Environment and Natural Resources Trust Fund
2010 Request for Proposals (RFP)

LCCMR ID: 141-E2

Project Title:

Monitoring and Modeling Minnesota Landscapes and Ecosystem Services

LCCMR 2010 Funding Priority:

E. Natural Resource Conservation Planning and Implementation

Total Project Budget: $ $390,000

Proposed Project Time Period for the Funding Requested: 2 years, 2010 - 2012

Other Non-State Funds: $ $0

Summary:

We will develop a current statewide land cover-use map, continue satellite monitoring of lake clarity, and model scenarios of the impact of changing land use on ecosystem services.

Name: Marvin Bauer

Sponsoring Organization: U of MN

Address: 1530 Cleveland Ave N
St. Paul MN 55108

Telephone Number: (612) 624-3703

Email: mbauer@umn.edu

Fax: (612) 625-5212

Web Address: land.umn.edu AND water.umn.edu

Location:

Region: Statewide

County Name: Statewide

City / Township:

_____ Knowledge Base _____ Broad App. _____ Innovation

_____ Leverage _____ Outcomes

_____ Partnerships _____ Urgency _____ TOTAL

PROJECT TITLE: Monitoring and Modeling Minnesota Landscapes and Ecosystem Services

I. PROJECT STATEMENT

Rationale. Minnesota, along with the nation and world, is facing unprecedented environmental changes. The future ecological and economic vitality of Minnesota and the sustainability of its natural resources depend on decisions being made today in the face of increased population, consumption, and development. Accurate and timely information on our land and water is essential to resource management and policy, particularly with respect to ecosystem services – resources provided by ecosystems that benefit humankind. Yet, policy makers and resource managers often lack the data and information necessary to make informed decisions concerning natural resources, the environment, and ecosystem services. To pick just one example, current land use information is needed to develop strategies that will protect the vital ecosystem service of clean water for human consumption, aquatic life, recreation and aesthetics.

Goals and Impacts. The goal of this project is to provide accurate, detailed, and up-to-date characterizations of the state's landscapes by a combination of monitoring and modeling: (1) satellite remote sensing to map and characterize land and water, and (2) models that can generate scenarios of the effects of changing land use on ecosystem services. The results of this joint monitoring-modeling approach will be used statewide in many sectors, providing data and information needed by our natural resource management agencies by effectively and economically mapping and monitoring the state's land and water resources.

II. DESCRIPTION OF PROJECT RESULTS

Result 1: Land mapping by satellite remote sensing ($124,360). 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 (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 of agricultural crops, forests, wetlands, grasslands, shrublands, and urban/developed land. The urban/developed class will be further classified to percent impervious surface area, an important indicator of environmental quality related to water quality, stormwater runoff, urban heat island effects, and aesthetics of landscapes. We will also analyze the land use changes of the past 40 years, comparing previous maps (1969, 1990, 2000) to 2010. In addition to being a very useful product on its own to many state stakeholders, this understanding of landscape dynamics will feed into our ecosystem models.

Deliverables	***Completion Date***
1. An updated, current statewide land cover-use map.	December 2011
2. Analysis of changes in land cover and use over the past 40 years.	March 2012
3. Maps and data available on the Internet.	June 2012

Result 2: Lake monitoring ($119,564). With fewer than 10 percent of lakes monitored using *in situ* data, there is a continuing need for comprehensive and economical assessments of lake conditions. We will continue monitoring lake clarity, a key indicator of water quality, to include 2010 Landsat data and conduct multi-date, seasonal monitoring of about 500 large lakes on two variables of increasing interest and importance – chlorophyll (a sign of algae and pollution) and suspended sediment concentrations (a sign of runoff and soil erosion) using data from new NASA satellites. Satellite remote sensing is an accurate and economical method to monitor the condition of lakes in Minnesota. With support from the LCCMR and Minnesota Pollution Control Agency, we have developed water quality maps of over 10,000 lakes for 1985, 1990, 1995,

2000, and 2005. We have also analyzed temporal and geographic patterns and trends, including the relationships to other lake properties, land use, and demographic factors. These data, available via our web-based LakeBrowser (water.umn.edu), are used by the MPCA and other agencies and citizens.

