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Households and Rural Water Systems

L. L. Janssen

A. A. Lundeen

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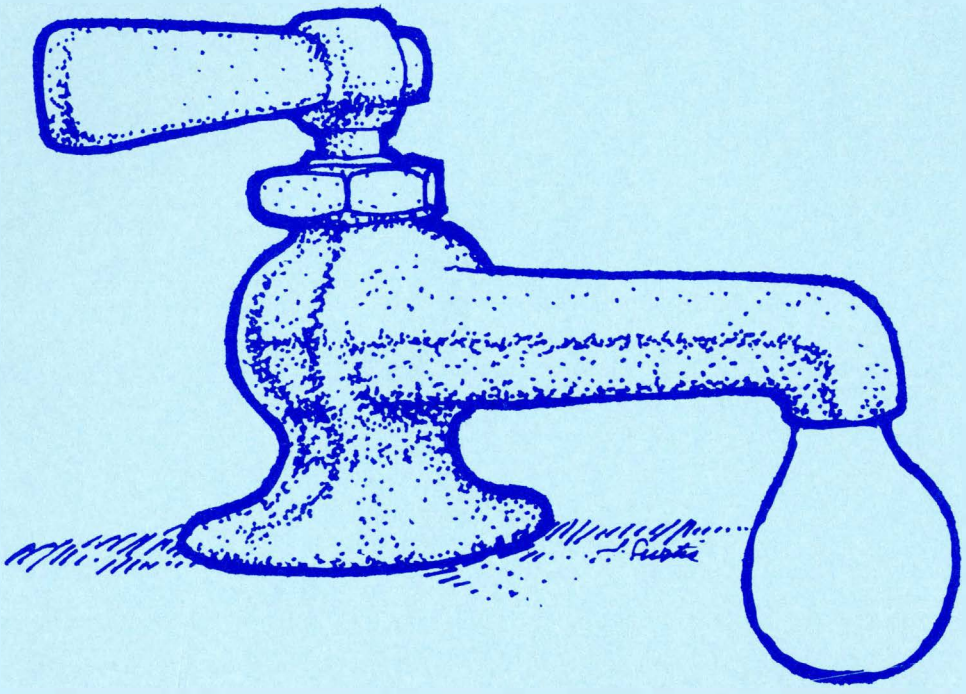

Agricultural Experiment Station • South Dakota State University • Brookings, South Dakota 57007

TO THE READER:

This bulletin reports household impacts of rural water system development based on a case study of the Brookings-Deuel Rural Water System. This study was conducted as part of Project B-056-S.Dak. funded by the United States Department of the Interior, Office of Water Research and Technology.

This bulletin is written for two audiences.

One audience is made of rural water system planners, public officials, and policy-makers who have worked with rural water systems. These readers will understand the results and findings, although the description of specific statistical procedures may not be exactly clear to them.

The other audience consists of community rural development specialists and other researchers doing work in rural water systems.

Tables in the text of the bulletin contain descriptive results and a few statistical tests. Tables in the appendix contain analyses of variance results and are intended to assist the second audience of specialists.

If you keep your own needs in mind as you read this bulletin, we feel you will gain some valuable insights into the relationships between a rural water system and the people who live in the area the system serves.

Cordially,

Larry Janssen

Larry Janssen

Ardelle Lundeen

Ardelle Lundeen

Households and rural water systems

Dr. Larry L. Janssen, assistant professor of economics
Dr. Ardelle A. Lundeen, associate professor of economics

During the 1970's, large-scale rural water systems expanded considerably in South Dakota and surrounding states. In South Dakota, rural water systems increased from 9 in 1970 to 30 in 1980; another 20 systems are proposed or under development in the early 1980's. Such systems, many with over 1000 hookups and large capital costs, have the potential to affect not only their own members but also others in the service area and the general public.

Several studies (3,5,6) have examined private sector and regional economic impacts of large-scale rural water system development. Two studies specifically addressed population growth and demographic impacts.

In a 1975 study, Stam (7) investigated whether new rural water systems led to population growth or whether population growth led to the construction of water systems. From data from six states, he concluded that population growth led to the construction of water systems, implying that rural water systems are built in response to a need and not as a means of development. A study of the Lincoln Rural Water System in South Dakota (8) showed, however, that population growth is encouraged by the availability of a rural water system and that families moving into the area have more elementary and secondary school children than established residents.

Public sector impacts (changes in state and local government expenditures and revenues) of large-scale rural water system development were examined by the authors in a case study (1, 2) of the Brookings-Deuel Rural Water System. Household, agricultural, and industrial impacts of rural water system development were traced. Most household impacts were associated with changes in demographic and housing-related characteristics. This report focuses on these characteristics.

Rural water system membership is voluntary; only members receive the direct benefits of the water supply. But rural water development is subsidized with government funds; consequently, the question of who receives direct benefits concerns policymakers and the tax paying public.

Rural water system development can also create costs and benefits to local governments within the service territory and to the public sector generally. A change in government expenditures can be traced to the rural water system if its installation triggers changes in population numbers, density, or composition which lead to changes in demand for public services. (Affected public services include schools, roads, snow removal, fire and police protection, and waste removal.) Normally, demand for these services will increase as population level or density increases in a region, resulting in increased public expenditures.

One of the major potential benefits of a rural water system is improvement in housing to take advantage of water availability. The public sector can benefit by increased revenues if home improvements result in increased assessed valuations.

Rural water system district planners are also interested in comparing characteristics of member and nonmember households. Certain household characteristics, such as income level and family size, are probably related to membership decisions. This type

of information can assist them in future planning decisions.

BROOKINGS-DEUEL RURAL WATER SYSTEM

The organization and development of the Brookings-Deuel Rural Water System (BDRWS) typify many systems constructed in South Dakota since 1970. Rural residents who encountered problems in the quantity and quality of their water supplies met, formed a nonprofit corporation, and organized the rural water system.

The system, located on the middle-eastern border of South Dakota adjacent to Minnesota, serves rural households in northern Brookings County, most of Deuel County, and southern Grant County (Fig 1). The system is located in the Big Sioux River Basin and secures water at two locations from a large aquifer in the basin. There are approximately 1150 individual service connections and 630 miles of pipeline in a service territory of 2000 square miles. Overall, BDRWS is average in size among larger systems in South Dakota.

In 1979, the system was serving about 45% of households in its service territory. Most members were located on farms and rural acreages and in small towns. BDRWS also serves seasonal lake cottages on two lakes (Hendricks and Cochrane) mobile home courts, subdivisions, and pasture taps. Water provided by BDRWS is not used for crop irrigation.

Most construction had been completed when this study was conducted and most signup members were receiving water from the system. Consequently the profile of member and nonmember household characteristics reflects initial differences or similarities between these groups. This profile may be expected to change gradually over time as more households become members.

