The Resilience Impacts of Green Infrastructure on Baraboo River Communities from Current and Future Flooding Hazards within Sauk County, Wisconsin

Submitted to:

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Introduction

Over the past 10 years Sauk County has recorded a number of near record and record flood events along the Baraboo River and its tributaries. During each flood the communities along the river have been adversely impacted. Due to this high number of flood events, the Sauk County Emergency Management Agency has requested a study to examine the current and future impacts to the Baraboo River. This scope of work will lead to identifying the current risks for Sauk County's communities along the Baraboo River due to current and future riverine flooding.

The University of Wisconsin's (UW) Space Science and Engineering Center (SSEC) and The Polis Center (Polis) at Indiana University – Purdue University, Indianapolis (IUPUI) have extensive experience modeling the impacts to communities from floods. The team leverages geospatial analysis techniques such as Hazus-MH and other spatial modeling tools to provide communities with a spatial representation of the vulnerabilities and risks to their communities.

Forty (40) current and future flood impact scenarios will be performed for the Baraboo River within Sauk County. Figure 1 shows the extent of the study area in Sauk County, Wisconsin.

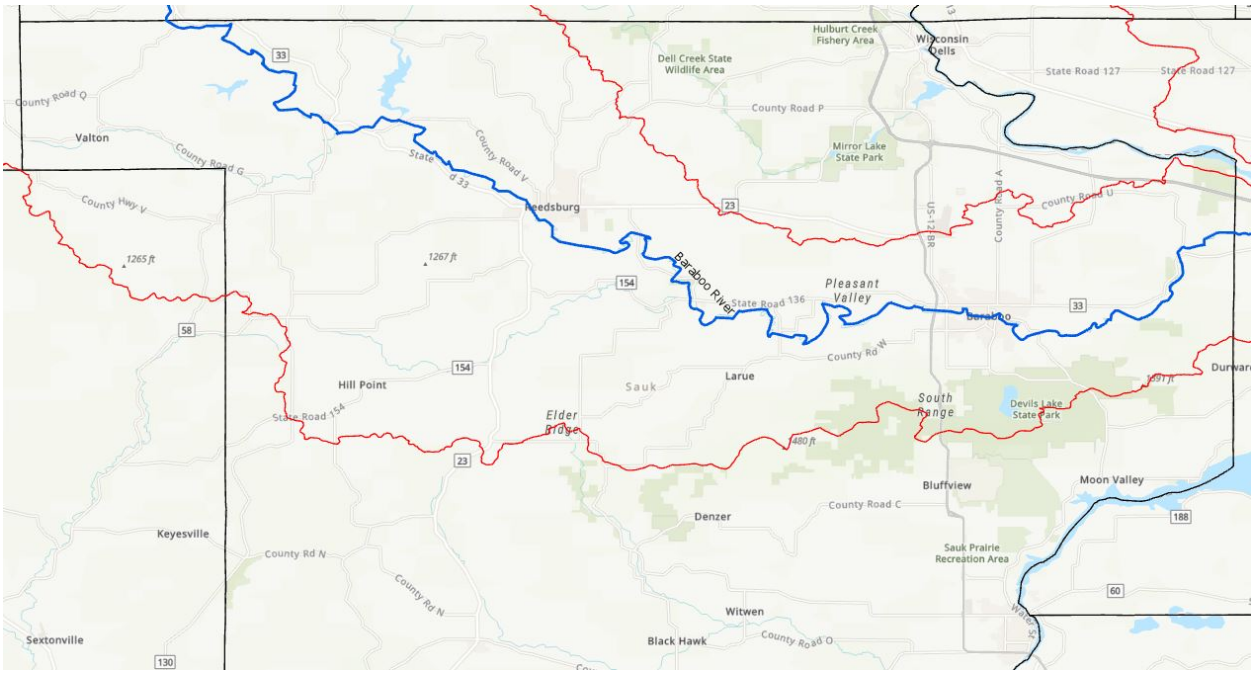

Figure 1: Baraboo River, Sauk County, Wisconsin

Project Management

Shane Hubbard (SSEC) will provide overall project management. Kevin Mickey will be responsible for the tasks listed for Polis. Jeff Jelinek will serve as the Sauk County point of contact.

