Adaptation Planning: Ideas from Annapolis

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The Roadmap

- Why Annapolis?
- What is the sea level rise trend?
- How to adapt to sea level rise?
- Where do we go from here?

Source: USA Today
Location, Location, Location
Historic Annapolis
United States Naval Academy
Land Acquisition

1955

2018
Storm Surge Flooding

US Naval Academy in Annapolis, MD
Remnants of Hurricane Isabel Sept 2003
Storm Surge Flooding

Downtown, City of Annapolis flooded in Tropical Storm Isabel, Sep. 2003
Homemade flood barrier and pump during Hurricane Sandy, October 30, 2012.
Nuisance Flooding

Parking lot in downtown Annapolis flooded to heavy rain and high tide, October 2010.
Nuisance Flooding

Sunny day high-tide flooding caused by backflowing stormwater drains, Feb. 2016.
Downtown flooding caused by several days of rain last month, September 9, 2018.
Nuisance Floods in Annapolis

• Averaged 3.6 minor flood days per year during 1957-1963
• ~ 34 days per year during 2006-2010
• ~ 40 days per year during 2010-2016 (max of 66 in 2011)

Annapolis City Dock September 19, 2017

Source: Sweet et al. (2014), NOAA (2017)
What is the Sea Level Rise Trend?

Global and Local Annapolis Mean Water Level Trends (1928 - 2017)

Sources: Adapted from National Climate Assessment (2014), Church & White (2011), NOAA tidesandcurrents.noaa.gov
What is the Sea Level Rise Forecast?

Maximum physically plausible land ice loss by 2100, with warming from unchecked carbon emissions

Upper limit mandated by USACE (2013)

Upper limit in IPCC 2013 report (small contribution from land ice)

Moderate - major carbon cuts (Paris Accord goal)

Linear extrapolation of tidal gauge trend

Most Likely Scenarios: 0.2-0.4 m (8-16 in) of SLR by 2050
0.5-1.5 m (20-60 in) of SLR by 2100

Source: Adapted from Hall et al (2016)
“Show Me the Data!”

Source: Adapted from Hansen et al. (2008)
“Show Me the Data!”

18,000 yrs ago ★ 420 ft lower

120,000 yrs ago ★ 20 ft higher

Today

Source: Adapted from Dr. Wanless presentation to Miami-Dade County Board of Commissioners (2008)
"There's still a lot about the rapid rate of Arctic change that we don't understand." - Mark Serreze, director of the National Snow and Ice Data Center.

Source: Stroeve et al. (2007)
Armor, Adapt, or Abandon?
U.S. Naval Academy Flood Protection
Examples of USNA Flood Protection
Some Assembly Required
Some Assembly Required
Off the Shelf Products
Homemade “Armor”
Homemade “Armor”
Adaptation Options
Adaptation Options
Adaptation Options
Adaptation Options
Raise or Raze?
Which options to choose?

Economics is a driving factor, also consider:

• Practicality
• Timeline
• Modularity
• Risk Calculus
• Economy of Scale
• Collective Benefits
What can you do?

- Be informed about sea level rise and tell others
- Learn from other region’s experiences
- Look for your vulnerabilities
- Take action, as needed, to Adapt, Armor, or Abandon
Questions?

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How Much More Will Sea Level Rise?

Local Sea Level Rise Varies due to Vertical Land Movement

Source: Hall et al. (2016), IPCC AR5 (2013)
Causes of Local Sea Level Rise vs. Global Sea Level Rise Trend

Source: Hall et al. (2016), IPCC AR5 (2013)