

Maryland Adaptation and Vulnerability Assessment



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Pilot Study Objectives

- Assess Vulnerability to SHA's Assets
- Develop Approaches to Address Current and Future Risk
- Provide Recommendations for Policy or Process Changes



Floating Debris Lodged in a Bridge during Flood Event at Seneca Creek in Germantown, MD
Photo Source: (FEMA/Skolnik 2006)

“Improve Resiliency of Maryland’s
Transportation System”

Identify Climate Stressors

Studied in Detail for Maryland

Sea Level Change

- USACE Procedures Established in Circular No. 1165-2-212 (2013)
- Newer LiDAR and Assign Nearest Tidal Station

Storm Surge

- HAZUS-MH 2.1 (Category 3 Storm Used)
- Stillwater Depth Grids Developed

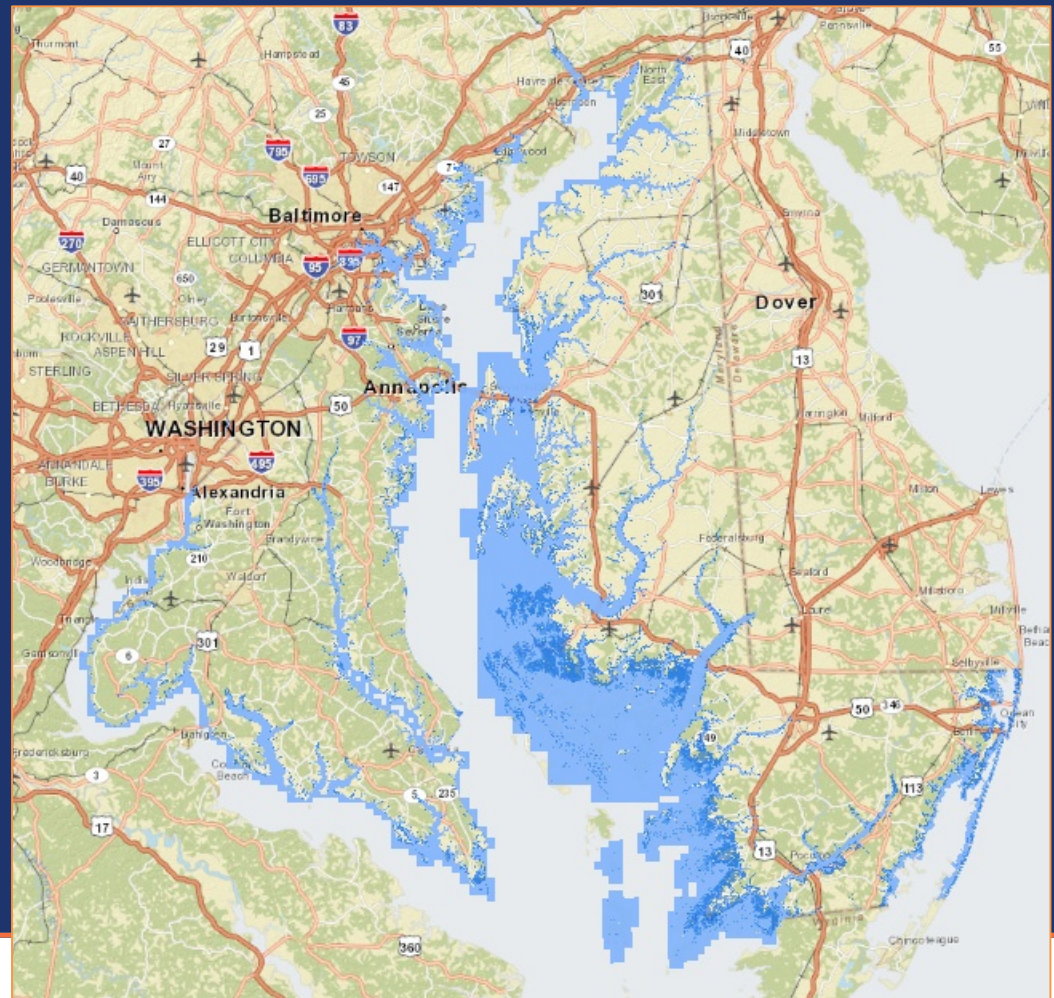
Precipitation

- Micro-scale Data Obtained from C-MIP
- Riverine Modeling in HAZUS-MH2.1 (future)

