Pooled Monitoring Initiative's Restoration Research Award Program

Project Title

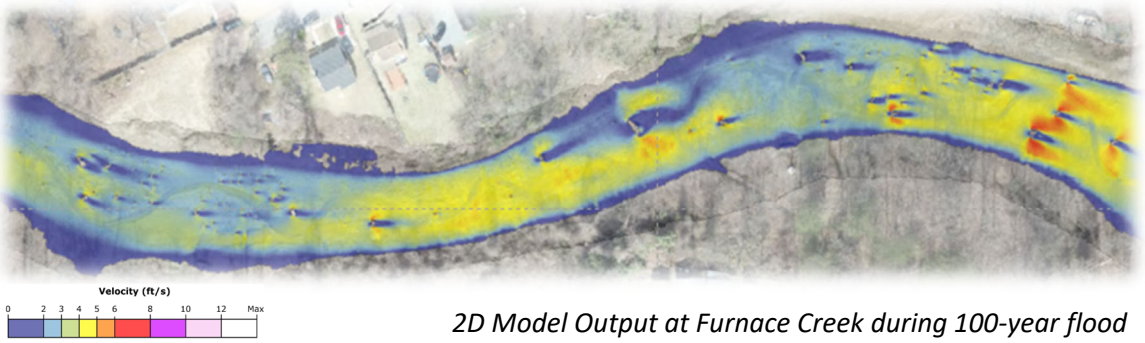
2D Model Reliability for Stream Restoration Design under Current & Future Climate Conditions

Lead Entity

University of Louisville Stream Institute

The Pooled Monitoring Initiative pools resources to support scientists who answer key restoration questions posed by the regulatory and practitioner communities. The research teams then provide the answers back to those who asked the questions for direct application. The goal of the program is to answer these key restoration questions that serve as a barrier to watershed restoration project implementation.

Questions? See cbtrust.org/grants/restoration-research/



2D Model Output at Furnace Creek during 100-year flood

Research question(s)

This research project was initiated in response to the following key question:

How can different restoration approaches or techniques and/or site conditions reduce the impacts of future climate change such as changing intensity duration frequency curves, frequency of storms, and/or periods of drought?

Issue addressed

Stream and wetland restoration projects are vulnerable to damage during flood events, which can be severe. The risk of flood damage to restoration sites in the Chesapeake Bay is likely to increase due to climate change. Two-dimensional (2D) hydrodynamic modeling is a technique that is widely used to evaluate the vulnerability of proposed restoration design to flood damage, allowing for design revisions which mitigate the risk of damage, project failure and underperformance.

There is presently limited information on the reliability of 2D models applied to flood vulnerability assessment in restoration. The first phase of this research focused on the collection of field data and the development of 2D models to evaluate reliability in 5 restoration sites. The second phase of this research explored how changes associated with a future climate change scenario – through an elevated extreme flood flow – will impact the vulnerability of sites examined in the first phase and similar restoration sites in the Chesapeake Bay.

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Vegetation with minimal (left) and moderate (right) evidence of flood disturbance

Project findings

In Phase 1, **2D models in all sites were found to be reliable for evaluating site vulnerability to flood damage**. Evidence included accurate simulation of the flow pattern and direction around structures, effective rock and sediment stability prediction, and agreement between 2D model velocities and the intensity of flood disturbance to the floodplain and shallow stream banks. The reliability was better for wide and shallow flows than for deep and narrow flow in incised channels.

In Phase 2, modeling of a climate change scenario (100-yr flow + 33%) showed that areas of sites that are presently vulnerable are at the highest vulnerability in the future. **Vulnerable areas include pinch points, areas where flow is concentrated, large vertical steps, and steep slopes**. Areas least vulnerable were those protected by backwater from downstream structures or downstream narrow valley reaches.

Recommendations

For practitioners, sponsors, regulators and other stakeholders, the results of this study should improve confidence in the use of 2D model output to make informed decisions during the design and permitting phase.

Future studies should (1) evaluate the flood classification framework at additional sites, with the goal of improving the connection between model output and the function of restored environments, and (2) evaluate 2D model reliability in environments not explored in this study, including other physiographic provinces of the Chesapeake Bay.

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Why does this study matter?

2D models are an important part of the restoration design process in the Chesapeake Bay. To obtain the necessary permits in some jurisdictions, designers are required to produce 2D model output and justify design decisions based on the results. There is limited data to support the reliability of 2D models used for this purpose. **This study reduces the existing knowledge gap and provides supporting evidence for the general reliability of 2D models.**

What should we do with this information?

2D model output which is based on an accurate representation of the existing site conditions and proposed design changes can be used to identify project vulnerabilities under frequent and extreme floods. Model output can be used to (1) identify potential problems and make appropriate changes, (2) make permitting decisions, and (3) anticipate restoration site trajectories under current and future climate conditions.

What will the end-user (regulator/manager and practitioner) do with this information?

For all stakeholders, the description of vulnerable areas should be considered when evaluating future restoration projects. **Restoration methods that lead to flood flows over vegetated floodplains are more resilient to flood damage than other approaches**. For practitioners, the variability of 2D model output across flood events at different sites demonstrates the importance of developing effective 2D models to determine site specific vulnerabilities to flood damage.

For more information:

To read this study's final report, please visit the Chesapeake Bay Trust's Pooled Monitoring Restoration Research landing page (https://cbtrust.org/grants/restoration-research/).

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