Environment and Natural Resources Trust Fund

M.L. 2022 Approved Work Plan

General Information

ID Number: 2022-152

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: June 23, 2022

Project Title: Water and Climate Information to Enhance Community Resilience

Project Budget: $564,000

Project Manager Information

Name: Tracy Twine

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

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Project Reporting

Date Work Plan Approved by LCCMR: June 27, 2022

Reporting Schedule: March 1 / September 1 of each year.

Project Completion: June 30, 2025

Final Report Due Date: August 14, 2025

Legal Information

Legal Citation: M.L. 2022, Chp. 94, Art. , Sec. 2, Subd. 04f

Appropriation Language: $564,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to provide information on potential future water resources to communities and individuals to guide adaptation planning.

Appropriation End Date: June 30, 2025

Narrative

Project Summary: To support Minnesota's climate resiliency investments, we will generate critical water resources information and share it with impacted communities and individuals to guide adaptation planning and water resources management.

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

Water in Minnesota is a critical cultural and natural resource, vital to our state's recreation and tourism, industry, agriculture, and Indigenous culture and lifeways. Warmer and wetter conditions, combined with more intense and frequent precipitation events, challenge our ability to effectively manage our water resources for people, plants, and animals. While precipitation is increasing on average across the state, the larger events may also cause more water to runoff and make less available to recharge groundwater. This can reduce water availability, a trend observed in some regions of the state already. Climate projections and hydrologic models are needed to take these observations and provide scenarios of possible Minnesota groundwater futures so communities can prepare for, and respond to, potential changes in groundwater reserves.

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

Two recent developments have created an opportunity to produce improved information about water fluxes under changing climatic conditions: (1) the University of Minnesota (UMN) has produced climate projection data sets optimized for Minnesota, and (2) the USGS has improved their Soil-Water-Balance (SWB) model code. UMN produced this climate dataset not only to examine what the climate of Minnesota might look like by the end of the century, but also to be used as input into models of other variables relevant to various sectors (i.e., economic, hydrologic, etc.). In this proposed collaboration, we have the unique opportunity to simulate the partitioning of precipitation as it reaches the surface of Minnesota under potential changes in climate. Here we propose to (1) understand how major fluxes of water including runoff, evapotranspiration, and groundwater recharge respond to climate forcings of precipitation and temperature under various future scenarios, (2) develop scenarios of the future impacts to replenishment of groundwater reserves, (3) create a data interface to engage stakeholders with these scenarios, and (4) develop a training module to connect users to the interface.

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?

This project will produce publicly available information about interactions between Minnesota's changing climate and groundwater recharge, evapotranspiration, runoff, and crop water demand. The information can be used to help communities and individuals address issues that intersect both groundwater and surface water. Potential applications of the products from this project include evaluating future irrigation needs due to long-term precipitation changes, assessing the risk of drinking water shortages for communities that rely on groundwater, and reducing impacts to Minnesota's lakes and rivers that have connections to groundwater systems.

Project Location

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

Statewide

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

Statewide

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Produce statewide, long-term simulations of groundwater recharge, runoff, crop water demand, and evapotranspiration

Activity Budget: $290,009

Activity Description:
We aim to use state of the art past, present, and future climate data sets with a newly updated USGS Soil-Water-Balance (SWB) model code to translate the climate data into statewide information about groundwater recharge, runoff, crop water demand, and evapotranspiration for the periods 1980 - 2020, 2040-2059, and 2080-2099.
A statewide application of the USGS SWB model already exists and is widely used; however, it has a number of limitations we will address through this project. First, the existing SWB application only covers the years 1996 to 2010; we will extend this range to 1981 through 2020 for a larger baseline. Second, the existing SWB application did not evaluate water budget changes in response to changing climate conditions; we will evaluate water budget changes for two emissions scenarios and two future time periods using newly developed climate datasets. Third, the existing SWB application focused on groundwater recharge; we will add plant evapotranspiration, runoff, and crop water demand to the list of simulated values. The resulting set of model projections will provide a range of values for possible future hydrologic water budget components.

Activity Milestones:

Description	Approximate Completion Date
Prepare Soil-Water-Balance (SWB) model for new climate input dataset--format, debug, test	December 31, 2022
Assemble observed streamflow, groundwater-level, evapotranspiration, and irrigation data for calibration of model	June 30, 2023
Run simulations with observations and historic climate data--evaluate and calibrate	May 31, 2024
Run simulations with future climate scenarios, evaluate and engage with visualization in Activity 2	April 30, 2025

Activity 2: Data Delivery and Capacity-Building for Connecting Science to Action

Activity Budget: $273,991

Activity Description:
The University of Minnesota Extension (Roop and Larson) is developing a dedicated climate services program to deliver critical climate-related information to a diversity of stakeholders across the state. This work includes the development of a suite of interactive data tools, trainings, convenings and technical support services. We will leverage this program and forthcoming website (climate.umn.edu) to develop an interface to connect the models, and an interactive data tool to visualize the climate projections and water budgets. This visualization will be supplemented by a series of training modules to help communities, industries, and individuals understand how to best use the data in decision-making, with an emphasis on how to use these data in existing decision-making frameworks. We will also develop a series of narrative-based scenarios using the model output to help illustrate to lake managers, community resilience professionals, public officials, and others the opportunities and potential outcomes and impacts that can result from different changes in climate and groundwater availability and accompanying adaptation interventions or solutions.

