6.50/m^3. Although the question is not addressed in this study, it is possible that the largest profit margins are made by the wholesale vendors who sell water to the distributing vendors. If these suppliers purchase water from SANAA at the official residential rate, which is likely in some cases, then at a sales price to vendors of US $1.50-2.00/m^3, their mark up would be about sevenfold.

Regression analysis was used to develop cost of supply functions from the data on the 21 vendors. In general, two models were fitted to the data, a linear and a power equation. For the rainy season and considering only operating costs (CRO) in Lps/mo, the equations are

$$CRO = 167 + 8.9\ Q\ ,\ R^2 = 0.74$$

$$CRO = 62.4\ Q^{0.59}\ ,\ R^2 = 0.67$$

where Q = volume sold in m^3/mo and R^2 = coefficient of determination, which measures how well the equation fits the data. The higher R^2 value shows that the linear equation fits better than the power function. Satisfactory results could not be obtained for predicting the sum of operating and maintenance costs in the rainy season. The first equation implies a set-up cost of Lps 167/mo which is incurred even if no water is sold. The exponent in the second equation of 0.59 is called the economy of scale factor. It represents roughly the percentage increase in vendor cost per percent increase in sales. Hence, if the vendors could increase sales by 100 percent, their operating costs in the rainy season would only increase about 60 percent.

For the dry season and considering only operating costs (CDO) in Lps/mo, the equations are

$$CDO = 565 + 7.9\ Q\ ,\ R^2 = 0.79$$

$$CDO = 20.4\ Q^{0.87}\ ,\ R^2 = 0.79$$

where Q is sales in m^3/mo. In this case, both equations fit the data equally well. The set-up operating cost is much higher in the dry season than in the wet, and economies of scale are less, as indicated by the larger exponent value.[5]

The regression equations for predicting the sum of operation and maintenance costs in the dry season (CDOM) in Lps/mo are

$$CDOM = 864 + 8.2\ Q\ ,\qquad R^2 = 0.68$$

$$CDOM = 41.7\ Q^{0.78}\ ,\qquad R^2 = 0.74$$

where Q = sales in m^3/mo. The second (power) equation fits slightly better than the linear model, and economies of scale are roughly the same as before.

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[5] An exponent value of 1.0 or higher in the power function indicates the absence of economies of scale.

These equations can facilitate several different kinds of analyses, one of which is the following. The official government price of water for residences is about US $0.25/m^3$. However, those who supply truck vendors sell water at a price of about US $2.00/m^3$, and the vendors in turn add about US $6.50/m^3$, resulting in a final price for households of about US $8.50/m^3$. If vendors could buy water at US $0.50/m^3$ instead of US $2.00/m^3$ (i.e., at a 100 percent mark up over the official government price instead of a sevenfold increase), the final selling price could drop to US $7.00/m^3$. If trucks with barrels could be replaced by tanker trucks with, say, four times the capacity (i.e., 8 m^3 compared to 2 m^3) and if the operating cost function remained about the same with an economy of scale factor of about 0.8, the final selling price to households could be reduced to about US $5.50/m^3$, which is about US $1.00 per 55-gallon drum.

4.4 Household Water Use Study

The average household in the sample of 214 interviewed has 5.6 persons, with 2.7 adults and 2.9 children. The average monthly income is US $230, with 90 percent earning less than US $400. In the rainy season, households use a total of 3.7 m^3/mo; in the dry season they use 3 m^3/mo. The corresponding per capita values are 22 and 17 lcd.

About 70 percent of the households carry water to their homes in both seasons. About 1.0 hr/day per household is spent collecting water in the rainy season by those households that carry water, increasing to 1.5 hr/day in the dry season, partly due to longer queuing times at sources. Not only does the average time increase in the dry season, but so does the variation, which seems due to the use of more sources when water is scarce than when it is plentiful.

