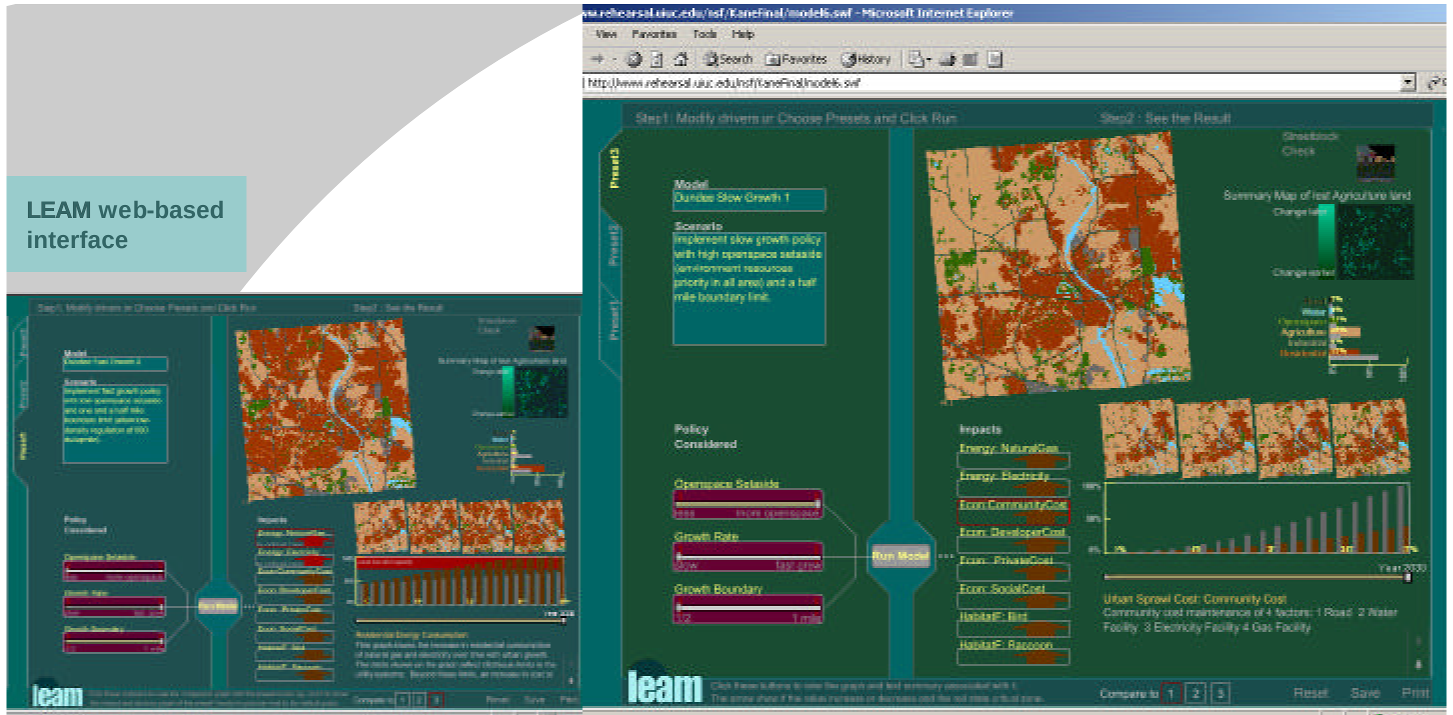

About the LEAM group

LEAM development and its application in several regions is conducted and managed by a team of faculty, staff, and students at the University of Illinois at Urbana-Champaign. This team brings together expertise in substantive issues, modeling, high-performance computing, and visualization.

