



Environment and Natural Resources Trust Fund (ENRTF) M.L. 2017 Work Plan

Date of Report: August 3, 2016

Date of Next Status Update Report: January 1, 2018

Date of Work Plan Approval:

Project Completion Date: June 30, 2020

Does this submission include an amendment request? No

PROJECT TITLE: High-Resolution Climate Projections to Aid Local Planning and Implementation Efforts

Project Manager: Peter Snyder

Organization: Regents of the University of Minnesota

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Location: Statewide

Total ENRTF Project Budget:

ENRTF Appropriation: \$411,000

Amount Spent: \$0

Balance: \$411,000

Legal Citation: M.L. 2017, Chp. xx, Sec. xx, Subd. xx

Appropriation Language:

[To be inserted following the MN Legislative Session in Spring 2017. This will be blank for the initial submission and will be provided to you at a later date.]

I. PROJECT TITLE: High Resolution Climate Projections to Aid Planning Efforts

II. PROJECT STATEMENT:

Minnesota’s climate is changing, as indicated by observed temperature increases and extremes in precipitation. These changes are impacting Minnesota’s valuable resources, such as swimmable, fishable lakes and rivers; productive forests that sustain iconic species, like moose and birch; fertile farmland cultivated for local food systems and commodity export; and many aspects of the built environment that support our daily lives, such as roads and bridges, stormwater/sewer infrastructure, potable water supply, and power utilities. Projections at the local level of further change in temperature, precipitation and other weather-related variables are urgently needed by researchers, planners, engineers, farmers and businesses to ensure sound planning and implementation of appropriate adaptation strategies for maintaining and protecting our natural environment, built infrastructure, economy and health.

The goal of this project is to provide detailed climate projections for those tasked with assessing impacts to Minnesota’s resources and those tasked with developing action plans for adapting to climate changes can make informed decisions.

The objectives of this project are to produce high-resolution (3 mile by 3 mile) climate model projections for the entire state of Minnesota. This will be done using numerical modeling resources at the University of Minnesota’s Minnesota Supercomputing Institute. The data will be disseminated on a publically-accessible web-based data portal along with educational information about climate change and best use of the provided data. Finally, the project will result in the development of educational resources that will be used in conjunction with University of Minnesota Extension to inform the public and train state and local agency professionals on using and interpreting the data for the purposes of developing action plans and adapting to Minnesota’s changing climate. The data derived from this project are essential for long-term planning and implementation of adaptation strategies for the protection of the state’s natural resources, infrastructure and health.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of *January 1, 2018*:

Project Status as of *July 1, 2018*:

Project Status as of *January 1, 2019*:

Project Status as of *July 1, 2019*:

Project Status as of *January 1, 2020*:

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Produce Minnesota-Specific Climate Model Projections

Description: We will use a computational technique called dynamical downscaling to take global climate models results used by the Intergovernmental Panel on Climate Change to produce new high-resolution climate model projections for the entire state of Minnesota from 1970 to 2099. We will use computational resources at the Minnesota Supercomputing Institute to produce these projections.

From previous NSF funded research we have ranked all the climate models as to their performance in representing the climate of Minnesota. Model performance was ranked according to how well it represented the 1970-2005 historical period for temperature, rainfall, snowfall, winds, cloud cover, and many other climate parameters.

We will use these top five performing climate models to use a computational technique called dynamical downscaling to develop high resolution climate change projections. We will do this for the 1970-2005 period so that we can evaluate the performance of the approach and insure that the model is working correctly and then run it into the future from 2005 to 2099 using two different emission scenarios that reflect moderate and high emissions throughout the remainder of this century. These scenarios will provide a lower and upper bound on the plausible outcomes for climate change in Minnesota. In total, ten projections of 130-years each will be produced – 1970-2099 for five models and two emission scenarios. These models will be produced statewide with the model resolving the climate in a region as small as 3 miles by 3 miles. Data will be processed, quality assured, evaluated and vetted, and stored on the data servers for a variety of different time frames (hourly, daily, monthly, seasonally, and annually). Data produced by this process will then be linked to the data portal and metadata and documentation will be provided for end-users based on meetings as detailed in Activity 2.

