THE DEMAND FOR WATER IN RURAL AREAS: DETERMINANTS AND POLICY IMPLICATIONS

The World Bank Water Demand Research Team

Improving the adequacy and quality of water supplies is a priority for rural development in developing countries. So far, the strategies of governments and international donors for tackling the problem have been supply-driven; the fundamental importance of demand in the selection of appropriate policies has been virtually ignored. The realization that effective policy and planning must take into account what the rural clients want and are prepared to pay for was the impetus for the World Bank's multicountry study of households' demand for improved water services.

This article summarizes the findings of the 1987–90 investigation of determinants of rural demand in selected regions of Latin America, Africa, and South Asia. The research team used both direct (contingent valuation) surveys and indirect (revealed preference) methods to estimate households' willingness to pay for different levels and types of improvement. The methodology produced some illuminating insights into how to decide what level of service is appropriate for a particular community and how the improved services should be paid for. The team identified four broad categories of village situations, with appropriate policies ranging from the provision of house connections at full cost at one extreme, to no improvement in traditional supplies at the other extreme.

Millions of people in developing countries face daily problems in obtaining water for domestic purposes. Recognizing the harm to health, economic productivity, and quality of life that can result from inadequate water supplies, international donors and the governments of developing countries have mounted numerous efforts to correct the problem.

The World Bank Research Observer, vol. 8, no. 1 (January 1993), pp. 47–70

The international community affirmed its commitment to improving water supplies by declaring the 1980s the United Nations' International Drinking Water Supply and Sanitation Decade; that commitment was reaffirmed at the 1990 New Delhi Global Conference on Safe Water and Sanitation.

Most of the initiatives emanating from this commitment have tackled the problem according to a formula described here as the "first standard" paradigm. The formula is based on a dual premise: that government must subsidize rural water supplies because many rural households are too poor to pay for improved water systems, but that, to achieve equity, those government funds must be spread thinly because public resources are also limited. This policy message was summarized in the declaration of the New Delhi Conference as "some for all rather than more for some."

Inevitably, the international donor community has not been unanimous in adopting this conception of the problem. Its "welfare state" implications have not been universally welcomed by many individuals in the World Bank and other donor organizations, who proffer an alternative, "second standard" paradigm. They contend that people can and will pay at least 3 to 5 percent of their income for improved water services.

Two observations motivated the investigation reported in this article: (a) both approaches concentrate on supply to the neglect of demand; and (b) neither has successfully solved the problem—the empirical evidence is that many of the water systems established according to these paradigms are either not functioning at all or not being used.

The research program was grounded on the recognition that policy and planning should be built on a better understanding of what improvements in their water services people really want and are willing to pay for. The research team therefore set out to investigate the determinants of household demand for improved water services—including relevant socioeconomic and demographic characteristics of the household as well as characteristics of existing and new water supplies, such as price, distance, quality, and reliability. The team believed that such information was vital to judicious decisions, both technical—such as the choice of appropriate technology or level of service—and financial—such as the monthly tariffs and connection fees to be charged for private house connections.

The Research Program

The studies sponsored by the World Bank to investigate these issues were carried out in Latin America (Brazil), Africa (Nigeria and Zimbabwe), and South Asia (Pakistan and India).[1] Each country study was led by researchers from a national institute or university, working in close collaboration with a team of World Bank staff and consultants. In three of the five studies various sites in several regions of the country were investigated. Sites in Brazil included a relatively well-off, water-abundant area in the southeastern state of Parana and a poor, dry area in the northeastern state of Ceara. In Pakistan three areas in the Punjab were selected: one had easily accessible, high-quality groundwater; another had easily accessible but brackish groundwater; the third was in an arid zone where groundwater was relatively deep and inaccessible. In India (Kerala State) one area had abundant, good quality groundwater, one area had abundant but saline groundwater, and one area suffered from water scarcity.

At the outset, the research team developed a common design, or "indicative protocol." The design was subsequently modified in some countries to take account of circumstances peculiar to a study area, but it did provide a conceptual framework and underlying logic that tied the different studies together. The common point of departure was the recognition that the issue central to planning policy for rural water supply in developing countries is to find out why households opt for an improved water source rather than the current supply. This focus on choice of water source is quite different from the focus in industrial countries, where it can be assumed that everyone will choose to use an improved source (for instance, a private house connection) if it is provided.

The researchers used both indirect (revealed preference) and direct (contingent valuation) methods to study how households made their choices about water sources. The indirect approach used discrete choice econometric techniques to model households' decisions and to derive estimates of welfare change from the actual choices that households made. The direct approach involved asking people who did not have an "improved" water source whether they would use a new source if it were provided under specified conditions, and how much they would be willing to pay for access to different kinds of improved water systems, such as a public tap or a private house connection. Such questions were often difficult to formulate, and devising them taught the team a lot about how to conduct contingent valuation surveys in developing countries (World Bank Water Demand Research Team, forthcoming). For example, it was hard to convey the notion of what was meant by the *maximum* an individual would be willing to pay. A respondent in Haiti asked an enumerator, "What do you mean the maximum I would be willing to pay? You mean when someone has a gun to my head?"

Our indicative protocol identified two categories of villages for study. In type A villages, households had already had the option of connecting to a piped water system; some had connected, others had not. In these villages we used an indirect approach to assess the determinants of households' decisions. Sometimes respondents in type A villages were also asked contingent valuation questions about their willingness to pay for various improvements in service and their response to different tariffs. In type B villages, improved water systems were not yet available, though in some cases they soon would be. Households in these villages were asked a series of hypothetical questions about whether they would choose to use an improved system if it were offered at a specified price (and connection fee). Econometric techniques were then used to analyze what determined their responses.[2]

The research design enabled us to compare the estimates of household demand for improved water services obtained by the indirect method with those elicited by the direct method. One of our methodological inferences is that because the results yielded by both techniques tell essentially the same story, we can be confident of the validity and robustness of our conclusions. (For methodological implications of the design, conduct, and analysis of the studies, see World Bank Water Demand Research Team, forthcoming.)

Opportunities arose in the course of the project to study some of the same research questions in other countries; results from three of these supplemental studies are included in this article. In southern Haiti and the Newala District of Tanzania, contingent valuation surveys were conducted in type B villages to determine households' willingness to pay for improved water services. In Kenya a study of water source choices was carried out in a type A village (Ukunda), but no contingent valuation questions were asked.

Determinants of Household Demand for Improved Water Service

Three sets of characteristics jointly influence a household's willingness to use, or to pay for, an improved water supply:

- The socioeconomic and demographic characteristics of the household, including education of family members; occupation; size and composition of family; and measures of income, expenditures, and assets.
- The characteristics of the existing or traditional source of water versus those of the improved water supply, including the cost (both financial and in time required to collect water), the quality, and the reliability of the supply.
- Households' attitudes toward government policy in the water supply sector and their sense of entitlement to government services.