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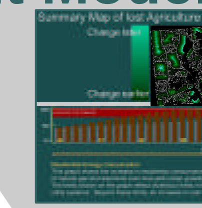
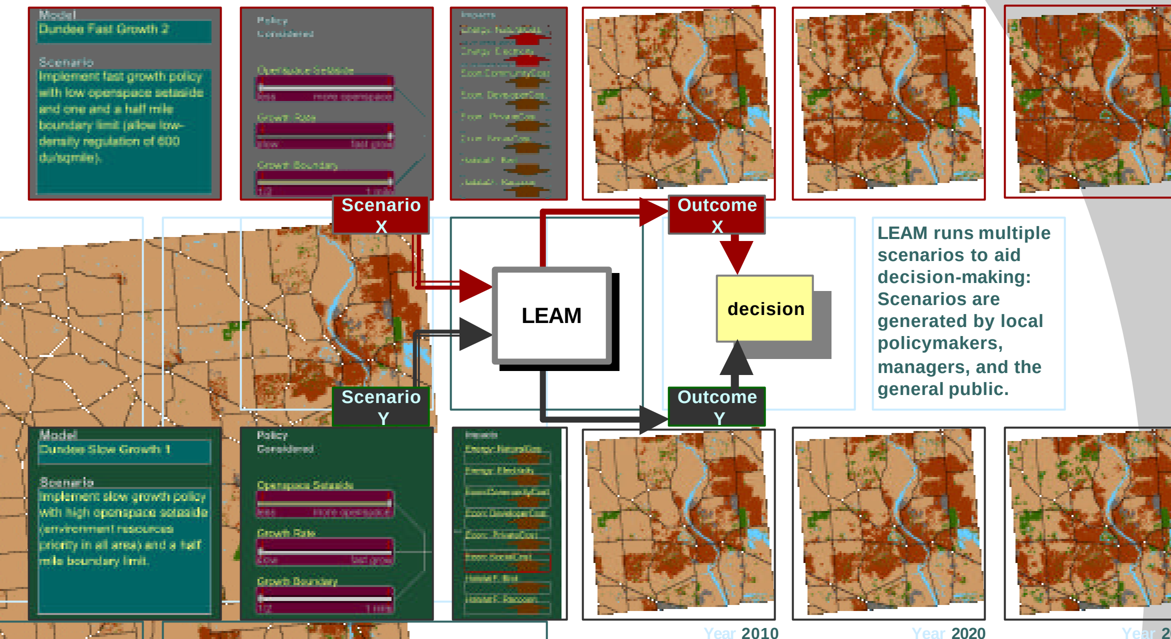
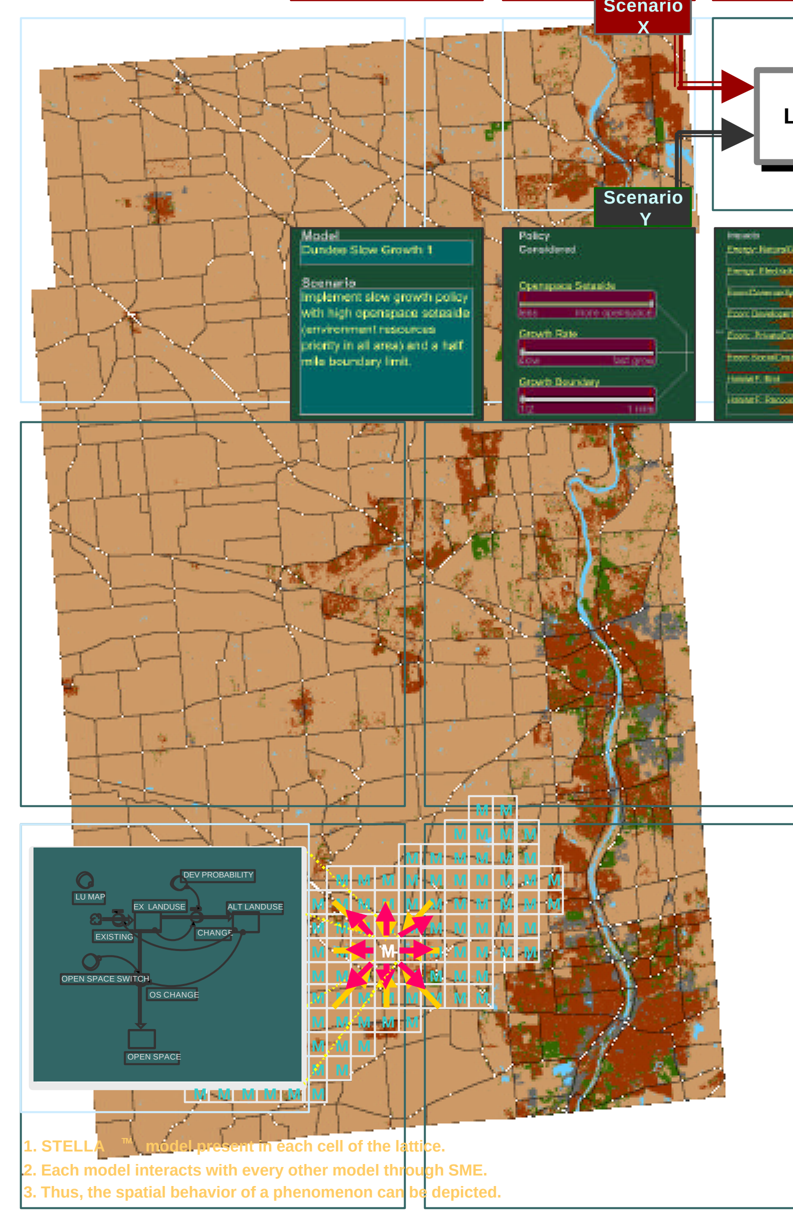
Recent work and simulation examples can be viewed at: **http://www.rehearsal.uiuc.edu/leam**

leam

Land-use Evolution and impact Assessment Model







The LEAM modeling environment is a graphic, spatial and dynamic decision-support tool that:

