Environment and Natural Resources Trust Fund
2015 Request for Proposals (RFP)

Project Title: **ENRTF ID: 033-B**

Informed Water Management: Mapping Scarcity,Threats, and Values

Category: B. Water Resources

Total Project Budget: $ 234,936

Proposed Project Time Period for the Funding Requested: 2 years, July 2015 - June 2017

Summary:

A land-surface model to map statewide water scarcity and abundance, assess water-related risks to industry, municipalities, and ecosystems. Quantify the economic values of water quality and quantity changes.

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Flow chart that illustrates how a biophysical model of climate, soil, and vegetation will be used to generate a statewide water budget based on potential threats to future water security. The outputs will be used in an economic valuation of water quality and quantity.

_____ Funding Priorities _____ Multiple Benefits _____ Outcomes _____ Knowledge Base

_____ Extent of Impact _____ Innovation _____ Scientific/Tech Basis _____ Urgency

_____ Capacity Readiness _____ Leverage _______ TOTAL

PROJECT TITLE: Informed water management: Mapping scarcity, threats, and values.

I. PROJECT STATEMENT

Minnesota is rich in water resources, but growing and diversifying demands on water have led to water stress, declining lake levels, and threats to water quality. Compared to other states, Minnesota still retains a comparative advantage in water resources needed to support healthy communities and economic development. To secure a long-term sustainable water future, however, better prediction of the availability and consumption of water, emerging threats to water security, and quantification of the economic value of our clean water resource is needed. Previous efforts to address water sustainability in Minnesota include visioning assessments (e.g. state water plan), and index models and planning tools (e.g. EQB water availability project). While these projects provide snapshots of water sustainability, they do not account for feedbacks between climate and land-use, rely on outdated climate models and data, and cannot be used to evaluate alternative scenarios that capture future threats to water sustainability. Finally, while data on the economic values of clean air are widely used in cost-benefit assessments and planning, there are no comparable data on the values of clean water. **We propose to address these gaps through an integrated biophysical and economic analysis of water sustainability using state-of-the-art models to achieve the following objectives:**

1. Develop a statewide metric for assessing present and future water scarcity.
2. Map and predict the dependencies and vulnerabilities of industry, municipalities, and ecosystems to changes in water quality and quantity.
3. Estimate the economic value of clean water.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Water balance modeling to develop a statewide water scarcity metric* **Budget: $ 85,000**

To identify locations of current and future water stress, we will use a coupled climate-soil-vegetation model, called Agro-IBIS, which represents the state-of-the-art in land surface modeling. The model simulates the biological and physical response of vegetation to changes in climate in individual grid cells, producing greatly improved water balance estimates over previous statewide models (e.g. 2008 LCCMR-Project 4a). The model predicts water loss through evapotranspiration, drainage, and runoff for any time period of interest (see Visual). The model can also account for irrigation and municipal, domestic, and industrial water use and adjust water balance calculations based on changing scenarios of water use. **Our use of improved models and updated climate data will more accurately identify regions of water abundance and water scarcity, data that will inform statewide water planning and permitting.**

Outcome	Completion Date
1. Processed soils, land-use, and downscaled climate data needed for water balance calculations and model calibration. Where available, we will also assemble current information on the location and consumptive rates of water users (irrigation, municipal consumption, and other water-intensive industries).	*Fall 2015*
2. Gridded map of water balance, including quantification of streamflow and groundwater recharge by sub-watershed.	*Spring 2016*
3. Statewide water scarcity metric that will identify regions of annual or seasonal water stress that can be used for planning and assessment.	*Fall 2016*

Activity 2: *Water sustainability risk mapping* **Budget: $78,000**

After new data are assembled and the model is calibrated to current conditions (Activity 1), it can be used to evaluate statewide threats to water security, including climate change, expansion of water-intensive industries, agricultural intensification, and urban development. We can also use the model to assess local risks to groundwater-dependent ecosystems, community water supplies, and economic development. Outputs of the model include gridded estimates of water scarcity or abundance and losses to surface or groundwater under different scenarios. **The resulting maps will aid long-term water planning, including identifying regions where it is important to re-use water or in risk assessments completed by lenders or developers considering the water sustainability of proposed projects.**