The response of a household to a new, improved water supply is not, we emphasize, due to any one set of determinants alone, but to their joint effect. It is this "jointness" that is modeled in the multivariate analysis. The multivariate analysis of water use in Ukunda, Kenya, for example, illustrates how a family there decides to purchase water from a kiosk rather than buy water delivered to its door by vendors, or draw water from a well (Mu, Whittington, and Briscoe 1990). Richer, better educated families with more women are more likely to use a kiosk. Kiosks are used more when the alternative water sources (wells or vendors) are more expensive, farther away, and provide lower quality water; they are used less as the price of water at the kiosk and the distance to the kiosk increase and as the taste of water from the kiosk declines. (These results are based on an analysis of actual household choices, not their responses to contingent valuation questions.)

Socioeconomic and Demographic Characteristics

This section summarizes the results of the research in terms of the first set of determinants delineated above, namely the socioeconomic and demographic characteristics that influence whether and how much households are willing to pay for improved water supplies.

MEASURES OF INCOME AND ASSETS. The first standard policy paradigm holds that rural households can pay very little or nothing for improved water services; the second standard paradigm assumes that they will readily pay 3 to 5 percent of their income. How well do these rules of thumb describe the demand of rural households for improved water services? Very poorly, the study shows.

Our empirical results show that willingness to pay for improved water services does not depend solely on income, but equally on the characteristics of both the existing and the improved supplies. Often, income is not even the principal determinant; the percentage of income that a household is willing to pay may vary widely. The following examples illustrate the point.

- In Chihota District of Zimbabwe, where existing water sources are relatively accessible, villagers are prepared to pay less than 0.5 percent of their income for access to an improved well.
- In Parana State in southern Brazil many households will pay virtually nothing for public taps, but will pay 2 percent of their income for yard taps.
- In southern Haiti households are willing to pay only about 1 percent of their income for public taps and about 2 percent for a private connection.
- In Ukunda, Kenya, households were already paying water vendors and kiosks about 9 percent of their income.
- In Anambra State in Nigeria many households pay water vendors 10 percent of their income in the dry season.

When the income elasticities of demand for access to improved water services could be computed (this was not possible in all of the studies because of the difficulty of collecting income data), they were uniformly low—0.15 in Brazil, 0.14 in India, 0.07 in Zimbabwe, and 0.06 in Kenya. These results suggest that a 10 percent increase in household income would result in roughly a 1 percent increase in the probability that a household would choose to use the improved water system. Overall, the findings suggest that household income, although often important, is not the overriding determinant of demand for improved services.

EDUCATION. One might expect that, as levels of education increase among household members, those households would be more aware of the health benefits of improved water supplies and would thus be more likely to use improved services if they were available. If improved services were not available, one would expect that such households would be willing to pay more to obtain them than would households with lower educational levels. And because better educated households might, for a variety of reasons, have higher opportunity costs for time spent collecting water from a source outside the house, they might well be willing to pay more for improved service than would other households.

Our empirical results generally confirm that better educated households are willing to pay more for improved water supplies. The contingent valuation studies conducted in the sweetwater zone in the Punjab show that a household whose most educated member had five more years of school than a comparable household without such an educated member, was on average willing to pay about 25 percent more for a private house connection. In Nigeria five more years of education increased a household's willingness to pay for both public taps and private connections by about 50 percent. In Brazil a family in which the head of household had one to four years of education was 7 percent more likely to connect to a piped distribution system than was a family in which the head of household had no education. A family in which the head of household had completed primary education was 20 percent more likely to be connected to the system than was a family in which the head of household was uneducated. In Kerala, India, households that included adults who had finished primary school were 6 percent more likely to connect to a piped distribution system than were households in which no adult had finished primary school. Finishing middle school increased the probability of connecting by an additional 13 percent. Subsequent increases in educational level had smaller effects: finishing secondary school increased the probability of connecting by an additional 5 percent; finishing college increased the probability by another 4 percent.

GENDER. To test how the gender of the respondent influenced the household's willingness to pay for improved water services, four of the contingent valuation studies were designed to interview both male and female respondents. Because women almost universally bear the burden of collecting water, sociologists who study household water use hypothesize that women would attach more importance to improved supplies than would men and that women would therefore be willing to pay more for such improvements. But in many cultures women do not have equal control over or access to the household's cash resources. When asked how much the household would be willing to pay for an improved water supply, a woman might be reluctant or unable to commit the household to a substantial financial obligation, even though in her opinion the improved water supply would be worth the expense. In fact, therefore, it was by no means clear how gender would influence the respondent's indicated willingness to pay for improved supplies.

In all four of the contingent valuation studies that tested for this effect, the gender of the respondent proved to be a statistically significant determinant. In Tanzania and Haiti female respondents were willing to pay more for access to public taps than were male respondents, but in Nigeria and India they were not willing to pay as much. In Nigeria women were only willing to pay about

50 percent as much as men for both public taps and private connections. In other words, the gender of the respondent appears to be an important influence in households' expressed willingness to pay for improved services, but the direction of that influence depends on the specific cultural context.

OCCUPATION. The effect of occupation on households' willingness to pay for improved service was mixed. Farming families in Haiti were willing to pay less than nonfarm families for access to a public tap. In Brazil respondents employed in the formal sector were willing to pay about 15 percent more than those employed in the informal sector. In India civil servants were more likely to be connected to the water distribution system than households where no one worked for the government. In Pakistan and Nigeria our survey found no difference between farm and nonfarm households in demand for improved water services.

FAMILY SIZE AND COMPOSITION. Surprisingly, the multivariate models rarely show any significant effect of family size and composition on households' willingness to pay for or to use improved services. This was true for variables such as household size, proportion of adult women in the family, proportion of children in the family, age of respondent, religion, and work experience outside the community (for instance, whether a member of the household was working abroad).[3]

Characteristics of Existing Versus Improved Water Supplies

It is the *difference* between what people have now and what they expect to receive that affects their demand. Yet the standard policy paradigms ignore the fact that households' willingness to pay for an improved water supply depends as much on the characteristics of existing alternatives as on the characteristics of the improved water supply. Our research assessed the effects of differing costs, quality, reliability of supply, and level of service on households' demand for improved services.

COST. Basic consumer demand theory (and common sense) suggest that households would pay more for an improved supply when costs in time and money of obtaining water from existing sources are higher than if such costs were low. Our studies found strong, consistent support for a substantial influence.

