MDOT Climate Change Adaptation Strategies for a Resilient Transportation System

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Office of Environment
Maryland transportation – a brief history....

- 1638 – First Established Toll for a River Crossing
- 1666 – First Road Law Passed
- 1787 to 1804 – Private Companies Built Turnpikes
- 1784 to 1848 – Focus on Railroads and Canals
- 1867 – First Government Involvement in Railroad/Canals
- 1904 – First Division of Highways
- 1929 – State Aviation Commission
- 1956 – The Maryland Port Authority
- 1969 – Metropolitan Transit Authority
Origin of MDOT

Established on July 1, 1971

Consolidated Independent State Transportation Agencies

- State Highway Administration
- Motor Vehicle Administration
- Maryland Aviation Administration
- Maryland Port Administration
- Maryland Transit Administration

Maryland Transportation Authority
MISSION STATEMENT
“The Maryland Department of Transportation is a customer-driven leader that delivers safe, sustainable, intelligent, and exceptional transportation solutions in order to connect our customers to life’s opportunities.”
Identifying Hazards
“Not so Fun” Fact

Hurricane Sandy caused over $10B in damage to coastal roads, rails, tunnels, and other transportation facilities in New York and New Jersey (Blake, et al. 2013, NOAA 2013).
What’s a DOT to Do?
The “Road” to Achieving Adaptive Capacity & Resilience

1. Explore Climate Hazards
2. Assess Vulnerability and Risks
3. Investigate Options
4. Prioritize Actions
5. Take Action
Pilot Study Objectives

• Assess Vulnerability
• Develop Engineering Approaches
• Make Resiliency Improvement Recommendations
Exploring Climate Hazards

- Temperature
- Precipitation (rain, snow, freezing rain)
- Sea Level Change
- Extreme Weather Events
- Cumulative Effects of Listed Stressors
Vulnerability Analysis Framework

Compile
- Compile Asset and Climate Information

Develop
- Develop Predictive Models

Evaluate
- Evaluate Primary Assets
Two Level Analysis

- **TIER 1**
  - Map Sea Level Change
  - Develop Climate Change Impact Zone
  - Analyze Flood Depth Grids with Centerline elevation
  - Develop Risk Indicators

- **TIER II**
  - Utilize Tools
  - Vulnerability Assessment Scoring Tool (VAST)
  - Hazard Vulnerability Index (HVI) = (Evacuation Code*0.5+1) + (Flood Depth Code+0.01)/4 + (0.7/Functional Classification)

PROVIDE ACCESSIBLE RESULTS
Climate Change Vulnerability Viewer

- https://arcg.is/ymbaW
CLIMATE CHANGE VULNERABILITY VIEWER
Kent Island 2015 50-Year Storm
Aerial Photo/Model Comparison Crisfield, MD

- City of Crisfield Facebook Page (https://www.facebook.com/pages/City-of-Crisfield)
- Tony Laird drone footage
Hazard Vulnerability Index

\[
\text{Hazard Vulnerability Index} = (\text{Evacuation Code} \times 0.5 + 1) + \frac{\text{Flood Depth Code} + 0.01}{4} + \frac{0.7}{\text{Functional Classification}}
\]

<table>
<thead>
<tr>
<th>Evacuation</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flood Depth (Feet)</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Flood</td>
<td>0</td>
</tr>
<tr>
<td>0 – 0.5</td>
<td>1</td>
</tr>
<tr>
<td>0.5 - 1</td>
<td>2</td>
</tr>
<tr>
<td>1 - 2</td>
<td>3</td>
</tr>
<tr>
<td>&gt;2</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Value</th>
<th>SHA Functional Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Interstate</td>
</tr>
<tr>
<td>2</td>
<td>Principal Arterial – Other Freeways and Expressways</td>
</tr>
<tr>
<td>3</td>
<td>Principal Arterial – Other</td>
</tr>
<tr>
<td>4</td>
<td>Minor Arterial</td>
</tr>
<tr>
<td>5</td>
<td>Major Collector</td>
</tr>
<tr>
<td>6</td>
<td>Minor Collector</td>
</tr>
<tr>
<td>7</td>
<td>Local</td>
</tr>
</tbody>
</table>
HVI for Anne Arundel County
Bridge VAST Methodology - Sea Level Change, All Coastal Counties
Vulnerability Assessment: Results

- Sea level change: 33 assets
- Storm surge: 172 assets
- Precipitation change: 102 assets
Bridge Exposure to Precipitation
### VAST – Data and Indicator Details

