Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-166

Proposal Title: Increased Intense Rain and Flooding in Minnesota's Watersheds

Project Manager Information

Name: Jason Ulrich

Organization: Science Museum of Minnesota - St. Croix Watershed Research Station

Office Telephone: (651) 261-1272

Email: julrich@smm.org

Project Basic Information

Project Summary: The causes of increased flooding and the most cost-effective solutions for reducing flood risk will be determined for the Cottonwood River watershed and nine other agricultural watersheds in southern Minnesota.

Funds Requested: $192,000

Proposed Project Completion: June 30 2024

LCCMR Funding Category: Small Projects (H)

Secondary Category: Water Resources (B)

Project Location

What is the best scale for describing where your work will take place?

Region(s): SE, SW,

What is the best scale to describe the area impacted by your work?

Region(s): SE, SW,

When will the work impact occur?

During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

In recent decades, many river communities across southern Minnesota's agricultural watersheds have seen a marked increase in flooding. In particular, research has shown the Cottonwood River watershed to be an epicenter of increased major flooding, as evidenced by the City of Springfield on the Cottonwood River experiencing several damaging floods in the last decade.

Suggested causes for increased flooding include increases in intense rain events, increased overall precipitation as well as a history of continual agricultural land alteration; however, there is still a lack of scientific consensus and usable information as to the relative importance of each of these potential causes.

As a result, many communities and watersheds are struggling to answer the following questions:
-What are the primary causes of recent increases in flooding?
-What is the relative importance of each of these causes?
-Based on these answers, what are the most cost-effective solutions for reducing flood risk?

An opportunity exists to fill a gap in our understanding of increased flooding in our agricultural watersheds. Filling this gap will ensure future flood planning -- and our State-wide narrative regarding flooding and its causes -- are informed by sound science and economic practicality.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

We propose quantifying the relative importance of potential causes of recent flooding in ten major, agricultural watersheds in southern Minnesota. With this information, we will then analyze the most cost-effective solutions to reduce future flood risk in these areas.

First, we will focus on the Cottonwood watershed because of its location at the center of recent flood increases, and its current, specific need for the proposed project results; the City of Springfield will provide a local perspective on the need for the project.

Our approach will be to develop a very detailed watershed model of the Cottonwood watershed to analyze past flood events from 1950-2020 to understand the causes and how they may have changed over time, including (but not limited to):
-Increases in intense storms
-Increases in overall precipitation
-Decreases in watershed storage (e.g., draining of wetlands, loss of soil-water storage)

Then, the model will be used to test and optimize solutions for reducing future flood risk based on cost and effectiveness. Last, the detailed analysis and results for the Cottonwood River watershed will be extended to the other nine project watersheds (to be determined) using a more generalized approach.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

Outcomes will include:
-A first-of-its-kind, quantitative understanding of the relative causes of flooding in ten major agricultural watersheds.
-Analyses of cost-effective solutions for reducing future flood risk in these ten watersheds.
-The Cottonwood watershed (including the City of Springfield) will receive needed information relevant to their current

challenges and future planning efforts.

These outcomes will help State agencies, watershed organizations, counties, and municipalities develop - and successfully fund - cost-effective strategies to reduce future flood risk.

An overarching outcome will be providing needed science-based information to policy-makers and the general public regarding this important and often contentious issue.

Activities and Milestones

Activity 1: Conduct detailed analysis and modeling of Cottonwood River watershed to quantify relative importance of flood causes.

Activity Budget: $90,000

Activity Description:
Our approach entails first intensively modeling the entire Cottonwood River watershed with specific focus on major towns on the river (e.g., Springfield, New Ulm). The Cottonwood will be modeled using the watershed model SWAT. The model will be developed to explicitly incorporate the most relevant hydrologic/flooding factors including climate, extent of drain tile, extent of row-crop agriculture, local tillage practices, and depressional/wetland/lake storage -- and how these factors have changed over time from 1950-2020. The model will be primarily calibrated and validated using USGS flow gauging data at New Ulm and with other flow data as available. Once this ”base-condition” model is completed it will be iteratively modified to alter (e.g., increase, decrease, or remove) the extents of the hydrologic/flooding factors individually. The comparison between the base-condition model results and each set of modified model results will quantify the flooding impact and relative importance of each cause/factor.

An important part of this Activity will be quarterly meetings with a technical advisory committee (TAC) which will review work progress and provide expert guidance. The TAC will consist of the local groups/agencies (Redwood-Cottonwood-Rivers-Control-Area, City of Springfield, SWCD's), as well as MPCA and DNR.

