GRAHAM SUSTAINABILITY INSTITUTE
UNIVERSITY OF MICHIGAN

GRAHAM EMERGING OPPORTUNITIES PROGRAM
CATALYST GRANT FINAL PROJECT REPORT

Project Title: Collaborative Assessment of Stormwater Runoff on Tribal Lands within the State of Michigan

Project Team:
Frank Marsik, PhD
University of Michigan, Dept. of Climate and Space Sciences and Engineering, Great Lakes Integrated Sciences and Assessments

Maria Carmen Lemos, PhD
University of Michigan, School for Environment and Sustainability, Great Lakes Integrated Sciences and Assessments

Robin Clark
Inter-Tribal Council of Michigan

Summary:

During the period from 1951 to 2017, annual precipitation has increased by 14 percent in the Great Lakes region, while the amount of precipitation falling in the heaviest one percent of storms has increased by 35 percent across the Midwest over this same time period (GLISA, 2019). One extreme event during the month of July 2016 led to extensive flooding in north-central Wisconsin, resulting in a State of Emergency declaration for the Bad River Band of Lake Superior Chippewa (Bad River Band, 2019). In response, Indigenous Tribes within the Great Lakes have pursued climate adaptation planning seeking to assess the susceptibility of their Tribal Nations to increased rainfall and extreme precipitation events.

Through funding from the Graham Sustainability Institute, the Great Lakes Integrated Sciences and Assessments (GLISA) and the Inter-Tribal Council of Michigan (ITCM) worked collaboratively to conduct a Tribal Climate Workshop in October 2017 to address these concerns. During the workshop, GLISA discussed the U.S. Environmental Protection Agency's (USEPA) National Stormwater Calculator (SWC), which provides a quantitative assessment of stormwater runoff in a modeled area/community, as well as the potential effectiveness and cost of low-impact development (LID) controls (e.g., rain gardens, permeable pavement) to reduce this runoff. Participants of the Tribal Climate Workshop indicated that these critical assessments are, however, time- and cost-prohibitive for many of their Tribal natural resources departments.

Through additional funding from the Graham Sustainability Institute, GLISA and the ITCM have collaborated with four ITCM-member Tribal Nations to perform a screening-level assessment of stormwater runoff for areas of concern within their Tribal communities. These Tribal Nations

included: (1) the Keweenaw Bay Indian Community, (2) the Saginaw Chippewa Indian Tribe, (3) the Little Traverse Bay Bands of Odawa Indians, and (4) the Grand Traverse Band of Ottawa and Chippewa Indians. It is hoped that these assessments will provide the participating Tribal Nations with quantitative information that will support their efforts to obtain funding to implement management practices necessary to protect Tribal infrastructure.

Our project team has worked with members of each of the four Tribal Nations to identify areas of concern thought to be potentially vulnerable to flooding as a result of heavy seasonal rains (including during periods of frozen or snow-covered soils) and/or extreme rainfall events. A report of assessment results was submitted to each of the respective Tribal Nations. We are currently in the process of conducting follow up phone conversations with each Tribal Nation to discuss project results. As of this writing, these follow-up phone calls have been conducted with the Keweenaw Bay Indian Community and the Little Traverse Bay Bands of Odawa Indians. Lastly, in March of 2020, we will be participating in a USEPA webinar to highlight project results.

Project Background and Approach:

As noted earlier, during July 2016, a series of thunderstorms moved across north central Wisconsin resulting in prolonged heavy rainfall over an a 24-hour period. This rainfall led to extensive flooding in north-central Wisconsin, resulting in the declaration of a State of Emergency for the Bad River Band of Lake Superior Chippewa (Bad River Band, 2019). In response, numerous Indigenous Tribes within the Great Lakes have sought to assess the susceptibility of their Tribal communities to increased rainfall and extreme events, such as the one which impacted north central Wisconsin.

