EFDC Model Development and Simulations

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EFDC 3-D Hydrodynamics Model Development
ongoing work since November 2019

Model refinements and re-calibration
Sea level rise simulations
Sea level rise and increased flow simulations
Prepared by:
Delaware Sea-Level Rise Technical Committee.

The Low, Intermediate and High planning scenarios correspond with the 5%, 50%, and 95% probability levels, under the IPCC AR5 RCP 8.5 emission scenario.
SLR Scenario Simulations

- Three dimensional EFDC model was refined
- SLR modeling approach and assumptions — Relative change in SL w.r.t. channel bottom
- Simulations
  - SLR — (0, 0.3, 0.5, 1.0, 1.6 m)
  - One representative dry year (2002) under SLR conditions and with increased freshwater inflows (500 or 1,000 cfs for 2 months)

SLR and flow sensitivity simulations to develop basic understanding

Example: 2002 hydrology with 1.6 m SLR
Animations

Simulation of 1.6 m of Sea Level Rise and with hydrological conditions from October 2002

Depth-averaged

Vertical Profile
Simulated tidally-averaged salinity profiles indicate that as sea level rises, the saltwater intrusion moves farther upstream.
Differences in Salinity along the Delaware Bay and Estuary
Simulations with hydrology from July - October, 2002

Differences in tidally averaged salinity over the four-month period

Change in Depth-averaged Salinity

Change in Near-bottom Salinity

The largest increase in salinity (1 to 4 ppt) occurs near RM 45 to 55, which may have significant impact on the health of the oyster habitats upstream of Ship John Shoal area.
During a prolonged low-flow period (similar to that of 2002) and SLR of 1.0 m or higher, the salt front may move upstream of RM 92.5 (mouth of Schuylkill River) and remain there for a month or longer.
Simulated salt front locations during 4-months of low flow conditions

With SLR of 0.5 m or higher, the range of salt front may pass the Schuylkill River with low flow conditions similar to those of 2002.
## Range of Salt Front for Different SLR
### Simulation of 2002 Dry Conditions

<table>
<thead>
<tr>
<th>SLR (m)</th>
<th>Min</th>
<th>Max</th>
<th>Average</th>
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</thead>
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<tr>
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<td>0.3</td>
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<td>1.6</td>
<td>67.14</td>
<td>104.30</td>
<td>93.40</td>
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Simulated salt front locations during 4-months of low flow conditions

Simulated seven-day moving average salt front location
The SF location with highest frequency moved from RM 86-88 (base case) upstream to RM 88-90 (SLR=0.3m), RM 90-92 (SLR=0.5m), RM 94-96 (SLR=1.0m), and RM 102-104 (SLR=1.6 m).
Simulations of July-October 2002 conditions with additional water released in August and September. A significant amount of water may be needed to keep the salt front below RM 92.5.
## Range of Salt Front during Dry Conditions (2002)

### Sensitivity of adding 500 or 1,000 cfs for 2 months

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<th>Average</th>
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<td>67.14</td>
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<td>92.38</td>
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<table>
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<th>SLR (m)</th>
<th>Min</th>
<th>Max</th>
<th>Average</th>
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</tr>
</tbody>
</table>

*Simulated seven-day moving average salt front location*
Evaluating the Effectiveness of Additional Freshwater Inflows

Salt Front Retreat Per 1,000 cfs of Additional Flow

$y = 0.3836x + 1.4111$

$R^2 = 0.9591$

Based on 500 cfs release

Based on 1000 cfs release

Relationships such as this may be helpful to inform decision-makers.
Salt Front Frequency Analysis for Additional Flow
SLR = 1.6 m; 2002 Dry Conditions

SLR = 1.6 m, no release

SLR = 1.6 m, Water Release = 500 cfs

SLR = 1.6 m, Water Release = 1000 cfs
Scenario Simulations with Various Hydrologic Conditions
Ten Representative Years

Ranked Flows at Trenton, NJ - Delaware River Mainstem


Simulations with current bathymetry of the Navigation Channel (45 feet below MLLW)
Simulated Salt Front Location
Summarized based on Hydrological Conditions

Simulated 7-day average salt front locations were used.
Simulated daily average salt front locations were used.
Frequency of Simulated Salt Front Location above the Schuylkill River (RM 92.5)

Simulated daily average salt front locations were used.
Caveats

- These analyses demonstrate the impact on salinity intrusion due to sea level rise in relation to the existing bathymetry.
- There are uncertainties related to future sea level rise that may require additional consideration.
  - Sediment transport/Channel dredging
  - Average seasonal cycle/storm surge frequency/hurricanes
  - Ocean Salinity/ Sea surface temperature
  - Hydrology with increased temperature and precipitation
- DRBC's Advisory Committee on Climate Change (AC3) will advise on assumptions and avenues of investigation.
Three dimensional EFDC model was refined

Simulations were performed for different SLR, hydrology, and additional flow

- SLR – (0, 0.3, 0.5, 1.0, 1.6 m)
- One dry year (2002) with increased freshwater inflows

Results may be used to inform formulation of FFMP2017 study alternatives

- Sea Leve Rise of 1.0 m or greater will push the salt front above RM 92.5
- Significant amounts of water will be needed to keep the salt front below RM 100 (based on 2002 hydrology)