Deliverables	***Completion Date***
1. Classification of lake clarity for all lakes larger than 20 acres.	December 2011
2. Measures of chlorophyll and suspended sediment in large lakes.	December 2011
3. Maps and data on the Internet.	January 2012

Result 3: Modeling ecosystem services ($146,076). Ecosystem services include *provisioning* of food, fresh water, fiber and other goods, *regulating* climate and water resources, and *cultural* services such as aesthetic and recreational value. Ecosystem services are extremely vulnerable to development and careful accounting of how land change affects ecosystem services is therefore crucial for making decisions as to continued development of the state and its resources. To this end, we will modify our existing ecosystem research and modeling to incorporate the satellite-derived data described above. We will then focus on four areas of concern to Minnesota, namely how our changing landscapes affect: (1) wetlands and agriculture, (2) climate regulation and freshwater resources, (3) river and stream flow, and (4) the nature of land at the rural/urban fringe.

Deliverables	***Completion Date***
1. Modification of ecosystem model to input satellite-derived land data.	July 2011
2. Incorporation of conversion of Minnesota's wetlands to other land use.	November 2011
3. Modeling of land change effects on climate and freshwater resources.	March 2012
4. Simulation of observed vs. idealized land change on river/stream flow.	June 2012
5. Generation of scenarios of land use change on ecosystem services.	June 2012

III. PROJECT STRATEGY

A. Project Team/Partners The project team includes five University of Minnesota faculty from the Departments of Forest Resources, Geography, and Soil, Water and Climate. Marvin Bauer and Joseph Knight will direct the satellite remote sensing; Steven Manson, Peter Snyder and Tracy Twine will lead the ecosystem services modeling. We will be assisted by two research staff and two graduate research assistants.

We will identify groups and individuals from Minnesota agencies (e.g., PCA, DNR, DAg, SWCD, Met Council) and organizations such as Minnesota Waters and 1000 Friends of Minnesota, who will serve as advisors to the project and users of its results. Finally, a critical form of partnership is Internet delivery of data, maps, and results via our land and water websites to agencies and other interested stakeholders.

B. Timeline Requirements. We see an orderly progression in our work as listed in the deliverables; there are no special requirements.

C. Long-Term Strategy. The objectives and approaches we propose 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.

Project Budget

IV. TOTAL PROJECT REQUEST BUDGET (2 years)

BUDGET ITEM	AMOUNT
Personnel: TBD research associate (post-doc), 100% (25% project management, 75% land classification). $91,500 salary; $29,554 benefits. 7/1/01 - 6/30/12.	$ 121,055
Leif Olmanson, research fellow, 60%. Lakes classification. $65,000 salary; $20,995 benefits. 7/1/01 - 6/30/12.	$ 85,995
Trent Erickson, information technology specialist, 25%. $22,600 salary; $8,362 benefits. Database and web-mapping development. 7/1/01 - 6/30/12.	$ 30,962
Graduate research assistants. 2 @ 50%, Ecoystems services modeling. $74,340 salary; $57,196 benefits. 7/1/01 - 6/30/12.	$ 131,536
Equipment/Tools/Supplies: Suplies - Ancillay data and sofware, $5,452. Services - computer lab user fees, $6,000.	$ 11,452
Travel: In-state. Field data collection, 3,000 miles @ 0.55 = $1,650, 20 days per diem @ $120 = $2,400; Total $4,050. MN GIS/LIS and Water Resources conferences. Conference registrations for 3 staff x 2 years = $1,390, per diem 4 days @ $130 = $520, mileage 280 miles @ 0.55 = $154, parking 4 days @ $12.50 = $50; Total $2,114 . Out-of-state. remote sensing and ecoystems conference registrations 2 @ $450 = $900, airfare 2 @ $600 = $1,200, per diem 6 days @ $131 = 786; Total $2,886	$ 9,000
TOTAL PROJECT BUDGET REQUEST TO LCCMR	**$ 390,000**

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period:	N/A	
Other State $ Being Applied to Project During Project Period:	N/A	
In-kind Services During Project Period: Salaries ($34,603) and fringe benefits ($11,777) of the 5 faculty at an average of 5% time will be provided by University; Total $45,780. Computer and image processing facilities will be provided by the University; estimated value, $25,000. In addition, satellite data with estimated value of $24,000 will be provided at no-cost to this project by MinnesotaView project.	$ 94,780	Secured
Remaining $ from Current Trust Fund Appropriation (if applicable):	N/A	
Funding History:	N/A	