More than 90 percent of the households collect rainwater, mainly from their roofs. The average amount is 1.7 m^3/mo per household. Hence, this source supplies nearly half of the total water consumed in the rainy season. The remaining amount from other sources is 2.0 m^3/mo, most of which is purchased. In the dry season, essentially all of the 3.0 m^3/mo per household is purchased, which means that households buy 50 percent more water in the dry season than in the wet, and their expenditures are correspondingly 50 percent higher.

About 15 percent of the households in both seasons use water at natural sources such as rivers and springs for bathing and clothes washing. However, more trips are made to these sources in the rainy season than in the dry, which may be due to the heavy pollution of rivers when flows are low.

The average household expenditures on purchasing water in the rainy and dry seasons are about US $14 and US $21 per month, respectively. These values represent 8 percent and 12 percent of total household income, and on an annual basis amount to a total of US $210. On the average, households pay US $7/$m^3$, which is 15 times more than what people in the industrialized countries pay for much better quality water that is delivered to taps in their houses. With 5.6 persons per house, the average per capita expenditure is US $37.50/yr which, if capitalized, would be far more than required to pay for a piped system. If the 80,000 persons living in the barrios of Tegucigalpa without water facilities or access only to public taps spend this amount on the average, the total expenditure during the year would be about US $3 million.

Table 7 summarizes data on the use of different sources in the rainy and dry seasons. The top four sources are vendors, neighbors, wells, and public taps used by 70 percent, 40 percent, 10 percent, and 7 percent of the houses, respectively. (The numbers do not total 100 percent because households use multiple sources.) A few houses use rivers and a few use other sources such as the workplace. Households using vendors have fewer children for carrying water than those using other sources, which may account in part for the higher use of vendors.

Table 7

Household Water Use

Source	% Houses	Income Lps/mo	Distance to Source in meters	Quantity m^3/mo	Price US$/$m^3$	Collection Time hrs/m^3
Vendors						
Rainy	70	500	50	1.8	8.50	3
Dry	70	500	50	2.5	8.50	2
Neighbors						
Rainy	40	450	550	1.3	7.00	43
Dry	40	450	550	1.5	7.00	44
Wells						
Rainy	10	380	600	1.2	3.50	21
Dry	10	400	450	1.4	4.00	21
Public Taps						
Rainy	7	380	400	1.9	3.00	18
Dry	7	380	400	1.9	3.50	38
River						
Rainy	4	-	-	0.8	0	-
Dry	4	-	-	1.1	0	-
Other						
Rainy	2	-	-	2.1	-	-
Dry	2	-	-	1.8	-	-

US$ = 1/2 of Lps figure

Table 7 shows an association between the number of houses using each source and the prices they have to pay. The most used source is vendors, but they charge the highest prices. Public taps are least used, and they charge the lowest prices. Water from rivers is free but is little used. An association also exists between the prices charged by the top four sources and the incomes of the users. Vendors, who charge the highest prices, are used by the households that have the highest incomes. Public taps, where prices are lowest are used by households with the lowest incomes. Neighboring houses and wells as sources of water follow this trend. This association suggests that as income increases, users can afford sources that charge higher prices.

The popularity of vendors seems due to their convenience. They usually deliver water to the door, which accounts for the average short distances in Table 7 associated with vendors. Some results are surprising. For example, 40 percent of the households use neighboring houses, paying a price only a little less than that charged by vendors. However, getting water from neighbors is not convenient. Both wells and public taps involve shorter distances than neighbors and have lower prices, yet they are less used.

There are several possible explanations of this phenomenon. Many people complained about the quality of water from wells and springs. They described the water as "salty" and unsuitable for drinking or cooking. Furthermore, they said that when used for washing it caused skin irritations and made clothes stiff and irritating. In some barrios, the people would not use well or spring water even though it was plentiful, conveniently located, and free of charge.

A possible explanation for not using public taps is more difficult. The distances shown in Table 6 are for those who use public taps, not for those who do not. With so few public taps in the barrio where this study was conducted, the distances and times required for those not using them are considerable, making taps a relatively remote source. The same might apply to wells.

