ICCE 2018
36TH INTERNATIONAL CONFERENCE ON COASTAL ENGINEERING 2018
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The State of the Art and Science of Coastal Engineering

Rapid Coastal Adaptation Assessment City of Annapolis

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City of Annapolis

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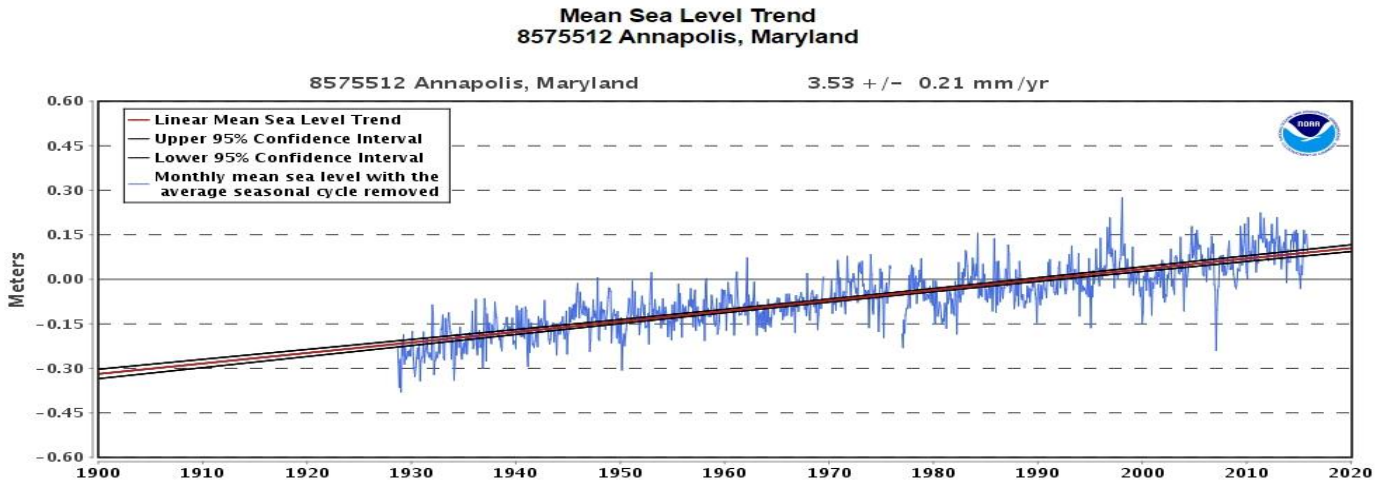
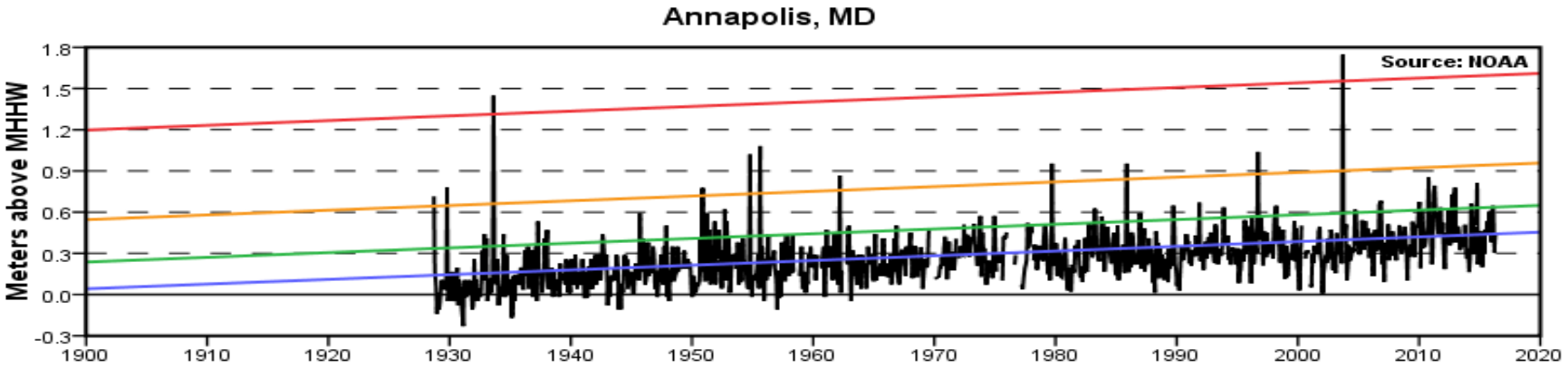
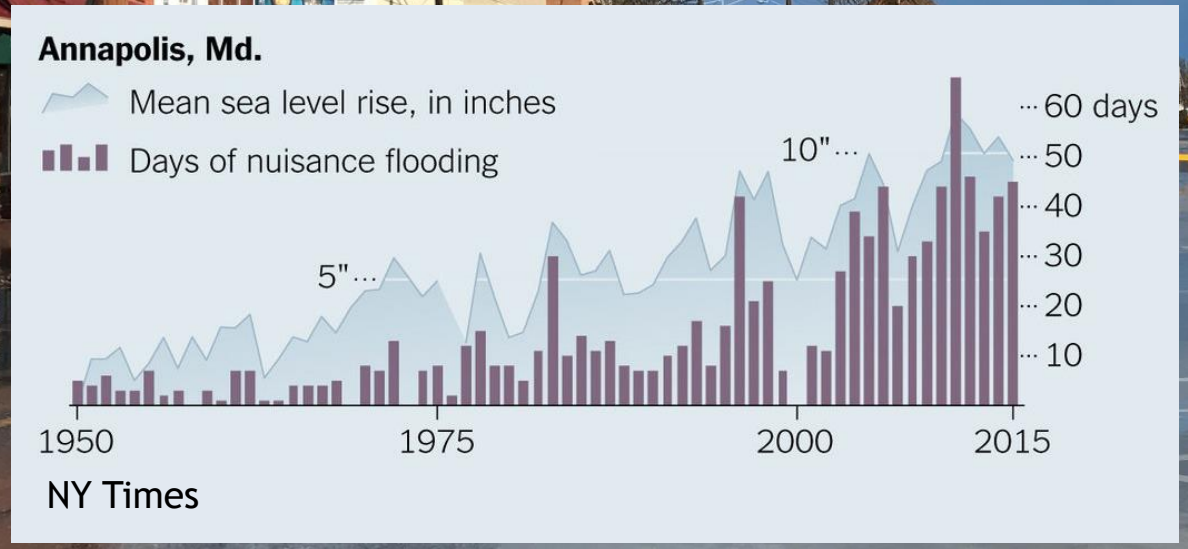