- In the arid zone in the Punjab, households living near a perennial stream would pay only one-third as much for a private house connection as villagers living farther away from reliable traditional sources.
- In Haiti households' willingness to pay for a private connection increased about 40 percent if their existing water source was an additional kilometer away.
- In Kenya a 10 percent increase in the price of water from a vendor or in the time required to collect water from a community well would increase

by 2 percent the probability that a household would purchase water from a kiosk.

- In villages in both the brackish and the sweetwater zones in the Punjab, almost all households had installed a private handpump in their house or compound. Many had also installed an electric pump to draw groundwater into an overhead storage tank, which provided water for indoor plumbing facilities. Such households had effectively replicated the water services available from connection to a public system. Not surprisingly, now that they had essentially solved their water problem, these households were prepared to pay much less for connection to a public system than were households that had not already made such investments.
- In Brazil households living in water-abundant areas were, other factors aside, willing to pay 22 percent less for a private connection than households living in a dry area.

"Other factors aside" is an important qualification in all of these findings. It is not universally true that people living in water-abundant areas are willing to pay less than people without readily available alternatives, because people in water-abundant areas may have higher educational levels or higher income levels (or both), which would increase their willingness to pay. For example, people in the relatively wealthy, water-abundant region of southeastern Brazil are much more willing to pay for improved water than people in the very poor, dry areas of southern Tanzania.

Economic theory correspondingly suggests that the more an improved water source costs in capital, recurrent monetary costs, and time, the less likely a household would be to choose it. This expectation is likewise confirmed in all of our research studies. The elasticity of demand for improved sources with respect to the monthly tariff—that is, the percentage change in the probability of using the improved source as a result of a 1 percent change in the monthly tariff—is often surprisingly large for both public taps (–0.7 in Zimbabwe and –0.4 in Kenya), and private connections (–1.5 in India, –0.7 in Brazil, and –0.7 in Pakistan). Our data for Pakistan and India allow us to calculate the elasticity of demand for improved sources with respect to one-time connection costs (and fees): –0.3 in India and –0.2 in the sweetwater and –0.1 in the brackish water areas of the Punjab. These results consistently indicate that households respond to *both* monthly tariffs and one-time connection fees in the manner suggested by economic theory, and that these effects are often sizable.

PERCEIVED QUALITY. Our empirical results support the expectation that a household would be more willing to pay for an improved source when the perceived quality of the existing or an alternative water source is poor. In some cases this effect was sizable. For example, in Kerala households living in areas with saline groundwater were 30 percent more likely to use an improved water source than were households in areas with good-quality groundwater.

In the brackish water zone in the Punjab, the water obtained from private handpumps was saline and often unsuitable for drinking. In villages that lacked a piped water system, 62 percent of households had installed electric motors on their wells to draw improved quality water from deeper levels and to enjoy the convenience of having plumbing facilities in their houses. In the sweetwater zone, the comparable figure was only 30 percent.

In other locations the quality of the alternative supplies was a statistically significant determinant of households' willingness to pay for improved supplies, but the effect was not substantial. In Haiti, for example, households that rated the quality of their existing water source "poor" were willing to pay about 10 percent more for a private connection than were those that rated the quality "satisfactory" or "good." The effect was also small in Kenya.

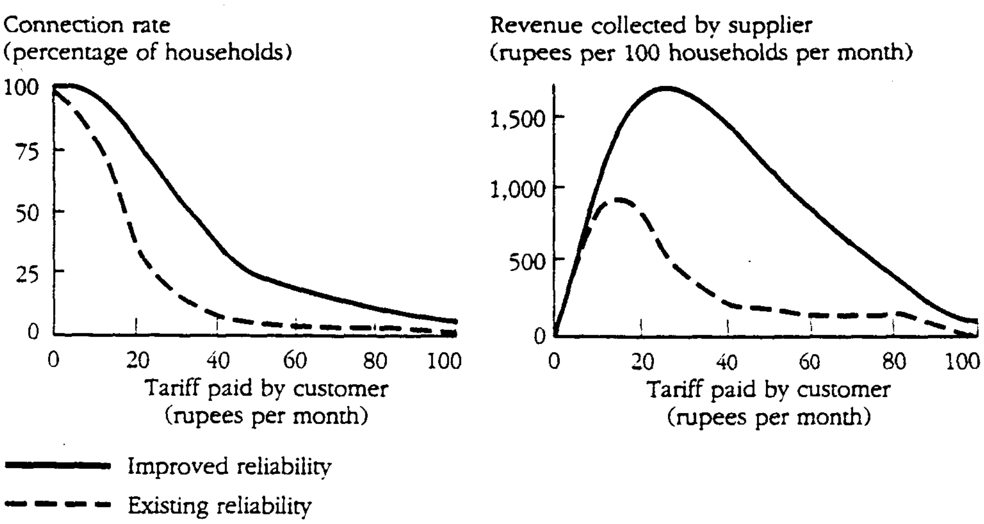
RELIABILITY. Reliability is crucial: households are typically willing to pay much more if the water from an improved source is reliable. In two of the study areas, India and Pakistan, the existing government-operated systems supplied water sporadically, usually for only a few hours each day and some days not at all. This unreliability causes considerable dissatisfaction. For example, only 17 percent of the Indian households already connected to the piped distribution system reported that they were satisfied with the system. (By contrast, 62 percent of those who were not connected said that they were satisfied with their water supply.)

In both India and Pakistan, households in villages where supplied water systems were already available were asked how much they would be willing to pay for more reliable service. The responses of households living in the brackish water area of the Punjab are illustrated in figure 1. Tariffs, the number of households connected to the system, and revenues could all be increased substantially if more reliable service were offered.

In simple terms increased reliability also means people can be less preoccupied with obtaining water and attend to other concerns. During the course of our study in Newala, Tanzania, we drove into a village about noon one day and found a queue of perhaps ten women waiting at a public tap. Because we had just come from talking to the head of the pumping station some kilometers away, we knew that no water had been delivered to this village in several weeks, so we stopped to ask the women why they were waiting at a dry public tab. They told us that they had heard a rumor that water was coming that day and had been waiting at the tap since early in the morning. But because the traditional water source was several hours away, they had to decide soon whether to wait longer or begin the trek to the traditional source. They were actually grateful that we could tell them definitively that no water would be coming that day.