- **can be publicly accessible (Web-based and easy to use),**
- **uses an open architecture of explicit and easily modified sub-models,**
- **captures feedback between systems,**
- **includes multiple scales and sub-systems,**
- **incorporates multiple factors (physical, social and economic) driving land-use change,**
- **produces 'what-if' land-use planning scenarios and 'so-what' impact evaluations,**
- **is transportable**

LEAM is generally a useful tool for examining the drivers and impacts of land-use change.

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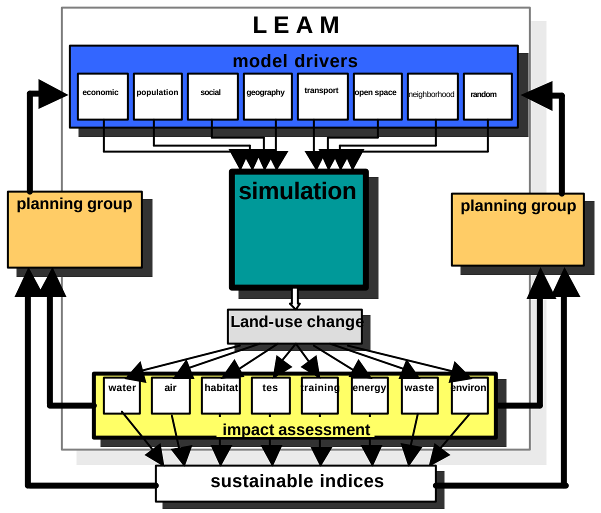
Problem



The LEAM spatial modeling environment: Includes model drivers and impact sub-models.

American cities are changing in surprising ways. Land-use change is being driven by new factors, in new ways, producing new patterns of urban development that affect the fundamental ways in which we interact our communities. Urban land areas are increasing at a much faster rate than their populations: between 1970 and 1990, New York City's population grew 5% and land area 61%, Chicago's population grew 4% and land area 46%, Cleveland's population declined 11% but land area still increased 33%. The most recent census reiterates these trends.

These sprawling land-use patterns are accompanied by a loss of environmentally sensitive lands including valuable wildlife habitat, wetlands, and farmland. Quickly changing land-use patterns also create challenges for urban and regional planning authorities in forecasting and managing new development, transportation and utility infrastructure issues, economic forecasting and assessment, and in fiscal budgeting exercises.

There is a vital need to know more about the factors driving urban expansion and land-use change. Equally pressing is the need to know more about the social, environmental and economic consequences of such change. Planners, policymakers, and citizens need tools that help them easily comprehend the complex relationships between driving mechanisms, land-use patterns, and impacts. Such a tool must be quickly and easily adaptable to the variations between study areas, contain and account for the important local forces affecting local urban expansion, and facilitate communication between policymakers, municipal officials, planners, interest groups, and the general public.

The Land-Use Evolution and Impact Assessment Model (LEAM) represents an innovative approach to simulating the evolution of urban systems in a spatial and dynamic visual decision support tool. LEAM uses a Cellular Automata (CA) approach tightly coupled with an open architecture for model development and high-performance computing capabilities for simulating land-use transformation. The simulations are then evaluated for their probable environmental, economic and social impacts so that 'what-if' scenarios can be played out in real time across multiple stakeholder groups.

Applications

Kane County, Illinois - an Illinois county forming the western border of the Chicago metropolitan area experiencing enormous pressure to develop. Early simulations of Dundee Township show that policy decisions to either encourage or discourage growth have lasting land-use pattern ramifications.

Fort Benning, Georgia/Alabama - a multi-county region centered on a critical military installation in the Southeast United States. Development patterns threaten to envelop the installation, with the possibility of impacting training activities on the base itself.

Benefits

LEAM is a computer-based tool that simulates land-use change across space and time. It enables planners, policymakers, interest groups and laypersons to visualize and test communal decisions and their consequences. The LEAM environment enhances our understanding of the connection between urban, environmental, social, and economic systems.