Through funding obtained through the Graham Sustainability Institute's Emerging Opportunities Program, GLISA and the ITCM collaborated with four ITCM-member Tribal Nations to perform a screening-level assessment of stormwater runoff for areas of concern for their Tribal communities. These assessments were performed using the USEPA SWC, which provides a quantitative assessment of stormwater runoff in a community, as well as the potential effectiveness and costs associated with the implementation of low-impact development (LID) controls (e.g., rain gardens, permeable pavement) to reduce this runoff.

The SWC predicts how much of the annual precipitation observed at a particular location will either infiltrate into the soil or evaporate from the soil surface. That amount of incoming precipitation that is not lost to either infiltration or evaporation is then considered to be runoff. This water "budget" also considers the potential for runoff from adjacent parcels into the area of study. These processes are graphically shown in Figure 1.

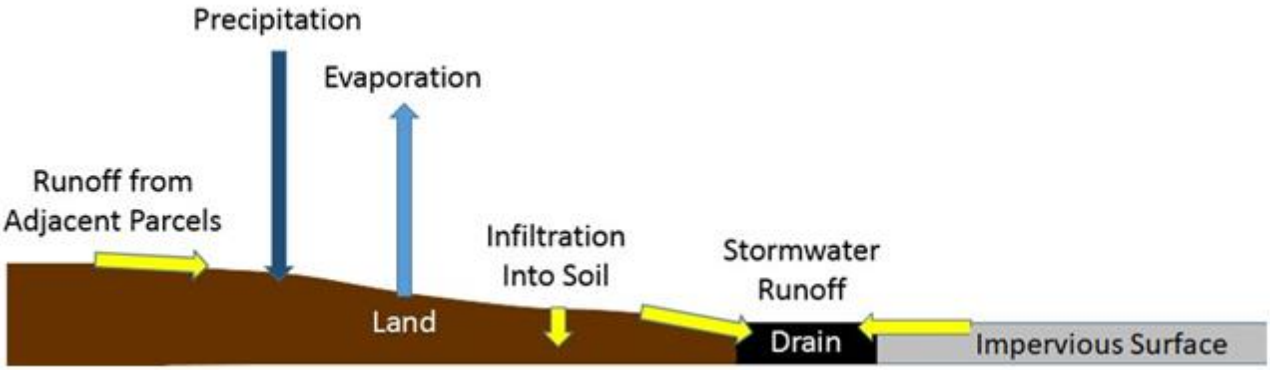

Figure 1. Conceptual representation of processes incorporated in the USEPA National Stormwater Calculator determination of site-specific stormwater runoff.

Simulation Setup

Prior to performing the stormwater runoff assessment for a given location, the user is prompted by the SWC to provide information that will allow for the proper characterization of the site(s) to be studied. Aside from the location and spatial extent (in acres) of the study area, the user must provide the following information:

1. Predominant soil type(s)
2. Soil drainage (infiltration)
3. Topography (slope of the surface)
4. Annual average precipitation
5. Annual average evaporation
6. Future climate scenarios to be modeled (optional)
7. Land cover
8. Limited Impact Design (LID) controls (optional)

The SWC software (both desktop and online applications) is linked to the appropriate data sets for soil type, topography, precipitation/evaporation, Climate Model Intercomparison Project 3 (CMIP3) climate model output (for consideration of plausible future climates), land cover type, LID controls and regional cost databases related to the implementation of selected LID control options.

Prior to the performance of the assessments for each of the four participating ITCM member-Tribes, the PI worked with each Tribal Nation to determine which areas of their Tribal lands were thought to be potentially vulnerable to heavy seasonal rains (including during periods of frozen or snow-covered soils) and/or extreme rainfall events.

For each of the Tribal Nations (and for each of their highlighted areas of concern), we performed one baseline assessment using only historically observed conditions without the application of LID controls. These assessments were followed by assessments of the impact of various LID controls on stormwater runoff predicted as a result if these historically observed conditions. Lastly, we

performed assessments of the stormwater runoff predicted under plausible future conditions (both with and without LID controls).