LEVEL OF SERVICE. Most of the studies examined households' demand for each of two levels of improved water service: public taps in the community, and

Figure 1. *How Reliability of Supply Affects Willingness to Pay for Piped Water: Punjab, Pakistan*



private house connections (or yard taps). In almost all cases people were willing to pay far more for private connections than for access to a public tap: in Nigeria 100 percent; in the arid zone of the Punjab, 130 percent. In Brazil and India, too, households were unenthusiastic about public taps but willing to pay for private connections. Only in Haiti could the difference be considered moderate (the preference was about 25 percent higher for private connections than for a public tap). Sometimes "improved" public water sources were even perceived to be a disadvantage. In Ukunda, Kenya, some households were alarmed when our researchers began field work because it was rumored that we might install handpumps on their open public wells. Villagers were concerned that the handpumps would break down and that they would no longer be able to obtain water from these wells.

Attitudes toward Government Provision of Water Services

The study conducted in Anambra State, Nigeria, uncovered a conundrum (Whittington, Okorafor, and others 1990). Households were already spending a lot of money in the dry season purchasing water from tanker truck vendors and neighbors—an average of about $6 per month in the dry season.[4] Most households were spending 6–10 percent of their income annually buying water from vendors. Yet when asked how much they were willing to pay per month for access to a public tap or a private connection to a piped distribution system, they indicated amounts significantly *less* than they were already paying vendors. For example, 30 percent of those surveyed were already paying vendors or neighbors about $7 per month in the dry season, but only 2 percent said that they would be willing to pay $7 per month for a private connection.

One reason for this seeming inconsistency was that many respondents felt that they were entitled to free or subsidized water and that it was the government's responsibility to provide their village with a new water system. Respondents who preferred to "wait for the government to help" were willing to pay 30 percent less than similar individuals who had a less sanguine view of the government's abilities. This issue—the effect of households' sense of entitlement to improved services on their indicated willingness to pay—arose in other studies as well. In newly independent Zimbabwe, for example, the government had made promises to rural people during the war of liberation. As a result, the vast majority of rural households now consider provision of clean water to be a fundamental government responsibility (Robinson 1988).

In countries with longer histories of independence and more experience with broken promises, people were often deeply cynical about the government's ability to deliver free water service of reasonable quality. These doubts were manifested in many ways. In one study site in Kerala, households were asked whether they would connect to a piped system that they were told was to be commissioned. Many respondents pointed out that pipes had actually been laid as part of an "emergency drought relief scheme" more than ten years previously but had never been operational. When informed of the authorities' commitment to commission a new water scheme, they told the enumerators that the only thing that was coming was an election, not water.

In the Punjab, households who lived in villages that already had piped water systems were extremely skeptical when asked about their willingness to pay for a more reliable system and bid less for such a system than households who lived in villages that had not had a bad experience.

In Tanzania "free water" had been a major promise of the new government upon independence, but after three decades of experience, more than half of the households surveyed in Newala District now felt that the government should *not* be responsible for providing free water. Households that had given up on the promises of free water were willing to pay 20 percent more than those who still believed it was the government's responsibility. Indeed, in the 1950s and 1960s under the British administration the operation and maintenance expenses of the old water system in the Newala District (the Makonde scheme) had been financed by a system of kiosks that sold water to individuals by the bucket. Typically each village had one kiosk, which was staffed by an attendant who sat inside and controlled the tap. This system of paying for water by the bucket was abolished in 1969. Since then water has been provided free but is highly unreliable, partly because of a shortage of operating funds. The abandoned kiosks still found in the center of most villages serve as a vivid reminder of how the old cost recovery system used to work. Many older people volunteered the opinion that the old system of paying for water by the bucket worked better than the current system, and they wished they could have it back again.

Despite their skepticism about government promises, many respondents still felt that they were entitled to free or subsidized water. Some contended that they already paid taxes that should be used to pay for improved water services and that there was no need to pay more. Others knew of nearby towns or communities where improved water services were provided at subsidized prices and felt that it would not be fair for their village to pay more than was being charged elsewhere. Finally, some households simply felt that it was worth the gamble to wait longer to see if government delivery materialized (or improved), rather than to pay realistic prices for water now.

Where respondents' answers to contingent valuation questions were influenced by their sense of entitlement to free government service, the questions evidently failed to elicit the "true" economic value of water to the household. But the findings reveal something equally important for policy: that the sense of entitlement and equity of many households may be a significant obstacle to charging realistic prices for water. We do not mean, however, to suggest that attitudes are fixed and inviolate. Indeed, our findings indicate that in many countries citizens are now wrestling with the question of the proper role for government in the rural water sector and that public opinion is changing.

Policy Implications: Four Types of Villages

The study addresses two questions that are critical in guiding policy for the rural water sector: What sorts of improved services, if any, should be provided in a particular village or region, and how should these improved services be paid for? The study revealed some consistencies in the ways villagers choose their water sources and in the amounts they are willing to pay for improvements. These consistencies suggest a simple classification scheme that may help policymakers answer those questions.

The classification is not meant to imply that communities can always be fit into neat, rigid categories. Nor is it meant to be used ex ante to enable planners to categorize villages and prescribe appropriate policies. Rather, the typology is intended to stimulate more careful thinking about the choice of appropriate policies.

Type I: High Willingness to Pay for Private Connections; Low Willingness to Pay for Public Taps

Type I villages are those in which most households' willingness to pay for reliable private connections is high relative to the costs of supply, and willingness to pay for public taps is low. Many more communities fall within this category than is commonly assumed. In one village in Nigeria, we received an unusual indication that the demand for private connections was high. Upon arriving we paid a visit to the local chief to ask his permission to interview selected households. We explained that we wanted to know how much people were willing to pay for private water connections. The chief indicated that the community was desperate for a new water system and that the survey was not necessary. He proposed to write us a check immediately for a substantial portion of the capital costs if we would sign a contract guaranteeing that the improved water system would be installed. He proceeded to pull out a check book from a European bank and was visibly disappointed when we explained that we simply wanted to conduct research and could not accept his check.

In our study, type I villages include those in Kerala, the irrigated areas of the Punjab, and both northeastern and southeastern Brazil. In general, most of the large rural communities in Southeast Asia, South Asia, Central and Latin America, and North Africa probably fall in this category. In these communities a large proportion of rural people want and are willing to pay substantial amounts for private connections; there is little reason they should not have them. Often, poor government policies are to blame for the failure to meet this demand. In both of the South Asia studies, the policy problems centered around the poor reliability of the existing piped distribution system.

The situation in the irrigated areas of the Punjab illustrates the problem. Here, government-financed water systems have been designed to accommodate an estimated water use of 40 liters a day per person, and private connections are not metered. This estimate is much too low when the marginal price of water to the household is zero, partly because humans are not the only users of water from the piped system. Many households in the villages we studied own animals that live in the family compounds. Water buffalos in particular need large amounts of water to stay cool. Traditionally they were taken to ponds outside the villages to cool off and drink—a time-consuming activity. When a piped system is installed in a village, most people find it more convenient simply to hose down their water buffalos in the street outside their houses.