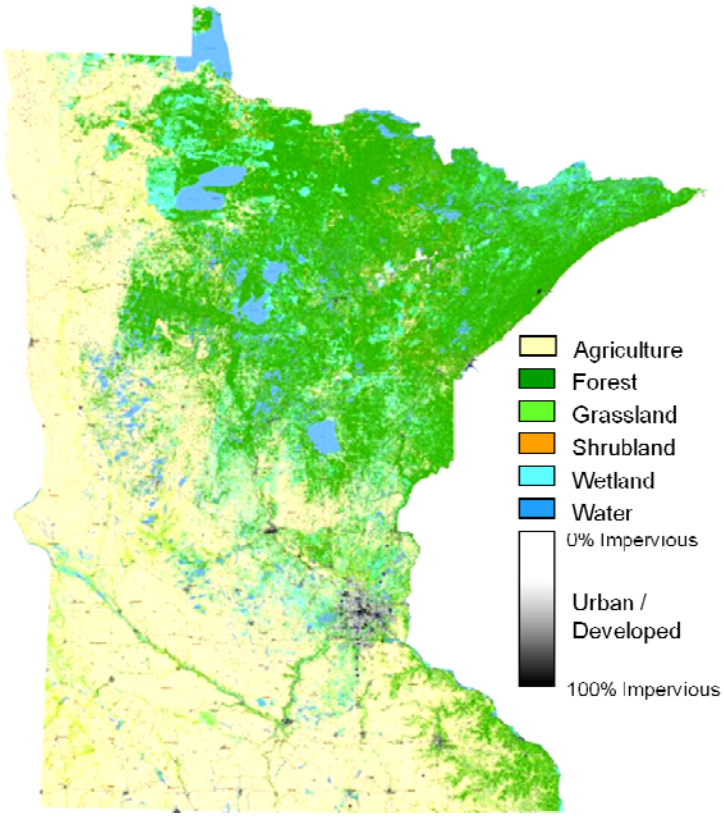

Figure 1. Land cover classification of Minnesota derived from 2000 Landsat Thematic Mapper data (see, **land.umn.edu**). More than 300 copies of the data, available by county, city/township, ecoregion and watershed, have been downloaded by agencies and individuals.

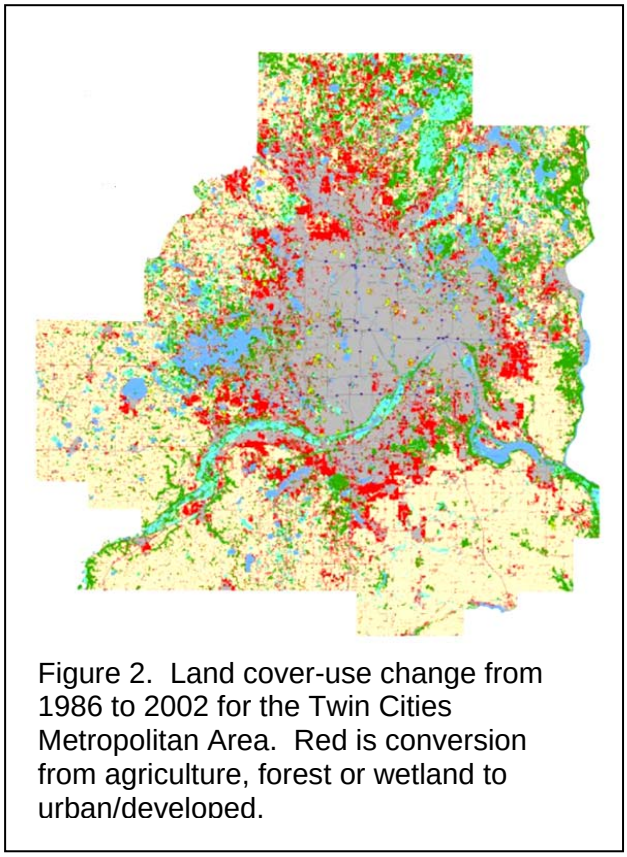

Figure 2. Land cover-use change from 1986 to 2002 for the Twin Cities Metropolitan Area. Red is conversion from agriculture, forest or wetland to urban/developed.