Using the finite computing resources at the Minnesota Supercomputing Institute, in the first year we will be able to run four projections out of ten, four in the second year, and two in the third year for a total of ten projections. As data are processed and vetted, data will be made available for end-user purposes.

Summary Budget Information for Activity 1:

ENRTF Budget: \$ 224,400
Amount Spent: \$ 0
Balance: \$ 224,400

Outcome	Completion Date
1. Produce results for first group of four climate projections	July 2018
2. Produce results for second group of four climate projections	July 2019
3. Produce results for third group of two climate projections	December 2019

Activity Status as of January 1, 2018:

Activity Status as of July 1, 2018:

Activity Status as of January 1, 2019:

Activity Status as of July 1, 2019:

Activity Status as of January 1, 2020:

Final Report Summary:

ACTIVITY 2: Develop Web Portal and Deploy Server to Disseminate Climate Projection Results

Description: The focus of Activity 2 will be on deploying the data server to the Minnesota Supercomputing Institute, developing the data portal web site, and developing the content for the web site. The data server will be online for a minimum of five years past the end of the project and up to seven years. The server will be used to disseminate the climate projection data in variety of formats and time scales.

The web portal will be designed with input from a user’s group identified through the Minnesota Climate Adaptation Partnership – a collaboration of universities, nonprofits, businesses and local, state and federal

agencies working on climate adaptation. The portal will allow users to specify information of interest (e.g., temperature, precipitation, snow cover), time period of interest (e.g., 2020-2050), averaging required (e.g., annual, seasonal, monthly, daily, hourly), area of interest (the whole state, a single location), visualization, and options of file formats for downloading. We will hold two User’s Group meetings in 2018 to identify the exact form and type of data that would be of most use to agencies and stakeholders interested in evaluating climate change impacts and mitigation and planning strategies.

The data server will be deployed in early 2019 and will be installed and maintained by Minnesota Supercomputing Institute staff. The server configuration will be determined by the Institute staff, installed, and maintained by staff.

In early 2019 we will also work with the consulting web developer to develop the web site including the functionality to allow for querying data required and integrating with the hardware of the Minnesota Supercomputing Institute. The web site functionality will be determined by the input of the User Group members, the state agencies, and the project team.

Summary Budget Information for Activity 2:

ENRTF Budget: \$ 83,200
Amount Spent: \$ 0
Balance: \$ 83,200

Outcome	Completion Date
1. Determine members of User’s Group for portal content development	May 2019
2. Host two meeting’s of the User’s Group to draft portal functionality and interface	October 2019
3. Deploy server to Minnesota Supercomputing Institute	January 2020
4. Develop web portal for data dissemination and deploy	March 2020

Activity Status as of January 1, 2018:

Activity Status as of July 1, 2018:

Activity Status as of January 1, 2019:

Activity Status as of July 1, 2019:

Activity Status as of January 1, 2020:

Final Report Summary:

ACTIVITY 3: Education and Outreach

Description: Activity 3 involves three primary efforts centered around education and outreach of the project results and climate change science.

First, we will produce a comprehensive set of online tutorials on the basics of climate change science, modeling of the climate system, how we produced the climate model data that is part of this project and the data portal, and proper use of the data that will be provided on the portal to the public. This content will be produced by the project manager in collaboration with the graduate student.

Second, we will partner with University of Minnesota Extension to incorporate information on use of the data, and portal use into their existing online climate adaptation training to help participants learn to access/use the

data to lead climate adaptation activities in their organizations and municipalities (the course targets natural resources, water, municipal infrastructure and human resources professionals).

Finally, we will provide two “train the trainer” workshops for state agencies, local municipalities and others who will then educate colleagues on best practices for using and interpreting the data for climate adaptation efforts. These meetings will target individuals who are working on climate change impacts and adaptation planning for state assets such as fishing and wildlife, forestry, human health, infrastructure, water quality, the energy sector, and commerce. In these meetings we will provide printed documentation about climate change, the data and how it was produced, and best practices of using the data. We anticipate that the individuals who attend one of these meetings will then be able to go back to their respective host agencies/businesses and share the information learned so that a wider audience can then use the data.

