Decision making

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Decision Aids for Local Decision-Making

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Rural areas and small communities had a higher population growth rate during the 70's than metropolitan communities. This is the first time this has occurred in 160 years. Preliminary 1980 census figures indicate that nonmetropolitan counties increased in population by about 15 percent, whereas metropolitan counties increased by about 9 percent from 1970-80. However, rural growth has occurred selectively. Many mining, resort-retirement and urban fringe counties grew by 40 percent or more in the 70's. On the other hand, nearly 500 of the 2485 nonmetropolitan counties continued to decline in population during the 1970's. [Secretary of Agriculture]

Decisionmakers in rapidly growing counties or communities are faced with the task of planning for growth. This includes estimating future growth and associated needs for community services so that sufficient capacity can be built into public service systems. Decisionmakers in declining areas face an equally difficult task of maintaining services for their constituents. Many of these communities are in heavily agricultural areas and lack alternative sources of employment. The reduction of population often leads to a decline in the economic base and in resources to support services.

Decisionmakers in both growing and declining rural areas need assistance in planning to accommodate change. A program to provide such assistance is ongoing at Oklahoma State University. Rural development decision aids developed and utilized at Oklahoma State University fall

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into three main areas and include:

1. prediction of growth or analysis of impacts of changes in economic base;
2. derivation of budgets for alternative community service delivery service systems; and
3. generation of information in administration of delivery systems.

If such decision aids are to be developed and maintained for use by Extension personnel, it is imperative that a strong research base be available to keep the research current and to develop new decision aids. The objectives of this paper are: (1) to discuss each of the types of decision aids specified above; (2) to review the importance of a solid research base in the development and maintenance of such decision aids; and (3) to discuss Extension delivery techniques for rural development decision aids.

Decision Aids to Predict Growth

For long and short range planning of community services, it is important that local decisionmakers have the best employment, income and population estimates available. A mistake of building a water or sewer treatment plant too small or too large can be costly and embarrassing to elected officials. They need the best estimates with which we can provide them.

Many community service needs are a function of the age of the population. For example, the number of school children in a community can be estimated from information on the number of children by age category. For these purposes, a demographic model which includes components of births, deaths and migration can be used. Migration is difficult to predict, but historical migration can be projected in lieu of more appropriate information.

If there is a change in the economic base or the structure of a community, more detailed models may be needed. Some of these include economic base, input-output, from-to, dynamic input-output or simulation. Shaffer and Tweeten in 1977 developed a local development model understandable by local decisionmakers. Applicability of Shaffer and Tweeten's work has been proven by the widespread adoption of their basic model. Similar models were computerized by personnel at the University of Florida, Purdue, South Dakota State and Texas A & M.

Presently, at OSU, we are using an input-output model and community service use coefficients as decision aids in long range rural development planning. An example of an application of our decision aids is a recent study for Weleetka, Oklahoma [Lenard, 1980a]. A new electricial equipment manufacturing plant is scheduled to employ 52 workers in 1981, 122 in 1982 and 175 in 1983. An input-output model was used to predict the secondary impact for employment and income. The employment estimates are presented in Table 1. Based on local conditions, such as unemployment and family size, population changes were also projected (Table 1).

In addition, the impacts these changes have on community services projected. Exsmples of impacts on community services are presented in Table 2. Also, estimates were made of sewer needs, fire calls, hospital bed days, physician office visits, solid waste generation and school taxes which would be attributable to the new plant. Local leaders used the estimates to evaluate the adequacies of local community services.

As researchers, we need to continue to improve our basic models and as Extension workers we need to relay the needs as we perceive them from the user level to researchers. Our local level background has con-

TABLE 1. Estimated Employment and Population Changes from the Proposed Plant Locating in Weleetka

	Years 1981	1982	1983
Estimated Employment Changes by Sector			
New Electrical Machinery Manufacturing	52	122	175
Construction	2	5	7
Transportation, Communications and Utilities	3	8	11
Wholesale and Retail Trade	12	28	41
Finance, Insurance, Real Estate and Business and Personal Services	10	24	34
Professional and Related Services	21	50	72
Public Administration	10	22	32
Estimated Total Employment	110	259	372
Population Changes			
New Electrical Machinery Manufacturing Employees and Their Families	21	44	62
Persons Employed in Other New Jobs and Their Families	21	48	71
Total Population	42	92	133
Estimated Number of New Households	13	31	45