Activity Milestones:

Description	Completion Date
Gather necessary climate and watershed data (soils, LiDAR, landuse, drain tile extent, wetland storage, etc.).	September 30 2022
Construct and calibrate watershed model.	December 31 2022
Run watershed model simulations and analyze results to quantify relative importance of flood causes/factors.	March 31 2023

Activity 2: Simulate solutions for reducing future flood risk in the Cottonwood watershed and calculate cost-effectiveness.

Activity Budget: $30,000

Activity Description:
Activity 2 entails using the completed, calibrated model and analyses of relative importance from Activity 1 to simulate different solutions for reducing flood risk in the Cottonwood watershed. Solutions will consist of one or more specific practices such as (but not limited to):
-“Mitigative”: Increasing upstream, field-scale storage (e.g., wetland restorations, controlled drainage, cover-cropping/no-till, land retirement).
-“Adaptive”: Increasing downstream, on-river storage (e.g., dams and impoundments) and construction of protective levees.

For each solution, the model will be modified to reflect the presence of the solution's practices. The simulations of the solution-modified model will be compared to the current, “base-condition” model simulations to quantify the effectiveness of each solution on flooding (in terms of reduction of flood risk) at different locations in the watershed. Cost and cost-effectiveness (a ratio of the dollars spent per unit effectiveness) will be calculated based on current published ranges of costs and the model-simulated effectiveness associated with each solution's practices. Last, the

solutions will be ranked and optimized by cost-effectiveness.

As with Activity 1, the project's technical advisory committee (TAC) will meet quarterly to discuss progress and provide expert guidance.

Activity Milestones:

Description	Completion Date
Select solutions and practices to be analyzed for cost-effectiveness.	May 31 2023
Modify watershed model to analyze cost-effectiveness of solutions and practices.	August 31 2023
Run watershed model solution simulations and summarize all Cottonwood findings.	October 31 2023

Activity 3: Extend results of Cottonwood watershed analyses to the other project watersheds.

Activity Budget: $72,000

Activity Description:
Activity 3 entails extending results from Activities 1-2 to nine additional agricultural watersheds in Southern Minnesota (TBD). These watersheds will be selected based on the availability of relatively complete precipitation and flow data, and their general similarity in terms of climate and landscape causes/factors (soils, extent of agriculture, watershed storage, etc.). Then, a statistical, GIS-based framework will be constructed to correlate/extend results from Activities 1-2 to the additional watersheds based on their shared climate and landscape causes/factors.

Much of the activity will be concerned with communicating the goals, progress and results of the project. Public meetings will be held annually in Springfield to discuss the project and its results. A detailed report specific to the needs of the Cottonwood watershed and City of Springfield will be created. In addition, Cottonwood watershed-specific fact sheets on the project will be created for public dissemination.

A full project report will be created for LCCMR covering all results and watersheds. The report and illustrative GIS data will be posted on Science Museum websites, social media posts summarizing and promoting the results will be composed, and the results presented (at least) twice at water resource and/or farm group conferences.

Activity Milestones:

Description	Completion Date
Select additional project watersheds and gather necessary data.	November 30 2023
Develop and execute statistical, GIS-based framework to extend Cottonwood results to all project watersheds.	February 28 2024
Develop outreach/communication deliverables.	June 30 2024

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Shawn Schottler	Science Museum of Minnesota - St. Croix Watershed Research Station	Dr. Schottler will assist and advice in all phases of the project.	Yes
Dr. Bruce Wilson	University of Minnesota - Department of Bioproducts and Biosystems Engineering	Dr. Wilson will assist and provide advisement in all Project Activities -- primarily, the modeling and statistical analysis aspects of Activities 1-3.	No
Kerry Netzke	Redwood-Cottonwood Rivers Control Area	Ms. Netzke is the executive director of the Redwood-Cottonwood Rivers Control Area. She will provide advice from a stakeholder's perspective based on her experience in the Cottonwood watershed and her extensive local knowledge of the issues around water and agriculture. She will also assist in coordinating outreach and communication deliverables.	No
Joe Stremcha	City of Springfield, MN	Mr. Stremcha is City Manager of Springfield and will provide assistance in gathering data necessary for modeling and analysis in Activities 1-2. He will also help coordinate outreach and communication deliverables in Activity 3.	No
Melanie Krueger	Brown County Soil and Water Conservation District	Ms. Krueger is District Manager of the Brown County SWCD, and will provide advice and data gathering assistance, and will participate in the periodic technical advisory meetings	No

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?