The average collection time for public taps in the dry season is twice that in the wet season (38 vs. 18 hr/m^3), which is due to longer queues when water is scarce and to the unreliability of supply. Water is available from taps only a few hours each day in the dry period, and households report that sometimes several days pass when there is none at all. This unreliability is also indicated by the standard deviation in collection time, which is five times higher in the dry season than in the wet season. This unreliability probably accounts for the fact that those who can afford it use more reliable (and expensive) sources. Even though public taps have an acceptable record of reliability in the rainy season, their poor record in the dry season might cause households to use other sources and to be reluctant to switch back and forth to this periodically unreliable source.

For each source, the average price charged in the rainy season is about the same as in the dry, which is surprising since water is more plentiful in the rainy period. The variation in prices is different for the four main sources. For both vendors and public taps, it is small. However, for neighbors' water and wells, variation is higher by a factor of three. For sellers at public taps, they all purchase water from government at the same price, which tends to stabilize their costs. There are not many vendors operating in this barrio (probably fewer than ten), and it is likely that they all know each other and the prices that are charged. The total number of wells and households that sell water, on the other hand, is much greater than the number of vendors and public taps. These widely scattered wells and households throughout the barrio which sell water have limited opportunities for contact with each other and they operate quite independently. Furthermore, the costs of operation for these sellers are probably not well defined. They probably charge what the traffic will bear, which contributes to price variation.

An analysis was made for the dry season of the households that obtain water from vendors and at least one other source. About half of the houses using vendors use at least one other source. Only one-third of all households rely

solely on vendors. Their average income is US $259/mo, which is 13 percent more than the average income of all households, which places them in the upper third of the sample. The households which rely entirely on vendors purchase an average of 3.0 m^3/mo, and they spend an average of US $25/mo, which is about nine percent of their income.

The water consumption by households that use vendors and at least one other source is 3.6 m^3/mo, and the average total expenditure is US $26/mo. These households purchase 2.2 m^3/mo from vendors at a cost of US $18/mo plus 1.4 m^3/mo from other sources at a cost of US $7.50/mo. Compared to those who rely solely on vendors, this group pays only 6 percent more for 22 percent more water. However, they incur the cost of having to carry water to their homes. In this group of households that obtain water from vendors and at least one other source, 70 percent buy water from neighbors, ten percent buy from wells, and ten percent buy from public taps.

An analysis was made of the seven percent of the households in the total sample that use public taps during the dry season. Of this seven percent, about half rely solely on taps, and the remainder use at least one additional source. The average income of the houses using only taps is US $127/mo; 80 percent of the households interviewed have incomes greater than this. The average quantity of water purchased from public taps is 2.4 m^3/mo which is well below the total sample average of 3.0 m^3/mo. This is equivalent to about 15 lcd. These houses pay US $8.50/mo, seven percent of their income.

4.5 Summary

The 21 vendors interviewed during this study employ similar equipment and practices and have similar costs. On average, they sell 150 m^3 per year at a price 34 times the government rate (US $8.50/$m^3$); their average annual revenue is US $12,350. Their average annual operating and maintenance costs are US $10,500, resulting in a profit margin of about 18 percent. However, if equipment costs are considered, profit drops below 10 percent. Clearly, vendors are not making exorbitant profits despite the high prices they charge. The water they purchase from private sources is the largest component of their costs (28 percent). They pay about seven times what the government charges its residential customers for water.

The price at which vendors sell water is at least 15 times higher than that charged for piped water in industrial countries. Furthermore, this water is usually of poor quality and requires at least some time and effort on the part of purchasers to bring it to their homes.