In addition to watering animals, households find many other uses for water when it is available at zero marginal cost. This high demand for water in a hot, arid climate, coupled with the low capacity of the system, means that water must be rationed by curtailing service.

Thus the water utility and the community are caught in a kind of "low-level equilibrium trap" (Singh and others 1992). Because water connections are not metered, people demand more water than the system can provide. To ration supplies, the water authority reduces the number of hours of service. Because the systems are unreliable, people are not willing to pay much for the service. Because households are not willing to pay, the water authority cannot charge realistic prices and does not collect sufficient revenues to manage the system properly, and reliability deteriorates further.

The way out of this trap is to install meters and charge higher prices for water. This will enable the water authority to collect the higher revenues required to improve service and move to a "high-level equilibrium." The key point to recognize is that household demand for water is affected by the price charged. If the marginal price to the household is very low (or zero), a household will use water for too many low-value purposes—particularly in arid areas.

The situation in Kerala provides a different example of a low-level equilibrium trap in type I villages (Singh and others 1992). Here the Indian government follows the "some for all, rather than more for some" rule. To obtain central government funding, local water authorities must provide distribution systems that offer only public taps; no private connections are allowed. Fortunately the operators of such systems are inventive and responsive to local demands: after systems are commissioned, private, metered connections are permitted.

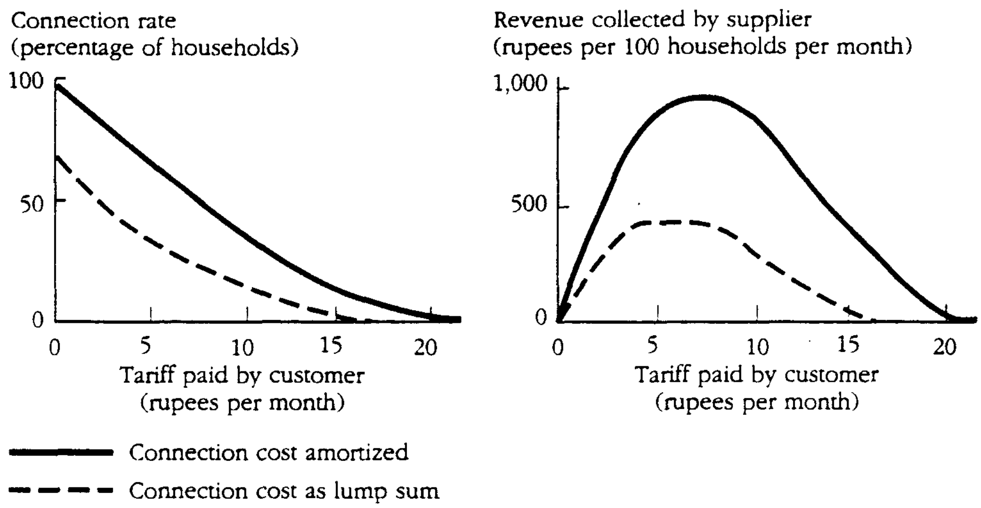
The result is totally perverse. Tariffs are much lower than people are willing to pay, and the number of connections is much smaller than would have been possible if higher tariffs were charged. The revenues collected by the water authorities are only a small fraction of the potential, and the system is so unreliable that households almost never use the public taps.

As in Pakistan, the way to break out of this trap is to abandon the supply-driven policy of "some for all" and replace it with a demand-driven philosophy that recognizes that many people want a higher level of service, and that they are prepared to pay a lot for it. Households' welfare gains in changing from the current policy (low tariffs with few private connections) to a new policy (higher tariffs and more private connections) can be huge. Our results (Singh and others 1992) for Kerala suggest that this policy change would increase the number of families benefiting from house connections by a factor of ten, increase the consumer surplus by a factor of five, and increase the water authority's revenues by a factor of eight.

In Brazil, by contrast, government policy is appropriately designed to encourage households to connect to the water distribution system. The principal problem is that, despite households' high willingness to pay for water, the water systems are subsidized. Water is very cheap, but no funds are available to expand and improve the system. Here the policy implications are simple and direct: increase tariffs and use the increased revenues to improve system efficiency and reliability.

Two additional key issues affect policy for many type I communities. First, in many places the real cost of credit to households is very high; in such circumstances initial connection costs and fees can be a serious barrier to connecting to a piped distribution system. Households stand to obtain large welfare gains if the water authority has access to lower-cost funds, finances the connection costs, and recovers them through higher monthly water charges. This policy is routinely followed in Latin America, with much success. Figure 2 shows that if such a policy were followed in Kerala, both the number of households connected to the system and the revenues collected could be approximately doubled.

Figure 2. *How Spreading Connection Costs over Time Affects Willingness to Pay for Piped Water: Kerala, India*



Second, in type I communities the needs of the poor can be met by providing free water at public taps without jeopardizing the financial health of the water authority. Providing free water from public taps will not materially affect the number of households connecting to the system or the revenues that can be collected by the water authority. (This would be true whether the private connections were metered or not.) The question of how availability of free public taps might affect the demand for private connections (or yard taps) was explicitly investigated in Brazil and India. In Brazil we found that the presence of free public taps did not dampen the demand for yard taps at all. In Kerala households that could choose between a free public tap and a metered private connection almost never chose the free tap (only about 2 percent of the time in areas where water was scarce or saline; never in water-abundant areas). In the irrigated areas of the Punjab, interest in free public taps was so low that it was decided not even to ask households about their willingness to pay for them.

Type II: A Few Will Pay the Full Costs of Private Connections; the Majority Will Pay the Full Costs of Public Taps

Households in type II communities are willing to pay for improved water services, but they vary substantially in what they are prepared to pay for different levels of service. Only a minority will pay the full costs of a private connection, but the majority will generally pay the full costs for access to water from public taps. The villages in Anambra State, Nigeria, and many of the better-off communities elsewhere in Africa and the poorer communities in Asia and Latin America would appear to fit into this category.

The mechanism used to charge for water is a key issue in type II communities. In contrast to type I communities, the provision of free public taps may significantly reduce the demand for private connections. And because the majority of the population will rely on public taps, some charge must be levied for water from the public taps for the water system to be financially viable.

At any given price for private connections, a decrease in the price of water from public taps will reduce the number of households that opt for a private connection. Similarly, for a given price for public tap water, an increase in the price of private connections will increase the number of households that choose to use the public taps. The tariff structure for a system of public taps and a limited number of private connections must be carefully designed so that households have the right incentives to choose appropriate levels of service.

