Pooled Monitoring Initiative's Restoration Research Award Program

Project Title

Climate Change Impacts to Restoration Practices

Lead Entity

Dr. Jon Butcher, Tetra Tech

Partners

David Sample, Tess Thompson, Sami Towsif-Khan, Virginia Tech

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/

Research questions

Climate change models predict that frequency and intensity of rain events will increase, that growing season will lengthen, and that other processes related to the Chesapeake community's approved set of BMPs will change. Should standards for stormwater practices, stream restoration, and other BMPs also change (e.g., plan to treat a two-inch rain event versus a one-inch rain event; design stream restoration practices for more frequent storms)?

Issues addressed

There are multiple global climate models (GCMs) and each model was run for multiple warming scenarios. Further variability is introduced by ways in which the model output is downscaled to a local spatial scale and daily or finer time scale relevant to evaluation of stormwater practices. We need to look across the range of predictions to evaluate potential future risks.
In prior work for CBT we developed methods and applied them across Maryland to update the rainfall intensity-duration-frequency (IDF) curves used in stormwater design based on GCM output with local bias correction. In the current work we address three important issues:

1. To what extent does downscaling method bias results?
2. Do Maryland's Environmental Site Design (ESD) requirements need to be changed to maintain similar levels of hydrologic control in a warming world?
3. How do results for protecting stream stability based on IDF analysis compare to continuous simulations of future climate?

Project findings

Different commonly used downscaled climate archives do contain systematic relative biases.

IDF calculations (e.g., the depth of a future 10-yr, 24-hr rainfall event) differ depending on whether the LOCA, MACA, or CORDEX archive is used. There is no "right" answer for future climate, but potential risks should be evaluated across multiple products.

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Project findings

ESD specifications are likely to perform according to design criteria under future climate

- Keep runoff from developed sites consistent with natural runoff from 1-year, 24-hr storm
- Treat water quality from a 95th percentile 24-hr event

Little increase projected for 24-hr events with recurrence of 1-year or less. But, large increases in more extreme events suggests problems

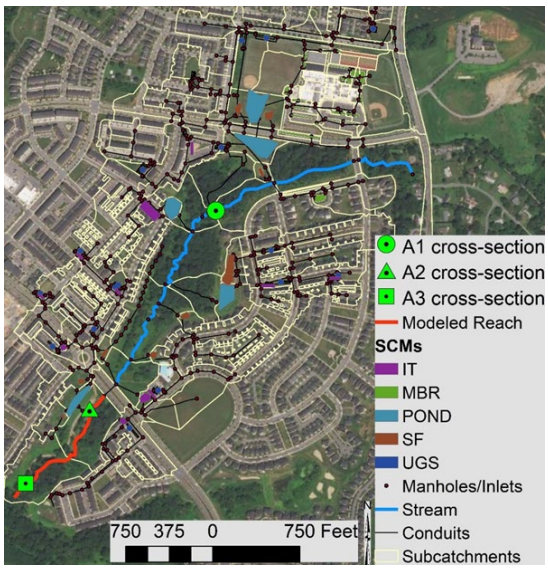
Continuous simulation suggests problems for maintaining stream stability.

We performed detailed simulations of hydrology and sediment transport in a well-studied stream with ESD-compliant BMPs in Clarksburg, MD and ran the model with realistic 5-minute precipitation series built from multiple climate projections.

- Existing ESD requirements unlikely to be fully resilient to future climate conditions due to the effects of extreme events
- Retrofitting existing SCMs to maintain or restore predeveloped sediment transport, as opposed to matching shear stress from a single defined event, could significantly reduce the extent of channel degradation

Recommendations

Consider the range of potential future climate conditions that a project may face over its service life. Seek solutions that will provide benefits regardless of the future climate conditions and that are readily modifiable if conditions do not turn out as predicted.



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Why does this study matter?

Increased rainfall intensity under future climate is likely to increase flood risk, affect stream stability, and impair success of stream restoration projects. Designs to maintain stability relative to historic climate may not be adequate for future climate.

What should we do with this information?

Future climate is uncertain, particularly for rainfall. There is a need to take a robust decision approach that considers the potential future conditions and seeks solutions that will provide net benefits regardless of how things turn out. Think about adaptability: hard structures that are expensive to modify may need to be designed with greater margins of safety, but other solutions that are more easily modified, such as bioretention, could wait to see how climate progresses, given sufficient mechanisms to require future modification.

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

Regulators and managers should ensure that stormwater design leaves room for modification as climate evolves. Stream restoration practitioners should evaluate the resilience of designs over conditions expected for the useful life of the project.

For more information:

For further details please visit the CBT Restoration Research website or contact the principal investigator at jon.butcher@tetratech.com.

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