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

Project Title: **ENRTF ID: 241-F**

Improving the Cost Effectiveness of Minnesota's Conservation Programs

Category: F. Methods to Protect, Restore, and Enhance Land, Water, and Habitat

Sub-Category:

Total Project Budget: $ 277,577

Proposed Project Time Period for the Funding Requested: June 30, 2022 (2 yrs)

Summary:

By developing management guidance sensitive to the landscape (soils & topography) and weather (temperature & precipitation), we can increase the cost effectiveness of water conservation efforts in Minnesota.

Name: Brent Dalzell

Sponsoring Organization: U of MN

Job Title: Dr.

Department: Department of Soil, Water, and Climate

Address: 439 Borlaug Hall, 1991 Upper Buford Circle

St. Paul MN 55108

Telephone Number: (612) 625-0445

Email bdalzell@umn.edu

Web Address: https://www.swac.umn.edu/directory/staff/brent-dalzell

Location:

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

By developing management guidance sensitive to the landscape (soils & topography) and weather (temperature & precipitation), we can increase the cost effectiveness of water conservation efforts in Minnesota.

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

PROJECT TITLE:
Where and When? Improving the cost effectiveness of Minnesota's water quality conservation programs.

I. PROJECT STATEMENT
Our overarching goal is to improve Minnesota's water quality by determining how to best implement conservation practices across both space and time. We will accomplish this by combining landscape analysis with predictive seasonal weather forecasting.

Soil erosion and loss of nutrients from farm fields represent significant threats to water quality and agricultural productivity. Agencies work to improve environmental quality through efforts to enroll farmers in conservation programs, with some efforts focused on establishment of long-term practices like buffer strips or grassed waterways. **Environmental benefits, however, may be achievable through more effective application of year-to-year management decisions made by the farmer.** For example, a cold and wet spring season could result in excessive losses of nitrogen fertilizer; resulting in financial loss to the farmer and degraded water quality. Reliable seasonal forecasting produces information that allows farmers to modify their fertilizer application and reduce runoff losses. Current approaches to conservation guidance do not account for changes in the effectiveness of conservation practices caused by inter-annual weather variability.

Policy makers, natural resource managers, and farmers must balance their decision making between long-term planning and short-term contingencies. While there are numerous climate model projections available to provide insight on how average climate conditions may be changing in Minnesota's future, there is currently a gap in information available for resource managers and farmers to make decisions on the seasonal or sub-seasonal scale. Because of the limited conservation funds available to policy makers and conservation programs, **we will develop guidance to increase the cost-effectiveness of conservation programs in Minnesota.** This guidance goes beyond current targeting approaches because it will also rely on seasonal weather forecasts to produce recommendations that are tailored for the upcoming year. Potential examples are provided below:

Seasonal Forecast	**Example of Proposed Management Guidance**
Warm & Wet Spring	*Runoff is likely.* → Recommend cover crops to increase available soil moisture storage and delayed spring fertilizer application to minimize runoff losses
Cold & Wet Spring	*Runoff is likely but cold weather will limit cover crops.* → Recommend reduced tillage and delayed spring fertilizer application.
Dry Spring	*Excess water runoff is unlikely to be a problem in most areas.* → Recommend targeted conservation tillage in sensitive areas, and typical fertilizer application during planting.

By developing management guidance sensitive to the landscape (soils & topography) as well as upcoming seasonal weather conditions (temperature & precipitation), it will be possible to increase the efficiency by which conservation resources are applied to Minnesota's agricultural landscape. We have preliminary results that show our ability to: *(1) evaluate how conservation practices can be spatially arranged to optimize environmental outcomes* and (2) *develop seasonal predictions of precipitation and temperature that will be key to determining the effectiveness of selected conservation practices.*

II. PROJECT ACTIVITIES AND OUTCOMES
Activity 1: Develop and validate seasonal forecast models and generate plausible weather scenarios.

The primary objective of this activity is to improve the lead time for seasonal forecast models in order to maximize effective planning and decision making to help develop optimal conservation management guidelines. We will develop a series of predictive models that rely on global climate variables to estimate Minnesota's

weather. Our preliminary models accurately predict Minnesota's springtime weather based on winds, temperature, and pressure conditions over North America and the Pacific Ocean. Results show very good agreement between observed and predicted weather, with a current model lead time of 2 months.

While aggregate conditions are predicted with good skill in our preliminary models, the day-to-day variability of weather systems is predominantly what drives insecurity in environmental systems. We will account for this by developing a stochastic weather generator to generate plausible future weather scenarios that are conditioned on the seasonal forecasts. Candidate weather simulations will exhibit the characteristics of the seasonal forecast and be used to predict landscape response to varying management practices.

ENTRF Budget: $ 71,876

Outcome	Completion Date
1. Identify two study watersheds in the Minnesota River Basin and perform exploratory data analysis	12/31/2020
2. Develop and test seasonal forecasting models with optimal lead time	06/30/2021
3. Develop and test stochastic weather generator at the seasonal scale	03/31/2022

Activity 2: Develop prescriptive guidelines to meet Minnesota's water quality goals.