Seawater in the Streets 40+ days / year



Stakeholder Engagement

29 Organizations, 175+ Public events, 4,000+ Person-encounters

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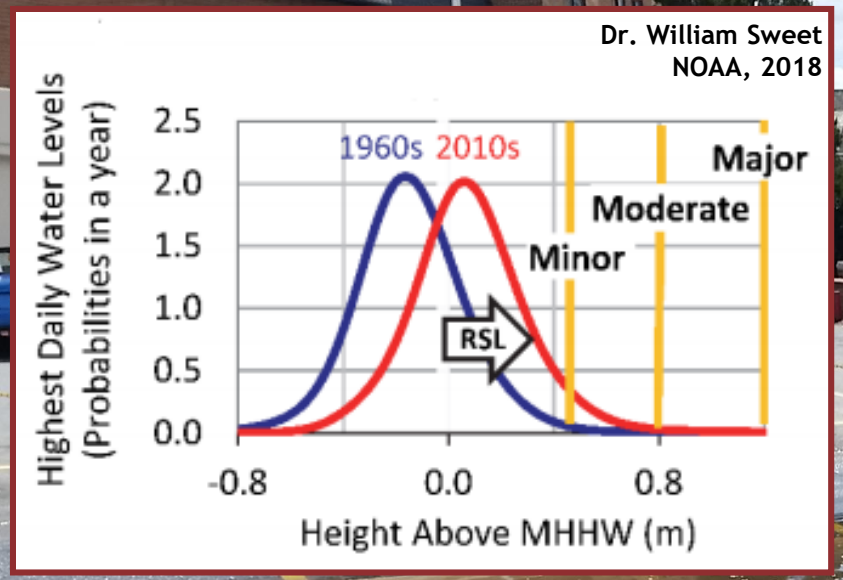
Expectations



What are you/we going to do about it?

Planning Response

48 Action Items
47 Projects
4 Structural

Rapid Coastal Adaptation Assessment

5 Steps

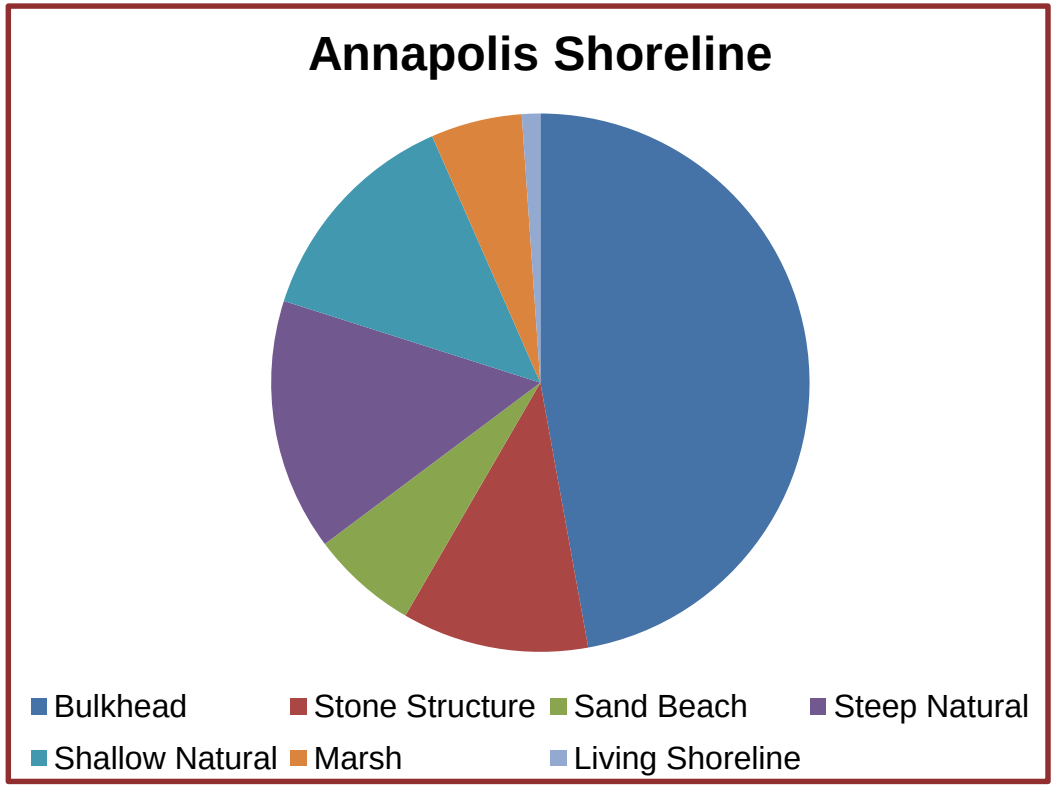
1. Team
2. Characterize the coast
3. Catalog adaptation measures
4. Develop cost models
5. Apply

Step 1: Team

Engineers and architects
- City planning team
- U. S. Army Corps of Engineers
- U. S. Naval Academy

