BEST MANAGEMENT PRACTICES

PRESERVING CLEAN WATER IN A CHANGING CLIMATE

REDUCING RISKS WITH STORMWATER BEST MANAGEMENT PRACTICES TO SAVE MONEY AND THE ENVIRONMENT

Jane Thomas

Restoring wetlands, like this entire island in Chesapeake Bay, helps buffer against storms.

Risk management is critical in any restoration project. Risks include those associated with climate patterns, such as more intense storms, as well as those associated with land use change, site selection, and design. Addressing these risks in conjunction with ongoing restoration efforts will prepare communities for greater variability and may result in cost savings and reduced risk.

A Changing Climate

One hundred years of data shows that Maryland is getting warmer on average by 1.8°F and by as much as 3.6°F in the winter. Warmer air holds more moisture, so changes in rainfall amounts are expected. Over the last century, Maryland has become wetter in March and September and drier in July and August. For example, Maryland is receiving an additional 6–12 inches of rain in September and 3–6 inches in April. Conversely, in July and August, the state is receiving 3–6 inches less rainfall.

Best Management Practices (BMPs) should be sited and designed with climate change impacts in mind.

- Increased flooding may overwhelm water infiltration, conveyance, and storage practices.
- Flooding and inundation will increase nutrient transport and impact vegetation sensitive to salinity and inundation.
- Greater storm frequency and intensity can increase shoreline and bank erosion in freshwater and tidal systems.
- Rising temperatures may harm vegetation and aquatic ecosystems.

The Good News

Incorporating climate change considerations into your project design will not require a wholesale change in implementation in most cases. Evaluating your project for its climate vulnerabilities and developing a range of strategies at the initial planning stage will increase effectiveness, decrease maintenance costs, and help to ensure you are meeting the U.S. Environmental Protection Agency's Total Maximum Daily Load requirements into the future. Many BMPs already address climate (see chart below) and will protect communities from increased flooding and ecosystems from rising temperatures and altered streamflows.

EXISTING PRACTICES PROVIDE A VALUE ADDED BENEFIT FOR REDUCING CLIMATE RISK

Management Practice	**Nutrient Benefit**	**Climate Resilience Benefit**				
		Temperature Reduction	Storm Buffer	Drought Buffer	Sea Level Rise Buffer	Wildlife Corridor
Wastewater Treatment Plant	●			●		
Stream Restoration	●	◖	◖			●
Forest Buffer	●	●	●			●
Wetlands	●		●	●	●	●
Infiltration	●		●	●		
Shoreline Erosion Control	●		●		●	
Vegetated Open Channel	●		●			

* Practices designated with a ◖ potentially buffer against climate impacts and could be enhanced through modifications suggested in this document.

STREAM RESTORATION

Climate Risk

Stream restoration practices are sensitive to changes in hydrology. In many cases, stream restoration projects are designed to carry the 1.5–2 year storm event.

- Summer droughts will concentrate nutrients, increase temperature, and reduce habitat for fish.
- More frequent bankful events will alter bed and bank stability and threaten downstream and communities in the floodplain.

Kirk Mantay

The Savage River Watershed Association restored a headwater stream of the Savage River in western Maryland.

Climate Solutions and Benefits

- Identify, protect, and/or replicate climate sensitive systems (e.g., vernal pools; intermittent, ephemeral, and perennial headwater streams).
- Address impacts on minimum flows associated with lower summer base flows and higher fall-winter flows.
- Give the stream room to migrate laterally to account for higher peak flows and enhance riparian corridors to reduce the impacts of high flows on in-stream species and flooding.
- Plant a high diversity of native vegetation to resist the impacts of invasive species, pests, and fire.
- Diversify habitat features such as deep pools, complex woody debris presence, and strong connections with groundwater and the floodplain.
- Enhance stream connectivity (e.g., fish blockage removal) for freshwater, temperature-sensitive aquatic animals so they can migrate to more favorable habitats, often further upstream, as temperatures warm and sea level rises.

URBAN TREE BUFFERS AND CANOPY

Climate Risk

- Increasing salinity from sea level rise and coastal and riverine flooding will stress native species and increase invasive species success.
- Drought, increased temperature, and lower soil moisture will make trees more susceptible to pests and disease. Young trees and bare roots will be most susceptible.
- Rising temperatures and carbon dioxide will place forests at greater risk to existing and new invasive species. Non-native invasives, such as oriental bittersweet and kudzu, are highly responsive to elevated carbon dioxide levels and are already being found in western Maryland.

Richard Conniff

Climate Solutions and Benefits

Urban tree canopy and forested buffers are two of the most beneficial practices in terms of addressing the impacts of climate change. The resiliency of these practices can be enhanced through the following:

- Planting riparian species that exhibit tolerance to drought, flooding, higher water tables, or salinity changes, as appropriate.
- Incorporating plant stock that has more vigor in size and age.
- Modifying planting schedules to maximize soil moisture availability.
- Including species that are near the northern edges of their ranges.
- Maintaining species diversity.
- Using vented tubes to help minimize the amount of heat stress to seedlings.
- Enhance water availability through soil amendments and root dips, sources of irrigation for young riparian plantings (e.g. rain barrel, cistern and other nonpotable water harvesting), and non-competitive low-growing cover crops for moisture retention.

INFILTRATION PRACTICES

Climate Risk

- Increased conveyance from more intense storms.
- Less infiltration from rising water tables and saturated soils.
- Increased clogging of media with sediment, increasing maintenance cost.
- Loss of vegetation from increased flooding and summer droughts.

