Wavelet Decomposition to Assess Development of Padre Island National Seashore, Texas, USA

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American Shore & Beach Preservation Association – 1 April 2016
Process Geomorphology

- Geologic framework influences geomorphology
- Decoupling of processes
- Free vs. forced

(Sallenger 2000)
“It is essential to understand this geologic framework before attempting to model the large-scale behavior of these types of coastal systems.”

(Riggs et al. 1995)
Padre Island National Seashore (PAIS)
PAIS Geologic Framework

(Fisk 1959)
PAIS Geomorphic Development

(Weiss and White 1980)
Subsurface Investigation

(Weymer et al. in review)
Signal Extraction

(a) Beach Width (m)
(b) Beach Volume (m³)
(c) Dune Height (m)
(d) Dune Volume (m³)
(e) Island Volume (m³)
(f) Zero-Mean Apparent Conductivity (3kHz)
(g) LIDAR DEM with NGDC CRM and Fire (1959) paleochannel
(h) Offshore Bathymetry Contours (depth in m)
Peak Spectral Density Plot

White noise
vs.
Structural control
vs.
Dissipative
Beach Width
Geologic Framework
Bathymetry (4km offshore)
Process Geomorphology

• Geologic framework influences geomorphology
• Decoupling of processes
• Free vs. forced

(Sallenger 2000)
Broader Impacts
References

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Beach-Dune Interaction

(Short and Hesp 1982)

(Duran and Moore 2013)
## Semantic Definitions

<table>
<thead>
<tr>
<th>Feature</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Shoreline (S)</td>
<td>Elevation threshold</td>
</tr>
<tr>
<td>Dune Toe (DT)</td>
<td>Relative topographic low Adjacent to &amp; landward of S</td>
</tr>
<tr>
<td>Dune Crest (DC)</td>
<td>Relative topographic high Adjacent to &amp; landward of DT</td>
</tr>
<tr>
<td>Dune Heel (DH)</td>
<td>Relative topographic low Adjacent to &amp; landward of DC</td>
</tr>
<tr>
<td>Backbarrier Shoreline</td>
<td>Elevation threshold</td>
</tr>
</tbody>
</table>
Relative Relief (RR)

- Topographic position
  - Range: 0 to 1

\[
RR_c = \frac{(Z_c - Z_{\text{min}})}{(Z_{\text{max}} - Z_{\text{min}})}
\]

Where:
- \( RR_c \) = Relative relief of center pixel \( c \)
- \( Z_c \) = Elevation of center pixel \( c \)
- \( Z_{\text{max}} \) = Maximum elevation within window
- \( Z_{\text{min}} \) = Minimum elevation within window

(Wernette et al. in press)
Parameterization

<table>
<thead>
<tr>
<th>Morpohometric Definition</th>
<th>RR</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>Dune Toe (DT)</td>
<td>0.2</td>
<td>Adjacent to &amp; landward of S</td>
</tr>
<tr>
<td>Dune Crest (DC)</td>
<td>0.8</td>
<td>Adjacent to &amp; landward of DT</td>
</tr>
<tr>
<td>Dune Heel (DH)</td>
<td>0.4</td>
<td>Adjacent to &amp; landward of DC</td>
</tr>
</tbody>
</table>

(Wernette et al. *in press*)
(Wernette et al. *in press*)
Shore-normal Profiles

- Dune Toe
  - Consistent with conceptual understanding

- Dune Crest
  - Performs well in low-relief environments

- Dune Heel
  - More consistent that current approaches

- Consistent with aeolian sediment transport zones

(Wernette et al. *in press*)
Island Morphometrics