Step 2: Assess Shoreline

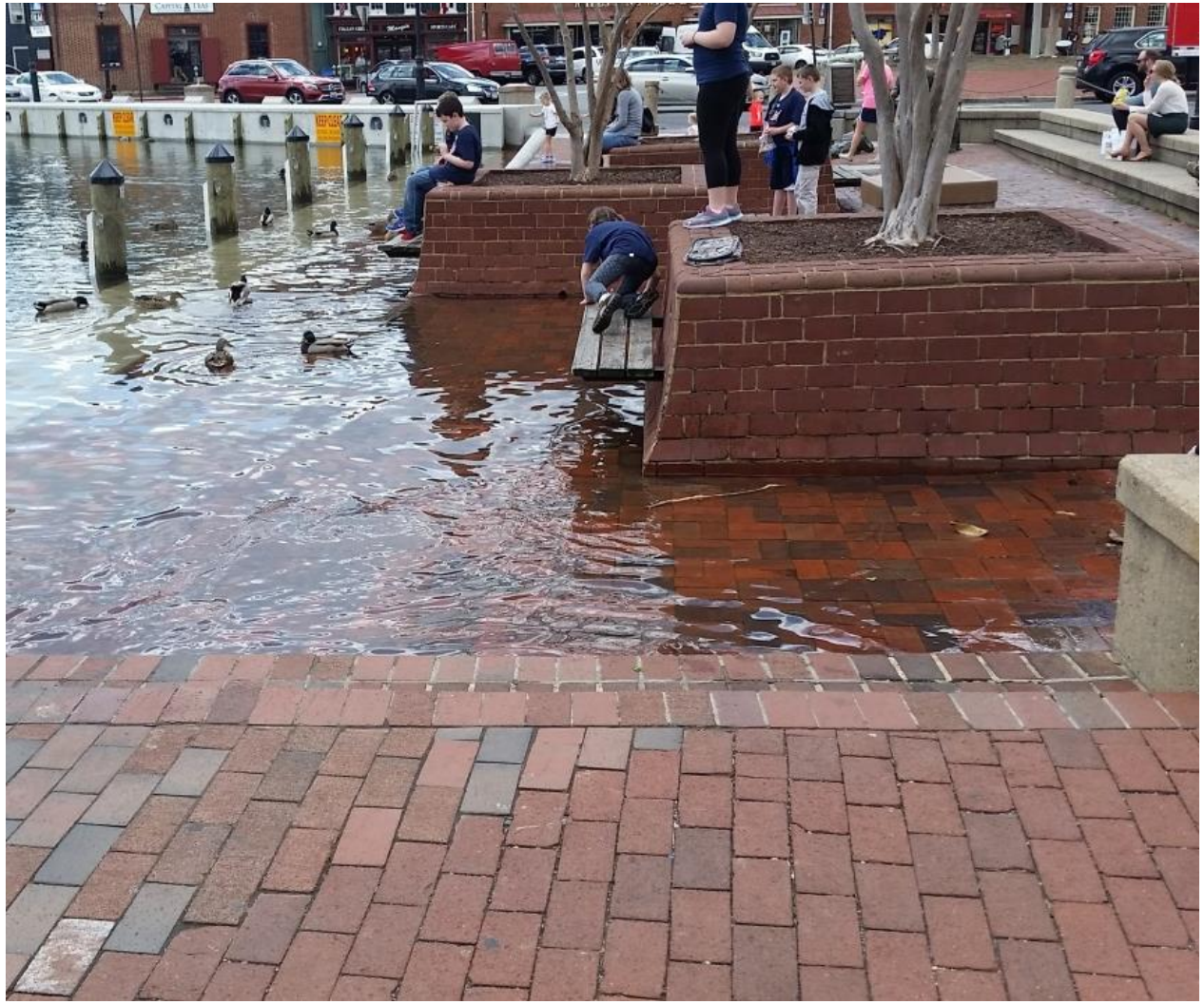
106,500 feet or 20.2 miles of shoreline



Step 3: Catalog Adaptation Measures

What works?

- Levees
- Floodwalls
- Bulkheads
- Stone sills with living shorelines
- Raise streets
- Raise public infrastructure



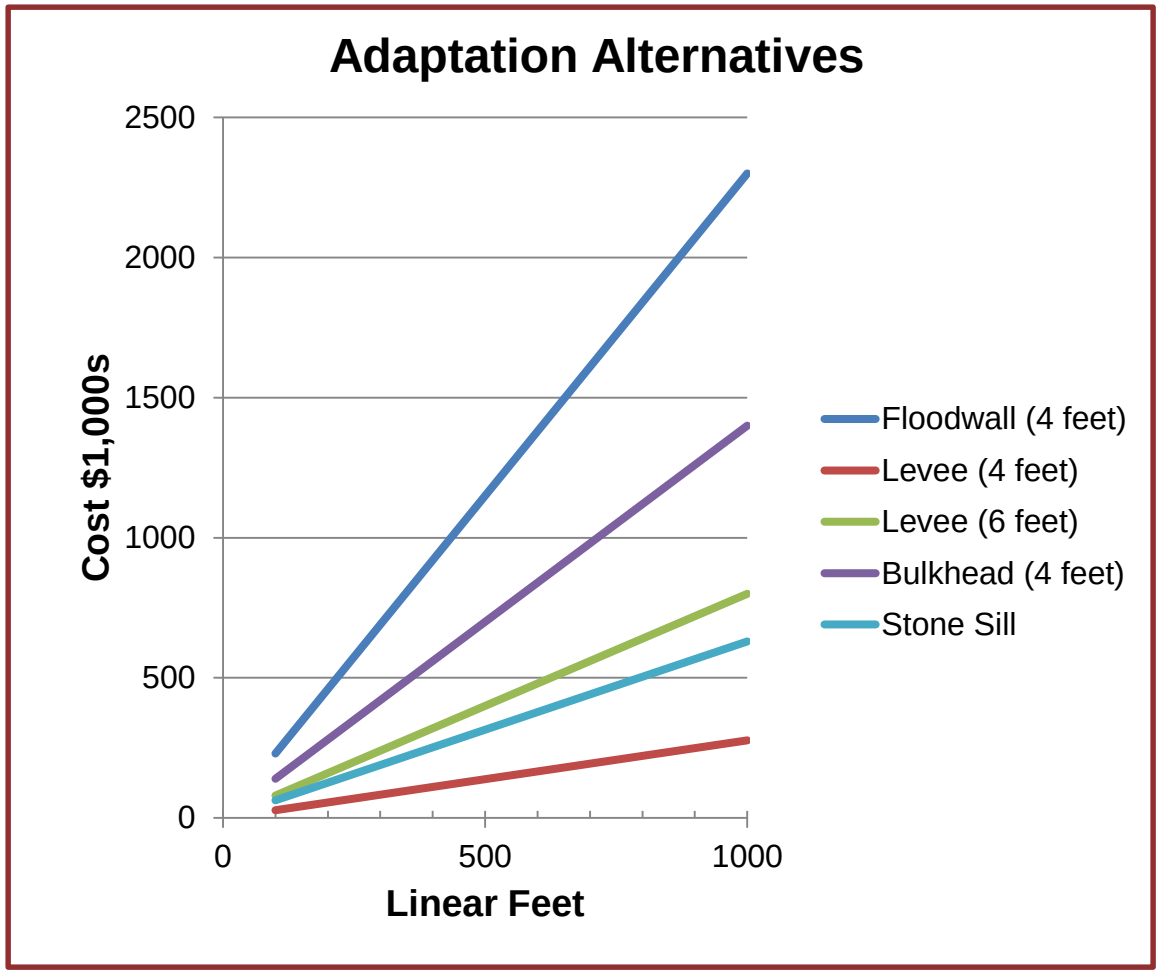
Step 4: Develop Parameterized Cost Models

Successful adaptation

- Assumptions
- U.S. Army Corps of Engineers data
- Data from other jurisdictions

