J. ENVIRON. SYS., Vol. 4(4), Winter, 1974

SOCIOECONOMIC IMPACTS OF RURAL LAND USE CONTROL: A SIMULATION STUDY

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ABSTRACT

The conversion of land for urban use is of concern not only at the urban fringe but also in the rural hinterlands, where large tracts have been subdivided and sold to urban residents for second homes or for speculation. To examine the consequences of policies for controlling rural land conversion, a systems dynamics model of land use and the economy of a rural California county was developed and simulated. The additional effects of reduced fuel availability on the tourist economy of the county are examined and the potential dangers and benefits of applying simulation methods to the policy making process are discussed.

During the 1960s, the remote rural subdivision became a widespread type of land use in the foothill and mountain areas of California. Alternatively characterized as a "recreational," "second-home," "premature," or "speculative" subdivision (depending on the source of the characterization), the remote rural subdivision may range in size from several hundred acres to 20,000 acres.[1] It is generally of suburban design and is marketed primarily in metropolitan areas as recreational and retirement retreats or as speculative investments.

The scale of recreational subdivision activity is large, as witnessed by the conversion of more than 500,000 acres in California alone between 1960 and 1969 [2]. In 24 northern counties of the state, more than 124,000 rural subdivision lots, encompassing 215,500 acres, were created during the period 1963-1973. While subdivision activity has been hectic, the rate of home-building on these lots has been slow—as of March 1, 1971, only 5,143 homes had been built—representing an annual build-out rate of 0.9 per cent [3].

[1] An excellent description of this phenomenon can be found in [1].

doi: 10.2190/VR55-DRTV-3AYX-85GQ
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In most of the affected counties, traditional economic activities of timber, mining, and cattle raising have declined in recent years, resulting in a decrease in resident population [2]. Yet demands for county services by residents and the costs of those services has risen; however, sources of county property revenues remained relatively constant. Given this situation, it is understandable that the rural subdivision is often viewed favorably by local officials, who see an increase in tax revenues resulting from the conversion of low-value grazing lands to residential property. They further expect service costs to be low because of low building rates. The appeal of the short run gains appears to cause local officials to disregard potential long-run costs that may arise from the subdivision.

Introduction and Background Of the Study Area

One area of California affected by subdivision activity is the counties of the northern Sierra Nevada Mountains. Plumas County, which is representative of these California mountain counties, was chosen as a study site primarily because of reasonable accessibility and a planning department which had conducted studies of county service costs.

Plumas County is located approximately 140 miles northeast of Sacramento, 215 miles northeast of San Francisco and about 570 miles northwest of Los Angeles. Like many rural California counties, Plumas experienced a substantial out-migration of young adults over the past 30 years. Between 1940 and 1970, the number of people age 20 to 34 fell from 3,650 to 1,774 or a drop of 51.4% [4]. The traditional economic activities of mining, lumbering and ranching have decreased in importance while the service and government sectors of the economy have increased substantially. In 1950, 45.9% of all employment was in the basic industries (i.e., agriculture, mining, manufacturing and construction) and 54.1% was in government and service. By 1970, only 29.8% of all employed people were in the former industries, while 70.2% were employed in service industries and government. Despite the substantial out-migration, the average annual unemployment rate has remained at or above 10% since 1960, with the exception of 1968 and 1969. The unemployment is cyclical in nature, falling to approximately 4.0 to 4.5% during the summer and climbing as high as 20% in the late winter and early spring [5].

The major population concentration occurs in the county seat–Quincy–an unincorporated area of 3,343. Three smaller population centers account for most of the remaining people. The major area of second home subdivisions is at Lake Almanor, a reservoir created by the Pacific Gas and Electric Company in the middle 1940s. This lake plus several smaller impoundments have been primarily responsible for the dramatic increase in recreational activity over the past 10 years.

During the period 1960 to 1969, 4,000 lots utilizing 8,000 acres were created in the county [6, 7]. Approximately 60% of the lots were for recreational or second home purposes. The trend has continued with the creation of 389 lots on 1,000 acres in 1970, and with applications for 894 lots using 3,500 acres during 1971 [7]. As of July 1971, there were 368 second homes and 3,330 vacant lots in recreational subdivisions [7]. Approximately 4,500 additional sites, which can be converted into second home subdivision lots, were owned by developers.

Modeling Philosophy and Approach

To investigate the effects of subdivision control policies that are available to local decision makers, a socioeconomic and land-use model of Plumas County was developed. The modeling approach chosen for this study is a modified version of the systems dynamics method introduced by Jay Forrester and his associates at MIT [8, 9]. Because of the heated debate that Forrester has generated, especially in academic circles, it is appropriate to consider some of the criticisms of his work and to state our position with regard to these methods.