2050 & 2100 Sea Level Change

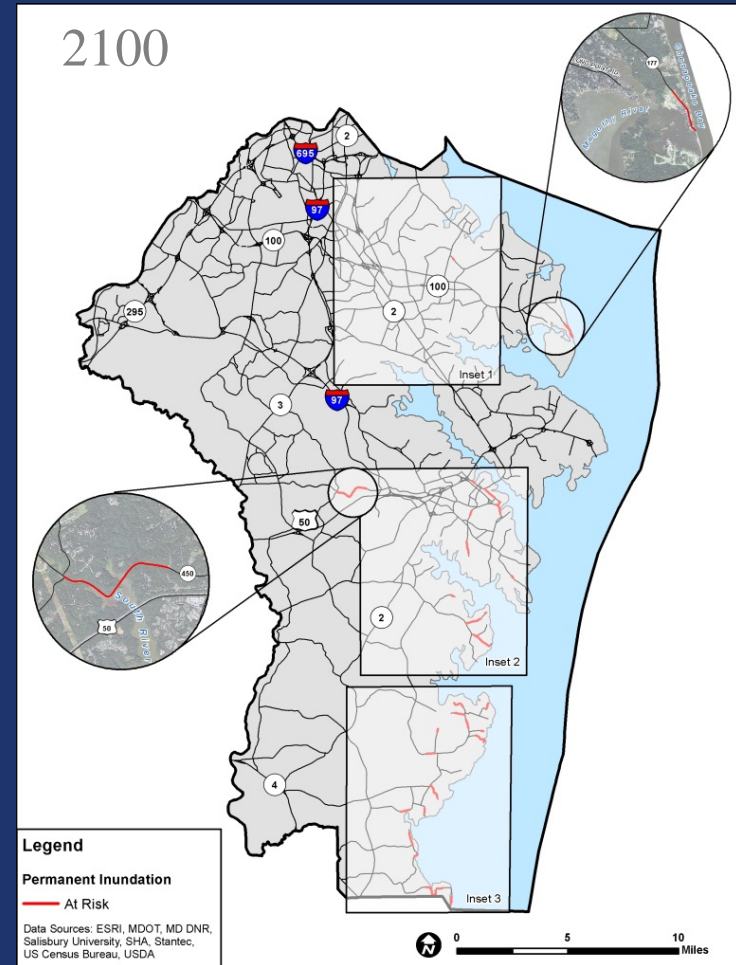
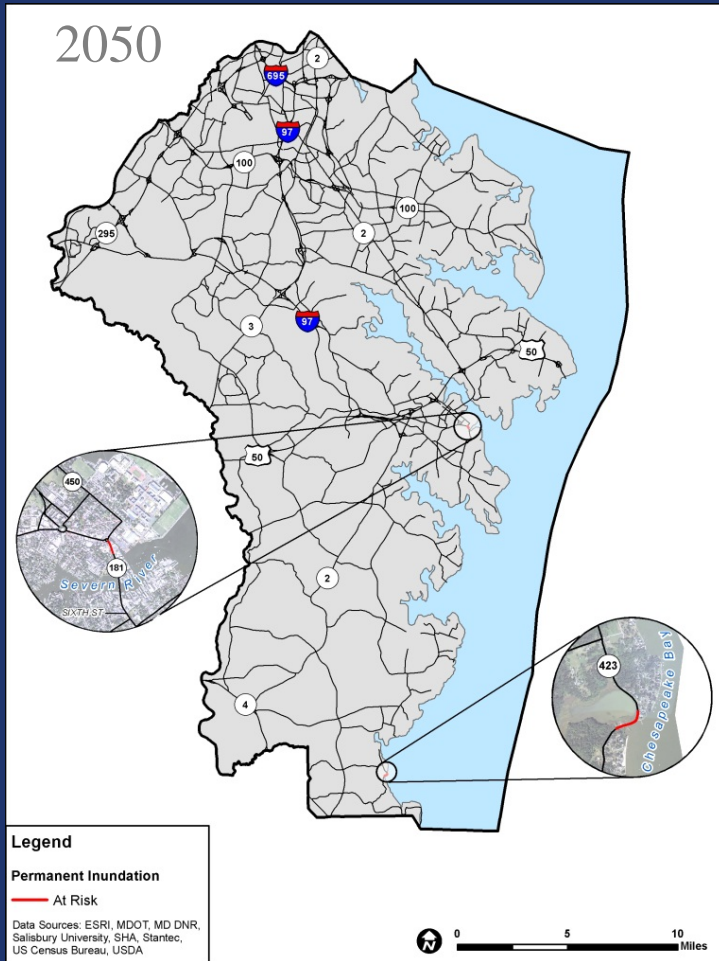
Eastern Shore Regional GIS Cooperative – Salisbury University

County	Tidal Station	2050		2100	
		MSL	MHHW	MSL	MHHW
Allegany	None	-	-	-	-
Anne Arundel	Annapolis	2.08	2.79	5.7	6.41
Baltimore	Baltimore	2.01	2.87	5.59	6.45
Baltimore City	Baltimore	2.01	2.87	5.59	6.45
Calvert	Solomons Island	2.1	2.82	5.76	6.48
Caroline	Cambridge	2.11	3.13	5.78	6.8
Carroll	None	-	-	-	-
Cecil	Chesapeake City	1.98	3.63	5.56	7.21
Charles	Washington DC	2.21	3.83	5.78	7.4
Dorchester	Cambridge	2.11	3.13	5.78	6.8
Frederick	None	-	-	-	-
Garrett	None	-	-	-	-
Harford	Baltimore	2.01	2.87	5.59	6.45
Howard	None	-	-	-	-
Kent	Annapolis	2.08	2.79	5.7	6.41
Montgomery	None	-	-	-	-
Prince Georges	Washington DC	2.21	3.83	5.78	7.4
Queen Annes	Annapolis	2.08	2.79	5.7	6.41
Somerset	Cambridge	2.11	3.13	5.78	6.8
St. Mary's	Solomons Island	2.1	2.82	5.76	6.48
Talbot	Cambridge	2.11	3.13	5.78	6.8
Washington	None	-	-	-	-
Wicomico	Cambridge	2.11	3.13	5.78	6.8
Worcester	Ocean City	2.06	3.25	5.86	7.05

