GLOBALIZATION AND WATER RESOURCES MANAGEMENT:
THE CHANGING VALUE OF WATER

AUGUST 6-8 AWRA/IWLRI-UNIVERSITY OF DUNDEE INTERNATIONAL SPECIALTY CONFERENCE 2001

VALUING WATER IN RURAL PUERTO RICO

H A Minnigh and Graciela I. Ramírez Toro[1]

ABSTRACT: The majority of Puerto Ricans, about 92%, is served potable water by an island-wide authority, the Autoridad de Acueductos y Alcantarillados (AAA). The remainder is largely served by small, private systems ranging in size from 2 to about 500 homes and most of these are in rural areas. Of these latter, those that fall within the EPA standard for community systems are subject to the same regulations and standards as the AAA. Relative charges for water are presented for some of these private systems and compared with AAA charges and approximate costs of production. In addition, the results of a questionnaire are presented. The questionnaire was administered to some 373 families in 23 systems and was intended, in part, to elicit the value users placed on their potable water and their understanding of the physical and management facets of maintaining that system.
KEYWORDS: Value of water, social valuation of water

INTRODUCTION

One of the first efforts of the autonomous island government in Puerto Rico was to complete a monumental task begun in the 1940's in the period of transition to the Commonwealth -- the provision of reliable potable water to its citizenry. Chief among the administrative steps to ensure that end, though later in implementation, was the creation of the Autoridad de Acueductos y Alcantarillados (AAA), the vehicle that owns and administers the vast majority of the island's water plants. The Authority also provides sewer service to most urban areas on the island, though this service is not the object of this study. Most Puerto Ricans still believe that the Authority provides water to all citizens. In fact, between 3 and 7% of the island's residents are served wholly or in part by a panoply of systems ranging from 1-cm lines shoved into a puddle backed-up behind a pile of rocks in a rivulet to conventional filter plants with streaming-current control of coagulant addition and miles of ductile-iron main.

Since many of these systems (non-AAA systems) are of a size to qualify as community water supplies, they fall under the Safe Drinking Water Act (SDWA) and are required to meet most of the same regulations as the Authority systems. The Puerto Rican government has been under some pressure to bring these small systems into compliance with SDWA. The government's policy has been, until very recently, to force users in these systems to connect to AAA sources, a neat trick in many cases, where there are no AAA systems or, just as likely, the available AAA system seldom or never carries any water (DOH, 1996). As part of efforts to educate these users and help bring these small systems into compliance, CECIA and RHI administered a didactic questionnaire designed to educe some of the importance of operating and maintaining a potable water system in compliance with accepted norms and applicable regulations. The communities, number of services and responses are presented at Table 1.

RELATIVE COSTS OF WATER

Consumer Costs of Water

Small private systems in Puerto Rico do not normally have any meters, nor do they charge based on passive measures of potential water use (use points, toilets, household members, etc.). Most commonly there is a monthly charge that varies in our experience from $3 to $20 per month, with the median between $5 and $10 per month. For our sample, the median is

[1] Respectively, RHI, The Northeast RCAP, PO Box 48, Lajas, PR 00667 and CECIA, Interamerican University of Puerto Rico, Edif. A. Lluveras, Recinto San Germán, San Germán, PR 00683.

$10 per month (1st quartile $5, 3rd =$12 and 95th percentile = $14.95) and the mean is $8.59. AAA charges are, for most residential users, $0.65/m^3, or about $0.0025/gal.