Express costs by parameters

- $ per linear foot
- $ per square yard

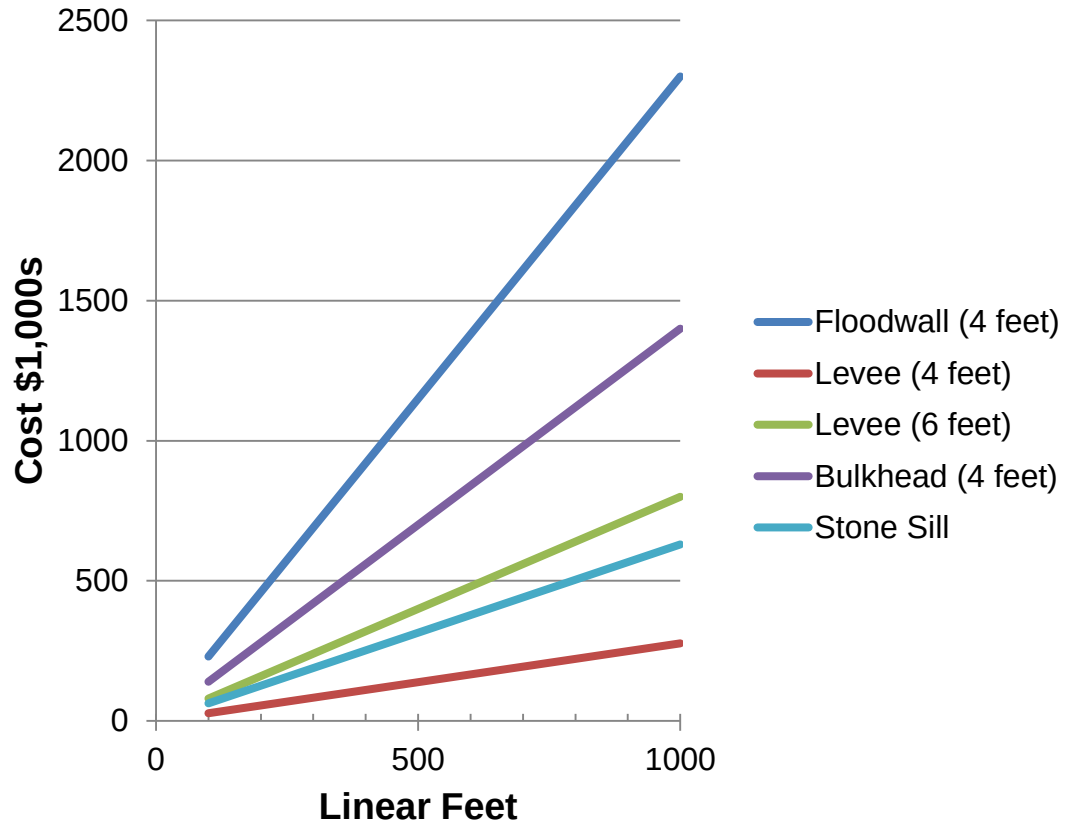


Adaptation Toolkit

Adaptation Alternatives

Floodwall, H-pile, 4 feet
Levee Embankment, 4 feet
Levee Embankment, 6 feet
Stone Sill, Living Shorelines
Timber Bulkhead, 4 feet, wood face
Timber Bulkhead, 4 feet, vinyl face
Raise Roadway, 2 feet H, 30 feet W
Raise Parking Lot, 2 feet, Asphalt
Raise Parking Lot, 4 feet, Asphalt

City Dock, Raise Seawall + Promenade, 2 ft
City Dock, Raise Seawall + Promenade, 4 ft
City Dock, New T-wall, 2 ft H
City Dock, New T-wall, 4 ft H



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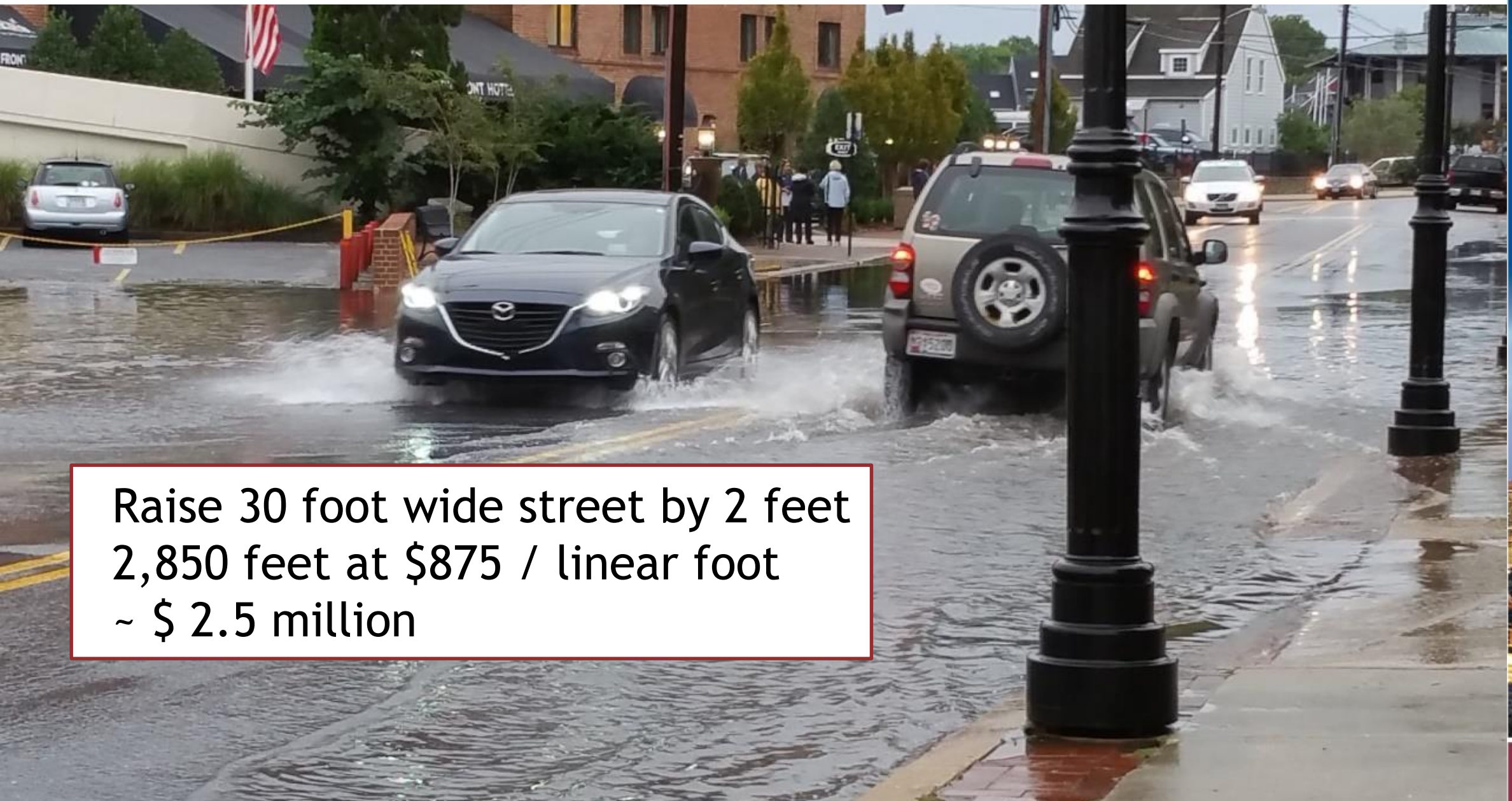
Step 5: Apply the Toolkit (example)



Raise 30 foot wide street by 2 feet
2,850 feet at $875 / linear foot
~ $ 2.5 million

Step 5: Apply the Toolkit (example)

50,207 feet existing bulkhead
Bulkhead 4 foot above MHW
~ $ 1,400 per linear foot
~ $ 70 million

What did we learn?