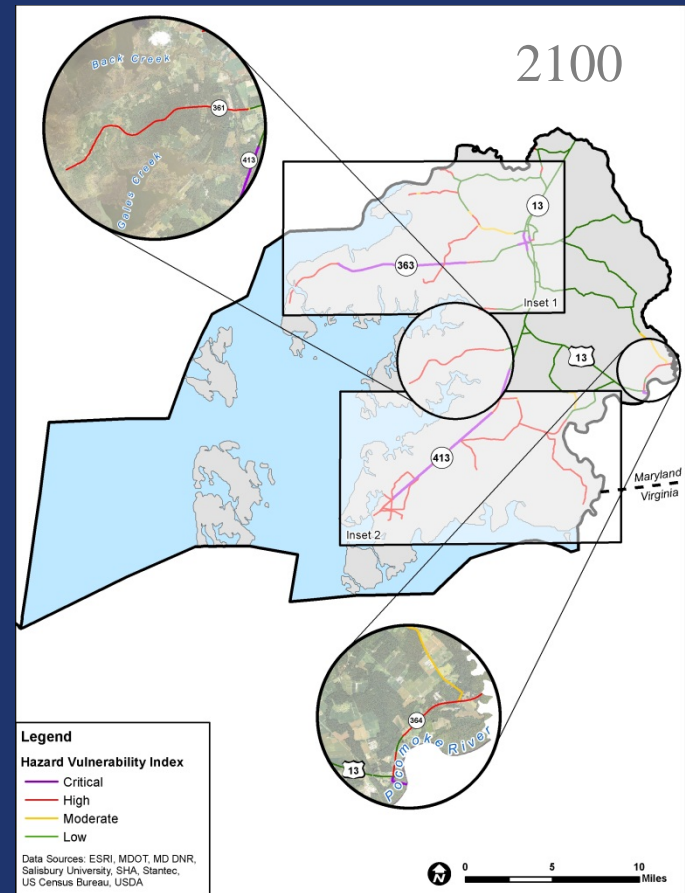
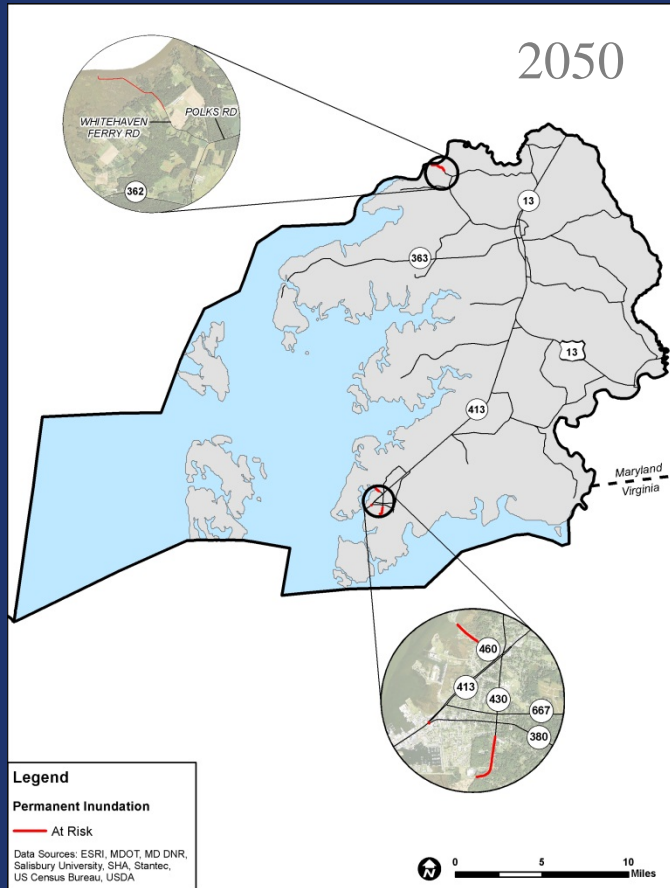


Methodology – USACE: Sea-Level Change Considerations for Civil Works Programs, October 2013

