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**Spatial Dynamic Modeling and Urban Land Use  
Transformation: An Ecological Simulation Approach  
to Assessing the Costs of Urban Sprawl**

Brian Deal\*  
and Daniel Schunk\*\*

August 2003

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\*Department of Urban and Regional Planning, email:

\*\*Sonderforschungsbereich 504, email: dschunk@uni-mannheim.de



Universität Mannheim  
L 13,15  
68131 Mannheim

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An Ecological Simulation Approach to Assessing the Costs of Urban Sprawl**

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<sup>\*</sup> Brian Deal is from the Department of Urban and Regional Planning, University of Illinois at Urbana-Champaign, Champaign, Illinois 61820. e-mail: [deal@uiuc.edu](mailto:deal@uiuc.edu)

<sup>\*\*</sup> Daniel Schunk is member of the Sonderforschungsbereich 504 and of the Mannheim Research Institute for the Economics of Aging (MEA), University of Mannheim, D-68131 Mannheim. e-mail: [dshunk@uni-mannheim.de](mailto:dshunk@uni-mannheim.de)

## **A b s t r a c t**

Assessing the economic impacts of urban land use transformation has become complex and acrimonious. Although community planners are beginning to comprehend the economic trade-offs inherent in transforming the urban fringe, they find it increasingly difficult to analyze and assess the trade-offs expediently and in ways that can influence local decision-making. New and sophisticated spatial modeling techniques are now being applied to urban systems that can quickly assess the probable spatial outcomes of given communal policies. Applying an economic impact assessment to the probable spatial patterns can provide to planners the tools needed to quickly assess scenarios for policy formation that will ultimately help inform decision makers.

This paper focuses on the theoretical underpinnings and practical application of an economic impact analysis sub-model developed within the Land use Evolution and Impact Assessment Modeling (LEAM) environment. The conceptual framework of LEAM is described, followed by an application of the model to the assessment of the cost of urban sprawl in Kane County, Illinois. The results show the effectiveness of spatially explicit modeling from a theoretical and a practical point of view. The agent-based approach of spatial dynamic modeling with a high spatial resolution allows for discerning the macro-level implications of micro-level behaviors. These phenomena are highlighted in the economic sub-model in the discussion of the implications of land use change decisions on individual and communal costs; low-density development patterns favoring individual behaviors at the expense of the broader community.

Key words: Dynamic Simulation, Spatial Modeling, Urban Sprawl, Sustainability, Urban Dynamics

## 1. Introduction

An extensive literature exists in the urban planning and regional science fields relating to large-scale urban models. Historically, computer based simulations of urban problems appears to have its origin in the 1950's metropolitan transportation studies (Klosterman 1994) and the geographic accessibility models that resulted. Theoretical urban simulation models for locating residential development and retail centers were added to the previously simple and straightforward transportation models in the 1960's. These successes encouraged a number of ambitious, expensive and highly visible attempts to build large-scale metropolitan simulation models. In 1973 Douglas Lee wrote a cornerstone article in the Journal of the American Planning Association that effectively eliminated large-scale urban modeling research for nearly 20 years. The article, titled *A Requiem for Large-Scale Models*, depreciated the then ambitious attempts to develop large-scale computer models of the metropolis (Lee 1973).

Despite the practical failures of the large-scale modeling efforts, the mathematical programming techniques developed for use in these models were found to be useful for constrained and well structured problems with a specified number of calculable variables, well-defined goals, and firmly established technical solutions (Dendrinis 1985). In 1969, Jay W. Forrester wrote his seminal work, *Urban Dynamics* (Forrester 1970), in which he develops a computer-based dynamic simulation tool to describe the changing fabric of the urban environment. Forrester's modeling tool was focused on a somewhat constrained problem set, but it enabled planners to introduce a temporal approach into previously static methodologies. According to Dendrinis however, these model types still failed to address analytic or empirically verifiable solutions (Dendrinis 1992). Forrester bases his work on his concepts of "industrial dynamics" and "industrial ecology" (Forrester 1961) that can loosely be tied to earlier work by the Urban Ecology movement in the 1920s. Some of the foundational ideas of Urban Ecology were initially broached in, *The Ecological Approach to the Study of the Human Community*, by R. D. McKenzie, and were first published in the American Journal of Sociology in November 1925. This article was intended to emphasize that methods utilized in the study of ecology may be "profitably applied" to the analysis of the human community (Park 1925). Along with earlier works by R. E. Park and E. W. Burgess, it developed in the discipline of Urban Ecology and became a precursor to one of the first ecologically based models of community development.

Advances in dynamic spatial modeling techniques currently used to analyze environmental and ecologically based systems, (Westervelt et al. 1995; Hannon and Ruth 1997; Costanza and Ruth 1998, Deal et al. 2000) are being developed to advance a modern Urban Ecology approach to urban systems modeling (Dendrinis 1992; Deal 1998; Deal 2001). The

technique allows for the incorporation of modern ecological theory, specifically the hierarchical patch theory, to be incorporated into dynamic urban systems modeling. A patch theory model recognizes that different time scales exist in a mosaic of patch locations across a landscape. This suggests that landscape dynamics are not uniform; that the dynamics in one patch of a landscape impact other, seemingly disparate patches. The population of a specific urban community changes slowly, even though each neighborhood may be undergoing rapid and dynamic change. When one neighborhood is in decline, another may be succeeding toward an equilibrium state, even though the larger landscape remains seemingly unchanged. This idea has been used in the ecological economics field to describe the problem of time discounting. Individual discount rates are high (10-20%); individuals typically put a larger value on short-term returns. Societal discount rates however, can be as low as 1-2%, placing more value on designing for the long term (Hannon 1994). To the community, the future can be an order of magnitude more important than it is to the individual (or patch). The community can be characterized as a mosaic of varying discounting ideals (individually high), even though the communal structure itself is more stable and considerate of the spatial reach and impacts of policy related decisions (Hannon 1995; Perrings and Hannon 1996).

Other applications in urban ecology have used a mathematical ecology approach. Mathematical models of the urban dynamic constructed by Allen and Deneubourg (1978) and Wilson (1981) are believed to be among the first attempts to adapt a non-linear ecological approach (Allen and Deneubourg 1978, Wilson 1981). In early ecological economic work, Samuelson recognizes the attractive elements of mathematical ecology (Samuelson 1971). Use of the Volterra-Lotka predator-prey model in Curry (1981) describes occupational competition in a spatially structured labor market. Sonis (1983) also uses Lotka-Volterra in modeling geographic diffusion processes. In terms of explicit urban ecological modeling Dendrinis (1979) and Dendrinis and Mullally (1985) take the concept one step further, addressing dynamic non-linear interdependencies, stability and equilibrium, conditions that they argue are necessary components of urban systems dynamics.

This paper builds on historic urban and mathematic ecology structure to introduce a new large-scale urban modeling technique and its subsequent application to determining the representative, true costs of urban land use transformation. This is accomplished by first describing current trends in American land use patterns, followed by a description of an urban ecological approach to modeling those trends using a spatially explicit dynamic simulation framework. A detailed description of the determination of fiscal impacts related to two simulation scenarios will then be described. Results include a somewhat innately conjectured realization that current low-density sprawl development patterns are preferred because they are relatively cheaper for the developer and individual purchaser at the expense of the broader community

and society as a whole; that is, social and communal costs increase much stronger relative to individual and developer cost, if the development density decreases. We also find that the dynamic spatial visualization features of our model are essential for communicating urban land use change and its impacts, especially for public policy decision makers.

### **Urban Sprawl – a brief overview**

Sprawling land use transformation patterns have been linked to rapid population growth (U.S.CensusBureau, 2002). This is a logical extraction, exponential change in urban populations require a change in services and housing, putting pressure for expansion at the edge of the system to accommodate the additional members. This correlation, however, produces an incomplete picture of the dynamics of change at the edge of urban systems. Some cities, for example Cleveland, OH and Peoria, IL, have stable or declining populations yet still exhibit rapidly expanding urban land uses (U.S.CensusBureau, 2002). Other logical factors associated with the sprawl phenomena are associated with the unprecedented economic prosperity in the US and associated rising disposable incomes. These economic dynamics made the purchase of undeveloped land and the construction of new houses more affordable. In addition, current tax laws and model building codes enable this construction to take place at the fringe where regulation is minimal and tax incentives maximal. Low commuting costs, a tertiary consequence of economic prosperity (through highly subsidized transportation systems), also helps to promote fringe development. Another often-overlooked factor in the sprawl phenomenon is the role of individual choice. An empirical survey conducted in 1991 found that low-density, single-family homes were the preferred living accommodations (Morrill 1991), although some have argued that the lack of alternatives in the new construction and upper-end markets may present a bias.

