Environment and Natural Resources Trust Fund
2011-2012 Request for Proposals (RFP)

LCCMR ID: 151-F3+4

Project Title: Understanding the Environmental Sustainability of Minnesota's Emerging Bioeconomy

Category: F3+4. Renewable Energy

Total Project Budget: $ $408,926

Proposed Project Time Period for the Funding Requested: 3 yrs, July 2011 - June 2014

Other Non-State Funds: $ 0

Summary:

This project will provide an integrated overview of how Minnesota's rapidly expanding bioeconomy will impact our soil, water, and air. Industry growth opportunities benefitting all three resources will be sought.

Name: Jason Hill

Sponsoring Organization: U of MN

Address: 1954 Buford Ave; 325 VoTech Building

Saint Paul MN 55108

Telephone Number: 612-624-2692

Email hill0408@umn.edu

Web Address

Location

Region: Statewide

Ecological Section: Statewide

County Name: Statewide

City / Township:

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

2011-2012 MAIN PROPOSAL

PROJECT TITLE: Understanding the environmental sustainability of Minnesota's emerging bioeconomy

I. PROJECT STATEMENT

Minnesota is a leader in renewable energy and renewable goods production (known as our "bioeconomy"), and we have the resource base and public support to remain at the forefront. Anticipated growth in production of ***biofuels, biopower, and bioproducts*** will impact our environment in a number of ways – both positive and negative, and often mixed. **Why** is it important for us to understand these effects as a whole? Simply put, our bioeconomy can only be sustainable if all stakeholders benefit, including farmers, bioindustry investors and workers, and citizens alike. State-specific guidance could help our burgeoning bioeconomy industry improve its environmental profile and bolster public enthusiasm for renewable technologies.

Goals for this project are to assess how Minnesota's rapidly expanding bioeconomy will impact our soil, water, and air. We will search for industry growth opportunities that benefit all three resources simultaneously. Our work will provide immediate actionable items useful to investors, and offer legislators and regulators a long-term vision of our bioeconomy landscape. **Outcomes** from this project include enhancements of our state's environment by improving how we use our land for food, feed, fiber, and fuel. Knowing how best to grow our state's bioeconomy will improve our overall economy and provide tangible benefits for our citizens. For example, farmers will benefit from improved soil quality and information on biomass crops best-suited to their land. Those who enjoy outdoor recreation will benefit from more diverse wildlife and better water quality. We all are made healthier by cleaner air and water.

How will this project achieve its goals? Our project is innovative in its simultaneous use of two state-of-the-art scientific models (Agro-IBIS and CAMx) for predicting the environmental response to human activities such as those related to our bioeconomy. Both models have seen improvements within the last year and now offer the spatial resolution needed for informative state-level analysis. Used together, these models will allow us to explore the benefits and trade-offs of different patterns of land use with increasing demand for bioenergy and bioproducts.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1 will include establishment of baseline conditions and development of alternative scenarios for use in Activities 2 and 3, which will consider ***land*** and ***water*** (Activity 2) and ***air*** (Activity 3) impacts of the growing bioeconomy. Activity 1 will also use results from Activities 2 and 3 to propose means of meeting multiple environmental goals.

Activity 1: Establishment of baseline and scenarios **Budget:** $ 68,154

We will begin our project by establishing baseline land-use conditions for Minnesota, and then developing scenarios for land-use change that might occur in response to greater demand from the growing bioeconomy industry (that is, biofuels, biopower, and bioproducts). Scenarios will be based upon economic, political, and social drivers for bioeconomy expansion. Particular attention will be paid to land-use patterns with multiple outputs (for example, combined food and bioenergy feedstocks) and potential fossil fuel reductions due to increased use of biofuel and biopower. These scenarios will serve as the basis for modeling environmental impacts in Activities 2 and 3. Activity 1 will also integrate the results from Activities 2 and 3 to investigate alternative pathways and outcomes for Minnesota's bioeconomy growth.

Outcome	Completion Date
1. Establishment of baseline conditions and land-use pattern scenarios	Dec 31, 2011
2. Development of recommendations for land use from Activities 2 and 3	Jun 30, 2014

Activity 2: Assessment of soil and water impacts **Budget:** $ 170,386

We will use Agro-IBIS (Integrated Biosphere Simulator) to model growth and management of crops and natural vegetation. Agro-IBIS calculates carbon, nitrogen, water, and energy flows, allowing us to answer questions such as: 1) Does growing bioenergy crops increase carbon sequestration at the state level? 2) How does the conversion of land for bioenergy crops change stream flow and the paths that water takes across the state? 3) How do anticipated changes in land cover affect surface climate, knowing that species can be sensitive to subtle changes? Agro-IBIS will be calibrated to state-specific agroecosystems, grasslands, and forestlands using a new historic (1948-2007) climate database. The Agro-IBIS grid will use approximately 2,250 cells (10 km by 10 km each) to cover the state.

