

**Environment and Natural Resources Trust Fund
2011-2012 Request for Proposals (RFP)**

LCCMR ID: 005-A1

Project Title: Mapping and Monitoring Minnesota Landscapes

Category: A1. Natural Resource Data and Information: Collection

Total Project Budget: \$ \$395,000

Proposed Project Time Period for the Funding Requested: 2 yrs, July 2011 - June 2013

Other Non-State Funds: \$ 0

Summary:

We will produce a current statewide digital land cover-use map, analyze changes and trends in land use over the past 40 years, and model scenarios of alternative future land use.

Name: Marvin Bauer

Sponsoring Organization: U of MN

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Location

Region: Statewide

Ecological Section: Statewide

County Name: Statewide

City / Township:

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ Employment	_____ TOTAL _____%

PROJECT TITLE: Mapping and Monitoring Minnesota Landscapes

I. PROJECT STATEMENT

Rationale. Land use maps and data are fundamental and critical ‘building blocks’ for land and water management by cities, counties, state and federal agencies. The lack of accurate and timely data is typically the weakest link in watershed assessments. We have Minnesota areas that are experiencing significant population increases and conversion of land uses, but most local and state agencies are using decade-old land use data in developing multimillion dollar watershed management plans. For example, the population and impervious cover (roads and roofs) of Washington County have nearly doubled from the 1980s. Because land cover-use can change quickly, statewide land cover-use maps and data need to be updated, taking advantage of current satellite imagery, along with 2010 Census data. Satellite remote sensing provides a cost-effective way to track changes in land cover/land use for the state.

The proposed project meets three important needs: (1) just as investors need up-to-date information to make investment decisions, so do local and state governments which are making multimillion dollar watershed management decisions; (2) the last statewide land cover-use maps and demographic census data are now 10 years old; and (3) this proposal responds to a key recommendation of the LCCMR’s Minnesota Statewide Conservation and Preservation Plan and will provide important data for numerous state, regional and local agencies. Over the next few decades, there will continue to be substantial challenges to preserving our land and water resources in the face of climate change and increases in population, energy demands, fires, drought, floods, and pest infestations.

Goals and Impacts. The goal is to map and model Minnesota’s changing landscapes via collaborative research between the University of Minnesota and the State of Minnesota. First, we will provide accurate, detailed, and up-to-date characterizations of the state’s land cover-use for use by local, state and federal agencies, and commercial and non-government organizations. Second, historical trends and demographic information will be analyzed and incorporated into models to project future land use changes, particularly of urban growth zones, agricultural land use, and forest and wetland changes. The land cover and land use data are basic information required for many environmental assessments by state and local natural resource agencies that are responsible for issues such as wastewater and watershed management. It is also an important opportunity to link the updated land use data with demographic data from the 2010 Census. The results and data will be converted into GIS layers for free distribution via the University of Minnesota (land.umn.edu), Minnesota Geospatial Office, and DNR Data Deli websites for widespread use by cities, counties, state agencies, and other land and watershed managers.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Land mapping by satellite remote sensing (\$245,000). While it is commonly recognized that land use in the state is changing, especially around population centers, comprehensive information on land use is not routinely acquired. The most recent 2000 statewide land cover-use map (see, land.umn.edu), based on our classifications of satellite data is now 10 years old. We will create an updated statewide land cover-use map and GIS database of agricultural crops, forests, wetlands, grasslands, shrublands, and urban/developed land utilizing state-of-the-art satellite image classification and GIS methods. The urban/developed class will be further classified to percent impervious surface area, an important indicator of environmental quality related to water quality, stream habitat, stormwater runoff, pollutant loading, and landscape management. These data are especially critical to the MPCA for watershed management, monitoring water quality of lakes and streams, and defining watershed management goals for Total Maximum Daily Loads (TMDLs) of sediment.

Outcome

1. An updated, current statewide land cover-use map and database.
2. Maps and area statistics by city, county, ecosystem and watershed on the Internet.

Completion Date

- December 2012
June 2013

Activity 2: Modeling changing landscapes (\$150,000). We will analyze the land use changes of the past 40 years, comparing previous maps (1969, 1990, 2000) to 2010. This comparison involves reconciling the varying data and methods used for each statewide classification to make it possible to compare the classification maps and area statistics, to characterize changes and trends in land cover and land use in Minnesota during the 40 years from 1969 to 2009. In addition to being a very useful product itself to many stakeholders, this understanding of landscape dynamics and trends will be inputs to models of current and future land use scenarios. Several cities, to be determined, will use detailed Census and land use change data as a part of Minimal Impact Design Standards (MIDS) pilot studies by the MPCA, creating effective models to be broadly adopted.