As described in Activity 3, implementation will consist of conveying the project results via many different outreach/communication deliverables: reports, fact-sheets, public meetings, social media posts, and presentations at conferences. The intent is to provide as many means possible to share the project's results to stakeholders and interested parties State-wide. Further, the completed Cottonwood watershed model developed in the project will be available to anyone to use in the future with no additional funding required.

All project implementation will take place within the funded project timeline. However, the project results could be extended State-wide with future funding.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Develop Market-Based Alternatives for Perennial Crops to Benefit Water Quality and Wildlife	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 08c	$150,000
Mapping Unprofitable Cropland for Water and Wildlife	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04n	$100,000

Project Manager and Organization Qualifications

Project Manager Name: Jason Ulrich

Job Title: Assistant Scientist

Provide description of the project manager's qualifications to manage the proposed project.
As a watershed hydrologist and modeler, my scientific studies focus on understanding and quantifying the effects of factors such as landuse, climate and agricultural practices on hydrology and water quality. My two principal areas of expertise are: 1) modeling the behavior of agricultural watersheds using the state-of-the-art models such as SWAT and HSPF, and 2) GIS analysis for better understanding of small-scale hydrologic and sediment processes using LiDAR elevation data. My experience combines modeling, GIS, and statistical analyses with economics to better predict the cost-effectiveness of proposed agricultural best-management-practices (BMP) strategies, and to understand the effects of climate change and agriculture on trends in river hydrology and water quality. I am currently project manager for the LCCMR-funded "Mapping Unprofitable Cropland for Water and Wildlife" project.

Affiliations:
2016-present: Assistant Scientist, St. Croix Watershed Research Station, Science Museum of Minnesota.
2019-present: Ph.D. Candidate, Water Resources Science. University of Minnesota.

Education:

2006. M.S., Water Resources Science. University of Minnesota.
2000. B.S., Natural Resources and Environmental Studies, University of Minnesota.

Selected Publications:
Almendinger, J.E. and J.S. Ulrich. 2017. Use of SWAT to Estimate Spatial Scaling of Phosphorus Export Coefficients and Load Reductions Due to Agricultural BMPs. Journal of the American Water Resources Association.

Ulrich, J.S. and P. Conrad. 2015. Cost-Effective Agricultural BMP Planning Using Precision Conservation Principles and Advanced GIS Tools: A Case Study in the Squaw Creek Watershed, Iowa. Presented at 2015 MN Water Resources Conference.

Schottler S. P., Ulrich, J.S., Engstrom, D.E. 2016. Comment on climate and agricultural landuse change impacts on streamflow in the upper Midwestern U.S. Water Resources Research.

Schottler S.P., Ulrich, J.S., Belmont, P., Moore, R., Lauer, J.W., Engstrom, D.E., Almendinger, J.E. 2013. Twentieth century agricultural drainage creates more erosive rivers. Hydrological Processes.

Organization: Science Museum of Minnesota - St. Croix Watershed Research Station

Organization Description:
The Science Museum of Minnesota (SMM) is a private, non-profit 501(c)3 institution dedicated to encouraging public understanding of science through research and education. The St. Croix Watershed Research Station is the environmental research center of the SMM with the mission to foster, through research and outreach, "a better understanding of the ecological systems of the St. Croix River basin and watersheds worldwide." The SCWRS supports an active year-round program in environmental research and graduate-student training, guided by a dedicated in-house research staff with direct ties to area universities and colleges. It collaborates closely with federal, state, and local agencies with responsibility for managing the St. Croix and upper Mississippi rivers and is a full partner with the National Park Service for resource management in parks of the western Great Lakes region. Its research has played a central role

in setting management policy for the St. Croix and Mississippi rivers, for establishing water-quality standards for Minnesota lakes and for developing long-term monitoring plans for the National Park Service.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Assistant Scientist		Project manager, primary modeler, analyst; developer of outreach/communication deliverables			30%	1.6		$124,000
Senior Scientist		Assist and advise with modeling, analysis, development of outreach/communication deliverables			30%	0.6		$63,000
							Sub Total	**$187,000**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Tools and Supplies	1 license for modeling, GIS, programming or statistical analysis software	Used for advanced analyses; modification of model and analytical source codes					$1,000
							Sub Total	**$1,000**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Five 320-mile round-trips to Cottonwood watershed area for 1 person plus intra-watershed travel - total of 2,000 miles; plus meals and 5 nights lodging.	Meetings and data collection during model development; progress meetings and outreach activities; presentations and meetings with gov't staff and general public.					$2,000

