Methodologies and Tools to Support Climate-Resilient Stormwater Best Management Practices

Update for the Urban Stormwater Workgroup

Krista Romita Grocholski, David Wood, Michelle Miro, and Michelle Berry

May 20, 2025

RAND
Community Health and Environmental Policy Program

Photo by Matt Rath/Chesapeake Bay Program

Project Overview

- **Objective**: Create an integrated toolkit of guidance materials, web-based tools, and references for integrating climate considerations into stormwater planning, management and/or design, as well as enhancements to Chesapeake Bay modeling. Including:
  - i) a vulnerability assessment tool,
  - ii) a decision-support tool and framework for integrating the information from a widely-used future precipitation tool,
  - iii) guidance on resilient design adaptations for stormwater infrastructure and restoration, and
  - iv) modeling enhancements to characterize the sensitivity of BMPs to climate change.
- **Timeline:** February 2024 – March 2029
- **Funder:** U.S. EPA

Project Team

RAND

Dr. Michelle Miro (PI)
Dr. Krista Romita Grocholski (Co-PI)

Chesapeake Stormwater Network

David Wood
Michele Berry

Carnegie Mellon University

Dr. David Rounce
Dr. Sarah Fakhreddine

The Water Institute

Dr. Jordan Fischbach
Dr. Nastaran Tebyanian
Dr. Ioannis Georgiou

Cornell University

Dr. Art DeGaetano

Status of Our Work

Activity 1: Vulnerability Assessment Tool

- Majority of research complete
- Drafting tool now
- Final tool complete in November 2025

Activity 2: Decision Support Tool

- Plan to kick off in June with arrival of new graduate student
- Host session at Baywide Stormwater Retreat
- Tool complete in March 2026
- Case studies complete in September 2026

Activity 3: Climate Resilient Design Guidebook

- Review of existing guidebooks and worksheets underway
- Host workshops in Fall 2025 and early 2026
- Guidebook complete in December 2026

Activity 4: BMP Climate Sensitivities

- Initial modeling of agricultural BMPs underway
- Urban BMP modeling approach in development
- Initial sensitivities expedited, due December 2025
- Final analysis complete February 2027

Additional outreach and training activities through March 2029

Activity 1. Vulnerability Assessment Tool

- **Objective:**
  - Develop a vulnerability assessment tool for local communities in the Chesapeake Bay watershed. The tool will provide step-by-step guidance on implementing vulnerability assessment approaches appropriate and practical for the stormwater management community in the Chesapeake Bay watershed.
- **Research Steps:**
  - Carry out literature review to identify and evaluate vulnerability assessment approaches and relevant datasets
  - Summarize vulnerability assessment approaches
  - Develop initial vulnerability assessment tool
  - Present tool framework for feedback and carry out pilot of vulnerability assessment tool
  - Finalize and publish tool
- **Output:**
  - Vulnerability assessment tool to help local jurisdictions and residential communities review and understand vulnerabilities of their existing and planned infrastructure to climate change by mid-November 2025

Activity 1. Vulnerability Assessment Tool

- **Objective:**
  - Develop a vulnerability assessment tool for local communities in the Chesapeake Bay watershed. The tool will provide step-by-step guidance on implementing vulnerability assessment approaches appropriate and practical for the stormwater management community in the Chesapeake Bay watershed.
- **Research Steps:**
  - ✓ Carry out literature review to identify and evaluate vulnerability assessment approaches and relevant datasets
  - ✓ Summarize vulnerability assessment approaches
  - Develop initial vulnerability assessment tool
  - Present tool framework for feedback and carry out pilot of vulnerability assessment tool
  - Finalize and publish tool
- **Output:**
  - Vulnerability assessment tool to help local jurisdictions and residential communities review and understand vulnerabilities of their existing and planned infrastructure to climate change by mid-November 2025

Activity 1. Overview of Literature Review and Interviews

Literature Review:

- Collect and examine vulnerability assessments (35 total), including hazard mitigation plans and related hazard or risk assessments relevant to stormwater management, flood hazards, and climate adaptation.

Interviews:

- 12 interviews with stakeholders from a range of organizations involved in stormwater management and climate adaptation.

Key Insights:

- Wide variation in assessment methods, from more qualitative to highly quantitative.
- Agency goals, capacity, and local risk profiles shape assessment design.
- Common barriers include limited resources and institutional constraints.
- Stakeholders seek clearer guidance and better tools for integrating climate into planning.

