LEAM

Landuse Evolution Assessment Model

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Problem

Military installations comprise a large and long-term investment made by the American people in the name of National defense. Installations embody enormous capital costs in infrastructure and personnel, and are critical resources for the sustainment of military readiness and projection capabilities. A current challenge to installation management is the continuous and rapid development of once rural land uses adjacent to our military assets, which threatens to compromise the integrity of this investment by undermining the military's ability to support its mission focus.

Landuse transformation near military installations affects how military lands are managed. For example, loss of habitat "outside the fence-line" can increase the importance of threatened and endangered species (TES) habitat inside the installation boundary. Growth of surrounding communities can also diminish the regional economic importance of the installation, and may advance interest in converting military installation lands to private sector purposes.

Planners for the installations and the surrounding communities must make decisions—separately and jointly—that effectively deal with this long-term threat. It is critical that all involved parties understand and agree on the key factors that determine and impact a region's overall sustainability. An important step in resolving some of these issues is to ensure that participants clearly understand the dynamic and spatial interactions between the military community's mission and land use needs, and the adjacent community's goals, planning policies, and probable spatial growth patterns.

The mLEAM modeling environment is a spatial, and dynamic decision support tool that:

- tests for long-term land development
- 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, economic) driving land-use change
- produces "what-if" land-use planning scenarios and "so-what" impact evaluations
- is transportable to all DoD installations.

mLEAM is broadly applicable for examining the drivers and impacts of land-use change and their affects on military mission sustainability.

This Spatial Decision Support System helps address vital questions for at-risk installations including:

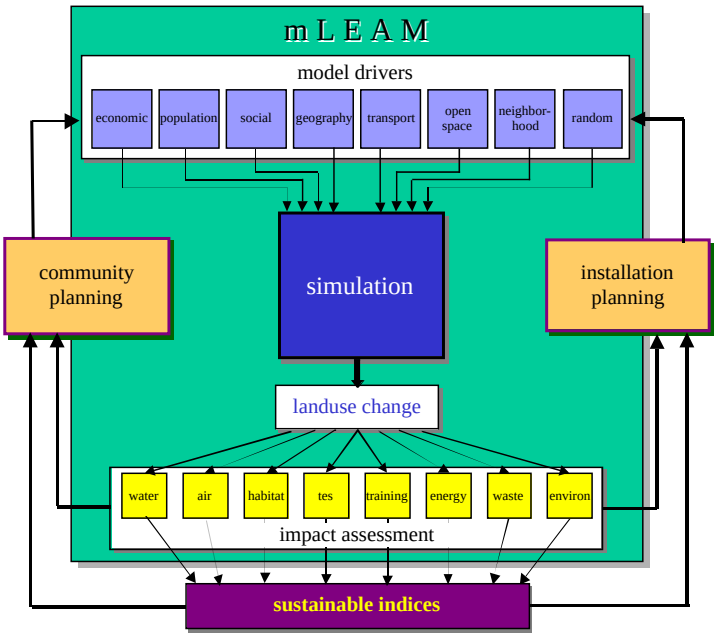
- How will changes in threatened and endangered species habitat affect military operations?
- What are the strategic regional infrastructure and policy investments that can improve the military's future training abilities?
- How can planners affect land use patterns now to allow for future training needs?
- What land use scenarios ensure habitat and growth opportunities without impacting military mission?

Approach

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. Developed at the University of Illinois, LEAM uses a Cellular Automata (CA) approach tightly coupled with an open architecture to develop land-use transformation simulations that are targeted toward military specific applications. 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.

