United States Department of Agriculture

Final Report

Title:	Characterizing uncertainty in land use/cover maps across the Upper Great Lake States region

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Non-Technical Summary

Land use/cover maps are used by local, state and federal agencies for decision making. Many of these organizations spend thousands to millions of dollars developing these databases. Indeed, the NASA-supported Landsat program has been in existence since the late 1970s and has cost taxpayers billions of dollars. In addition, many decision support systems and simulation models use land use/cover maps for input. For example, the online L-THIA Decision Support System uses the National Land Cover Database (NLCD) as input to its runoff and non-point source pollution routines. Some local governments use the maps to estimate the amount of impervious surface. General rules of thumb have been developed by the USGS and EPA that has guided local planning; for example, it is often reported that watershed impairment occurs once a watershed exceeds 11% impervious cover. However, very little attention is given to the fact that the methods used to derive a land use/cover map may contain inherent uncertainties that question the reliability of these simple metrics. Comparison of land use/cover maps derived from different satellite remote sensing platforms has been a hot area of research in the last 5-7 year. In particular, many researchers have examined how Landsat, AVHRR and MODIS derived vegetation indices vary with sensor. In general, these researchers have found that there are considerable variations in the products derived from these sensors. However, few researchers have examined how these differences might impact our understanding of ecosystem dynamics and how uncertainty inherent in these maps might impact decision making. It is well known that land use/cover patterns impact hydrologic dynamics. There are a considerable number of hydrologic models that use land use/cover maps as inputs. Understanding how true urbanization trends versus uncertainty in the content of land use/cover maps impact important is critical to land use planning that eventual impacts potential for floods, nutrient loading to streams, etc. I intend to compare different land use/cover maps developed using two common methods: one from heads-up digitizing developed by local government and another from classifying satellite remote sensing imagery that is developed by state natural resource agencies. New tools and methods will be employed to compare these datasets. Executing two different kinds of models, a land use forecast model and a hydrologic model, will help us to understand the implications of data quality in model predictions.

Accomplishments

Major goals of the project

The objective of this project is to determine how variable land use/cover data are between different data collection methods (e.g., satellite remote sensing, heads up digitizing, aerial photo-interpretation) for the same location and time period. I conducted a preliminary analysis last year that showed that the differences between land use/cover maps processed using different methods for the same location and year were greater than 20 years of land use change represented in maps compiled using the same method. I will develop and then apply robust map comparison tests and examine how different data processing techniques impact land use change maps as they are used for planning and forecast modeling. The target audience includes a variety of users of land use/cover data, such as natural resource managers, modelers and planners. This work builds on my previous McIntire-Stennis Project which focused on characterizing land cover changes in the Upper Great Lakes States region. I propose to accomplish the following tasks over the next five years: 1. Develop a set of map comparison metrics. These will include using metrics used in land use model calibration and wildlife monitoring (e.g., presence/absence).

2. Compile and process several different land use datasets. I have compiled extensive, high quality land use/cover maps for the Upper Great Lakes Region as well as acquired satellite remote sensing derived land use/cover maps generated by state natural resource agencies. I will use these maps to conduct a comparative analysis of differences between observed change across maps developed using one method with differences between methods for the same location and time. 3. Test how differences in land use maps for the same location and time impact (a) land use forecasts and (b) hydrologic dynamics such as runoff. This project will be based on a recent NSF III-XT research project on data learning methods for land use change modeling and the FNR Signature Area Partnering for Land Use Sustainability (PLUS). The anticipated outcomes include: (1) better knowledge of the nature of differences in land use/cover maps being used by planners and natural resource managers; (2) the development and application of existing and new map comparison metrics that shed light on map differences and (3) the impact that differences in land use/cover maps might have on the prediction of runoff and nutrient loads from standard USDA developed hydrologic models. I anticipate completing the first task in year one, the second task in years 2 and 3 and the third task in years 4 and 5. Deliverables will include the development of a web site that explains how to compare maps, a summary of my research findings and the implications of the work for planning, natural resource management and to modelers who use land use/cover maps as inputs to their models. I also intend to incorporate the data and techniques into a graduate course in Landscape Ecology. Presentations at professional meetings of American Association of Geographers and the International Association of Landscape Ecologists will be made.

What was accomplished under these goals?

Several papers published in Tier 1 journals (Agriculture, Ecosystems and Environment; Landscape and Urban Planning; Applied Geography) that summarize new calibration metrics of land use coupled to hydrologic models. Some work has also focused on error propagation from land change models through to hydrologic models. Databases that were compiled for analysis were eventually used to parameterize our land change model (the Land Transformation Model). Web site has interface to land use change metrics that relate to natural resource tipping points. Dashboards are used to present this information to land use and natural resource stakeholders. Presentations of this work have been made at American Association of Geographers (AAG), International Association of Landscape Ecology (IALE) and the International Association of Great Lakes Researchers (IAGLR). Database and methods are now incorporated into a journal level course called Spatial Ecology and GIS offered to students studying natural resources planning and decision making.

What opportunities for training and professional development has the project provided?

One workshop (Oct 30, 2013) was held where state extension reps were trained on the use of tippingpointplanner.org. These extension reps will then train others in their state come Feb of 2014.

How have the results been disseminated to communities of interest?

We have piloted a community project in Lake County, Indiana Dec of 2013.

What do you plan to do during the next reporting period to accomplish the goals?

{Nothing to report}

Participants

Actual FTE's for this Reporting Period

Role	Non-Students or faculty	Students with Staffing Roles			Computed Total by Role
		Undergraduate	Graduate	Post-Doctorate	
Scientist	1.5	0	0	0	1.5
Professional	3.7	0	0	0	3.7
Technical	0	0	0	0	0
Administrative	0	0	0	0	0
Other	0	0	0	0	0
Computed Total	5.2	0	0	0	5.2

Student Count by Classification of Instructional Programs (CIP) Code

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{NO DATA ENTERED}

Target Audience

Land use and watershed planning groups across the United States and various NGOs (e.g., The Nature Conservancy) which use the results of the forecast models and land change analysis. Our group has been contacted by planning offices around the country (e.g., Seattle recently) to acquire land use forecasts. There has been a focus on the Great Lake states but recent years (last two) as we have built a decision support system (DSS) around land use and water quality models. This DSS work has been coordinated with extension offices in land grant universities in IN, OH, NY, IL, WI, MI and MN. Results of our agricultural land use change analysis have been provided to USDA NASS (in the form of journal articles published this year).

Products

Type	Status	Year Published	NIFA Support Acknowledged
Journal Articles	Published	2013	NO

Citation

Evidence for increased monoculture cropping in the Central United States. 2013. Agriculture, Ecosystems and Environment. 165:50-59.

Other Products

Product Type

Databases

Description

A large GIS based dataset with crop rotation for the lower 48 states

Product Type

Software or NetWare

Description

An online decision support system (www.tippingpointplanner.org)

Changes/Problems

No major changes to report. The work is highly related to other funded projects (NIFA supports analysis and calibration tool development) and non-NIFA funds support forecasting and roll out of the results to web sites with community engagement. There was a bit of a delay in getting the web site connected with communities as the first extension staff person hired to facilitate this left. The replacement person (K. Salazar) is making great headway with connecting the DSS and models/analysis results to communities that can use these online planning resources.