Maps and measures of land use change and trends from the remotely sensed imagery can be combined with other kinds of demographic and geographic data, such as U.S. Census information. We will combine these various forms of geographic data with well-established and tested computer modeling approaches to gain insight into the factors that influence changing land use and model scenarios of alternative future landscapes. This effort will begin with estimating future development scenarios along with corresponding impervious cover changes for two sensitive ecoregions--Northern Lakes and Forests and North Central Hardwoods--based on demographic, socioeconomic and environmental trends. Projections will be used to evaluate potential improvement or degradation patterns based on MPCA Index of Biotic Integrity (IBI) analyses. We will work with university and agency researchers to incorporate updated data into future projections of changes to agriculture, forests, wetlands, and urbanization.

Outcome

1. Analysis of changes-trends in land cover and use over past 40 years.
2. Model scenarios of past, current and future landscapes.
3. Maps, data and model scenarios available on the Internet.

Completion Date

- January 2013
March 2013
June 2013

III. PROJECT STRATEGY

A. Project Team/Partners. The project team includes three University of Minnesota faculty from the Departments of Forest Resources and Geography. Marvin Bauer and Joseph Knight will direct the satellite remote sensing; Steven Manson will lead the modeling and work with the MPCA on projections. We will be assisted by two research staff and two graduate research assistants supported by LCCMR trust funds.

The Minnesota Pollution Control Agency will be a primary partner with Bruce Wilson serving as our liaison and participating researcher on land use and water quality change analyses. The MPCA is the lead agency for the MIDS, TMDL, and stormwater management efforts that will rely on the updated information provided by the proposed work.

We will also identify other agencies and groups (e.g., DNR, MN Geospatial Office, Met Council, MIDS partnering cities, watershed districts to serve as advisors to the project and users of its results. Finally, a critical form of partnership is Internet delivery of freely accessible data, interactive maps, and summary graphics via our land website to agencies and other interested stakeholders, as well as citizens.

B. Timeline Requirements. We will complete the project in two years.

C. Long-Term Strategy and Future Funding Needs. The objectives and approaches we propose directly support the LCCMR Statewide Conservation and Preservation Plan, which recommends that the state “invest in generating base data and information necessary to support conservation planning,” and more specifically “update statewide land cover databases and remote sensing capabilities.” We recommend they should become part of a long-term initiative by the state for monitoring and analysis of its land and water resources.

IV. TOTAL TRUST FUND REQUEST BUDGET (2 years)

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
Personnel:	
TBD research associate (post-doc), 100% (25% project management, 75% land classification). \$45,750 salary; \$30,470 benefits. 7/1/011 - 6/30/13.	\$ 121,969
TBD research fellow, 100%. \$65,000 salary; \$21,645 benefits. 7/1/11 - 6/30/13. Satellite data processing and classification.	\$ 86,645
Trent Erickson, information technology specialist, 25%. \$22,600 salary; \$9,063 benefits. 7/1/11 - 6/30/13. Database and web-mapping development.	\$ 31,663
Graduate research assistants. 2 @ 50%, \$76,296 salary; \$59,768 benefits. 7/1/11 - 6/30/13. Data analysis for change detection and modeling land use scenarios.	\$ 136,064
Equipment/Tools/Supplies: Ancillary data and software license fees, \$4,659.	\$ 4,659
Travel: Field data collection: 4,500 miles @ 0.50 = \$2,250, 40 days per diem @ \$120 = \$4,800; Total \$7,050. MN GIS/LIS conferences: Registrations, 3 @ 220 = \$660, per diem 3 days @ \$120 = \$360, mileage 340 miles @ 0.50 = \$170. Total \$1,190.	\$ 8,000
Additional Budget Items: Services - computer lab user fees, 3 x 2 years @ \$1,000 = \$6,000.	\$ 6,000
TOTAL ENVIRONMENT & NATURAL RESOURCES TRUST FUND \$ REQUEST	\$ 395,000

V. OTHER FUNDS

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
In-kind Services During Project Period: Salaries and fringe benefits (\$20,000) of the 3 faculty at an average of 5% time will be provided by University. Computer and image processing facilities will be provided by the University (estimated value, \$25,000). In-kind salary for Bruce Wilson (MPCA) 1 month direct and indirect (estimated value \$16,000 for two years).	\$ 61,000	