METHODOLOGY

Objectives

The major objective was to investigate demographic changes associated with installation of a rural water system. A second objective was to compare housing and water sources characteristics of rural water system member and nonmember households. A third objective was to compare rural water system member and nonmember use of and satisfaction with public services.

The general issue examined throughout this study is whether selected characteristics of rural water system member households are similar to or substantially different than those of nonmember households. Detailed comparisons of member and nonmember households were made for the following household characteristics:

1. Farm/nonfarm employment and income orientation
2. Annual household income levels
3. Education level of adults
4. Age level of adults and families
5. Number of children living at home
6. Incidence and costs of home remodeling
7. Degree of satisfaction with selected public services provided by local governments (schools, police and fire protection, road maintenance, snow removal, and waste disposal)

If there were significant differences between member and nonmember households, we would expect that rural water system member households would have (1) a greater nonfarm orientation, (2) higher annual income levels, (3) more years of formal education, (4) younger adults, (5) more children living at home, (6) higher incidence and costs of home remodeling, and (7) a lesser degree of satisfaction with public services than would nonmember households.

Data sources and analysis procedures

Mail and personal surveys of a sample of rural water system member and nonmember households located in the BDRWS service territory secured the data.

Analysis of respondent characteristics almost always involved comparisons of rural water system member and/or new residents with nonmembers and longtime residents serving as control groups. Length of residence was assumed to be associated with many respondent characteristics and, furthermore, interrelated with rural water system membership. It was important to separate any effects of rural water system membership from effects of length of residence.

Households were classified as "longtime" or "new" based on location of residence in 1972 and 1978. The year 1972 was the first year of serious discussion about forming a rural water district. Residents moving into or relocating within the BDRWS service territory after 1972 may have been influenced in their location decisions by rural water system development while longtime residents may have remained because of BDRWS development.

A common thread in all of the statistical procedures[1*] was analysis of respondent characteristics by rural water system membership (members and nonmembers) and length of residence (new and longtime residents). For each characteristic, data was tabulated for member/nonmember and new/longtime resident comparisons. Many of these comparisons are shown in the tables in this report. When appropriate, chi-square tests of statistical significance are also presented.

Analysis of variance and multiple regression procedures were used to examine the probability level of significance for rural water system membership after accounting for the effects of other variables and interaction terms. The overall level of significance and proportion of variance explained (R^2) by the model was of secondary importance. Statistical tests of significance were evaluated at the 5% probability level, unless otherwise noted.

In some models, attention was also given to location (region or lake), employment (farm, nonfarm, or retired) and to other factors to explain variation in respondent characteristics.

Survey procedures and response rates

Mail surveys of township households (farm, rural acreage, and village households) and lake households were conducted in late 1978 and in 1979. Since most township households involved permanent residents while most lake households involved seasonal residents, there were some differences in the questionnaires for township versus lake households.

Various directory lists gave the names and addresses of over 2100 households located in the BDRWS service territory (Fig 1). This list of households, including 1830 township households and 277 lake households, represented 85-90% of member and nonmember households in the service territory.[2] From these household lists, samples of 472 township households (26% of township households) and 139 lake households (50%) of lake households) were selected for mail surveys. Households in each survey were stratified by rural water system membership and location (region or lake) prior to sample selection. Township households were also separated by length of residence prior to sample selection; lake households were not so stratified, due to insufficient information prior to sample selection.[3,4,5]

For each survey, questionnaires were pretested and modified prior to mailing. Households not responding to the initial letter and mail questionnaires were contacted through two follow-up mailings over a 6-week period.

The mail survey of township households was conducted in November and December 1978. Upon completion of the mail survey, a fourth of respondents and nonrespondents was selected for personal interviews which were conducted in mid-March and early May 1979.[6] Personal interview respondents who had not responded to the initial mail survey were asked to complete the mail and personal survey questionnaires.

Township survey results are based on responses from 272 households,

*All footnoted material appears in Endnotes at the back of this publication.

