Dynamic Simulation of Rural Social and Economic Interactions

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INTRODUCTION

The Rural Community Modeler (RCM) presents a prototype version of a simulation model that recreates the behavioral dynamics among many rural community elements. The model forecasts how different community elements will change over time due to the adoption of specific actions or policies or natural growth or aging. In every community, changes result from a combination of natural forces and public policy. RCM describes why these changes occur, how they can be influenced and what to expect in the future. Individuals and organizations using RCM will gain a better understanding of the forces that shape their community as well as insights into actions that will successfully influence those forces. RCM demonstrates how an urban dynamics model might be constructed, how it would function and what supporting data would be required to make the model a functional planning tool. The current model configuration measures community conditions based on changes relative to the initial starting point. Mathematically, the model utilizes ratios of current conditions divided by initial conditions. If current housing conditions improve, for example, relative to the starting point, then the community becomes more attractive. Improvement in housing conditions, however, does not necessarily mean that all substandard housing has been eliminated; only that housing quality has improved. The use of relative measures avoids the requirement for accurate data while still providing reasonable urban behavior. More accurate data, of course, will produce better projections and more realistic behavior.

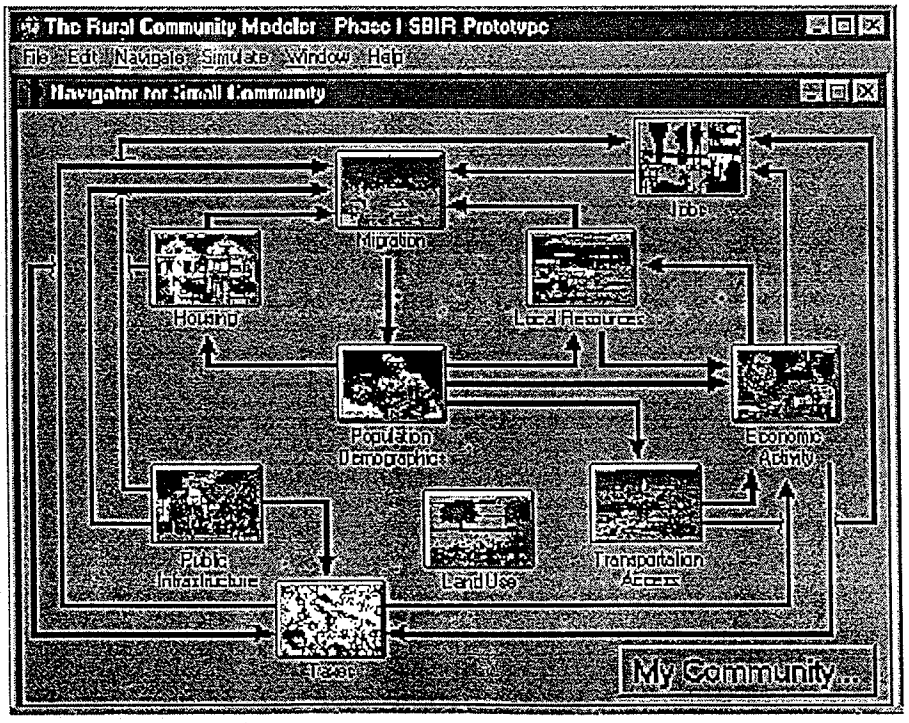

Figure 1 - RCM Navigator Screen

RCM APPLICATION ARCHITECTURE

The RCM program opens with a display of the Navigator screen shown in Figure 1. The Navigator screen displays ten interconnected buttons with topic titles. Each button accesses data about the button topic. The connecting lines and arrows indicate the most important relationships among the topics. These relationships form a rich feedback web that underscores the adage that "everything is connected to everything else." Only the land use button looks unconnected; in reality it has the most connections, linked by two-way arrows to housing, public infrastructure, local resources, economic activity and transportation access. Clicking on one of the buttons displays the data entry window associated with that button topic. The user can enter data into the topic areas by clicking on each button and selecting the topic tabs.

In addition to the ten topic buttons, the Navigator screen contains a My Community button in the lower right corner. Clicking on the My Community button opens a "short-cut" window that allows a first-time model user to bypass the data entry windows by using a few general data points to infer all of the other model parameter values. The data short-cut window is useful for rapid exploration of the model's behavior. However, more experienced model users will want to utilize more refined data, accessed through the topic buttons.