Two major areas of objection have been voiced by most critics. First, is the disregard that Forrester shows for the use of actual data in his models [10, 11]. His models are intendently mental constructs that are designed to simulate the major characteristics of systems, either urban, industrial, or world systems [12]. Many critics, especially economists, have criticized Forrester for his total neglect of empirical data and his disenchantment with statistical methods, e.g., regression analysis, that is typically used by economists in their modeling efforts [9]. Therefore, it is not entirely surprising that Forrester has generated heated response from economists, and other practitioners who rely heavily on statistical estimation methods [11]. We feel that this heated, and sometimes vitriolic, exchange is unfortunate because it tends to overlook some real advantages of Forrester's approach to systems modeling. There is nothing in the basic systems dynamics method, with its level and rate equation structure and the use of multiplier functions to modify the rate equations, that prevents the use of empirical data or statistical methods for estimating parameters. A fine example of the combination of econometric methods within the system dynamics formulation may be found in the regional simulation by H. R. Hamilton and his associates at Battelle Laboratories [13].

Our position on the use of system dynamics is compatible with that of Hamilton et al., which is to make use of the best features of the systems dynamic approach and to use available data and statistical methods for estimating parameter values and relationships among variables. We recognize that lack of knowledge of behavioral relationships and lack of adequate data will always face a modeler of socio-economic systems. To fill these gaps until better information is available, we accept the reliance on expert opinion. In our model, the equations are not all written in the multiplier form that are characteristic of *Urban Dynamics* and especially of *World Dynamics*. Some rate equations may be written as linear equations or transformed linear equations that emerge from a regression analysis.

The second major area of criticism of Forrester concerns his excessive promotion of this methods as a panacea for the solution of our social ills. Forrester would have policy makers base their decisions entirely on the results of his simulation studies and has proposed training a large cadre of systems dynamicists who would provide the necessary information for politicians and decision-makers. In this way, decision-makers could avoid the perils of intuitive thought that Forrester has pointed to on various occasions [12]. Forrester has been quite clear in promoting a technocracy in which politics is replaced by computer simulation techniques as a basis for decision-making and public policy [14]. We feel that this is a dangerous position for several reasons. Even if the state of our knowledge about human behavior and the data were sufficiently complete to build an accurate socio-economic model, we would still face the questions of defining what is the public interest; what are appropriate criteria for evaluating alternative policies; what value biases underly the choice of factors and relationships that are included in the model; how does one choose evaluative criteria [14]. It is possible that a utilitarian welfare calculation would lead to the selection of policies that consistently neglect the preference of certain groups. Such a situation might lead to dysfunctional responses that are unlikely to be included in a system model. The technocratic mode, based on computer studies, cannot account for the benefits that result from the political resolution of conflict over goals and values—imperfect as that political process may be.

In one of the most incisive critiques of Forrester's work that has been published to date, Leo Kadanoff has demonstrated that the result of Forrester's urban model and the policy recommendations that emerge from it depend strongly on Forrester's value biases, which determine the assumptions used and the structure of the model itself. By making minor changes in this model, but essentially using all of its basic elements, Kadanoff comes up with entirely different policy recommendations. He summarizes:

> I do not suggest that these conclusions should be considered as a reliable result of the careful analysis which has been based on a fully evaluated model. On the contrary, the results are different in point of view and in substance from the stated conclusions of Forrester's examination of the very same model. He and I have each used the model to explain our different points of view and to put our reasoning in numerical form.
>
> Models like this one provide an illuminating way of discussing public policy issues. However, the discussion would give more light if the model were more realistic [10].

Kadanoff demonstrates neatly and with great skill the dangers inherent in accepting the results of the model, especially one that is uncalibrated. He is much more modest in his objectives, which are to use the model as a learning device and to examine the results of different value assumptions and different views of how the system of interest functions. The issue of values comes into account when one compares alternative policy measures.

As part of its use as a learning device, the model can provide a forum for discussion between analyst, decision-makers and other interested parties. The potential benefits of using simulation models in such an interactive fashion to help define problems and explore assumption and value conflicts, has been discussed at length by Goldberg [15], who has had extensive experience in this area as a key figure in the large Vancouver regional simulation modeling program. Goldberg indicates that a major problem is making the model available to interest groups that are not powerful and highly visible as well as to decision makers and organized interests, who usually have access to such information. He shows a concern, expressed also by other social critics, that information and technology (in this case computer technology) are not neutral in their application. Differences in access and in resources with which to employ such technology result in changes in political and economic power–most often in the direction of greater maldistribution. Goldberg proposes several possible means by which public access may be improved, including public workshops and the use of legal aid advocates to help citizens utilize information.

Despite the criticism of Forrester's approach and conclusions, some of his critics see great value in his techniques. Kadanoff states that Forrester's model making ". . . is so brilliant and beautiful that his ideas are certainly worthy of examination and further development. I would reject the conclusions but accept the model as an appropriate basis for further work" [10]. This is indeed high praise coming from a scientist who has worked with much more precise models and also has considerable knowledge of urban systems and urban problems.