Task 1: Project Initiation, Project Management, and Onsite Visit

Within one month of Notice to Proceed, SSEC will conduct a 1/2 day, onsite visit with key stakeholders. Project objectives, milestones, and constraints will be reviewed as part of this meeting. The purpose of the visit will be to identify any unique issues related to the built and natural environment as well as other issues and considerations that may be pertinent to the study. The visit will also provide an opportunity to engage the local stakeholders by sharing with them the purpose and intended outcomes of the study. It is assumed that this project will be completed using FEMA's Hazus-MH 4.2 product.

SSEC Deliverable:

- Kickoff Meeting

Polis Deliverable:

- Kickoff Meeting

Task 2: Future rainfall projections for Sauk County

We propose to apply to Sauk County, Wisconsin, our methodology to calculate 50-year, 24-hour return levels of precipitation that we already derived for Liberty County, Georgia, based on available statistically downscaled global climate model output (see description in Section X). We will employ the same Generalized Extreme Value methodology for Sauk County, using Baraboo as the representative station, due to its extensive daily data coverage since 1950. For this project, our analysis will include three extensively utilized downscaled products (WICCI, LOCA, and MACA), two future time periods (mid- and late 21st century), and two commonly-used greenhouse gas emission scenario (RCP4.5 and RCP8.5). This analysis methodology enables quantitative uncertainty estimates by utilizing large sets of global climate model output and multiple emissions scenarios. We anticipate that three weeks of salary apiece for PIs Michael Notaro and Stephen Vavrus, in the University of Wisconsin-Madison Nelson Institute Center for Climatic Research, will be sufficient to complete this work. Our analysis could easily be scaled up later to include a more complete spatial coverage of locations throughout Wisconsin.

SSEC/CCR Deliverable:

- Downscaled precipitation estimates

Task 3: Developing Building Inventory for the Baraboo River

Infrastructure Inventory Development

Polis will develop an improved building inventory by leveraging local parcel, building footprint and Computer Aided Mapping and Appraisal (CAMA) data for the study area which covers six unique assessing entities for fifteen jurisdictions within Sauk County, Wisconsin.

The following assumptions apply:

- Polis will provide the Sauk County's Assessor with a list of Hazus-MH required attributes necessary to perform a flood risk analysis. The Sauk County's Assessor will provide Polis with CAMA data and documentation for each assessing entity in the study area consistent with these requirements, to include explanations of domain values; parcels and building footprints within one month of notice to proceed. All CAMA data will be provided in the same file structure and format.
- All data required for this project will be provided to Polis in a digital format. No digital conversion or review of scanned or paper documents will be required as part of this project.
- Building point locations will be placed at the center of building footprints where possible. Unless CAMA data is associated with a unique structure identifier in the GIS data, the centroid of the largest structure within a parcel will be designated as the location of all buildings in that parcel. Where this is not possible, buildings will be placed at parcel centroids.
- Data in the CAMA files will be leveraged to populate attributes required for Hazus-MH flood loss estimation. Where such attributes do not exist, regionally valid default values will be applied.

Polis will leverage the county provided data to develop a Building Inventory Toolkit, using the Esri Data Interoperability Extension, to automate the development of ready-to-import Hazus-MH compliant User Defined Facility inventory as well as an updated General Building Stock inventory, both suitable for modeling flood risk in Hazus-MH. No workflow documentation associated with using the Building Inventory Toolkit, or instruction on the use of the Building Toolkit, will be developed or provided as part of this project.

The User Defined Facility data will be delivered to the SSEC in a personal geodatabase.