<table>
<thead>
<tr>
<th>Component</th>
<th>Indicator</th>
<th>Weight</th>
<th>Indicator Value</th>
<th>Score</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure</td>
<td>Modeled SLC Inundation Depth (2050 Mean Higher High Water)</td>
<td>35%</td>
<td>$x \geq 3$ Feet of inundation from MHHW&lt;br&gt;$1.4 \leq x &lt; 3$ Feet of inundation from MHHW&lt;br&gt;$0 &lt; x &lt; 1.4$ Feet of inundation from MHHW&lt;br&gt;$x \leq 0$ Feet of inundation from MHHW</td>
<td>4</td>
<td>Locations with larger projected amounts of sea level change are likely to be impacted by projected changes in climate, including permanent inundation.</td>
</tr>
<tr>
<td></td>
<td>Proximity to Coastline</td>
<td>10%</td>
<td>$1 \leq x &lt; 500$&lt;br&gt;$500 \leq x &lt; 1,000$&lt;br&gt;$1,000 \leq x &lt; 5,000$&lt;br&gt;$5,000 \leq x &lt; 24,576$</td>
<td>4</td>
<td>Assets that are located a shorter distance from the coastline are more likely to be affected by sea level change.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Fast Experience with Storm Surge</td>
<td>45%</td>
<td>Demonstrated at least moderate damage during past storm surge events&lt;br&gt;Demonstrated at least minor damage during past storm surge events&lt;br&gt;No experience of damage beyond operational disruption during past storm surge events&lt;br&gt;No experience of prior storm surge</td>
<td>4</td>
<td>Structures that have demonstrated sensitivity in the past are likely to be sensitive in the future.</td>
</tr>
<tr>
<td></td>
<td>Underclearance</td>
<td>20%</td>
<td>A ($&lt; 10'$)&lt;br&gt;B ($10'$ to $&lt; 20'$)&lt;br&gt;C ($20'$ to $&lt; 30'$)&lt;br&gt;D ($30'$ to $&lt; 40'$), E ($&gt; 40'$)</td>
<td>4</td>
<td>Assets with a lower underclearance are more likely to experience impacts when exposed. For example, surge is more likely to overtop the structure and cause damage or disruption.</td>
</tr>
</tbody>
</table>
**Integrating Results into Practice: Planning**

**Climate Change Impact Areas**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is this Project within an area potentially affected by Sea Level Change?</td>
<td>Yes</td>
</tr>
<tr>
<td>Mean Sea Level 2050</td>
<td></td>
</tr>
<tr>
<td>Mean Sea Level 2100</td>
<td></td>
</tr>
<tr>
<td>Mean High High Water 2050</td>
<td></td>
</tr>
<tr>
<td>Mean High High Water 2100</td>
<td></td>
</tr>
<tr>
<td>Is this a non-state Project located on State lands?</td>
<td>No</td>
</tr>
<tr>
<td>Is this project involving construction of a new road or bridge due to a storm event?</td>
<td>No</td>
</tr>
<tr>
<td>Is this project involving construction of a new building/facility or reconstructing an existing building/facility due to a storm event?</td>
<td>No</td>
</tr>
</tbody>
</table>

*Notes: The hydraulics analysis determined that up to 100-year storm flooding events would not overtop the bridge. The roadway approaches to the bridge are being raised between 1 to 2.5 feet. Additional roadway improvements may be needed to address future flooding.*
FHWA Pilot Studies

- 2018 - 2020/2024 Resilience and Durability to Extreme Weather
- 2017-2019 Asset Management, Extreme Weather, and Proxy Indicators
- 2016-2017 Nature-based Resilience for Coastal Highways
- 2013-2015 Vulnerability Assessments and Adaptation Options
- 2010-2011 Vulnerability Assessments
MDOT’s Renewable Energy Program
Energy Program

- Energy Efficiency
  - Executive Order
- MDOT Owned Solar Arrays
  - MDOT MTA
  - MDTA
  - MDOT MAA
  - MDOT MPA
- Renewable Energy Development
  - RFP and TORFP Process
  - TO’s to date
Executive Order 01.01.2019.08 – Energy Savings Goals for State Government

- State spends >$210M/year on energy-related utilities
- Reduction in energy costs since 2014
- MEA and DGS develop and manage an energy-savings initiative with the goals of, by 2029, reducing energy consumption in State-owned buildings by 10% compared to a FY18 baseline
MDOT Owned Solar Arrays

Photovoltaic Systems owned by MDOT through Energy Performance Contracts:

- MDOT MTA
- MDTA
- MDOT MAA
- MDOT MPA
  - Shed 10
  - Cruise Terminal

In 2016 MDOT used 385,000MW of conventional energy, equivalent to the same amount of energy used by 31,500 homes.
MDOT has installed solar, wind, and geothermal energy systems at MDOT facilities. In 2016, these systems generated 1.829MWh, saving $200,000 and reducing our CO2 emissions by 1,285 MT.

- RFP Development
- Master Contractor Qualification
- Task Orders
MDOT’s Sustainable Materials Management Program
Sustainable Materials Management Maryland (SM³)

E.O. 01.01.2017.13
Waste Reduction and Resource Recovery Plan for Maryland
SM³ Draft Strategic Plan

Vision

Improve the environment and create economic development and job creation opportunities in the State of Maryland by identifying and executing creative and innovative sustainable materials management projects and activities, through public and private sector voluntary collaborations, including the Maryland Department of the Environment (MDE) and other Maryland governmental entities.

Mission

Identify and collaborate with a wide range of multi-sector companies and entities, along with their suppliers, and key public-sector leaders to design and implement materials management initiatives and projects for Maryland in a way that will foster the establishment of new materials management businesses in Maryland; conserve natural resources; meet State climate change goals for 2030 and beyond; and, embrace new and more effective measures of success.
Recommended Actions

1. Identify Legislative Barriers
   - RCRA
   - State regulatory definitions
   - Regulatory and legislative language
   - Refining metrics and measures
   - Engage Small Medium Enterprises (SME’s)
   - Support the creation of new technologies
   - Educate consumers
Recommended Actions

2. Creation of a new Maryland’s Waste Reduction and Resource Recovery Innovation Center (MWR³ Innovation Center)

- Provide four areas of development focused on collecting and processing what has historically been called “wastes”
- Include a Research and Technology Center designed to attract and refine innovative technologies that can be used and applied to address new and creative ways to utilize various kinds of wastes
For more information on MDOT’s Energy and Sustainable Materials Management Programs:

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