While we may be somewhat more reserved in our praise of Forrester's model making, we do feel that it represents a breakthrough in building models of complex systems.[2] Using his level-rate structure, which breaks the rate equation into normal rates and multipliers that modify the normal rates, one is able to build a model from the component relationships that reflect the underlying dynamics of the process.

EQUATION STRUCTURE

The level variables (state variables) describe the condition of the system at any particular point in time. The rate variables specify the way in which the levels are changing at any time. Most of the rate equations are constructed from normal rates and multipliers, which are functions of other auxiliary variables. The system of equations consists of nonlinear, coupled, first order differential equations, where the rate variables can be functions of any or all of the level variables of the system. The system of differential equations is solved by numerical integration, in our simulation by calling the CSMP INTGRL function.[3]

[2] See [16] for more complete discussion.

[3] The model is programmed in CSMP-73, a version of the IBM-CSMP that was written for the Burroughs B-6700 by one of the systems programmers at the University of California, Davis.

A typical equation describing second home activity is shown below:

Number of Second Homes (present year)	=	Number of Second Homes (last year)	+ Number of Second Homes built during year
	–	Number demolished during year	

The last two terms are rates. The rate equations are written in terms of a normal rate that is modified by attractiveness or incentive multipliers. To illustrate, the rate of addition of second homes is expressed as:

Number of Second Homes built during year	=	Attractiveness-to-build multiplier due to property tax ratio	X	Attractiveness-to-build multiplier due to vacancy ratio
	X	Attractiveness-to-build multiplier due to environmental quality	X	Normal building rate

At the reference state, the multiplier values are defined to be 1.0 and the number of second homes built per year is equal to the normal building rate times the number of vacant lots (potential homesites). As the system departs from its reference state, the attractiveness-to-build multipliers change in value to reflect the new values of the variables that affect the building rate, i.e., tax rate, vacancy ratio, environmental quality.

The critical problem in building a system dynamic model is to construct the rate equations by determining the appropriate multiplier functions from the available data base. Where data is lacking, we accept the Forrester approach of using the considered opinion of knowledgeable individuals. For Plumas County, there was substantial useful data already available [5, 6, 7]. We also had detailed discussions with knowledgeable citizens and local officials[4] who helped us obtain a better understanding of the system. Examples of information collected in this manner were the amount of land subject to development (i.e., potential developable sites) and the effect of increased taxes on the rate of tax delinquency. These individuals provided us with information about the thinking of the population on further development of second home subdivisions and recreation areas.

Development of the Model

The model consists of three sub-sectors as shown in Figure 1. The sectors are highly interrelated and the division is in some ways arbitrary. From a conceptual

[4] Among those interviewed were the County Planner, County Engineer, Agricultural Extension Agent, Chamber of Commerce President, tax collector, and county assessor.

