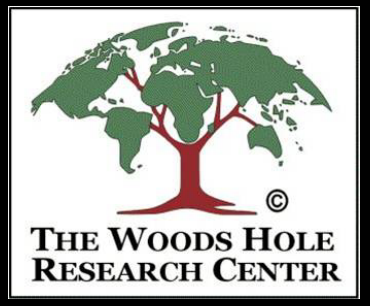
# Spatial Predictive Modeling and Remote Sensing of Land Use Change in the Chesapeake Bay Watershed

**Nancy Bockstael**
Dept. of Agriculture and Resource Economics
University of Maryland, College Park

**Scott J. Goetz**
The Woods Hole Research Center
Woods Hole, Massachusetts

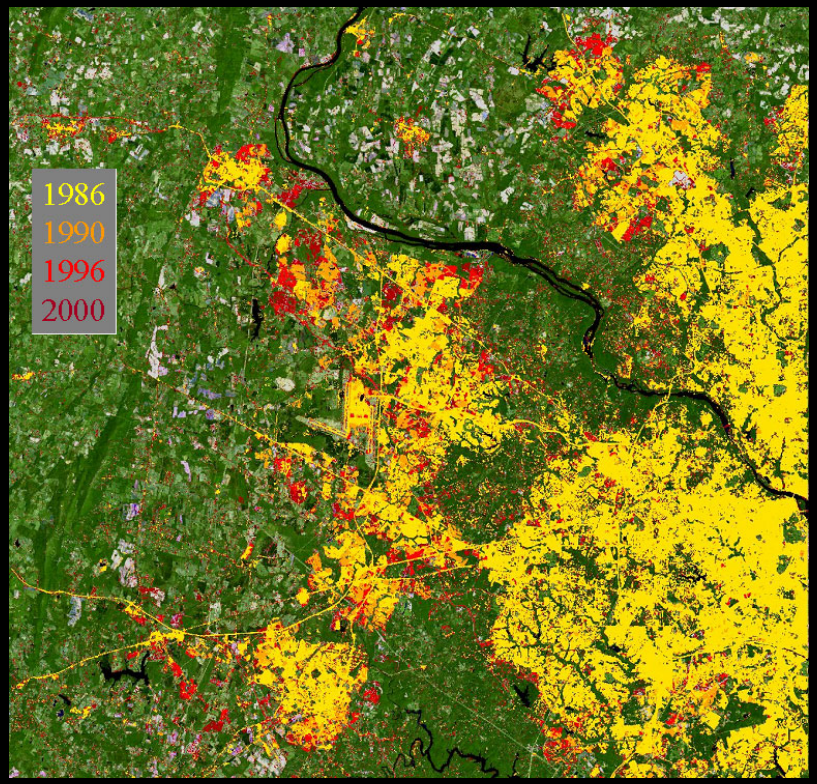
**Claire Jantz**
The Woods Hole Research Center
Woods Hole, Massachusetts





# Introduction

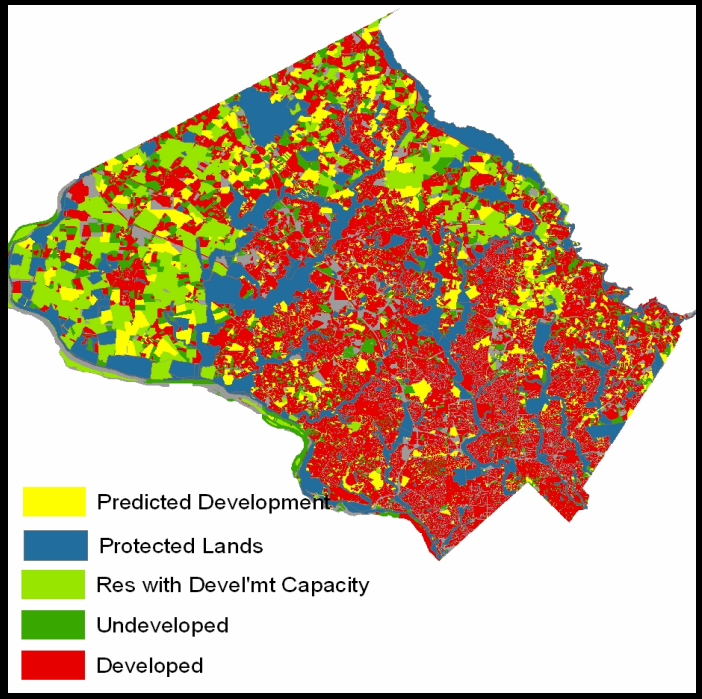
- Questions
  - How has urbanization changed the landscape and consumed resource lands?
  - What form will urbanization take in the future under different land use scenarios?
- Goals & Approach
  - To map and monitor changes in the urban / exurban environment using multi-scale satellite imagery.
  - To develop economic models of land use change over time, focusing on low density development at the urban-rural fringe.
  - To exploit data derived from satellite imagery to calibrate cellular automaton models and enrich economic models.
  - To compare and contrast economic models with cellular automaton and resource allocation models, and test the performance and sensitivity of the models.