Permanent Inundation for Anne Arundel



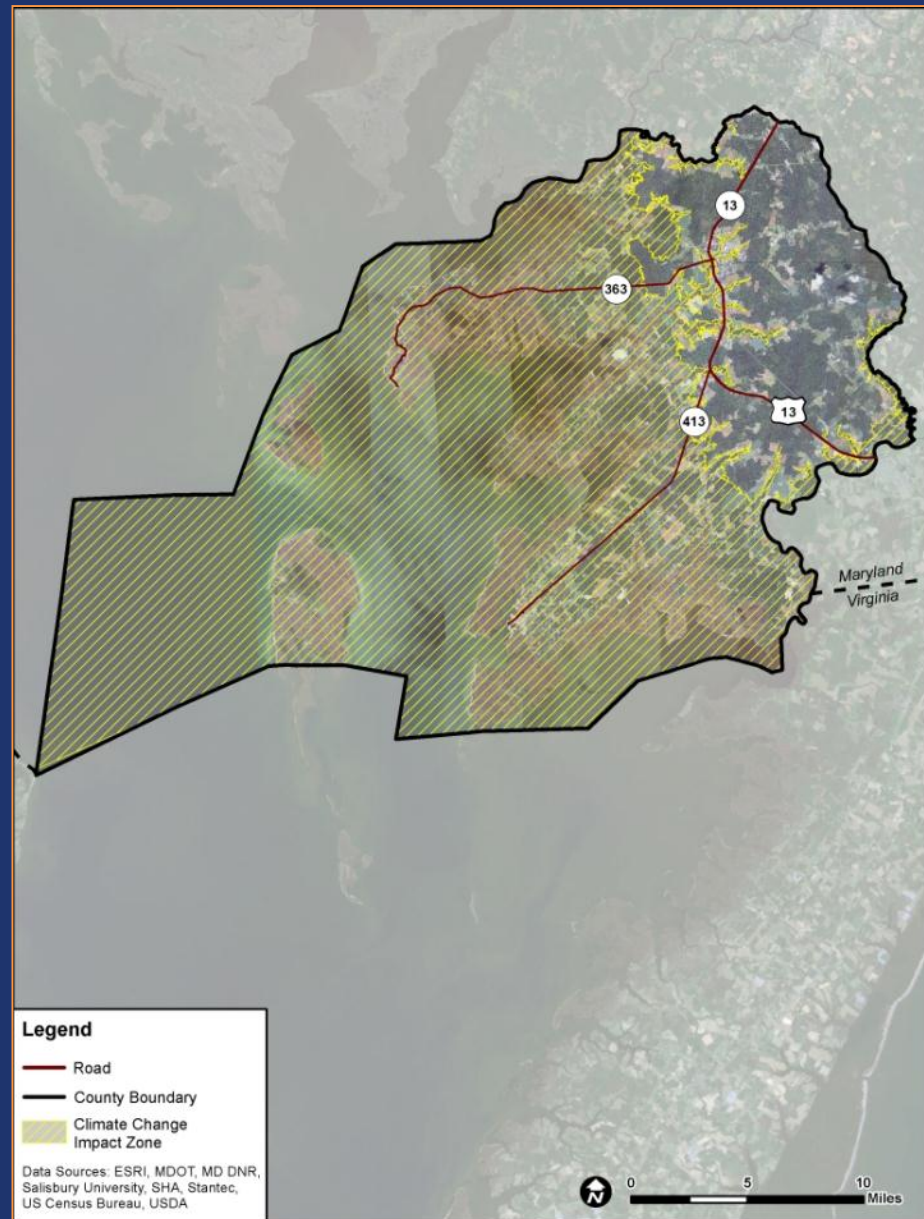
Permanent Inundation Somerset County



Key Step

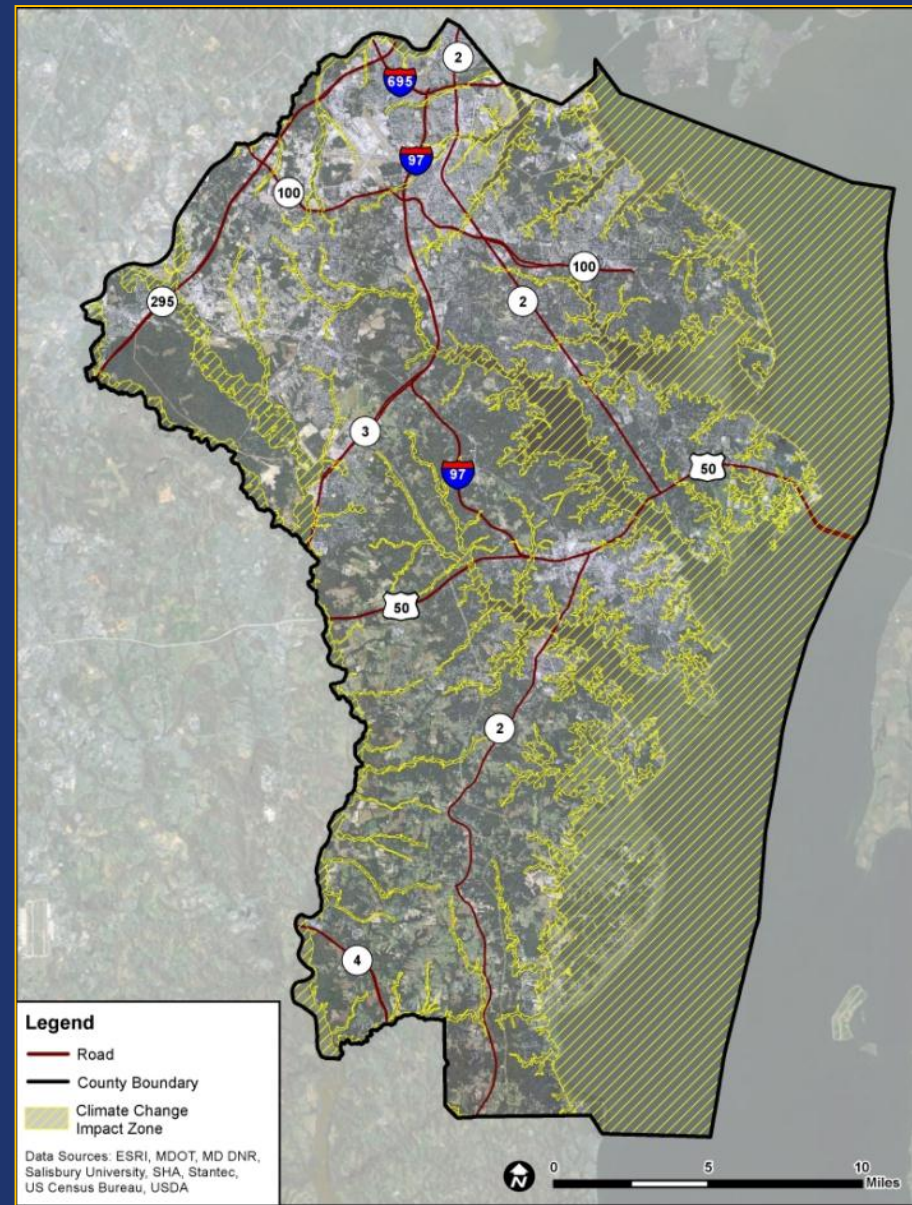
Assess Vulnerability

- Two Pilot Counties
- Initial Screening of Assets
- Tools Used
 - Hazard Vulnerability Index
 - VAST



Initial Screening

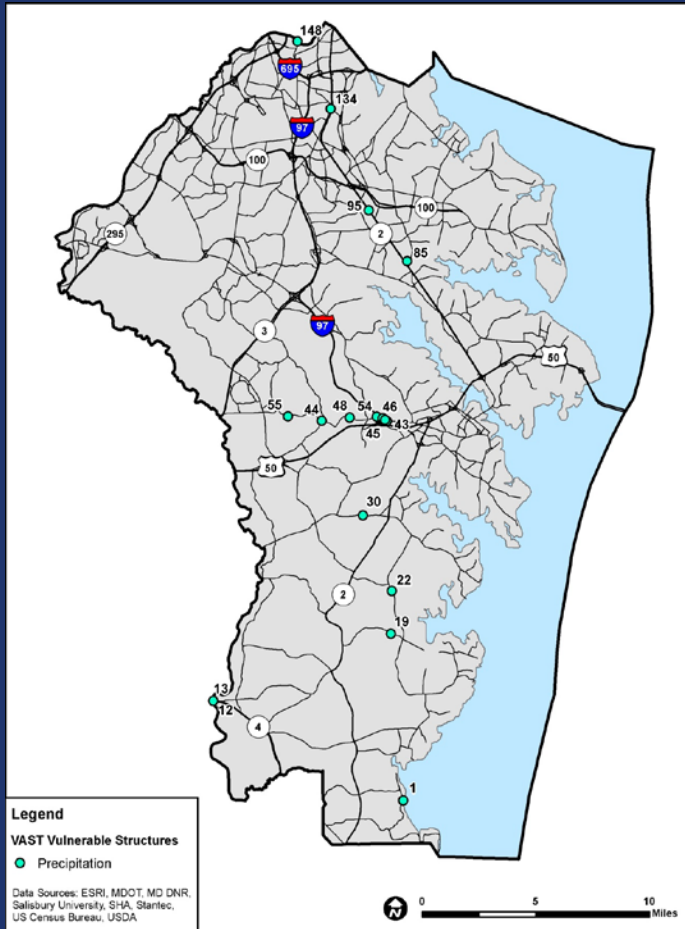
- Climate Change Impact Zone Map Created Using GIS
- Eliminate assets at low to no risk prior to use of VAST
- Used SLOSH (Cat 3), 2100 MHHW, FEMA 100 year Floodplain, plus 50 ft buffer



Results of Screening

Assets	Anne Arundel County		Somerset County	
	Number of Assets	Evaluated in More Detail	Number of Assets	Evaluated in More Detail
Bridges including large culverts	517	150	86	72
Small culverts and conveyances	Culverts- 12,024 Conveyances- 8,601	Culverts- 1,174 Conveyances- 843	Culverts- 1153 Conveyances 1135	Culverts- 739 Conveyances 847
Miles of roadway	2,554.28 miles	114.99 miles	503.92 miles	285.2 miles

FHWA Vulnerability Assessment Scoring Tool Results



Vulnerability to Precipitation		
Structure ID	VAST Score	Evacuation Route
134	3.1	Yes
44	2.8	No
30	2.8	No
43	2.8	No
45	2.8	No
46	2.8	No
1	2.6	No
22	2.6	No
95	2.5	Yes