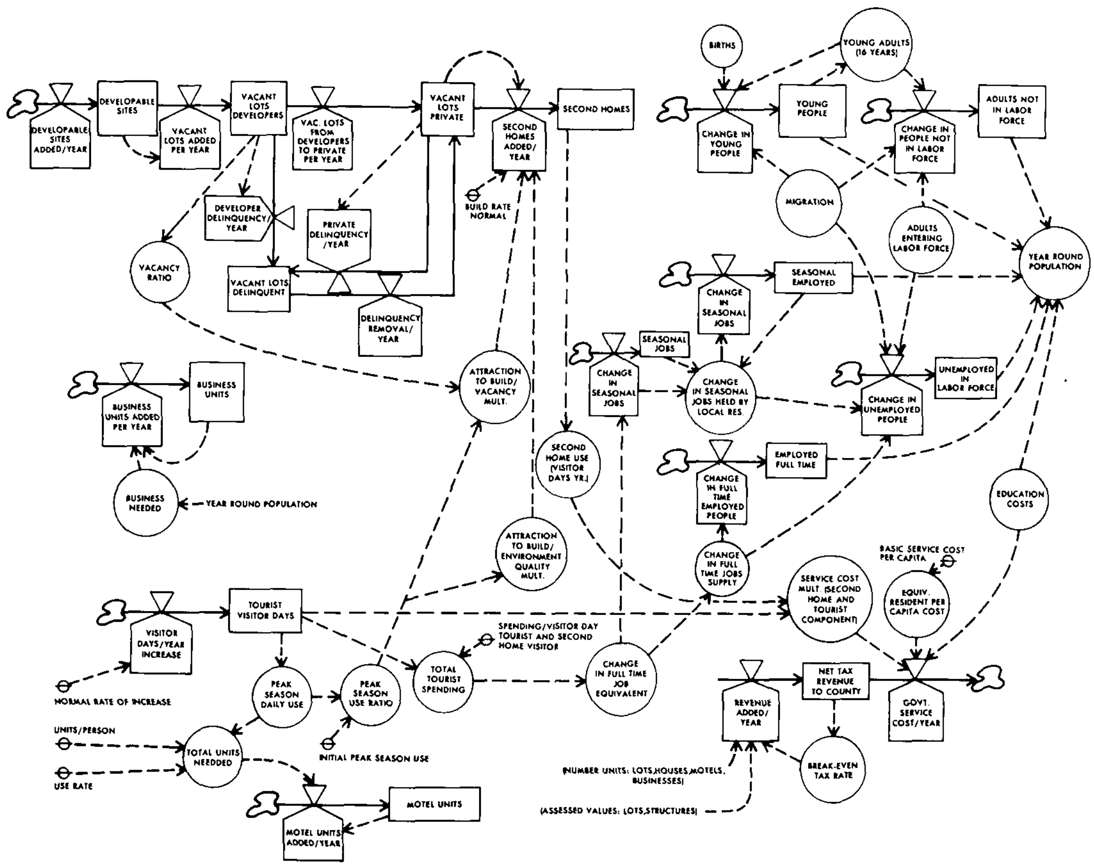

Figure 1. Flow diagram for model.

standpoint, however, it makes sense to talk about a second home and vacant lots sector, a population and employment sector, and a tourist and business unit sector. There are 13 level variables: developable sites, vacant lots (privately owned), vacant lots (developer owned), delinquent lots, second homes, tourist visitor days, business units, motel units, and five classes of population—young people (age 0-15), adults not in the labor force, unemployed persons in the labor force, persons employed in seasonal jobs, and persons regularly employed (more than 26 weeks per year). The initial values of the levels and other constants are tabulated in Table 1.

SECOND HOME SECTOR

Lots are developed from the stock of potential homesites at a rate that is controlled by developers unless local governments intervenes (control strategies #1 and #2). Developed lots are transferred to individuals by means of a sales rate variable that is influenced by property tax levels and the level of environmental quality. Tax delinquency (i.e., not paying property taxes) by individual owners

Table 1. Initial Conditions and Constants of the Model

	Initial Value of Levels:		
Developable sites (NDS)	= 4500	Employed adults seasonal (NP4)	= 1617
Vacant Lots (private) (NVLP)	= 1687	Employed full time (NP5)	= 4116
Vacant Lots (developer) (NVLD)	= 1643	Second Homes (NSH)	= 368
Lots delinquent (NVLDL)	= 132	Tourist days (NTVD)	= 3,000,000
Young People (NP1)	= 3312	Motel Units (NMU)	= 593
Adults not in Labor Force (NP2)	= 2391	Business Units (NBUR)	700
Unemployed adults (NP3)	= 271		
	Normal Rates:		
Sales of Vacant Lots (SRN)	= .10	Lot delinquency (private)	= .04
Potential site development (DSCM)	= .10	Lot delinquency (developer)	= .04
Second Home Building (BORN)	= .015	Tourist visitation increase (NRI)	= .05
	Expenditures		
Spending required to add one employee	= $40,000		
Second home resident visitor day	= $1.50		
Tourist Visitor Day	= $2.16		
	Assessed Valuation:		
Year-round home (AVYR)	= $ 3,500	Motel Unit (AVM)	= $2,000
Second Home (AVSH)	= $ 3,475	Other Properties (AVNOP)	= $ 125
Business Unit (AVB)	= $10,000	Vacant Lots (AVVL)	= $ 500
	Government Service Costs		
Education (EDCST)	= $815/pupil per year		
Police, fire, public works (BSC)	= $150/resident		
Vacant lots (BSCL)	= $45.00/lot		
Other properties (BSCOP)	= $2.00/acre		

and developers is included in the model with the assumptions that individual delinquency is a function of tax rate and developer delinquency is a function of the fraction of unsold lots. Second home building is affected by the property tax rate, vacancy ratio (i.e., the number of homes divided by the total number of lots) in the second home subdivision and environmental quality. By second homes we mean structures which are not the primary residence of the owners.

The measurement of environmental quality is based on the peak-season crowding ratio, which assumes that attractiveness-to-build will decrease as peak-season crowding and environmental degradation increases. This is an aggregated and somewhat indirect measure of variables which affect an individual's perception of environmental quality, e.g., air pollution, noise, water pollution and traffic congestion. The peak-season crowding ratio is more directly related to noise and traffic congestion and least related to water quality.

POPULATION AND EMPLOYMENT SECTOR

The total population is divided into five categories: 1) young people, age 0-15 (NP1); 2) adults, not in the labor force–all persons above age 15, not seeking employment (NP2); 3) unemployed adults 16 and over in the labor force (NP3); 4) adults employed seasonally–less than 26 weeks per year (NP4); and 5) adults employed fulltime–more than 26 weeks per year (NP5). The major variables affecting population growth are births, deaths and the creation of new jobs. The number of births per year depends on the number of permanent residents and the unemployment rate–the higher the unemployment rate the lower is the incentive to have children. Mortality rates are estimated for each population group to reflect the difference in age composition. These are assumed to remain constant throughout the simulation period.