Summary Budget Information for Activity 3:

ENRTF Budget: \$ 103,400
Amount Spent: \$ 0
Balance: \$ 103,400

Outcome	Completion Date
1. Develop web-based educational materials on climate change and data usage	March 2020
2. Provide two “train the trainer” workshops	June 2020

Activity Status as of January 1, 2018:

Activity Status as of July 1, 2018:

Activity Status as of January 1, 2019:

Activity Status as of July 1, 2019:

Activity Status as of January 1, 2020:

Final Report Summary:

V. DISSEMINATION:

Description: Three main modes of dissemination will result from this project.

First, data that is generated from the dynamical downscaling of climate data will be made available via a web portal. This web portal will consist of a data server housed at the Minnesota Supercomputing Institute and integrated with MSI long-term storage devices. The web site (URL to be determined) will be developed by the web developer consultant and allow user queries for targeted purposes. The web site will also contain training and educational materials as to the basics of climate change, best use of the data, and best practices when working climate model data for particular applications.

Second, project manager Snyder will partner with University of Minnesota Extension to incorporate information on portal use into their existing online climate adaptation training to help participants learn to access/use the data to lead climate adaptation activities in their organizations and municipalities (the course targets natural resources, water, municipal infrastructure and human resources professionals). Furthermore, two “train the trainer” workshops will be provided for state agencies, local municipalities and others who will then educate colleagues on best practices for using and interpreting the data for climate adaptation efforts.

Third, a set of three research articles will be produced that will share what is learned on this project regarding the methodology of dynamical downscaling climate projections, the science of climate change impacts and mitigation in Minnesota, and outreach of climate change science to agencies and the general public.

Status as of January 1, 2018:

Status as of July 1, 2018:

Status as of January 1, 2019:

Status as of July 1, 2019:

Status as of January 1, 2020:

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview:

***This section represents an overview of the preliminary budget at the start of the project. It will be reconciled with actual expenditures at the time of the final report.**

Budget Category	\$ Amount	Overview Explanation
Personnel:	\$ 353,000	1 project manager at 11% FTE each year for 3 years (\$41,000); 1 postdoctoral scholar at 100% FTE each year for 3 years (\$187,000); 1 graduate student at 50% FTE each year for 3 years (\$125,000).
Professional/Technical/Service Contracts:	\$30,000	1 contract for web site development for data portal server TBD through competitive bid.
Equipment/Tools/Supplies:	\$11,000	Purchase of long-term storage space (100 TB) on existing Minnesota Supercomputer Institute storage devices to house climate data that will be accessed by the server.
Capital Expenditures over \$5,000:	\$9,000	1 data server to be housed at Minnesota Supercomputing Institute to disseminate climate data.
Printing:	\$8,000	Printing and binding of training materials to be used in communicating education and outreach materials to state and local agencies as to best use of data and practices with data (\$2,000); Publication costs for 3 publications associated with scientific articles on the project methodology, findings, and outreach efforts (\$6,000).
TOTAL ENRTF BUDGET:	\$411,000	

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than \$5,000:

One computer data server will be purchased and housed at the Minnesota Supercomputing Institute (MSI) to store and disseminate climate model projections produced by the project. Because the data will be housed at

the Institute on purchased storage space on existing devices, MSI requires that the project cover the cost of the computer server and that it match (as best as possible) the existing hardware that is currently in place. This will likely be HP or Dell server hardware. The server will remain in place for the life of the hardware and maintained by MSI staff.

Total Number of Full-time Equivalent (FTE) Directly Funded with this ENRTF Appropriation: 4.83 FTEs

Total Number of Full-time Equivalent (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: N/A

B. Other Funds:

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
State			
University of Minnesota, Minnesota Supercomputing Institute	\$945,000	\$0	In-kind services for dynamical downscaling work – based on cost per Supercomputing Unit
University of Minnesota	\$13,600	\$0	Project Manager Snyder will contribute 1 month of in-kind support per year
TOTAL OTHER FUNDS:	\$958,600	\$0	

VII. PROJECT STRATEGY:

A. Project Partners:

Project Partners Not Receiving Funds:

- Minnesota Department of Natural Resources
 - Greg Spoden, State Climatologist
 - Kenny Blumenfeld, Senior Climatologist
- Minnesota Department of Agriculture
 - Bob Patton, Supervisor, Energy and Environment Section
- Minnesota Department of Health
 - Kristin Raab, Minnesota Climate & Health Program Director
- Minnesota Department of Transportation
 - Andrea Hendrickson, State Hydraulics Engineer
- Minnesota Pollution Control Agency
 - Paul Moss, Climate Adaptation Coordinator
- Minnesota Climate Adaptation Partnership

Each of these agencies has pledged formal agency support of this project and will assist in coordinating effort centered on identifying data needed to support their efforts related to climate change impacts and adaptation. Individual contacts at these agencies will provide in-house support of the project and coordinate providing information to the project so that the most useful data will be produced. Additionally, these agencies will participate in a series of meetings at the start of the project to inform the project manager and at the end of the project for two training workshop events.

B. Project Impact and Long-term Strategy:

The data derived from this project are essential for long-term planning and implementation of adaptation strategies for the protection of the state’s natural resources, infrastructure, commerce, and health. The data will be used by the Department of Natural Resources to understand the spatial variation in climate change across the state and help inform the management of sensitive natural resources, such as future changes in plant communities and fish and wildlife populations. It will be used by the Department of Transportation to allow hydraulic engineers to predict changes in river and stream flows over time and to assess the vulnerability of

bridges, culverts and roadways to flooding so that options to build in resilience or mitigate impacts can be considered. It will directly inform the agency’s efforts with the Flash Flood Vulnerability and Climate Adaptation pilot project. This information will aid the Department of Agriculture’s development and enhancement of best practices for soil and water management and to help plan for and respond to livestock disease outbreaks. This information will help the Pollution Control Agency better assess and reduce future vulnerabilities to wastewater treatment plants, stormwater management systems, and solid waste management facilities. The data will also enhance the agency’s ability to assist communities to plan for future climatic conditions. This information will enable Department of Health epidemiologists to forecast how future climate change scenarios may impact people’s health, particularly associated with extreme heat events, reduced air quality, rising pollen levels, drought, flood events, and diseases carried by ticks and mosquitoes. In summary, this data will be directly useful to these and other agencies preparing for Minnesota’s changing climate.

Because the data will be made publically available for a period not less than five years after the completion of the project, the data will find new uses as new climate change impacts and concerns arise. The long term consequences of this project are far reaching with a multitude of public and private sector potential.

Sometime in the next 5-10 years a new round of climate model simulations will be made available to scientists worldwide. These new models will be even more refined than existing models with better representation of the climate system and reduced uncertainties. At that time, opportunities will open for revising the efforts undertaken in this project with new models when they become available.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	\$ Amount
National Science Foundation: two grants of funds to conduct numerical climate modeling and dynamical downscaling with a methodology that pertains to the work proposed in this project.	January 2008 – August 2015	\$586,097

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:

A. Parcel List: N/A

B. Acquisition/Restoration Information: N/A

IX. VISUAL COMPONENT or MAP(S): See attached figure

X. RESEARCH ADDENDUM: N/A

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than January 1, 2018; July 1, 2018; January 1, 2019; July 1, 2019, and January 1, 2020. A final report and associated products will be submitted between June 30 and August 15, 2020.

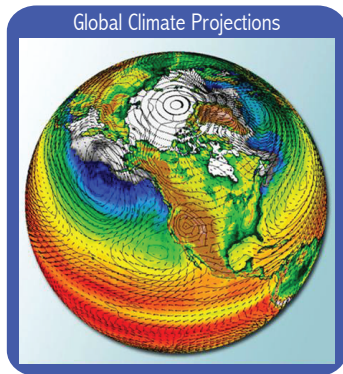
**Environment and Natural Resources Trust Fund
M.L. 2017 Project Budget**



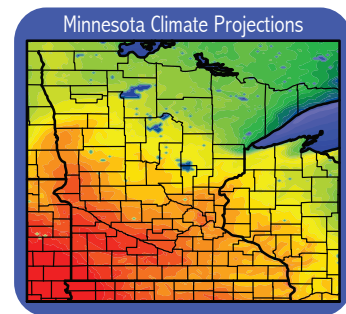
Project Title: High-Resolution Climate Projections to Aid Local Planning and Implementation Efforts
Legal Citation: Fill in your project's legal citation from the appropriation language - this will occur after the 2016 legislative session.
Project Manager: Peter K. Snyder
Organization: Regents of the University of Minnesota
M.L. 2016 ENRTF Appropriation: \$411,000
Project Length and Completion Date: 3 Years, June 30, 2020
Date of Report: 08/03/2016