The impacts of the sprawl phenomena have been well documented recently (Kay 1998; U.S. Geological Survey 2000; U.S. Census Bureau 2002). Low-density patterns of development require an auto-reliant transportation system and produce consequent increases in congestion and commuting times. Not surprisingly, it has been shown that as urban densities decrease, per capita gasoline consumption increases, both nationally and internationally (Newman, 1989). This leads to air quality considerations and the associated costs rendered to human and environmental health. Access to open space and the loss of sensitive ecological and agricultural lands to urbanization are also issues of concern. The U.S. Department of Agriculture's 1997 National Resources Inventory Report (USDA 1997) shows the rate of farmland and other open space losses lost to fringe urban development have has more than doubled in recent years to over 3.2 million acres a year. Additionally, low-density development often occurs in a "leapfrog" pattern that fragments habitat and destroys sensitive wetlands.

The societal implications of low-density fringe development are many and complex. Economic segregation caused by large monolithic developments is most evident at the urban fringe. The migration of these specific income types also causes a 'donut' effect in central core districts. Resources are moved to the fringe, causing social instability and decline at the center, increasing the economic disparity between the central core and urban fringe. An increase in family relocation and mobility may also contribute to this loss of social capital in our urban core areas. Intra and inter urban mobility reduces attachment to place as well as to each other. Without such attachment, our awareness and our concern over the plight of the local environment and over the strength of our social connections are diminished. As a result, environmental and social capital decline (Rohe and Gates 1985; Putnam 1995; Putnam 2000).

One obstacle in developing a regional understanding of fringe land use transformation and its communal implications is the complexity and diversity of the issues and disciplines involved in the discussion. New theory, tools, and methods of research in ecological systems promise to improve our understanding of the dynamics of change in urban environments. We now have access to sophisticated computational and theoretical tools for characterizing ecological systems that can inform complex spatial urban models. A multi-disciplinary, ecosystems modeling approach, using cellular automata modeling techniques, now allow researchers and professionals to address urban land use change in greater detail at a greater variety of scales enabling a more sophisticated analysis of urban land use change and its economic consequences.

## **2. Methodology**

Concurrent with mathematical ecological systems approaches, recent work in urban systems modeling has begun to utilize an arithmetic approach as well. Socioeconomic and geographically based information sets are integrated into dynamic and spatially oriented visualization tools using a Cellular Automata (CA) based data processing and visualization system (Birkin 1990; Batty 1992; Clarke et al. 1996; White and Engelen 1997). A cellular automaton is a discrete dynamic modeling system. Space, time, and the states of the system are represented in a regular spatial grid or lattice, and possess any one of a finite number of states. The states of the cells in the lattice are updated at each time step according to a local rule or a programmed model. The state of a cell at any given time is dependent not only on its local rules for change but also on the states of its nearby neighbors at the previous time step. All cells on the lattice can be considered interdependent relational entities and are updated synchronously, so that the visual state of the entire lattice advances in discrete time steps. CA is typically considered an 'agent based approach', combining elements of many fields of research

in the methodology (Langton 1989; Wolfram 1994; Epstein and Axtell 1996). Assumptions are made concerning the micro-level; behavior can be observed on a micro- and a macro-scale.

In urban systems modeling, a cellular automaton is typically specified to give a spatially detailed representation of the evolution of the urban land-use patterns. Cell states represent land uses; transition rules express the likelihood of a change from one state to another as a function both of existing land uses and the inherent suitability of the cell for each possible use. Engelen et al. (1997) used this technique to represent urban land use dynamics to forecast climate change on a small island setting. Wu and Webster (1998) presented a model that also included user decisions to determine model outcomes. White's St. Lucia model (White and Engelen 1997) is an example of high-resolution CA modeling of urban land-use dynamics and an attempt to use the standard non-spatial models of regional economics and demographics, as well as a simple model of environmental change for predicting the demand for future agricultural, residential, and commercial/industrial land uses. An urban growth model of the San Francisco Bay Area (Clarke et al. 1997) is another example of using relatively simple rules in the CA environment to simulate urban growth patterns.

#### **A Disaggregated, Ecosystem Approach to Complex Spatial Models**

Spatially explicit modeling of complex environmental problems is essential for developing realistic descriptions of past behavior and the possible impacts of alternative management policies (Risser and Karr 1984). The conceptual complexity of formulating, building, and calibrating intricate models and the noted weaknesses with a single modeler paradigm, has led to a general recognition of the need for a more disaggregated, collaborative modeling system. To address the conceptual complexity and collaborative barriers to spatio-temporal ecosystem model development, an integrated environment for high performance spatial modeling, called the Spatial Modeling Environment (SME) has been developed at the University of Maryland Institute for Ecological Economics. SME transparently links icon-based modeling environments with advanced computing resources and Geographic Information Systems (GIS), allowing modelers to develop spatial simulations in a user-friendly, graphical environment (Maxwell et al. 1999). Automatic code generators construct (spatial) simulations and enable distributed processing over a network of parallel and serial computers, allowing transparent access to state-of-the-art computing facilities. The environment imposes the constraints of modularity and hierarchy in model design, and supports archiving of reusable model components (SME 2002). The system removes the 'black box' complexities and advances a disaggregated approach to spatial modeling.



## **The Land Use Evolution and Impact Assessment Model (LEAM)**

The Land use Evolution and impact Assessment Model (LEAM), utilizes the SME collaborative environment adapted for the purpose of developing a Spatial Decision Support System (SDSS) to evaluate human development patterns. Developed at the University of Illinois with funding from the National Science Foundation, LEAM describes land-use changes across a landscape that result from the spatial and dynamic interaction among economic, ecological, and social systems in the region. In the LEAM approach, groups or individuals who have substantive knowledge relating to a particular system develop and test separate models of that system. These contextual sub-models are run simultaneously in each grid cell of raster based GIS map(s); linked to form the main framework of the dynamic spatial model (LEAM). The SME collaborative approach enables the model to be created in an open and distributed manner that brings different expertise to bear on the problem. Inputs to the model utilize USGS national land use data sets (30x30m resolution), census and economic data (readily available and transportable to multiple sites), along with variables relating to impact assessments sub-models (e.g. habitat, eco-regional inputs, water and energy inputs) to parameterize the model. The resulting products of LEAM model runs will be an analysis of a series of policy scenarios; GIS maps or movies show the transformation of the subject landscape as a product of policy related inputs. These dynamic visual outputs are critical for testing policy scenarios and raising concerns regarding the impacts of development, environmental degradation, or conflicting land-use policies (George 1997). The SDSS developed includes a simple user interface and transportable data sets for application to multiple sites.

The fundamental LEAM approach to capturing land use transformation dynamics begins with model drivers (Figure 1). Model drivers are considered those forces, typically human, that contribute to urban land use transformation decisions. They also describe land use transformation probabilities. The simulation visually displays the landscape transformation realized at each time step using scenario-based planning exercises. The resulting visual images are then analyzed for environmental impacts during the impact assessment phase. Sustainability indices based on the derived impacts are then developed to feed back into the model drivers.

<INCLUDE FIGURE 1 HERE>

### **MODEL DRIVERS**

A simple illustration of the model drivers can be viewed in Figure 2. The LEAM model uses a 30m x 30m raster based land use map (LU MAP), based on the USGS National Land Cover Data (NLCD). The initial maps are used to parameterize the existing land use conditions (the model uses a 30 x 30 meter resolution to simulate the parcel by parcel decision making that influences urban growth patterns). The existing land use is then analyzed for its development

probability (DEV PROBABILITY) at each time step. The probability of a cell changing to an alternate land use (ALT LANDUSE) depends on how the conditions for change in the immediate (as well as global) area of study have changed using a Markov chain approach.