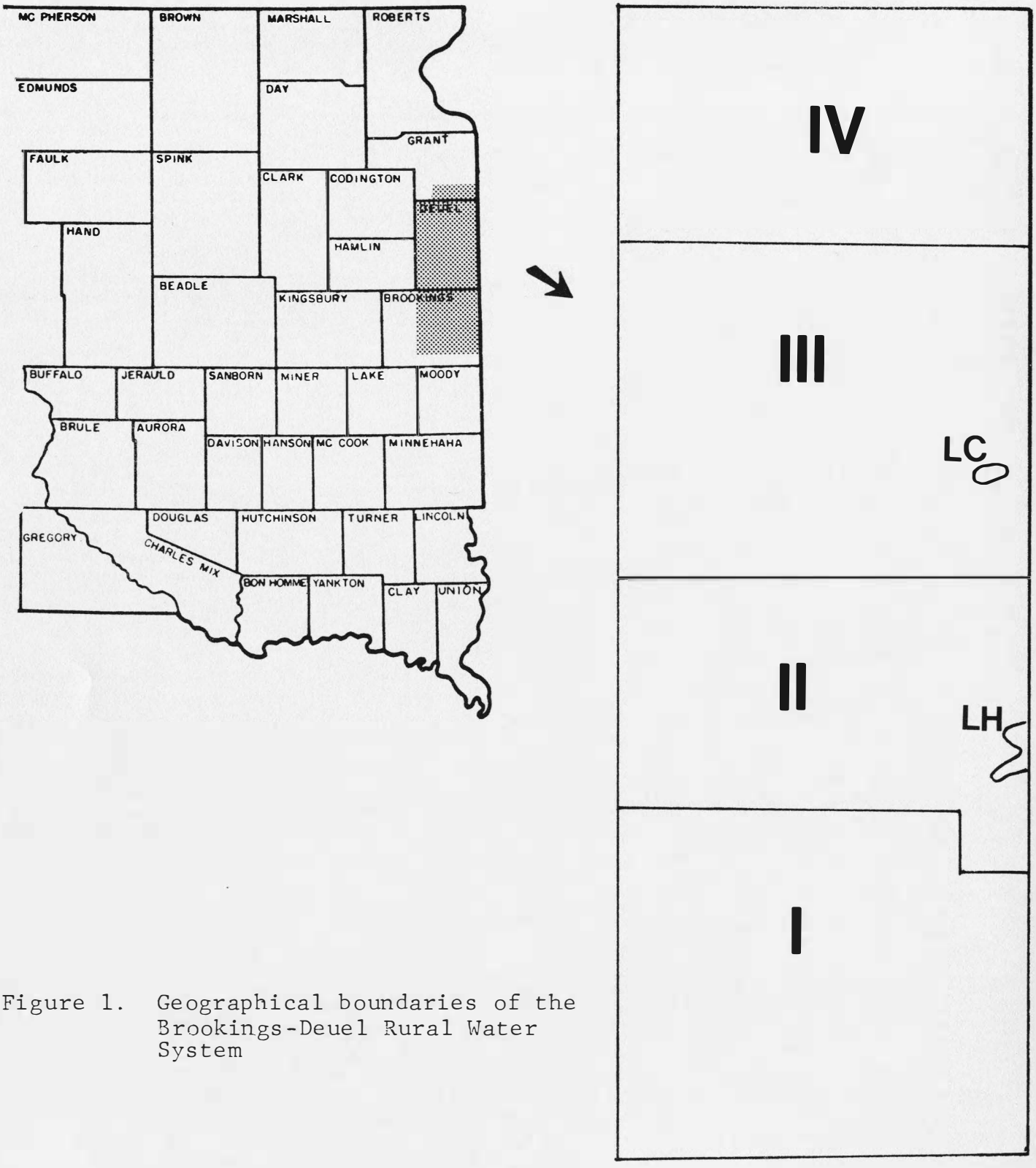

Figure 1. Geographical boundaries of the Brookings-Deuel Rural Water System

I - Southern Brookings County
II - Northern Brookings County and southern Deuel County
III - Central Deuel County
IV - Northern Deuel County and southern Grant County
LC - Lake Cochrane
LH - Lake Hendricks

57.6% of the 472 households surveyed. The response rate for members (75%) was higher than that for nonmembers (45%). The distribution of township respondents by rural water system membership, length of residence, and region is shown in Table 1.

The mail survey of lake households was conducted during June and July 1979, with no follow-up personal interview surveys. Seventy households (50.3% of sampled households) completed the survey. The response rate for members (60%) was higher than that for nonmembers (40%). The distribution of lake household respondents by rural water system membership and location is shown in Table 2.

The total number of township and lake survey respondents was more than half of all households contacted and more than a seventh of all households located in the BDRWS service territory. Most respondents answered all questions asked. Respondents were included in the analysis if they answered all except one or two questions. The usual response rate to a question was 95-100%. The lowest response rate to a question was 85% (respondent income level).

FAMILY AND HOUSING CHARACTERISTICS OF TOWNSHIP SURVEY RESPONDENTS

Results in this section are based on responses from 272 township households (farm, rural acreage, and village households) located in the BDRWS service territory.

Employment and farm orientation characteristics

The relationship between membership and the respondent's farm or nonfarm orientation was based on information about (1) the primary and secondary occupations of adult household members and (2) the proportion of household income obtained from farm sources.

The distribution of household employment was

1.	Farm employment only	46%
2.	Farm and nonfarm employment	17%
3.	Nonfarm employment only	18%
4.	Retirement	19%

Households were also classified by the principal occupation status of the head of household (Table 3). The overall interpretation of Table 3 is that households actively employed, (both farm and nonfarm occupations) are strongly associated with rural water system membership.[8] Retirement households were most frequently nonmembers. Longtime residents tend to be farmers or retired persons, while most new residents are actively employed with a relatively high proportion of nonfarm employment.

A related measure of farm-nonfarm orientation is the proportion of annual household income obtained from farm sources - rental and proprietors' income (Table 4).[9] Seventy-seven percent of longtime residents reported a majority of their net income originated from farm earnings. A majority of new residents reported most of their household income was obtained from nonfarm sources. Chi-square test results indicate proportion of income from farm sources was significantly related to length of residence, but not to rural water system membership.

Findings from the employment and income approaches to farm-nonfarm orientation are consistent. Length of residence is significantly related to respondent's farm orientation. Rural water system membership is not related to respondent's farm orientation.

Income level relationships

Another issue examined is whether household income level is associated with rural water system membership. Eighty-five percent of all respondents reported their annual income level - the lowest response to any question (Table 5).

Table 1. Distribution of township survey respondents by rural water system membership, length of residence, and region

Region	Distribution of Respondents: Length of Residence and Membership — New Member	New Nonmember	Old Member	Old Nonmember	Total Number of Respondents
Central Brookings	24	17	18	24	83
N. Brookings-S. Deuel	16	3	29	19	67
Central Deuel	29	7	37	19	92
N. Deuel-S. Grant	4	2	15	9	30
Total Number of Respondents	73	29	99	71	272

Table 2. Distribution of lake survey respondents by rural water system membership and location

Lake	Distribution of Respondents: Member	Nonmember	Total
Cochrane	34	21	= 55
Hendricks	14	1	= 15
Total	48	22	70

Table 3. Distribution of employment by rural water system membership and length of residence for township respondents

A. Employment Category		Distribution of Respondents: Membership		Length of Residence		
		Member	Nonmember	New	Old	Total
Farm	%	64.7	47.3	52.5	62.3	58.6
Nonfarm	%	21.8	22.6	36.6	13.0	22.0
Retired	%	13.5	30.1	10.9	24.7	19.4
Total	%	100.0	100.0	100.0	100.0	100.0
N =		170	93	101	162	263

B.

	Chi-Square Tests of Statistical Significance: Employment - Farm, Nonfarm & Retired			Employment - Farm & Nonfarm Only		
Variables	X^2	d.f.	P	X^2	d.f.	P
Membership by Employment	11.64	2	0.0030	0.82	1	0.3640
Length of Residence of Employment	22.95	2	0.0001	13.71	1	0.0002

The following notation is used in Table 3 and many subsequent tables in this report:

N_2 = Number of respondents
X^2 = Chi-square value
d.f. = Degrees of freedom
D = Probability level of significance

Table 4. Proportion of township respondents' income obtained from farm sources by rural water system membership and length of residence

Proportion of Income from Farm Sources (percent)		Distribution of Respondents				
		Membership		Length of Residence		
		Member	Nonmember	New	Old	Total
100	%	43.0	33.7	28.1	46.8	39.6
50-99	%	24.7	30.4	20.8	30.5	26.8
1-49	%	13.3	21.7	24.0	11.7	16.4
0	%	19.0	14.2	27.1	11.0	17.2
Total		100.0	100.0	100.0	100.0	100.0
	N =	158	92	96	154	250
	X^2 =	5.33		21.53		
	d.f. =	3		3		
	P =	0.1494		0.0001		

Table 5. Township household income level by rural water system membership and length of residence

Household Annual Income (1978 dollars)		Distribution of Respondents				
		Membership		Length of Residence		
		Member	Nonmember	New	Old	Total
$ 0-$ 4999	%	12.7	28.1	14.6	21.1	18.6
$ 5000-$ 9999	%	19.7	28.1	14.6	28.2	22.9
$10000-$14999	%	27.5	13.5	24.7	20.4	22.1
$15000-$19999	%	12.0	12.4	13.5	11.3	12.1
$20000-$24999	%	11.3	5.5	15.7	4.9	9.1
$25000 and above	%	16.8	12.4	16.9	14.1	15.2
Total	%	100.0	100.0	100.0	100.0	100.0
	N =	142	89	89	142	231

Low annual income levels (less than $10,000) are associated with nonmembers and longtime residents. High annual income levels ($20,000 or more) are associated with rural water system members and new residents.

