Workshop on New Developments in U.S. Land-Use Data Collection and Analysis: Implications for Agriculture and Rural Land

Executive Summary

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Sponsored by USDA Economic Research Service (ERS) and the Farm Foundation

Introduction

A variety of data collection programs are transforming opportunities to track and analyze U.S. land use over time and space. The USDA Economic Research Service and the Farm Foundation sponsored a workshop on October 16-17 convening producers and users of U.S. land-use data focusing on agriculture and rural land. The workshop drew about 75 participants and included presenters from several USDA and other Federal agencies, as well as academic, non-profit, and private sector organizations. The workshop presentations focused on:

- Disseminating information on the status and future directions of new and on-going U.S. Federal land-use data collection programs focusing on agriculture and rural land.
- Disseminating information on current and potential uses of these data by government agencies, academic researchers, private companies, and not-for-profit organizations.
- Identifying modeling methodologies and other approaches for analyzing and integrating these data to address administrative, business, and policy needs.
- Identifying priorities and recommendations for future data collection, coordination, dissemination, and analysis efforts.

The comments and research results summarized below are those of the workshop presenters and participants and may not be attributed to the Farm Foundation, the Economic Research Service, or the U.S. Department of Agriculture.

Welcome and Introduction

Mary Bohman, Director, Rural and Resource Economics Division at USDA Economic Research Service (ERS), opened the workshop by thanking the participants and the Farm Foundation and highlighting ERS's role in compiling and analyzing land-use data. Since 1945, ERS has been reconciling disparate data from across Federal agencies and other sources to provide the Major Land Uses data, the only land-use estimates that sum to all the private and public land in the United States. Ruben Lubowski, Shawn Bucholtz, and Vince Breneman, the workshop coordinating committee co-chairs from USDA/ERS, provided a further welcome and described the workshop rationale and organization. Two speakers then introduced the workshop by discussing the development and use of land-use data within the U.S. Department of Agriculture:

ERS Land Use Data for Policy and Analysis: Past, Present and Future. Ralph Heimlich, formerly with USDA/ERS and now at Agricultural Conservation Economics, provided a historical review of land-use data development and analysis at ERS. Future data development priorities are more direct use of remotely-sensed land cover data; incorporation of Common Land Unit (CLU) data; integration of land use, economic, and physical data; extension of spatially-sampled data (NRI point data after 1997); and extension of Major Land Uses (MLU) data to

county level for 1997-2002 and beyond. Priorities for future analysis are crop supply response to bioenergy development and associated environmental consequences; impacts on agriculture from urbanization and expanded impacts of risk management policies; and incorporation of point-based simplified environmental and normative economic models.

USDA Remote Sensing Data Collections: Implications for Land-Use Land-Cover Applications. Glenn Bethel, USDA Remote Sensing Coordinator, USDA Foreign Agricultural Service (FAS) described USDA applications benefiting from timely land cover monitoring and reviewed the progress and future directions of USDA's investments in creating seamless "ready to use" base imagery, digitizing business data layers with the Common Land Unit (CLU), and various imagery programs. The National Agriculture Imagery Program (NAIP) has the goal of producing a new 2 and 1 meter county mosaic every 1 and 5 years, respectively in order to update farm records and provide compliance checks for farm programs. Other imagery programs include resource photography, the National Resources Inventory (NRI), and medium resolution satellite imagery (AWiFS and Landsat) for operational monitoring.

Luncheon Presentations

Two luncheon speakers broadened the focus of the workshop with presentations on urban and global land-use analyses during the first and second days, respectively.

Seeing the Elephant: Multi-Disciplinary Measures of Urban Sprawl. Gerrit Knaap, Professor and Director, Center for Smart Growth Research and Education, provided an urban policy perspective on land-use data and research with the first day's luncheon talk. Drawing on a research paper coauthored with Yan Song, University of North Carolina at Chapel Hill, and Reid Ewing and Kelly Clifton, University of Maryland, this presentation reviewed different disciplinary approaches for conceptualizing and measuring urban sprawl. Over the last two decades substantial progress has been made in measuring and analyzing spatial patterns that constitute the problem known as urban sprawl. Because of the disciplinary boundaries of these research efforts, parts of the problem are understood better than the problem as a whole.