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	Produce Minnesota-Specific Climate Model Projections			Develop Web Portal and Deploy Server to Disseminate Climate Projection Results			Education and Outreach				
Personnel (Wages and Benefits)	\$224,400	\$0	\$224,400	\$33,200	\$0	\$33,200	\$95,400	\$0	\$95,400	\$353,000	\$353,000
<i>Peter Snyder, Project Manager: \$41,000 (75% salary, 25% benefits); 11% FTE each year for 3 years.</i>											
<i>1 Postdoctoral Scholar: \$187,000 (82% salary, 18% benefits); 100% FTE each year for 3 years.</i>											
<i>1 Graduate Research Assistant: \$125,000 (54% salary, 46% benefits); 50% FTE each year for 3 years.</i>											
Professional/Technical/Service Contracts											
<i>TBD (competitive bid): Web site development of data portal to be housed on server at Minnesota Supercomputing Institute.</i>				\$30,000	\$0	\$30,000				\$30,000	\$30,000
Equipment/Tools/Supplies											
<i>Purchase of long-term (5-7 years) storage space on existing Minnesota Supercomputing Institute storage devices to house downscaled climate model projections that will be accessed by the deployed server.</i>				\$11,000	\$0	\$11,000				\$11,000	\$11,000
Capital Expenditures Over \$5,000											
<i>Linux-based data server to store and disseminate downscaled climate model projections. To be housed at Minnesota Supercomputing Institute.</i>				\$9,000	\$0	\$9,000				\$9,000	\$9,000
Fee Title Acquisition											
Easement Acquisition											
Professional Services for Acquisition											
Printing											
<i>Printing and binding of training materials to be used in communicating education and outreach materials to state and local government agencies as to best use of data and metadata produced by the project.</i>							\$2,000	\$0	\$2,000	\$2,000	\$2,000
<i>Publication costs for 3 publications associated with scientific articles on the downscaling approach, research findings regarding climate change in Minnesota, and outreach strategies for working with state and other governmental agencies.</i>							\$6,000	\$0	\$6,000	\$6,000	\$6,000
Travel expenses in Minnesota											
Other											
COLUMN TOTAL	\$224,400	\$0	\$224,400	\$83,200	\$0	\$83,200	\$103,400	\$0	\$103,400	\$411,000	\$411,000

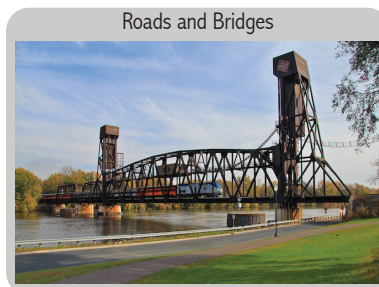
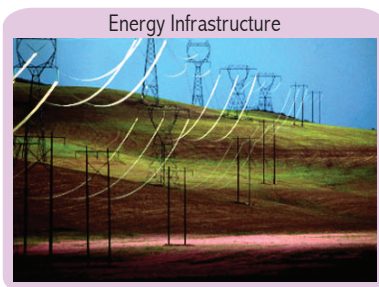
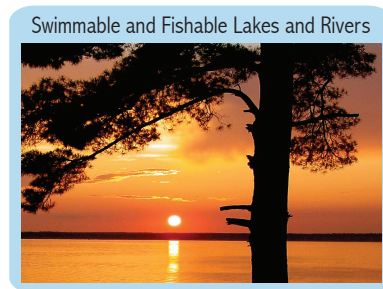
Our future depends...



Credible Projections
of Minnesota's
Changing Climate



on good information to respond to changes in the climate



This project will provide valuable Minnesota-specific climate change information to those responsible for maintaining and protecting our natural environment, infrastructure, economy, and health as we transition to a stronger and more resilient Minnesota