Outcome	Completion Date
1. Maps capturing the location and impacts of threats to future water quality and quantity. Where there is uncertainty about water use or future threats, we will use scenarios to explore many plausible alternatives.	*Fall 2016*
2. Identification of key tradeoffs, risks, and vulnerabilities of water-dependent sectors and groundwater-dependent ecosystems (i.e. lakes, trout streams) based on modeled scenarios of future climate, land and water-use.	*Spring 2017*

Activity 3: *Economic assessment of the value of clean water* **Budget: $72,000**

We systematically underestimate the value of water in decisions and planning because we lack an accounting of the full costs associated with changes in water quality and quantity. **We propose a comprehensive inventory of the value of water that can be used in cost-benefit studies, risk analyses, and return-on-investment calculations.** The economic value of clean water includes costs associated with water treatment, lost property values, degraded recreational opportunities, beach closures and water-borne diseases, impacts to groundwater-dependent ecosystems, and water-related infrastructure investments. Many of these data are collected by state agencies, but have not been assembled and evaluated such that they can be used in spatial planning or integrated with alternative scenarios of water use (such as those generated by the model in Activity #1 & 2).

Outcome	Completion Date
1. Statewide inventory of water-related costs and benefits.	*Winter 2016*
2. Spatially-explicit economic values for changes in water quality and quantity based on alternative future scenarios developed in Activities #1-2.	*Summer 2017*

III. PROJECT STRATEGY

A. Project Team/Partners

The project will be led by UMN researchers with expertise in biosphere-atmosphere modeling, eco-hydrology, and environmental economics. Dr. Twine is a co-developer of the Agro-IBIS model – she will lead the statewide water balance modeling. Dr. Brauman is Lead Scientist for Global Water Assessment and an expert in mapping and modeling water scarcity – she will develop the water scarcity metrics. Dr. Keeler is Lead Scientist for the Natural Capital Project, a leading group in the science and practice of mapping and modeling the values of nature. Keeler will manage the project and lead the water valuation activities.

B. Project Impact and Long-Term Strategy

The proposed work will deliver valuable information on the status, trends, and future condition of one of the state's most valuable resources. The project leverages existing state data and cutting-edge research and models to create new spatial maps and tools that will support more informed water management. **The outcomes of the work will identify current problem areas, major threats to water sustainability by region, and potential risks to different sectors that rely on clean water. In addition, the project will provide in-demand information on the value of clean water – information that can be used in cost-benefit assessments, permitting decisions, and more informed analyses of tradeoffs.** This project is a stand-alone effort and not part of a longer-term funding request, although it builds and expands on model development and applications in Minnesota and globally. We will also collaborate with the Institute on the Environment's digital media platform *ensia.com* to create web-based resources to disseminate data and highlight key findings generated through project activities.

C. Timeline Requirements

The project will start July 2015 and continue for 24 months to allow time for data collection and processing, model calibration, and scenario analysis.

2015 Detailed Project Budget

Project Title: Informed water management: Mapping scarcity, threats, and values.