In Honduras, vending patterns are distinctively different between the wet and dry seasons. In general, vendors sell eight times more water in the dry season than in the wet, and they travel five times as far. They fill their trucks only once a day 14 days per month in the rainy season, compared to four times per day 28 days per month in the dry. Despite the reduced demand for water in the rainy season, the selling price in wet and dry seasons is about the same. There are small economies of scale in the operation of vendors; doubling sales would increase costs about 80 percent. If they could purchase water at a markup of only 100 percent instead of seven times the official rate, if they could capture economies of scale by quadrupling the size of

their deliveries, and if the savings from these measures were passed on to consumers, the selling price of water would be cut almost in half, but would still be very high.

Households on average use 3.7 m^3/mo in the rainy season and 3.0 m^3/mo in the dry. This is equivalent to 22 and 17 lcd for the two seasons, respectively. Nearly half of the water used in the wet season is rainwater collected from roofs.

Households pay an average of US $14 and US $21/mo to purchase water in the wet and dry seasons, respectively. This amounts to about US $210 per house per year or US $38 per person, which is roughly 10 percent of total household income. If this amount were spent by the 60,000 persons in Tegucigalpa without water facilities or with access only to public taps, the total annual expenditure would be US $6 million, which would pay for a piped system and provide larger quantities of water and significant time savings.

The most commonly used source of water in the barrio where this study was conducted is rainwater, used by more than 90 percent of the households. The next most common source is vendors, used by 70 percent of the houses, and the least-used source is public taps (seven percent of the households). Neighbors' water sources and wells lie between these extremes.

Vendors charge the highest prices and are used by the households with the highest incomes. Public taps charge the lowest prices and are used by households with the lowest incomes. It is clear that the popularity of vendors is due to the convenience of deliveries to the door.

The reasons for using other sources are less clear than those for using vendors. It appears that public taps and wells are used much less than vendors and neighbors because they are less available. Also, many people complain about the poor quality of well water; it is salty, causes skin rashes, and makes clothes stiff, which irritates the skin. With respect to public taps, they are unreliable, especially in the dry season. The average time to collect water from taps in the dry period is more than twice that in the wet, and the standard deviation is four times larger. This is due to longer queue times and the fact that public taps are only supplied with water a few hours daily once the rainy season ends. Households seem to prefer more reliable sources.

Two major conclusions emerge from this study. The first is that vendors are not making large profits and consequently there is little rationale for government regulation of vendor prices. It is conceivable, however, that in Tegucigalpa those who supply water to vendors are earning large profits, which might be regulated by government. Another basis for regulation would be control of water quality. The second major conclusion is that households are willing and able to pay substantial amounts for water supply. The average annual expenditure of about US $38 per person would pay for an adequate piped system. Governments, therefore, need not assume that water supplies must be presented as a gift to the people. Households, even very poor ones, will pay much more than five percent of their incomes for water. However, it is necessary that they receive reliable service since they cannot both pay for a system that does not work and at the same time purchase water from private sellers to meet their needs.

Chapter 5

IMPROVING WATER VENDING SYSTEMS

Because water vending will continue to play a major role in water service in developing countries for the foreseeable future, donors and water authorities need to consider ways in which it may be improved. This does not imply that water vending is necessarily the most appropriate method of water delivery. It simply means that it exists, serves a need, and probably deserves consideration as one means to improve water supplies.

5.1 Justifications for Public Sector Intervention in Water Vending Activities

There are three principal justifications for public sector intervention in water vending activities.

Public Health. Households may be unaware that vendors are selling contaminated water. In fact the vendors themselves are unlikely to know the bacteriological quality of the water they are selling. Even if the household willingly uses polluted water, the consequences may fall not only on members of the household, but also on other members of the community. As a public health hazard they require government action.

Prevention of Anticompetitive Practices. Price fixing, monopolistic barriers to entry into the water vending "industry", or other anticompetitive practices may call for a government response. If the price of vended water is artificially high, due either to a controlled price or a deliberately restricted supply, then government intervention may be called for. Such a situation could arise for any of the following reasons: (a) capital market imperfections (potential vendors could not borrow sufficient funds to enter the business), (b) a local monopoly or oligopoly formed by corruption, including physical intimidation of potential competitors, or (c) government restrictions or regulations which create barriers to entering the business. In this case, if the government sets a lower price, the monopoly profits can potentially be transferred from the vendors to the consumers of vended water.