<INCLUDE FIGURE 2 HERE>

A Markov chain describes the behavior of transition probabilities between the varying states of a system. The process considers the different states that any particular cell in the modeled landscape can assume and the statistical probabilities that govern the transition of the phenomenon from one state to another. In the LEAM approach, any developable cell in the landscape has a probability of land use change associated with it. The calculation of the cell's probability is based on a set of criteria that is evaluated by the model at each time step. Each variable considered in the chain affects the overall development probability (DPR) of land use change

$$DPR = LUex (f (Ut , Nr, Ec, Pp, So, Oc, Rr, Rs, Dm, Gt, Tr...))$$

Where:

- LUex determines the existing land use condition
- Ut defines utilities and resources available at the site
- Nr describes the neighboring land use characteristics
- Ec represents the local economic conditions
- Pp represents the gross population projections
- So represents social decision making factors
- Oc describes the probability that the cell will develop as open space
- Rr determines the presence of roads
- Rs defines the random chance of land use change (spontaneous growth)
- Gt describes the spatial growth trends of the region
- Dm describes the geography of the area
- Tr represents traffic congestion coefficients

Each driver is developed as a sub-model; definitions are completed and run independent of the larger LEAM organization. Variables of interest can be scaled and plotted in formats that help visualize sub-model behavior and contextual experts can calibrate and test sub-model behavior before it becomes integrated into the larger model. Using iconographic modeling techniques for sub-model development greatly decreases the learning curve for enabling

contextual experts; it also increases the ease with which the model can be changed and calibrated. The effects of changes made can be viewed immediately; allowing the user to concentrate on modeling instead of computational details (Maxwell et al. 1999).

Model drivers represent the dynamic interactions between the urban system and the surrounding landscape. Scenario maps visually represent the resulting land use changes. Altering input parameters (policies) change the spatial outcome of the scenario being studied. This enables “what-if” planning scenarios that can be visually examined and interpreted for each simulation exercise. One alternative scenario may include the construction of a new road in the area being studied. Results of the LEAM Model with a new road system added shows how the land use transformation patterns may vary with the road system added. In this case the planning decision to revise the transportation network in the area has dramatically changed the way the region has developed.

As previously noted, many CA based tools exist to identify probable patterns of development. What is generally lacking is the identification of the societal and fiscal impacts that these may probably exert. The identification of these impacts is an important component of the LEAM modeling system.

#### **Economic/Fiscal Impact Assessment Sub-Model**

Within the planner’s triangle of conflicting goals three major planning aspirations are represented and sit at opposing corners of a triangle – social justice, economics and ecology. The center of the triangle represents a sustainable solution. How each of the conflicting goals is resolved determines the overall sustainability of the plan (Campbell, 1996). Land use decisions made in favor of economic gains are often detrimental to environmental and social systems. Using the LEAM economic and fiscal impact assessment sub model structure, spatio-temporal development transformation scenarios are examined for their expected future societal impacts allowing for a quick assessment of the long-term costs (economic, social, and ecologic) associated with any given scenario. The calculations of the sub-model are based on the Social Cost of Alternative Land Development Scenarios (SCALDS) cost accounting framework developed by the US Department of Transportations Federal Highway Administration (Conrad 1998), see Figure 3. The SCALDS model builds on three components: infrastructure costs, public and private costs, and internal and external costs using a ‘full cost’ framework. A full cost framework includes the externalities associated with a transaction, which are the benefits and costs not typically registered through market transactions. The primary impacts of urban land use transformation are captured through changes in the costs of providing infrastructure services to households, businesses, and governments.

The inclusion of specific cost factors is based on their significance and on whether the factor can be attributed to and/or measure alternative development patterns.

The LEAM dynamic, spatial approach has several advantages when compared to classic accounting frameworks:

- **Dynamic representation.** The ability to describe the changing costs of a given scenario provides an enormous advantage to static tables and graphs.
- **Visualization.** Mapped images are powerful representations of spatial data. Add to the dynamic, the ability to associate mapped images with the economic dynamics and the importance of where things happen becomes just as important as when and if the action takes place.
- **Micro-level assumptions.** Typical macro-level assumptions relating to the average costs of varying development densities<sup>1</sup> are not necessary in a spatially explicit approach. In the LEAM approach, these costs are based on verifiable micro-level assumptions made at the smallest spatial resolution (e. g. average road construction costs per unit length of road). Proportionate costs can then be calculated by changing the per-cell densities of infrastructure development.
- **Site specificity.** Since the model can be applied to varying geographic locations, site-specific costs and economic characteristics can easily be accounted for.

LEAM economic/fiscal impact assessment areas currently considered<sup>2</sup>: development costs, individual costs (the privately born costs associated with development), communal costs, and the externalities or societal costs associated with the scenario. Cost factors used to calculate these assessment areas include: i) Roads – the costs associated with the construction, maintenance, and operations of roads in the study area; ii) Utilities – the installation, maintenance and operational costs of energy systems, potable water systems, and waster water systems needed to service the scenario developments; iii) Land use – the costs associated with the loss of agricultural and ecologically significant land uses; iv) Air/Water quality – the economic impacts of poor air and water quality.

<INCLUDE FIGURE 3 ABOUT HERE>

**Roads:** Road construction is required to access any developed cell. When a cell transforms to another use, a required percentage of the cell must also accommodate an associated percentage of road construction, depending on the new land use (residential, industrial commercial – high/low density). Road construction costs can then be calculated on per square

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<sup>1</sup> These assumptions generally differ extremely. For example, Duncan (1989) reports that the compact development costs for roads is 40% in percent relative to a sprawling area. Frank (1989) reports 73%; and Burchell reports (1992, 1997) cost proportions of 74% and 88%.

<sup>2</sup> We have tried to keep the following presentation of the cost calculations rather short and refer to the used literature sources where necessary. For further information on implementation details, please contact the authors or consult our website: <http://www.rehearsal.uiuc.edu/projects/leam/>

meter basis with regionally or even cell specific costs. The operations and maintenance costs associated with one square meter of road can also be included using regionally or cell specific data. This will enable regional distinctions between geographic or geo-political areas to be included. The costs of maintaining a road network in Northern Illinois, for example, will greatly differ from the costs to maintain a similar network in southern California.

**Utilities:** Utilities installation costs occur at the time of land conversion and are usually born by the developer and passed on to the buyer at the time of sale. Utility installation and construction costs for sewage, water, electrical service and natural gas service are included in the model. The costs depend on the density and type of development: Certain per unit construction costs are incurred in the conversion to low-density development; further costs occur when a low-density cell is converted to a high-density cell; the direct conversion from non-urban use to high-density development is cheaper than the gradual conversion from non-urban use over low-density use to high density development (based on Duncan 1989; Frank 1989; and Burchell 1992, 1997).

Maintenance and operation costs are also based on the type and density of the development. These costs are typically communally distributed. The operational energy costs of the individual unit are calculated using the US Department of Energy's PLACES3 standard (USDOE 1996). PLACES3 differentiates between low-density households and high-density households. Regionally specific data for the average energy cost per household and trends for consumption are obtained from the US Department of Energy. From the Environmental Protection Agency (EPA), the average potable water consumed per household per day was obtained, and again we differentiated between low- and high-density households. (US EPA 1996). Regionally specific per gallon water costs can then be applied for household potable water costs.

**Land use:** The average value of various land use types was abstracted from Costanza (et al)'s valuation of the world's ecosystem services and natural capital (Costanza et. al. 1997) and the data was adapted to our 30 x 30 meter grid resolution. An aggregation of land use types was used to simplify model calculations and computational expense based on the US Geological Survey's (USGS) national land use classifications. Resulting groupings of forested lands, wetlands, farmlands, urban spaces (differentiated by development density) and open space areas were created. Societal costs of conversion from un-urban to urban were then calculated. Each scenario cell transformation from non-urban uses to urban at each time step constitutes a societal cost if the value of the existing land use exceeds the value of new transformation.

It is recognized that typical infrastructure installation and construction costs incurred are generally paid by the land developer and passed to the new owner at the initial transaction. Operational and maintenance costs, however, are borne by the community as a whole and it is important to capture these communal costs when determining the true costs of development.

**Air/water quality.** The air pollution sub model simulates the air pollution that is due to fossil fuel combustion. Other factors contributing to air pollution are considered not being a direct function of development density. Values are provided for natural gas, fuel oil, coal and gasoline. The model includes generation of carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), and nitrogen oxides (NO<sub>x</sub>).<sup>3</sup> The following table shows the pollutant concentrations used in the model.