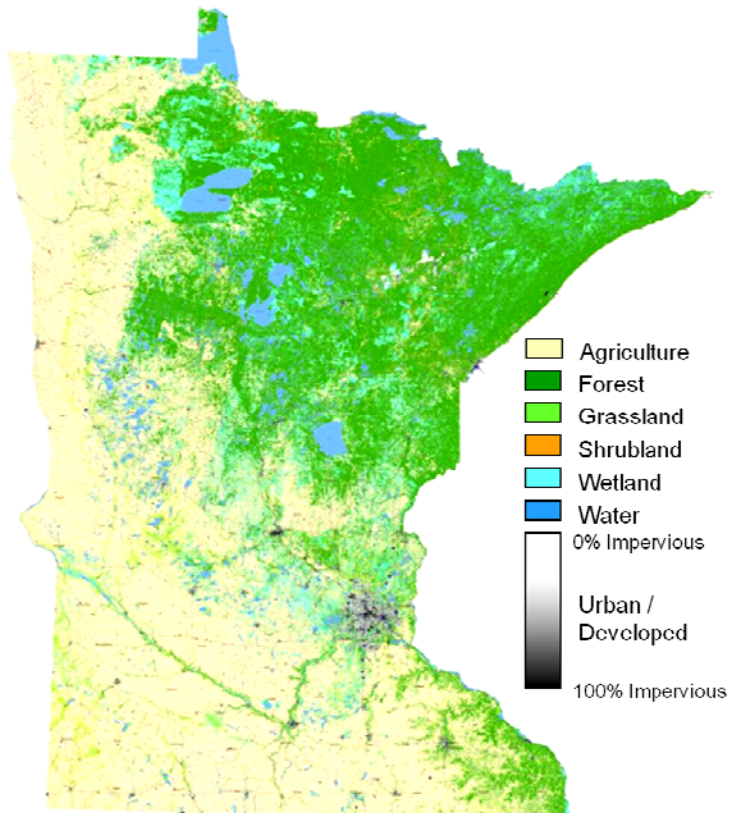


Figure 1. Land cover classification of Minnesota derived from Landsat Thematic Mapper data (see, land.umn.edu). More than 300 copies of the data have been downloaded by agencies and other users.

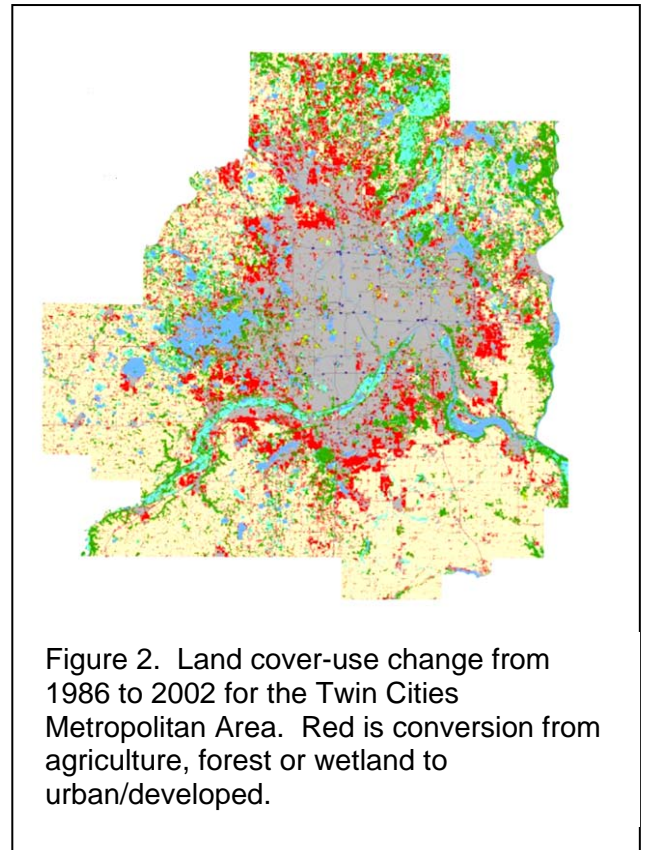


Figure 2. Land cover-use change from 1986 to 2002 for the Twin Cities Metropolitan Area. Red is conversion from agriculture, forest or wetland to urban/developed.

