The University of Vermont
COLLEGE OF ENGINEERING & MATHEMATICAL SCIENCES

Richard Barrett Scholarships Program
Cover Page

Title of Project: **Studying the Impact of Urban Heat on Microenvironments**

Is this proposed research associated in any way with academic credit? No

If yes, please explain the connection fully in the proposal or research plan and establish that the project is eligible for Richard Barrett Scholarship funding (see Guidelines).

STUDENT PROPOSER/APPLICANT

Name: Zachary Roussel E-mail: zroussel@uvm.edu

Address: 10 Hungerford Terr., Burlington VT, 05401

Major: Environmental Engineering Estimated Date of Graduation: May 2021

FACULTY MENTOR

Name: Dr. Gregory Rowangould Department: Civil and Environmental Engineering

Address: 33 Colchester Ave, Burlington VT E-mail: growango@uvm.edu

Will your faculty mentor be available to support/mentor you throughout the majority of the summer? (Y) / N (Circle one)

Is there a graduate/PhD student working in the lab that could also support/mentor you? (Y) / N (Circle one)

If yes, please list that individual's name: Britany Antonczak

Apply on Handshake at https://uvm.joinhandshake.com/jobs/3423232 for job #3423232 by uploading and submitting the following documents:

- ✦This signature page
- ✦A project description describing the proposed research -OR- a statement of interest and research plan
- ✦A budget and budget justification (Please refer to Section 5 in the Guidelines, Award Amount and Budget Constraints)
- ✦The faculty mentor's short c.v.

By signing this cover page the student proposer and faculty mentor certify that the proposal or statement of interest was written by the student, that the faculty mentor assumes fiduciary oversight and responsibility for the operating budget, and (in the case of a project associated with a course granting academic credit) that the project is eligible for Richard Barrett Scholarship funding.

Zachary Roussel
Student Proposer's signature

Faculty Mentor's signature

Questions?
Contact Rebecca Kronenbitter, Coordinator CEMS Career Readiness Program at Rebecca.Kronenbitter@uvm.edu of Jeff Marshall, Associate Dean for Research at jmarsha1@uvm.edu

Project Description: Studying the Impact of Urban Heat on Microenvironments

Zachary Roussel

Introduction:

As the worldwide population continues to grow, people are looking towards urban areas to minimize the amount of used space. The development of urban areas has a drastic change on the environment, often changing the area's climate. One challenge many urban areas are facing is the formation of urban heat islands. Urban heat islands are characterized by an increase in temperature due to the built environment they encompass. This increase in heat is heavily due to impervious surfaces like roads and sidewalks and the geometry of roads and structures in reference to the sun. Understanding the relationship between urban heat and local infrastructure could help mitigate the development of urban heat islands in new cities and existing urban areas.

Relevance:

Urban heat islands are responsible for increased emissions of greenhouse gases, increased energy consumption, and impaired air and water health (EPA, 2020). Concerns of these impacts exist heavily in disadvantaged communities. Because of this, possible solutions are imperative to progress as a society. Urban heat research is vital in an area like Burlington because very little research has been done on urban heat islands in moderate climates. This is because, unlike places with hot arid climates, not all buildings are equipped with air conditioning for hot summers. To understand urban heat, it is important to examine how microenvironments are impacted by sun radiation due to small changes in local infrastructure and natural life.

Proposed Procedure:

To begin this research, an instrument must be created that can monitor temperature and GPS location simultaneously. One device that can take both measurements simultaneously is ideal as it allows data to be compiled more easily. To do this, I plan to use a Raspberry Pi4 along with an attachment thermocouple and GPS receiver. I expect the assembly and coding of the Raspberry Pi to take an extensive amount of time but will be manageable with my skillset. I want to make three Raspberry Pi systems to collect data at multiple sites simultaneously. I expect to examine microclimates throughout Burlington during different weather conditions and compare how the temperature varies between locations. The end goal would be to create a heat map of each area examined in reference to the infrastructure within it and around it in order to see correlations between the built environment and temperature.

Preparation:

Throughout the Spring 2020 semester, I have been doing research on urban heat with Dr. Gregory Rowangould and PhD student Britany Antonczak. I have done extensive research on both urban heat and the monitoring of temperature with a thermocouple. By the beginning of the summer, I will have a grasp on how to analyze changes in temperature over small areas.

I have experience using a Raspberry Pi from a high school internship. In CE010 (Geomatics), we learned the basics of using GIS and in my research, I am working to create heat maps by integrating temperature and GPS data together. In EE075, I am currently learning complex circuit design concepts which will aide me in the creation of my sensor.

References:

Ali-Toudert, Fazia, and Helmut Mayer. "Numerical Study on the Effects of Aspect Ratio and Orientation of an Urban Street Canyon on Outdoor Thermal Comfort in Hot and Dry Climate." *Building and Environment*, vol. 41, no. 2, 2006, pp. 94–108., doi:10.1016/j.buildenv.2005.01.013.

"Heat Island Impacts." *EPA*, Environmental Protection Agency, 25 Nov. 2019, www.epa.gov/heat-islands/heat-island-impacts.