For CMIP3 projections of plausible future climates, both near-term (2020-2049) and far-term (2045-2074) projections were considered. For both of latter these periods, projections representing plausible (a) hot/dry, (b) median, and (c) warm/wet futures were considered. According to the National Stormwater Calculator User's Guide (USEPA, 2019):

"The scenarios were derived from a range of outcomes of the World Climate Research Program's CMIP3 multi-model dataset (Meehl et al., 2007). This dataset contains results of different global climate models run with future projections of population growth, economic activity, and greenhouse gas emissions. The results have been downscaled to a regional grid that encompasses each of the calculator's rain gage and weather station locations. Three different scenarios are available that span the range of changes projected by the climate models: one is representative of model outputs that produce hot/dry conditions, another represents changes that come close to the median outcome from the different models, and a third represents model outcomes that produce warm/wet conditions."

As suggested above, stormwater runoff can be significantly impacted by the presence of frozen and/or snow-covered soils, both of which are commonly observed seasonally within the Tribal Nations that participated in this project. For this reason, we included one simulation for each site studied that estimated the stormwater runoff for historically observed conditions using a general estimate of frozen soil conductivity rates provided in Kane and Stein (1983) for historically observed conditions without LID controls.

Findings:

Through the performance of this project, site-specific model assessments of the stormwater runoff resulting from annual average and extreme event rainfall events (historically observed) and plausible future climate conditions were determined. As would be expected, the implementation of LID controls at each site led to a reduction in the amount of stormwater runoff associated with annual average rainfall estimates. While the amount of stormwater runoff was often similar between the different LID control options, the costs associated with the implementation of the different LID controls were often significantly different. For example, the use of LID control options of disconnection, green roofs and permeable pavement were estimated to be considerably more expensive (per percentage of impervious surface replaced by the LID controls) than the other modeled LID control options.

The characteristics of a given site will dictate which LID control options are reasonable to consider for the site. For example, if a particular site has an extensive area paved with concrete, but with few buildings present, then a plan for implementation of a green roof is not likely to be a particularly effective LID control option to consider. However, rain gardens may provide a reasonably effective reduction in runoff and would be considerably cheaper than the application of permeable pavement to replace a similar spatial area of concrete. It is our feeling that comparison of these different, site-specific cost estimates of the implementation of particular LID

control options will be of value to the participating ITCM member-Tribes as they consider the effectiveness and cost-efficiency of different practices to mitigate the impact of stormwater runoff within their Tribal lands.

Outputs:

As has been discussed, prior to the initiation of this project, we consulted with each of the four participating Tribal Nations to determine which sites within their Tribal lands they deemed vulnerable to flooding during heavy seasonal rains (including during periods of frozen or snow-covered soils) and/or extreme rainfall events. Following the identification of these Tribe-specific sites, the assessments were performed. At the completion of these assessments, each of the Tribal Nations received a written report which included the following:

1. Project Summary
2. Methodology
3. Summary of the stormwater assessments performed for each identified site within the given Tribal Nation.
    a. Each assessment summary included:
        i. A description of the site and the model assumptions used in the assessment (acreage of area assessed, soil runoff potential, soil drainage rates, topography/slope, and land cover characterization)
        ii. Simulation results for the site for both historically observed and plausible future climates (tabular data included in appendices of each report)
        iii. Graphical presentation of Extreme Event Rainfall/Runoff Depth (inches) and Extreme Event Peak Rainfall/Runoff Intensity (inches/hour) for historically observed conditions without application of LID controls only.
4. Summary of Results
    a. As has been discussed earlier in this report, the goal of this work was to provide each Tribal Nation with a screening-level overview of stormwater runoff for each of the prescribed locations and for varying meteorological conditions (historically observed and plausible future climates). As a result, the project report summaries did not include any specific recommended actions to reduce the stormwater runoff at any given site. Such recommendations were not within the expertise of the project PI and co-PIs.

    In some instances, the Tribal Nations noted to us that flooding can occur within their Tribal communities due to the inability of the existing stormwater infrastructure to handle the magnitude of the runoff. In these instances, we did recommend consideration of the use of the USEPA's Stormwater Management Model (SWMM) for a more complete assessment of the ability of a given Tribe's underground stormwater infrastructure to handle the projected stormwater runoff conditions. In contrast, while driven by the SWMM, the SWC estimates only the *above-ground stormwater runoff* at a given site/study area without consideration of the underground infrastructure.