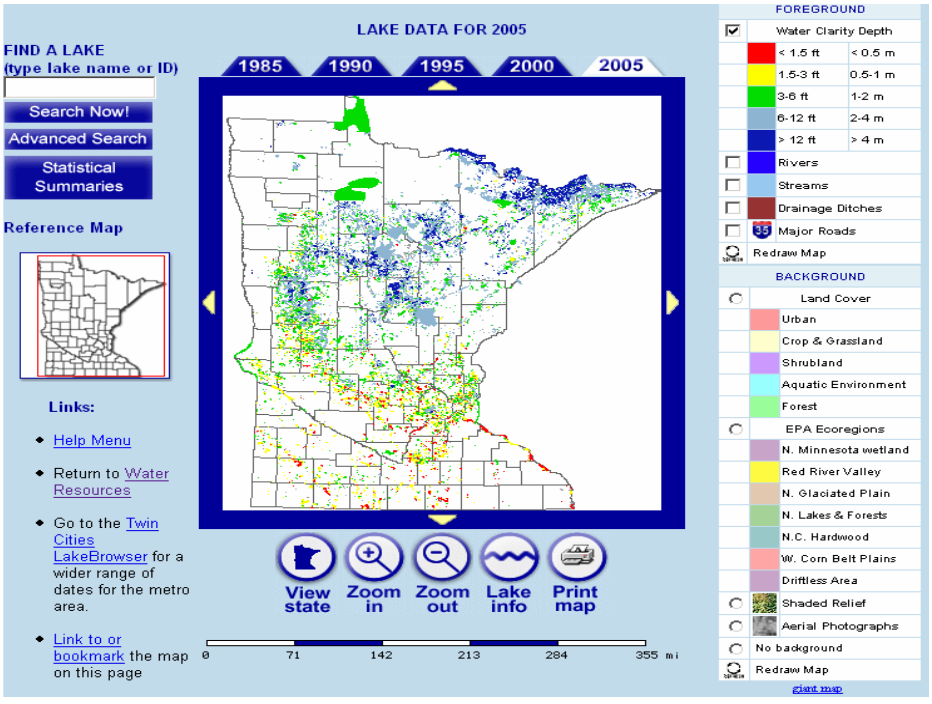

Figure 3. Data for more than 10,500 lakes are available for five times from 1985 - 2005 in the LakeBrowser (see, **water.umn.edu)** – a web-based mapping tool that enables searches and display of results for individual lakes. The website has had more than 250,000 unique visits over the past five years.

Project Manager Qualifications

Marvin Bauer is professor of remote sensing and director of the Remote Sensing and Geospatial Analysis Laboratory (http://rsgl.gis.umn.edu/) at the University of Minnesota. He has extensive research experience developing 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 quality. Much of his research involves interdisciplinary collaborations with faculty of other 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.

Bauer is a fellow of the American Society of Photogrammetry and Remote Sensing (ASPRS) and 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 25 years to NASA's terrestrial remote sensing programs, and the ASPRS SAIC Estes Memorial Teaching Award (2007). He has been a visiting scientist (1994-95) at the NASA Goddard Space Flight Center and is Editor-in-Chief (since 1980) of Remote Sensing of Environment journal, the #1-rated remote sensing journal.

Steven Manson is an associate professor and McKnight Land Grant Professor in the Department of Geography. His research combines environmental research, social science approaches, and geographic information science to understand changing urban and rural landscapes as part of longer term research on environmental change, decision making, and understanding complex human-environment systems.

Peter Snyder is an assistant professor in the Department of Soil, Water and Climate. He is a climate scientist studying the biophysical and biogeochemical interactions between the atmosphere and the biosphere with numerical models, observations, and data analysis in the Arctic, tropics, and mid-latitudes.

Tracy Twine is an assistant professor in the Department of Soil, Water and Climate. She is researching the effects of climate and land use change on ecosystem services using numerical models. She is currently directing a DOE-National Institute for Climate Change Research study that examines the potential effects of climate change and increasing carbon dioxide and ozone concentrations on agroecosystems of the U.S.

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

Organization Description. The University of Minnesota is one of the most comprehensive research universities in the country. 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 satellite remote sensing, by resource agencies in Minnesota.