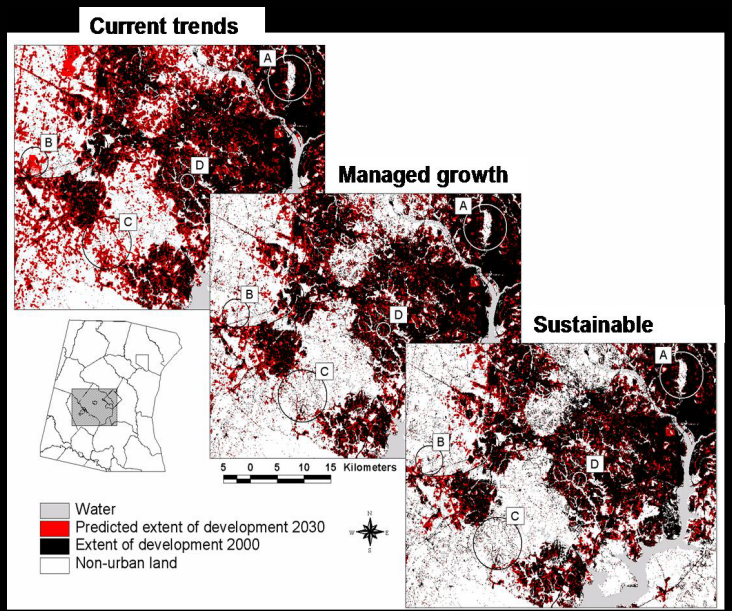

Changes in impervious surface cover (urbanization) northwest of Washington, DC

# Results

- Most significant results
  - Low density residential development (exurban sprawl) can be captured with multi-scale remote sensing & subpixel algorithms.
  - Cellular automaton (CA) models can be calibrated with satellite data sets in order to capture development probabilities under different policy scenarios.
  - Economic models (EC), based on process of land use change decisions, can capture outcomes of policy change, including unintended ones.
  - CA and EC models generate somewhat different predicted patterns of development.
- Future steps
  - Further comparison of CA and EC model predictions and analysis of model constraints.
  - Address pixel versus parcel mismatch issues.
  - Further integration of remote sensing variables into the EC model.
  - Focus on publications (see final slide)