The other major component of demographic change is migration, which has been an important factor in rural areas of California for at least thirty years. The net out-migration is the result of young unemployed adults who leave the county. This loss is only partially compensated by older retired or semi-retired persons who have immigrated to the area. When unemployment is high compared to the base period, a net out-migration is produced by the model. The majority of these migrants are assumed to be unemployed adults (NP3), the balance consisting of young people (NP1) and adults not seeking employment (NP2). When unemployment is low relative to the base period, there is net in-migration [13].

As implied above, employment is critical to the modeling of population changes. It is assumed that one "job-equivalent" is created for each $40,000 of additional spending by tourists and second homes residents.[5] A "job equivalent"

[5] This figure was derived from recalculating the results of the input-output study of Drake et al., [17] allowing for a 25% inflation factor over the six year period and lower multipliers for Plumas County than Tuolumne County.

is defined as one full-time job. In reality, only a fraction of new jobs are actually full-time, some are seasonal. This fact is reflected in the model by separation of the "full-time job equivalent" into full-time and seasonal jobs. It is assumed that each job equivalent consists of two seasonal jobs and 0.5 full-time job. All full-time, most are seasonal. This fact is reflected in the model by separation of year-round residents. The remaining seasonal jobs are filled by non-residents who migrate in for the summer season. All residents filling either full-time or seasonal jobs are drawn from the unemployed category (P3).

TOURIST AND BUSINESS SECTOR

Tourists are defined as other than second home users who visit the county for recreation or other purposes. The level of tourism at time t is determined from the previous value and the change in tourism from t-1 to t, which depends on the environmental attractiveness multiplier.

The calculation of the number of motel units needed (NMU) is based upon the level of tourism and the peak-season vacancy ratio (PSUR). PSUR is defined as the average percentage of motel units vacant during the period June 1 to September 1. If the number of units needed is larger than the number available, the difference is added over a three year period (exponential delay).

The calculation of the number of business units other than motels needed comes directly from year-round population. There appear to be only a few businesses which are primarily dependent upon tourists. Larger establishments rely primarily on year round residents. Therefore, tourists affect the creation of non-motel business units through their expenditures which provide new jobs and encourage population growth.

The Break-even Tax Rate

Information from each of the sectors feeds into the calculation of the break-even tax rate (BETR)–i.e., the tax rate necessary to equate expenditures with revenues. The costs considered are net of all subventions (reimbursements from the state or federal government), which means looking at only the portion of local expenditures that are supported by property tax revenues. The break-even tax rate is used as the basic measure for evaluating policy alternatives. While the tax rate is, admittedly, a limited criterion for evaluation, it is a major factor considered by local decision makers. Other criteria which can be used in conjunction with BETR for evaluation of the merit of different policies will be discussed in a subsequent section.

The major costs which must be considered are education and basic services (i.e., police, fire, roads, and welfare) for each of the land use types. Educational costs are calculated directly from the year-round population by determining the fraction of people of school age and multiplying by the educational cost per student. Other components of government service costs are calculated from a normal rate per capita and multipliers which reflect increasing per capita costs with increasing resident and tourist population [18]. The costs of servicing vacant lots and non-urban properties were added to obtain the total service cost [6]. These basic service costs were assumed to increase at an annual rate of 11% over a five year period based on a locally prepared report [6].

The sources of revenue considered are property taxes on vacant lots, second homes, permanent homes, motel units other business units and all other non-urban properties. Sales taxes and other locally generated revenues are assumed to remain at a constant percentage of total local revenues. Because of the relative isolation of the county, it is unlikely that a regional shopping center would be built so as to substantially change the sales tax picture. Therefore, for this study only property tax revenues were considered.

Policy Alternatives

The baseline run assumes no direct control policy (the null alternative–P0). Limitations on growth result only from internal feedback from the environment. There are two basic internal controls. The first results from changes in environmental quality that are caused by increases in the total number of tourists and second homeowners. As crowding increases the rate of growth of tourism, lot sales, and second home building is reduced. The second "natural" control is the tax rate multiplier which modifies the build-out rate of second homes.

Control policy #1 (P1) permits no further lot development when the vacancy ratio exceeds 50 per cent,[6] a form of control that could be exercised by the refusal of county supervisors to grant subdivision applications. This policy is effected in the model by a multiplier which reduces the rate of transfer from developable sites to vacant lots to zero.

Control #2 is a milder form of #1 and allows transfer from developable sites to vacant lots but at very low rates when the ratio of second homes to developed lots is low. This policy is effected in the model by extending the table used for control policy #1.