Satellite Views of Urbanization, Net Primary Production, and the Human Demand for Food and Fiber: Can the Earth Keep Up? During the second day's luncheon, Marc Imhoff, Terra Project Scientist, NASA Goddard Space Flight Center, presented research that combined satellite data on city lights, socio-economic data, and biophysical models to estimate that humans annually consume 20% of Earth's total net primary production (NPP) on land on a global basis. This is a powerful aggregate indicator of human impacts on the biosphere. The uneven regional and local distribution of NPP-carbon supply and demand indicates the degree to which various human populations rely on NPP "imports" and are vulnerable to climate change, and suggest policy options for slowing future NPP demand growth.

Data and Research Presentations

Sessions during the first day and a half of the workshop included paired data and research presentations according to different land-use data categories: Survey-Based Data, Administrative Data, and Remote-Sensed Data. The sessions in the afternoon of the second day featured other applications of land-use data for modeling environmental impacts and assessing bionergy potential.

Survey-Based Land-Use Inventories

Analyzing Changes in Agri-Environmental Conditions Using the National Resources Inventory. J. Jeffery Goebel, USDA Natural Resources Conservation Service (NRCS), discussed the National Resources Inventory (NRI), a scientific (statistical) longitudinal survey of natural resource conditions and trends on nonfederal land in the United States. It is conducted by NRCS in cooperation with Iowa State University's Center for Survey Statistics and Methodology. The NRI was conducted on a five-year cycle during the period 1982 to 1997, but is now conducted annually. NRI data were collected every five years for 800,000 sample sites; annual NRI data collection occurs at slightly less than 25 percent of these same sample sites.

Modeling the Spatial Distribution of Land Uses with National Resources Inventory Data. Andrew J. Plantinga, Oregon State University, and David Lewis, University of Wisconsin, estimated an econometric land-use model estimated for North and South Carolina using NRI point data. Land-use transition probabilities from an econometric analysis are matched to parcels in a GIS and provide a set of rules that govern land-use change in a landscape simulation. The simulation model is used to predict future spatial patterns of forest land use under baseline and policy scenarios. The spatial arrangement of forest land is an important indicator of habitat quality for many bird species of conservation concern.

Forest Inventory and Analysis, Brad Smith, U.S. Forest Service, described the design, objectives, status, and budgeting of U.S. Forest Service's Forest Inventory and Analysis (FIA) program, the only comprehensive forest inventory for each of the 50 States and 8 Caribbean and Pacific Island groups. FIA is a systematic survey design-based inventory using a hexagon grid and plot system to provide uniform national coverage every year. The FIA switched from a periodic State by State cycle in 1999 to an annualized system designed to operate in every State every year. 48 States will be implemented by 2008. Data are fused to generate maps of forest ownership. Partner contributions since 2000 have averaged about 12% of all program funds and leverage the grid system to provide additional regional and local data layers.

Modeling and Forecasting Forest Inventories in the United States. David N. Wear and Robert Huggett, U.S, Forest Service, described ongoing development of the United States Forest Assessment System (USF^AS) in support of RPA Assessments and other strategic analysis on forest conditions and change in the United States. This modeling system draws on Forest Inventory and Analysis (FIA) data and links analysis in three separate domains: Forest Uses, Forest Dynamics, and Ecosystem Services. The Forest Dynamics domain forecasts forest conditions in the United States at the plot level and derives regional forecasts from the area frame design of the survey.

