

Needs and Research Requirements for Land-Change Modeling

A study committee of the Board on Earth Sciences and
Resources, National Research Council

Commissioned by USGS and NASA

Statement of Task

- Goals
 - Assess the **analytical capabilities and science and/or policy applications** of existing modeling approaches.
 - Describe the **theoretical and empirical basis and the major technical, research, and data development challenges** associated with each modeling approach.
 - Describe **opportunities for improved integration of land observation strategies** (including ground-based survey, satellite, and remote sensing data) with land-change modeling to improve land-change model outputs to better fulfill scientific and decision making requirements.

Committee Membership

- Larry Band, UNC Chapel Hill
- Dan Brown (Chair), Michigan
- Kass Green, Kass Green and Associates
- Elena Irwin, OSU
- Atul Jain, Illinois
- Eric Lambin, Stanford and Louvain
- Gil Pontius, Clark University
- Karen Seto, Yale
- B.L. Turner, Arizona State
- Peter Verburg, Vrije University Amsterdam
- Mark Lange (Study Director), NAS

Process

- *Meeting 1:* DC – briefing by USGS and NASA, discuss statement of task and process
- *Meeting 2:* Chapel Hill – public input session on modeling approaches and suitability for particular applications
- *Meeting 3:* DC – report outlining, construct email survey
- *Meeting 4:* Woods Hole – review survey results, report drafting

Participants in Open Meeting

Johannes Feddema David Lewis
David Newburn Nathan Moore Nancy Harris
Dawn Parker Ray Quay Nate Herold
Gary Shenk Jonathan Smith Bruce McCarl
Dave Theobald Dean Urban Brian O'Neill
Roger White Alex Anas Trist West
Bob Abt Felix Creutzig,
Tom Evans Rebecca Dickson
Hong He Ron Eastman

Application Domains for LCMs

- Land-climate interactions
- Water quantity and quality
- Biotic diversity, ecosystem function, and tradeoffs among ecosystem services
- Food and fiber production
- Energy and carbon (sequestration)
- Urbanization, infrastructure, and the built environment

Data Characterizing Land Change

- RS observational advances create opportunities
 - Increased temporal, spatial and spectral detail
- Other Data for LCMs can be limiting
 - Land values, disaggregate social data, cadasters
- Classification vs. continuous variables
- Opportunities to improve data availability and accuracy

Modeling Concepts Discussed

- Pattern and Process
 - Contrasts between pattern-based (inductive) approaches and process-based (deductive or structural) approaches
- Projection, Forecast, and Scenario
 - Contrast explaining/learning goal with project/predict goal
- Model Uncertainty
 - Contrast models in terms of how they handle stationarity and uncertainty in LC processes
 - Discussed best practices

Modeling Approaches

Discussed approaches for modeling land changes spatially

- Machine learning models
- Cellular models
- Economic models
 - Partial and General Equilibrium models
 - Econometric models
- Agent-based models
- ... and their hybrids

Public and Committee Discussions

- How well do different modeling approaches serve different science and application domains?
- What are the data requirements of the different approaches and how well are they served by available data?
 - Observations considered broadly to include satellite, in situ, survey, and other sources.
- What new modeling and observational advances would improve the state of land change modeling?

Current Status

- Final drafting of report text and graphics.
- Not yet in review, but soon (weeks).
- Review process 3-4 months, including response to reviewers and final doc.

My hopes

- That the report will serve as a touchstone for future discussions about contrasting modeling approaches.
- That the report helps clarify the conceptual route to take from scientific or decision making problem to proper model use.
- That the report provides impetus for future development of land-change model implementations, data support for models, and infrastructure for the LCM community.

Thank You