Analysis of variance (ANOVA) tests of household income levels are shown in Appendix Table 1. The multiple R^2 statistic indicates 28.3% of variation in household income level was explained by the four factors of employment (EMPLOY), regional location (REGION), length of residence (NEWRES), and rural water system membership (RWSUSER) and all possible two-factor interaction terms. Employment was included to account for differences in income levels between farm, nonfarm, and retired household. The factors of employment and rural water system membership were statistically significant along with the interaction terms of (1) region and length of residence, and (2) rural water system membership and length of residence.

The statistical results indicate that rural water system membership is related to household income level after accounting for effects of employment, region, length of residence, and all interaction terms. Overall, higher income levels are associated with rural water system members.

Education characteristics

Education can directly contribute to expanded occupation choice and quality of life. It can indirectly affect the composition of demand for public services.

All respondents were asked the number of years of schooling completed by each adult member of their household. Since there were no overall differences between education level of all adults and head of household, findings are reported for head of household only.

The median education level is 12.0 years of schooling. Three fourths of rural water system member households and five sixths of new resident households completed high school, while less than three fifths of nonmember and longtime resident households completed high school. More than a third of new resident adults had completed 16 or more years of education compared to less than 5% of longtime residents. Approximately one sixth of members and nonmembers had completed 16 or more years of school.

Respondents' age and length of residence are significantly related to education levels, while rural water membership is not a significant factor (Appendix Table 2). The interaction term of membership and length of residence was statistically significant at the 10% probability level. The model explained 25.1% of variation in head of household education levels.

Overall, results indicate BDRWS member and nonmember adults have similar levels of education.

Family size, number of children and age level characteristics

Family size and composition can affect the level and composition of household demand for private and public services. The age level of family members and the number of children living at home affect home remodeling decisions and purchases of water-related appliances. Number of school age children affects demand for public schools and transportation-related services such as school busing, snow removal and road maintenance.

One of the relationships tested in this study was whether rural water system member households were younger families with more children per family living at home than nonmember households.

Average respondent family size was 3.13 people. Fifty-four percent of respondents' families had no children living at home; 31% had one or two children at home; 15% had three or more children at home (Table 6). Most of the variation in household size by membership and length of residence was related to number of children living at home. For example, 56% of member households had one or more children living at

Table 6. Township respondent family size, number of children, and age levels by rural water system membership and length of residence.

	Disbribution of Respondents				
	Member	Nonmember	Old	New	Total
No. of reporting households[a]	169	96	101	164	265
Family Size:					
No. of adults and children per household mean =	3.46	2.55	3.45	2.93	3.13
No. of children per household mean =	1.33	0.58	1.46	0.81	1.06
Distribution of Households by No. of Children Living at Home:					
No children	% 43.7	70.8	32.7	66.5	53.6
One or two children	% 36.9	20.9	46.5	21.3	30.9
Three or more children	% 19.4	8.3	20.8	12.2	15.5
Total	100.0	100.0	100.0	100.0	100.0
No. of Children per Household with Children mean =	2.37	2.00	2.18	2.42	2.28
Age Level					
All respondents					
Median	26.2	48.0	24.8	42.5	31.0
Mean	29.7	43.1	25.0	40.9	34.0
Head of Household					
Median	47.2	57.0	35.7	55.8	51.1
Mean	47.0	58.8	40.3	56.1	50.0

[a]Family size and household distribution statistics are based on 265 reporting households(97.5 percent of township respondent households). Six of these 265 households did not report ages of family members. Age level statistics are based on 259 reporting households.

home compared to only 29% of nonmember households. Sixty-seven percent of new resident households had one or more children living at home compared to 33% of longtime residents. For households with children, the mean number of children was 2.28 with relatively little variation by membership or length of residence.

Age level of adults, length of residence, and rural water system membership were significantly associated with number of children living at home (Appendix Table 3). The interaction of membership and length of residence was statistically significant at the 10% probability level. A third of the variation in number of children living at home was explained by the variables in the model.

Age level data for 259 reporting households showed half of the respondents were young and middle-age adults from 19-59 years old, a third were children, and a sixth were 60 years of age or older. The median age level of all respondents was 31.0 years, while the median age level of head of household was 51.1 years (Table 6). Considerable variation in age levels of all respondents and head of household was evident by membership and length of residence. Younger adults, mostly with children, were associated with member and new resident households, while elderly adults with no children were associated with nonmember and longtime resident households.

The factors of employment, length of residence, rural water system membership, and their interaction terms in an ANOVA model explained 64.6% of variation in the age level of respondent households (Appendix Table 4). The employment factor was included to account for probable variation in age levels of farm, nonfarm, and retired adults. The main effects of employment, length of residence, and rural water membership were statistically significant. No interaction effects involving rural water system member were significant.

These results indicate that age level of adults and number of children living at home are associated with rural water system membership. Rural water system member and new resident households are generally young and middle-age families with children. The number of children per household with children does not significantly vary between members and nonmembers or between new and longtime residents.

Selected past location characteristics of new households

New resident households, defined as households changing residential location since 1972, were examined for past location characteristics and factors influencing their location decision.

Seventy percent of new resident households relocated less than 25 miles, while 20% relocated 100 miles or more. Forty-six percent of new resident households had moved from a farm location; 24% had moved from a rural acreage or village; and 30% had moved from an urban center ranging in size and location from Madison, Brookings, Watertown, and Sioux Falls, South Dakota to Minneapolis-St. Paul, Chicago, and Los Angeles.

All new residents were asked to list one or more principal reasons for their relocation decisions.[10] Responses are summarized as follows:

1. Occupation - related decisions 51%
2. Lifestyle, "country living" decisions 21%
3. Nearness to relatives 14%
4. Retirement decisions 4%
5. Local property tax and school district considerations 5%
6. Availability of rural water system and other utilities 5%

Housing characteristics

Eight of nine respondent households reported owning their home.[5] Ninety-six percent of households reported living in a single-family home on a permanent foun-

dation. Other respondents lived in mobile homes and apartments. Almost all homes had basements (94%) and bathrooms (98%). The average number of rooms, excluding bathrooms, was seven.

