

**Environment and Natural Resources Trust Fund
2020 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 005-A

Optimizing Land Cover Data for Water Resource Analysis

Category: A. Foundational Natural Resource Data and Information

Sub-Category:

Total Project Budget: \$ 370,000

Proposed Project Time Period for the Funding Requested: June 30, 2023 (3 yrs)

Summary:

This project will employ new techniques and technologies to improve the accuracy and usability of the crop land data layer in Minnesota for water resource analysis.

Name: Matt Drewitz

Sponsoring Organization: MN Board of Water and Soil Resources

Job Title: Measures and Outcomes Coordinator

Department: _____

Address: 11 Civic Center Plaza
Mankato MN 56001

Telephone Number: (507) 766-5020

Email matt.drewitz@state.mn.us

Web Address

Location:

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

This visual shows the current cropland data layer and shows its limitations. The visual also depicts how the new data will help identify cover crops.

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



PROJECT TITLE: Optimizing Land Cover Data for Water Resource Analysis

I. PROJECT STATEMENT:

Tracking the adoption of cover crops that protect nearby waterways from sediment, nitrogen and phosphorus pollution is critical for sustainable agriculture planning and management. Satellite remote sensing during clear days in the months of November and December can be used to track cover crop adoption based on the fact that cover crops are typically still green in color during that time. However, other crops also have a green color at that time, including alfalfa, hay or pasture. In the US, the Cropland Data Layer (CDL) is the only publicly accessible and nationally used dataset of crop type information. It is a geospatial land cover map that is updated every year by United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). CDL parcels classified as alfalfa, hay, or pasture can in principle be subtracted (masked out) from late fall satellite images in order to identify locations where cover crops are planted. However, this approach has limitations, because while the CDL reasonably assesses the major crops of corn and soybeans, it does not accurately classify alfalfa, hay, or pasture. The CDL also is relatively inaccurate in classifying minor crops that appear green during the period from May to October, including small grains, canning crops, sugar beets, potatoes, wetland complexes, filter and buffer strips, and pollinator habitats. If we want to track the adoption of planting cover crops into these minor crops (after their harvest), it is imperative to have a CDL that accurately classifies minor crops. Due to errors in classifying minor crops with the CDL, it is imperative to develop an alternative land use classification method for minor crops. The focus of this project is to leverage new data and deep learning techniques to improve the accuracy and usability of the CDL for water resource analysis in Minnesota.

Multiple opportunities exist for improving the CDL. The current workflow USDA uses to develop the CDL is first collecting ground truth information through field surveys and censuses, and then combining these data with 30-meter (m) resolution Landsat satellite imagery to train a land cover classifier, and finally using that classifier to determine the land cover type of each 30x30m pixel at a regional scale. Two serious problems in this workflow include: (i) ground truth labels are biased towards corn and soybean; and (ii) the USDA classification algorithm approach dates back to more than a decade ago. In this project, we will employ new sampling approaches and the most sophisticated deep learning algorithms to improve the overall accuracy of predicting agricultural land cover for minor crops and land uses in Minnesota. By using near real-time satellite data, we anticipate publishing an improved CDL months earlier than the USDA CDL.

II. PROJECT ACTIVITIES AND OUTCOMES (Duration is July 1, 2020 to June 30, 2023)

Activity 1 Title: Collect ground truth and remote sensing data for major and minor crops

Description: The University of Minnesota (U of M) will collect ground truth data for major and minor crop classification during July and October of 2020 in collaboration with staff from two Soil and Water Conservation (SWCDS) districts across Minnesota regions differing in soil characteristics, slope, and rainfall patterns. At least 200 field locations in each of these counties will be visited to collect ground truth data, locations will include corn and soybeans, as well as a number of minor crops and land uses. Remote sensing data will be collected at a 10 m spatial resolution using both the Landsat-8 and Sentinel 2 satellites for the surveyed sites on as many dates as possible between May and November 2020. The results from this analysis will be summarized in a technical report.

