

**Environment and Natural Resources Trust Fund**

# 2021 Request for Proposal

## **General Information**

**Proposal ID:** 2021-230

**Proposal Title:** Opening or Closing Parks in a Pandemic?

## **Project Manager Information**

**Name:** Michele Guala

**Organization:** U of MN - St. Anthony Falls Laboratory

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## **Project Basic Information**

**Project Summary:** We plan to model the virus spread across Minnesota cities and test opening/closing park scenarios by simulating the stochastic motion of individuals through more or less attractive areas.

**Funds Requested:** $343,000

**Proposed Project Completion:** 2024-06-30

**LCCMR Funding Category:** Foundational Natural Resource Data and Information (A)

## **Project Location**

**What is the best scale for describing where your work will take place?** Region(s): Metro

**What is the best scale to describe the area impacted by your work?** Region(s): Metro

**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 comparison to many other states in the US, the response to the COVID-19 virus in Minnesota was rapid. From early March, through the middle of April 2020, early preventive measures imposed by Governor Tim Walz at the first hint of community spread, were tremendously effective. In this time period, unlike other areas in the country, there was, in Minnesota, no sustained exponential growth in the total number of infected individuals, hospitalized patients, Intensive care unit patients, or deaths.
However, against the background of this early success in controlling the spread of the COVID-19 virus, the Minneapolis Park and Recreation Board, as reported in the April 3rd 2020 Star Tribune, still decided to close all beaches, park facilities, restrooms and drinking fountains until the fall of 2020. This is an important decision, that, in the expectation of continues waves of pandemic viral infections, has relevance beyond just the immediate situation. There are no easy, general or global guidelines. Information collected in many different regions of the nation and the world indicates that, during a pandemic, decisions on the access to public spaces
like parks is best based on local data and socio-environmental conditions.

**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.**

As the implication of closing city and state parks on the economy are significant, a science-supported decision must be pursued. Opening or closing parks require a stochastic, territory-specific, calibrated model that can account for the mobility of individuals, the attraction of specific locations, and the probability that clustering individuals will facilitate the spreading of the infection. The more popular the attraction, the smaller the distance between neighbors, the higher the chance of being inflected. Hence, spatial increases in population density, or clusters, identify potential hotspots for the spread of the virus. Our hypothesis is that within a specific parks’ catchment, the movement and behavior of individual agents, in relation to the possibility of infection, can be modeled and simulated mathematically through coupling classic diffusion theories with territory-specific information.
The main novelty of the proposed work is to leverage on our ability to model stochastically sediment particles in a river , extend it to individuals in a community and build a predictive model of virus diffusion on a realistic Minneapolis map. The model will be validated and applied to test the consequences of opening and closure of parks, beaches and potentially other public natural spaces.

**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?**

The use of natural resources is at stake. The following project outcomes will support the decision making process.
1) Constrained simulation on the territory. A random walk simulation will be extended from a generic two-dimensional domain to a selected highly-density populated Minnesota map, using roads and paths, to constrain individual movements within realistic options.
2) Calibrated simulations. Once individuals are in contact, they may, or may not transmit the virus, depending on the policy in place, e.g. wearing masks or maintaining some distance.We will tune the governing parameters and validate the model with data available from MN Health.

## **Activities and Milestones**

### **Activity 1: Simulating individual trajectories on open domains : Random walk model**

**Activity Budget:** $95,000

**Activity Description:**A stochastic simulation of individuals (agents) moving randomly on a two-dimensional map will be developed. Agents will obey an imposed probability density function governing their waiting times in a given home location and the path length and times of excursions form that home. Building on the expertise of the project PIs, to predict sediment advection, diffusion and dispersion in a river using stochastic modeling, this simulation will model the excursions of agents and their contact with other roaming agents in the same way as grains and pebbles collide on a river bed. A large number of individuals (agents) will be distributed at initial time t0 on a homogeneous two dimensional map. Their locations at time t0 represent their home. With growing time, individuals will stay home, sampling different resting times or move away from home sampling different velocities. The first goal is to prescribe the distribution of these two stochastic variables and simulate the daily dispersion of individuals.
Then we can define contacts within a certain area and the infection growth based on an assigned probability of virus transmission per contact.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Dispersion of a large number of individuals in a homogeneous two dimensional map is simulated. | 2022-05-31 |
| The contact between individuals is defined and the virus transmission is simulated | 2022-06-30 |