The mean age of respondents' houses was 50 years; less than 15% of the housing had been built since 1972. In many cases, the reported housing age was for the oldest or main portion of the house and did not reflect more recent addition of basements, bedrooms, and bathrooms.

Rural water system membership is not related to variation in housing age, incidence of home ownership, incidence of home building, or number and type of rooms.

Home remodeling characteristics

Home remodeling and improvements have considerable potential impact on the quality of life for residents, aesthetic appeal, and property values of residences and property tax receipts.

All respondents were asked about home remodeling decisions and associated costs from 1975-1978. Thirty-one percent of all respondents reported some remodeling work with highest propensity to remodel reported by new residents (41%) and rural water system members (37%). Chi-square tests indicate these relationships are statistically significant at the 2% probability level.

Total remodeling costs per household varied from $200 to $40,000 with a mean expense of $6480 per household. Expenditure did not vary by length of residence or rural water system membership.

One may conclude that rural water system members are more likely to engage in home remodeling. However, remodeling costs per household are similar for member and nonmember households.

Water source characteristics

Most BDRWS members covered in the survey did not rely on the rural water system for their entire water needs, but used multiple sources of water for farm and household use (Table 7). For example, just 12% of the members used only the rural water system for farm use, but as many as 70% relied on rural water for at least part of their farm needs. About 53% of members relied on the rural water system as their exclusive household water source, and 44% used rural water in conjunction with well water. In some cases the water from BDRWS was used for drinking and water-related household appliances while well water was used for lawn watering.

About 91% of nonmembers used private wells as their only household water source while 9% hauled water to their house. Wells were the only source of water for livestock for 58% of nonmembers. Most other nonmembers obtained water from ponds, creeks, and wells.

FAMILY AND HOUSING CHARACTERISTICS OF LAKE SURVEY RESPONDENTS

For most family characteristics, the profile of lake households was considerably different than the profile of township households. Lake households had much higher annual income levels, median education levels, and different family age distributions than township households. Almost all lake households are seasonal residents, while township households are permanent residents.

Employment and income characteristics

Five sixths of lake households indicated one or more family members were employed in nonfarm occupations, primarily professional and managerial occupations. Both husbands and wives in half of these households were employed. An eighth of the households had retired residents, while another 5% were engaged in farming.

Income levels of lake households were much higher than income levels reported by township residents. Three fifths of lake

Table 7. Distribution of household and farm water sources by rural water system membership for township respondents

	Rural Water System Membership			
	Member		Nonmember	
	Number	Percent	Number	Percent
Household Water Sources				
Rural water system only	91	53.2	0	0.0
Rural water system and well	76	44.4	0	0.0
Private well only [a]	4	2.4	91	91.0
Hauling only	0	0.0	9	9.0
Total	171	100.0	100	100.0
Farm Water Sources [b]				
Rural water system and well	62	49.6	0	0.0
Rural water system only	15	12.0	0	0.0
Rural water system and ponds or creeks but no well	11	8.8	0	0.0
Well only	20	16.0	45	58.4
Well and ponds or creeks	15	12.0	30	39.0
Ponds and creeks only	2	1.6	2	2.6
Total	125	100.0	77	100.0

[a] Private well water was used for household use. Water from BDRWS was used for watering livestock at a different location.

[b] Includes only respondents indicating a farm-water source for their livestock regardless of the respondent's primary occupation.

households reported annual incomes exceeding $20,000 (Table 8). Sixty-nine percent of rural water system members and new residents reported annual income levels exceeding $20,000, and less than 10% of them reported incomes of less than $10,000.

Rural water system membership and education are significantly related to household income levels; but age level, length of residence, and interaction terms are not (Appendix Table 5). Overall, 28.5% of variation in income levels was explained by the variables considered.

Education level characteristics

Forty-five percent of lake household respondents had completed a college education, and 88% had completed high school. The median education level of 14.2 years is 2.2 years above the median level for township respondents. Rural water system member adults average one more year of education than nonmember adults.

Statistical analysis, shown in Appendix Table 6, indicates 34% of variation in education level is explained by the variables of age and income levels, membership, and length of residence plus their interaction term. Coefficients for age and income level were significant at the 5% probability level while rural water system membership was significant at the 9% probability level. Membership interaction terms were not significant.

Overall, the level of education of lake households is weakly related to rural water system membership. Education level is not related to rural water system membership in township respondent households.

Family size, number of children, and age level characteristics

Family size, number of children, and age level information about lake households is summarized in Table 9.

Average lake respondent family size was 3.44 persons. Forty-four percent of respondents' families had no children living at home; 38% of families had one or two children at home; while 18% had three or more children. Variation in household size was primarily related to number of children per household. Fifty-seven percent of longtime residents, 29% of new residents, and 44% of all lake households had no children living at home. For households with children, the mean number of children living at home was 2.2 with little variation by length of residence or rural water system membership.

Age level of adults and length of residence are significantly associated with number of children living at home (Appendix Table 7). Rural water system membership is not statistically significant individually or as an interaction term.

Family age distributions are different between lake and township households. Lake households had a much higher proportion of middle-age adults from 40-59 years old and a much lower percentage of young adults from 19-39. Also, three fourths of lake household children were 13-17 years old compared to one third of township household children. Age level differences by length of residence or rural water system membership are not as distinct for lake households as for township households.

Statistical analysis indicates 22% of age level variation was explained by rural water system membership and length of residence plus their interaction term (Appendix Table 8). Length of residence was significant, but membership and interaction of membership and length of residence were not.

For lake respondents, rural water system membership is not associated with number of children living at home or age level of adult respondents. This finding differs from results for township households.

Lake use and permanent location characteristics

Most lake homes are not occupied year-round and are not the principal home of

Table 8. Lake respondent's household income level by rural water system membership and length of residence

Household Annual Income Level		Distribution of Respondents				
		Membership		Length of Residence		
		Member	Nonmember	New	Old	Total
$ 0-$ 4999	%	2.2	16.7	3.4	8.8	6.3
$ 5000-$ 9999	%	6.7	16.7	0.0	17.6	9.5
$10000-$14999	%	11.1	11.1	17.2	5.9	11.1
$15000-$19999	%	11.1	16.7	10.3	14.7	12.7
$20000-$24999	%	20.0	5.6	20.7	11.8	15.9
$25000 and above	%	48.9	33.3	48.3	41.2	44.5
Total	%	100.0	100.0	100.0	100.0	100.0
	N=	45	18	29	34	63

Table 9. Lake respondent family size, number of children, and age levels by rural water system membership and length of residence

	Distribution of Respondents				
	Membership		Length of Residence		
	Member	Nonmember	New	Old	Total
No. of Responding Households N =	47	19	31	35	66
Family Size					
No. of Adults and children per household Mean =	3.51	3.26	4.06	2.77	3.44
No. of Children per household Mean =	1.30	1.05	1.67	0.83	1.23
Distribution of Households by No. of Children					
No children %	40.5	47.4	29.0	57.1	43.9
1 or 2 children %	40.5	36.8	41.9	34.3	37.9
3 or more children %	19.0	15.8	29.1	8.6	18.2
Total %	100.0	100.0	100.0	100.0	100.0
No. of children per Household with children	2.2	2.2	2.4	2.0	2.2
Head of Household Age Level[a]					
Median	52.0	53.1	51.0	59.8	52.5
Mean	52.1	58.1	48.5	58.5	53.8

[a]Age level statistics are based on 64 reporting households.

their residents. Only 5 of 70 lake respondents indicated their lake home is their permanent residence.