Data generated to support General Building Stock Inventory enhancements will be limited to values required to update the Hazus-MH database tables reporting building counts, square footage, building replacement values and content replacement values. The General Building Stock data will be delivered to the SSEC as a personal geodatabase of individual building locations with attributes that are compliant with the import requirements of the Hazus-MH Comprehensive Data Management System (CDMS) 'Import Site Specific Data to Aggregate Data' function.

A draft version of the updated building inventory will be provided to the SSEC and Sauk County for review within three months of receipt of the CAMA, parcel and building footprint data. The SSEC and Sauk County will review the draft data. Feedback from Sauk County will be compiled by the SSEC and provided to Polis within two weeks of receiving the draft data. Polis will modify the toolkit as appropriate based on the provided feedback within the limitations of this scope of

work. A final version of the building toolkit and outputs will be delivered within two months of receiving feedback.

Polis Deliverables

- Building toolkit
- Ready-to-import, Hazus-MH compliant User Defined Facility data
- Ready-to-import, Hazus-MH compliant General Building Stock data

Sauk County Deliverables

- CAMA data and documentation for each assessing entity in the study area consistent with these requirements, to include explanations of domain values; parcels and building footprints

Task 4: Risk Assessment Modeling of Current and Future Conditions with and without Green Infrastructure

Conduct Loss Estimation Studies

A combined total of forty (40) flood scenarios will be modeled. For each scenario identified below, SSEC will perform a Hazus-MH and GIS-based risk assessment. Each scenario will be based on hazard inputs provided by SSEC. SSEC provided hazard products will include.

- Depth grids for each of the forty (40) scenarios in the form of Hazus-MH Release 4.2.2 compliant Esri grids.
- Documentation explaining how each of the flood hazards was developed as well as any appropriate caveats regarding their intended use to be included in the final report.

Current day scenarios will use the building inventory and essential facility data for Sauk County.

The following scenarios will be analyzed as part of this study.

- Scenarios 1 - 5: Current flood damage and loss estimations for the 10, 25, 50, 100, and 500 year return periods based upon current (present day) flood risk with an updated current building inventory (2019) from local building data (no green infrastructure will be included in the analysis). No green infrastructure is included.
- Scenarios 6 - 10: Current flood damage and loss estimations for the 10, 25, 50, 100, and 500 year return periods based upon current (present day) flood risk with an updated current building inventory (2019) from local building data. Green infrastructure is included.
- Scenarios 11 - 15: Future flood damage and loss estimations for the 10, 25, 50, 100, and 500 year return periods based upon future rainfall projections in the year 2080. The 25% rainfall projection will be used. Current (present day), but updated current building

inventory (2019) from local building data (no green infrastructure will be included in the analysis).

- Scenarios 16 - 20: Future flood damage and loss estimations for the 10, 25, 50, 100, and 500 year return periods based upon future rainfall projections in the year 2080. The 25% rainfall projection will be used. Current (present day), but updated current building inventory (2019) from local building data. Green infrastructure will be included in the analysis).
- Scenarios 21 - 25: Future flood damage and loss estimations for the 10, 25, 50, 100, and 500 year return periods based upon future rainfall projections in the year 2080. The 50% rainfall projection will be used. Current (present day), but updated current building inventory (2019) from local building data (no green infrastructure will be included in the analysis).
- Scenarios 26 - 30: Future flood damage and loss estimations for the 10, 25, 50, 100, and 500 year return periods based upon future rainfall projections in the year 2080. The 50% rainfall projection will be used. Current (present day), but updated current building inventory (2019) from local building data. Green infrastructure will be included in the analysis).
- Scenarios 31 - 35: Future flood damage and loss estimations for the 10, 25, 50, 100, and 500 year return periods based upon future rainfall projections in the year 2080. The 75% rainfall projection will be used. Current (present day), but updated current building inventory (2019) from local building data (no green infrastructure will be included in the analysis).
- Scenarios 36 - 40: Future flood damage and loss estimations for the 10, 25, 50, 100, and 500 year return periods based upon future rainfall projections in the year 2080. The 75% rainfall projection will be used. Current (present day), but updated current building inventory (2019) from local building data. Green infrastructure will be included in the analysis).