The third control policy limits tourism rather than second home construction or vacant lot development by limiting development of recreational facilities and access to the area. The limitation of facilities development enters the model through the tourism attractiveness-multiplier-due-to-environmental-quality, which has been previously referred to as the crowding indicator.

[6] This policy was one of a number of proposals embodied in a series of bills (AB 1300-1304) to deal with remote subdivisions introduced during the 1970 session of the California Legislature. While this particular proposal was killed in committee, a large percentage of suggestions were passed and signed into law.

Analysis of Simulation Results

The results of the control policies are tabulated in Table 2. The relevant variables shown are year round population (YRP), young people (NP1), adults over 16 not in labor force (NP2), unemployment rate (peak-season, UNEMR), number of vacant lots (TVL), number of second homes (NSH), number of tourist visitor days (NTVD), and break-even tax rate (BETR).

The results of the baseline run P_0 indicates that over the thirty year period there is a 9.1% increase in year round population; however, there is a significant change in the composition of the population. In the base year 28.3% of the population is in NP1 while in year 30, only 20.1% of the population consists of young people. Furthermore, an absolute decline in the number of people is projected for this category. Meanwhile, the proportion of the population consisting of adults 16 and over not in the labor force is estimated to go from 20.4% in the base year to approximately 31.0% by year 30. It is projected that there would be a 65% increase for this group over the simulation period. Such demographic changes will require a shift in government expenditures from education to welfare, health and police protection. Finally, each of the control policies result in approximately the same total population at a given time.

For all of the simulations, the unemployment rate rises from 4.5% to 5.5% during the peak season. Therefore, unemployment rates would be in the range of 16-20% during the winter or off-season.

The major differences between policies occur in the tourist and second home sector. The results in Table 3 show that there is some slight interaction between second home/vacant lot activity and the number of tourists visiting the county. The greater the number of vacant lots and second homes, the lower is the number of tourist visitor days. This is due, in part, to the fact that tourists and second home owners both affect the crowding or environmental quality multiplier. As one group increases, it reduces the attractiveness of the area to the other group.

Two major concerns of local policy makers with regard to recreational subdivisions are: 1) the actual amount of building and 2) the rate of delinquency. Policies P_0 and P_3 result in approximately the same proportion of lots with second homes (9.6%) in year 30 as in year 0. In contrast, policies 1 and 2 result in substantially higher levels of building with approximately 24% and 17% of total second home sites being built on.

Under all of the simulations, the percentage of delinquent lots at the end of the third decade is between 12.5% and 15%. Even though P_1 has the highest rate, because there are fewer total lots, it has the smallest number of delinquencies. This indicates that if conditions remain unchanged there may be an increase in delinquencies from the present 4%.

All of the control policies produce a lower tax rate than the no-control alternative. If the policy maker is sensitive to the tax rate this result would suggest he carefully consider the value of a control policy. P_1 is superior at year

Table 2. Simulation Result for Three Control Policies and Tourism Increase Rate of 5 per cent, Plumas County

Year	Control policy[a]	Resident population	Number of delinquent lots	Total of vacant lots	Second homes	Tourist visitor days (in millions)	Tax rate (per $100 assessed)
0	None	11,707	132	3,462	368	3.00	6.08
10	None	12,211	755	7,210	564	4.67	8.22
10	P_1	12,211	412	3,288	542	4.67	8.01
10	P_2	12,211	452	3,773	544	4.67	8.04
10	P_3	12,191	748	7,209	570	3.99	8.07
20	None	12,530	1,310	10,818	916	6.49	8.86
20	P_1	12,529	434	3,100	730	6.50	8.49
20	P_2	12,529	550	4,177	750	6.49	8.54
20	P_3	12,444	1,257	10,800	934	4.38	8.39
30	None	12,767	1,936	14,434	1,358	8.18	9.48
30	P_1	12,765	451	2,946	884	8.22	8.99
30	P_2	12,766	665	4,691	941	8.22	9.07
30	P_3	12,596	1,785	14,321	1,480	4.53	8.59

[a] P_1 = number of new lots approved when less than 50% of total lots are built on.
P_2 = reduced rate of lot approval.
P_3 = reduction in the rate of creation of campgrounds, roads and other recreational facilities.

ten but in year 20, P_3 provides a lower rate. By year 30, the tax rate under P_3 is $0.40/$100 assessed value less than the next best alternative (P_1) and $0.89/$100 assessed value less than the no control policy.

Effect of Energy Shortages—Alternative Models

Recent events have seriously affected the availability and price of petroleum. To test the implications of limited fuel supplies two additional simulations were run. The first, called model A, assumed that tourist visitor days would increase at a rate of 2% instead of the historical rate of 5%. The second, model B, assumes not only the lower rate of increase but also an initial drop of 25 per cent over the next two years compared to the 1970 level.