Oke, T.r. "Street Design and Urban Canopy Layer Climate." *Energy and Buildings*, vol. 11, no. 1-3, 1988, pp. 103–113., doi:10.1016/0378-7788(88)90026-6.

Sharmin, Tania, et al. "Microclimatic Modelling in Assessing the Impact of Urban Geometry on Urban Thermal Environment." *Sustainable Cities and Society*, vol. 34, 2017, pp. 293–308., doi:10.1016/j.scs.2017.07.006.

Budget:

Item	Cost
3 x Raspberry Pi4's	3 x $55 = $165
3 x 32 GB Micro – SD card	3 x $10 = $30
3 x Adafruit Ultimate GPs with USB – 66 channel w/ 10 Hz updates	3 x $50 = $150
3 x Thermocouple Amplifier MAX31855 breakout board (MAX6675 upgrade)	3 x $15 = $45
9 x Mini USB Fan	9 x $3 = $27
3 x Raspberry Pi Power Supply	3 x $8 = $24
3 x Pi Heat Sink	3 x $2 = $6
3 x battery pack	3 x $24 = $72
6 x Type K thermocouple	~ $600
3 x GPIO ribbon and T splitter	3 x $10 = $30
Total:	**$1,149**

Zachary Roussel

10 Hungerford Terrace | Burlington, VT 05405 |(774) 644-4826 | zroussel@uvm.edu

EDUCATION

The University of Vermont | Burlington, VT — August 2017 - May 2021
B.S. in Environmental Engineering
GPA | 3.41

Durfee High School | Fall River, MA — August 2014 - June 2017

LEADERSHIP EXPERIENCE

Engineers Without Borders | Outreach Coordinator
University of Vermont | Burlington, VT | 2019-2020

- Plan and coordinate events between the club and community members
- Maintain contact with community members

National Society of Black Engineers | Outreach Coordinator
University of Vermont | Burlington, VT | 2019-2020

- Maintain communications between external affinity and engineering groups and our student organization
- Contact and plan with local organizations for engineering programs

Alpha Phi Omega | Service Chair, New Member Educator
University of Vermont | 2018-2020

- Helped coordinate service opportunities in the Burlington area for club members to attend
- Coordinated events with new club members and lead their new member education meetings

WORKING EXPERIENCE

Vienna Public Schools | English Teacher — 2019
GRG 23 Alterlaa | Vienna, Austria

- Worked in an English classroom in an Austrian Middle School
- Helped students age 11-14 learn English

Citizens for Citizens, Inc. | Assistant Group Leader — 2019
Fall River, MA

- Managed a group of twenty 5-8 year-olds in summer daycare programming
- Created and implemented lesson plans

College of Engineering and Mathematical Sciences | Undergraduate Research Assistant — 2020
The University of Vermont | Burlington, VT

- Test and design a system to monitor GPS coordinates and temperature at the same time
- Aide a grad student in their Urban Heat research

SPECIAL SKILLS

Experience using: Matlab, AutoCAD, Civil 3D, ArcGIS, Solidworks, and Microsoft Excel

RELEVANT COURSEWORK

Circuit Analysis, Transportation Systems, Hydraulics, Environmental Quantitative Analysis, Water and Wastewater Engineering, Plant and Soil Science, Graphical Communications, Geotechnical Principles, and Geomatics

DR. GREGORY ROWANGOULD

The University of Vermont, Department of Civil & Environmental Engineering, 33 Colchester Ave, Votey Hall 353, Burlington, VT 05405
Gregory.Rowangould@uvm.edu, Tel. (802) 656-3596

EDUCATION

PhD **University of California**, Davis (2010)
Civil and Environmental Engineering: concentration in Transportation

MS **University of Maine**, Orono (2006)
Resource Economics and Policy: concentration in Environmental Economics

BS **University of Maine**, Orono (2003)
Chemical Engineering

ACADEMIC APPOINTMENTS

University of Vermont, Burlington, VT
Associate Professor, Department of Civil & Environmental Engineering (8/2019 – current)
Director, UVM Transportation Research Center (1/16/2020 – current)

University of New Mexico, Albuquerque, NM
Associate Professor, Department of Civil, Construction & Environmental Engineering (6/2019 – 8/2019)
Director, New Mexico Local Technical Assistance Program (NM LTAP) Center (4/2017 – 8/2019)
Assistant Professor, Department of Civil, Construction & Environmental Engineering (8/2012 – 6/2019)

OTHER PROFESSIONAL EXPERIENCE

Sustainable Systems Research (SSR), LLC, Davis, CA
Principle (5/2017 – current)

Natural Resources Defense Council, Santa Monica, CA
Transportation and Air Quality Science Fellow (7/2010 – 7/2012)

SELECTED EXTERNAL SERVICE

Transportation and Air Quality Committee (ADC20), Transportation Research Board of the National Academies, Washington, D.C.
Committee Member & Research Subcommittee Vice Chair (5/2017 – current)
Committee Member & Paper Review Co-Chair (4/2014 – 4/2017)

Transportation Research Part D: Transport and Environment, Elsevier Ltd.
Member of the Editorial Board (1/2017 – current)