IV. TOTAL ENRTF REQUEST BUDGET *2* years

BUDGET ITEM	AMOUNT
Personnel: Full-time, 12 month appointment for a Post-doctoral Research Associate in the Department of Soil, Water, and Climate. This individual will generate new down-scaled climate data and parameterize and run the Agro-IBIS model to support Activity #1. Salary is $50,000 plus $10,375 fringe (20.75%).	$ 60,375
Personnel: One-month salary equivalent for Dr. Twine to supervise the Agro-IBIS modeling and mentor the Post-docoral Associate. One month salary is $9,644 plus $3,134 for fringe benefits (32.5%).	$ 12,778
Personnel: Two-month salary equivalent, in each of the two project years for Dr. Brauman to complete the water scarcity analysis and risk assessments described in Activities #1-2. One month salary is $6,583 plus $2,140 for fringe benefits (32.5%).	$ 34,891
Personnel: Three-month salary equivalent, in each of the two project years for Dr. Keeler to complete the water quality risk assessment and water valuation work described in Activities #2-3. In addition, Keeler will serve as project manager, supervise the Junior Scientist, and coordinate project activities and data dissemination. One month salary is $5,833 plus $1,896 for fringe benefits (32.5%).	$ 46,372
Personnel: Full-time, 18 month appointment for a Junior Scientist to be based at the Institute on the Environment. This individual will assist with spatial data management, mapping and analysis, and new data collection to support proposed Activities #1-3. Annual salary is $40,000 per year plus $13,700 fringe (34.2%).	$ 80,520
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 234,936

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period: *The Institute on the Environment, University of Minnesota, has supported and will continue to support research and outreach activities conducted by the Natural Capital Project. The IonE funding is not dedicated or commited specifically to this proposal, but can support software development, and complimentary activities. Total funding for this project to date is $500k, with an additional $300k projected for FY14 and FY15.*	$ -	*Secured*
Other State $ To Be Applied To Project During Project Period: *N/A*	$ -	
In-kind Services To Be Applied To Project During Project Period: *The University of Minnesota's Facilities and Administrative rate is 52% of modified total direct costs (total direct less graduate student fringe, capital equipment, subawards over $25,000 and on-site facilities rental). The amount, if F&A expenses would have been allowed on the project, would be $123,072. The University will provide office space, IT services, and administrative / financial services in support of the project.*	$ 123,072	*Secured*
Funding History: *N/A*	$ -	
Remaining $ From Current ENRTF Appropriation: *N/A*	$ -	