Opportunities abound for policy errors in type II villages. A classic example is the common policy of providing unmetered private connections to a few households, charging them a fixed monthly fee. In type II villages this is a sure recipe for system failure. If a water authority provides unmetered private connections to a few, these households can then provide water at essentially zero marginal cost to unconnected households. This presents the connected households with a strong financial incentive to sell water to unconnected households. One common arrangement is for connected households to charge unconnected households a fixed monthly fee for unlimited access to water from their tap—an arrangement that will undercut virtually any per-bucket price charged for water at public taps. Soon all households in a community may enjoy essentially a zero marginal price for water, and too much water will be demanded. Supply will be rationed by reduced reliability, the quality of service will decline for everyone, and cost recovery will become impossible—the "low-level equilibrium trap" in yet another guise.

A more appropriate policy is to establish a system of public kiosks that charge for water by the bucket. Prices should be set to cover the full costs of the system. Households should have the option of obtaining a private metered connection if they will pay the full costs of supply. If the water authority operates the public kiosks, the prices there should cover the costs of staff and operating expenses. The price charged to connected households should not be designed to discourage private sales: if private connections are metered, the water authority will receive its revenues regardless, and households can buy and sell water among themselves at their convenience. An alternative is to privatize the kiosks, in effect making little distinction between connections for private use and connections for resale.

The key to the success of both public and private kiosk systems in type II villages is to ensure that any household that desires a private, metered connection can always obtain one if it is willing to pay the full costs.[5] Providing this option is important for several reasons. The first is practical. In most type II villages there is a group of influential people who will want and press for private connections or yard taps. If such connections are not officially sanctioned, many of these people will obtain them illegally anyway, and the water authority will not collect any revenues from households that would otherwise be among its best customers.

Second, rural areas of developing countries are not static economic entities. Many type II communities are in the process of evolving into type I communities. Water supply policies should be structured to assist, not hinder, this transition. Water systems should be designed so that evolution from primarily public taps to primarily private connections can occur conveniently and efficiently. Third, so that households already connected to the system cannot take advantage of their position, all households should have the option of a private connection to the distribution system if they are willing to pay the full costs of supply (Lovei and Whittington 1991). The universal option of connecting provides a powerful deterrent to monopoly pricing by connected households or privately owned kiosks.

Type III: Households Are Willing to Pay for Improved Service, But Improvement Is Very Costly

From a demand perspective, type III communities are similar to type II communities: in both cases a relatively high proportion of the population is willing to pay a considerable amount for water from public taps. The difference is on the cost side. In type II villages sufficient revenues can be collected from households to pay for the full costs of the public taps. In type III villages the costs of the improved water system are higher than the beneficiaries are willing to pay. Costs may be high because of aridity, low population densities, or lack of other infrastructure (for instance, electricity). In such cases improved systems cannot be built and operated without subsidies. Type III villages are often found in arid areas. Examples in our research include villages in Newala District, Tanzania, and Rawalpindi, Pakistan (a nonirrigated area in the Punjab).

In type III communities many households typically spend a great deal of time and energy collecting water from traditional sources and, unless improved sources are provided, will continue to do so. Households that collect water from distant, polluted, unreliable sources are almost always willing to pay a substantial portion of their income to avoid hauling water over long distances. In the Tanzania study members of most households were walking five to six hours a day to collect small amounts of water from traditional sources or unreliable public taps. Households on average were willing to pay about 6 to 8 percent of their cash income for reliable service from public taps in their village. But 6 to 8 percent of a household's income in this poverty-stricken region is not very much money in absolute terms—nothing like enough to pay the full costs of supply.

Household contributions could cover about 50 percent of the operation and maintenance costs. Virtually no one was willing to pay the full costs of a private connection.

In the poor type III communities in the dry Rawalpindi District, the situation was somewhat more complex. Here a few families were willing to pay considerable amounts for private connections, and the costs of providing a private connection were not substantially greater than providing access to a public tap (on a per household basis). Most households, however, could not pay the full costs of either level of service.

Devising an appropriate policy for type III villages is not simple. The dominant level of service must be public taps; as in type II communities, cost recovery mechanisms that allow households to pay by the bucket have important advantages over schemes that require households to pay a fixed monthly fee. Yet the few households that are willing to pay the full costs of a private connection should be allowed that option. Metering of all private connections is essential, and the tariff structure must be carefully coordinated with that used by the kiosk system. As in type II communities the tariff structure and other water regulations should be designed, not to discourage connected households from selling water to neighbors, but to discourage them from profiting unduly from their connections.

On the financing side, neither the "full cost recovery" policy recommended for type I and II communities nor the supply-driven, "basic needs" policy that provides free service is suitable for type III communities. An appropriate policy response would recognize, first, that the sum of the outside resources available to such communities from both internal and external sources is insufficient to meet the long list of their needs and, second, that households' needs will be best met if they are able to allocate their limited resources to the projects they consider most important. The point here is not that such communities should not receive transfers from others, but that these transfers should be designed so that they do not distort the community's choice process. In other words, outside agencies and donors should not take it upon themselves to decide which projects (such as water) are of highest priority for communities: if subsidized development funds are available, communities should themselves allocate such funds to the needs they deem most important. In type III villages household demand for improved water services is high, and given a choice, many communities would in fact decide to spend development funds on improved water services. The essential points are that, even where subsidies are used for water supply, any rural water program must be demand-driven and that a considerable portion of the resources must be mobilized from the beneficiaries.

Type IV: Low Willingness to Pay for Improved Water Service

In type IV villages most households are unwilling to pay for improved water services. Communities in central Zimbabwe are examples of villages in this category. In these villages it is not feasible to recover the costs of either public taps or private connections. But the problem is quite different from the high benefit, high cost situation in type III communities. In Zimbabwe the fundamental problem is that people would pay very little for improved services *both* in absolute terms and as a proportion of income.

In these areas there simply are no financially viable options for improving rural water supply at this time. Providing improved supplies is not likely to induce substantial changes in economic activity or dynamic multiplier effects, as it would in type III communities. The challenge is how to respond to this dilemma. The dominant response of many donors and governments in the past has been to step in and subsidize. But the resulting supply-driven programs have been a dismal failure. Many systems provided under such programs have fallen into disrepair, and no one in those communities cares much about making them operational.

In our view, the appropriate policy response in such situations is to recognize that the people of the community are in the best position to decide how available subsidies should be used. Improved water services are not a high priority in type IV communities. They have other, more pressing needs for roads, schools, and clinics. If subsidies became available, households would typically choose to spend them on something other than improved water services. The conclusion, unpalatable as it may be to some, would be to defer improvements in water supply until they are wanted and to concentrate the available resources on higher-priority needs.