Table 1. Systems with questionnaire results

System Name	Municipality	Responses	Services	Percent response
PAJITAS FALCÓN	Aguas Buenas	2	51	3.9%
COMUNIDAD HATILLO	Añasco	21	70	30.0%
NARANJO	Añasco	41	41	100.0%
PIÑALES ARRIBA	Añasco	9	60	15.0%
QUEBRADILLAS 13 FARALLÓN	Barranquitas	6	368	1.6%
LOS VELAZQUEZ	Caguas	5	82	6.1%
PARCELAS NUEVAS CANABONCITO	Caguas	18	140	12.9%
SECTOR LOZADA Y POZO DULCE, INC	Caguas	37	200	18.5%
SECTOR PEPE HOYOS	Cayey	7	60	11.7%
ALMIRANTE	Cidra	16	60	26.7%
PELEGRIN SANTO	Cidra	8	80	10.0%
JUAN DIEGO	Fajardo	8	35	22.9%
ACUED. COM. MAGUEYES	Lares	15	26	57.7%
COM. LAS CUARENTA	Lares	20	54	37.0%
VEGA ACEVEDO	Lares	31	90	34.4%
BO. MONTE LLANOS	Ponce	3	115	2.6%
COLLADO	Ponce	3	120	2.5%
LA CUCHILLA II	Ponce	39	126	31.0%
RIO CHIQUITO	Ponce	30	70	42.9%
QUEMADOS	San Lorenzo	11	76	14.5%
ACUD. RURAL GUACIO, INC.	San Sebastian	28	80	35.0%
LA ESTANCITA BO. RONCADOR	Utuado	9	60	15.0%
ACEITUNA II	Villalba	6	27	22.2%
		373	2,091	17.8%

For small systems, using estimates of use based on the experience of many observers with systems on the Island and on minimum household use estimates required by funding agencies for average household use in place of meter readings, we can estimate unit charges. Most observers agree that about 70-80 gallons per day (gpd) represents the average household use for most of these rural systems. Rural Utility Services, the division of the US Department of Agriculture's Rural Development program that provides loans and grants for construction of small water systems and components, requires a minimum of 150 gpd for projects submitted for funding. Table 2 presents those unit costs for our sample and a single system with meters and a minimum charge, while Table 3 presents those costs for all systems reporting monthly charges in the EPA inventory in 1997 and for all systems from the municipalities surveyed from the same data set.

Table 2. Unit costs for water from systems surveyed.
(23 systems, 302 respondents)

	Charges	Charges per gallon at stated usage	
	Per month	80 gpd	150 gpd
Median	$11.00	$0.0046	$0.0024
Average	$10.68	$0.0045	$0.0024
Minimum	$3.33	$0.0014	$0.0007
Maximum	$18.00	$0.0075	$0.0040
		20 m^3/month = 176 gpd	
Metered system, Minimum	$20.00 (for 20 m^3)	$0.0038	

Note: Respondents occasionally reported multiples of the monthly cost, usually because water bills were paid on a frequency other than monthly or because a respondent was paying more than one water bill.

Table 3. Unit costs for water from all systems reporting and from municipalities with systems surveyed

	Charges	Charges per gallon at stated usage	
	All Systems (78)		
	Per month	80 gpd	150 gpd
Median	$5.50	$0.0023	$0.0012
Average	$6.69	$0.0028	$0.0015
Minimum	$1.00	$0.0004	$0.0002
Maximum	$20.00	$0.0083	$0.0044
	All systems in municipalities surveyed (36)		
Median	$7.00	$0.0029	$0.0016
Average	$7.12	$0.0030	$0.0016
Minimum	$1.00	$0.0004	$0.0002
Maximum	$15.00	$0.0063	$0.0033
	All systems reporting having charges <$5.01/month (39)		
Median	$4.00	$0.0017	$0.0009
Average	$3.76	$0.0016	$0.0008
Minimum	$1.00	$0.0004	$0.0002
Maximum	$5.00	$0.0021	$0.0011

It is apparent from Table 2 that our surveyed systems generally pay more than AAA users. In addition, for all systems only the median, minimal-usage case charges less than AAA. The major source of uncertainty here is the quantity of water used; many households use in excess of the average, but, again, the average usage is around 80 gpd. This suggests that our questionnaire sample is somewhat skewed. In sum, 74 (of 302) respondents paid <$5.01 in our survey.

Table 3 gives the same data for all systems reporting as at 1997. In addition, charges for all systems with data in municipalities with systems surveyed are reported. Both these cases evidence about the same, i.e., most users pay more than the AAA norm, except for our median-charge user. A little more light is shed by looking at the systems reporting charges whose monthly charge is less than $5.01 ($6.00 month for the 80 gpd user is $0.0025/gal). As indicated by our median charge, $5.50, half our reporting group pays this lower figure and all these users pay less than the AAA average.