Activity Milestones:

Description	Approximate Completion Date
Develop preliminary data interface and visualization with initial model output	January 31, 2023
Conduct user testing; update tools based on user feedback	June 30, 2023
Publish visualization and develop toolkit resources	December 31, 2024

Finalize visualization and toolkit materials; deliver at least two trainings for target stakeholder groups	May 31, 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Tracy Twine	University of Minnesota	Project Lead, oversee climate data analysis	Yes
Heidi Roop	University of Minnesota	Co-PI, oversee visualization and data portal activities, coordinate development of Extension training resources, supervise student	Yes
Stefan Liess	University of Minnesota	Co-PI, climate modeler, oversee interface between climate data and SWB model, help supervise student	Yes
Joel Larson	University of Minnesota	Extension program leader for water, assist with connecting the products and results with Water Resources Center audiences and stakeholders	No
Steve Westenbroek	USGS	SWB model developer. Will be involved in all aspects of SWB modeling and incorporate any updates to SWB model code needed to meet the goals of this project	Yes
Jared Trost	USGS	USGS project and data manager, assembly of input data sets, assistance with model calibration and data visualization	Yes
Martha Nielson	USGS	SWB model calibration expert, will provide guidance for model calibration and quantification of uncertainty.	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
The primary vehicles for disseminating the project findings will be through University of Minnesota Extension programs and the Minnesota Climate Adaptation Partnership (MCAP). UMN Extension is a major outreach arm of the University of Minnesota with a mission to serve the public through applied research and education. Our mission is to make a difference by connecting community needs and University resources to address critical issues in Minnesota.

MCAP works to develop critical climate science knowledge, champion climate adaptation leadership and supports climate resilience actions and collaborations across communities, sectors, and levels of government to ensure Minnesota is making needed progress to prepare for our changing climate. MCAP is a leading multi-sector group dedicated to climate adaptation and resilience in Minnesota and partners directly with state, federal and local governments, the private sector, non-profit, Tribes, community organizations, and individuals.

Through UMN Extension and MCAP, we provide a range of programs, products, and tools to help communities and individuals across Minnesota respond to a changing climate. For this project, we will work with existing teams who focus on crop production, water management, irrigation, and climate. These teams share information, data, and tools through multiple channels and venues, including field days, blog posts, podcasts, webinars, and other in-person and virtual events. As a measure of the reach of these groups, in 2021 the Extension water team hosted more than 100 events that reached more than 5,000 individuals.

We will acknowledge support by ENRTF according to their posted guidelines. This will include logos and/or the acknowledgement text on all presentations, posters, publications, outreach materials and websites. We will tag ENRTF when posting material related to this funded project on social media.

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 work be funded?

Upon project completion, we expect these datasets to be maintained as part of the dedicated climate services program being developed through University Extension. While the datasets evolve as our knowledge is updated, the infrastructure developed will be maintained into the future. Interpretations of the data will be available to the public, and SWB model output will be available as input to users of other models.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
MITPPC #2: Early Detection, Forecasting and Management of Brown Marmorated Stinkbug (Halymorpha halys)	M.L. 2014, Chp. 312, Sec. 8	-
Understanding Water Scarcity, Threats, and Values to Improve Management	M.L. 2015, Chp. 76, Sec. 2, Subd. 04a	$234,000
Protection of State's Confined Drinking Water Aquifers - Phase II	M.L. 2016, Chp. 186, Sec. 2, Subd. 04h	$433,000
Techniques for Water Storage Estimates in Central Minnesota	M.L. 2017, Chp. 96, Sec. 2, Subd. 04h	$250,000
Setting Realistic Nitrate Reduction Goals in Southeast Minnesota	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04m	$350,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Tracy Twine		Lead PI			36.5%	0.06		$12,015
Heidi Roop		Co-PI			36.5%	0.12		$19,609
Stefan Liess		Co-PI			36.5%	0.24		$24,063
Graduate Student		MS			88%	3		$155,688
							Sub Total	**$211,375**
Contracts and Services								
United States Geological Survey (USGS)	Sub award	Simulate major components of the land surface water cycle (groundwater recharge, runoff, crop water demand, and evapotranspiration) with past, present, and future climate data and soil and land cover data sets in newly updated USGS Soil-Water-Balance model. Costs include project/data management, modeling, IT costs, calibration, reporting, meeting travel.				1.77		$288,100
University of Minnesota Supercomputing Institute (MSI), GEMS, and project personnel	Internal services or fees (uncommon)	$5,000 for data portal development, $50,000 for API development (estimated by CFANS GEMS)				0		$55,000
University of Minnesota Supercomputing Institute (MSI)	Internal services or fees (uncommon)	Funds are requested to pay for data storage on the Minnesota Supercomputing Institute's (MSI) data drives, necessary to process model data and store data for both Activities. 10TB above the in-kind Tier 1 storage provided by MSI is required for our model storage needs.				-		$6,269
							Sub Total	**$349,369**
Equipment, Tools, and Supplies								