<INCLUDE TABLE 1 HERE>

The (indirect) costs associated with the use of non-renewable energy sources include degradation of health, vegetation and property due to air pollution from combustion of fossil fuels. These costs vary depending on the data source. This model incorporates data from various studies done at Pace University (Ottinger, 1990; Ottinger et al. 1996) summarized in the following table.

<INCLUDE TABLE 2 HERE>

Automotive energy consumption and the resulting air pollution is based on US average figures as presented in (Herendeen 1998), and an estimated 2.9 persons per household in Kane County over the forecast time of the scenario.

### 3. Results

An application of the land use evolution and impact assessment model was made recently to Kane County, Illinois. The main goal of this simulation is to evaluate the influence of urban growth in the critical area on economic and fiscal factors. Housing in Kane County is fairly homogeneous, dominated by detached, single-family homes; a trend that is likely to be the norm in the future (Gruen 2000). The County's *2020 Land Resource Management Plan* (Gruen 2000), projects a 60% growth in households by 2020, amounting to 69,000. The County is actively working to control sprawling development patterns in the critical growth area. This suggests that the county is interested in promoting an increase in density - an increasing population that is decreasing in intensity over time or growth with a decreasing fringe development rate (Figure 4). This becomes the policy scenario tested using the LEAM approach – what are the fiscal impacts related to a policy that increases development density vs. the ‘do nothing’ policy?

<INCLUDE FIGURE 4 HERE>

#### PROJECTED ECONOMIC IMPACTS

The fiscal impacts sub-model was applied to assess the costs associated with two scenario runs – high density and low density. Salient variables considered include:

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<sup>3</sup> These values were obtained from Buonicore and Davis (1992) and from Anderson (1995) for automotive fuel.

- Developmental cost – typically borne by the developer and passed to individual buyers.
- Individual costs – costs that are the responsibility of the home buyer (including property taxes).
- Communal costs – costs that become the responsibility of the community at large, such as the maintenance of the roadway system after incorporation.
- Social costs – the externalities associated with developments that are not included in other definable costs.

The efficacy of the economic/fiscal impact assessment model is tested using two LEAM scenario outputs that represent extreme low-density and extreme high-density scenarios for the same housing demand/population projection. The spatial development patterns are determined by the dynamics of the model and their plausibility was checked with local and regional community planners. In scenario 1 (low density – 0.68 households per 30 x 30 m cell according to the USGS NLCD data set), there are no restrictions on housing density and the subsequent land use changes occur in highly disaggregated and sprawling patterns. Scenario 2 assumes the implementation of density regulations on the newly developed housing stock, increasing urban densities in the newly formed districts (1.36 households per 30m x 30 m cell). Results of model runs show the reduced spatial extent of new urbanized areas that occurs in areas zoned for higher densities (Figure 5).

The fiscal impacts associated with the low-density scenario are shown in Figure 6.

<INCLUDE FIGURE 5 HERE>

<INCLUDE FIGURE 6 HERE>

The same procedure was used to conduct an economic impact assessment of a high-density scenario (Figure 7). The fiscal impacts associated with the high-density scenario are shown in Figure 8.

<INCLUDE FIGURE 7 HERE>

<INCLUDE FIGURE 8 HERE>

Fiscal impact assessment curves (Figures 6 and 8) show the dynamics in each cost category. Both figures show development, individual, social and communal costs under the scenario assumption that low-density development is tolerated in each newly developed cell without feedback. In both scenarios, all costs are increasing over time. A noted difference between societal and communal costs in both scenarios reflects a common perceptual problem regarding the true costs of residential development. Although both communal and societal costs are eventually born by the larger community, typical cost projections consider only short-term communal costs and disregard both long-term communal and all associated societal costs, grossly underestimating the fiscal impacts of the proposed development.

In the two scenarios considered, low-density development patterns incur higher costs in all four categories. By year 28 communal costs are 98% higher and societal costs 28% higher in the low-density condition. Individual and developmental costs are also increasing - individual costs 13% higher and development costs are 17% higher when comparing the low-density to the high-density development scenario at simulation year 28.

#### **4. Discussion**

Comparing the communal and the social costs under the low and high-density scenarios reveals significantly higher costs associated with low-density outcomes. Low-density development may be individually more desirable however, since more of the costs (communal and societal) are born by others in the short term. Even if parts of the social costs are ultimately paid for by the individual, the individual's perception may be that low-density development is cheaper than high-density development due to the short time horizons generally associated with individual decisions (Hannon 1994). A social or communal perspective however, clearly favors high-density development. Especially when considering the lack of societal benefits (fiscally) generated from low-density developments.

If the projected growth patterns reach some stable equilibrium state - i.e. population stabilizes or a development moratorium is considered, where no development takes place and redevelopment is the only land use change activity - the projected accumulated communal cost curve will show a linear increase. Income to the community will also show a linear increase, since population changes will be minimal. Depending on the redevelopment density, either the communal cost function or the communal tax income function will increase at a faster rate. A critical 'fiscal density' is achieved when both functions increase at similar rates. If actual development densities are below this critical 'fiscal density' threshold, the community will be faced with a decreasing net balance between tax income and communal costs for housing development. If actual development densities rise above the critical fiscal density, the net returns to the community will be positive.

There are three interests in a development decision: i) the communal interests of the area in which the new development will take place, ii) the interests of the developer or business taking the initial risk, iii) and the interests of the individual, the person that generates the demand for the developed property and is ultimately responsible for the parcel in question. These three interests can be portrayed in a similar manner to the planner's triangle of conflicting goals (Campbell 1996), so that each economic interest sits on opposing points of the triangle (Figure 9), with an economically equitable solution at the center. An economically equitable solution is achieved when a balance between the competing interests is achieved - when each party receives an acceptable portion of the burden. The low-density scenario, although



considered positive by the individual, places too much burden on the community to be considered an equitable or sustainable solution. A high-density scenario may be more equitable, but have shifted the burden too far in the other direction.

<INCLUDE FIGURE 9 HERE>

Various studies (Frank 1989; Duncan 1989; Burchell and Listokin1995; Bank of America 1995) look at the relationship between land use patterns and infrastructure costs (i.e. local and county roads, water, sewers, and schools). They estimate that for eighteen communities in Southeast Michigan, managing growth (relative to unmanaged growth) can produce annual savings of over \$5 million (Burchell 1997). Burchell also finds in a New Jersey study that managed growth is 2% less costly than unmanaged growth for both municipalities and school districts (Burchell 1992). The implication is that current, unmanaged, low-density development demands more community costs than they provide communal benefits over time. The solution to this dilemma of increasing communal costs and decreasing benefits has traditionally been growth; incorporating adjacent lands to increase the tax base and take advantage of typically low impact land uses (agricultural property taxes are a small fraction of urban land use taxes) and newly developed urban land uses. Alternative solutions, a higher tax rate per capita, or a permanent and early switch to more compact and sustainable development patterns are rarely considered. The inherent feedback loops in the sprawl paradigm are generally self-reinforcing and favor fringe development, instead of self-correcting as they are in equilibrium models.

Our collaboration with the planners in Kane County (and other planning agencies in Peoria and the State of Illinois) over the course of this work has revealed some interesting observations:

- planning decisions are heavily influenced by fiscal analysis, even though current methods for analyzing the fiscal impacts of spatial economic variables, i.e. land use patterns, is often incomplete and rather short-term oriented.
- “soft variables” or variables that are difficult to quantify, such as societal costs or quality of life measures are rarely effective in influencing planning decisions.
- reliable and understandable models are needed to help quickly assess soft variables for inclusion in spatial fiscal analysis to help engage decision makers toward a broader understanding of the real implications of land use change.

## 5. Conclusion

Dynamic models of complex and interconnected ecosystems enable scientists to experiment with and thus come to understand the interactions of dynamic system components. While good progress has been made in the development of physical and biological system models, there have been fewer attempts and less success at developing social system models. Though specific parts of the front-end of the LEAM-model and its ecological impact assessment features are still under development, valuable insights into the critical and sensitive components of urban systems and the fiscal implications have already been obtained, mainly due to the interdisciplinary exchange and the need to formalize one's thoughts into the framework of a computer model.