Approach

The fundamental LEAM approach to modeling urban land-use transformation dynamics begins with drivers, those forces (typically human) that contribute to land-use change. Each driver is developed as a contextual sub-model run simultaneously in each grid cell of raster-based GIS map(s); linked to form the main framework of the model and produce landscape simulation scenarios. Sub-models are completed and run independent of the larger LEAM framework so that variables can be scaled and plotted in formats that help visualize and calibrate sub-model behavior before it becomes integrated into the larger model.

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 (different policies, trends, and unexpected events), 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.

Once model simulations are established, it is important to recognize the impacts that the resulting changing land use patterns will have on the environmental, economic and social systems of the community. The assessment of probable impacts is important for understanding the 'so-what' of simulations. If things change in this way, what does it mean for society, the economy, and the environment? Am I happy with that outcome? If not, what policies are needed to achieve results that I find more satisfactory? These 'so-what' impact assessments are also important for comparing simulation outcomes and results, needed to improve communal decision-making. The impacts assessed by the LEAM model are also used in the creation of sustainable indices and indicators that can feed back into the model drivers for new policy formation.

The LEAM spatial modeling environment: Simulation, drivers, and Impacts

Current model driver sub-models (more are in production) include:

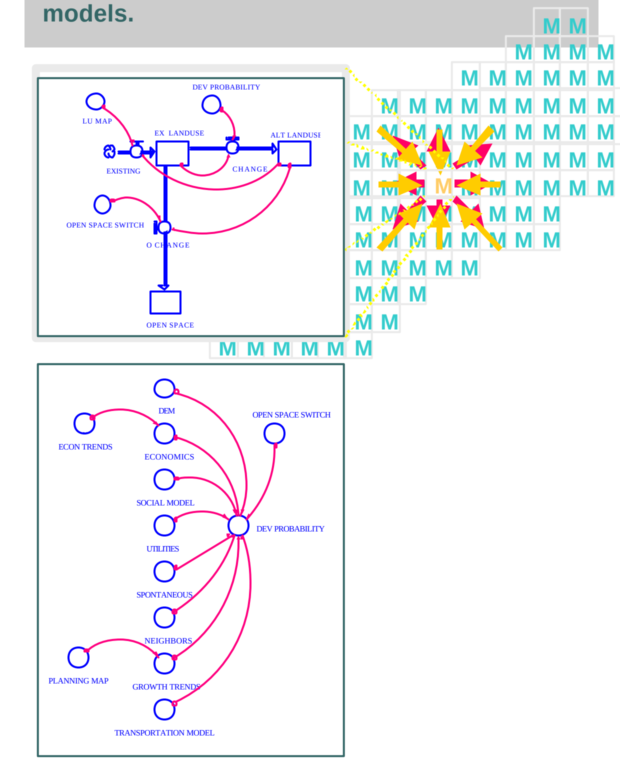
- Land Price, Economic factors, Population factors, Social factors, Geographic limits and factors, Transportation mechanisms and factors, Utility and Infrastructure requirements, Neighborhood development factors, Resource limitations and factors, Open space requirements, and Stochastic scenario drivers.

Impact assessment sub-models currently include:

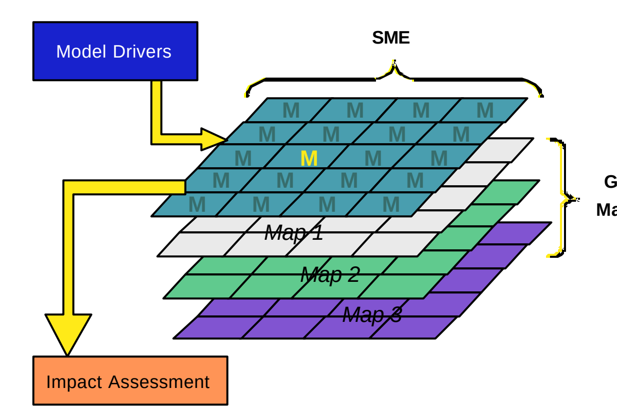
- Water quality and quantity, Air quality, Habitat fragmentation, Threatened/Endangered species, Energy impacts, Economic impacts (societal and fiscal), and Ecological impacts.

LEAM model applications are processed in a distributed, high-performance computing environment and results are presented using an easy-to-navigate, Web-based graphic user interface. Scenario results and impact assessments can be displayed in a number of ways: as simulation movies, through a built-in mapping tool, in graph or chart displays, or simply as raw data.

LEAM converts the existing land use of a 30x30 meter cell to another based upon local area dynamics, the influence of neighboring cells, and the interaction of the driver sub-models.



Calculating the Probability of Development: Driver Sub-models.



The LEAM approach combines the strengths of STELLA modeling, geographic information systems (GIS), and the spatial modeling environment (SME) software to produce dynamic land-use simulation scenarios.