#1 Context

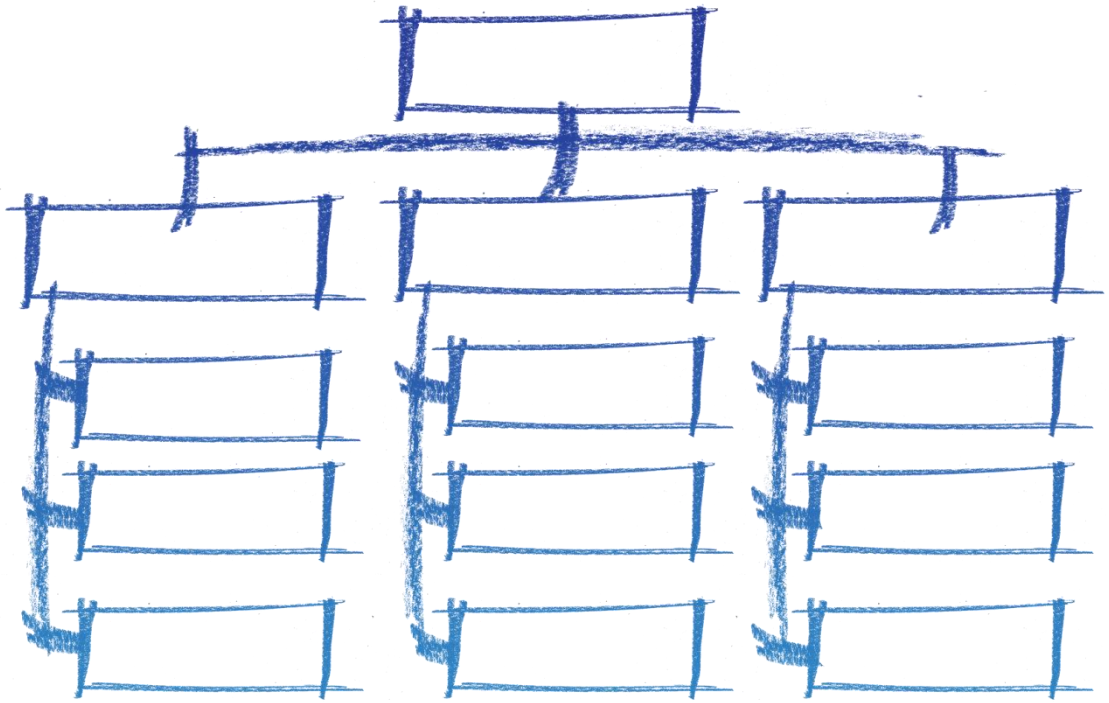

Adaptation
~ $100+ million
20.2 miles
Miles of Shoreline
20 Annapolis
3,190 Maryland
17,140 Gulf coast
28,763 Atlantic coast
City of Annapolis
20.2 miles
~40 K people
~106 M annual budget (FY18)
Debt Service
30 years @ 5%
~6.4 M annual / $100 M