Source: [Lenard, 1980a]

TABLE 2. Examples of Impacts on Community Services Resulting from New Plant

Item	1981	1982	1983
Number of New School Children	16	34	49
Additional Water Needs (Gallons)	1,076,400	2,566,800	3,726,000
Additional Ambulance Calls	2	3	5
Additional Sales Tax Receipts	$5,958	$15,369	$24,294

Source: [Lenard, 1980a]

vinced us of needs for (1) more in-depth localized information about the impacts of economic change and (2) more information about the dynamic impacts of development or decline. Researchers are moving in this direction. An example is the regional model developed to analyze coal development in North Dakota [Toman]. Steve Murdock and Larry Leistritz are refining this model to measure the economic and demographic impacts on three communities of a nuclear repository. A community simulation model is being developed at OSU [Woods]. The model uses a gravity model to estimate the service area of a community, then location quotient and input-output techniques are combined to constitute an economic model. The economic portion of the model is then made dynamic by a recursive system of equations which are driven by final demand estimating equations. The demographic portion of the model is based on a population model employing births and deaths. Migration is used to fit the demographic portion of the model with the economic portion of the model. The model predicts employment and income by industrial sector, population by age cohorts, community fiscal measures and community service needs. Fiscal measures include the amount of revenue generated by source, such as sales tax or user charges. Community service information includes predictions of needs for water, sewer, solid waste, fire, ambulance, police, hospital beds and physician visits.

Decision Aids to Evaluate Alternative Community Service Delivery Systems

The decision aids employed most frequently by Oklahoma rural development Extension personnel are community service budgets. Farm management Research and Extension personnel have employed budgets for years and they are the foundation of many of their programs. Likewise, we have found that they are the cornerstone of our community service programs.

In Oklahoma, Research and Extension personnel in recent years have emphasized providing budgets for community services, and responses from local decisionmakers have been overwhelming. Now that local decisionmakers, state personnel and others have become aware of our capabilities, requests for budget studies are almost more than personnel can handle. For example in 1980, Oklahoma Cooperative Extension Service personnel completed over 100 specific community service budget studies. These budget studies serve not only to build a clientele for Rural Development Extension but also to provide a needed service. A recent letter from the Mayor of Durant, Oklahoma attests to this fact. The letter to Charles Browning, Dean of Agriculture reads:

> "We wish to express our appreciation of your fine staff and their report, in regards to the ambulance study for Bryan County. The data they collected and the information they presented will be most helpful in our determination of how to handle the situation. We will probably use their experience again at a later date."

To illustrate the results of a budget study, a recent emergency medical services (EMS) study will be summarized [Lenard, 1981]. The research base for the Extension application is found in an EMS handbook [Doeksen, 1979].

The city council of Sayre, Oklahoma requested a budget analysis of their Emergency Medical Service. They were seeking the best delivery system for the least cost. The study included an analysis of all ambulance runs made during the preceeding year. Data were analyzed by a computer program and calls were sorted by type, time of day, place of pick up, destination, response times, etc. The information aids a system manager in planning for staffing and equipment needs.

Next, an estimate of future calls was made to give decisionmakers an idea of future capacity needs of the system. Methodology derived from the research project was used to estimate calls for 1981 (Figure 1). Ambulance calls were classified into three types: (1) highway accidents; (2) transfers; and (3) other medical calls. Highway accident calls were specified as a function of the number of autos and motorcycles in the service area. Transfer calls were defined as the movement of patients between hospitals and were specified as a function of the size and services of the local hospital, the local medical staff and other medical factors. Transfers can be estimated from records of the local hospital. Other medical calls included all other calls and are generally for emergency reasons, such as heart attacks, strokes, etc. These were found to be a function of age. Using nine age categories, utilization rates were derived which indicate the number of calls per 1,000 population. These utilization rates can be used with area population data to predict the number of other medical calls. By applying the methodology, 406 calls were estimated for the Sayre EMS service in 1981. In addition, a demographic model was employed to estimate the population of the area from 1980-1990. Using the methodology in Table 3, the number of EMS calls was projected. For example, there were projected to be 449 calls in 1985 and 498 calls in 1990.