Inequitable Distribution of Property Rights to Water Resources. A third justification for government intervention may occur when there is an inequitable ownership of a water source. For example, if all the vendors purchased water from a single source controlled by one individual, the vendors' prices to the households might

be determined in a competitive market while the owner of the source collects monopoly profits. For example, in Indonesia water vending from a house connection is so profitable that new house connections are made inordinately expensive in order to maintain the market for the individuals with house connections. In this case the government may be justified in facilitating the provision of more house connections to achieve a more equitable distribution of water resources.

Given these justifications for public sector action, what can donors and water authorities do to improve vending? Several approaches suggest themselves.

5.2 Possible Public Sector Responses to Water Vending Activities

Improve Quality of Vended Water. First, authorities may attempt to improve the quality of water sold by vendors. The simplest actions would be (a) to prohibit the use of contaminated sources when alternatives are available and (b) to require that vendors use approved containers that would prevent contamination. In Ukunda, neither measure would be necessary because the vendors obtain good water from a piped system and already use plastic containers with screw-on tops. Government authorities would also periodically test the bacteriological quality of water sold by vendors and provide the public with the results.

Measures such as adding chlorine to supplies distributed by tanker-trucks might be practical in special situations. Health education programs could inform consumers of the importance of buying water from approved vendors. Vendors themselves could be instructed in the basic principles of water supply and health and in proper water handling.

Improve the Technology of Transporting Water. Authorities could sponsor education, demonstration, or technical assistance programs for water vendors introducing alternative technologies for transporting water. In our two case studies, however, vendors appear to have found appropriate cost-effective methods for transporting water. One should not be optimistic about the ability of central water authorities to find better methods than those already adopted locally.

Improve the Scheduling of Deliveries and Route Rationalization. Third, vending operations may be improved by increasing the efficiency of the distribution and delivery system. Regularizing vendor routes and delivery schedules is appealing where vendors crisscross each others' paths all day and carry around water which they may not sell, such as in Ukunda. There are, however, drawbacks to such

increased government involvement. For example, customers would lose flexibility. In addition, there are already market pressures which serve to regularize routes. In fact, this was the case in Ukunda where vendors offered regular customers lower prices, credit, and better service. Standardization of routes and delivery scheduling is more likely to come about by the organization of vendors, although this may lead vendors to divide the market and raise prices.

Make Vending Legal. The fourth and simplest action which the government can take to improve vending is to recognize that when the market for vended water is competitive, vendors are performing a valuable service and that their activities should be legitimized. In many developing countries vendors are considered illegal and operate in the informal sector under constant threat of arrest or harassment. In Ukunda vendors were initially suspicious of our study because they feared it might lead to the imposition of taxes or penalties. Yet vendors serve millions of people without receiving public subsidies. Acknowledgment of the legitimacy of water vendors' activities is essential if technical assistance for water vendors is to be effective.

Impose Price Controls on Direct and Wholesale Vendors. Fifth, in urban and periurban situations in which vendors purchase water from individuals with private connections, the water authority has typically imposed restrictions on the number of new house connections, ostensibly to restrict use of a limited supply, but more likely to ensure connected customers with a reliable market. Those with private connections can collect excessive profits. There is no justification for allowing those fortunate enough to have one of the few connections to make such large profits.

One solution is for the authority to impose a maximum price which such direct vendors can charge. In Ukunda the kiosk owners could not charge either individuals or distributing vendors more than 0.15 ks per 20-liter container. The kiosk owners were required to post the legal price at their place of business.