#2 Properly Frame the Problem

- Not a flood problem
- Not an engineering problem

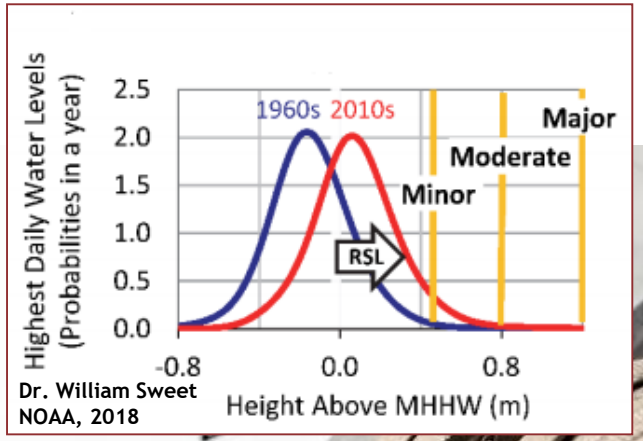
Economic Development

#3 No Clear Organizational Home

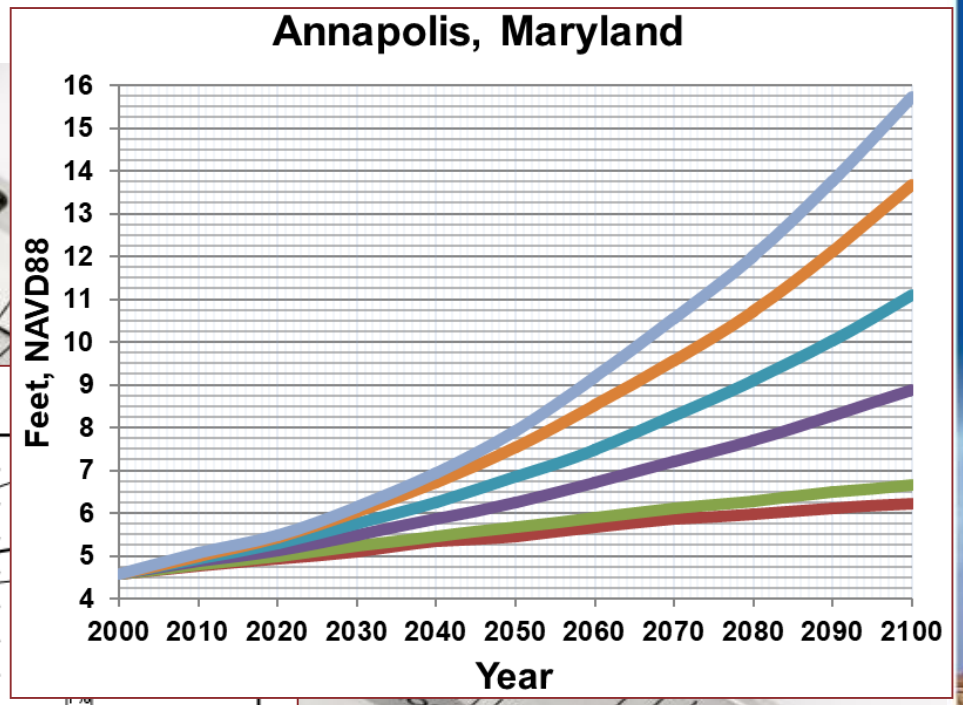


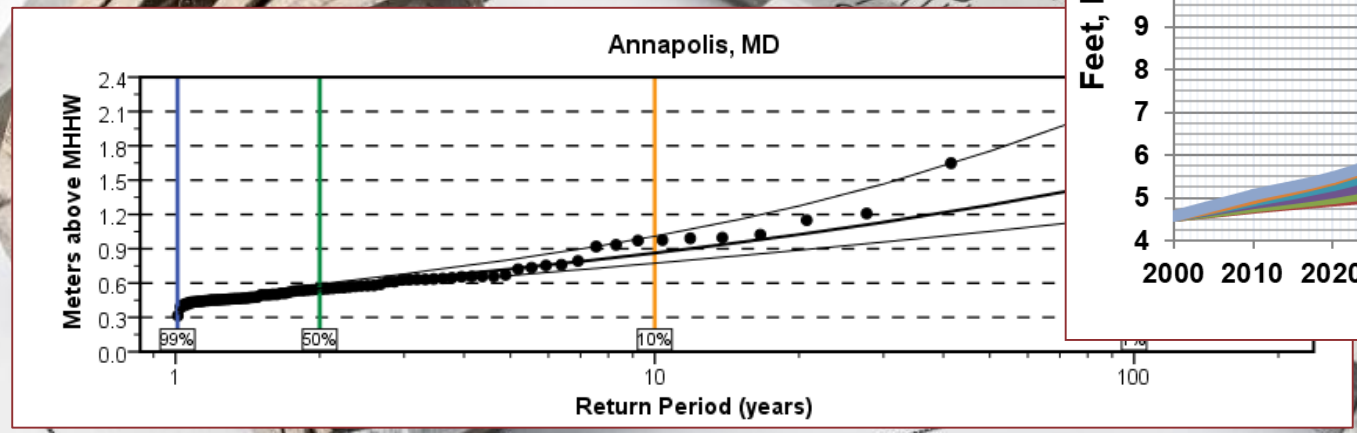
Public Works
Emergency Management
Building Codes
Planning and Zoning
Historical Preservation
Economic Development
Sustainability
Resilience
Finance
Legal
Elected Officials

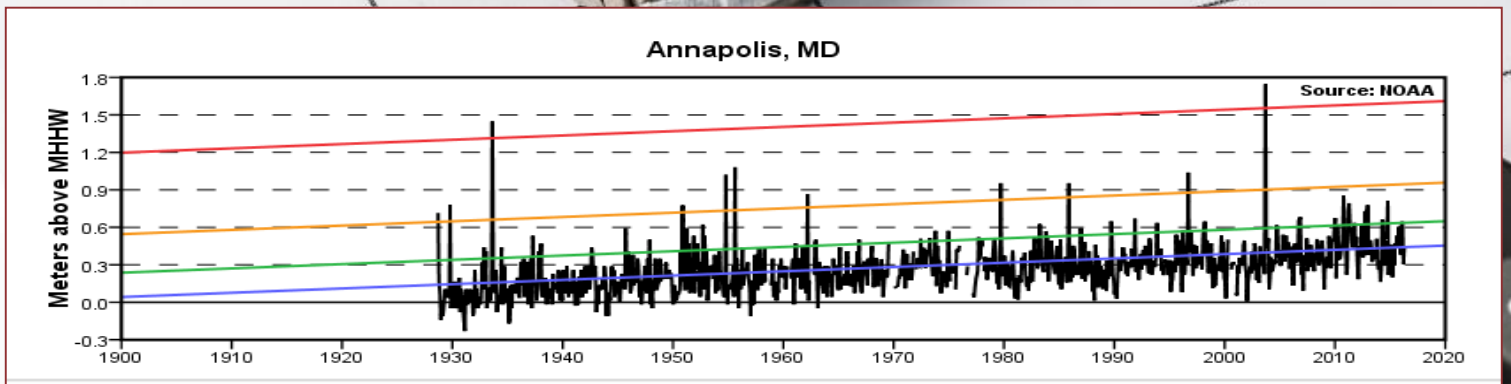
#4 Knowledge Gaps

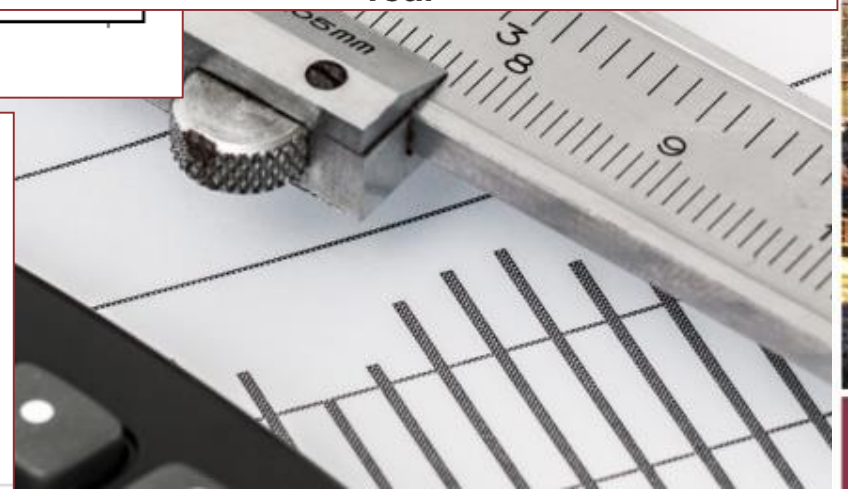


Dr. William Sweet
NOAA, 2018









On-line Training Curriculum

Tools & Data -

- NOAA
- FEMA
- U.S. Army Corps

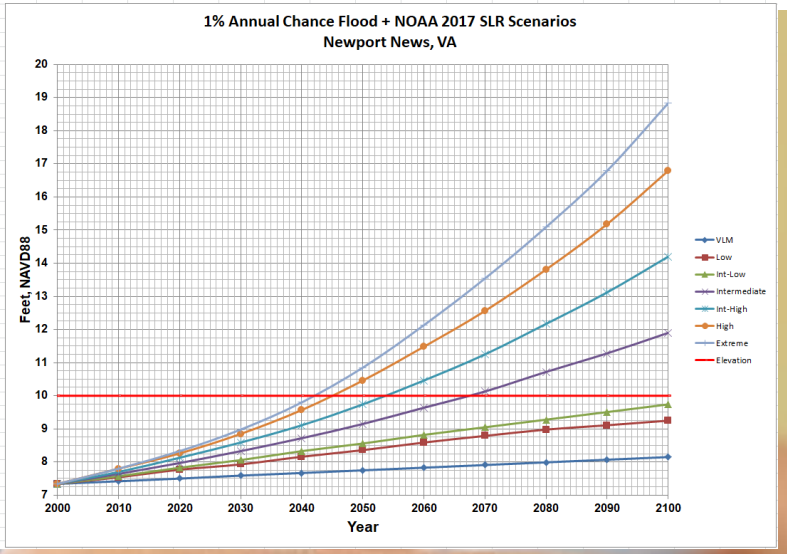
Flood Elevations and SLR Scenarios
600 Jefferson Avenue, Newport News, VA 23607

