Changing Landscapes: Anticipating the effects of local land use decisions
Decision Support Tool Summary

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L-THIA

The Long-Term Hydrologic Impact Assessment (L-THIA) model was developed as a straightforward analysis tool to provide estimates of changes in runoff, recharge and nonpoint source pollution resulting from past or proposed land use changes. It gives long-term average annual runoff for a land use configuration, based on actual long-term climate data for that area. By using many years of climate data in the analysis, L-THIA focuses on the average impact, rather than an extreme year or storm.

L-THIA results are intended to provide insight into the relative hydrologic impacts of different land use scenarios. The results can be used to generate community awareness of potential long-term problems and to support physical planning aimed at minimizing disturbance of critical areas. It is an ideal tool to assist in the evaluation of potential effects of land use change and to identify the best location of a particular land use so as to have minimum impact on the natural environment of the area. Recent concern over urban sprawl has focused on several land use change issues, including the failure to account for hydrologic aspects of land use change that can result in flooding, stream degradation, erosion, and loss of groundwater supply. L-THIA was developed to provide a quick, accessible tool to use in assessing the long-term impacts of land use change.

L-THIA results can be used to aid land use planners in a variety of ways. For instance, a planner may decide to change the land use based on soil type, to minimize impact in a given area. That is because the same land use located on different hydrologic soil types has different impacts. Also, since the amount of runoff generated by different land uses is a function of the hydrologic soil type and the land use, relocating land uses based on the hydrologic soil type can in some cases significantly reduce the long-term impact of the development.

L-THIA is currently available in three forms:

1. L-THIA WWW is a spreadsheet version that models runoff and NPS pollution changes;
2. L-THIA GIS is a set of Avenue scripts that automate the process of runoff impact modeling within ArcView; and
3. L-THIA GIS WWW allows interactive mapping of an area of interest with a custom java interface within a web browser.

PlaceIT

PlaceIT is an ArcView 3.2 extension that allows users to accomplish two tasks. In the first, they can select parcels and "develop" them for residential use at a selected density level. They are provided with immediate (and later, summary) information about the amount and type of land that has been "converted." The second allows for allocation of land in multiple categories, as a tool for developing a land-use plan over time, and to allow comparison of alternatives. Users may also turn off or on additional layers (e.g., themes that depict development opportunities or constraints), zoom and pan, search for areas fitting criteria and other routine GIS functions. The user operates at a parcel level, presumably the unit for land-use decisions, though it could be easily programmed to operate on a different unit of analysis.

In addition to ArcView's standard tools, the interface has a dialog with tools and buttons that run Avenue scripts. A set of icons allows

the user to select the types of land uses that will be included in the allocation process. For example, our version includes four levels of residential density, industrial use, parks/open space, and commercial land-use categories, though whatever categories are desired could be included in the scripts. With these tools, the user can change land uses interactively over an entire jurisdiction, one parcel at a time. A summary report can be generated showing the total number of acres in each category, with changes noted. You can save changes as a new scenario for future comparisons with other land-use plans.

When a user selects a parcel for a land-use allocation, the system will provide a warning if that parcel is currently in a restricted-for-development category. In our working version, the user is warned if the selected parcel is already developed or within an environmental corridor or farmland protection area. You can also choose a "subdivision" mode, allowing you to add or delete selected parcels interactively. These are then highlighted and temporarily allocated to residential use. These areas can be summarized as to impact, or saved out as individual polygons (in an ArcView shape file), for further analysis.

Selected parcels can be fed into ArcView summary tools that will generate simple statistics on the type and amount of land to be converted from current uses. These data can also be linked to impact-assessment models such as water-quality models, transportation-congestion predictions, fiscal-impact reports, and so forth.

Windows to my Environment

Sponsored by the Environmental Protection Agency (EPA) in partnership with federal, state, and local partner organizations, Window to My Environment (WME) is a new website designed to improve access to useful community-based environmental information. EPA and the States are developing a comprehensive exchange network that will provide a wide range of shared data and information among EPA, States, Tribes, localities, the regulated community, and other data partners. WME represents a concerted effort to develop a "geographic portal" for integrating that environmental information by local geography to help answer common questions, examine critical problems, and discover potential solutions for environmental protection and human health issues.

Particular features of WME include:

- **State-of-the-Art Interactive Mapping Tools:** WME allows YOU to control the geography that you visit where you can map and view the location of regulated facilities, monitoring sites, waterbodies and watersheds, demographics with traditional geographic designations like streets, counties, schools, etc. Zoom, pan, and move all around the area and watch the information you receive dynamically shift before your eyes to reflect the new geography you have chosen. Then take a look at the 3-Dimensional view of local area land use patterns in your area.
- **Data on "Ambient" Environmental Conditions:** WME provides daily Ultra Violet (UV) Index reading and advice on health effects of exposures to sunlight, locations/reports from local air and water quality monitoring sites, land cover characteristics, and more.
- **Access to Analytical and Reporting Tools:** WME links to EPA's Envirofacts, TRI Explorer and Surf Your Watershed tools, as well as state tools like Pennsylvania's "E-Facts" and Delaware's "Environmental Navigator" provides you with the ability to generate custom reports on specific chemicals, facilities and trends in a selected area.
- **Local Governmental Services and Contacts:** WME links you to dozens of government and non-government organizations and contacts with information on local issues in your area.