Activity 1. Defining Vulnerability Assessment

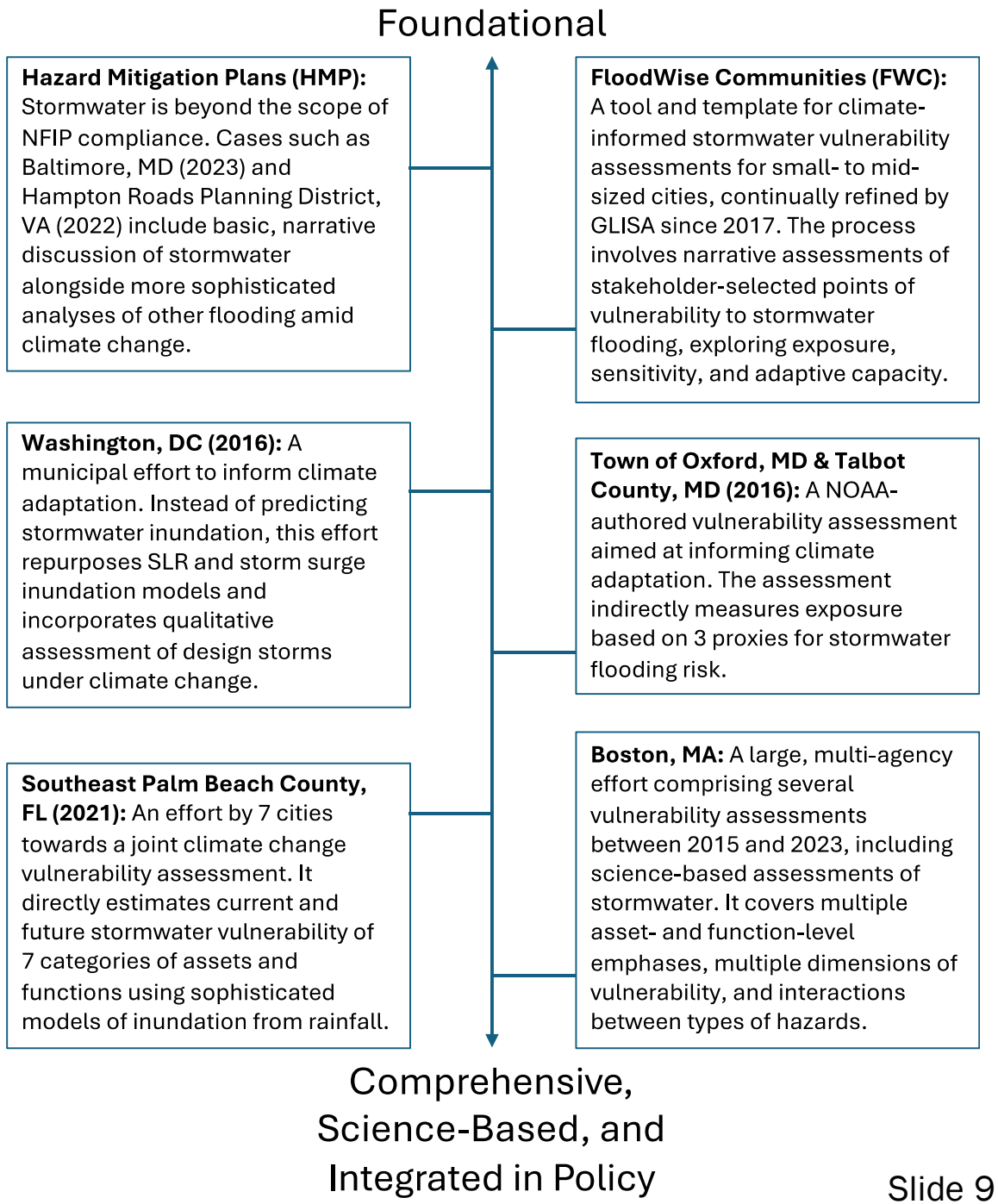
- **Established Working Definition:**
  - Synthesized literature and practice to define vulnerability assessment as a system's susceptibility to hazards, assessed through elements like assets, functions, and populations.

- **Core Dimensions:**
  - Exposure – How frequently elements are at risk
  - Sensitivity – Potential impacts of hazards on system elements
  - Adaptive Capacity – Ability to mitigate or respond

Activity 1. Vulnerability Assessments in Practice

- Broad spectrum of vulnerability assessments from foundational (HMPs) to advanced (Climate Plans), as well as qualitative to quantitative
- 7 representative cases show diversity in complexity and depth

- Common findings:
  - Structural vs functional vulnerability both matter
  - Adaptive capacity often under-assessed
  - Data/method constraints shape scope
  - Climate hazards often treated in silos



Activity 1. Vulnerability Assessment Barriers

Category	Key Challenges
Data & Modeling Gaps	- Missing/outdated data - Incomplete flood and stormwater records- Inconsistent data across jurisdictions - Need better models for all flood types - Hard to track infrastructure changes - Few tools to compare system vs. design capacity
Technical Needs	- Better tools to analyze GSI, failure risks, and local climate effects - Need fast, flexible modeling platforms - Tools to find flood hotspots and combine data
Regulatory & Planning Barriers	- New rules stress volume control but reduce flexibility - No central data source for coordination - Hard to align policies across states - Climate guidance not consistently used in planning
Capacity & Coordination Gaps	- Not enough staff or technical know-how in lower resourced communities - Hazards may be missed if only self-reported - Limited cross-agency collaboration
Funding & Risk Assessment	- Few resources to assess financial risk - Not enough funding for data and upgrades - Need more tailored, cost-effective solutions
Communication Issues	- Resilience often framed around regulation, not future risk - GSI benefits (social, ecological) underplayed - Need clearer, more consistent messaging on risk

Activity 1. Next Steps

- Develop draft vulnerability assessment tool, to include:
  - What is a vulnerability assessment?
  - How are they used by and useful to stormwater agencies?
  - What are the main approaches to carrying out a vulnerability assessment?
  - How do you select an approach?
  - How do you carry out a vulnerability assessment?

- Pilot the tool with a local stormwater agency
  - Pilot agency will meet with us to review and understand the tool
  - They will use the tool to assess how they would carry out a vulnerability assessment, what approach they would select, and set up a plan to do so
  - Provide feedback on the function and format of the tool

Thank you.

Contact Information
Michelle Miro: Michelle_Miro@rand.org
Krista Romita Grocholski: kristarg@rand.org

Cornell University

Carnegie Mellon University

THE WATER INSTITUTE

CHESAPEAKE STORMWATER NETWORK

RAND

MARISA
a NOAA Mid-Atlantic CAP team