In Surabaya, the public water authority (PAM) attempts to expropriate some of these profits itself by maintaining a two-tier residential rate structure. Households in Surabaya with private connections are metered. Any household which consumes more than a moderate amount for its own use is assumed to be selling water to others, and PAM automatically increases its per unit charge.

On the other hand, price controls imposed on vendors operating in a competitive market are unlikely to be either administratively feasible or economically sound. Price controls would drive many vendors out of business and needlessly deprive people of a valuable option for meeting their water needs.

Increase the Supply of Water Available to Both Individuals and Vendors. Sixth, in urban and periurban areas, probably the most positive action donors or water authorities can take with respect to improving vending is to increase the quantity of water available to vendors. In most instances the existence of widespread vending is an indicator of water "shortage" in the sense that consumers are demanding and are willing to pay for more water than can be provided by the existing water delivery system. The greatest disadvantage of vended water is its high price which results primarily from two factors: (1) the high costs of transporting water by vendors and (2) monopoly control of water sources. Increased supplies of water for vendors and increased numbers of distribution points from which vendors can obtain water will reduce the cost.

Efforts by water authorities to increase supplies may mean assisting water vendors to organize. In developing countries the public sector simply does not have the resources to undertake all water system construction required to meet the needs of rapidly growing populations. Funds need to be obtained from the individuals being served, and the private sector should be involved. Vendors often carry water long distances along a straight route from their source which could easily be served by a pipeline; vendors themselves may be able to finance and build such a pipeline.

Licensing. Improvements in vending might be facilitated by licensing vendors, which would also provide a means of collecting revenues from vendors, influencing technology choices with respect to water transport, and ensuring adequate water quality.

Promote Community Organization and Political Action. Public authorities may face a corrupt, monopolistic market for vended water which cannot be changed merely by increasing the overall system capacity. In such cases an eighth approach is required to improve vending, community organization and political action. In his analysis of water vending in Port-au-Prince, Fass (1982) showed how difficult it is for expatriates to come to grips with the realities of local water politics in a large Third World city. Failure to understand the magnitude and politics of water vending can lead to problems in planning system expansion.

5.3 Costs of Public Sector Actions

The potential benefits of these approaches must be counterbalanced by the costs and risks of public sector intervention. The standardization of routes and schedules or licensing of vendors entails substantially increased administrative costs. Such responsibilities are difficult to handle and, besides, increase opportunities for corruption and abuse of government authority. The government itself may well be the cause of the anticompetitive and inequitable practices.

5.4 Other Reasons for Public Sector Interest in Water Vending Activities

Planning agencies and water authorities can obtain useful information for planning purposes by studying water vending. For example, information on water vending can be useful for estimating the benefits of a piped water system because the quantity of vended water sold at a given price is an indicator of the demand for improved water services. Just as importantly, the data on water vending provide concrete evidence that households are able and willing to pay substantially for water. The funds available from donor agencies and government treasuries for water supply improvements are simply not sufficient to meet the huge demands in developing countries. Consumers must bear a much larger share of the costs of water supply improvements (IBRD, 1985). It thus becomes important to identify sites where people are willing and able to pay for improved water services. Information on water vending provides such identification.

Information on water vending may also be necessary for provision of piped water. When water vendors constitute powerful political constituencies, if their interests are poorly understood or ignored, they may block the implementation of a project that threatens their livelihoods. In periurban areas, vendors have little to fear; no matter how rapidly pipes are introduced, the population unserved by piped water grows more rapidly.

Chapter 6

SUMMARY AND CONCLUSIONS

6.1 Major Findings

Many of 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. The following are the most significant:

- 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 percent 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 percent of the total consumed in the village. People in Ukunda spend about nine percent of their income on vended water.

- Both case studies indicate clearly that most households are prepared to pay for convenience--i.e., they will pay for water delivered to the house rather than collect it free from a distant source. Also, people are prepared to pay more for water from a distant source than use convenient water sources with less palatable water.

- In both case studies households were paying much more for vended water than the costs of providing 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.