CommunityViz

CommunityViz provides a complete set of integrated GIS (Geographical Information Systems) software tools to allow planners and resource managers the information to make

informed planning decisions. CommunityViz software utilizes software technology from ESRI and functions as an ArcView extension. CommunityViz is comprised of individual components that are offered either as a complete, integrated suite or in various combinations to meet a user's particular needs. Its many ease-of-use features include wizards, pre-designed QuickStart scenarios, a special tool for build-out analysis, and many other features that get planners up and running quickly.

CommunityViz includes the following software components:

Scenario Constructor is a scenario analysis tool that provides the underlying framework for the powerful alternative-comparison capabilities of CommunityViz. It also provides a rich set of quantitative impact analysis capabilities, offering the functionality of a "spatial spreadsheet" that can perform numerical computations on geographic data in real time.

Policy Simulator uses agent-based modeling techniques to simulate likely future impacts of community planning proposals, providing planners with a view of likely economic and demographic outcomes years into the future.

SiteBuilder 3D enables users to build photo-realistic, three-dimensional, interactive models of their land-use proposals. Once built, the models allow 3D simulation "fly-through" and exploration, giving users the ability to visualize land-use proposals and even change them in real time.

Dane INDEX

The Dane INDEX model is a custom adaptation of the INDEX model to Dane County, Wisconsin. INDEX, which also utilizes parcel-level land use data, produces a variety of indicators associated with alternative development patterns, such as land use mix, pedestrian connectivity, and changes in vehicle-trips and vehicle-miles of travel. INDEX can compare indicators for two or more alternative land use scenarios. The analyst must supply the characteristics of each scenario, including a street layout and land use type and planned densities by parcel. If the model is applied to a specific proposed development, computer-aided design (CAD) files from the developer can be imported into the model's GIS environment.

Dane County added two components to the INDEX model that were of particular interest to local planners: fiscal impacts and stormwater runoff. The fiscal impact model, a spreadsheet model linked to the GIS land use data in Dane INDEX, was developed by a local firm and utilizes locally collected data, including municipal budget information from the last 10 years and interviews with local staff. The L-THIA, mentioned on page 1 was also integrated into Dane INDEX.

The effort required developing the data to support the Dane INDEX model will vary depending upon the availability of local land use data. In the Township of Vienna, the number of indicators was reduced to reflect non-existing infrastructure. For the Stoughton pilot study, Dane County shared in the expense of creating new data.

TURM

Dane County Land Conservation and the University of Wisconsin have developed the Thermal Urban Runoff Model (TURM). Data from summer storms indicate that rainfall temperature decreases substantially (18 deg. C) during the course of a thunderstorm. Runoff temperature data indicates that the very high temperatures of paved surfaces receiving rainfall initially produces energy release by evaporation, but high temperature runoff is quickly generated by typical rainfall intensities.

The TURM model simulates runoff temperatures from paved areas, and also temperature reduction after the runoff passes through rock-filled channels, open vegetated swales, infiltrating surfaces, conduits and also rock-filled chambers that can be used to cool the first flush of heated stormwater runoff. The model calculates the heat transfer between runoff and the surrounding media, based on

assumptions of complete mixing of runoff water, and modeling of heat transfer and the thermal gradient within the media containing the flow. Several runoff temperature impact mitigation demonstration projects have been implemented, based on the model analyses.

CITYgreen

CITYgreen is a powerful GIS application for land-use planning and policy-making. The software conducts complex statistical analyses of ecosystem services and creates easy-to-understand maps and reports. CITYgreen calculates dollar benefits based on your specific site conditions.

CITYgreen analyzes:

- Stormwater Runoff
- Air Quality
- Summer Energy Savings
- Carbon Storage and Avoidance
- Tree Growth

With CITYgreen, you can take advantage of natural systems to produce the maximum economic benefits for your growing community. CITYgreen uses the most up-to-date scientific research to calculate the dollar value of trees and vegetation.

CITYgreen creates:

- Broad regional studies or detailed small site assessments
- Ecological maps revealing the value of resources
- Models for future growth
- Colorful, easy-to-understand presentations
- Automatic reports that summarize key findings

Use CITYgreen is targeted at a variety of audiences. Planners model development scenarios and evaluate landscape ordinances. Engineers estimate the impact of tree loss on stormwater management costs. Urban foresters justify increases in maintenance, planting, and preservation. Educators teach forestry, environmental studies, landscape architecture, and city planning. Citizen groups advocate environmentally friendly solutions. Developers save money on erosion control and stormwater management. Regulatory agencies measure the air quality benefits of greenspace.

References:

1. L-THIA: http://danpatch.ecn.purdue.edu/runoff
2. PlaceIT: http://www.lic.wisc.edu/pubs/PlaceIT.pdf
3. Windows to my Environment: http://www.epa.gov/enviro/wme/
4. CITYgreen: http://www.americanforests.org/productsandpubs/citygreen/
5. CommunityViz: http://www.communityviz.com/
6. Dane INDEX: Curt Kodl, Dane County Planning & Development
7. TURM: Aicardo Roa-Espinosa, et al., Department of Soil Science, Atmospheric and Oceanic Science University of Wisconsin-Madison, Department of Biological Systems Engineering