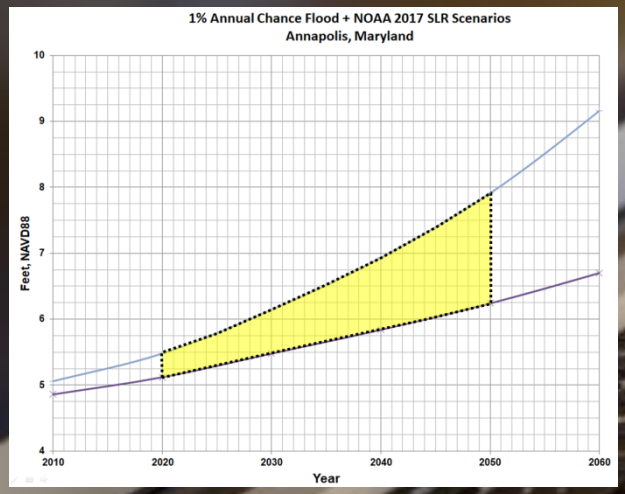
Elevation	Description
-0.25	MSL feet NAVD88
0.95	MHW, feet NAVD88
1.15	MHHW, feet NAVD88
5.40	10% Annual Chance Flood Elevation, feet NAVD88
7.50	1% Annual Chance Flood Elevation, feet NAVD88
8.90	0.2% Annual Chance Flood Elevation, feet NAVD88
5.72	Estimated Highest Storm Surge Relative to MSL, feet
10.00	Property Elevation of Interest, feet NAVD88

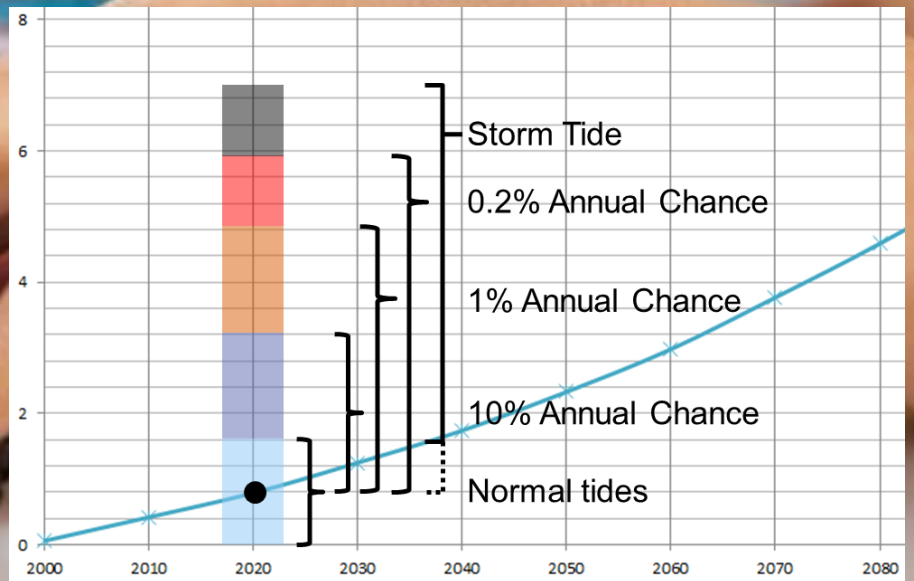
	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017	NOAA2017	
Year	VLM	Low	Int-Low	Intermediate	Int-High	High	Extreme	Elevation
2000	0.09	0.09	0.09	0.09	0.09	0.09	0.09	
2010	0.17	0.29	0.32	0.39	0.45	0.55	0.55	10
2020	0.25	0.52	0.58	0.72	0.88	1.01	1.08	10
2030	0.34	0.68	0.81	1.08	1.34	1.6	1.73	10
2040	0.42	0.91	1.08	1.47	1.86	2.32	2.55	10
2050	0.5	1.11	1.31	1.9	2.49	3.21	3.6	10
2060	0.58	1.34	1.57	2.39	3.21	4.23	4.88	10
2070	0.66	1.54	1.8	2.88	4	5.31	6.29	10
2080	0.74	1.73	2.03	3.47	4.92	6.56	7.84	10
2090	0.82	1.86	2.26	4.03	5.87	7.93	9.54	10
2100	0.9	2	2.49	4.65	6.95	9.54	11.58	10

1% Annual Chance Flood Elevation, feet NAVD88

Year	VLM	Low	Int-Low	Intermediate	Int-High	High	Extreme	Elevation
2000	7.34	7.34	7.34	7.34	7.34	7.34	7.34	10
2010	7.42	7.54	7.57	7.64	7.7	7.8	7.8	10
2020	7.5	7.77	7.83	7.97	8.13	8.26	8.33	10
2030	7.59	7.93	8.06	8.33	8.59	8.85	8.98	10
2040	7.67	8.16	8.33	8.72	9.11	9.57	9.8	10
2050	7.75	8.36	8.56	9.15	9.74	10.46	10.85	10
2060	7.83	8.59	8.82	9.64	10.46	11.48	12.13	10
2070	7.91	8.79	9.05	10.13	11.25	12.56	13.54	10
2080	7.99	8.98	9.28	10.72	12.17	13.81	15.09	10
2090	8.07	9.11	9.51	11.28	13.12	15.18	16.79	10
2100	8.15	9.25	9.74	11.9	14.2	16.79	18.83	10







