

A Research Note on:

PEOPLE AND PRICES: RURAL WATER SYSTEMS IN OKLAHOMA

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ABSTRACT

Conserving natural resources is a topic of concern for housing researchers. Although conservation of energy resources has been well documented, less attention has been given to water conservation strategies. Previous research concentrates on water conservation in metropolitan areas with little emphasis on rural households. The research presented in this paper is the result of a mail survey to rural households in Oklahoma. This paper examines the implications of alternative pricing strategies for water conservation measures.

Rural water system users are unique because some have alternative sources of water. Demand estimates using regression analysis show that there are differences in the seasonal demand for water. Water systems using pricing strategies that take account the different seasonal demands for rural water may be faced with the problem of water users utilizing alternative sources of water, such as wells. Traditional water conservation measures, such as increasing the price of water, become obsolete for those households with alternative sources of water. Those alternative sources allow users to circumvent conservation measures.

INTRODUCTION

Conservation of natural resources is a topic of concern to housing researchers. The availability of sufficient resources to provide quality shelter is a critical need for all individuals. Considerable research has been conducted on household energy use and conservation recommendations. There has been less research, however, focusing on water. Studies by Howe (1982) and Billings and Agathe (1980) on urban population samples find that the price of water directly affects conservation measures. However, little information is available on the effects of price on water conservation for those households having alternative sources of water.

This study focuses on rural water system users and the conservation effect estimated with price increases. The Farmers' Home Administration (FmHA) defines a rural water system as one that serves a population of less than 10,000 individuals (Lawrence, 1980). Using this definition, 75 percent of the systems supplying water in the United States are rural systems. Oklahoma alone has over 500 rural water systems. The ability of these systems to promote water

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conservation during droughts can be critical.

PROCEDURES

Mail questionnaires were sent to a total of 668 households in Oklahoma. The households were randomly selected among users of rural water systems from each of the four state regions. The survey included a second mailing for those households not responding. The total response was 347 usable surveys, for a 52 percent return rate. Data from the survey were used to determine factors affecting the consumption of water for household use, as well as the estimated price elasticities.

RESULTS

Household Characteristics

The sample households are similar to the average Oklahoma household. The average household in the sample includes 2.8 persons. Households in the sample range in size from one to 12 persons. Households headed by individuals over 60 years of age are generally smaller than those headed by individuals in their 30s or 40s. Results of the survey show that 19 percent of the population sampled is 60 years of age or older. This compares with the 1980 census for the state of Oklahoma showing that 16 percent of the population was over the age of 60 (see Tables 1 and 2).

Table 1. Frequency of Household Size, Rural Water Systems, Oklahoma.

Number of Persons Per Household	Number of Observations	Percent
1	52	15
2	117	33
3	59	17
4	49	14
5	30	9
6	6	2
Over 6	7	2
No Response	27	8
Total	347	100

The median family income for the households sampled is \$20,000–25,000. This compares with median family for all Oklahomans of \$17,688 for the year 1979. When expressed in 1983 dollars, the median family income for 1979 was \$24,250, which is comparable to that of the survey sample (see Table 3).

Most (87 percent) of the households in the sample live in single-family dwellings. The typical length of residence is 14 years, with the minimum period being one year and the maximum being 64 years. Many of the respondents have been members of a rural water system for a number of years. The mean year for hook-up to a rural water system was 1973. The earliest hook-up occurred in 1917 and the latest hook-up was in 1983 (see Table 4).

Table 2. Distribution of Household Members by Age Group, Rural Water Systems, Oklahoma.

Age	Number of Observations	Percent
0-5	77	9
6-10	65	7
11-14	62	7
15-19	75	8
20-29	104	12
30-39	101	11
40-49	117	13
50-59	124	14
60+	175	19
Total	900	100

Water Quality Availability and Alternative Sources

Most respondents moved to their present location from within Oklahoma. Fifty-four percent of the respondents moved from either the same county or from within the same rural water system. Forty-six percent of the respondents say that they moved from a town, while only ten percent of the respondents say they relocated from an urban area (see Tables 5 and 6).

When comparing the quality of their current water with the water they used before, 47 percent of the respondents feel it is as good as the previous source of water, 22 percent feel it is worse, and 20 percent of the respondents feel it is better.

Most rural water system users in the sample feel that they can use as much water as they wish. The majority use water to wash their cars, about half use water for gardens. Less than half of the respondents, however, use water for lawn sprinkling and livestock enterprises. Only six percent of the respondents report that an alternative source of water for household use is available, but over 30 percent of the respondents indicate that an alternative source of water for non-household uses is available.

ANALYSIS

Using results from the survey data, regression estimates determine factors affecting the consumption of household water for families. The factors observed are household size, income, price and non-household alternative sources of water. Monthly consumption for the individual households is used as the dependent variable.

A total of 347 households who responded (representing 14 different rural water systems) serves as the sample for this study. There are 296 usable quarterly observations. Lack of household income data accounts for the major reduction in usable observations. Bias may enter the estimates from nonresponse to the survey and nonresponse to income information.