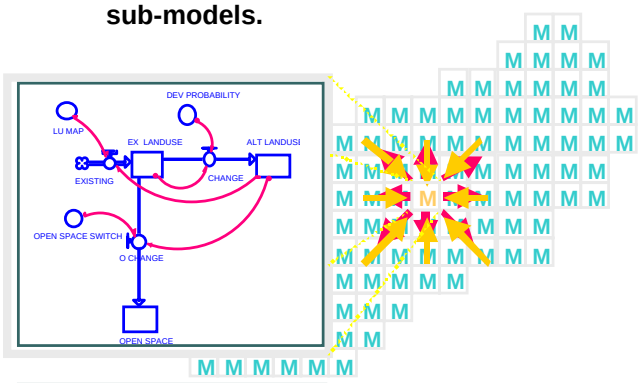
Model Drivers

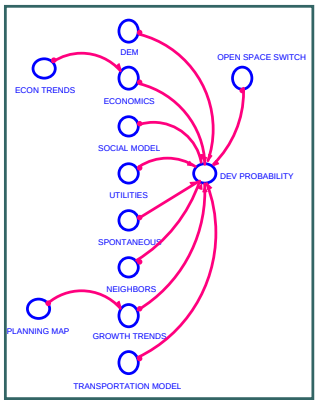
The fundamental LEAM approach to capturing land use transformation dynamics begins with model drivers. Model drivers represent those forces (typically human) that contribute to urban land-use transformation decisions. Each driver is developed as a contextual sub-model run simultaneously in each grid 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 independently 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.



The LEAM spatial modeling environment — which includes model drivers and impact sub-models.

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





Calculating the probabilities of development in sub-model drivers.

Model drivers represent the dynamic interactions between urbanized systems and the surrounding landscape. Scenario maps visually represent the resulting land use changes. Altering input parameters (e.g., policies) changes 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.

Current model driver sub-models include:

- Economic drivers
- Population drivers
- Social drivers
- Geographic limits and drivers
- Utility and Infrastructure requirements
- Neighborhood development drivers
- Resource limitations and drivers

- Open space requirements
- Stochastic scenario drivers
- Transportation mechanisms and drivers
- Military specific drivers.

Impact Assessment

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 the development of the "so-what" part of the simulated scenarios. If things change in this way, so what does it mean from an socio-economic and environmental point of view? Is the outcome satisfactory? If not – what policies are needed to achieve results that would be more satisfactory? These "so-what" impact assessments are also important for the comparison of simulation outcomes and results needed to improve collaborative decision making.

The impacts of LEAM projected land use operations are evaluated with GIS. Impact assessment operations currently include:

- Water quality and quantity
- Air quality
- Habitat fragmentation
- Threatened and endangered species
- Training area impacts
- Energy impacts
- Economic impacts (societal and fiscal)
- Ecological impacts
- Military specific impact assessments (TES habitat, frequency, air space, UXO, range use, community interaction, noise and dust).

Sustainable Indices

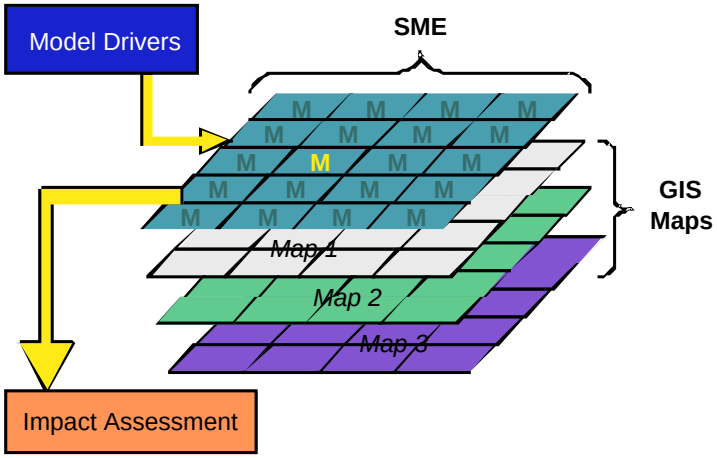
Sustainable indices are an important tool for making informed decisions about development. The LEAM modeling process allows the user to rank the importance of various indicators (habitat, energy, water, sewage, trash, air quality, and open space) and then calculates an overall index of sustainability.

Benefits

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

The LEAM modeling environment is a graphic, spatial, and dynamic decision support tool that is easily accessible, uses an open architecture, captures feedback, is multi-scaled and multi-factorial, producing "what-if" land-use planning scenarios and "so-what" impact evaluations.

LEAM is a broadly applicable tool for examining the drivers and impacts of land-use change and their affects on military mission sustainability.