Sea Level Rise Planning: Technical Principles & Practice

On-line course
$0 cost scholarships available
- limited number
- end users

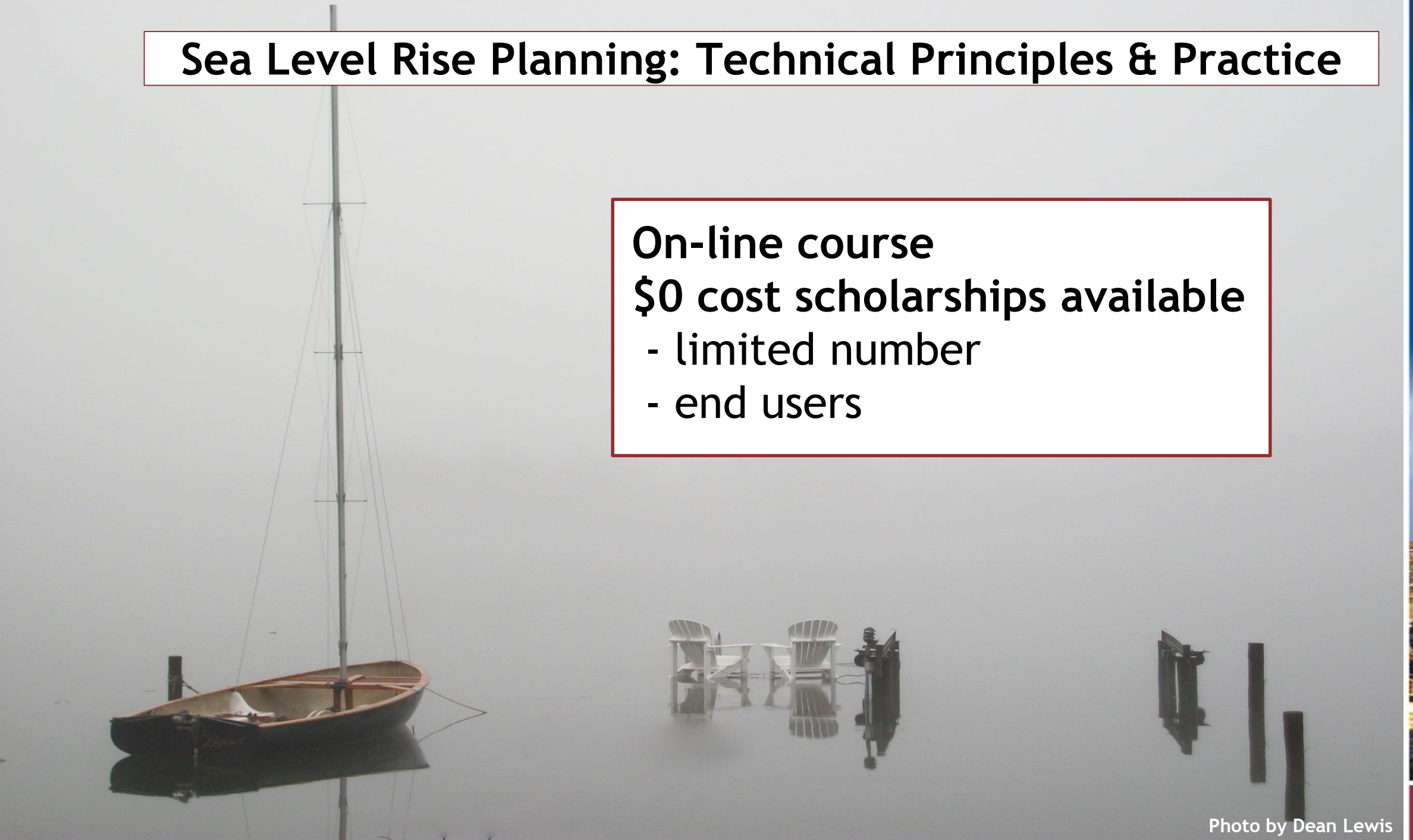


Photo by Dean Lewis

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For More Information

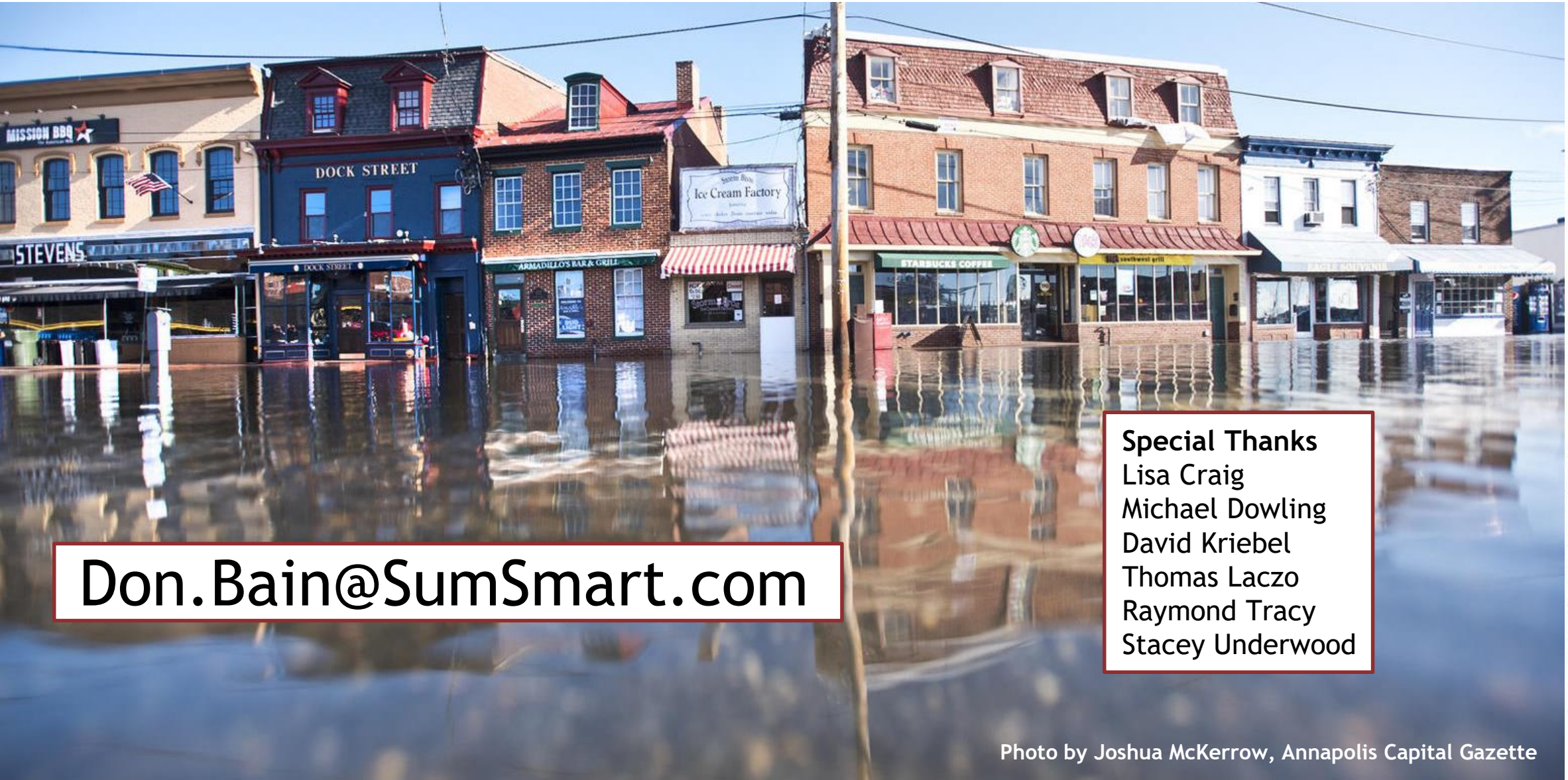

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Photo by Joshua McKerrow, Annapolis Capital Gazette