SSEC/CCR Deliverable:

- Flood Depth Grids
- Flood Analysis Results

Task 5: Final Report

Polis will deliver a report that contains the following elements:

- Table reporting the Hazus-MH provided inventory totals for building count, building replacement cost, content replacement cost and build square footage by Hazus-MH General Occupancy Type (Residential, Commercial, Industrial, Agricultural, Government, Religion and Education).

- Table reporting the updated totals for building count, building replacement cost, content replacement cost and build square footage by Hazus-MH General Occupancy Type (Residential, Commercial, Industrial, Agricultural, Government, Religion and Education).
- Description of significant issues, if any, identified during the project related to the Sauk County provided data.
- Recommendations for future updates

Cost and Delivery Schedule

The services and deliverables outlined in this proposal will be provided for a fixed fee of $80,000.

The following information documents the schedule for each task to be completed by SSEC. The cost basis for this proposal is included in the Budget Narrative section.

Task 1: Onsite Meeting	Within 60 days of notice to proceed
Task 2: Downscaled Precipitation study	Within 90 days of notice to proceed
Task 3: Building Inventory	Within 180 days of notice to proceed
Task 4: Risk Assessments	Within 300 days of notice to proceed
Task 5: Report	Within 60 days of completing Task 4

Budget Narrative

We request a total dollar amount of $80,000 to fund the activities as described in the proposal narrative. The costs to conduct the activities described in this proposal are summarized in the budget pages provided. Cost estimates in these budget pages are based on historical events and experience.

Personnel

The following individuals have been identified as key personnel to this proposal:
Shane Hubbard – 258 hours

Time quoted for key personnel is the total amount of anticipated effort required to complete the proposed effort over the life of the project, including during periods of no cost extension. All effort for key persons will be sponsor paid effort. Fulfillment of the effort commitment will be defined as a total for the entire project period. We cannot guarantee effort for key personnel commitments per budget period given the uncertain volatile nature of research and funding availability. Funding reductions will result in a scaled back effort; the project narrative, the budget, and key personnel obligations will all be reduced in the same manner (i.e. if the funding is cut 25%, we will cut 25% of the project narrative and 25% of the labor and cost involved) unless otherwise negotiated.

This section identifies the staff required and their time commitment (hours needed) to conduct this proposed work. To calculate hourly rates for salaried employees, the formula is Total Salary divided by billable hours. SSEC hourly rates are calculated using a base of 1,350 billable hours per year for Faculty and 1,777 billable hours for Academic Staff. Vacation, holiday and sick leave time is not charged directly to the projects. To achieve the goals of this proposal, we estimate an approximate total effort as follows:

Name	**Title**	**Classification**	**Hours**	**% Effort***
Hubbard, Shane	PI	Academic Staff	258	15%
Name	**Title**	**Classification**	**Months**	**% Effort***
Notaro, Michael	Senior Scientist	Academic Staff	0.70	6%
Vavrus, Stephen	Senior Scientist	Academic Staff	0.75	6%
Veregin, Howard	State Cartographer	Academic Staff	0.60	5%
* % Effort is based on a 12 month period of performance				

Fringe Benefits

Fringe rates are dependent on employee classification (which is listed under the Personnel section). A detailed summary of how the fringe benefit rate is calculated at the University of Wisconsin-Madison is available at: https://www.rsp.wisc.edu/chap4/rn/rn19-2.cfm

Travel

The SSEC travel office monitors current airfares, hotel costs, car rentals, taxi fares, etc and provides estimates for travel costs for frequent meeting sites. The UW-Madison, in accordance with state law, reimburses per diem travel costs for hotel and meal expenses. All travel must be approved by the SSEC administration. Travel costs are reviewed by the SSEC travel office and one of the SSEC Executive Directors. Travel has been budgeted for the PI to travel to travel to local sites to conduct research activities. Costs are estimated at $7 daily fleet car rental, $39 mileage costs and one daily per diem cost of $15.

