Marsh Mudflat Dynamics under Sea Level Rise (SLR)

Advancing fundamental understanding and adaptation

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Overview of Salt Marshes in the South Western Delta

INTRODUCTION

3: The Land of Saeftinghe
- Marsh Details
  - Width (W): 3000m
  - Length (L): 6200m

2: Hellegat Salt Marsh
- Marsh Details
  - Width (W): 205m
  - Length (L): 773m

1: Sint Annaland Salt Marsh
- Marsh Details
  - Width (W): 650m
  - Length (L): 3000m

Dutch Water Design
INTRODUCTION
System Components

- Semi-diurnal tidal dynamics, mean tidal range ~ 3.9m with small waves
- Banks of active shipping channel have suffered major erosion
- Water levels have increased ~3mm (mouth) and ~15mm (inner sections) of the Estuary. (Temmerman, et al., 2005)
- Predominantly cohesive/fine sediments

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain</td>
<td>2500 x 500</td>
<td>[m]</td>
</tr>
<tr>
<td>Cell Size</td>
<td>10 x10</td>
<td>[m]</td>
</tr>
<tr>
<td>Wave Height</td>
<td>2 - 3 (Storms) &amp; 0.7 (Normal)</td>
<td>[m]</td>
</tr>
<tr>
<td>Tidal Range Variations</td>
<td>4.49 to 5.93m</td>
<td>[m]</td>
</tr>
</tbody>
</table>

Figure: The Hellegat Salt marsh, Western Scheldt (Best, et al., 2018)
For more information kindly see Best, et al., (2018)
RESULTS

Wave, Tidal Range & Sediment Impact on Marsh-Mudflat Dynamics

- Tidal amplitude $\geq$ Marsh level, waves dissipate at MHWL = gentler transitions.
- Dredging may result in steep slope formations and instability with narrower marsh platforms.
- Restoration works which stir up the sediment offshore allow for greater deposition in the marsh.
• Salt marshes were shown to unable to adapt under SLR (IPCC RCP 8.5, 1.14m/century and NOAA 2.0m/century). Distinct tipping points do exist.
• Larger tidal prism increases the flow velocities thereby enhancing seaward erosion and landward deposition.
• Critical rate of increase, 4mm/yr where channels completely incise platform.
RESULTS
Below Ground Biomass

- Higher bio/accumulation rates = marsh heightening + progradation under SLR
- Initial conditions are critical e.g. bed elevation
- Biomass production not sufficient in low production marshes.
- Survival is gained by increasing the system’s overall accretion rate > 5mm-yr.
The marsh-mudflat system drowns under sea level rise scenarios. Drowning depends on spatially and temporally varying morphology. Further works should however explore the dynamics of the sediment budget for specific locations.
Future research may utilize process-based approaches to evaluate engineering solutions for protection and restoration strategies.