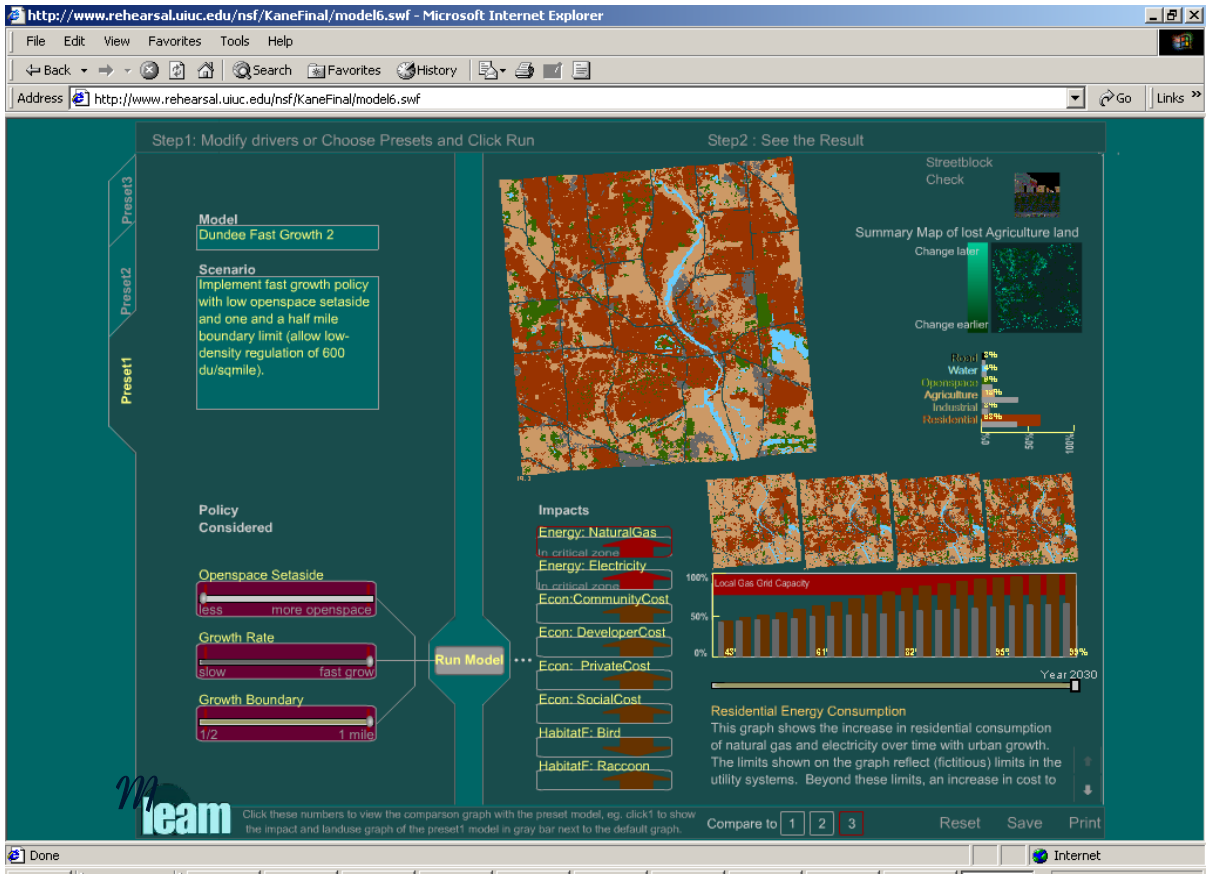
The LEAM approach combines the strengths of STELLA modeling, geographic information systems (GIS), and the spatial modeling environment (SME) to produce dynamic land-use simulation scenarios.

Application

LEAM model applications are processed in a distributed, high-performance computing environment. Results can be presented in a simple-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.

Fort Benning, Georgia/Alabama

An initial application of LEAM was conducted for the Fort Benning/Columbus, GA region, a multi-county region centered on a critical military reservation in the Southeast. Development patterns threaten to envelope portions of the installation, with the possibility of impacting training activities on the installation.



Sample LEAM web-based user interface.

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