This paper has presented theoretical underpinnings of such a large-scale computer model and the successful application to the methodologically simple problem of the calculation of the cost of urban sprawl was presented. One of the strongest features of the agent-based approach of our model is the emergence of macro-behavior based on micro assumptions. This gives the discussion about the fiscal impacts of urban development a new dimension, since agent-based models can more easily be calibrated to site-specific properties and vague assumptions about average impacts become unnecessary. The visualization of modeled results has proven to be successful, especially in cultivating cooperation with planners and other regional decision makers. Mapped images are extremely powerful for displaying the spatial interactions and dynamic movement of human development patterns. Although difficult to represent in static format the animations of these images provide a strong case for the use of spatial simulation modeling for more intensive land use change applications. We anticipate that the dynamic animation of the mapped images will also become important in future work regarding the most efficient development control strategies and the quantification of environmental impacts.

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## References

- Allen, P., J. L. Deneubourg, 1978. The Dynamics of Urban Evolution. Final Report to the US Department of Transportation.
- Anderson, J.F., 1995. Alternative Fuels for Fleets: An Overview. Transportation-related Air Quality, Transportation Research Record 1472, National Academy Press, Washington, DC
- Bank of America, California Resources Agency, Greenbelt Alliance, Low-Income Housing Fund, 1995. Beyond Sprawl: New Patterns of Growth to Fit the New California. San Francisco
- Batty, M., 1992. Urban Modeling in Computer-Graphic and Geographic Information System Environments. Environment and Planning 19: 678-708.
- Birkin, M., 1990. Elements of a Model Based Geographic Information Systems for the Evaluation of Urban Policy. Geographic Information Systems. L. Worral. London, Belhaven Press.
- Buonicore, A.J., and Davis, W. T., (Editors), 1992. Air Pollution Engineering Manual. Van Nostrand Reinhold: New York
- Burchell, Robert W. and David Listokin., 1995. Land, Infrastructure, Housing Costs and Fiscal Impacts Associated with Growth: The Literature on the Impacts of Traditional versus Managed Growth. Presented at the Alternatives to Sprawl Conference in Washington DC
- Burchell, Robert W. (Editor), 1992a. Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan, Report II: Research Findings. Trenton: New Jersey Office of State Planning
- Burchell, Robert W. (Editor), 1997a. Fiscal Impacts of Alternative Land Use Patterns in Michigan: The Costs of Current Development Versus Compact Growth. Southeast Michigan Regional Council of Governments.
- Burgess, E.W., 1928. Residential Segregation in American Cities. Annals of the American Academy of Political and Social Science V.140: 105-115.
- Burgess, E. W., 1924. The Growth of the City: An Introduction to a Research Project. American Sociological Society Publications V.18: 85-97.
- Campbell, S., 1996. Green Cities, Growing Cities, Just Cities? Urban Planning and the Contradictions of Sustainable Development. Journal of the American Planning Association 62(3): 296-312.
- Clarke, K. C., S. Hoppen, Leonard J. Gaydos, 1996. Methods and Techniques for Rigorous Calibration of a Cellular Automaton Model of Urban Growth. Third International Conference/Workshop on Integrating Geographic Information Systems and Environmental Modeling, Santa Fe, NM.

- Clarke, K. C., S. Hoppen, Leonard J. Gaydos, 1997. A self-modifying cellular automaton model of historical urbanization in the San Francisco Bay area. *Environment and Planning B: Planning and Design* vol. 24: 247-261.
- Conrad, Lawrence M., S. N. Seskin, 1998. *The Costs of Alternative Land Use Patterns (SCALDS)*. Department of Transportation Federal Highway Administration, Washington DC, U.S.
- Costanza, R. and M. Ruth, 1998. Using dynamic modeling to scope environmental problems and build consensus. *Environmental Management* 22:183-195.
- Costanza, R, R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton and M. van den Belt, 1997. The Value of The World's Ecosystem Services And Natural Capital. *Nature*. Vol 387, 15 May: 253-260
- Curry, L., 1981. Division of Labor from Geographical Competition. *Annals of the Association of American Geographers* 71, 2: 43-77.
- Day, C., 1990. *Places of the Soul*. San Francisco, The Aquarian Press.
- Deal, B., 1998. The Urban Patch Model: Defining Ecological Patterns in the Urban Ecosystem. Accepted for publication in: *Human Ecology Review*. forthcoming.
- Deal, B., 2001. Ecological Urban Dynamics: the Convergence Spatial Modeling and Sustainability. *The Journal of Building Research and Information*, 29,5: 381 - 393
- Deal, B., C. Farello, M. Lancaster, T. Kompare and B. Hannon, 2000. A Dynamic Model of the Spatial Spread of an Infectious Disease: The Case of Fox Rabies in Illinois. *Environment Modeling and Assessment* V. 5: 47-62.
- Dendrinos, D. S., 1979. *A Basic Model of Urban Dynamics Expressed as a Set of Volterra-Lotka Equations*. Washington, D.C., US Department of Transportation.
- Dendrinos, D. S., 1985. *Urban Evolution: Studies in the Mathematical Ecology of Cities*. New York, NY, Oxford University Press.
- Dendrinos, D. S., 1992. *The Dynamics of Cities: Ecological Determinism, Dualism, and Chaos*. New York, NY, Routledge.
- Duncan, James E., (Editor) 1989. *The Search for Efficient Urban Growth Patterns*. Tallahassee: Florida Department of Community Affairs.
- Engelen G., R. White R. and I. Uljee, 1997. Integrating Constrained Cellular Automata Models, GIS Decision Support Tools for Urban Planning Policy Makers. *Decision Support Systems in Urban Planning*. in: Timmermans H. (ed.) 'Decision Support Systems in Urban Planning', E&FN Spon, London, pp.125-155.

- Epstien, J. M. and R. Axtell (Editors),1996. *Growing Artificial Societies*. Washington, DC, Brookings Institution Press.
- Ford, L. R., 1994. *Cities and Buildings: Skyscrapers, Skid Rows and Suburbs*. Baltimore, The Johns Hopkins University Press.
- Forrester, Jay Wright, 1961. *Industrial Dynamics*. Cambridge, Massachusetts. M.I.T. Press
- Forrester, Jay Wright , 1970. *Urban Dynamics*. Cambridge, Massachusetts. M.I.T. Press
- Frank, James E., 1989. *The Cost of Alternative Development Patterns: A Review of the Literature*. Washington, DC Urban Land Institute.
- George, R. V., 1997. Hyperspace: communicating ideas about the quality of urban space. *Journal of Planning Education and Research* 17: 63-70.
- Gruen Gruen + Associates, 2000. *Market and Economic Analysis for an economic development strategy for Kane County*. A report to Kane County Development Department & Economic Development Committee, C987
- Hannon, B., 1991. Accounting in Ecological Systems. *Ecological Economics: The Science and Management of Sustainability*. R. Costanza, Columbia University Press: 234-252.
- Hannon, B., 1994. Sense of Place: Geographic Discounting by People, Animals and Plants. *Ecological Economics* 10,2: 157-174.
- Hannon, B., 1995. Input-Output Economics and Ecology. A special edition of *Structural Change and Economic Dynamics*. In honor of Nobel Laureate L. W. Leontieff. F. Duchin (ed.). 6-3: 331-333.
- Hannon, B. and M. Ruth, 1997. *Modeling Dynamic Biological Systems*. New York, NY, Springer-Verlag.
- Kay, J. H., 1998. *Asphalt Nation : How the Automobile Took over America, and How We Can Take It Back*. Berkeley, CA, University of California Press.
- Klosterman, R. E., 1994. Large Scale Urban Models: Retrospect and Prospect. *Journal of the American Planning Association*. 60(1), pp. 3 -6
- Langton, C. G., 1989. *Artificial Life*. Redwood City, CA, Addison - Wesley.
- Lee, D. B., 1973. A Requiem for Large-Scale Models. *Journal of the American Institute of Planners* 39:163-178
- Levin, S. A. and R. T. Paine, 1974. Disturbance, Patch Formation, and Community Structure. *Proc. Nat. Acad. Sci. USA* 71(7): 2744-2747.
- MacArthur, R. H. and E. O. Wilson, 1967. *The Theory of Island Biogeography*. Princeton, NJ, Princeton University Press.
- Maxwell, T., F. Villa, et al., 1999. *The Spatial Modeling Environment (SME)*. Solomons, MD, International Institute for Ecological Economics, Center for Environmental Science, University of Maryland System.