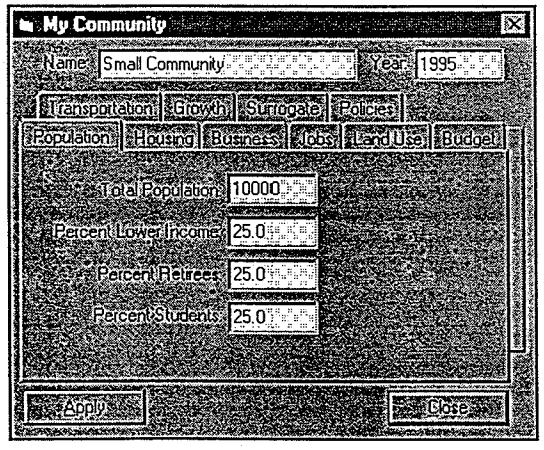

Figure 2 - My Community Data Entry Window (Population Tab)

FEEDBACK STRUCTURES

The Navigator screen shown in Figure 1 displays the model's primary feedback structure. Recognizing the importance of this feedback structure is essential to creating a realistic picture of the dynamics of community change.

Feedback connections among topic areas, while appearing simple on the diagram, become more complicated at the detailed level of model operation. For example, migration in response to job availability depends upon the type of jobs, the wages and the number of jobs. Migration responses play an important role in the model. The movement of people in response to perceived opportunities ultimately determines the size and character of every community. People exhibit clear preferences concerning residential and work locations. While not everyone is able to act on their preferences, sufficient numbers of people do move in response to changing conditions to impact the social and economic makeup of a community.

DATA ENTRY

RCM data entry may follow one of three options. Users may select their community (or its closest analog) from a pull-down menu available in the New Project dialog and use the default data in the program library. These data are sufficient to simulate community dynamics. Another, more detailed method, allows users to redefine one or more of the twenty aggregate data points that appear on the My Community screen. Finally, the user may open the data nodes on the interaction diagram to access any or all of the many hundreds of parameter values that define the community. Because default values define every model variable, the user may overwrite as many or as few of these data as desired (and may save different data sets as separate scenarios).

The multi-level user interface facilitates model interaction and eliminates the need for extensive data-collection prior to model simulation. Over time, as more extensive data becomes available, they may be entered in to the model to update operation. In addition to simplifying data entry, RCM also simplifies both scenario-building and output generation by including a number of pre-defined policy scenarios and output graphs for the first-time user.

HOUSING

Clicking on the Housing topic button will open the display in Figure 3. The arrows depict changes to the three housing types. The vertical arrows represent new construction, defined by the percentage growth in the market per year. (The feedback impacts on housing construction are accessed through the Construction tab.) The horizontal arrows represent the filter-down of housing units over time. Filter-down describes the process whereby aging and obsolescence tend to push housing units down to

lower economic markets. The right-most arrow defines the eventual demolition of lower income housing that has reached the end of its social and economic life span. (The Aging Rates tab accesses the data that defines housing aging rates and life spans.)

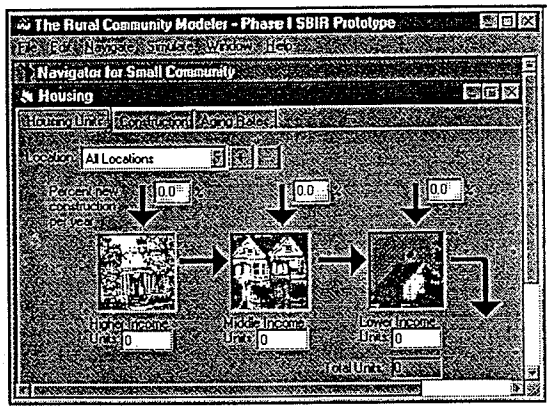

Figure 3 - Housing Window (Housing Units Tab)

In addition to the three types of housing, defined by market pricing, the Location list allows the user to further divide the housing market into as many geographical areas or neighborhoods as desired. The numbers across the bottom of the window indicate the initial distribution of units across the three housing types at the beginning of a model simulation. The user may change these numbers to reflect any specific community.

Within the larger housing market, changing conditions will alter the percent of new construction each year in each price market and in each geographical location. The model includes two multipliers on housing construction; market demand and land availability.