Sixty percent of the 65 seasonal lake respondents reported their permanent residence was located in eastern South Dakota, mostly in Brookings, Watertown, or Sioux Falls. Almost all remaining respondents were from western Minnesota or from the Minneapolis-St. Paul metropolitan area.

Seasonal lake home use characteristics are reported in Table 10. The median number of usage days was 45. New residents and rural water system members had a considerably higher lake home daily use rate than longtime residents and nonmembers..

Approximately a third of seasonal lake respondents lived within 25 miles of their lake home, while a fourth of the lake families lived more than 100 miles from their lake home. Seventy-four percent of rural water system members lived more than 25 miles from their lake homes compared to 52% of nonmembers.

Housing, home ownership, and home remodeling characteristics

All lake respondents reported owning their lake home. Twenty-six percent were mobile homes while 74% were cottages or houses on a permanent foundation. All except three lake homes had one or more bathrooms. The average number of rooms, excluding bathrooms, was four. The average lake lot was 0.8 acres. Significant variation in these characteristics by rural water system membership, length of residence, and lake residence was not found.

The mean age of lake housing was 14 years with a third of houses or mobile homes built since 1973. Less than a fifth of lake respondents reported their lake home to be more than 20 years old. A significantly higher proportion of new residents and rural water system members have built or live in newer homes than longtime residents and nonmembers.

Approximately 43% of member and nonmember respondents indicated their lake home was suitable for all-weather use. New residents had a significantly higher proportion (65% vs. 20%) of all-weather lake houses than longtime residents.

Lake home remodeling during 1975-1978 was reported by 28% of the respondents. Average remodeling cost was $4400 per household with a range from $200 to $20,000. There was no significant variation in incidence or cost of remodeling by membership, length of residence, or lake residence.

Water source characteristics

The availability of a dependable supply of quality water for lake home use can substantially improve the usability and quality of lake homes. Most (85%) members relied on the rural water system as their only source of water. Half of nonmembers used well water, while the remainder hauled water to their home or used lake water.

Overall, lake respondent members rely more on the rural water system than township respondents. The high incidence (50%) of nonmembers hauling water to their lake home indicated additional rural water system development is possible along both lakes.

RESIDENTS' SATISFACTION WITH PUBLIC SERVICES

Personal survey respondents were asked about their use of and level of satisfaction with eight public services; sewage disposal, solid waste disposal, snow removal, road maintenance, schools, school busing, fire protection, and law enforcement. The primary purpose was to secure quantitative data to test whether rural water system members and/or new residents were less satisfied with public services than nonmembers or longtime residents. Level of satisfaction answers were coded from 1-9 with 1 indicating the lowest degree of satisfaction, 5 indicating neutral feelings, and 9 the highest level of satisfaction.

There were 90 households in this sample with the number of responses per public service ranging from 47 to 87. Overall

Table 10. Lake home use characteristics of nonpermanent lake household respondents by rural water system membership and length of residence[a]

	Distribution of Respondents				
	Membership		Length of Residence		
	Member	Nonmember	New	Old	Total
Lake Household Use Rates--No. of Days Per Year					
Mean =	45.0	20.0	43.7	30.0	40.0
Median =	50.5	43.0	57.0	40.0	45.0
Distance from Permanent Residence to Lake Residence:					
1 - 25 miles %	26.0	47.4	31.3	33.3	32.3
26 - 99 miles %	48.0	31.6	46.9	39.4	43.1
100 or more miles %	26.0	21.0	21.8	27.3	24.6
Total	100.0	100.0	100.0	100.0	100.0
N =	46	19	32	33	65

[a] Five of 70 respondents indicated their lake home was their permanent residence. These respondents are not included in this table.

sample means for users of each service were fairly high, ranging from 7.24 for snow removal to 8.62 for school busing. Since 9 indicates highest possible satisfaction, most households were relatively well satisfied with their public services.

A test for difference in public service satisfaction means between members and nonmembers and between longtime and new residents was made using two-factor analysis of variance. There were no significant statistical differences at the 10% level between either of these groups for any services. Further analyses were made including the covariates of age, income, and education. Again, there were no significant differences at the 10% level.

SUMMARY

Findings are based on responses from 272 township households (farm, rural acreage, and village households) and 70 lake households (mostly seasonal residents located along Lake Cochrane and Lake Hendricks). This represented over 50% of households contacted and over one seventh of all households located in the BDRWS service territory.

Findings

Major findings from the surveys of township households are

1. Three fifths of township households were involved in farming. Rural water system membership was not related to respondents' farm or nonfarm employment and income orientation. A significantly higher proportion of new residents than longtime residents was employed in nonfarm occupations and received a majority of income from nonfarm sources.

2. Rural water stystem member households had significantly higher annual income levels than nonmember households had.

3. Education level of adults was not related to rural water system membership.

4. Rural water system member families were much younger than nonmember families. New resident families were much younger than longtime resident families. The same relationships held for age level comparisons of heads of households.

5. A significantly higher proportion of rural water system member households and new resident households had one or more children living at home than nonmember or longtime resident households. For households with children, there were no significant differences in the number of children per household by rural water system membership or length of residence.

Family characteristics of lake households were different from township households. Almost all lake households had seasonal residents while township households had permanent residents. Lake households had much higher annual income levels, greater education levels, and a different family age distribution than township households.

Major findings for lake households are

1. Only 5% of lake households had family members employed in farming or receiving income from farm sources.

2. Rural water system member and new resident households had significantly higher annual income levels than nonmember and longtime resident households.

3. Rural water system member adults had an average of one more year of education than nonmember adults, but the difference was not statistically significant.

4. New resident families were much younger than longtime resident families. There was little difference in age level distribution

of rural water system member and nonmember families.

5. Incidence of and number of children per household were not significantly related to rural water system membership. However, a significantly higher proportion of new residents had one or more children living at home than long-time residents.