NOTE: During the latter stages of this project, the PI was contacted by Jason Bernagros of the USEPA Office of Research and Development to discuss our collaboration with Tribal Nations on this project. Mr. Bernagros has invited the PI to participate in a national webinar (currently scheduled for March 25, 2020) to discuss this project as part of a larger USEPA webinar series.

5. *Post-Project Workshop/Webinar (Added: 4/26/2021)*

Following the approval of a no-cost extension for the project, originally submitted July 14, 2020, a post-project virtual workshop/webinar was conducted on April 13, 2021, from 10:00 to 11:30 AM. The overarching goal of this workshop/webinar was to present the "lessons learned" from this project to member-Tribes of the ITCM. The design and delivery of this webinar was conducted in collaboration with Bill Bernier and Anthony Rinna of the ITCM to ensure that it met the needs of the member-Tribes.

- Pre-Workshop/Webinar Registration

The PI created a workshop/webinar registration form that was distributed by Bill Bernier of the ITCM. Registrants were asked to provide the following information:

i. Name
ii. Tribal or organizational affiliation
iii. Email address
iv. Response to the following question: "With regard to potential impacts of extreme precipitation, what are particular areas of concern for your Tribal Nation, community or organization? Potential examples include: access to culturally important sites, impacts on emergency services due to flooding or collapsing roadways, susceptibility of food resources/medicinal plants to flooding, soil erosion, etc."
v. Response to the following question: "What are your key expectations and or desired takeaways from this workshop?"

Seventeen individuals responded to the registration form.

- Workshop/Webinar

Using the information provided from the registration, the following agenda was developed:

- Welcome from Bill Bernier (ITCM) and Frank Marsik (University of Michigan)
- Brief Presentation on observed and projected changes in extreme precipitation across the Great Lakes region
- Introduction to the Great Lakes Integrated Sciences and Assessments' Great Lakes Adaptation Data Suite (GLADS)
    - GLADS is a quality-controlled clearinghouse of observational and projection data to aid researchers and practitioners in understanding Great Lakes climate. Omar Gates (GLISA) presented participants with information on how to request access to the GLADS data. Additionally, participants were advised that a web-based interface was being created

that would allow researchers and practitioners to directly access the data.

- Presentation by Omar Gates (GLISA) on GLISA's Scenario Planning Approach to climate adaptation. The initial state of this five-part process requires the practitioner/organization to "Define and describe management goals". To simulate this part of the process, participants were placed in virtual (Zoom) breakout rooms and asked to address the following questions:
    - What are your current management practices for handling stormwater for areas of concern?
    - How would you respond to an extreme precipitation event?
    - With the right amount of funding, what would you change to better prepare for an extreme precipitation event?

- Presentation the USEPA National Stormwater Calculator
    - Rather than present specific results from the collaborative assessments associated with this project, Frank Marsik presented an example assessment using a location within Washtenaw County. The lessons learned from this project were integrated into the presentation.
- The workshop/webinar concluded with a question-and-answer session.

Outcomes:

The proposed outcomes for this project, as outlined in the original project proposal, were:

1. Using the assessments performed as part of this project, the participating ITCM-member Tribes **will be able to develop management best practices** to protect the critical infrastructure and valued aquatic resources in their communities.
2. These assessments will **provide quantitative information necessary to seek federal funding** to implement these practices.

We believe that the results obtained from this project will allow each of the participating Tribal Nations to achieve these objectives or, at the very least, take substantive steps toward these objectives. Following the review of their Tribal-specific project reports, and follow-up phone conversations with the project PI, it is possible that a one or more of the Tribal Nations may desire to perform additional stormwater runoff assessments to refine the information needed to submit proposals to obtain the funding necessary to implement proposed infrastructure improvements. In such cases, the project team is willing to work with these Tribal Nations to guide their staff in the performance of these additional assessments.