Outcome	Completion Date
1. Calibration of Agro-IBIS to Minnesota specific biomes	Jun 30, 2013
2. Estimation of soil and water impacts of bioeconomy using Agro-IBIS	Dec 31, 2013

Activity 3: Assessment of air impacts **Budget:** $ 170,386

We will use CAMx (Comprehensive Air Quality Model with Extensions) to estimate the changes in Minnesota air quality resulting from the scenarios from Activity 1. Focus will be on two pollutants, particulate matter and ground-level ozone, that impact human health, visibility, and crop production. We will explore which populations in Minnesota (for example rural versus urban) are most affected by air pollution from the bioeconomy. Our analyses will incorporate reduced fossil fuel emissions owing to increased use of renewable energy and products, as well as changes in emissions from vegetation as these can vary substantially across land-use types. The CAMx grid will use approximately 14,000 cells (4 km x 4 km each) to cover the state.

Outcome	Completion Date
1. Estimation of life cycle emissions of bioeconomy and fossil systems	Dec 31, 2012
2. Estimation of emissions from plants, for vegetation and land-use types	Dec 31, 2012
3. Estimation of air quality impacts of bioeconomy using CAMx	Dec 31, 2013

III. PROJECT STRATEGY

A. Project Team/Partners

Dr. Jason Hill (Resident Fellow–Institute on the Environment–UofM), an expert in bioenergy and life cycle assessment, will serve as the project manager and will lead Activity 1. Drs. Tracy Twine (Assistant Professor–Department of Soil, Water, and Climate–UofM) and Peter Snyder (Assistant Professor–Department of Soil, Water, and Climate–UofM) will lead Activity 2. Dr. Twine, an expert in land use and climate change effects on biogeochemistry, will focus on cropland and grassland, while Dr. Snyder, an expert in biophysical effects of land cover change on the climate, will focus on forests. Drs. Julian Marshall (Assistant Professor–Department of Civil Engineering–UofM) and Dylan Millet (Assistant Professor–Department of Soil, Water, and Climate–UofM) will lead Activity 3. Dr. Marshall, an expert in air pollution exposure and environmental equality, will focus on CAMx modeling. Dr. Millet, an expert in the atmospheric chemistry of air pollutants, will focus on emissions from various lands-use types.

B. Timeline Requirements

This timeline is not bound by growing seasons, but rather is based upon the best estimate for the time required to complete the proposed activities.

C. Long-Term Strategy and Future Funding Needs

This proposal is not a component of a longer-term project requiring additional investment. We plan to leverage it to obtain funding from out-of-state agencies.

2011-2012 Detailed Project Budget

IV. TOTAL TRUST FUND REQUEST BUDGET *3* years

BUDGET ITEM	AMOUNT
Personnel: Postdoctoral Researcher #1 (50% of Activity 1; 100% of Activity 2) (75.6% Salary and 24.4% Fringe) (3 Years)	$ 204,463
Personnel: Postdoctoral Researcher #2 (50% of Activity 1; 100% of Activity 3) (75.6% Salary and 24.4% Fringe) (3 Years)	$ 204,463
Contracts:	$ -
Equipment/Tools/Supplies:	$ -
Acquisition (Fee Title or Permanent Easements):	$ -
Travel:	$ -
Additional Budget Items:	$ -
TOTAL ENVIRONMENT & NATURAL RESOURCES TRUST FUND $ REQUEST	$ 408,926

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period:	$ -	
Other State $ Being Applied to Project During Project Period:	$ -	
In-kind Services During Project Period:	$ -	
Remaining $ from Current ENRTF Appropriation (if applicable):	$ -	
Funding History:	$ -	

Project Manager Qualifications

Jason Hill is a resident fellow of the Institute on the Environment at the University of Minnesota, where he also serves as program coordinator in the Institute's Global Landscapes Initiative. His research interests include the technological, environmental, economic, and social aspects of sustainable bioenergy from current and next-generation feedstocks. His work on carbon-negative biofuels from diverse prairies and on how land-use change affects biofuel life-cycle greenhouse gas emissions has been published in the journals *Science* and the *Proceedings of the National Academy of Sciences*. He is currently focusing on how the rapidly expanding global transportation biofuels industry impacts climate change, biodiversity, air pollution, and human health. Prior to his current appointment, he was employed as a research associate in the University's Departments of Applied Economics and Ecology, Evolution, and Behavior, and as an assistant professor in the Departments of Biology and Environmental Studies at St. Olaf College. Dr. Hill received his A.B. in Biology from Harvard College and his Ph.D. in Plant Biological Sciences from the University of Minnesota.

Organization Description

The *University of Minnesota* is a comprehensive public university serving as both the state land-grant university, with a strong tradition of education and public service, and Minnesota's primary research university, with faculty of national and international reputation.

Today's environmental challenges can't be solved with business-as-usual thinking. That's why the University of Minnesota's *Institute on the Environment* (IonE) is taking a new approach. We're discovering solutions to Earth's biggest problems through cutting-edge research, partnerships and leadership development.