Findings from both surveys indicate certain demographic characteristics are associated with rural water system members and new residents. However, there is very little evidence that the rural water system is a major factor in location and housing-related decisions made by members or new residents. The only significant differences between member and nonmembers were:

1. BDRWS members had a higher incidence of home remodeling than nonmembers, and

2. BDRWS members owned newer lake homes and used their lake homes more frequently than nonmembers.

Members and nonmember households did not vary in their rate of use and satisfaction with eight local government public services.

Forty-five percent of township and lake households located in the BDRWS service territory were rural water system members by early 1979. Most members, except lake households, did not rely on the rural water system for their entire water needs, but used multiple sources of water for farm and household use.

IMPLICATIONS

Demographic characteristics and changes in those characteristics have implications that policy makers and researchers should consider when evaluating water projects. Several implications of this study for local governments, public subsidy policies, and further research follow.

Implications for local governments

No findings in this study indicate that initial rural water system development is a catalyst in the social and economic development of the Brookings-Deuel service region. It is only one of many factors.

Home remodeling and improvements by rural water system members can influence real property values over time. If these increased values are translated into increased taxable assessed values, the tax base for local governments can increase by modest amounts.

Local government officials are continually pressed by many constituents to provide high quality public services. Rural water system development does not necessarily lead to increased pressures for providing additional public services.

Findings from this case study indicate that rural water system members are neither more nor less satisfied with local government public services than nonmembers. Other findings indicate that member families consist of younger adults than nonmember families, have more school age children, and use more school-related public services. However, there is very little evidence that rural water system development was a causal factor in location decisions or public service choices.

Implications for subsidy policies

State and federal government agencies provide substantial subsidies to rural water systems through matching grants and low interest loans. The justification for these subsidies does not arise from rural water systems providing public (social) goods. The provision and use of public rural water does not involve "nonexclusion" or "joint consumption". Households can choose to belong or not belong to rural water systems, and only members receive direct benefits of water from this source.

Government subsidies have often been used to provide merit goods. Merit goods are private or public goods that provide benefits to many individual households and to the overall community. Low cost rental

housing, school lunch programs, and public museums are examples of merit goods receiving government subsidies.

Rural water systems have some characteristics of merit goods - to households and farms they provide a convenient, dependable supply of good quality clean water for livestock and human use. These attributes also benefit society because they improve general health and well-being.

Some public subsidies are intended to reduce income disparities between households and regions by subsidizing low-income households or low-income regions. Rural water system project financing is influenced by a regional income objective. The amount of subsidy for rural water projects is related to projected use and repayment capacity. Projected repayment capacity is linked to median income levels of the service territory. However, rural water system membership within a region is not restricted by income tests for individual households.

Income level findings from this case study clearly indicate that BDRWS member households have higher average annual incomes than nonmember households. However, per capita income levels are similar, since member family size is larger than the family size of nonmember households. The main implication of this finding is that public subsidies linked to regional development and income objectives should not be expected to initially benefit most lower income households within the region.

Public subsidies are frequently justified in building infrastructure (highways, airports, sewer systems, water treatment plants) that facilitate economic growth. Findings from this study indicate rural water system development leads to increased home remodeling and water appliance purchases. However very little population increase or relocation activity can be attributed to rural water system development.

Economic growth can also occur from livestock production increases or from reduced costs of providing water per unit of output. These potential sources of economic growth were not examined in this study.

Future research

Longer term growth impacts of rural water system development should be examined to verify or refute initial findings. This study only examined initial development impacts.

Lake households had a considerably different demographic profile than township households. Lake household impacts have not been reported in other studies. Further examination of lake households and other rural nonfarm households are needed to better understand the impacts of rural water system development on household location decisions.

Livestock production impacts need to be thoroughly examined. What are the health and productivity impacts of rural water systems for cattle, hogs, sheep, and poultry? What are the relative per unit costs of providing water from this source compared to alternative sources? What proportion of farmer members receive productivity and convenience benefits from this water source? Agricultural impacts of rural water system development are likely to be small unless considerable livestock production increases occur.

ENDNOTES

1. The Statistical Package for the Social Sciences (SPSS) for OS/360, Version H on the IBM computer at South Dakota State University was used for data processing and statistical computation purposes (4).

2. Members excluded from the sample were landlords not residing in the service region, nonfarm corporations, nonprofit institutions, and members living in municipalities and rural subdivisions where collective decisions were made concerning membership in the rural water system. Nonmembers excluded from the sample were landlords residing outside of the service region and households not included in county directories, lake ownership directories, telephone directories, or other lists used to develop the sample frame.

3. For township households, a 40% sampling rate was selected for new residents compared to a 20% sampling rate for longtime residents. This resulted in an overall sampling rate of 26%.

4. Location strata were added to insure equal proportions of households located in each region or by each lake were included in the sample.

5. In both surveys, households were randomly selected within each stratum. Respondents were asked several questions in the surveys to permit proper post-survey strata classification. Less than 2% of township respondents were misclassified by region and rural water system membership strata, while 14% were misclassified by length of residence strata. Eight percent of lake respondents were misclassified by membership strata. Post survey (correct) strata were used for the actual statistical analyses.

6. Personal interviews of a subsample of respondents and nonrespondents to the mail survey were used to obtain more detailed information necessary for the public sector impact simulation model. Of interest to this report were questions concerning respondents' use of and satisfaction with public services.

7. Respondents from 90 of 118 households subsampled completed the personal interviews. Of these 90 respondents, 32 had not responded to the earlier mail survey and were asked to complete the mail and personal survey questionnaires. This procedure permitted examination of nonrespondent bias to the mail survey. No statistically significant differences in characteristics and responses to questions were found between the two groups. Therefore, analysis of township survey results is based on the entire data set of 272 respondent households.

8. Several chi-square tests are reported in this study. The following remarks are an interpretation of this statistic for the category variables employment by membership. The null hypotheses tested is that observed and expected cell frequencies for the factors of membership (member, nonmember) and employment (farm, nonfarm, and retired) are equal. The chi-square test statistic (X^2) is 11.64 with two degrees of freedom. The level of statistical significance or probability of accepting the null hypothesis under repeated sampling conditions is 0.3% (P=0.0030). If our criterion value is set for the 5% probability level we reject the null hypothesis and accept the alternative hypothesis that observed and expected cell frequencies are not equal, which implies a statistically significant relationship between membership and employment.

9. Income source data were cross-checked with employment data. Findings indicate close agreement between income and employment measures of farm orientation. Retirement households were evenly divided between farm and nonfarm income orientation.

10. The analysis of factors involved in the location decision is not comprehensive. New residents were not asked to compare and rank the relative importance of the same set of location decision factors.

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Appendix Table 1. Analysis of variance of township household income levels.