Current approaches to applying conservation practices to agricultural landscapes do not commonly consider weather data. Even if only long-term average weather data were considered, environmental benchmarks will be missed roughly half of the time (and met or exceeded the other half of the time) because of the great variability in Minnesota's weather. With the help of accurate seasonal forecasts, however, conservation efforts can be tailored to account for temporal variability of weather in addition to spatial variability of where to best place practices on the landscape. *We will quantify the benefits of conservation practices under different seasonal conditions by using a watershed-scale model combined with future weather scenarios (Activity 1).* Modeled outcomes of conservation practices will be analyzed with the goal of prescribing practices that are well-positioned to protect against predicted environmental challenges of the coming year.

ENTRF Budget: $ 205,700

Outcome	Completion Date
1. Perform initial model calibration and validation of two study watersheds	12/31/2020
2. Develop a method to link weather scenarios with the watershed model	06/30/2021
3. Evaluate 10-12 conservation practices under varying weather scenarios	12/31/2021
4. Develop guidance for conservation practice implementation	06/30/2022

III. PROJECT PARTNERS AND COLLABORATORS:

Name	Title	Affiliation	Role
Brent Dalzell, Ph.D.	Research Associate	Univ. Minnesota (WRC)	Principle Investigator
Lucia Levers, Ph.D.	Research Associate	Univ. Minnesota (WRC)	Co-Investigator
Andrew Verdin, Ph.D.	Research Scientist	Univ. Minnesota (ISRDI)	Co-Investigator

IV. LONG-TERM IMPLEMENTATION AND FUNDING

This project will provide critical insight into the inter-annual variability of the effectiveness of natural resources conservation policy. In addition to reporting to LCCMR, scientific advances in spatial and seasonal forecasting analyses will be submitted for publication in peer-reviewed scientific journals. This project will lay the groundwork for future efforts (to be funded by state and/or national agencies) in which we aim to include stakeholders to provide the most salient information possible when developing management guidelines.

Attachment A: Project Budget Spreadsheet
Environment and Natural Resources Trust Fund
M.L. 2020 Budget Spreadsheet
Legal Citation:
Project Manager: Brent Dalzell, Ph.D.
Project Title: Improving the cost effectiveness of Minnesota's conservation programs
Organization: University of Minnesota; Department of Soil, Water, and Climate
Project Budget: $277,577
Project Length and Completion Date: Two years; completed on June 30, 2022
Today's Date: March 15, 2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ -	$ -	$ -
Research Associate: Brent Dalzell (PI), Salary plus fringe for 50% support for the two-year duration of the project. UMN fringe rate for FY 2020 is 36%.	$ 85,941	$ -	$ 85,941
Research Associate: Lucy Levers (Co-I), Salary plus fringe for 50% support for the two-year duration of the project. UMN fringe rate for FY 2020 is 36%.	$ 89,184	$ -	$ 89,184
Research Scientist: Andrew Verdin (Co-I), Salary plus fringe for 50% support for the two-year duration of the project. UMN fringe rate for FY 2020 is 36%.	$ 96,152	$ -	$ 96,152
Travel expenses in Minnesota - in accordance with the UMN Travel Policy			
Registration and travel to MN Water Resources Confernce (St. Paul, MN) to present results and gain feedback from local stakeholders. Three registrations supported over the duration of the two-year project. Travel will be conducted in compliance with University of Minnesota guidelines for costs associated with registration and car travel.	$ 800	$ -	$ 800
Other - in accordance with the UMN Travel Policy			
Travel to one national confernece (to be determined) for one person to present research results and gain feedback from a national audience of scientsts in support of advancing the science. Travel will be conducted in compliance with University of Minnesota guidelines for costs associated with registration, travel, lodging, and per diem.	$ 4,000	$ -	$ 4,000
Fees associated with publishing results from this work in peer-reviewed journals.	$ 1,500	$ -	$ 1,500
COLUMN TOTAL	$ 277,577	$ -	$ 277,577

SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State:		$ -	$ -	$ -
State:		$ -	$ -	$ -
In kind: UMN Indirect Cost Rate (54%) waived for LCCMR-supported projects.	secured	$ 149,891	$ -	$ 149,891

Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS	Amount legally obligated but not yet spent	Budget	Spent	Balance
		$ -	$ -	$ -

Where and When? Improving the cost effectiveness of Minnesota's water quality conservation programs.