ENRTF BUDGET: \$40,000

Outcome	Completion Date
1. Summarize ground truth data for minor crops in two counties collected by SWCD staff	Jan 30, 2021



**Environment and Natural Resources Trust Fund (ENRTF)
2020 Main Proposal Template**

2. Compare USDA CDL classification with ground truth data to assess extent of errors in CDL	Mar 30, 2021
3. Summarize preliminary accuracy in predicting minor crops using remote sensing data	May 31, 2021

Activity 2 Title: Expand geographic scope of ground truth and remote sensing data collection and refine tools for classifying remote sensing images into locations with minor crops

Description: The University of Minnesota (U of M) will expand ground truth and remote sensing data collection during spring, summer and fall of 2021 in collaboration with staff from six SWCDs. Remote sensing data for these counties will be analyzed and calibrated against ground truth data using refined deep learning algorithms based on results of Activity 1.

ENRTF BUDGET: \$300,000

Outcome	Completion Date
1. Summarize results of ground truth data collection for minor crops/land uses and compare these results with USDA CDL classifications	December 31, 2021
2. Develop new deep learning techniques for analyzing remote sensing data to better identify minor crops/land uses	July 30, 2022
3. Assess accuracy of deep learning techniques to classify minor crops/land uses in six Minnesota counties relative to ground truth data	December 31, 2022

Activity 3 Title: Refine Classification Tools to Develop and Improve CDL Map for Minor Crops/Land uses

Description: The fine-tuned classification algorithm that achieved the best performance in Activity 2 will be applied across the whole state to generate a state-wide map of crop types/land uses. Post-processing will be applied to remove pixel-level noise so as to make sure all pixels within a sub-field are classified as the same crop type. The project team will develop a technical report that summarizes project findings, state-wide statistics and recommendations. The refined crop type map, along with detailed documentation of map accuracy and recommended use, will be published as a geospatial data layer on MnGEO commons for public use and benefit.

ENRTF BUDGET: \$30,000

Outcome	Completion Date
1. Develop map with improved accuracy at identifying locations with minor crops/land uses	March 31, 2023
2. Develop technical report summarizing project findings and recommendations	May 31, 2023
3. Publish geospatial data on the MnGEO commons	June 15, 2023

III. PROJECT PARTNERS AND COLLABORATORS: Collaborators include the University of Minnesota Departments of Soil Water and Climate, Bioproducts and Biosystems Engineering, and Computer Science and Engineering, and the Minnesota Office for Soil Health. Project partners advising on this project will include the Minnesota Department of Agriculture, Minnesota Pollution Control Agency, the Minnesota Geospatial Agency (MnGEO), and the Minnesota Association of Soil and Water Conservation Districts.

IV. LONG-TERM IMPLEMENTATION AND FUNDING: Data from this project will be shared on the MnGEO commons and the public will have access to readily use this data. This data will be updated on an annual basis. The outputs of this data will be used to inform the on-going Tillage and Erosion Survey Project sponsored by BWSR and the U of M Soil, Water, and Climate Department. Also, this foundational data layer will be utilized in water quality decision support models such as the Agricultural Conservation Planning Framework (ACPF) and Prioritize Target and Measure Application (PTMApp).

Attachment A: Project Budget Spreadsheet
 Environment and Natural Resources Trust Fund
 M.L. 2020 Budget Spreadsheet



Legal Citation:

Project Manager: Matt Drewitz, Measures and Outcomes Coordinator

Project Title: Optimizing Land Cover Data for Water Resource Analysis

Organization: Minnesota Board of Water and Soil Resources

Project Budget: \$370,000

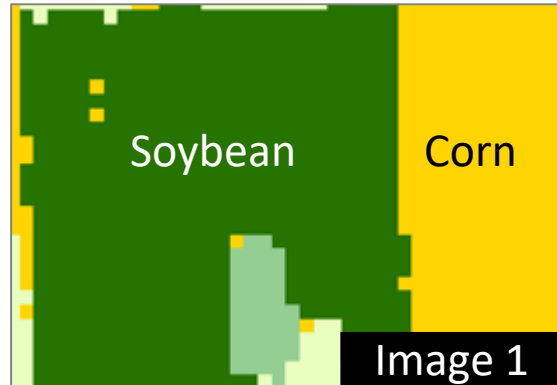
Project Length and Completion Date: 3 years, June 30, 2023