	Conference Registration Miles/ Meals/ Lodging	2 trips to conferences + registration: 400 miles round-trip per for 1 person; plus meals and lodging	Present results of project to professional and/or farm-group conference audiences.					$1,500
							Sub Total	**$3,500**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Printing	Hard-copy printing costs	Producing multiple copies of bound final reports; printing presentation posters					$500
							Sub Total	**$500**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$192,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
In-Kind	Science Museum of Minnesota	Support services from Science Museum of Minnesota 40.83% of direct costs	Secured	$76,352
In-Kind	City of Springfield - 25 hours of engineering staff time	Help in data collection and coordinating/hosting meetings.	Secured	$4,075
In-Kind	Brown County Soil and Water Conservation District -- staff time	Technical staff time for help with data collection and project advisement	Secured	$3,000
			Non State Sub Total	**$83,427**
			Funds Total	**$83,427**

Attachments

Required Attachments

Visual Component

File: 583997fe-f91.pdf

Alternate Text for Visual Component

Graphic illustrates proposal to better understand causes of recent flooding in southern Minnesota's agricultural watersheds and to determine cost-effective solutions for reducing future flood risk. The project proposes first studying the Cottonwood watershed, an epicenter of increased flooding, and then extending these results to nine other agricultural watersheds in southern Minnesota, to be determined. A map showing the Cottonwood as well as Blue Earth, Cedar, Chippewa, Crow, Des Moines, L...

Optional Attachments

Support Letter or Other

Title	File
Science Museum of Minnesota - Organizational Letter of Support	feb9c865-217.pdf
Brown County Soil and Water Conservation District - Letter of Support	e9ffe2ca-b18.pdf
City of Springfield, MN - Letter of Support	2e3ef264-226.pdf
Redwood-Cottonwood Rivers Control Area - Letter of Support	b2ba3e6c-1db.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

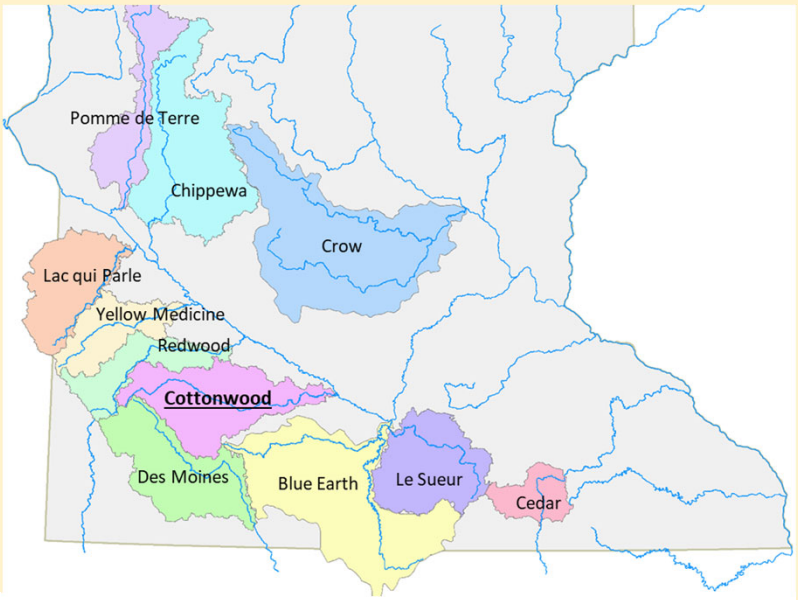
Does the organization have a fiscal agent for this project?

No

Project Title: Increased Intense Rain and Flooding in Minnesota Watersheds

Flooding has increased in many of Minnesota's agricultural watersheds.

Cottonwood River watershed an epicenter of recent increases



Map of Cottonwood watershed and possible additional project watersheds (TBD)

MN river communities struggling to find economical solutions for reducing flood damage because exact causes remain unclear:

Increases in Intense Rain or Agricultural Land Alteration?

- **We will *quantify the causes of recent flooding* and determine *cost-effective solutions for reducing flood risk* in the Cottonwood River watershed.**
- **These results will then be extended to nine additional watersheds.**