The research base allows for the prediction of costs and returns for alternative systems. Forms were derived for easy analysis and presentation. The summary form is presented in Figure 2. The top portion of the form can be used to estimate receipts. For example, if a $55 base rate is charged plus $1 per mile one way and 70 percent of the patients pay their bills, $23,467.50 will be collected.

FIGURE 1. Application of EMS Research to Sayre, Oklahoma

FORM I

Procedure Used to Estimate Number of Calls, Mileage and Receipts for Emergency Medical Service

Specify service area and community where ambulance is located.

Sayre and surrounding area

I. Estimate the number of calls for the service area

A. Estimated number of calls for highway accidents = 39

B. Estimated number of transfers (calls transferring patients between hospitals) = 78

C. Estimated number of other medical calls

population by age group	population of service area in thous.	no. of calls per thousand in each age group per year	no. of calls in each age group per year
below 20	1.992	8.57	15
20 - 29	.624	17.07	15
30 - 39	.578	13.66	10
40 - 49	.684	16.82	11
50 - 59	.829	28.04	19
60 - 64	.466	46.42	17
65 - 69	.399	59.91	22
70 - 79	.568	137.32	73
80 +	.310	255.10	107
		Total other medical calls	289

D. Total ambulance calls: 39 (highway calls) + 78 (transfer calls) + 274 (other medical calls) = 400

FIGURE 2. Summary Form of EMS Alternatives Facing Decisionmakers in Sayre, Oklahoma

Form III
Procedure Used to Compare Estimated Annual Receipts and Costs for Alternative Ambulance Delivery System

I. Estimated Receipts	**Alternative Fee Rates**			
	$45	**$55**	**$65**	**$75**
Ambulance Fee $____ x (____ number of calls)=	17,595	21,505	25,415	29,325
Mileage Fee ($1 per mile one way)	12,020	12,020	12,020	12,020
Total receipts	29,615	33,525	37,435	41,245
Receipts at 70% payment	20,730.50	23,467.50	26,204.50	28,941.50
Receipts at 60% payment	17,769.00	20,115.00	22,461.00	24,807.00
II. Estimated Costs	**1st alternative**	**2nd alternative**	**3rd alternative**	**4th alternative**
Specify vehicle	2 Hightop Vans	2 Hightop Vans	2 Hightop Vans	
Communication system	VHF	VHF	VHF	
Labor system	Partially Paid	Volunteer	Volunteer	Hospital
A. Capital expenditures Vehicle depreciation	$ 8,145.00	$ 8,145.00	$ 8,145.00	$ 8,145.00
Communication (Base)	$ 563.50	$ 563.50	$ 563.50	$ 563.50
Communication (Vehicle)	$ 530.00	$ 530.00	$ 530.00	$ 530.00
Building Depreciation	$ 3,470.00	$ 3,470.00	$ 3,470.00	$ 3,470.00
Pagers	$ 530.60	$ 530.60	$ 530.60	$ 530.60
Interest	$	$	$	$
Subtotal	$ 13,239.10	$ 13,239.10	$ 13,239.10	$ 13,239.10
B. Operating Expenses Vehicle	$ 8,532.50	$ 8,532.50	$ 8,532.50	$ 8,532.50
Communication	$ 450.00	$ 450.00	$ 450.00	$ 450.00
Building	$ 1,862.88	$ 1,862.88	$ 1,862.88	$ 1,862.88
Medical	$ 3,755.50	$ 3,755.50	$ 3,755.50	$ 3,755.50
Subtotal	$ 14,605.88	$ 14,605.88	$ 14,605.88	$ 14,605.88
C. Labor costs Subtotal	$ 28,330.	$ 9,366.	$ 7,300.	$ 23,460.
D. Training cost	$ 250.00	$ 250.00	$ 250.00	$ 250.00
E. Miscellaneous	$ 250.00	$ 250.00	$ 250.00	$ 250.00
Total	$ 43,435.88	$ 24,471.88	$ 22,405.88	$ 38,565.88

Annual capital and operating costs for four alternative systems are summarized on the bottom portion of the form. The first alternative involves a system with volunteers and paid personnel. Total estimated annual costs equalled $43,435.88. The second and third alternatives include volunteer systems whereas the last is a hospital based system.