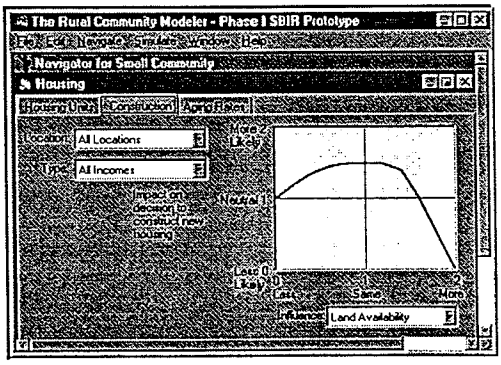

Figure 4 - Housing Window (Construction Tab)

The function displayed in the graph quantifies an assumption concerning the likely response of home builders to changes in housing market conditions. If conditions improve, they are likely to build more houses; if conditions worsen, they are likely to build fewer houses. Clicking on the graph steps the user through several pre-defined assumptions, varying from no effect (flat line) to substantial effect (steepest curve). The model user may test model behavior by substituting their own assumptions concerning market behavior.

POPULATION/DEMOGRAPHICS

Population may be classified along three independent dimensions: age, race and income. Figure 5 shows the five age groups that graphically represent the model structure. The birth rate, shown as a single parameter, is a composite of the three central age groups and separate death rates can be defined for each population age group. The numbers beneath each of the five population age groups identify the number of individuals in each group (by category and income).

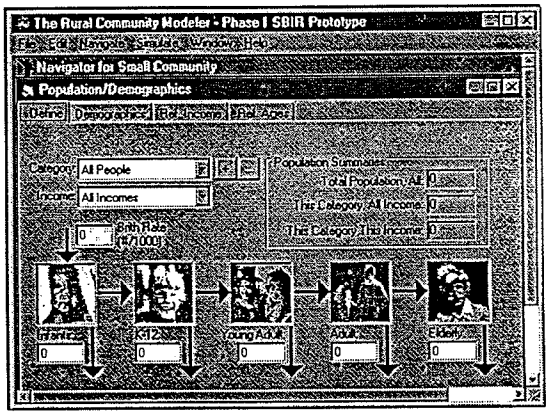

Figure 5 - Population/Demographics (Define Tab)

PREFERENCES TAB

The movement of people into and out of a community constitutes one of the most important dynamic forces at work over time. The model captures these migrational flows and also includes measures of local conditions that can alter these flows. The migration window defines assumptions concerning migrational preferences for each population group and sub-group. Figure 6 shows how the model captures these migrational influences.

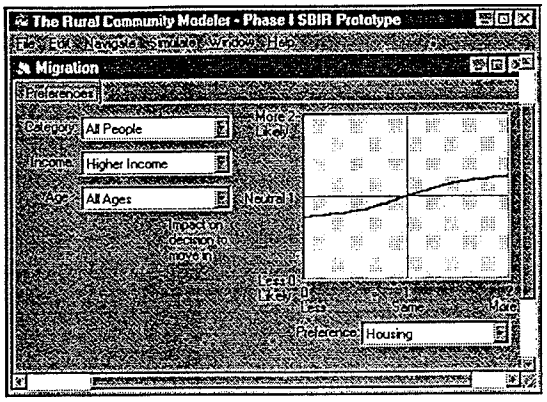

Figure 6 - Migration (Preferences Tab)

The drop down title box in the lower right reveals five influences on household migration:

- Housing availability,
- Job availability,
- Public services,
- Natural resources, and
- Tax rates.

The horizontal axis on the display graph measures changes in community conditions over time. The vertical axis supplies the model with a multiplier value between zero and two that is used to modify the underlying average net-migration flow. For example, if more jobs are created, then job availability will rise and, all other things being equal, more people may be attracted to the community. If more jobs are created at the same time that taxes are raised, then the net effect on migration may be neutral. Clicking on the graph cycles through a set of pre-defined functional relationships that quantify differing assumptions concerning how individuals and households in each of the three income classifications may respond to changing community conditions. The user may select any of these alternative assumptions and test the resulting impact on model behavior.

MODEL UTILITY

RCM will help community planners improve the quality of their planning process in two ways:

- Clarify the cause-and-effect relationships that "connect everything to everything else", and

- Trace the longer-term consequences of alternative "what-if?" plans and policies on the future of their community.

Thinking about and clarifying the many "second-order" community interactions helps both planning professionals and community residents better understand the forces that shape their community. Tracing the impact of decisions aimed at influencing those forces assists everyone establish planning priorities. A sharper understanding of community dynamics and a keener statement of community priorities builds a consensus for action.

RCM may perform a variety of functions. Planners may use the program to assist in defining community variables and interactions. Public leadership may use the program to gauge the relative outcome of alternative policy choices. And, educators may introduce RCM into classrooms to augment their students' learning experiences. RCM's dynamic viewpoint extends beyond traditional analysis to provide a richer description of how real communities function and how they respond to the ever-present forces of time and change.

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