Materials and Supplies

These items are required to support the research infrastructure of a particular project. They include items such as data storage materials, small computer peripherals, off the shelf computer software such as compilers, computer maintenance licensing agreements, desktop computers, laptops, conference registration and abstracts, and in-house publishing. Costs are based on current estimates and recent purchases with our contracted providers. We have budgeted for $970

Sub award

Subward to The Polis Center (Polis) at Indiana University – Purdue University, Indianapolis (IUPUI) will be made to support the research outlined in the proposal document. Total amount of the subward to the Polis Center will be $30,000. Additional budget breakdown is included in the Budget Details section.

University Indirect Cost

Indirect cost is assessed for this agreement at the local government rate of 15% on a total direct cost basis, based on U.S. Government approved rates for research conducted on campus at the University of Wisconsin Madison. A copy of the negotiated rate is available at https://www.rsp.wisc.edu/rates/rates.pdf

Budget Details

Total Proposal

I.	Labor and Fringe Benefits	Hours	Hourly Rate	Salary	Fringe %	Fringe	Cost	Totals
	a) PI - Shane Hubbard	258	45.08	11,631	35.0%	4,071	15,702	
	Subtotal			11,631		4,071		$15,702
		Months	Annual Rate	Salary	Fringe %	Fringe	Cost	
	Other UW Labor							
	c) CCR -Senior Scientist - Notaro	0.70	97494	5,687	35%	1,990	7,677	
	d) CCR -Senior Scientist - Vavrus, S.	0.75	94772	5,923	35%	2,073	7,996	
	e) Geography - State Cartographer - Veregin, H.	0.58	109736	5,304	35%	1,856	7,160	
				16,914		5,919		$22,833
II.	Travel							
	MSN Local science team travel							$61
III.	Materials and Supplies							$970
IV.	Subaward IUPUI (POLIS)							$30,000
V.	University Indirect Cost at 15% (TDC)							10,434
	Proposal Total							**$80,000**

Budget Details

IUPUI Sub award – The Polis Center

# Mos:	12				9				3	
	SALARY	**Role**	**FY 21 Annual Salary**	**FY 21 % Effort**	**FY 21 project budget**	**FY 22 Annual Salary**	**FY 22 % Effort**	**FY 21 project budget**	**Project Total**
	Bodenhamer, David	PI	$239,542	1.0%	$ 1,797	$246,728	1.0%	$ 617	$ 2,413
	Cardwell, Marianne	GIS Project Coordinator	$ 78,023	11.5%	$ 6,705	$ 80,363	11.0%	$ 2,210	$ 8,915
	Mickey, Kevin	Director Professional Edu	$ 98,976	5.0%	$ 3,712	$101,945	5.0%	$ 1,274	$ 4,986
	TOTAL SALARY				**$ 12,213**			**$ 4,101**	**$16,314**
	FRINGE BENEFITS			**Rate**			**Rate**		
	Bodenhamer, David	PI		39.31%	$ 706		39.31%	$ 242	$ 949
	Cardwell, Marianne	GIS Project Coordinator		39.31%	$ 2,636		39.31%	$ 869	$ 3,504
	Mickey, Kevin	Director Professional Edu		39.31%	$ 1,459		39.31%	$ 501	$ 1,960
	TOTAL FRINGES				**$ 4,801**			**$ 1,612**	**$ 6,413**
TOTAL PERSONNEL COST					**$ 17,014**			**$ 5,713**	**$22,727**
TOTAL OTHER EXPENSES					**$ -**			**$ -**	**$ -**
TOTAL DIRECT COSTS					**$ 17,014**			**$ 5,713**	**$22,727**
INDIRECT COSTS		*32%*			**$ 5,444**			**$ 1,828**	**$ 7,273**
TOTAL COSTS					**$ 22,458**			**$ 7,542**	**$30,000**