Today's Date: April 15, 2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET		Budget	Amount Spent	Balance
BUDGET ITEM				
Personnel (Wages and Benefits)		\$ -	\$ -	\$ -
Professional/Technical/Service Contracts: BWSR will contract with U of M Soil, Water, and Climate Department through a sole-source, professional technical contract. Through this contract, a detailed work plan, budget, and timeline will be developed. BWSR will require detailed invoices and reports from the U of M on a quarterly basis. Dr. David Mulla will be the Project Investigator for the U of M. The U of M will partner with Soil and Water Conservation District staff (field work) and U of M Minnesota Office for Soil Health staff (outreach).		\$ 370,000	\$ -	\$ 370,000
Equipment/Tools/Supplies		\$ -	\$ -	\$ -
Capital Expenditures Over \$5,000		\$ -	\$ -	\$ -
Fee Title Acquisition		\$ -	\$ -	\$ -
Easement Acquisition		\$ -	\$ -	\$ -
Professional Services for Acquisition		\$ -	\$ -	\$ -
Printing		\$ -	\$ -	\$ -
Travel expenses in Minnesota		\$ -	\$ -	\$ -
Other		\$ -	\$ -	\$ -
COLUMN TOTAL		\$ 370,000	\$ -	\$ 370,000
SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT				
	Status (secured or pending)	Budget	Spent	Balance
Non-State:		\$ -	\$ -	\$ -
State: Tillage and Erosion Survey Project via the Clean Water Fund - BWSR (\$30,000) and U of M (\$60,000) staff time dedicated to this project will be leveraged as match over the 3 year LCCMR project duration.		\$ 90,000	\$ -	\$ 90,000
In kind: Potential for National Science Foundation in-kind match. Amount unknown at time of application.		\$ -	\$ -	\$ -
Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS		Budget	Spent	Balance
		\$ -	\$ -	\$ -

Project Title: Optimizing Land Cover Data for Water Resource Analysis

Current Technology:



Existing technology can show distinct differences between corn and soybean fields (Image 1). However, with mixed land cover and smaller land tracts (Image 2) it is difficult to distinguish row crops from non-row crops (pasture, forest, alfalfa) with the current cropland data layer information. This makes identifying cover crop acres even more difficult.

This Proposal:

