Sea Level Rise in Delaware

Presented by
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to
The Center for the Inland Bays
Scientific and Technical Advisory Committee

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Sea level has been fluctuating ever since there have been seas.
Late Cretaceous 75 million yrs ago

Greenhouse Earth
Last 2.6 million yrs

Huge ice sheets advance/retreat

Icehouse Earth
During the last glacial episode, massive glacial ice sheets, up to two miles thick, covered the northern half of North America and Greenland. In North America, ice sheets extended southward to Long Island and Cape Cod.

Delaware - 17,000 ybp: sea level -425 feet;

Ancestral Delaware River flowed to edge of continental shelf where shoreline was located;

Similar climate to arctic northern Canada - tundra, boreal forest.

Graphic courtesy Delaware Estuary Atlas and J.C. Kraft
11,000 ybp: glaciers melting, sea level rising; climate similar to Maine

2007: shoreline has migrated to present position

Graphics courtesy Delaware Estuary Atlas and J.C. Kraft
Post-Glacial Sea Level Rise

- Meltwater Pulse 1A
- Last Glacial Maximum

Sea Level Change (m)

Thousands of Years Ago

- Santa Catarina
- Rio de Janiero
- Senegal
- Malacca Straits
- Australia
- Jamaica
- Tahiti
- Huon Peninsula
- Barbados
- Sunda/Vietnam Shelf
Eustatic vs. Relative Sea Level Rise

• Eustatic sea level rise refers to the change of the volume of the global ocean.

• Relative Sea-Level Rise refers to the change at a particular location.
  – Varies depending on tectonic uplift or subsidence.
  – commonly exceeds the global rate of sea-level rise.
  – Important factor when determining coastal vulnerability and management plans.
100 yr tide gauge record

Short-term cycles in relative sea level

Geologic perspective:
Sea level has always been dynamic
An updated Holocene Sea-Level Curve for the Delaware Coast
Daria L. Nikitina, James E. Pizzuto, Reed A. Schwimmer, Kelvin W. Ramsey
June 1999

The updated curve documents a rate of sea-level rise of 0.9 mm/yr from 1250 yr BP to present (based on 11 dates), in good agreement with other recent sealevel curves from the northern and central U.S. Atlantic coast, while the previous curve documents rates of about 1.3 mm/yr (based on 4 dates). The precision of both estimates, however, is very low, so the significance of these differences is uncertain.
Fig. 7. Comparison of the envelope of the updated sea-level curve with Belknap and Kraft's (1977) curve.
IPCC 2007 Report

- 3 volumes & synthesis
- Nearly 3,000 pages
- [www.ipcc.ch](http://www.ipcc.ch)

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2007

The IPCC 4th Assessment Report is coming out
*A picture of climate change*
the current state of understanding
The rate of sea level rise is accelerating.
What might happen?

• Sea level rise
  – Land loss: coastal erosion
    • Wetlands (< 2’ above MHW)
    • Beaches (5-10’ above MHW)

• Migration of coastal landforms and changes to coastal environments
  – Potentially adverse affect on coastal species

• Storms & Flooding
  – Storm surge and waves impact farther inland
  – Potential to increase intensity of tropical storms
  – Reduce drainage rate of low-lying areas

• Coastal Water Supplies
  • Encroachment of saltwater wedge into estuaries & shallow coastal aquifers
How to calculate what might happen

Beach Response to Sea Level Rise

Brunn Rule
How NOT to calculate what might happen

Inundation Maps do not represent reality

Projection for 2100: 1m SLR
Coastal Sensitivity to Sea-Level Rise:
A Focus on the Mid-Atlantic Region

http://www.climatescience.gov/Library/sap/sap4-1/final-report/default.htm
Sea-Level Rise Predictions

- IPCC – 22 to 44 cm above 1990 levels by mid-2090 (8.6 to 17.3 in)
- EPA – 9 to 88 cm by 2100 (3.5 to 34.6 in)
- USGS – 15 to 95 cm by 2100 (6 to 37 in)
- NOAA – 50 cm by 2100 (19.7 in)

Variability in prediction due to uncertainties.
Global Mean Sea Level

(IPCC, 2007)
Effects of Sea-Level Rise

• Tidal inundation of low-lying areas
• Coastal erosion of wetlands and beaches
• Barrier island migration
• Increased coastal flooding
• Increased salinity of aquifers and estuaries
Uncertainties of Coastal Response

• Shorelines are in a continual state of change in response to natural processes.

• Difficult to quantify the range of factors that influence coastal change.
Assess Vulnerability

Example:

Wetland survival in response to three potential sea-level rise scenarios:

- Current rate
- Current rate +2 mm/yr
- Current rate +7 mm/yr

(CCSP 4.1)
Goals and Future Plans

• Strike a balance between growing populations desire to use coastal areas and the coast’s naturally changing shoreline
• Protect life and property from coastal hazards
• Protect coastal wetlands and habitats in harmony with economic growth.
• Continue research, data collection and planning to assess coastal vulnerability and improve coastal management actions to adapt to sea-level rise and maintain societal expectations for natural resources and land use.

(CCSP 4.1)
Beaches

Doug Inman, University of California, San Diego

• SEDIMENT SOURCES
• SEDIMENT PATHWAYS
• SEDIMENT SINKS
Fig. 6. Histogram showing the distribution of marsh accretion rates along the Delaware coast determined from $^{210}$Pb analyses.
Flooding impacts – permanent, ephemeral; (courtesy of Wendy Carey)
Other impacts on wetlands? - e.g. snow goose grazing, etc.
Courtesy of Wendy Carey