COASTAL EROSION RISK ASSESSMENT AT PORTUGUESE SPEAKING COUNTRIES
CERA: An open-source application to assess coastal erosion risk

Pedro Narra
Universidade de Aveiro

Supervisors:
Carlos Coelho (UA) and Francisco Sancho (LNEC)
PRESENTATION STRUCTURE

• Introduction;
• Vulnerability assessment;
• Consequence assessment;
• Risk assessment;
• Geographic Information Systems (GIS);
• Study areas;
• Data gathering and processing;
• Results;
• Conclusions;
• Future Developments.
INTRODUCTION

• 2/3 of worldwide population live within coastal zones;
• Anthropic action increases vulnerability of coastal zones;
• Existent methodologies are specific of one location and are difficult to use and have access;
• Objective: create a methodology and respective application that is both easy to use and flexible enough to be applicable in different coastal environments.
## VULNERABILITY ASSESSMENT

### VULNERABILITY PARAMETERS OF COELHO (2005)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Very low 1</th>
<th>Low 2</th>
<th>Moderated 3</th>
<th>High 4</th>
<th>Very high 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distance to shoreline</strong></td>
<td>&gt;1000</td>
<td>[200, 1000]</td>
<td>[50, 200]</td>
<td>[20, 50]</td>
<td>≤ 20</td>
</tr>
<tr>
<td><strong>Topography (m)</strong></td>
<td>&gt; 30</td>
<td>[20, 30]</td>
<td>[10, 20]</td>
<td>[5, 10]</td>
<td>≤ 5</td>
</tr>
<tr>
<td><strong>Geology</strong></td>
<td>Magmatic rocks</td>
<td>Metamorphic rocks</td>
<td>Sedimentary rocks</td>
<td>Non-consolidated coarse sediments</td>
<td>Non-consolidated fine sediments</td>
</tr>
<tr>
<td><strong>Geomorphology</strong></td>
<td>Mountains</td>
<td>Rock cliffs</td>
<td>Erosive cliffs; sheltered beaches</td>
<td>Exposed beaches; plain</td>
<td>Dunes; river mouths; estuaries</td>
</tr>
<tr>
<td><strong>Ground cover</strong></td>
<td>Forest</td>
<td>Vegetation cultivated</td>
<td>Non-covered</td>
<td>Rural urbanized</td>
<td>Urbanized; industrial</td>
</tr>
<tr>
<td><strong>Anthropogenic actions</strong></td>
<td>Shoreline stabilization intervention</td>
<td>Intervention without sediment sources reduction</td>
<td>Intervention with sediment sources reduction</td>
<td>Without interventions or sediment sources reduction</td>
<td>Without interventions and with sediment sources reduction</td>
</tr>
<tr>
<td><strong>Maximum significant wave height (m)</strong></td>
<td>&lt; 3.0</td>
<td>[3.0, 5.0]</td>
<td>[5.0, 6.0]</td>
<td>[6.0, 6.9]</td>
<td>≥ 6.9</td>
</tr>
<tr>
<td><strong>Maximum tidal range (m)</strong></td>
<td>&lt; 1.0</td>
<td>[1.0, 2.0]</td>
<td>[2.0, 4.0]</td>
<td>[4.0, 6.0]</td>
<td>≥ 6.0</td>
</tr>
<tr>
<td><strong>Average erosion / accretion rates (m/year)</strong></td>
<td>&gt; 0.0</td>
<td>Erosion</td>
<td>Erosion</td>
<td>Erosion</td>
<td>Erosion</td>
</tr>
</tbody>
</table>

- **Very low (1)**: Very low impact
- **Low (2)**: Low impact
- **Moderated (3)**: Moderated impact
- **High (4)**: High impact
- **Very high (5)**: Very high impact
# CONSEQUENCE AND RISK ASSESSMENT

