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Integrating Social Drivers and Environmental Impacts using a Geographic Information System: The Land Transformation Modeling Project.

Presenter: David W. Hyndman.

Abstract

We present an overview of the main activities of our Land Transformation Modeling (LTM) Project. With funding from EPA, the Michigan Great Lakes Protection Fund and NASA, we are developing a set of coupled models that characterize social drivers and subsequent environmental impacts of land use/cover change as it occurs across the Great Lakes Region. Study areas include: Grand Traverse Bay Watershed, Saginaw Bay Watershed, Upper Great Lakes forested ecosystems and the Miombo Woodlands in Africa.

Our LTM modeling framework employs an Object Modeling Technique (OMT) approach, using the object oriented scripting language *Avenue*, which is part of the ArcView geographic information system (GIS) application. We couple the GIS algorithms with the Stuttgart Neural Network Simulator so that historical land use/cover patterns can be associated with the spatial-temporal drivers developed by the GIS model. Forecasts of future land use/cover landscapes are made using the pattern file generated from the neural network training of the spatial-temporal historical data. Stochastic processes are also introduced into the model to simulate specific land use related human behaviors and policies. Finally, a unique 3-dimensional driving variable is being developed so that high quality views and vantagepoints in a watershed can be incorporated into the urban sprawl module of the LTM.

A variety of ecological process/impact models are then coupled to the land use/cover change predictions. These include:

Groundwater flow & solute transport model. A groundwater flow and solute transport model has been coupled to the land use/cover change model using the GMS and MT3D simulation models. Solutes associated with land uses are introduced into the groundwater and solute transport and flux are estimated for long durations (e.g., several decades) in our study watershed.

Dynamic Biogeochemistry Modeling of Streams. NETPATH and PHREEQC are used to examine the dynamic properties of stream water biogeochemistry as it is altered by surrounding land use/cover patterns. Water quality is also assessed by developing comprehensive indicators (some of which involve the use of multivariate statistics) of land uses.

Genetic "Fingerprinting" of E. coli. Our water quality sampling revealed the presence of E. coli at many locations in our Grand Traverse Bay Watershed. Sheridan Haack is using a rep-PCR technique to identify unique colonies. This information is then incorporated into the GIS so that associations between land use patterns and E coli strains can be made.

Forest Cover Patterns. We are using the North American Land Cover (NALC) MSS scenes to quantify the historical changes in forest cover across the Upper Great Lake States. These forest cover maps are associated with parcel changes on decadal scales and socioeconomic covariates of parcelization and forest cover changes are linked to changes in land use change.

The LTM project also has a strong outreach component. Researchers interact with land use stakeholders (e.g., land use planners, citizen groups, elected officials) on a regular basis. An interactive web site has been developed (http://www.ltm.msu.edu) that allows users to interact with GIS maps, view animations of model output and work with virtual reality images. Background information on the LTM applications and illustrations of land use change from aerial photos and satellite images are also provided at the web site.

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