Hazard Vulnerability Index (HVI)

Risk =

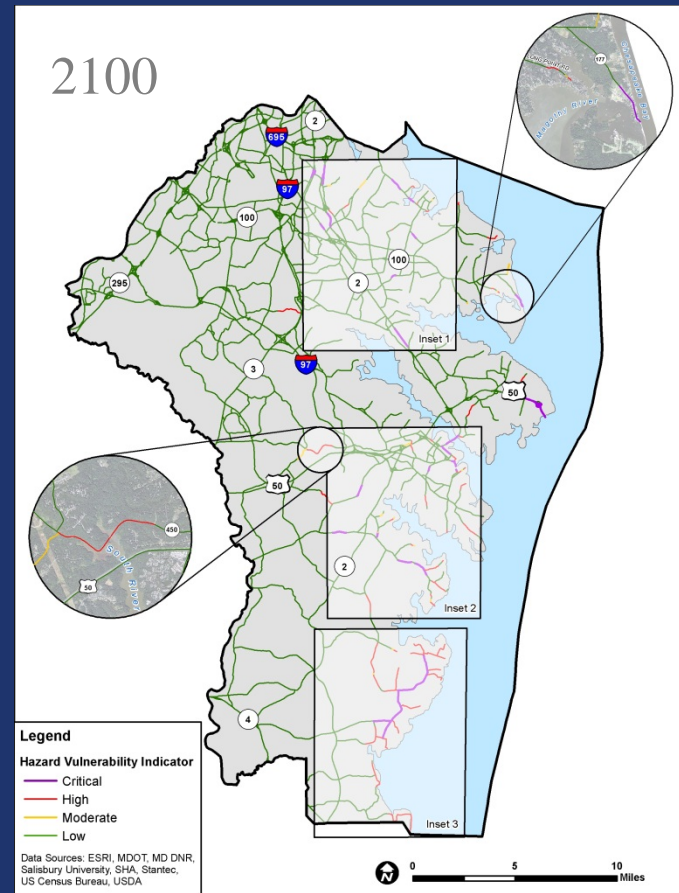
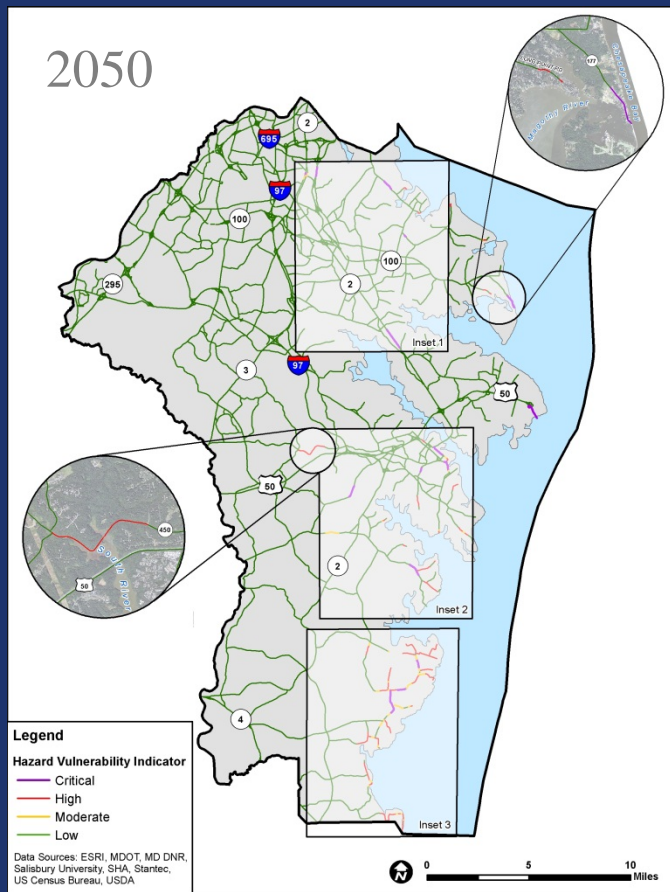
$$(Evacuation\ Code * 0.5 + 1) * \left(\frac{(Flood\ Depth\ Code + 0.01)}{4} \right) * \left(\frac{0.7}{Functional\ Classification} \right)$$

