Mapping of flood risk in Emilia-Romagna coastal areas

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Flood risk in Emilia-Romagna coastal areas

The north-western Adriatic coast is exposed to a high-risk of flooding mainly due to exceptional sea level caused by storm surge.

The risk is due to the extent of low-lying areas and to the high economic value of the coastal system.
Physical factors

Storm surges are frequent in the Adriatic sea particularly during Autumn and Winter time; often associated to waves coming from south-east (Scirocco)

A detailed analysis of the maximum sea water levels and of the residual tide (surge component) was carried out by Masina & Ciavola within Micore project.

<table>
<thead>
<tr>
<th>Return periods</th>
<th>Total water level</th>
<th>Residual tide</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2</td>
<td>0.85 m</td>
<td>0.61 m</td>
</tr>
<tr>
<td>T10</td>
<td>1.05 m</td>
<td>0.79 m</td>
</tr>
<tr>
<td>T100</td>
<td>1.28 m</td>
<td>1.02 m</td>
</tr>
</tbody>
</table>
flooding of urban areas and tourism infrastructures
Flood effects on natural areas and consequences on the ecosystem

Year 2000
Year 2005
Year 2011

DTM LIDAR

70 m
effects on the unconfined coastal aquifer

Measures of piezometric level and electrical conductivity (EC) reveal a strong connection between sea level and coastal aquifer parameters.
Studies and monitoring

Classification of the most critical zones is based on:

• Morphological features
• Monitoring of post-event impacts
Run-up evaluation

for T1 - T10 - T100 return periods.
Analysis carried out along transects spaced 500 m - in collaboration with Unife (Armaroli C., Ciavola P., Masina M.)
Historical storm database

31 localities recorded flooding events in the period 1946-2010

Sea flooding

[Map showing localities with flooding data]

[Bar chart showing frequency of flooding at various localities]

Localities:
- Goro e Gorno
- Lido Volano
- Spiaggia Romea
- Lido Nazioni
- Lido Scarichi
- Casalborsetti
- Marina Ravenna
- Lido Adriano
- Foce Savio
- Cervia
- Cesenatico
- Villamarchesa
- Bellaria-Scafe Marina
- Riccione Sud
A new method to produce hazard maps

The new target is the risk maps as expected by Directive 2007/60/EC (EFD) -Dlgs 49/2010

The first step, by June 2013, flood hazard maps

No standard protocol at national &/or european level

No specific funds dedicated at present
Conceptual method based on GIS

It's a first step of a complex procedure that requires availability of Lidar data and of the historical sea storm parameters to provide the scenarios.

Comparison between topographic surface and sea level for a given hazard scenario:

- LIDAR
- Critical height: 0.8 m s.l.m.
- Sea level

Identification of the pathway & exclusion of "isolated" depressed areas:
Hazard scenarios

The considered scenarios combine:
storm surge + astronomical tide + wave set up

<table>
<thead>
<tr>
<th>Tr (Years)</th>
<th>Surge</th>
<th>Mean high tide</th>
<th>Set-up</th>
<th>Total elevation sea surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tr 1</td>
<td>H critic = 0.61</td>
<td>0.4</td>
<td>0.22</td>
<td>1.22 m</td>
</tr>
<tr>
<td>Tr 10</td>
<td>H critic = 0.79</td>
<td>0.4</td>
<td>0.3</td>
<td>1.49 m</td>
</tr>
<tr>
<td>Tr100</td>
<td>H critic = 1.02</td>
<td>0.4</td>
<td>0.39</td>
<td>1.81 m</td>
</tr>
</tbody>
</table>

Values are derived from literature and compared to historical data from sea-storm catalogue
The damping component

Defined comparing the maximum run-up and flooding lines corresponding to real past events

Ctg β = 0.002
The GIS matrix

Defined the shortest paths for the water to reach the different areas - analysis by ArcGIS tool Cost Distance Spatial Analyst.

Elevation of the individual cells

<table>
<thead>
<tr>
<th></th>
<th>0.5</th>
<th>0.4</th>
<th>0.3</th>
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<td></td>
</tr>
<tr>
<td>0.2</td>
<td>0.1</td>
<td>0.3</td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>

Euclidean distance

Cost distance

Cells above the critical height

Depressed cells
The GIS model

for a quick re-run of the model considering different DTM, scenarios, damping factor, etc.. a diagram from esri arcgis model builder was created.
Example of hazard map

Example of hazard map for Cesenatico
Ongoing and Next steps

comparison of the sea-flood hazard map with:

Run-up evaluation along 500 m spaced beach profiles

Flood maps of Cesenatico and Lido di Savio obtained using the Mike Model (Zanuttigh et al)

Validation of the results with all flooding data from sea-storm catalogue

in situ GPS measurements of evidences of future significant sea-storms
Final considerations

✓ the proposed method is a fast, simple and economic system to produce flood hazard maps
✓ indicative water depth can be computed
✓ it's quite replicable and exportable to other regions if lidar data and sea-storm scenarios are available

✓ The GIS analysis doesn't consider run-up because it needs a dedicated formula
✓ it doesn't take into account morphological evolution of the beach
✓ No information regarding flow velocity
Thank you for attention