Production Costs of Water

While production figures are a little harder to come by, and while the AAA has annual deficits, they also admit to water losses of 40% in their major systems, although most observers believe the figure is probably closer to 50% or more. If we use the $2.50/1,000 gallon figure for the total cost of production and distribution we are very conservative. Costs for single medium-sized surface water systems (<20 MGD) utilizing conventional treatment are about $1.20/1,000 gal. The large number of AAA systems and the very large distribution systems related to them must effect production and distribution costs. In any event, the cost to the consumer is $0.0025/gal.

Most non-AAA systems have only rudimentary books, if any, and estimation of actual costs is further complicated by an array of "special arrangements" that is truly daunting. For example, we know of one system (not otherwise included in this report) that has two wells. One, the major producer, is operated on a timer and regularly wastes several hours of production per day in tank overflow. The second well is used to maintain pressure to about a dozen houses at the highest elevation in the system when the distribution tank is not dead full; this well is pumped 24 hours and, of course, during periods of little use, also overflows the tank. Combined production (delivered to the storage tank) is about 40-50 gallons per minute. Fortunately for these users, the municipality in which they live pays the electrical cost for the well that is pumped 24 hours.

In addition to uncertainties about operating costs, almost all non-AAA systems in Puerto Rico have been capitalized, at least in part, by public entities with no payback. For example, most of these systems have tanks built under a number of programs that provided these units as grants to the communities. Most distribution systems were (and are) either installed by the community itself or by one of those grant programs; in the case where labor is provided by the community, the pipe and fittings are usually a gift from the municipality or, less often, private industry. That being said, Table 4 presents data from a system that should be considered representative of what might or could be normal; this system was capitalized with a loan from the-then Farmer's Home Administration and has paid principal and interest regularly for about 15 years. In addition to the original system, users have added a great deal of main (approximately double the installed base) and two new wells, emergency generating capacity and maintained the system from income. Note that, since this is a groundwater system and both well built and well maintained this system is in compliance with the SDWA.

Table 4. Costs of production for a model non-AAA system

Customer charges, 1992-1997				
	Monthly bill	Average use per service (gpd)	Cost per gallon	Total gals.
Median	$13.43	178	$0.0025	2,833,950
Average	$13.34	173	$0.0026	2,752,843
Min	$10.41	133	$0.0026	2,133,782
Max	$16.43	200	$0.0027	3,183,373
US Average for systems with 20-500 services (EPA, 1998)	$17.58	200	$0.0029	3,000,000

Costs of Production, 1992-1997				
	Total/yr	Per service	Per gallon	Income – Costs
Median	$59,252	$113.95	$0.0017	$24,568
Average	$59,927	$115.24	$0.0018	$23,326
Min	$40,977	$78.80	$0.0016	($14,486)
Max	$82,117	$157.92	$0.0021	$20,387

Note that usage in this system is metered, and is considerably higher than our consensual "average" for the Island. This system is unusual in a number of other ways: it has water meters and reads them monthly; has four wells and pays all energy costs itself; it has a paid, full-time operator and part-time assistance; has an aggressive collection policy for unpaid water bills and; owns and maintains an emergency generating plant of sufficient capacity to run two wells. For all that, costs to consumers in this system are not significantly different from those experienced by either our survey systems or systems in general.

Table 5 presents a more normal state of affairs; a system with no meters, 70 services, a surface water source with gravity feed throughout and only chlorination. In addition, this system has essentially volunteer administration, the current norm for these non-AAA systems, though they do pay their operator $150/month. Even facing this, for Puerto Rico, very large increase in monthly charges, these users are actively pursuing the loan with the stated rationale that they would prefer to have safe and reliable water.

Table 5. Charges and costs for a surface-water system; minimal complexity

	Per service, per month		
Conditions	Operating	Total	Capital
Existing (1995 – 1997, approximate)	$2.86	$2.86	
With $38,622 loan, 40 years at 4.5%, *	$23.17	$25.65	$2.47
Existing	80 gpd	150 gpd	
Customer charges (per gal)	$0.0014	$0.0007	
Costs (per gal)	$0.0012	$0.0006	
Charges - Costs (per gal)	$0.0002	$0.0001	

*- This loan amount is 25% of the total required for a well, raw water line, emergency generator and minor improvements to the distribution system. This level of required repayment is common in Puerto Rico. Operating costs include: $3,157 for electrical power, $642 for chlorine, $2.220 for required analyses, $7,800 for operator salaries and a capitalization set-aside -- $7,724, 5% of the total loan amount, paid-in annually. Users understand that this is a very high estimate and will likely be somewhat lower with adjustments to the capital set-aside.

