Erosion and flood risk analysis

Jim Hall, Xingzheng Wu, Mike Walden, Nicolas Roche, Richard Dawson
Sediment flux along the flood vulnerable coast
Soft Cliff And Platform Erosion

Based on work by Kamphuis, Nairn, Skafell and Bishop

Published in Coastal Engineering 2005 (Walkden & Hall)

Includes beach, platform and cliff

Tidal timestep

Physical basis but with reduced complexity, for larger scales and faster run times

100 km, 100 years < 1 hour
SCAPE profile development
Cliff rebound after seawall failure
Assembly of Norfolk model sections
Model testing
Future simulation uncertainties

Scenarios of greenhouse gas emissions -> probabilistic climate. Currently only sea-level rise, waves and surge to be added.

Management (scenarios)
Currently 5, based on removal or development of existing defences

Socio-economic development (scenarios).
## Scenarios and management options

<table>
<thead>
<tr>
<th>Emissions</th>
<th>Global Temp/SLR (m)</th>
<th>Management</th>
<th>Measures</th>
<th>Socio-economic</th>
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</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Low 0.18 – 0.38</td>
<td>M1</td>
<td>Removal of all defences</td>
<td>WM</td>
<td>World Markets</td>
</tr>
<tr>
<td>A1B</td>
<td>Medium 0.21 – 0.48</td>
<td>M2</td>
<td>‘SMP’</td>
<td>NE</td>
<td>National Enterprise</td>
</tr>
<tr>
<td>A1F1</td>
<td>High 0.26 – 0.59</td>
<td>M3</td>
<td>Maintain existing defences</td>
<td>GS</td>
<td>Global Sustainability</td>
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<tr>
<td>High ++</td>
<td></td>
<td>M4</td>
<td>Construct seawalls everywhere</td>
<td>LS</td>
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<tr>
<td></td>
<td></td>
<td>M5</td>
<td>The ‘SMP’, without beach nourishment</td>
<td>BU</td>
<td>Business as Usual</td>
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</table>
Maintain existing defences
Management Scenario A

Remove existing defences
Sea Palling: Remove existing cliff defences

Year

Beach Volume (m$^3$/m)
Sea Palling: Maintain existing cliff defences
Spatial distribution of beach level for various sea level rise scenarios

Annualbeachlevel_SectStatE1-E4M5VB Fig2.46CP.opj
Temporal distribution of beach level for various sea level rise scenarios

![Graph showing temporal distribution of beach level for various sea level rise scenarios.](Annualbeachlevel_TempStatE1-E4M5VB_Fig2.51CP.opj)
Number of nourishment events for various Management scenarios

Beach nourishment trigger levels

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<tr>
<th>Area</th>
<th>Action Level</th>
<th>Emergency Level</th>
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<tr>
<td>Cart Gap to Reef 5</td>
<td>+0.2mOD</td>
<td>-0.5mOD</td>
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<tr>
<td>Reef 5 to Reef 13</td>
<td>+0.2mOD for gaps between reefs</td>
<td>-0.5mOD</td>
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<tr>
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<td>-1.0mOD for seaward end of salients</td>
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<tr>
<td>Reef 13 to Winterton-on-Sea</td>
<td>+2.0mOD</td>
<td>0.0mOD</td>
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Timescale of nourishment events for various management scenarios

- M1 Remove
- D1
- M2 SMP
- D2
- M3 Maintain
- D3
- M4 Seawall
- D4

Year
Annual nourishment events

E-scenario4, M-ALL Fig 1.28CP.opj
Flood defence breaching

Critical beach level: -0.8m

Seawall
Typical breach discharge
3.3 Animation of T10

- T10 (N2B1B3)
3.3 T2 under various water levels and beach levels animation.
Typical flood depth
Depth damage curve

![Depth damage curve graph]

- **Residence**
- **NonResidence**
Phase 1 results

Erosion risk to 2100

Flood risk to 2100
New flood risk results

![Graph showing expected annual damage over years for different emission scenarios: E(1)M(1)S(1-5).]
### Flood risk

#### Fig 3N-20 SES E(4)M(1-5)S(5)

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Conclusion

The Coastal Cimator accounts for the interactions between coastal erosion AND flood risk
- on a broad spatial scale
- over extended timescales.

Uncertainties in sea level rise and model internal variability are sampled to give probabilistic predictions of
- cliff top recession
- beach volume
- dike failure
- flood risk
- socio-economic scenarios

Questions: What are the likely management options for the Happisburgh to Winterton coast?