Evacuation	Code
No	0
Yes	1

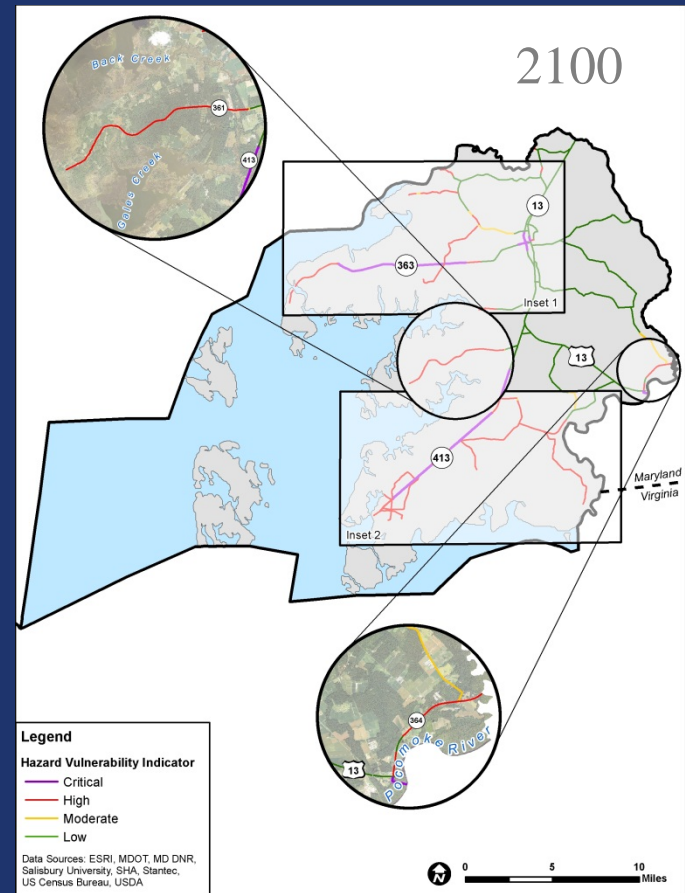
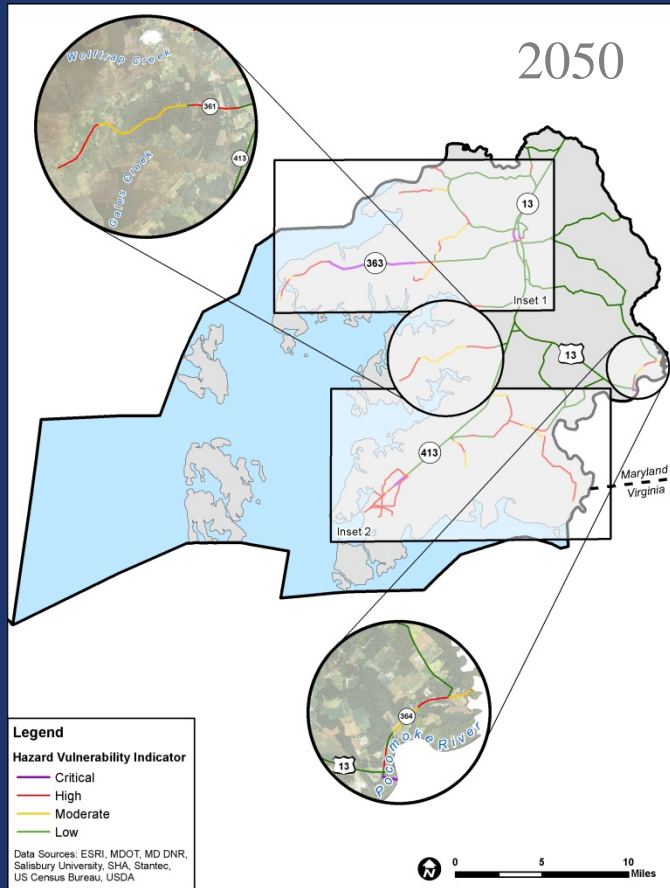
Flood Depth (Feet)	Code
No Flood	0
0 – 0.5	1
0.5 - 1	2
1 - 2	3
>2	4

Value	SHA Functional Class
1	Interstate
2	Principal Arterial – Other Freeways and Expressways
3	Principal Arterial – Other
4	Minor Arterial
5	Major Collector
6	Minor Collector
7	Local