Administrative Data

FWS Wetlands Database and Wetlands Status and Trends, Mitch Bergeson, U.S. Geological Survey, described the U.S. Fish and Wildlife Service's Wetlands Database, Mapper, and Status and Trends programs. FWS has maintained a wetlands mapping effort for over 30 years. The FWS Wetlands Geodatabase forms the framework for NSDI wetlands spatial data layer and has

been digitally mapped for 55% of the Nation to date. These data improve on historic NWI wetlands data by providing standardized data storage and schema, improved quality of mapping, standardized data updates and additions, integration of supporting information, and seamless data storage. The Wetlands Status and Trends program aims to determine the status and trends of wetlands in the United States and produce comprehensive, statistically valid acreage estimates of the Nation's wetland resources based on remote sensed imagery with field verification.

Common Land Unit. Ted Payne, USDA Farm Service Agency (FSA), described efforts to establish the Common Land Unit (CLU) for mapping the nation's farms and fields. Along with partner agencies, FSA is implementing desktop GIS at more than 2,500 field service centers across the country. The majority of FSA's business data contains geospatial components or is referenced to geographic locations (e.g., land records, field locations, and soil types). CLU data layer development is the most critical component for the successful implementation of GIS by the FSA. This layer will ultimately include all farm fields, rangeland, and pastureland in the United States. In conjunction with digital imagery and other data, FSA will use the CLU data layers to support farm service programs, monitor compliance, and respond to natural disasters.

Profiling Expiring CRP Acres Through the Use of the Common Land Unit Database, Shawn Bucholtz, USDA Economic Research Service and now USDA Farm Service Agency, characterized the 2.2 million acres exiting the Conservation Reserve Program (CRP) in 1997 as landowners chose not to extend or re-enroll their expiring contracts. Several land characteristics were examined, including erosion, productivity, proximity to water bodies, and landscape configuration. The primary innovation of this research occurs through integrating the Common Land Unit database, SSURGO soils database, National Hydrography Database, and Cropland Data Layer to provide spatially detailed insights into the potential impact of expiring contracts.

Remote-Sensed Data

The 2007 Cropland Data Layer. David M. Johnson, USDA National Agricultural Statistics Service (NASS), described the Cropland Data Layer Program, an offshoot of the Agency's Remote Sensing for Agricultural Estimation Program. Satellite data categorized by crop is used as an auxiliary variable in a regression approach to refine state and county crop acreage estimates. The two major goals of this program are to: 1) combine remote sensing imagery, USDA/Farm Service Agency reported data and NASS survey data to produce supplemental, unbiased acreage estimates for the state's major commodities, and 2) produce a crop-specific digital land cover data layer for distribution in industry standard formats. The CDL is a unique "agricultural specific" land cover geospatial product that is reproduced annually in several states.

Cropland Data Layer Use in Forecasting Crop Production and Harvest, George Muehlbach, John Deere & Company, discussed a project forecasting rice production and harvest in the Mississippi Delta region. Multiple years of data from the Cropland Data Layer were used to construct "pseudo" Common Land Units with estimated field boundaries. An economic model using cost and returns data from the USDA Economic Research Service was used to forecast field-level crop choices. Yield histories from Risk Management Agency (RMA) records were also integrated to compare performance of traditional versus genetically improved rice varieties.

USGS EROS Land Cover Activities. Terry Sohl, Science Applications International Corporation (SAIC) and U.S. Geological Survey described U.S. land cover data development at the USGS Center for Earth Resources and Observation (EROS). The National Land Cover Dataset (NLCD) for 2001 includes imagery, topographic derivatives, ancillary data, land cover, canopy, imperviousness, change and metadata for all of the continental U.S. and Alaska. The Land Cover Trends Project aims to document the types, geographic distribution, and rates of change in U.S. land cover from the 1970s to 2000 and to determine the drivers and consequences of the change. Change estimates are developed for EPA Level III ecoregions using Landsat MSS and TM imagery covering stratified random sample blocks within each of these regions.