In this example, if 70 percent of patients pay their bills and a $65 base charge plus $1 per mile is employed, then the volunteer system would break even. If a paid and volunteer system or a hospital based system is desired by local decisionmakers, another source of income or a subsidy of some sort is needed at the $65 base rate.

The budget analysis presents the alternatives confronting the local decisionmakers. The alternatives are constructed to reflect their desires. In addition to EMS budget studies, Extension personnel at OSU conduct budget studies for fire services, clinics, water delivery, solid waste disposal, transportation systems for the elderly, and sewage disposal. [Doeksen, 1981]

Decision Aids for Administration of Delivery Systems

As we worked with decisionmakers, requests involving other decision aids surfaced. In each case, research was undertaken to develop the aids that could be used in future applications. Requests surfaced concerning: (1) optimum location of emergency equipment; (2) least cost service routes; and (3) potential revenues associated with alternative rate structures. Each of these is discussed below.

Optimum Location of Emergency Equipment

The decisionmakers of Bryan County [Lenard, 1980b] decided to create an EMS district to serve the entire county. Location of ambulances is critical to providing the best quality service. Local leaders requested a study to evaluate alternative locations. A general transportation model was used to minimize a linear objective function with respect to specific linear constraints [Oehrtman]. For Bryan County, there were seven possible ambulance locations. These were Caddo, Bokchito, Bennington, Durant, Calera, Colbert and Achille. Once the supply points (locations) were designated, it was necessary to delineate demand areas. These were assumed to follow township lines within the county. This procedure resulted in the creation of 30 demand areas. Road miles from each of the seven supply points to the center of each demand point were computed to determine a mileage matrix. The remaining data needed by the location model are the number of annual calls for ambulance service expected from each demand area. These were estimated as a function of area populations. The computer model was run to determine the least cost combination of locations.

If two locations are desired, the locations which yielded the lowest estimated average response time are Bokchito and Durant (Table 3). By having vehicles at these locations, the estimated average response in miles was 2.4 miles and the maximum was 23.5 miles. The three locations to minimize average response time were Bokchito, Durant and Colbert. Estimated average miles to an emergency dropped to 1.6 whereas the estimated maximum distance remained unchanged. First and second choice solutions are presented. In addition to providing quality of service data as reflected in the response times, costs are estimated for each system. The annual cost of providing service from two locations was estimated as $167,519 whereas the annual cost, if service is provided from three locations was estimated as $187,618. Local decisionmakers must decide whether the increased cost is worth the reduction in response time.

Table 3. Optimum Location, Response Time and Annual Capital and Operating Costs for Two or Three Locations, Bryan County, Oklahoma

Minimize Response Time to Get to Emergency	First Choice		Second Choice	
Two Locations	Bokchita, Durant		Colbert, Durant	
Three Locations	Bokchita, Durant, Colbert		Bokchita, Durant, Achille	
Distance to Emergency (Miles)	Max.	Avg.	Max.	Avg.
Two Locations	23.5	2.4	37.5	2.45
Three Locations	23.5	1.6	23.5	1.7

Least Cost Service Routes

Another decision aid which was developed to meet local requests is a routing model [Oehrtman]. Requests have been received concerning appropriate routes for solid waste trucks and school buses. A recent example of applying the problem to a school system with 102 bus stops to pick up 219 children is used to illustrate the model. Each bus has a capacity of 48 children therefore assuming one route per bus, five buses would be required to transport the children from their homes to school and vice versa.