The results of alternative models (shown in Tables 3 and 4) are similar to those reported for the base model. However, population growth is slower, unemployment is higher and the shift to an older age distribution is slightly more pronounced. One major difference between these models and the base model is that the break-even tax rate is lower in these models. A second and more important difference is that the preferable control strategy is P1 rather than P_3 in both models A and B. In any case, all control strategies are better than the no action alternative with the exception of controlling tourist facilities in model B over the first 20 years. It is not surprising that controlling these facilities would have little effect for this model since with the initial 25% drop, there would be immediate excess capacity. It is not until tourism is substantially above the 1970 level that a policy controlling facilities has any effect.

Summary of Results

In both the base model and the models that incorporate the possible effects of energy shortages, the control strategies provide lower break-even tax rates than the no action alternative. Some reflections about the models provides an explanation for the observed behavior. Vacant lots which have been considered large net revenue producers are estimated to just about break-even from year 10 on. Also a planning department study [6] estimates that second homes will be net revenue consumers in Plumas by year 10, which leaves only other properties (i.e., agricultural, forest, and utility land) commercial, and industrial land uses as net revenue producers. Since service costs per capita increase with resident and tourist population [6, 18, 19] a larger population causes an increased tax rate. Therefore, a strategy that encourages production of second homes, vacant lots and tourism ultimately causes higher tax rates. Apparently, a policy that reduces either second homes or tourism, leads to a reduced tax rate.

Table 3. Simulation Results for Three Control Policies and Rate of Tourism Increase of 2 per cent, Plumas County

Year	Control policy[a]	Resident population	Number of delinquent lots	Total of vacant lots	Second homes	Tourist visitor days (in millions)	Tax rate (per $100 assessed)
0	None	11,707	132	3,462	368	3.00	6.08
10	None	12,172	741	7,208	572	3.63	8.00
10	P_1	12,172	402	3,286	544	3.63	7.78
10	P_2	12,172	442	3,771	546	3.63	7.81
10	P_3	12,170	740	7,208	572	3.52	7.97
20	None	12,433	1,253	10,797	940	4.31	8.37
20	P_1	12,432	404	3,089	741	4.31	7.98
20	P_2	12,432	516	4,171	762	4.31	8.04
20	P_3	12,414	1,241	10,795	943	3.82	8.27
30	None	12,607	1,799	14,318	1,484	5.02	8.69
30	P_1	12,604	395	2,900	930	5.03	8.16
30	P_2	12,604	596	4.660	1,000	5.03	8.24
30	P_3	12,563	1,761	14,305	1,499	4.02	8.48

[a] P_1 = number of new lots approved when less than 50% of total lots are built on.
P_2 = reduced rate of lot approval.
P_3 = reduction in the rate of creation of campgrounds, roads and other recreational facilities.

Table 4. Simulation Results for Three Control Policies with a 25 per cent Drop in Total Tourist Visitor Days Due to Energy Crisis and a 2 per cent Rate of Tourism Increase, Plumas County

Year	*Control policy*[a]	*Resident population*	*Number of delinquent lots*	*Total of vacant lots*	*Second homes*	*Tourist visitor days (in millions)*	*Tax rate (per $100 assessed)*
0	None	11,707	132	3,462	368	3.00	6.08
10	None	12,142	718	7,193	590	2.71	7.58
10	P_1	12,142	389	3,271	589	2.71	7.36
10	P_2	12,142	429	3,762	591	2.71	7.39
10	P_3	12,142	718	7,193	590	2.71	7.58
20	None	12,394	1,221	10,772	975	3.30	8.16
20	P_1	12,393	388	3,067	763	3.30	7.76
20	P_2	12,393	499	4,170	786	3.31	7.82
20	P_3	12,393	1,220	10,772	975	3.22	8.15
30	None	12,561	1,751	14,281	1,538	3.95	8.46
30	P_1	12,558	376	2,874	956	3.96	7.92
30	P_2	12,559	577	4,670	1,030	3.96	8.01
30	P_3	12,550	1,740	14,279	1,540	3.62	8.40

[a] P_1 = number of new lots approved when less than 50% of total lots are built on.
P_2 = reduced rate of lot approval.
P_3 = reduction in the rate of creation of campgrounds, roads and other recreational facilities.

Concluding Comments

Our experience leads us to believe that the approach to modeling presented here can increase the understanding and insight of the analyst and, hopefully, the decision-maker. The description of the method is offered with those aims in mind, not with the intent of providing correct answers to a complex problem.

In the context of the goals set for this investigation, the use of the tax rate calculation as a major decision variable is reasonable (and mirrored that used by actual decision-makers). However, the tax rate is only one of many variables which should receive consideration in the evaluation of alternative policies. At a minimum, we would suggest a multi-attribute model which would include the following items:

1. Environmental and ecosystem impacts, e.g., air water, and land quality, vegetation and wildlife. These items are required to be discussed in environmental impact reports (EIR's), which must be filed for private projects such as subdivisions under the California Environmental Quality Act (1970) [20].
2. Impacts of policies on equity goals–i.e., how different income or interest groups are affected differently.
3. The effect on recreational benefits of additional development.
4. Other socio-economic impacts that result from the changing age distribution of the population.