- The two case studies affirm the experiences from elsewhere; the prices vendors charge for water are high because hauling water manually is hard work and requires some capital investment. In the two study areas vendors were making a fair return on their labor and investment, but they were not making exorbitant profits.

- The statistical analysis of data from the Ukunda household interviews shows that the demand for vended water is systematically related to some of the

household and source characteristics suggested by economic theory. Those households which use vended water are farthest from other sources and have fewer women. Households with higher education levels are less likely to choose open wells. Surprisingly, in Ukunda, households with higher incomes are not more likely to use vended water; income is a factor in the slum areas of Tegucigalpa.

- In Ukunda, the probability that a household will choose a public tap (kiosk) for its water source falls dramatically as distance from the public tap increases. If the tap is more than 500 meters from the household, almost no one will use it. If the tap is as much as 500 meters away, 75 percent of the households in Ukunda would choose a vendor; 25 percent would choose an open well. If the tap is within 100 meters of the household, over 80 percent of the households would choose it. These results suggest that water supply planners need to give attention to the spacing of public taps. If public taps were installed within 100 meters of every household, they would eliminate most water vending.

- Where vendors draw water from approved sources, use proper containers, and charge reasonable prices, government regulation may not be necessary or advisable. However, where privately controlled sources are used--and particularly where these taps are on the public water supply system--and where charges are exorbitant, as in some instances in Tegucigalpa, the water authority would be justified in stepping in and lowering the prices the owners of such private taps could charge.

- Vending exhibits small economies of scale, is flexible, and exhibits little unused capacity. During wet seasons when demand for water may slacken, the vendors reduce their work load or find other employment.

- Vending systems can play a valuable role in bridging the period of time from which a community can afford only a few improved sources until the time when incomes are at a level which can support a piped system with private yard taps or house connections. Vending systems do not entail significant capital costs, so they are much more flexible and cheaper than installing wells and handpumps.

- Vending systems permit households to adjust their water purchases to fit their cash flow situation. Households which use vendors do not have to meet fixed m ly payments when their incomes fluctuate.

- In some cases water vending studies may result in a fundamental rethinking of the water situation in a city or region. Rather than viewing water supply as a social service to which everyone is entitled, in areas with extensive vending activities, managers of water utilities may realize that the piped distribution system is offering an inferior product and is not competing effectively with the water vendors. In such a situation, the water utility's challenge is to extend an improved service and thus increase its market share.

6.2 Recommendations

- Water vending studies should be carried out in most developing countries in order to provide information for improved water supply planning. Information from such studies may be decisive in convincing policy makers that not only are people able and willing to pay for improved water services, but they are already paying more for vended water than would be necessary to recover the full costs of a well-run, piped distribution system. Water vending studies can also assist with the structuring of tariffs.

- Universities in less developed countries can carry out such water vending studies. USAID should support such groups by providing guidelines for water vending studies and by providing reference materials.

- Surveys of water vending practices should be conducted in both the rainy and dry seasons (such as was done in Tegucigalpa). The survey in Ukunda was conducted in the rainy season. If a survey can only be conducted once, it is better to do it during the rainy season, as it indicates the lower limits of the amount of vending and on the prices charged.

6.3 Areas for Future Activity

- The discrete choice model developed in the Ukunda case study needs to be tested in different locations particularly where individuals walk farther to water sources than is the case in Ukunda and where there is more variation in the prices of vended water.

- In both of the case study areas vendors are selling good quality water in relatively competitive markets. Water vending may need to be investigated where vendors are selling contaminated water drawn from polluted sources.

- In some locations vendors set monopoly prices for vended water. Effective ways of offsetting monopolistic practices need to be determined.

- The design and implementation of national water vending surveys need to be further studied to provide a systematic and comprehensive assessment of water vending. Understanding the magnitude and cost structures of vending throughout a country will permit better allocation of limited resources and determine whether cost recovery goals are feasible.

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