

PROJECT TITLE: *DEMONSTRATION STORMS FOR IDENTIFYING CLIMATE VULNERABILITY*

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I. PRELIMINARY MATERIALS

A. Research project objective

The goal of this research is to show how using extreme demonstration storms to evaluate vulnerability to climate can lead to risk mitigation and adaptation in communities that have not recently experienced extreme events. We worked with water resource managers to identify specific water resource management and physical infrastructure vulnerabilities to the demonstration storm conditions. We also worked with them to identify a set of the most promising adaptation strategies to build resilience to climate impacts.

B. Stakeholders and decision makers

- American Water Resources Association, WI Chapter
- Association of Clean Water Administrators
- Central States Water and Environment Association
- City of Madison, WI
- City of Middleton, WI
- City of Monona, WI
- City of Verona, WI
- Dane County, WI: Board of Supervisors, Department Heads
- ECI - 50 years of Watershed Modeling conference
- Iowa County
- NOAA Sectoral Applications Research Program (NIDIS, WEF, WERF, and AWWA)
- North American Lake Management Society conference
- North East-North Central Cooperative Extension Dean's and Directors
- Northeast Climate Science Center
- UCOWR/NIWR/CUAHSI conference
- United States Geological Survey
- University of Wisconsin Risk Management
- Wisconsin Association of Floodplain Stormwater and Coastal Management
- Wisconsin League of Municipalities
- Wisconsin Legislature

C. Approach

We simulated the flood conditions that would have occurred had the 2008 Baraboo River, WI extreme rainfall event occurred thirty miles to the southeast, over the Yahara Lakes watershed of Dane County, WI. We then consider three general areas of vulnerability: lake flooding, urban stormwater flooding, and sanitary sewer inflow, and then presented the identified vulnerabilities from each modeling exercise to the water resource managers in the Yahara Lakes watershed who are responsible for lake level management, urban stormwater management, and sewage collection and treatment.

For this project we used NOAA NEXAD radar data to estimate the spatial and temporal distribution of the June 2008 extreme precipitation events centered over the Baraboo River watershed in south-central Wisconsin. We then transposed that rainfall distribution over the Yahara chain of lakes (Madison, WI), and used the USDA Soil and Water Assessment Tool (SWAT) to analyze the impact of the transposed storm. The SWAT model was calibrated to actual stream flows at three USGS gages in the watershed, and for two historical storm events. The calibrated SWAT model was used to calculate total expected runoff inflow volume into Lake Mendota, had the transposed rainfall actually occurred over the Mendota watershed. The rise in lake stage was derived to calculate an extreme event outflow hydrograph, and identify potential flooding in rural and urban catchments.

To facilitate the use of the storm transposition approach by others, we have written a computer program (*TranStorm*) that extracts precipitation time series from NWS-NEXRAD data of an extreme rainfall event (e.g. the 2008 storm over the Baraboo River, WI). The user provides the geographic coordinates of the watershed to which the rainfall is to be transposed. The *TranStorm* program determines the location in the storm that would have produced the greatest cumulative precipitation over the entire watershed, and transposes the rainfall to that location. (There is a second option for calculating the transposition, where the user can specify a location within the storm.) For both the transposed and the un-transposed locations, *TranStorm* provides rainfall time series, averaged over the watershed or sub-watersheds specified by the user. In the latter case a unique precipitation time series is generated for each sub-watershed.

Throughout this project, we collaborated with the water resource managers in the Yahara Lakes watershed who are responsible for: 1) lake level management, 2) rural runoff management, 3) urban stormwater management, and 4) sewage collection and treatment. We evaluated the utility of the transposed demonstration storm for making decisions about climate vulnerability and hazard mitigation, and have implemented a dissemination plan that includes consulting engineers that would use this approach with other communities.

D. Matching funds

(Not applicable)

E. Project partners

- Brown and Caldwell (consulting engineers)
- City of Madison, WI (stormwater utility)
- Dane County, WI (land conservation department)
- Madison Metropolitan Sewerage District
- McMahan Group (consulting engineers)

- Montgomery and Associates Resource Solutions (consulting engineers)
- MSA (consulting engineers)
- Princeton University
- Southeast Wisconsin Regional Planning Commission
- WI Department of Health Services
- Wisconsin Department of Natural Resources (runoff management program)
- Wisconsin Sea Grant