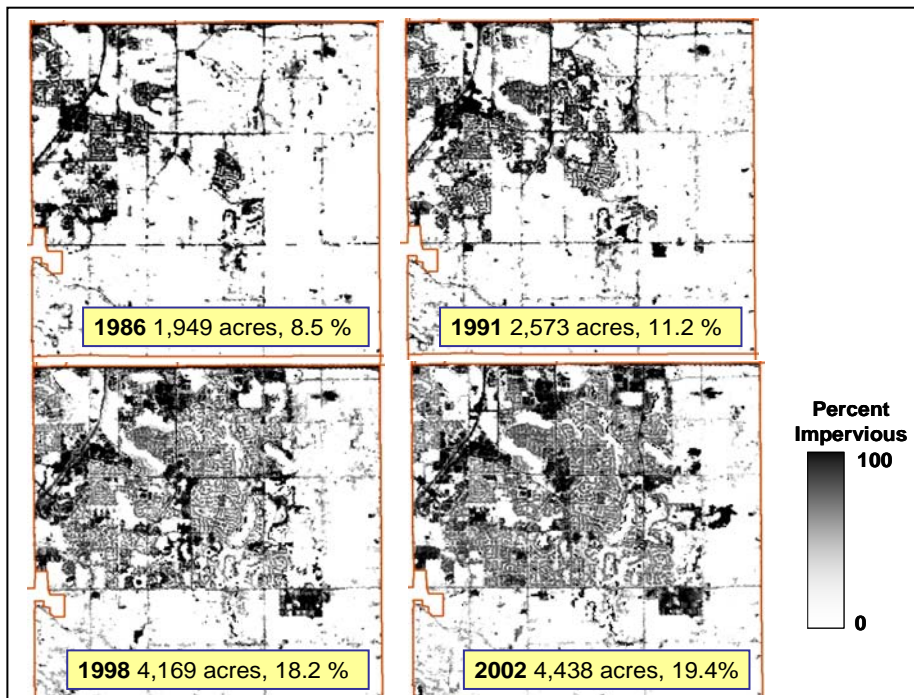


Figure 3. Change in impervious surface area for Woodbury, 1986 – 2002.

Project Manager Qualifications and Organization Description:

Marvin Bauer is professor of remote sensing and director of the Remote Sensing and Geospatial Analysis Laboratory (rsl.gis.umn.edu) at the University of Minnesota. He has extensive experience in research and applications of satellite remote sensing to inventory and monitor land and water resources. His current research emphasizes the development of quantitative satellite remote sensing for land cover classification and change detection, impervious surface mapping, and monitoring lake water quality. He has been principal investigator of several NASA grants, as well as State of Minnesota contracts for mapping and monitoring land cover, impervious surface area and lake and river quality. Much of his research involves interdisciplinary collaborations with faculty of other colleges and departments including Civil Engineering, Ecology and Evolutionary Behavior, Geography, and Soil, Water and Climate. He teaches classes in remote sensing of natural resources and environment and digital remote sensing.

A fellow of the American Society of Photogrammetry and Remote Sensing (ASPRS), Bauer has received several awards recognizing his contributions to remote sensing research, teaching and service, including the Lifetime Achievement Award (2006) from the Minnesota GIS/LIS Consortium, recognizing contributions to the development of remote sensing applications in Minnesota; the NASA Distinguished Public Service Medal (1995), recognizing outstanding scientific contributions over the past 25 years to NASA's terrestrial remote sensing programs; and the ASPRS SAIC Estes Memorial Teaching Award (2007). He was a visiting scientist (1994-95) at the NASA Goddard Space Flight Center and is Editor-in-Chief of Remote Sensing of Environment journal, the #1-rated remote sensing journal.

Joseph Knight, assistant professor in the Department of Forest Resources, conducts research characterizing natural and anthropogenic landscape change using multispectral and multitemporal image data to assess impacts on natural resources, wetlands mapping and characterization, and thematic accuracy assessment methods development.

Steven Manson is an associate professor in the Department of Geography and fellow of the University's Institute on the Environment. His research combines environmental research, social science approaches, and geographic information science to understand changing urban and rural landscapes. This work is part of his longer term research on environmental change, decision making, and understanding complex human-environment systems. He was a NASA Earth System Science Fellow, received the Young Scholar Award from the University Consortium for Geographic Information Science, a McKnight Land Grant Professorship, and is a NASA New Investigator in Earth-Sun System Science.

Bruce Wilson is a limnologist and research scientist with the Minnesota Pollution Control Agency. He has led several water quality assessment efforts of major lake and river systems in Minnesota and has provided technical assistance to over 50 locally led watershed management projects. His current work includes monitoring the effectiveness of stormwater Best Management Practices and the Minimal Impact Design Standards Project.

Organization Description. Remote sensing research, focusing on forestry applications of aerial photography, was initiated at the University of Minnesota in 1952. The Remote Sensing Laboratory, established in 1972, has been the focal point of research, instruction, and outreach in natural resource applications of aerial photography and satellite imagery. The Laboratory has contributed to the development and application of aerial photography, and more recently satellite remote sensing, by resource agencies in Minnesota.