Climate Solutions and Benefits

- The use of infiltration practices, such as rain gardens and swales, can help to build resilience to climate change through a number of means, including:
  - Using flood and drought tolerant plantings.
  - Applying soil amendments that provide additional infiltration, soil productivity, and storage of carbon.
  - Enhanced plant growth during warmer winters and higher carbon dioxide emissions.
- To reduce future risk, practitioners should increase runoff holding areas, develop maintenance schedules to monitor for potential failures and design practices for minimal sediment clogging risk.

WETLAND RESTORATION

Climate Risk

Wetlands enhance nutrient and sediment retention and increase coastal and nearshore resiliency, but are at risk from:

- Increased inundation and vegetative loss from erosion, salinity change, and sea level rise.
- Loss of function from extended drought and heat.
- Rising temperatures and carbon dioxide which may enhance invasive species success (e.g., *Phragmites*).

Jane Thomas

Climate Solutions and Benefits

Wetlands reduce climate risk by stabilizing banks, storing floodwaters, buffering coastal ecosystems, and reducing downstream and nearshore flooding. The resiliency of restoration projects can be enhanced through the following means:

- Assessing the risks of sea level rise and storm surge in coastal areas and evaluating downstream flooding in non-coastal regions.
- Restoring wetland function by removing impervious surfaces or hardened shorelines inland to enhance their ability to respond and migrate inland with rising sea levels.
- Planting water and salt tolerant plants inland from wetland restoration projects to prolong viability to rising waters and increased flood occurrence.
- Maintaining and enhancing diversity of plantings to help with changing salinity and flooding conditions.

SHORELINE EROSION MANAGEMENT

Climate Risk

- Increased erosion from storm surges and sea level rise.
- Land subsidence resulting from groundwater extraction.
- Upland development and an increase in impervious surfaces and land use practices will occur because land will be lost due to sea level rise and citizens will have to move inland.
- Decreased plant survival from sea level rise and salinity change.

Climate Solutions and Benefits

- Replace degraded and dilapidated hardened shorelines with living shorelines, where feasible, to maintain natural storm buffering, erosion, and sediment control.
- Avoid placement of hard structures or impervious surfaces that prohibit the inland movement of coastal habitat as sea level rises.
- Select plant species that are tolerant to salinity changes and increased temperature.

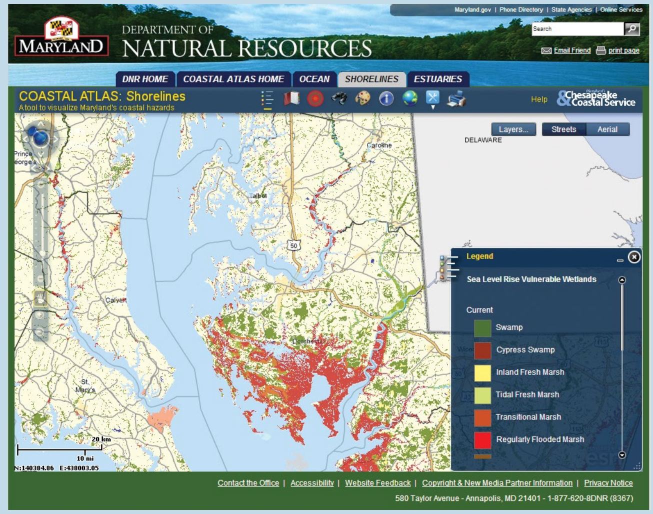
TOOLS TO ACHIEVE CLIMATE SOLUTIONS

COASTAL ATLAS ONLINE MAPPING TOOL

The Coastal Atlas is an online mapping tool, developed by Maryland's Chesapeake and Coastal Service. The tool can be used to inform shoreline erosion management decisions, long-range planning, floodplain management, and/or restoration project targeting. Visit the Coastal Atlas to:

- Access coastal hazard data including coastal inundation from storms, areas at risk to sea level rise, and shoreline erosion.
- Identify areas of high erosion to prioritize Best Managment Practices siting and design.
- Access Living Shoreline Suitability Index for Worcester, Somerset, and Calvert Counties.
- View areas identified as Wetland Adaptation Areas (areas where wetlands are likely to migrate in response to sea level rise).
- More resources:
  - NOAA Atlas 14 (http://dipper.nws.noaa.gov/hdsc/pfds/)
  - NOAA's Restoration Center (http://www.habitat.noaa.gov/restoration/index.html)

Access the Coastal Atlas:
http://www.dnr.state.md.us/ccp/coastalatlas/



CLIMATE RESILIENT PLANT SPECIES

Woody Plants

Species	Drought	Flooding	Salinity
Atlantic White Cedar	●	●	
Bald Cypress	●	●	
Black Locust		●	●
Chokeberry	●	●	
Eastern Cottonwood		●	●
Hackberry	●	●	
Live Oak		●	●
Northern Bayberry	●	●	●
Sweet Pepperbush		●	●
Sweetgum	●	●	
Waxmyrtle	●	●	

Herbaceous Plants

Species	Drought	Flooding
Black-eyed Susan	●	
Butteryfly Weed	●	
Cardinal Flower	●	●
False Indigo	●	
Sedums	●	
St. John's Wort	●	●
Tickseed	●	
Turtlehead	●	●

Resource: Maryland Stormwater Design Manual, Appendix A
www.mde.maryland.gov

Maryland's Adaptation Website:
www.dnr.maryland.gov/climatechange

Maryland Smart, Green & Growing

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