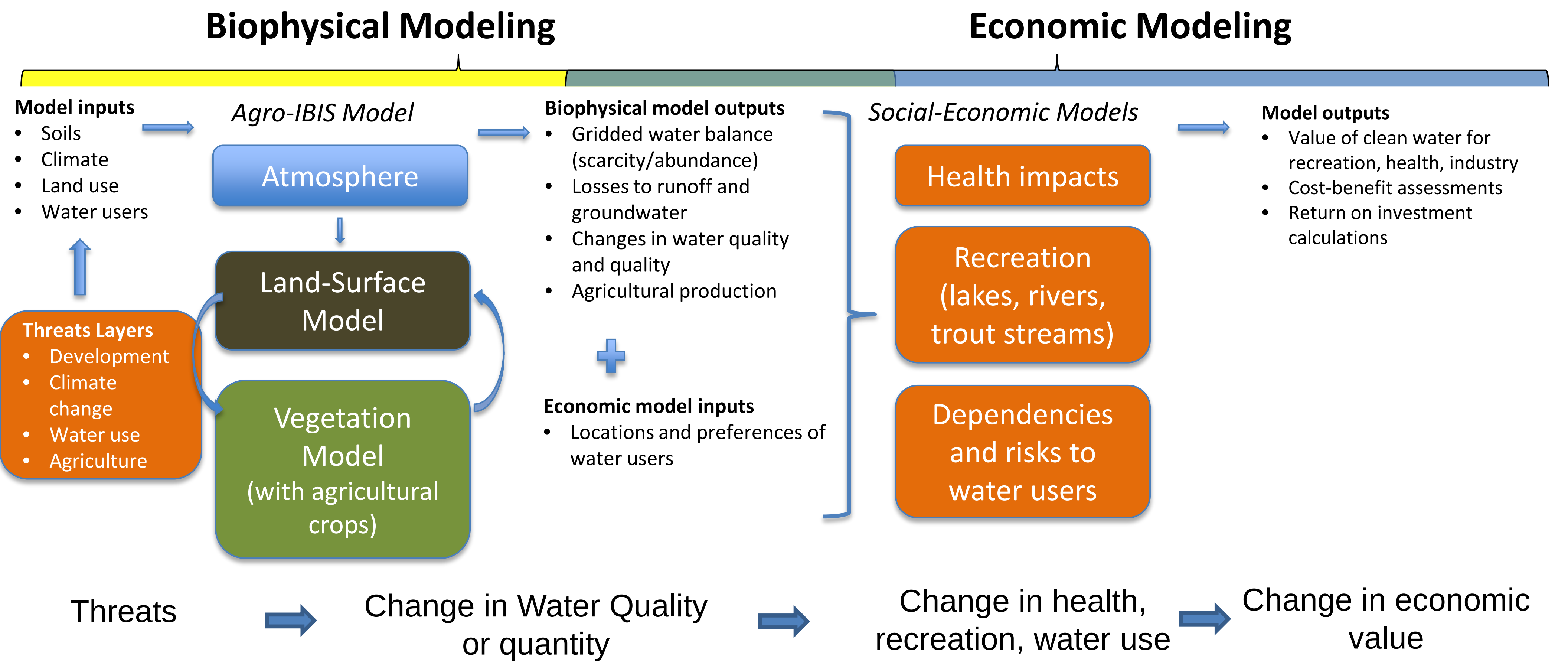

Figure caption: The project links a biophysical model of vegetation and climate (Agro-IBIS) to economic valuation models that translate changes in water quality and quantity into economic values. Agro-IBIS uses as input high-resolution climate data down-scaled from the most recent CMIP5 global climate model output (used the 2013 IPCC AR5 report) for historic and future scenarios of climate change. Other model inputs include soil texture (from state soil survey data) and land use. Agro-IBIS simulates the growth and water use of vegetation at every grid cell statewide and captures the biological and physical response of plants to climate variability and change, along with changes in atmospheric carbon dioxide. The simulation of agricultural crops in the vegetation model, in particular, is a state-of-the art tool not yet represented in other models, but one that has been tested extensively for > 10 years in the Agro-IBIS model. Model inputs will be updated to reflect alternative scenarios of land use, water use, and climate corresponding to threats identified in Activity #2 (land-use change, climate, development). Outputs of the model include per-grid cell water balance estimates that can inform statewide water scarcity or abundance metrics, and losses of water to runoff or groundwater. Modeled changes in water quality and quantity will then feed into economic valuation approaches focusing on the social costs of water pollution to recreation, health, and water users.

Project Manager Qualifications & Organization Description:

Bonnie Keeler, Institute on the Environment, University of Minnesota

Dr. Keeler's research is on the assessment and valuation of ecosystem services, which are the goods and services provided by natural systems that enhance human well-being. She uses Geographic Information Systems (GIS) and spatially-explicit models to evaluate how different policies, actions, or decisions affect the provision of ecosystem services. She then couples these ecological models with tools from economics to estimate the value of changes in ecosystem services. Keeler developed a framework for valuing water quality-related services using integrated biophysical and economic models. She has applied this framework to case studies in land-use change and associated costs to groundwater contamination and the recreational value of lakes in Minnesota and Iowa. Keeler has a Ph.D. in Natural Resources Science and Management from the University of Minnesota (2013), a M.S. in Ecology from the University of Minnesota (2007), and a B.A. in Biology from the Colorado College (2001).

Keeler is currently Lead Scientist for the Natural Capital Project, a patnership between the University of Minnesota, Stanford University, the Nature Conservancy, and the World Wildlife Fund. The Natural Capital Project develops simple, use-driven approaches to valuing nature and provides free, open source ecosystem service software tools to a broad community of users. With the Natural Capital Project, she is applying ecosystem services approaches to improve water management, quantify the externalities associated with land-use change, and support decision-making in urban and agricultural ecosystems.

Institute on the Environment, University of Minnesota
The mission of the Institute on the Environment is to discover solutions to Earth's most pressing environmental problems by conducting transformative research, developing the next generation of global leaders and building world-changing partnerships. The Institute supports programs addressing global food and agricultural systems, sustainable enterprise, and environmental leadership.