	Equipment	one desktop computer	dedicated to project for student to connect to supercomputer and analyze data	X				$1,500
							Sub Total	**$1,500**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	two trips, potentially > 100 miles, for car rental & meals for 6 people	engage with stakeholders in region identified as key groundwater resource to train on data visualization, learn their concerns					$756
							Sub Total	**$756**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Printing	training supplies	printing materials for training stakeholders on data portal					$1,000
							Sub Total	**$1,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$564,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Equipment, Tools, and Supplies		one desktop computer	In the case of this project, we will be using computing resources at the Minnesota Supercomputing Institute (MSI) to run models and process data. In order to access MSI the project requires a desktop computer so the student can access MSI from their office.

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount
State				
			State Sub Total	**-**
Non-State				
In-Kind	UMN waived overhead	UMN will not charge overhead from this project	Secured	-
			Non State Sub Total	**-**
			Funds Total	**-**

Attachments

Required Attachments

Visual Component

File: 65f2f395-2ae.pdf

Alternate Text for Visual Component

Maps showing 1996-2010 mean potential groundwater recharge, projected change in winter air temperature by 2100 (baseline 1990), and projected change in spring daily precipitation by 2100 (baseline 1990) across the state of Minnesota shown as examples of models to be combined. Photos of a wet crop field, lake, and well shown as example of water resources that will be quantified in the project. Photos of scientists and stakeholders engaged in tours of fields and map examination....

Optional Attachments

Support Letter or Other

Title	File
USGS Letter of Intent	ebae4cd5-167.pdf
Background Check Form	5e7d0094-aa1.pdf
Research Addendum	245d4ded-cec.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

No changes to report

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I agree to the UMN Policy.

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

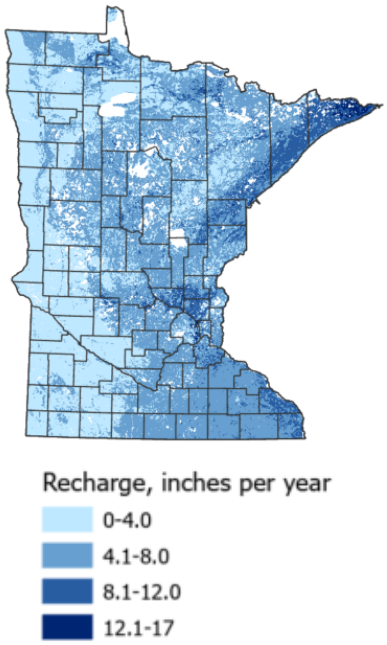
Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

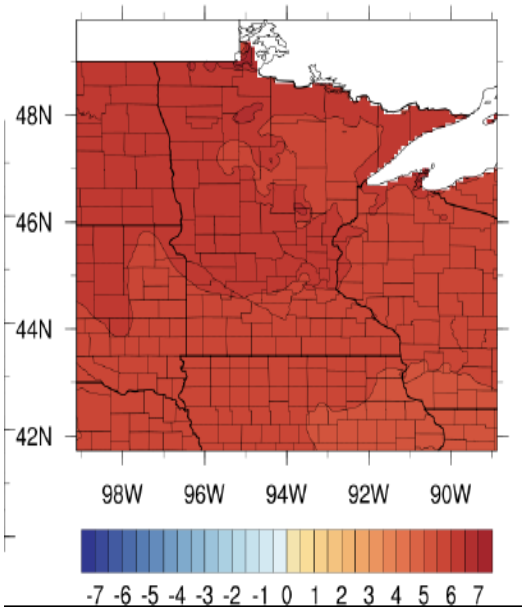
Water and Climate Information to Enhance Community Resilience

1) Combine groundwater models and climate projections to develop scenarios of Minnesota's warmer and wetter future

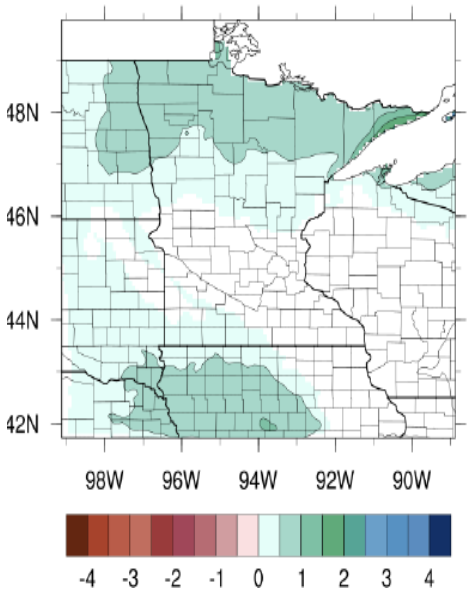
1996-2010 mean potential groundwater recharge



Simulated change in winter air temperature (°C) by 2100



Simulated change in spring daily precipitation (mm) by 2100



2) Use combined models to assess impacts on water resources, including irrigation, lakes and rivers, and drinking water

3) Collaborate with communities and stakeholders to inform their planning and decision-making