### **Activity 2: Simulating trajectories on realistic Minneapolis maps: Constrained simulation**

**Activity Budget:** $133,000

**Activity Description:**We will target South West Minneapolis as a residential area benchmark case. It is a highly density populated area, by MN standards, with several park facilities, four popular lakes surrounded by separated bike and walking paths with multiple opportunities to congregate around rest areas and facilities. Simulations will reproduce a weekend or late afternoon scenarios where individuals will move and likely experience contacts and virus transmission in aggregation points, or nearby streets. Different scenarios will be tested to constrain the parameter space within realistic bounds.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Shape and parameter of probability distribution functions for stay-home time and going-out velocity are explored | 2023-05-31 |
| Virus transmission is simulated under different hypothetical scenarios where geographical attractors are identified. | 2023-05-31 |
| The dispersion of a large number of individuals on Minneapolis map is simulated. | 2023-05-31 |

### **Activity 3: Tuning the simulation governing parameters to measured data**

**Activity Budget:** $115,000

**Activity Description:**With the simulation in place, tuning the model parameters will be devoted to reproducing the exponential growth in virus cases that were observed in early spring 2020 (March 8-March 24); efforts will be aimed at reproducing the observed 5 days doubling time taking into account the levels of activity observed. Then, revised parameter estimates to replicate virus spreading due to the loosening or tightening of restrictions and the resulting changes in movement patterns, will be established. For example, the switch from exponential to essentially linear growth and the ~1.09 reproduction number observed after the initial shelter at home decision was put in place (March 28-April 14) should be captured by the model when enforcing agent restrictions. During summer 2020 the closing of Minneapolis parks could provide a new set of data for hopefully intermediate scenarios. It is important that our model reproduce these trends to demonstrate its ability to bridge between the (microscale) behavior of each individual with the (macroscale) behavior of the population ensemble.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Tuning the parameter space, reproduce the growth of COVID-19 cases (infected and hospitalized) h | 2024-03-31 |
| Opening and closing of parks and beaches are simulated | 2024-05-31 |
| Simulations results are translated into guidelines for the opening of parks and beaches | 2024-06-30 |

## **Project Partners and Collaborators**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Organization** | **Role** | **Receiving Funds** |
| Raphael Stern | Civil, Environmental and Geo Engineering, UMN | Assistant professor, Department of Civil, Environmental, and Geo- Engineering, UMN, expert in transportation systems and modeling of travel dynamics. He will co-supervise the PhD student and a few undergraduate students during activity 2 and 3 | Yes |
| Vaughan Voller | Civil, Environmental and Geo Engineering, UMN | James L. Record Professor, Director of Graduate Study, Department of Civil Environmental and Geo-Engineering, UMN expert in analytical, numerical and Monte-Carlo simulations of diffusion and dispersion transport processes. He will co-supervise the requested student in the mathematical modeling. | Yes |

## **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?**The expected outcome is a location-specific dynamical model to support decision-making related to imposing restrictions on aggregation in public spaces, such as beaches and parks, during a pandemic. The long term strategy, partially implemented in the proposed activities, would be to assimilate in the model current data from cell phone locations in order to transform a predictive algorithm and case by case scenario into a more constrained and realistic real-time model. We do not believe COVID-19 is a one-time event. There could be multiple waves and state agencies may need to restrict aggregation in public spaces under their control.

## **Other ENRTF Appropriations Awarded in the Last Six Years**

|  |  |  |
| --- | --- | --- |
| **Name** | **Appropriation** | **Amount Awarded** |
| Assessing the Increasing Harmful Algal Blooms in Minnesota Lakes | M.L. 2016, Chp. 186, Sec. 2, Subd. 04b | $270,000 |

## **Project Manager and Organization Qualifications**

**Project Manager Name:** Michele Guala

**Job Title:** Associate Professor and Associate Director of St Anthony Falls Laboratory, UMN

**Provide description of the project manager’s qualifications to manage the proposed project.**In the last 9 years at UMN I graduated 5 PhD students, I was promoted to tenured associate professor and I received funding from the national Science Foundation, US Department of Energy, Excel Energy and, as co-PI, from MnDOT and LCCMR. My current position, as Associate Director for Research at the St Anthony Falls Laboratory, gave me the opportunity to witness operations and management at a larger scale, and to contribute to define long term strategies for the laboratory finance and for its recognition at the federal level.
The proposed activities are, to some extent, aligned with my thrust area of research, since I am familiar with the proposed modeling techniques borrowed from the stochastic transport of sediments in rivers. In addition, I believe the team I organized for this project cover the necessary expertise, from applied mathematics to transportation network and data collection of users' location, to deliver what we promise.