Brent Dalzell[1], Andrew Verdin[2], and Lucy Levers[3]

UNIVERSITY OF MINNESOTA

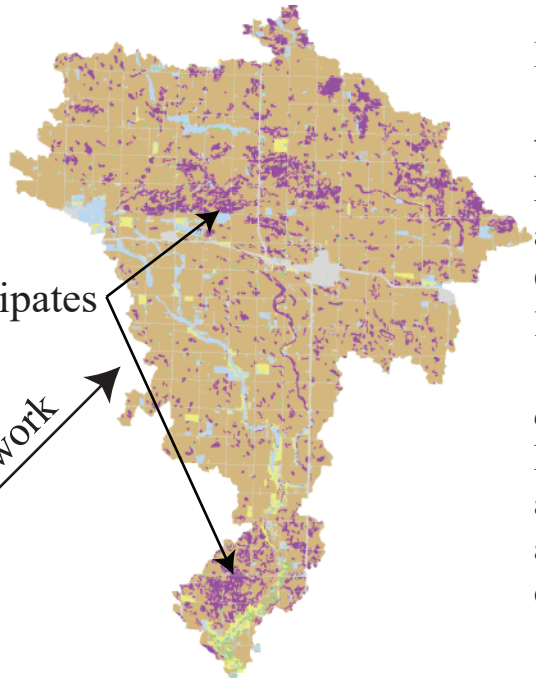
[1] Dept. of Soil, Water, and Climate, [2]Institute for Social Research and Data Innovation, [3]Water Resources Center.

Accounting for Weather Projections from Seasonal Forecasting.

Seasonal Forecasting: **When** to put things.

Optimal System:
Data Driven
Cost Effective

Targeted management anticipates seasonal variability and landscape elements.



Current System:
Simpler to Implement
Not Cost Effective

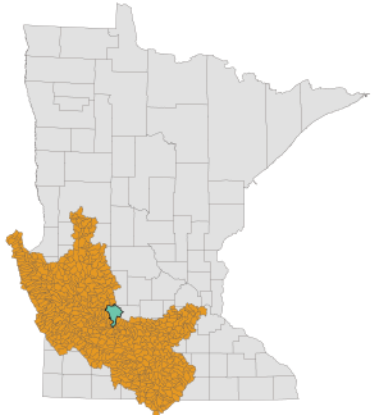
Not targeted for sensitive conditions.

Example Guidance Outcomes

warm & wet spring:
Recommend delayed fertilizer application to reduce runoff. Cover crops at sensitive locations.

cold & wet spring:
Recommend delayed fertilizer application and reduced tillage at sensitive locations (cover crops not likely to do well).

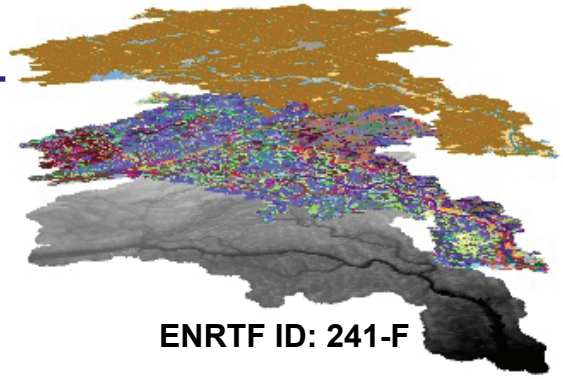
dry spring:
Recommend cover crops or reduced tillage only at sensitive locations (low runoff risk).



Work will be performed on two tributaries in the Minnesota River Basin.

Spatial Analysis: **Where** to put things.

Accounting for Landscape Differences in:
- Land Use / Management
- Soils
- Topography



05/12/2019

ENRTF ID: 241-F

PROJECT TITLE: Where and When? Improving the cost effectiveness of Minnesota's water quality conservation programs.

Project Manager: Brent Dalzell

Dr. Dalzell is a Research Associate at the University of Minnesota in the Department of Soil, Water, and Climate. He applies a variety of approaches to understand human impacts on Earth resources with particular focus on landscapes that have been modified for agriculture. This includes computer modeling approaches as well as field- and lab-based research aimed at quantifying movement of water, carbon, sediment, and nutrients in the landscape. Relevant to this proposed project, Dr. Dalzell has extensive research with watershed-scale modeling of agricultural landscapes in the Upper Midwest, including watersheds in the Minnesota River Basin. Those efforts include combining watershed-scale model outputs with complementary data sources and analytical approaches to improve model robustness and support cross-disciplinary research efforts.

Organization: Department of Soil, Water and Climate; University of Minnesota

From its' beginnings in 1913, the Department of Soil, Water, and Climate has contributed substantially to science that functions in support of preserving and restoring Minnesota's soil and water resources. Research from the Department of Soil, Water, and Climate has been integral to advancing the state of the science with respect to improving Minnesota's water quality through improved stewardship of managed landscapes. The Department has an excellent collection of support staff, faculty, and research associates with prior experience with LCCMR-funded projects. Our research team will have monthly in-person meetings throughout the duration of the project to ensure suitable progress and discuss challenges that may arise.

For this project, we have assembled a team of experienced researchers with the collective skills to ensure the success of the proposed work:
Dr. Dalzell (Dept. of Soil, Water, and Climate) will serve as the overall project manager as well as conduct the watershed scale modeling effort.
Dr. Levers (Water Resources Center) will conduct the spatial and cost-benefit analyses by linking watershed-scale model outputs with an optimization programming approach to identify landscapes that meet environmental benchmarks while protecting farmer income.
Dr. Verdin (Institute for Social Research and Data Innovation) will refine seasonal weather forecasting approaches and generate weather data to drive watershed modeling for evaluating how prescribed management scenarios may change with the weather.