Toward a New Paradigm

The challenge in formulating rural water supply policies is simple to state: devise institutional arrangements that are effective in providing people with the services that they want and for which they are willing to pay. This study does not address the critical institutional questions (which relate to the respective roles of public agencies, the private sector, nongovernment organizations, and the users themselves), but it does shed light on the levels of service and the financing arrangements that will emerge from a demand-driven approach.

Selection of the type of service to be provided, and the associated tariffs to be charged, is a two-step process. The first step involves collecting data on demand so that a menu of level of service and financing options can be devised that is both feasible and sensible in the particular setting. The second step involves households choosing a particular level of service (at a prescribed tariff). It is important to emphasize that, wherever possible, households must be given choices (between, say, a house connection and a public tap) and that such choices should remain open over time (so that, for example, a household that initially chooses to use a public tap can later upgrade to a house connection).

In this context, how are planners to collect information on demand, and how can they know what combinations of level of service and financing arrangements might be appropriate in a particular area?

Finding the Indicators

In general, detailed household surveys of the type conducted under our research program are necessary for defining the menu of feasible and sensible options from which households can choose. Rigorous procedures for sampling villages in regions, and households in villages, will enable planners to study fewer villages and interview fewer households and generalize their findings with more confidence. Still, in most countries a substantial effort to collect data will be required to categorize villages along the lines suggested above and to adapt policies to fit local realities.

There is, however, an exception to our general call for expanded data collection. A great deal can often be learned about local water conditions from surveys of water-vending activities, which are much easier and faster to carry out than are large-scale contingent valuation surveys of households' willingness to pay. Where water vending is prevalent, demand for improved water services almost certainly is high. Communities with substantial water-vending activities are thus not type IV villages.

If the majority of households in a community are buying water from private vendors, then it is not likely to be a type III village either. If most households can afford water from vendors, they should generally be able to pay for the full costs of private connections, even in arid areas with high costs of supply.

The extent of water-vending activities can sometimes also be used to distinguish between type I and type II villages. If most households buy water from vendors *throughout the year*, this probably indicates a type I village; if water vending is prevalent but tends to be *seasonal*, then demand for vended water is likely to be lower, an indication of a type II village. In these type II villages, households seek alternatives to purchasing water from vendors because the price of vended water is so high. A substantial minority—or even a majority— will buy some water from vendors but may also collect some water from traditional sources; other households collect all their water from traditional sources. In the rainy season most households stop buying from vendors and collect rainwater and water from traditional sources (as in Anambra State, Nigeria).

The absence of water vending can be an important indicator for water resource planners, but it must be interpreted carefully. Prolific water vending is but one indication of high willingness to pay. If households have already invested substantial amounts of capital in improving their private water supply, they may have little need for water from private vendors. For example, in the irrigated areas of the Punjab, almost all households have installed private handpumps; in southeastern Brazil most households have invested in private wells. In the Newala District of Tanzania, one third of the households in our sample had gone to the considerable expense of building rainwater collection tanks. Although such capital investments indicate a high demand for water, they may also dramatically improve households' water supply and thus reduce willingness to pay for further improvements in the short run.

Another indicator of high willingness to pay for water is a large amount of time spent collecting water. In this case households are making substantial efforts to obtain water, but, unlike the situation where households have made capital investments, collection costs can be *immediately* reduced by installing an improved water system. Willingness to pay for improved water is very likely to be high, and thus villages without vending, but where members of households are walking long distances to collect water, are not type IV villages.

If there is no water vending and no evidence that households have invested in private capital improvements or spend substantial effort collecting water, then such villages are likely to be type IV communities. The absence of water vending itself is not sufficient to identify type IV communities, but if such communities are candidates for improved water supplies, it should give water resource planners pause. If the benefits of improved water services are great, why hasn't the private sector found this market? The answer may be that household demand for improved services is not as great as assumed.

Formulating Policy

If planners and donors are willing to spend the time and resources necessary to understand local water demand and supply better, the outlines of a new formula for rural water supply policies can be discerned. In this new paradigm the appropriate policies would be different in each of the four different types of communities.

Type I communities offer exciting possibilities. Here most people want, and are willing to pay the full costs of, reliable water service delivered through private, metered connections (or yard taps). In such communities the objective should be to abandon the low-level equilibrium trap—the cycle of poor service, low willingness to pay, little revenue, and low reliability—in favor of a high-level equilibrium—private connections, high willingness to pay, and high reliability. Although water would be available free from public taps, this strategy would substantially increase the proportion of the population using private connections, the welfare gains to households, and the revenues to the water authority: everyone wins.

Type II communities also offer opportunities for achieving both improved water services and full cost recovery. In such villages the dominant service level would be public taps, although households would always have the option of a metered private connection if they were willing to pay the full costs of service. In these communities the greatest challenge is to devise systems for collecting revenue that are sensitive to people's preferences about when they want to buy water and how they want to pay for it. Kiosks appear to be an attractive option, because many households want more flexibility and control over their expenditures on water than is available from a cost recovery system based on fixed monthly fees that must be paid throughout the year. In most type II communities unmetered private connections will result in poor service and prevent full cost recovery.

In type III communities the benefits of improved water services are high—people will pay a significant proportion of their income for improvement—but the costs of supply are even higher. In such communities improving water services is a priority, and households would typically choose to use available subsidies for the purpose. The appropriate service level for most households would be public taps, but the water authority should permit any households that are prepared to pay the full costs of a private, metered connection to have one. As in type II communities, unmetered private connections will create problems for the water authority and the community and should be avoided.

Finally, in type IV communities people are unwilling to pay for any type of improved water service. In such places any available subsidies could be better used to provide other community services—and for the time being, the appropriate rural water supply policy is simply to do nothing.

Notes

The principal members of the World Bank Water Demand Research Team are John Briscoe (World Bank), Dale Whittington (University of North Carolina at Chapel Hill, United States), Mir Anjum Altaf (Applied Economics Research Centre, Karachi, Pakistan), Paulo Furtado de Castro (Institute of Social and Economic Planning, Brazil), Charles Griffin (University of Oregon, United States), Apia Okorafor and Augustine Okore (University of Nigeria, Nsukka), Bhanwar Singh and Radhika Ramasubban (Centre for Social and Technological Change, Bombay, India), Peter Robinson (ZIMCONSULT, Zimbabwe), and V. Kerry Smith (North Carolina State University, United States). Financial support for the study was provided by the Danish Agency for International Development, the Norwegian Agency for International Development, the Swiss Development Corporation, the United Nations Development Programme, the United States Agency for International Development, and the World Bank.

1. Publications resulting from the work of this research program are listed in the bibliography; some but not all of these publications are cited in the text.