The expansion of the decision criterion from a single attribute to a multi-attribute function will necessarily complicate the selection of a preferred alternative. A brief look at the already large and rapidly expanding literature on multi-objective decision-making will serve to confirm the difficulties in reaching a satisfactory technical resolution of this problem [21]. However, this should not be cause for despair. We see as the desired objective of policy analysis the exploration of conflicts among goals and values and the provision of information about the probable gains and detriments to different groups that is necessary to promote a more informed, rational, and democratic political process. Goldberg is to the point: "... the present political process needs information to function and it is this information that we see as our ultimate goal" [15].

ACKNOWLEDGMENTS

We wish to thank T. H. Long for his excellent programming help, Michael Kent for collecting the data, and Barbara Sloan and Rick Parrish for their helpful suggestions which improved the model. We are also indebted to several citizens of Plumas County, especially Larry Fites, Darrell Payne, Bob Moon, Art Scarlett, Mrs. Alexander, and Dow Bettis who gave generously of their time and knowledge. This research was supported by a grant from the Rockefeller Foundation to the Division of Environmental Studies, University of California at Davis and by a supplementary grant from the Social Science Data Processing Service, also at Davis.

REFERENCES

1. James J. Parsons, "Slicing Up the Open Space: Subdivisions Without Homes in Northern California," *Erdkunde*, Vol. 26, No. 1, 1972, pp. 1-8.
2. California Department of Conservation, Division of Soil Conservation, *The Environmental Impact of Urbanization in Foothill and Mountain California*, Sacramento, 1971.
3. Thomas E. Dickinson, "Remote Subdivision Activity in 24 Northern California Counties, 1963-1970," unpublished data.
4. University of California, Agricultural Extension, *Plumas County Selected Economic Data*, Quincy, California.
5. California Department of Human Resources Development, *California Manpower Indicators from the 1970 Census, Plumas County*, Sacramento, July 1972.
6. L. A. Fites, *Plumas County Taxation Impact Study*, Office of the Planning Director, County of Plumas, Quincy, California, May 25, 1972.
7. L. A. Fites, Vacant Lot Study in Plumas County, Office of the Planning Director, County of Plumas, Quincy, California, September 1, 1972.
8. Jay W. Forrester, *Principles of Systems*, Cambridge, Massachusetts: Wright-Allen Press, 1968.
9. Jay W. Forrester, *Urban Dynamics*, Cambridge, Massachusetts: MIT Press, 1969.
10. Leo P. Kadanoff, "From Simulation Model to Public Policy," *American Scientist*, 60 (Jan.-Feb., 1972), pp. 74-79.
11. Martin Shubik, Review, "Modeling on a Grand Scale," of *World Dynamics* by J. W. Forrester, *Science*, Vol. 174, No. 4013, p. 1014, Dec. 3, 1971.
12. Jay W. Forrester, "Counterintuitive Behavior of Social Systems," *Technology Review* 73 (Jan. 1971).
13. H. R. Hamilton, S. E. Goldstone, et al., *System Simulation for Regional Analysis: An Application to River Basin Planning*. Cambridge: The MIT Press, 1969.
14. Theodore Roszak, "Technocracy: Depotism of Benificient Expertise," *The Nation*, Sept. 1, 1969, pp. 180-190.
15. Michael A. Goldberg, "The Last of the Dinosaurs or the First of the Primates: Yet Another Simulation Study," Faculty of Commerce and Business Administration, The University of British Columbia, Vancouver, B.C., Mimeo, 1972.
16. S. I. Schwartz and T. C. Foin, "A Critical Review of the Social Systems Models of Jay Forrester," *Human Ecology*, pp. 161-173, Vol. 1, No. 2, 1972.
17. Ronald Drake, et al., *Selected Economic Consequences of Recreational Development: Tuolumne County, Case Study*, Agricultural Extension, University of California, No. 68-4, Berkeley: August, 1968.

18. William Bryan, *The Effects of Growth on the Urban Environment*, Interdisciplinary Systems Group, Project Report #6 NSF GI-27, University of California, Davis, 1972.
19. Gregory D. Tillson, et al., *Local Tax Impact of Recreational Subdivisions: A Case Study*, Oregon State University Extension Service, Special Report 365, Corvallis: July 1972.
20. Comment, "Aftermammoth: Friends of Mammoth and the Amended California Environmental Quality Act," *Ecology Law Quarterly* 3 (1973) 349-389.
21. A review of the literature and a stimulating discussion of the issues may be found in, Hudson, Barclay M., Martin Wachs, and Joseph L. Schofer, "Local Impact Evaluation in the Design of Large-Scale Urban Systems," *J. American Institute of Planners*, 40 (1974) 255-265.