Minority Fellows Program, Transportation Research Board of the National Academies
Mentored 4 minority fellows (3 undergraduates, 1 graduate) (2015 – 2019)

RELEVANT PEER REVIEWED RESEACH

A1. Tayarani, M. * and **G. Rowangould**. (2020). *Estimating Exposure to Fine Particulate Matter Emissions from Vehicle Traffic: Exposure Misclassification and Daily Activity Patterns in a Large, Sprawling Region*. Environmental Research, 182. doi.org/10.1016/j.envres.2019.108999

A2. Rowangould, D., **G. Rowangould**, E. Craft and D. Niemeier. (2019) *Validating and Refining EPA's Traffic Exposure Screen Method.* International Journal of Environmental Research and Public Health, 16 (3). doi:10.3390/ijerph16010003

A3. **Rowangould, G**., R. Nadafianshahamabadi*, and A. Poorfakhraei*. (2018). *Programming Flexible Congestion Mitigation and Air Quality Program Funds: Best Practices for State DOTs.* Transportation Research Record: Journal of the Transportation Research Board of the National Academies. doi.org/10.1177/0361198118782801

A4. Rowangould, D., **G. Rowangould**, and D. Niemeier. (2018). *Evaluation of the Health Impacts of Rolling Back a Port Clean Trucks Program*. Transportation Research Record: Journal of the Transportation Research Board of the National Academies. doi.org/10.1177/0361198118782801

A5. Tayarani*, M., Nadafianshahamabadi*, R., Poorfakhraei*, A., **Rowangould, G**. (2018). *Evaluating the cumulative impacts of a long range regional transportation plan: Particulate matter exposure, greenhouse gas emissions, and transportation system performance*. Transportation Research Part D: Transport and Environment 63, 261–275. doi.org/10.1016/j.trd.2018.05.014

A6. Tayarani*, M., Poorfakhraei*, A., Nadafianshahamabadi*, R., **Rowangould, G**. (2018). *Can regional transportation and land-use planning achieve deep reductions in GHG emissions from vehicles?* Transportation Research Part D: Transport and Environment 63, 222–235. doi.org/10.1016/j.trd.2018.05.010

A7. Poorfakhraei, A*., M. Tayarani*, and **G. Rowangould**. (2017). *Evaluating Health Outcomes from Vehicle Emissions Exposure in the Long Range Regional Transportation Planning Process*. Journal of Transport & Health. 6: 501-515.

A8. Nadafianshahamabadi, R*., M. Tayarani*, and **G. Rowangould.** (2017). *Differences in Expertise and Values: Comparing Community and Expert Assessments of a Transportation Project*. Sustainable Cities and Society. doi:10.1016/j.scs.2016.08.027

A9. Tayarani, M*., A. Poorfakhraei*, R. Nadafianshahamabadi*, and **G. Rowangould**. (2016). *Evaluating unintended outcomes of regional smart-growth strategies: Environmental justice and public health concerns*. Transportation Research Part D: Transport and Environment 49, 280–290. doi:10.1016/j.trd.2016.10.011

A10. **Rowangould, G.** (2015). *A New Approach for Evaluating Regional Exposure to Particulate Matter Emissions from Motor Vehicles*. Transportation Research Part D: Transport and Environment. 34: 307-317.

A11. **Rowangould, G.** (2013). *A Census of the United States Near-Roadway Population: Public Health and Environmental Justice Considerations*. Transportation Research Part D: Transport and Environment. 2: 59-67.

A12. **Gould, G.** and D. Niemeier (2011). *Assignment of Emissions Using a New Locomotive Emissions Model*. Environmental Science and Technology. 45(13): 5846- 5852.

A13. Niemeier, D., **G. Gould,** A. Karner, M. Hixson, B. Bachmann, C. Okma, Z. Lang and D. Heres Del Valle (2008). *Rethinking downstream regulation: California's opportunity to engage households in reducing greenhouse gases*. Energy Policy, 36(9)

*****Students advised by Dr. Rowangould

CURRENT RESEACH SUPPORT

United States Environmental Protection Agency 11/2019 - current
People, Prosperity and Planet (P3) Student Design Competition
Role: PI, Funding $25,000

TranSET University Transportation Center, Louisiana State University/U.S. DOT 8/2019 – current
ABQ Streets Project: Creating Alternative Residential Street Designs
Role: PI, Funding: $50,000

United States Environmental Protection Agency 1/2016 – current
Science to Achieve Results (STAR) Research Program - Early Career Award: Evaluating the Timeline of Particulate Matter Exposure from Urban Transportation and Land-Use Greenhouse Gas Mitigation Strategies Using a Novel Modeling Framework
Role: PI, Funding: $335,605

STUDENTS SUPERVISED

- Currently advising 4 graduate students (2 MS and 2 PhD) and 2 undergraduate research assistants
- Advised 6 graduate students that have graduated (2 MS and 4 PhD, 3 are now Postdoctoral Scholars and 1 is an Assistant Professor)
- Advised 5 undergraduate research assistants (two became MS students)