2. Multivariate models were estimated with the data from both types of villages. Data from the type A villages were used to estimate probit and logit models of households' decisions to use the improved system (see, for example, Briscoe and others 1990; Altaf, Jamal, and Whittington 1992; Altaf and others 1991; and Singh and others forthcoming). Data from the type B villages were used to estimate ordinary least squares, ordered probit, multinomial logit, and tobit models of the determinants of households' responses to contingent valuation questions (see, for example, Whittington and others 1989; Whittington and others 1990; Altaf, Jamal, and Whittington 1992; Whittington and others 1992). In specific instances other models were also estimated (for example, switching regressions in India, and duration models in Pakistan).

3. These results may be partially explained by the fact that, conceptually, family size enters the household's utility function in two places: in the benefits derived from the improved source and in the costs of obtaining water from the existing source. The larger the household, the more water it needs in total (although perhaps the less it needs per person). This would imply that a household's benefits (or willingness to pay) for a piped connection would increase as family size increases. On the other hand, in most rural communities it is women and children who fetch water from sources outside the home, and the larger the number of women and children in a household, the more time (labor) the household unit has to collect water. The value of labor to a household probably goes down as the supply of labor goes up—and thus the value of a private connection decreases. Our models are unable to distinguish between these two effects.

4. Dollars ($) are U.S. dollars throughout.

5. The purchase price of a water meter in many places in developing countries is on the order of $35–$40. Installation costs vary but are roughly equivalent to the purchase price of the meter. The full costs of using meters, however, must include reading and repairing the meters and the use of more complex billing and financial systems.

References

The word "processed" describes informally reproduced works that may not be commonly available through libraries.

Altaf, M. Anjum, Haroon Jamal, J. L. Liu, V. Kerry Smith, and Dale Whittington. 1991. "A Random Utility Model for Connections to Public Water Systems in Developing Countries: A Case Study of the Punjab, Pakistan." World Bank, Infrastructure and Urban Development Department, Washington, D.C. Processed.

Altaf, M. Anjum, Haroon Jamal, and Dale Whittington. 1992. *Willingness to Pay for Water in Rural Punjab, Pakistan.* UNDP/World Bank Water and Sanitation Program Report Series 4. Washington, D.C.

Altaf, M. Anjum, Dale Whittington, V. Kerry Smith, and Haroon Jamal. Forthcoming. "Rethinking Rural Water Policy in the Punjab, Pakistan." *Water Resources Research.*

Briscoe, John, Paulo F. de Castro, Charles Griffin, J. North, and O. Olsen. 1990. "Toward Equitable and Sustainable Rural Water Supplies: A Contingent Valuation Study in Brazil." *World Bank Economic Review* 4, no. 2: 115–34.

Briscoe, John, and David de Ferranti. 1988. *Water for Rural Communities: Helping People Help Themselves.* Washington, D.C: World Bank.

Lovei, Laszlo, and Dale Whittington. 1991. "Rent-seeking in the Water Supply Sector: A Case Study of Jakarta, Indonesia." Infrastructure and Urban Development Discussion Paper 85. World Bank, Washington D.C. Processed.

MacRae, D., Jr., and Dale Whittington. 1988. "Assessing Preferences in Cost-Benefit Analysis: Reflections on Rural Water Supply in Haiti." *Journal of Policy Analysis and Management* 7, no. 2: 246–63.

Mu, Xinming, Dale Whittington, and John Briscoe. 1990. "Modeling Village Water Demand Behavior: A Discrete Choice Approach." *Water Resources Research* 26, no. 4: 521–29.

Ramasubban, Radhika, and Bhanwar Singh. 1989. "The Efficiency of Improved Supply System in Meeting Rural Waste Demand for Domestic Needs: Evidence from Northern Kerala." Centre for Social and Technological Change, Bombay. Processed.

Robinson, Peter. 1988. "Willingness to Pay for Rural Water: The Zimbabwe Case Study." ZIMCONSULT, Harare. Processed.

Schneider, M. L., and E. E. Whitlach. 1991. "User-Specific Water Demand Elasticities." *Journal of Water Resources Planning and Management* 117, no. 1: 52–73.

Singh, Bhanwar, Radhika Ramasubban, Ramesh Bhatia, John Briscoe, Charles Griffin, and C. Kim. Forthcoming. "Rural Water Supply in Kerala, India: How to Emerge from a Low-level Equilibrium Trap." *Water Resources Research.*

Whittington, Dale. 1992. "Possible Adverse Effects of Increasing Block Tariffs in Developing Countries." *Economic Development and Cultural Change* 41, no. 1: 75–87.

Whittington, Dale, John Briscoe, Xinming Mu, and W. Barron. 1990. "Estimating the Willingness to Pay for Water Services in Developing Countries: A Case Study of the Contingent Valuation Method in Southern Haiti." *Economic Development and Cultural Change* 38, no. 2 (January): 293–311.

Whittington, Dale, Donald T. Lauria, and Xinming Mu. 1991. "A Study of Water Vending and Willingness to Pay for Water in Onitsha, Nigeria." *World Development* 19, no. 2/3: 179–98.

Whittington, Dale, Donald T. Lauria, Daniel A. Okun, and Zinming Wu. 1989. "Water Vending Activities in Developing Countries: A Case Study of Ukunda, Kenya." *International Journal of Water Resources Development* 5, no. 3: 158–68.

Whittington, Dale, Xinming Mu, and Robert Roche. 1990. "Calculating the Value of Time Spent Collecting Water: Some Estimates for Ukunda, Kenya. *World Development* 18, no. 2 (February): 269–80.

Whittington, Dale, M. Mujwahuzi, G. McMahon, and Kingakim Choe. 1989. *Willingness to Pay for Water in Newala District, Tanzania: Strategies for Cost Recovery* WASH Field Report 246. Water and Sanitation for Health Project, Washington, D.C.

Whittington, Dale, Apia Okorafor, Augustine Okore, and A. McPhail. 1990. "Strategy for Cost Recovery in the Rural Water Sector: A Case Study of Nsukka District, Anambra State, Nigeria." *Water Resources Research* 26, no. 9: 1899–1913.

Whittington, Dale, V. Kerry Smith, Apia Okorafor, Augustine Okore, J. L. Liu, and A. McPhail. 1992. "Giving Respondents Time to Think in Contingent Valuation Studies." *Journal of Environmental Economics and Management* 22 (May): 205–25.

World Bank Water Demand Research Team. Forthcoming. "How Reliable Are Contingent Valuation Studies in Developing Countries? Evidence from a Multi-Country Study." World Bank, Infrastructure and Urban Development Department, Washington D.C. Processed.