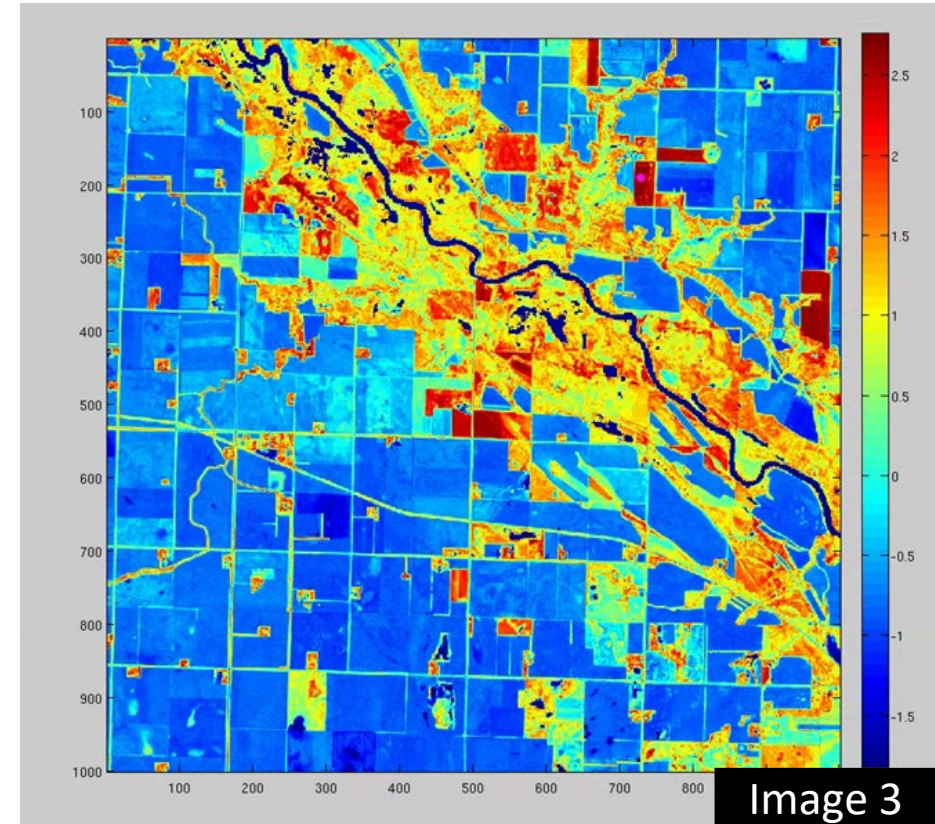


Image 3 shows a representation of a Deep Learning Similarity Map. Red areas depict land with living cover in the fall of the year. These areas will be cross referenced with the enhanced cropland data layer created through this project to better predict the presence of cover crops.

Project Manager Qualifications

Proposed Project: *Optimizing Land Cover Data for Water Resource Analysis*

Project Manager: Matt Drewitz

Organization: Minnesota Board of Water and Soil Resources (BWSR)

Title: Measures and Outcomes Coordinator

BWSR Mission Statement and Charge: Improve and protect Minnesota's water and soil resources by working in partnership with local organizations and private landowners. BWSR is the state soil and water conservation agency, and it administers programs that prevent sediment and nutrients from entering our lakes, rivers, and streams; enhance fish and wildlife habitat; and protect wetlands. The 20-member board consists of representatives of local and state government agencies and citizens.

Project Manager Experience – Matt Drewitz:

Education

BA Biology, Gustavus Adolphus College

MS Environmental Science, Minnesota State University-Mankato

Thesis Title: *Effectiveness of Ridge Tillage and Conventional Tillage Practices on Soil Conservation*

Work Experience

- **Senior Planner, Environmental Quality, Minnesota Department of Agriculture (MDA) (2000-2006):** Worked with water quality and livestock management policy development for the MDA. Responsible for managing numerous research and outreach projects that the MDA undertook with the University of Minnesota. These projects include the development of the Minnesota Phosphorus Index, developing technology to mitigate air emissions for livestock operations, and developing strategies for improved manure and nutrient management. In addition, managed two LCCMR projects dealing with manure digestion technologies to reduce greenhouse gas emissions and create electricity from on-farm systems.
- **Clean Water Specialist, BWSR (2006-2016):** Assisted in developing and implementing BWSR's competitive grant program for the Clean Water Fund for the Land, Water, and Legacy Amendment. Managed numerous grants with local units of government, provided input on local water plan and watershed based One Water, One Plans, and provided technical assistance to local and State partners on water resource management issues.
- **Measures and Outcomes Coordinator, BWSR (2016 to Present):** Statewide coordinator for BWSR on tracking environmental outcomes from BWSR funded projects and activities. Currently, managing contracts for the Tillage and Erosion Survey project, the PTMApp watershed planning tool, and the BWSR eLINK reporting system. Assists partner agencies in developing statewide reports such as the Clean Water Fund Performance Report and the Minnesota Nutrient Reduction Strategy. Provides technical assistance to local government staff on developing measurable outcomes for project and watershed plans. Assists with BWSR's soil health initiatives through the Minnesota Office for Soil Health and recently completed an LCCMR project focusing on promoting soil health in Southeastern Minnesota.

Experience with Managing LCCMR Projects

Managed and completed three (3) LCCMR projects as a project manager for MDA and BWSR. Recently, completed the project *Southeast Minnesota Cover Crop and Soil Health Initiatives (M.L. 2015, Chp. 76, Sec. 2, Subd. 04e)* and presented the project findings to the LCCMR at their December 2018 meeting.