The area served by the school is presented in Figure 3. All bus stops were numbered and the number of children to be picked up at each stop was indicated. In addition, a mileage matrix was specified which indicated the miles from each bus stop to each other bus stop. The computer routing program was then used to select the five routes which would minimize

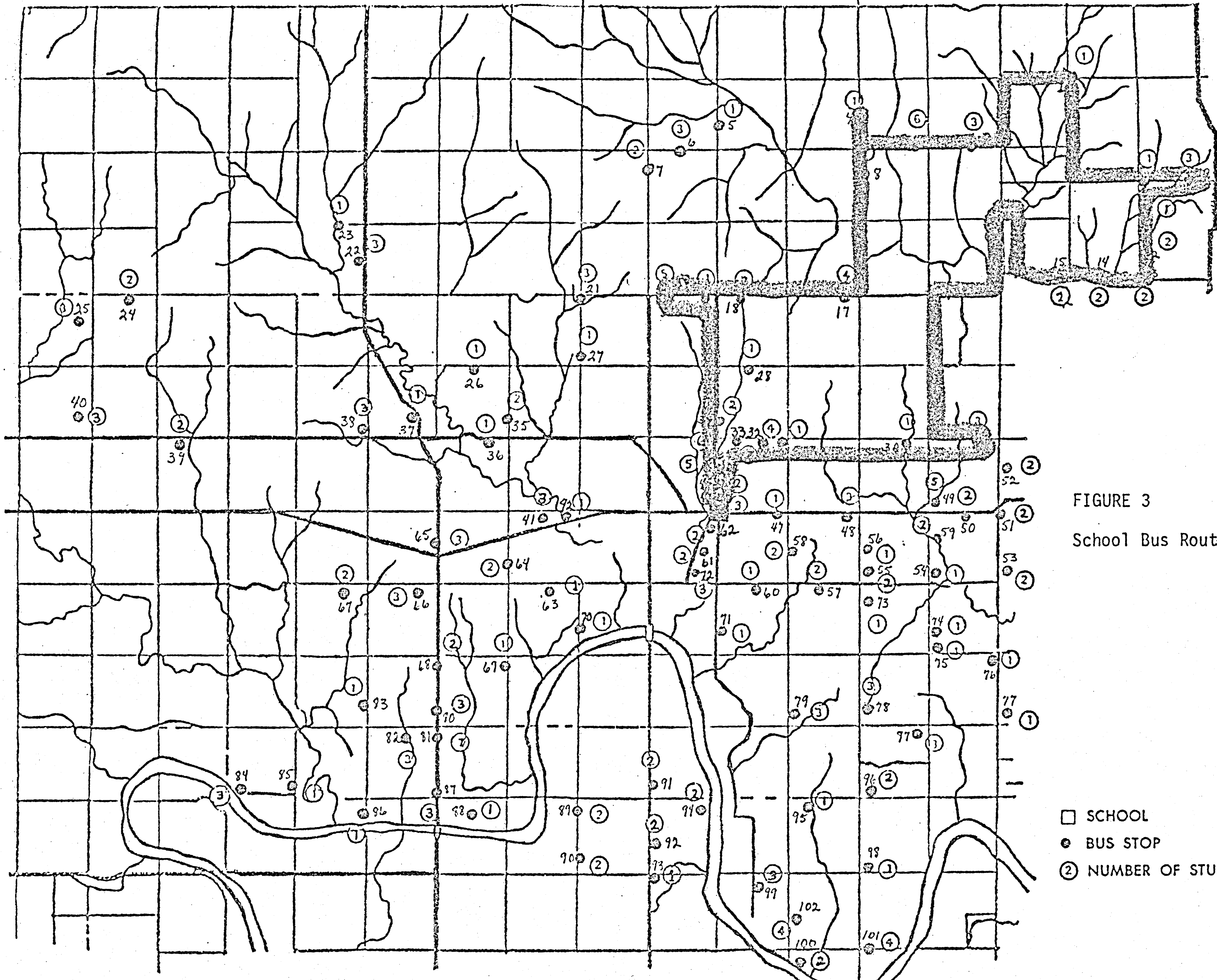

FIGURE 3

School Bus Route 1

miles traveled without exceeding bus capacity or time limits. Route 1 is summarized in Figure 3. The five routes specified by the computer program minimize the mileage traveled by the five buses.

A Utility Rate Structure Model

The estimation of revenues associated with community services that have complicated rate structures (such as water systems) can be a rather complex procedure. A computer program was developed at Oklahoma State University for this purpose.