- McIntosh, R. 1985. *The Background of Ecology*. Cambridge, MA, Cambridge University Press.
- McKenzie, R. D. 1925. *Ecological Approach to the Study of the Human Community*. *American Journal of Sociology* November Edition
- Morrill, R.L., 1991. *Myths about Metropolis*. In: J.F.Hart, (Editor), *Our Changing Cities*. John Hopkins Univ. Press: Baltimore, MD.
- Newman, P., and Kenworthy, J., 1989. *Cities and Automobile Dependence: An International Sourcebook*. Aldershot UK: Gower Publishing.
- Orr, D. W., 1992. *Ecological Literacy: Education and the Transition to a Postmodern World*. Albany, NY, State University of New York Press.
- Orr, D. W., 1994. *Earth in Mind: On Education, Environment, and the Human Prospect*. New York, NY, Island Press.
- Ottinger, R., 1990. Getting at the true cost of electric power - The Environmental Costs of Electric Utility Operations, *The Electricity Journal*, 3: 14-23
- Ottinger, R., Olav Hohmeyer, and Klauss Rennings (Editors), 1996. *Social Costs and Sustainability: Valuation and Implementation in the Energy and Transport Sector*, New York: Springer-Verlag.
- Park, R. E., E. W. Burgess, 1925. *The City*. Chicago, IL, University of Chicago Press.
- Parsons Brinckerhoff Quade & Douglas, Inc. ECO Northwest, 1998. *The Full Social Costs Of Alternative Land Use Patterns: Theory, Data, Methods And Recommendations*. Prepared for U.S. Department of Transportation. Federal Highway Administration.
- Perrings, C. and B. Hannon, 1996. *A Sense of Time and Place: An Introduction to Spatial Discounting*. Ecology, Society, Economy, Conference at Universite de Versailles, Paris. Plenary Session.
- Putnam, R., 1995. *Bowling Alone: America's Declining Social Capital*. *Journal of Democracy* 6: 65-78.
- Putnam, R., 2000. *Bowling Alone: The Collapse and Revival of American Community*. New York, NY, Simon and Schuster.
- Risser, P. G., J. R. Karr, 1984. *Landscape Ecology: Directions and Approaches*. Champaign, IL, Illinois Natural History Survey.
- Rohe, W. M. and L. B. Gates, 1985. *Planning with Neighborhoods*. Chapel Hill, NC, The University of North Carolina Press.
- Samuelson, P. A., 1971. *Generalized Predator Prey Oscillations in Ecological and Economic Equilibrium*. *Proceedings of the National Academy of Sciences* V. 68: 980-993.
- SME 2002. <http://www.uvm.edu/giee/SME3/>, International Institute for Ecological Economics, Center for Environmental Science, University of Maryland System.

- Sonis, M., 1983. Competition and Environment: A Theory of Temporal Innovation Diffusion. In: D. Griffith and A. Lea, Evolving Geographic Structures. The Hague, Martinus Nijhoff.
- Stern, R.B. and Stuart, D.G, 1980. Beware the pitfalls in fiscal impact analysis, *Planning*, 46: 15-17
- U.S. Bureau of the Census, 2002. *Sprawl City*, U.S. Bureau of the Census.
- U.S. Department of Energy, 1996. *The Energy Yardstick: Using Place3s to Create More Sustainable Communities*. Produced for the Center of Excellence for Sustainable Development, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy. (<http://www.sustainable.doe.gov/pdf/places.pdf>)
- U.S. Department of Energy, Energy Information Administration, 1998. *A Look at Residential Energy Consumption in 1997* (<http://www.eia.doe.gov/emeu/consumption>)
- U.S. Environmental Protection Agency, 1996. *Environmental Indicators of Water Quality in the United States*. Washington, DC, U.S. Environmental Protection Agency, Office of Water.
- US Bureau of the Census, 2002. *US Bureau on the Census Data on Urban Areas*. (<http://www.sprawlcity.org>)
- US Department of Agriculture, Natural Resource Conservation Survey, 1997. *1997 National Resources Inventory*. Washington, DC, USDA.
- US Geological Survey, 2000. *Gigalopolis: The twenty-first century system of world cities*. <http://www.ncgia.ucsb.edu/projects/gig>.
- Van der Ryne, S. and S. Cowan, 1996. *Ecological Design*. Washington, DC, Island Press.
- Westervelt, J. D., B. M. Hannon, 1995. *Dynamic, Spatial, Ecological Modeling: A Demonstrated Simulation of the Sage Grouse Habitat at the Yakima Training Center*. Champaign, IL, U.S. Army, Corps of Engineers, CERL.
- White, R. and G. Engelen, 1997. Cellular automata as the basis of integrated dynamic regional modeling. *Environment and Planning B: Planning and Design*, 24: 235-246.
- Wilson, A. G., 1981. *Catastrophe Theory and Bifurcation: Application to Urban and Regional Systems*. London, Croom Helm.
- Wolfram, S., 1994. *Cellular Automata and Complexity*. Reading, MA, Addison - Wesley.
- Wu, F. and C. J. Webster, 1998. Simulation of Land Development through the Integration of Cellular Automata and Multicriteria Evaluation. *Environment and Planning B: Planning and Design*, 25: 103-26.

## TABLES

Pollutant	Gas	Oil	Coal	Gasoline
SO <sub>2</sub> (kg/GJ)	0.00025	0.29499	1.26586	0
NO <sub>x</sub> (kg/GJ)	0.05889	0.08676	0.25107	0.00038
CO (kg/GJ)	0.01462	0.01492	0.08966	0.00322
CO <sub>2</sub> (kg/GJ)	49.4409	73.0866	85.9842	81.6849

**Table 1.** Pollution estimates in kg/GJ for various fuels.

SO <sub>2</sub> (\$/kg)	NO <sub>x</sub> (\$/kg)	PM (\$/kg)	CO <sub>2</sub> (\$/kg)
4.475	1.808	2.624	0.015

**Table 2.** The societal costs of relevant air pollutants in \$/kg.



FIGURES

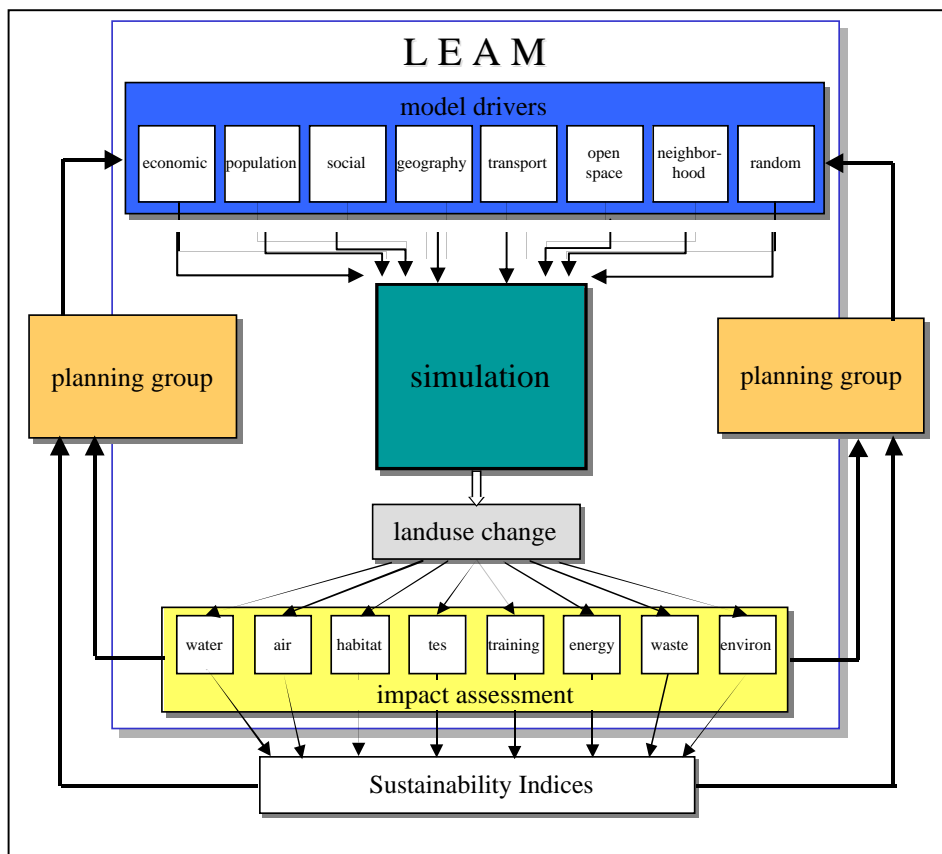


Figure 1. The LEAM spatial modeling environment.