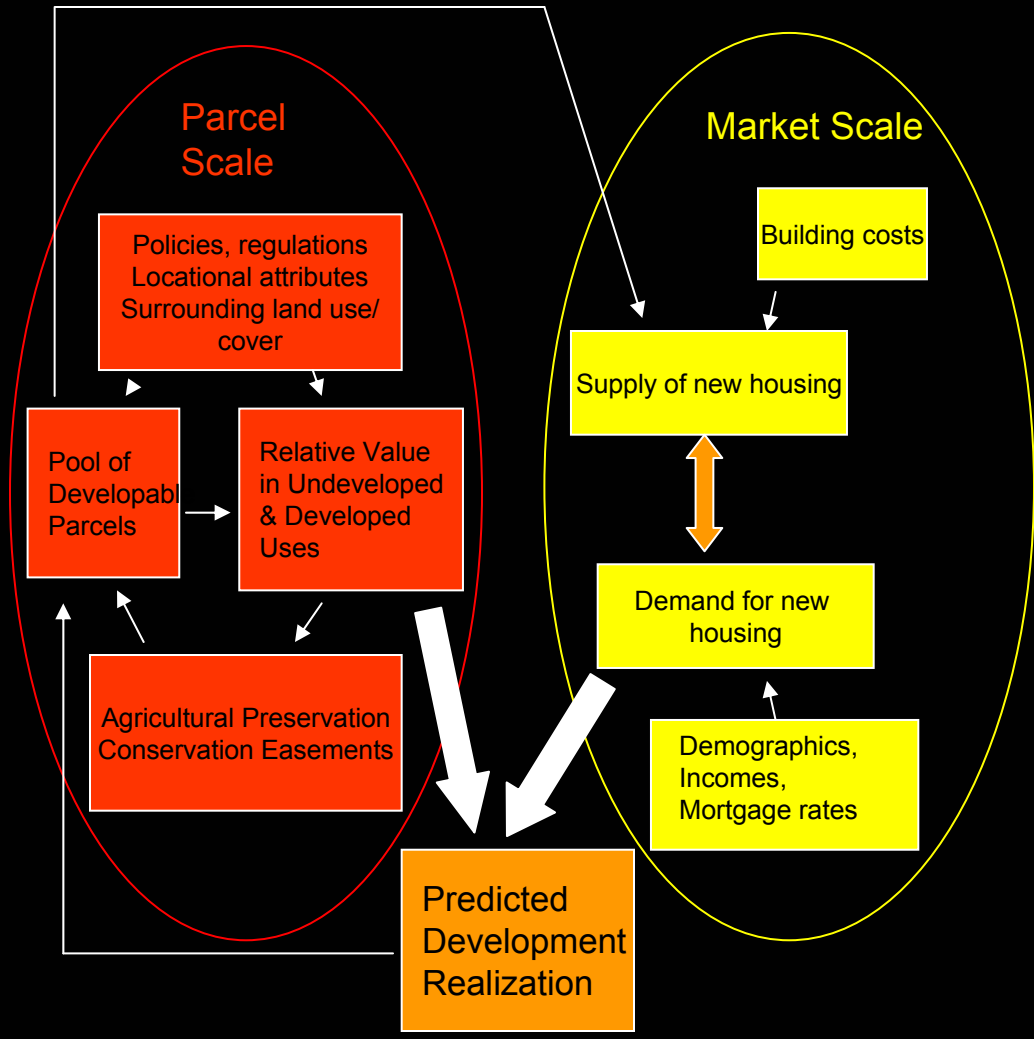



2030 projections from different land use models



# Conclusions

- Exurban sprawl continues to consume valuable resource lands (forests, farms and wetlands) despite recent policy changes.
- Advances in remote sensing of exurban land use change can be used to calibrate, constrain and inform various types of land use change models.
- The value of remote sensing data is increased when combined with economic data.
- Process based land use change models can test hypotheses about the effects of policy.
- Process and pattern based land use modeling can be used synergistically and have the potential for informing policy decisions.




Process based model

# Publications


- Bockstael, N. and E. Irwin. Public policy and the changing landscape. *Estuaries* (in press).
- Elvidge, C., P. C. Sutton, T. W. Wagner, R. Ryznar, S. J. Goetz, A. J. Smith, C. Jantz et al., Urbanization *in* G. Gutman, D. Skole, and C. Justice, eds. *Land Change Science: Observation, Monitoring, and Understanding Trajectories of Change on the Earth Surface* (in press).
- Irwin, E. and N. Bockstael. Endogenous spatial externalities: empirical evidence and implications for exurban residential land use patterns. *Advances in Spatial Econometrics, Methodology, Tools and Applications*. Edited by L. Anselin, R. Florax and S. Rey (in press).
- Irwin, E. and N. Bockstael, "Land Use Externalities, Growth Management Policies, and Urban Sprawl," *Regional Science and Urban Economics* (in press).
- Jantz, C. A., S. J. Goetz, and M. A. Shelley. 2004 Using the SLEUTH urban growth model to simulate the land use impacts of policy scenarios in the Baltimore-Washington metropolitan region. *Environment and Planning B* 31(2):211-228.
- Jantz, C. and Goetz, S.J. Scale dependencies in an urban land use change model. *International Journal of Geographic Information Systems* (in press).
- Goetz, S.J., Jantz, C.A., Prince, S.D., Smith, A.J., Varlyguin, D. and Wright, R.. Integrated analysis of ecosystem interactions with land use change: the Chesapeake Bay watershed. In: G.P. Asner, R.S. DeFries and R.A. Houghton (Editors), *Ecosystem Interactions with Land Use Change*. American Geophysical Union, Geophysical Monograph Series. Washington DC, 13 pp. (in press).
- McCauley, S., and S. J. Goetz. Mapping residential density patterns using multi-temporal Landsat imagery and a decision-tree classifier. *International Journal of Remote Sensing* 25(6):1077-1094.
- Nilsson, C., Pizzuto, J.E., Moglen, G.E., Palmer, M.A., Stanley, E.H., Bockstael, N.E. and Thompson, L.C. Ecological Forecasting and the Urbanization of Stream Ecosystems: Challenges for Economists, Hydrologists, Geomorphologists, and Ecologists. *Ecosystems*, 6 (7): 659-674. 2003.
- Palmer, M.A., Moglen, G.E., Bockstael, N.E., Brooks, S., Pizzuto, J.E., Wiegand, C. and VanNess, K., 2003. The ecological consequences of changing land use for running waters, with a case study of urbanizing watersheds in Maryland. In: K.M. Krchnak (Editor), *Human Population and Freshwater Resources: U.S. Cases and International Perspectives*. Yale University Press, New Haven, CN,5pp. 85-113.