**Organization:** U of MN - St. Anthony Falls Laboratory

**Organization Description:**The St. Anthony Falls Laboratory is an interdisciplinary center of the University of Minnesota and one of the most recognized research laboratories in the US in the field of environmental fluid mechanics. In the last decade we expanded our interests and research breadth to include living organism, as algae, mussels and fish, as well as humans physiology (respiratory tract and turbine noise hearing).

## **Budget Summary**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Category / Name** | **Subcategory or Type** | **Description** | **Purpose** | **Gen. Ineli gible** | **% Bene fits** | **# FTE** | **Class ified Staff?** | **$ Amount** |
| **Personnel** |  |  |  |  |  |  |  |  |
| Michele Guala |  | Project manager and student main supervisor |  |  | 27% | 0.24 |  | $51,266 |
| Vaughan Voller |  | Professor, co-PI |  |  | 27% | 0.18 |  | $54,190 |
| Rafael Stern |  | Assistant professor, co-PI |  |  | 27% | 0.24 |  | $42,731 |
| graduate student (amount below includes salary and tuition) |  | set up and perform the simulations |  |  | 43% | 1.5 |  | $158,692 |
| Patrick Arnold, IT specialist |  | help the student interfacing with the Minnesota Supercomputer Institute for simulations |  |  | 24% | 0.07 |  | $6,651 |
| Undergraduate Student |  | assist with collecting anonymous data from the cellphone networks |  |  | 0% | 0.5 |  | $12,470 |
|  |  |  |  |  |  |  | **Sub Total** | **$326,000** |
| **Contracts and Services** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Equipment, Tools, and Supplies** |  |  |  |  |  |  |  |  |
|  | Tools and Supplies | Dedicated desktop computer or laptop | to perform simulation |  |  |  |  | $2,000 |
|  |  |  |  |  |  |  | **Sub Total** | **$2,000** |
| **Capital Expenditures** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Acquisitions and Stewardship** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Travel In Minnesota** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Travel Outside Minnesota** |  |  |  |  |  |  |  |  |
|  | Conference Registration Miles/ Meals/ Lodging | 1 conference per year for the student and one of the PI | present scientific results | X |  |  |  | $12,000 |
|  |  |  |  |  |  |  | **Sub Total** | **$12,000** |
| **Printing and Publication** |  |  |  |  |  |  |  |  |
|  | Publication | 2-3 scientific papers are expected to result from the planned research activities | an increasing number of journals require publication fees, typically in the range between 1000 and 1500 per article. |  |  |  |  | $3,000 |
|  |  |  |  |  |  |  | **Sub Total** | **$3,000** |
| **Other Expenses** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
|  |  |  |  |  |  |  | **Grand Total** | **$343,000** |

### **Classified Staff or Generally Ineligible Expenses**

|  |  |  |  |
| --- | --- | --- | --- |
| **Category/Name** | **Subcategory or Type** | **Description** | **Justification Ineligible Expense or Classified Staff Request** |
| **Travel Outside Minnesota** | Conference Registration Miles/Meals/Lodging | 1 conference per year for the student and one of the PI | It is important for the education and intellectual growth of the student to disseminate his results and learn from peers in the community. Conferences are essential. |

### **Non ENRTF Funds**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Category** | **Specific Source** | **Use** | **Status** | **Amount** |
| **State** |  |  |  |  |
|  |  |  | **State Sub Total** | **-** |
| **Non-State** |  |  |  |  |
| In-Kind | Unrecovered F&A | Support of SAFL facilities where research will be conducted. | Secured | $160,724 |
|  |  |  | **Non State Sub Total** | **$160,724** |
|  |  |  | **Funds Total** | **$160,724** |

## **Attachments**

### **Required Attachments**

#### **Visual Component**

File: [f698696f-62c.pdf](https://lccmrprojectmgmt.leg.mn/media/map/f698696f-62c.pdf)

#### **Alternate Text for Visual Component**

The visual provides a predicted diffusion of COVID-19 cases based on the actual data recently available (at least up to the LCCMR deadline). The visual also provide a sketch of sediment grains in rivers and individual (agents) dispersing on a South West Minneapolis map including the lake parks.

## **Administrative Use**

**Does your project include restoration or acquisition of land rights?**
 No

**Does your project have patent, royalties, or revenue potential?**
 No

**Does your project include research?**
 Yes

**Does the organization have a fiscal agent for this project?**
 Yes, Sponsored Projects Administration