Modeling Land Use with USGS Data. Terry Sohl, Science Applications International Corporation (SAIC) and U.S. Geological Survey, described the FOREcasting SCEnarios of change (FORE-SCE) model used to create high-resolution land cover projections under multiple scenarios for large geographic regions. Parts of the FORE-SCE model are parameterized with historical land cover change information from the U.S. Land Cover Trends project, which analyzes contemporary (1973-2000) land cover change in the conterminous United States. FORE-SCE applications to date (Western Great Plains, Southeastern U.S., and Northeastern U.S.) have focused on providing regional, 250m-resolution land cover in support of climate modeling partners. Future work will address the potential impacts of a developing biomass-for-biofuel industry in the Northern Great Plains, using an integrated approach combining land cover modeling, biogeochemical modeling, hydrologic modeling, and economic components.

Modeling Environmental Impacts of Land Use and Bioenergy Potential

Development and Application of a Regional and Local Land Cover for Evaluating Bird Habitat and Conservation Impacts. Megan McLachlan and Mike Carter, Playa Lakes Joint Venture, Ryan Reker, Rainwater Basin Joint Venture, and Andy Bishop, US Fish and Wildlife Service, developed and applied a regional landcover layer for a Conservation Effects Assessment Project (CEAP) evaluation that estimates the effects of the Conservation Reserve Program (CRP) on priority bird species in the Mixed-grass Prairie Bird Conservation Region (BCR). Multiple spatial data layers (USDA – Common Land Unit, NAIP Imagery, RWBJV Imagery, among others) are also integrated to create a more detailed fine-scale landcover layer for priority landscapes. The landcover is used as a core dataset for habitat mapping, spatial modeling, and bird population objective setting applications.

Protecting Watershed Ecosystems through Targeted Local Land Use Policies. JunJie Wu and Christian Langpap, Oregon State University, and Ivan Hascic, OECD, combined an econometric model of land use choice with three models of watershed health indicators to examine the potential effects of land use policies on watershed ecosystems through their effect on land use choice. The analysis is conducted using parcel- and watershed-level data from four western states in the United States (California, Oregon, Washington, and Idaho). The results suggest that local incentive-based land use policies and property acquisition programs could have relatively large positive impacts on water quality and the number of species at risk, while policies that attempt to change the returns to alternative land use would have small impacts. The results also suggest the potential for targeting these policies depending on the land use composition of watersheds.

Spatial Contours of Potential Biomass Crop Production and Competitive Land-Use Threat. Frank Howell, University of Mississippi, used a model developed at Oak Ridge National Laboratory to provide estimates of biomass crop production circa 2002. All told, bio-energy systems, and biomass crop production in particular, will be important elements of national security, economic vitality, and public policy. Using spatial analysis methods, significant clusters of counties reflecting high potential biomass crop "zones" were identified and characterized for the U.S. Since there will be competitive land-uses for areas in these agronomically optimal zones, potential "threats" from urbanization were identified including population growth, farmer resistance to adoption, and farm exits.

Wrap-Up Panel and Discussion

The wrap-up panel was chaired by Walt Armbruster of the Farm Foundation and included Kathleen Bell, Associate Professor, University of Maine; Glenn Bethel, USDA Remote Sensing Coordinator, USDA Foreign Agricultural Service; and Ralph Heimlich, Agricultural Conservation Economics and formerly USDA Economic Research Service. The panel was charged with distilling lessons from the workshop and identifying priorities for future data collection and research activities. Observations and recommendations that emerged from the panel member comments and accompanying discussion were as follows:

<u>Data Access and Dissemination</u>

- Facilitating access to Federal data is critical for academic researchers, specifically for universities and other institutions with limited resources.
- Minor changes in data collection and dissemination can greatly increase the benefits generated from land-use data sets. In some cases, it is a simple matter of the agencies letting the researchers know that the data exist and making them available.

Recommendation #1: Develop a global memorandum of understanding (MOU) that would allow users to gain access to a variety of data sets.

Recommendation #2: Expand use of the USDA Data Gateway and/or private sector channels to facilitate data dissemination.

<u>Interaction between Data Providers and Users</u>

- The workshop provided opportunities to learn about many new data sources and allowed establishment of personal contacts that will facilitate future exchange of information.

Recommendation #3: Encourage dynamic feedback between data providers and users on the uses and value of land-use data.