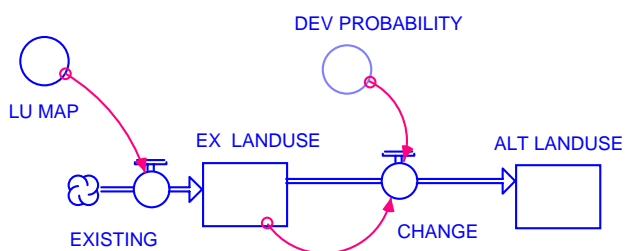
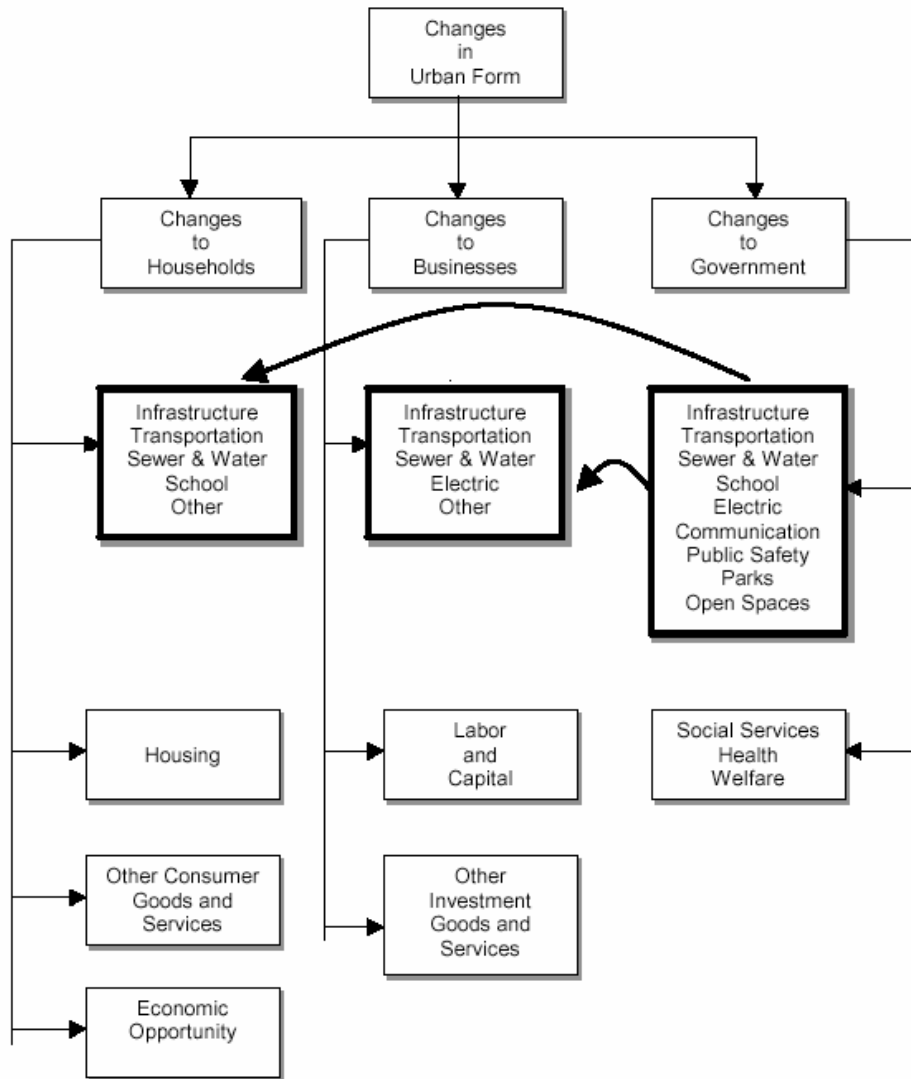


Figure 2. LEAM simple model driver structure.



**Figure 3.** The Social Cost of Alternative Land Development Scenarios (SCALDS) full cost accounting framework.

Kane County, IL  
New Housing Permits to Population

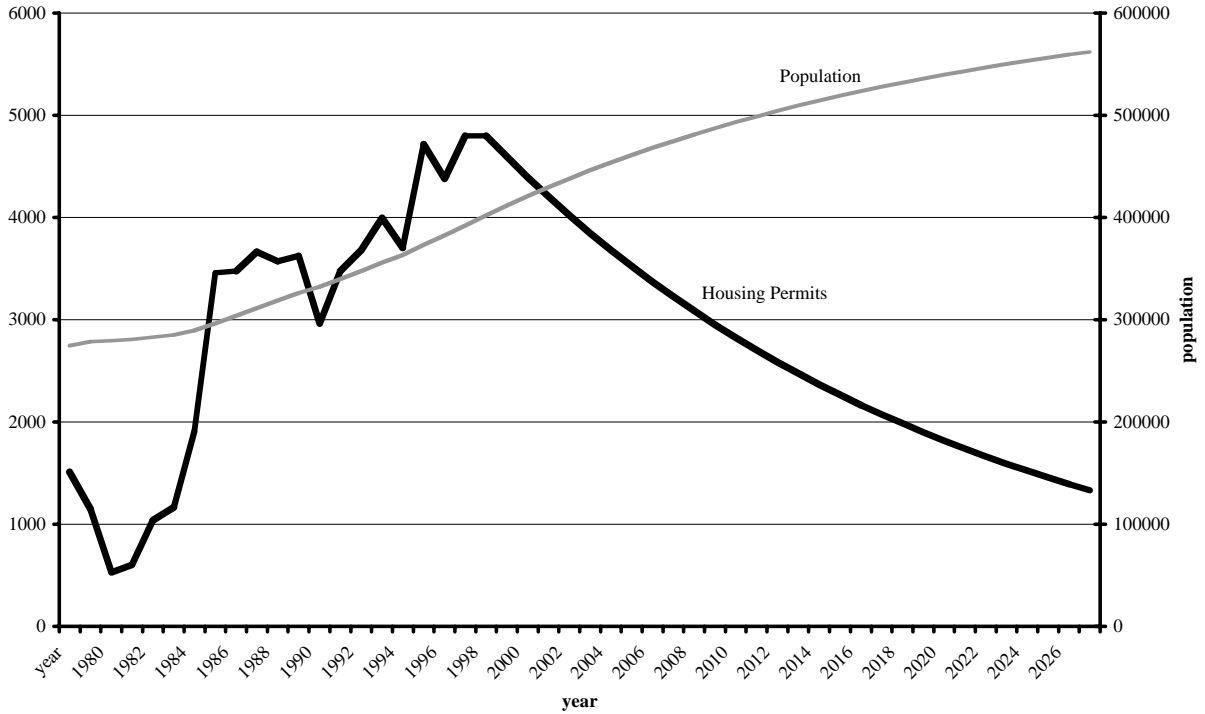


Figure 4. Number of new housing units in Kane County.