NON-TRADITIONAL METHODS OF ESTIMATING THE VALUE USERS HAVE FOR WATER SERVICE

Users in Puerto Rico tend to value the provision of water of whatever quality over the provision of service by the Authority, the body legally charged to provide water and sanitary service. This is evidenced all over the island by the very great number of non-AAA systems and the fact that many users in remote areas have individual storage tanks and both AAA and non-AAA service. Many, if not most of those non-AAA sources are surface water and completely untreated.

Figure 1. Source for the system in Table 5 (70 services).

Figure 2. A typical trek to the source for a system; this one has 18 services. Note the water line in the air above the upper figure and the rope to ease ascent.

The AAA has an unenviable record for reliability of service. This same point was very eloquently put in a public meeting where a municipality was proposing to replace an existing, largely complying system with service from the AAA. The president of the system said, "We prefer to have water, not a water system." Without addressing the question of the justice of this perception, the perception is there. One more example; there is an area between the municipalities of Comerio and Naranjito, the barrios of Doña Elena (Comerio) and Anones (Naranjito) that has four systems with storage tanks and sources all within a radius of about 3 km with some 1,000 families served or needing service. The AAA has distribution lines directly in front of about 700 of those users, and these users are adamant in their refusal to connect to the AAA. This reflects the good sense of these users since the AAA lines never have water and are served by a system with no reserve capacity at all.

This explains to some degree the extent to which rural populations in Puerto Rico will go to get a reliable supply of water. Figures 1 and 2 illustrate some of the difficulties overcome and the compromises with quality made. These physical facilities have largely been built by users over time and include one system with over 6 km of 4" PVC laid over terrain like that illustrated in Figure 2 by system users on weekends over a period of 18 months.

Our survey illustrated some of the other, non-traditional ways to value water. Table 6 illustrates the perception of users of their water and that of AAA.

Table 6. Opinions of user's water and AAA water.

	Opinion of my water				
Opinion of AAA	Good	OK	Bad	Don't know	Total
Good	58	9	2		69
OK	110	42	3	2	157
Bad	91	6	5		102
Don't know	1	2			3
Total	260	59	10	2	331

Pearson χ^2 28.190, exact significance = 0.021

Of those who thought that AAA water was good, only 11 (3.3%) thought their water was less than good. Of users who thought their water was good, 202 (61%) believed that AAA water was less than good. Some of the same loyalty is shown in Table 7, where users were asked if they suffered symptoms with a frequency or regularity they thought was unusual.

Table 7. Opinion of respondent's water and reported symptoms

Symptoms	Opinion of my water			
	Good	OK	Bad	Total
Frequent stomach aches	7	4	4	15
Diarrhea	3	5		8
Skin infections	2	2	2	6
others	1	2		3
all of the above	1	2	2	5
Total	14	15	8	37

Astonishingly, 14 respondents (38%) who reported one or more of the symptoms presented thought their water was good; 29 (78%) thought their water was good or OK, better than bad, in other words.

DISCUSSION

It is apparent that users in remote areas served by non-AAA systems are willing and do pay, and may pay charges significantly in excess of those attendant on the simplest form of system, illustrated in Table 5. The form of payment need not be money or even value in barter (labor for service) and can be reflected in the communal effort required to build and maintain their system. On that basis, the great majority of non-AAA systems evidence a high value assigned to their non-AAA system. This effort notwithstanding, some question remains. In responses to the questionnaire, some 75% knew what type of source they had while 9% incorrectly identified their source and 16% incorrectly thought they had multiple sources. These, and the level of response in most systems, suggest that generally only part of the community is involved in the operation and maintenance of the system. This bears-out anecdotal observation through some ten years working with these rural systems, where operators and interested users are generally older and usually complain of a lack of effective interest on the part of other users.

ACKNOWLEDGMENT

The Authors gratefully acknowledge the financial support of the Gabriella and Paul Rosenbaum Foundation of Chicago, IL., without which much of this work would have been impossible.

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