## CONSEQUENCE PARAMETERS OF COELHO (2005)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Very low</th>
<th>Low</th>
<th>Moderated</th>
<th>High</th>
<th>Very high</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population density (inhabitant/km²)</td>
<td>&lt; 125</td>
<td>[125, 250]</td>
<td>[250, 500]</td>
<td>[500, 1000]</td>
<td>≥1000</td>
</tr>
<tr>
<td>Economy (employment/km²)</td>
<td>0</td>
<td>[0, 120]</td>
<td>[120, 240]</td>
<td>[240, 480]</td>
<td>&gt; 480</td>
</tr>
<tr>
<td>Ecology</td>
<td>No ecological relevance</td>
<td>Agricultural reserve; areas of community interest</td>
<td>Ecological protected area</td>
<td>Coastal protection zone</td>
<td>Natural reserve</td>
</tr>
<tr>
<td>Heritage</td>
<td>No heritage to preserve</td>
<td>Scattered houses; roads</td>
<td>Urban centers</td>
<td>Regional historic buildings; critical facilities</td>
<td>National monuments</td>
</tr>
</tbody>
</table>

## RISK MATRIX OF COELHO (2005)

<table>
<thead>
<tr>
<th>Vulnerability</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>I</td>
</tr>
<tr>
<td>2</td>
<td>I</td>
</tr>
<tr>
<td>3</td>
<td>I</td>
</tr>
<tr>
<td>4</td>
<td>II</td>
</tr>
<tr>
<td>5</td>
<td>III</td>
</tr>
</tbody>
</table>
GIS application called CERA (Coastal Erosion Risk Assessment);
- Uses Coelho (2005) methodology
- Developed in Python and Qt;
- Plugin for QGIS, a free and open-source software;
- Allows integration with other GIS features.
STUDY AREAS

TESTING STUDY AREAS FOR CERA: AVEIRO, PORTUGAL AND MACANETA, MOZAMBIQUE.
DATA GATHERING AND PROCESSING

MAPS FOR VULNERABILITY PARAMETERS IN AVEIRO, PORTUGAL.
STUDY AREAS

MAPS FOR CONSEQUENCE PARAMETERS IN AVEIRO, PORTUGAL
STUDY AREAS

MAPS FOR VULNERABILITY PARAMETERS IN MACANETA, MOZAMBIQUE
STUDY AREAS

MAPS FOR CONSEQUENCE PARAMETERS IN MACANETA, MOZAMBIQUE
RESULTS

• Stripe of 2 km parallel to the shoreline was classified;
• High vulnerability along the coastline (class IV);
• Consequence level varies across all classes;
• Parishes at north present higher level on consequences;
• Risk is higher at north and at Aveiro port.

FINAL OUTPUTS FOR AVEIRO, PORTUGAL
RESULTS

- Classifications in Macaneta are less varied;
- Vulnerability class is similar to Aveiro, due to its similarities in terms of coastal environment;
- Consequences are mostly absent from this area;
- Risk is lower than in Aveiro.
CONCLUSIONS

• Objective: create a methodology and respective application that is both easy to use and flexible enough to be applicable in different coastal environments;
• GIS application was developed, integrating Coelho methodology to assess vulnerability, consequences and risk to coastal erosion;
• Aveiro and Macaneta were used as test areas to the application.
FUTURE DEVELOPMENTS

• Assessment of new study area: Mexico;
• Locate an additional study area, with different characteristics from the current study sites;
• Sensitivity analysis on the parameters identified as important in coastal erosion risk assessment;
• Start development of original methodology and respective GIS application.
FUTURE DEVELOPMENTS

NEXT STUDY SITE TO ASSESS: TRANSECT BETWEEN PUNTA MAROMA AND PUNTA BETE, MEXICO
COASTAL EROSION RISK ASSESSMENT AT PORTUGUESE SPEAKING COUNTRIES
Past and Future Development

Pedro Narra
pedronarra@ua.pt

Supervisors:
Carlos Coelho (UA) and Francisco Sancho (LNEC)

Thank you for your attention and feedback!