Recommendation #4: Create a data users advisory group to the USDA Natural Resources Conservation Service (NRCS) to provide input on dissemination strategies and other issues relating to the National Resources Inventory (NRI).

Preservation of Historical Record

- The USDA is moving towards "perfect" current information through provision of yearly land cover information completed during the growing season and constant monitoring linked to the Common Land Unit (CLU) for disaster assistance and other program administration purposes.
- The Farm Service Agency (FSA) and other agencies are throwing away historical administrative data of great potential value for research and policy analysis.

Recommendation #5: Provide incentives for preserving and archiving historical data and ensuring consistent quality over time.

Data Coordination

- Many land-use data collection efforts serve similar purposes and opportunities may exist for more collaborative and economical uses of resources.
- Opportunities exist to cross validate information using land-use data from different sources.

Recommendation #6: Establish a data council within USDA that would meet periodically to exchange information and coordinate across agencies collecting and analyzing land-use datasets.

Recommendation #7: Establish a data coordinator position within USDA, analogous to the position of remote sensing advisor, who could monitor where different agencies are going and where they could collaborate in terms of data collection and analysis efforts.

Data Integration

- Provision of data on rural as well as non-rural land uses is critical for policy and research.
- Different data sources may be complimentary as well as, possibly, redundant.
- The Common Land Unit (CLU) provides a means of relating a variety of data sets to a wealth of information on farm operators.

Recommendation #8: The USDA Economic Research Service (ERS) could play a greater role in repackaging confidential data for public distribution by removing individual identifiers, aggregating, and merging so as to extract maximum information with minimum disclosure.

Recommendation #9: The USDA Economic Research Service (ERS) could develop a "spatial and digital" analog of the Major Land Uses data series incorporating satellite imagery and other new data products. This would push State-level estimates down to the county level or even lower and could be retrofitted to 2002 and 1997 to provide a historical perspective.

Organization

The Workshop Coordinating Committee in USDA/ERS included Ruben Lubowski, Shawn Bucholtz, and Vince Breneman (Co-Chairs); Kathy Kassel, Nancy McNiff, Tina Terry, Linda

Felton, Cynthia Ray, and Victor Phillips, Jr. Walt Armbruster, Steve Halbrook, and Vicki Liszewski of the Farm Foundation also provided key planning and organizational support.

Links for Land-Use Data and Information

USDA Aerial Photography Field Office

- NAIP and USDA Aerial Data
  http://apfo.usda.gov

USDA Data Gateway

- Data products packaged by county
  http://datagateway.nrcs.usda.gov

U.S. Forest Service

- Geospatial data clearinghouse
  http://fsgeodata.fs.fed.us
- Forest Inventory and Analysis (FIA) Data
  http://fia.fs.us
- Data for National Forests
  http://svinetfc4.fs.fed.us/

USDA Economic Research Service (ERS)

- Major Land Uses Data
  http://www.ers.usda.gov/Data/MajorLandUses/

Forest Service's Remote Sensing Applications Center (RSAC)

- Fire Mapping, Resource Information
  http://www.fs.fed.us/eng/rsac/

Foreign Agricultural Service (FAS)

- Crop Explorer (Global imagery, weather)
  http://www.pecad.fas.usda.gov/cropexplorer/

Fish and Wildlife Service (FWS) Wetlands Geodatabase

- FWS Wetlands Digital Data, Mapping, and Status and Trends Information
  http://wetlandsfws.er.usgs.gov

National Agricultural Statistics Service (NASS)

- NASS Cropland Data Layer (CDL)
  http://www.nass.usda.gov/research/Cropland/SARS1a.htm

Natural Resources Conservation Service (NRCS)

- National Resources Inventory (NRI)
  http://www.nrcs.usda.gov/technical/nri/

U.S. Geological Survey (USGS)

- USGS Land Cover Institute (LCI)
  http://landcover.usgs.gov/
- National Land Cover Database
  http://landcover.usgs.gov/uslandcover.php
- Land Cover Trends
  http://edc2.usgs.gov/LT/index.php