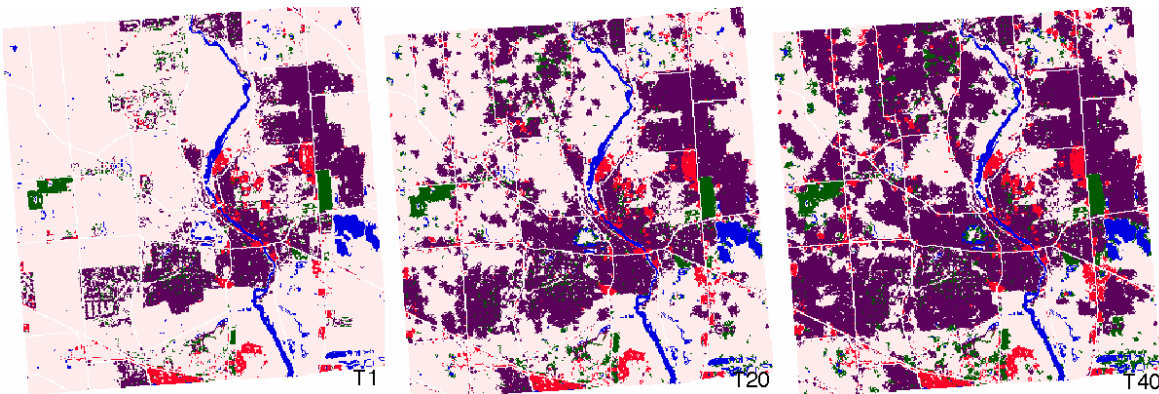
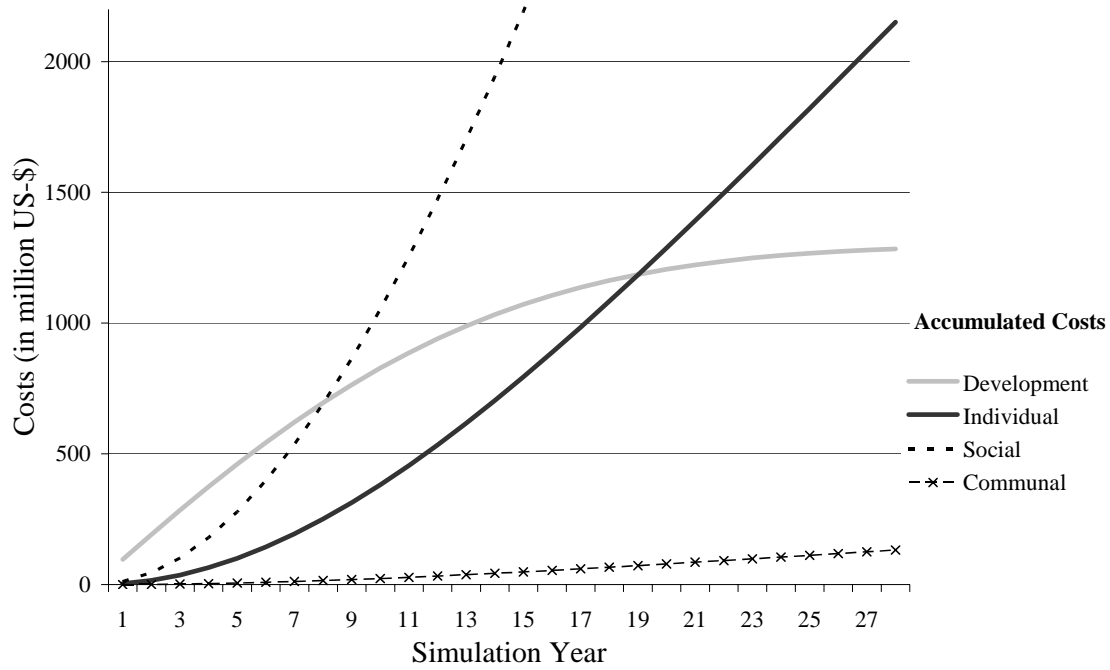
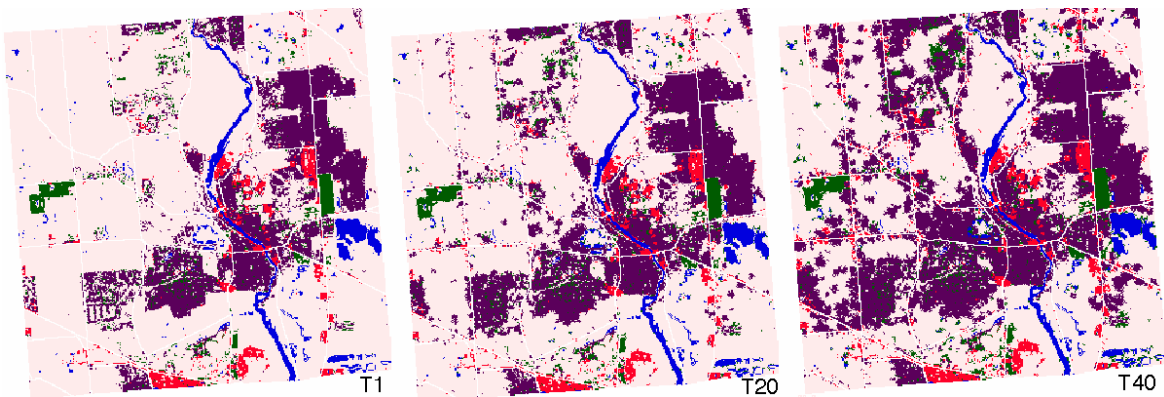


Figure 5. Dundee Township in Kane County – scenario 1 “low-density” scenario. Purple areas are residential cells, red are commercial, green are set aside open space and blue cells are water. Pink is agricultural land or undeveloped cells. Note the spread and magnitude of the low density scenario

## Economic Impact Assessment Low Density Scenario

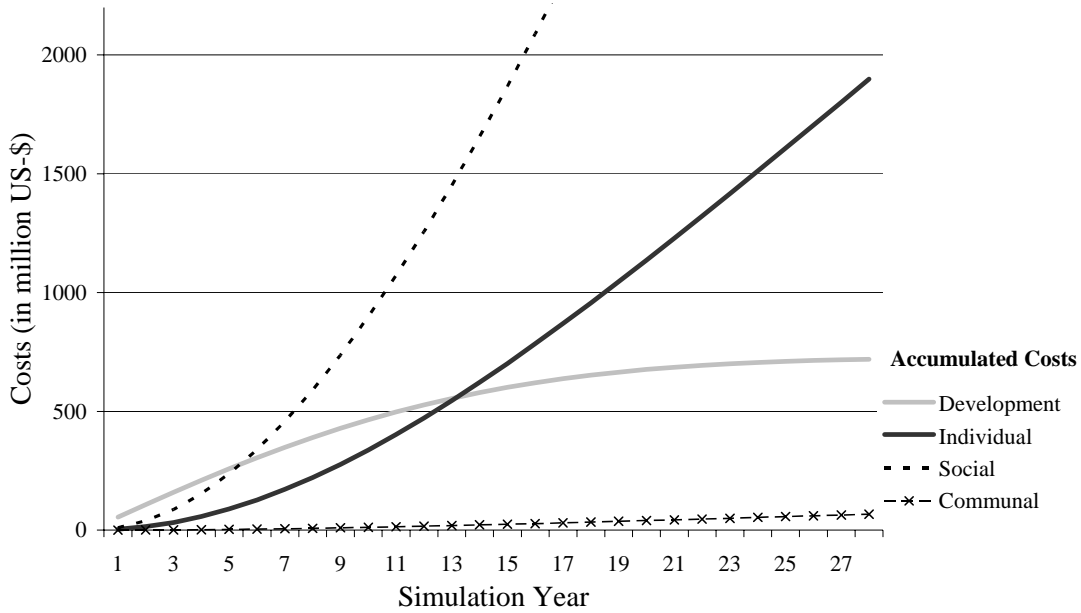


**Figure 6.** The fiscal impacts of the low-density scenario over time.

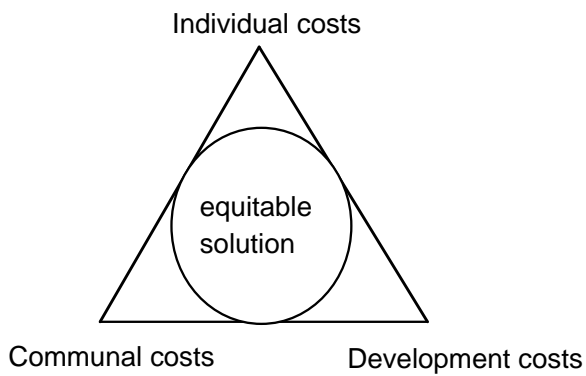


**Figure 7.** Dundee Township in Kane County – scenario 2 “high-density” scenario. Note the reduced spatial footprint of the new urban areas.

## Economic Impact Assessment High Density Scenario



**Figure 8.** The fiscal impacts of the high-density scenario over time.



**Figure 10.** The planner's triangle of conflicting goals adapted to economic burdens associated with land use change.

Equitable solutions balance competing interests.

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