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	106.407	7	15.201	6.695	0.000
EMPLOY	56.242	2	28.121	12.385	0.000
REGIONS	11.664	3	3.888	1.712	0.166
NEWRES	0.942	1	0.942	0.415	0.520
RWSUSER	8.657	1	8.657	3.813	0.052
2-Way Interactions	72.993	17	4.294	1.891	0.021
EMPLOY REGION	15.596	6	2.599	1.145	0.338
EMPLOY NEWRES	2.546	2	1.273	0.561	0.572
EMPLOY RWSUSER	4.444	2	2.222	0.979	0.378
REGION NEWRES	21.149	3	7.050	3.105	0.028
REGION RWSUSER	9.236	3	3.079	1.356	0.257
NEWRES RWSUSER	16.834	1	16.834	7.414	0.007
Explained	179.400	24	7.475	3.292	0.000
Residual	454.112	200	2.271		
Total	633.512	224	2.828		

272 cases were processed
47 cases (17.3 pct.) were missing R^2=0.283

Appendix Table 2. Analysis of covariance of education level of head of household-township survey

Source of variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	61.432	1	30.716	4.422	0.013
NEWRES	60.908	1	60.908	8.769	0.003
RWSUSER	0.867	1	0.867	0.125	0.724
Covariates	463.810	1	463.810	66.774	0.000
Aged	463.810	1	463.810	66.774	0.000
2-way Interactions	18.460	1	18.460	2.658	0.104
NEWRES RWSUSER	18.460	1	18.460	2.658	0.104
Explained	543.703	4	135.926	19.569	0.000
Residual	1625.350	234	6.946		
Total	2169.053	238	9.114		

272 cases were processed
33 cases (12 pct.) were missing

$R^2 = 0.251$

Appendix Table 3. Analysis of covariance of number of children per township household

Source of Variance	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	51.2	2	25.6	19.1	0.000
NEWRES	17.9	1	17.9	13.4	0.000
RWSUSER	26.7	1	26.7	20.0	0.000
Covariates	114.8	1	114.8	85.9	0.000
Aged	114.8	1	114.8	85.9	0.000
Interactions	3.7	1	3.7	2.8	0.098
NEWRES RWSUSER	3.7	1	3.7	2.8	0.098
Explained	169.7	4	42.42	31.7	0.000
Residual	339.6	254	1.34		
Total	509.3	258	1.97		

272 cases were processed
14 cases (5.1 pct.) were missing $R^2 = 0.333$

Appendix Table 4. Analysis of variance of age of head of household-township survey

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main effects	41001.242	7	5857.320	54.370	0.000
EMPLOY	17368.777	2	8684.387	80.612	0.000
REGION	301.747	3	100.582	0.934	0.425
NEWRES	9450.535	1	9450.535	87.723	0.000
RWSUSER	1089.859	1	1089.859	10.116	0.002
2-Way Interactions	3931.277	17	231.252	2.147	0.006
EMPLOY REGION	1247.760	6	207.060	1.930	0.077
EMPLOY NEWRES	792.251	2	396.125	3.677	0.027
EMPLOY RWSUSER	281.201	2	140.601	1.305	0.273
REGION NEWRES	575.342	3	191.781	1.780	0.152
REGION RWSUSER	431.853	3	143.951	1.336	0.263
NEWRES RWSUSER	5.367	1	5.367	0.050	0.824
Explained	44932.520	24	1872.188	17.387	0.0
Residual	24562.730	228	107.731		
Total	69495.250	252	275.775		

272 cases were processed
19 cases (7.0 pct.) were missing

$R^2 = 0.646$

Appendix Table 5. Analysis of covariance of lake household income levels

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main effects	9.801	2	4.901	2.515	0.091
NEWRES	1.206	1	1.206	0.619	0.435
RWSUSER	8.016	1	8.016	4.113	0.048
Covariates	24.661	2	12.330	6.327	0.004
AGED	0.898	1	0.898	0.461	0.500
EDUCATE	17.085	1	17.085	8.767	0.005
2-Way Interactions	4.313	1	4.313	2.213	0.143
NEWRES RWSUSER	4.313	1	4.313	2.213	0.153
Explained	38.775	5	7.755	3.979	0.004
Residual	97.439	50	1.949		
Total	136.214	55	2.477		

Covariate Raw Regression Coefficient

AGED	-0.014
EDUCATE	0.185

70 cases were processed
14 cases (20.0 pct.) were missing

$R^2 = 0.284$

Appendix Table 6. Analysis of covariance of education level of head of household-lake survey

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main effects	25.274	2	12.637	1.560	0.220
NEWRES	0.893	1	0.893	0.110	0.741
RWSUSER	24.988	1	24.988	3.085	0.085
Covariates	158.302	2	79.151	9.771	0.000
AGED	48.440	1	48.440	5.980	0.018
INCOME	71.551	1	71.551	8.832	0.005
2-Way Interactions	21.088	1	21.088	2.603	0.113
NEWRES RWSUSER	21.088	1	21.088	2.603	0.113
Explained	204.663	5	40.933	5.053	0.001
Residual	405.047	50	8.101		
Total	609.710	55	11.086		

Covariate Raw Regression Coefficient

AGED	-0.099
INCOME	0.776

70 cases were processed
14 cases (20.0 pct.) were missing

$R^2 = 0.336$

Appendix Table 7. Analysis of covariance of number of children per lake household

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main effects	12.320	2	6.160	3.898	0.026
NEW	11.287	1	11.287	7.142	0.010
USER	0.186	1	0.186	0.118	0.733
Covariates	14.411	1	14.411	9.119	0.004
AGED	14.411	1	14.411	9.119	0.004
2-Way Interactions	4.388	1	4.388	2.776	0.101
NEWRES RWSUSER	4.388	1	4.388	2.776	0.101
Explained	31.118	4	7.780	4.923	0.002
Residual	93.241	59	1.580		
Total	124.359	63	1.974		

Covariage Raw Regression Coefficient

AGED -0.047

70 cases were processed
6 cases (8.6 pct.) were missing

$R^2 = 0.250$

Appendix Table 8. Analysis of variance of age of head of household-lake household

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main effects	1798.667	2	899.334	8.365	0.001
NEWRES	1335.913	1	1335.913	12.425	0.001
RWSUSER	224.855	1	224.855	2.091	0.153
2-Way Interactions	0.082	1	0.082	0.001	0.978
NEWRES RWSYSER	0.082	1	0.082	0.001	0.978
Explained	1798.750	3	599.583	5.577	0.002
Residual	6450.961	60	107.516		
Total	8249.711	63	130.948		

70 cases were processed
6 cases (8.6 pct.) were missing

$R^2 = 0.218$

CONTENTS

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