Table 3. Household Income, Rural Water Systems, Oklahoma, 1983

Income (\$)	Number of Observations	Percent
0 - 5,000	30	10
5,001 - 10,000	40	13
10,001 - 15,000	52	17
15,001 - 20,000	22	7
20,001 - 25,000	47	15
25,001 - 30,000	19	6
30,001 - 35,000	26	8
35,001 - 40,000	17	6
40,001 - 45,000	12	4
45,001 - 50,000	9	3
50,001 - 55,000	8	2
55,001 - 60,000	12	4
60,001 - 70,000	2	1
70,001 - 80,000	5	2
80,001 - 90,000	0	0
90,001 - 100,000	4	1
Over 100,000	1	1
Total	306	100

The following quarterly demand function results from OLS estimation:

$$\begin{aligned}
 MW = & 12.801 - 9.46MP + 1.87MP^2 - 0.691D + 0.077D^2 \\
 (t) & (3.52) \quad (-2.96) \quad (2.22) \quad (-1.12) \quad (2.29) \\
 & + 1.172 SIZH + 0.064INCOM - 0.0059NHALT \\
 & (3.60) \quad (2.78) \quad (-.060)
 \end{aligned}$$

$$R^2 = 0.29, F = 16.59$$

where

MW = average monthly water usage by quarter per household in thousands of gallons

MP = marginal price in dollars per thousand gallons

D = difference variable and is equal to the actual water bill less the water bill if water was priced at the marginal price

INCOM = 1983 annual household income in thousands of dollars

SIZH = number of people in household

NHALT = percent of non-household

All signs of the variables are as expected. All coefficients are statistically significant from zero at the five percent probability level or better, except D and NHALT. The adjusted R^2 is 0.29 and the F statistic is statistically significant at the 0.0001 probability level.

Table 4. Type of Residence, Rural Water Systems, Oklahoma

Type	Number of Observations	Percent
Mobile Home	41	12.0
House	301	87.0
Duplex	1	0.3
Apartment	3	0.4
No Response	1	0.3
Total	347	100

Table 5. Prior Location of Households, Rural Water Systems, Oklahoma

Previous Residence	Number of Observations	Percent
Location in same rural water system	85	24
Location in same county	105	30
Location in Oklahoma	75	22
Location outside Oklahoma	45	13
No response	37	11
Total	347	100

Table 6. Reasons for Moving to a Rural Water System, Oklahoma

Reason	Number of Observations	Percent
To obtain employment	17	5
Transfer by employer	12	3
Preference for rural living	119	34
To change lifestyle	32	10
Dislike for other residence	19	5
Other	96	28
No response	52	15
Total	347	100

The overall mean monthly water consumption per household in the sample is 7,140 gallons and the mean marginal price is \$1.78 per thousand gallons.

In order to determine the responsiveness of quantity demand to changes in price, the price elasticity of demand is computed on a seasonal basis. Price elasticity of demand is defined as the percentage change in quantity demanded due to one percent change in price. It is expressed mathematically as

Quarterly marginal price elasticities computed at the seasonal mean values are as follows:

First quarter:	-0.80
Second quarter	-0.80
Third quarter	-1.76
Fourth quarter	-0.28

These results indicate that the water consumption of rural households is the least price elastic during the fourth quarter, which corresponds to late fall-early winter. Water consumption of rural Oklahoma households is the most price elastic during the third quarter, which corresponds with late summer. Rural Oklahoma households are apparently much more price elastic than the urban households reported by Howe (1982) and Billings and Agthe (1980). In the Howe study, the price elasticities for urban water were -0.06 for winter and 0.43 for summer. In this study, income elasticity of demand equals 0.24.

CONCLUSION

The profile of rural water system users in the Oklahoma study indicates that there is little difference between those users and the general state population. The typical user in this study is slightly older, lives in a single-family detached home and has an income comparable with other families in the state. The major difference between rural water system users and others is the availability of alternative sources for water use.

Having alternative sources for water changes the price elasticity for rural system users. For policy-makers, this means attempts to conserve water by raising prices may change consumer behavior, but may not actually conserve water. The user will use less of the rural water system services, but will switch to alternative sources, such as private wells, streams or ponds.

Using pricing mechanisms to affect water use is a difficult position. Previous research (Gould and Ferguson, 1980; Nordin, 1976; Taylor, 1975) shows that there are economies of scale that encourage more use of the system and that policies are developed that promote water use. Since current pricing is based on equipment and maintenance and not on the cost of the resource itself, it is difficult to determine methods that will conserve water resources.

Water shortages do occasionally occur due to the seasonal availability of water in Oklahoma. This study shows that the late summer is the most price elastic quarter of the year for water system users in Oklahoma. When resources need to be conserved the most, price changes will work most effectively. In order to tap this effect, however, seasonal pricing by rural water systems would

be required.

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