Update Added: 4/26/2021

The post-project workshop/webinar that was hosted on April 13, 2021, allowed us to share the lessons learned from the collaborative assessments with member-Tribes and Tribal organizations, some of which did not participate in the original assessment. Tribal Nations and organizations participating in the workshop/webinar were:

- Inter-Tribal Council of Michigan
- Chippewa Ottawa Resource Authority
- Bay Mills Indian Community
- Gun Lake Tribe
- Little Traverse Bay Bands of Odawa Indians

Representatives from several other Tribal Nations registered for the event, though they did not attend on the day of the event. However, all registrants were sent a copy of the presentation, as well as contact information for both Frank Marsik and Omar Gates.

Eleven people participated in the workshop/webinar, nine of which were from Tribal Nations or organizations. While a formal evaluation of the event was not performed, the ITCM collaborators felt that valuable information was conveyed to the participants, including discussions by the ITCM about potential collaborative efforts by the ITCM and member-Tribes related to efforts to improve land-use characterization information on Tribal lands. Additionally, Frank Marsik was able to follow up with Jason Bernagros, USEPA, regarding a National Stormwater Calculator application question that arose during the workshop. This information was then conveyed to the questioner and all participants in a follow-up email.

References:

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GLISA (2019): Climate Change in the Great Lakes. Retrieved from http://glisa.umich.edu/.

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Meehl, G. A., C. Covey, T. Delworth, M. Latif, B. McAvaney, J. F. B. Mitchell, R. J. Stouffer, and K. E. Taylor. (2007). “The WCRP CMIP3 multi-model dataset: A new era in climate change research”, Bulletin of the American Meteorological Society, 88, 1383-1394.

USEPA (2019): SWC Users Guide Desktop v1.2.0.1_june_2018.

Project Personnel Details:

Frank J. Marsik, PhD: The PI for this project is Dr. Frank J. Marsik, an associate research scientist and lecturer within the University of Michigan’s Department of Climate and Space Sciences and Engineering. Dr. Marsik is also a research scientist with the Great Lakes Integrated Sciences and Assessments (GLISA) during the course of the project. Dr. Marsik was responsible for the overall coordination of this project. Dr. Marsik was assisted by two undergraduate students who were supported by this grant (Raymond Surya, University of Michigan, Ann Arbor, MI) and

a grant from the National Science Foundation (Sydni Voakes, Keweenaw Bay Indian Community, Lanse, MI).

Maria Carmen Lemos, PhD: The Co-PI for this project will be Dr. Maria Carmen Lemos, Associate Dean for Research within the University of Michigan's School for Environment and Sustainability. As the co-director of the Great Lakes Integrated Sciences and Assessments (GLISA), she served as a liaison between the project and GLISA resources and staff.

Robin Clark: Ms. Robin Clark is an environmental specialist with the Inter-Tribal Council of Michigan (ITCM), Incorporated and has a wealth of experience working with Indigenous Tribes of the region. For this project, she served as a laison between the project PI and ITCM member-Tribes.

While not formally included in the original proposal, the following individuals served as the primary contacts for the ITCM member-Tribes that participated in this project:

- Jonathan Mauchmar and Lauren Dey (Little Traverse Bay Bands of Odawa Indians, Harbor Springs, MI)
- Stephanie Cree (Keweenaw Bay Indian Community, Lanse, MI)
- Carey Pauquette (Saginaw Chippewa Indian Tribe of Michigan, Mt. Pleasant, MI)
- Jonathan Aylward and Carolyn Sonderegger (Grand Traverse Band of Ottawa and Chippewa Indians, Peshawbestown, MI)

Evaluation:

In our proposal, we noted that we would ask each of our Tribal collaborators to evaluate:

(a) whether the Tribal Nations felt that the effort was truly collaborative and that they wereequal partners in the process,
(b) whether the Tribal Nations felt that the collaborative effort met the needs of theirspecific Tribes, and
(c) what steps could have been taken to improve the collaborative effort and finalassessment results.

Our goal is to work with the Graham Sustainability Institute to send a brief survey to the participating Tribal Nations associated with this project, along with a request to send the results to the Graham Sustainability Institute to insure anonymity of the responses.