II. ACCOMPLISHMENTS

A. Project timeline and tasks accomplished

- 9/5/12 A project logic model was created to guide development of the transposition tool, and provide a template for evaluation of outcomes and impact.
- Project partners group meetings: 8/1/12, 2/15/13, 8/2/13.
- Local stakeholder presentations and feedback gathering: 9/14/12 University of Wisconsin-Disaster Ready University meeting; 10/16/12 Wisconsin Association of Floodplain Stormwater and Costal Management (presentation); 11/7/12 North American Lake Management Society conference (poster presentation); 4/18/13, 5/14/13, 6/27/13, 7/10/13, 7/17/13, 10/3/13 Dane County Climate Adaptation Planning (community presentations); 1/8/14 Iowa County, Dodgeville, WI (presentation); 3/27/14 City of Madison Stormwater Utility (presentation); 4/2/14 Dane County Stormwater Managers (presentation); 4/24/14 Dane County Lake Level Managers (presentation); 5/21/14 University of Wisconsin Risk Management (briefing); 7/24/14 Aldo Leopold Nature Center Public Lecture (presentation).
- Regional/National dissemination: 9/24/12 Fifty Years of Watershed Modeling conference, Boulder, CO (poster presentation); 1/17-1/18/13 Northeast Climate Science Center Stakeholder Meeting, Minneapolis, MN (presentations); 2/28/13 Central States Water and Environment Association, Government Affairs Seminar (presentation); 3/8/13 American Water Resources Association, WI Chapter (presentation); 10/18/13 Wisconsin League of Municipalities, Green Bay, WI (presentation); 12/11/13 Wisconsin Legislature (presentation); 1/13/14 United States Geological Service, Middleton, WI (presentation); 2/21/14 NOAA-SARP webinar, with NIDIS, WEF, WERF, and AWWA (presentation); 3/12/14 Association of Clean Water Administrators, National Webinar (presentation); 4/17/14 Northeast Climate Sciences Center, Amherst MA (presentation); 6/18-20/14 UCOWR-CUAHSI Water Systems, Science, and Society Under Global Change (presentation); 7/14/14 North East-North Central Cooperative Extension Dean's and Directors (presentation).

Project Evaluation.

As the NEXRAD and rainfall-runoff modeling progressed, a workshop was held to provide proof-of-concept for the rainfall transposition, and assess the usability of the *TranStorm* program (see: 2/15/13 Project Stakeholder Meeting, Madison). Workshop attendees comprised the original stakeholder advisory group, with the addition of consulting engineers likely to use the transposition technique. Following a presentation by the project team, discussion turned to the potential value of the data and

analytical approach for those working on community stormwater management and system design issues.

Evaluation of the workshop impact concluded that stakeholders were highly engaged with the research project team during the February 15 presentation and discussion. Enthusiasm for potential applications of the data and the visual presentation was very high. Stakeholders suggested that the information would be most useful when discussing design, budget, and system management needs with elected officials and members of the public, especially in public forums. Using actual data from known and "named" storms, e.g., the "Baraboo River Storm of 2008", was seen as very powerful and effective for communicating potential -- much more effective than probability curves based on potential frequency of storm events.

The stakeholders contributed many suggestions for additional outputs and tools that would make the approach more useful to them. Stakeholders expressed the opinion that the approach would be especially helpful for areas where there is zero tolerance for any flooding, e.g., near a regional emergency health center (UW Hospital) in Madison, where any flooding that disrupts access poses a critical public health threat. The stakeholder group was eager to begin applying project outputs in their work.

B. Application of your findings to inform decision-making

We have been working with the Dane County Land and Water Resources Department (LWRD) to refine the projections of impacts from the transposed 2008 storm upon lake level management and urban flooding. The Dane County Executive has included more than \$60,000 in funding in the 2015 budget for better monitoring of the effects of changing climatic conditions on the Yahara lakes and river system. In addition to increasing areal coverage by rain gages, LWRD will purchase 4 river monitoring stations, water level sensors, and a river surveyor. LWRD staff state that they are... "constantly analyzing our infrastructure and management procedures to better prepare for events that *TranStorm* helps us model".

C. Planned methods to transfer the information and lessons learned from this project

We are also using the methods, tools, and data developed in this project to evaluate whether state and local stormwater ordinances adequately prevent increases in flooding as a result of urban and suburban development. Our stakeholders in this effort are the Wisconsin Department of Natural Resources and the Dane County Land and Water Resources Department. Our preliminary results indicate that current ordinances are not adequate.

D. Significant deviations from proposed work plan

- Non-point (rural) erosion and runoff quality were not explicitly addressed in the storm vulnerability analysis.
- The role of internally drained areas in the Yahara Lakes watershed was identified as a significant factor when modeling stream flow. This was not anticipated in the proposal and is original work by one of the project students (Brugger).