In order to make the program operable, data must be input on number of users and consumption by user for each month in a year. Alternative rate structures can then be specified and the computer will calculate total revenues which would be generated from these users from each rate structure alternative. [Nelson, 1980]

Decisionmakers for Ottawa County Rural Water District Number 2 in Northeastern Oklahoma requested assistance from Cooperative Extension in estimating revenues which they might expect from alternative rate structures. They wished to compare these revenues with estimates of costs for upgrading their system. The decisionmakers provided appropriate data on system use.

Computer outputs such as the one shown in Figure 4 were then generated for several rate structures. Water district decisionmakers used this information to set new water rates.

Importance of a Research Base

An Extension program which delivers decision aids to local leaders needs a strong and continuing research base. Rural Development researchers need to continue: (1) improving on decision aids by better prediction of community growth and decline and evaluation of impacts; (2) updating and

FIGURE 4. Information Below is Based on the Following Price Scheme:

Under 1500 gallons: flat rate of $7.50

Next 3000 gallons are charged at : $0.110 per 100 gallons

Next 2000 gallons are charged at: $0.080 per 100 gallons

Next 3500 gallons are charged at: $0.075 per 100 gallons

Above 10000 gallons charged at: $0.070 per 100 gallons

Total Water Sales (Dollars) by Month and Use Class

MO	Less Than 1500	1500 To 4500	4500 To 6500	6500 To 10000	More Than 10000	Total
J	803	1281	398	293	125	2899
F	548	565	457	799	1979	4347
M	638	883	677	489	726	3412
A	585	750	604	866	1144	3948
M	525	784	716	753	1051	3831
J	510	761	559	929	815	3574
J	503	620	711	965	878	3677
A	548	601	562	1054	1055	3820
S	578	750	666	826	838	3657
O	623	534	661	943	971	3731
N	683	757	639	777	609	3464
D	660	926	675	660	446	3366
AV	600	768	610	779	887	3644

Total Annual Dollars: $43726.89

improving community service budgets and analyses; and (3) providing new decision aids as new problems surface. A community simulation model is needed which is sensitive to many local issues and can predict important variables over time.

Concerning our community service budget analysis, much research work remains. Specific needs are:

1. to provide better demand or usage coefficients;
2. to determine if a service is price elastic or inelastic;
3. to estimate economies of size;
4. to estimate at what usage levels, additional capital inputs are needed;
5. to provide quality of service measurements; and
6. to continually update budget data.

The Delivery Process

Other than the usual procedure of having the requests go through the county Extension director with assistance provided by the area and state rural development specialist, several features are thought to be critical to successful delivery of rural development decision aids by Oklahoma Cooperative Extension. These include:

1. a team effort involving all related agencies;
2. rapid responses to requests; and
3. specific community reports.

When a request is received, OSU personnel involve all related agencies. For example, if an emergency medical service request arises, personnel from the State Health Department, State Highway Department, Health Systems Agency and Sub-State Planning District become part of a response team. Each agency has expertise to contribute to the solution of a community problem.

Community leaders are impressed by such joint efforts and recognize to whom they may turn if questions arise in specific areas. Since this approach is working, other agencies are aware of our contributions and often refer budget studies to us.

Local leaders appreciate quick response to their crises. Many of the studies have been computerized to facilitate rapid response [Nelson, 1981]. The goal of Extension personnel has been to complete a study within four weeks of the date the request is received. In addition, a computer terminal is often taken along to a community when a final report is delivered, so that other alternatives can be analyzed via telephone connection if community leaders so desire. The computer programs are written in interactive modes so they are easily used and understood by local leaders.

The last unique aspect of the delivery process is to leave copies of final reports with community leaders. Reports include names, agencies and telephone numbers of everone involved with the report. Written reports are good advertisements for Extension as leaders from other communities see the reports and become aware of the assistance which Extension can provide.

These decision aids have built a strong and large clientele. Many community leaders have written the Dean of Agriculture or the President of the University indicating their appreciation of Extension's assistance. If we ever need someone to "go to bat" for Rural Development Extension in Oklahoma, we are confident that the many community leaders for whom Extension has worked will gladly support our programs.

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