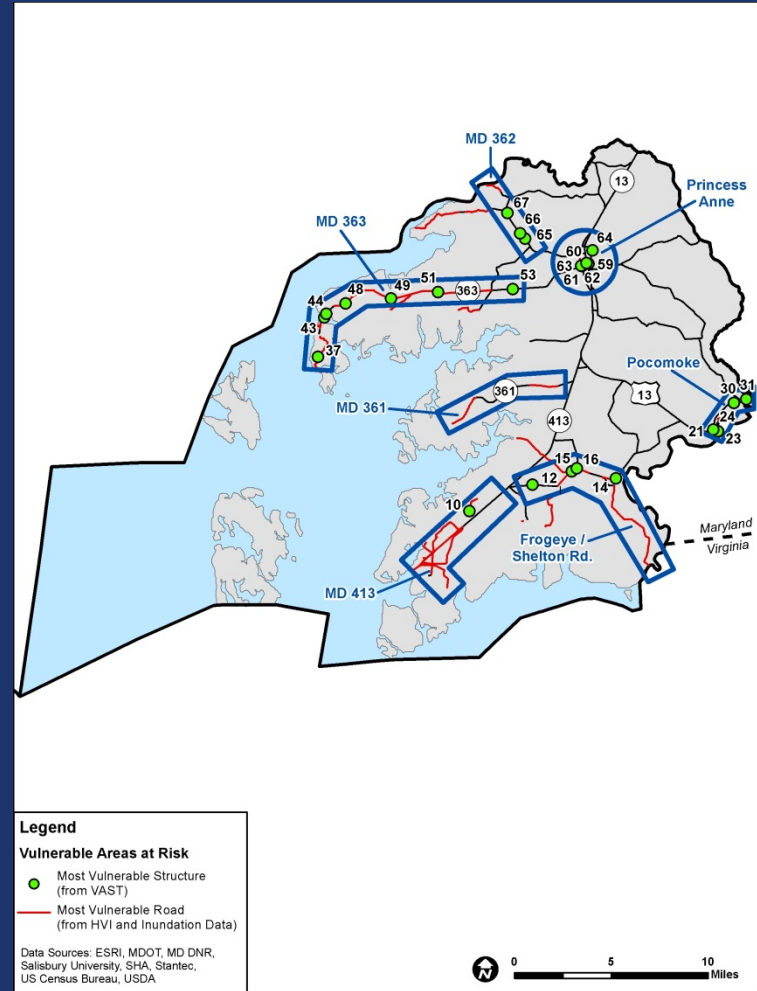
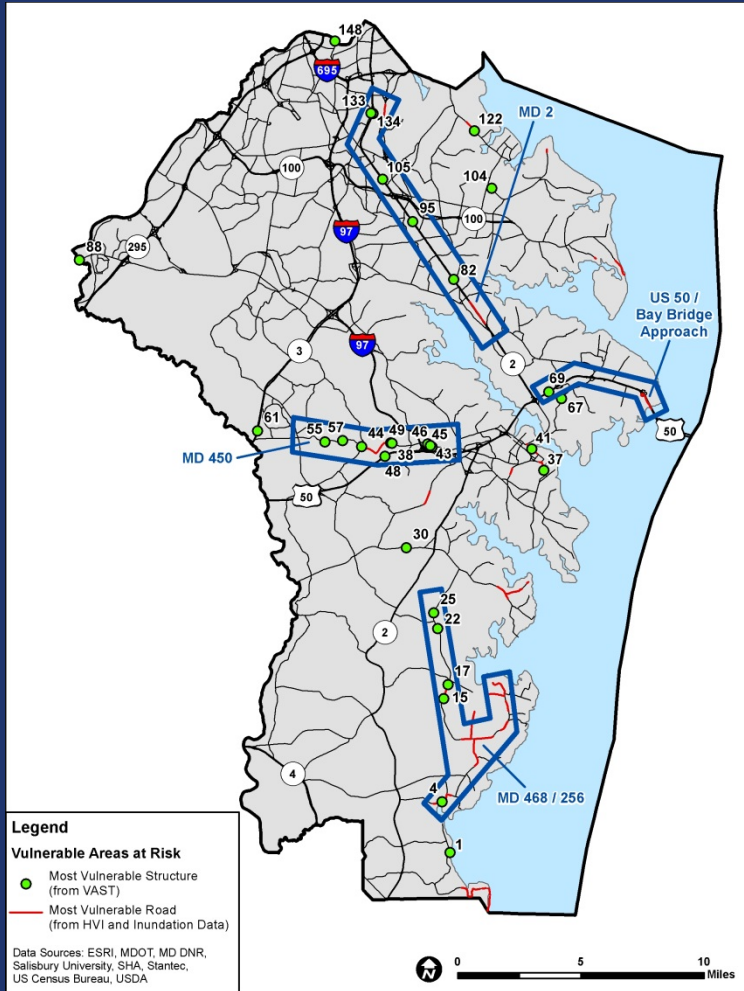
HVI for Anne Arundel County



HVI for Somerset County



Vulnerable Areas at Risk



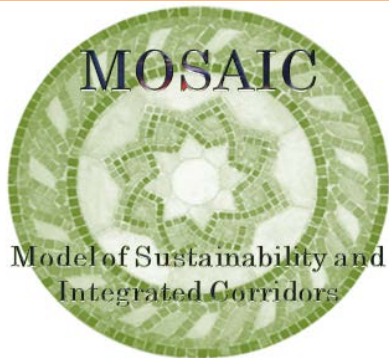
Results

- Anne Arundel County and Somerset County
 - Permanent Inundation
 - 2050 & 2100 Sea Level Change (USACE)
 - 2050 & 2100 Sea Level Change with 100 Year Storm Event (HAZUS-MH)
 - Storm Surge Considerations (Still Water)
 - Hazard Vulnerability Index (HVI)
 - Vulnerability Scores from VAST for bridges
 - Vulnerable Areas at Risk

Asset Management

- Incorporation of vulnerability results into organization's processes
 - Sea Level Rise mapping review on all projects
 - NEPA documentation for projects with identified vulnerable assets
 - Identify vulnerable assets in planning documents – MOSAIC – Model of Sustainability and Integrated Corridors

Asset Management



- Define Corridor
- Define Sections
- Data Inputs
- Execute Model
- View Results
 - Map results
 - Interactive map display
 - Data package
 - PDF report
 - Input parameters table
 - File GDB
 - Corridor
 - Sections
 - Buffers
 - Processed GIS layers

- The MOSAIC tool will allow SHA:

- To take a data driven approach to the Highway Needs Inventory
- Analyze different project improvement alternatives to expedite the project planning process
- Organize data layers and develop outputs to assist in corridor selection