E. Completed publications, white papers, or reports.

Vavrus, S. J., and R. Behnke, *A comparison of projected future precipitation in Wisconsin using global and downscaled climate model simulations: Implications for public health*, International Journal of Climatology, Volume 34, Issue 10, pages 3106–3124, August 2014

TranStorm software and user guide.

III. GRAPHICS

Attached as: NA12OAR4310098_Final_Report.ppt

IV. WEBSITE ADDRESS FOR FURTHER INFORMATION

(Not applicable)

V. ADDITIONAL RELEVANT INFORMATION NOT COVERED UNDER THE ABOVE CATEGORIES

A. List of previously submitted project deliverables

8/1/12 Project Advisory Group Meeting (Madison), *8-1-12 Advisory Group meeting notes.pdf*

9/24/12 Fifty Years of Watershed Modeling conference (Boulder, CO), *ECI 50 Years of Watershed Modeling - Poster.pdf*

9/5/12 Project Logic Model, *NOAA SARP 12 logic model.pdf*

10/16/12 Wisconsin Association of Floodplain Stormwater and Coastal Management (Madison), *Potter WAFSCM.pdf*

11/7/12 North American Lake Management Society conference (Madison), *NALMS Extreme Rainfall Poster fin10-29-12.pdf*

2/15/13 Project Stakeholder Meeting (Madison), *2-15 Stakeholder meeting agenda.pdf*; *02-15-13 NOAA-CSI-SARP Meeting NotesDB-DSL.pdf*; *2013-02-15 DBrugger NOAA-SARP Meeting REVISED FOR PDF.pdf*; *Brugger 2-15-13 Presentation.mp4*

2/28/12 Central States Water and Environment Association, Government Affairs Seminar (Madison), *2-28-13CSWEAGovAffairs.pdf*

3/8/13 American Water Resources Association, WI Chapter, Managing Wisconsin's Urban Water Resources (Milwaukee), *DBrugger 2013-03-04 AWRA.pdf*

4/9/13 University of Wisconsin-Madison, InterEgr102, *InterEgr102 DSL 4-9-13.pdf*

4/18/13 Dane County Climate Adaptation Planning (Madison), *Dane County Climate Action Council 4-18.pdf*

5/14/13 Dane County Climate Adaptation Planning, Madison, WI, *Dane County Forums 6-26-13.pdf*

6/27/13 Dane County Climate Adaptation Planning, Verona, WI, *Dane County Forums 6-26-13.pdf*

7/10/13 Dane County Climate Adaptation Planning, Monona WI, *Dane County Forums 6-26-13.pdf*

7/17/13 Dane County Climate Adaptation Planning, Middleton, WI, *Dane County Forums 7-15-13.pdf*

8/2/13 Project Stakeholder Meeting, Madison, *8-2-13 Stakeholder meeting agenda.pdf*; *August 2 Stakeholder presentation finalDB 8-2-13.pdf*

10/3/13 Dane County Climate Adaptation Planning, Madison, WI, *Dane County Board Climate Briefing 10-3-13 with notes.pdf*

10/18/13 Wisconsin League of Municipalities, Green Bay, WI, *League of Municipalities 10-18-13.pdf*

12/11/13 Wisconsin Legislature, Madison, WI, *Capitol Forum-Precipitation 12-11-13.pdf*

1/8/14 Iowa County UW-Extension, Dodgeville, WI, *1-8-14 Iowa County.pdf*

1/13/14 United States Geological Service, Middleton, WI, *USGS 1-13-14.pdf*

2/21/14 NOAA Sectoral Applications Research Program webinar, with NIDIS, WEF, WERF, and AWWA, *Potter-SARP Webinar 2-21-14.pdf*

3/12/14 Association of Clean Water Administrators, National Webinar, *WICCI Climate Change Webinar Presentation To ACWA March 12 2014 fin.pdf*

3/27/14 City of Madison Stormwater Utility, *COM Stormwater Briefing 3-27-14.pdf*

4/2/14 Dane County Stormwater Managers, *SWMM modeling work.daneco.NH 4.2.14.pdf*

4/17/14 Northeast Climate Sciences Center, Amherst MA, *NESC-Spring workshop-2014-Potter.pdf*

4/24/14 Dane County Lake Level Managers, *4-24-14 meeting slides DF.pdf*

5/21/14 University of Wisconsin Risk Management Briefing, *5-21-14 RM meeting slides DSL.pdf*

6/18-20/14 Water Systems, Science, and Society Under Global Change, *Potter UCOWR-CUAHSI.pdf*

7/14/14 North East-North Central Cooperative Extension Dean's and Directors Conference, *NENC_UW-Ex_Liebl_7-14-14.pdf*

7/24/14 Aldo Leopold Nature Center Public Lecture, *ALNC 7-24-14.pdf*