TRANSPORTE DE SEDIMENTOS EN LA PLATAFORMA CONTINENTAL DEL DELTA DEL EBRO: MODELIZACIÓN Y PREDICCIONES

Juan Fernández¹-³, Gabriel Jordà², Manuel Espino¹, Vicenç Gracia¹, Agustín Sánchez-Arcilla¹
1. LIM-UPC, 2. IMEDEA, 3. SIMO
Introduction

• Importance of inner shelf – aquaculture, fisheries
• High suspended sediment concentration impact on biota
• High energy events transport great quantities of sediment from shallow waters to deeper ones.
• Some pollutants absorb to cohesive materials
• Lack of numerical studies of the sediment dynamics at a shelf scale

• The main objective of this presentation is to describe results from the implementation of a sediment transport model in the Ebro Delta continental Shelf, and forecasting possibilities
Numerical Model - Symphonie

- Pole d’Oceanographie Cotiere in Toulouse
- 3D primitive equation model of the coastal ocean.
- Implemented and validated in different coastal and ROFI areas
- Sediment transport module
- Possibility of bed armouring
- Cohesive and non-cohesive material
Model Implementation – First Steps

- Low resolution grid (2000m)
- Nested high resolution grid (500m)
- The model potential vorticity method (MPV) - initialization technique
- Current and sediment transport model calibrated
Implementation and calibration

- Freshwater, stratification, grid size, vertical level number, roughness length and friction coefficient roles evaluated.
- Sediment transport module implemented for 4 non-cohesive class and one aggregate.
- Spin-up role analysed.
- Sediment transport parameters calibrated

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Partheniades Resuspension coefficient</td>
<td>0.00004</td>
</tr>
<tr>
<td>Smith &amp; McLean Resuspension Coefficient</td>
<td>0.00300</td>
</tr>
<tr>
<td>Transition criteria from Cohesive to Non Cohesive (% of clay)</td>
<td>0.04</td>
</tr>
<tr>
<td>Porosity (%)</td>
<td>0.73</td>
</tr>
<tr>
<td>Sediment density (kg/m³)</td>
<td>2650</td>
</tr>
<tr>
<td>Clay Diameter (m)</td>
<td>2.0000E⁻⁰⁶</td>
</tr>
<tr>
<td>Silt Diameter (m)</td>
<td>5.5000E⁻⁰⁵</td>
</tr>
<tr>
<td>Fine Sand Diameter (m)</td>
<td>7.5000E⁻⁰⁵</td>
</tr>
<tr>
<td>Coarse Sand Diameter (m)</td>
<td>1.1500E⁻⁰⁴</td>
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• High river discharge
• North winds, intensity higher offshore, but same pattern onshore.
• High current velocities associated to watercourse and wind interactions.
Period 1 – Salinity peak 2

- River plume developed on surface
- Offshore winds narrow and deepen plume influence
- Wind relaxation creates baroclinic instability
Height and Class Change – Period 1 – Tripod 1

• Height increases in Tripod 1 as reported by Guillen et al (2005)
• Height changes associated to silt deposition
Height and Class Change – Period 1 – Whole Shelf

- Variables analyses around peak event
- Peak concentration around the Ebro Delta
- Clay material in suspension and off the model domain
- Silt becomes dominant class

<table>
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<tr>
<th>Bottom SSC (g/l) (a)</th>
<th>Bottom Height Change (c)</th>
<th>Clay Distri. (%) (d)</th>
<th>Silt Distri. (%) (e)</th>
<th>Fine Sand (%) (f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/01/1997 00:00</td>
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<td>08/01/1997 00:00</td>
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Sediment Transport Sensitivity Tests

- No riverine input
- No waves
- No bed armouring
- No resuspension

- Great influence of waves and bed armouring
- Poor influence of river and currents role (in tripods area)
Bed Armouring

Bed armouring plays a major role in the model predictions

If bed armouring not included: finer class (clay) dominant

If bed armouring is included: other classes significant.

Bed armouring process limits the availability of fine grains
Main objectives are:

– Assess the sources of information required and their reliability

– Assess the difficulties on implementing an operational sediment transport model

– Assess the results accuracy

- Implementation carried out from February 2009 to June 2009.

- All data sources were analysed and compared to actual recorded data (Spanish Port Authority and XIOM data).

- Results for three 15 days continuous events (from 15/02/2009 to 21/03/2009) will be presented
Hydrodynamic Data Sources

• Hydrodynamic boundary conditions have or will be obtained from:
  • MFS
  • MERCATOR
  • ESEOMED

• Wind data: information gathered from:
  • AEMET
  • SMC

• Wave data: information gathered from:
  • SMC
  • Puertos

• Watercourse data:
  • Operational hydrological model data could not be gathered. Recorded data used.
  • Ebro River SSC-discharge relationship formula used.
Sediment Transport Data Sources

- Satellite images: Meris case II satellite images. Analysed and processed using the MERIS case 2 Regional Processor (Doerffer and Schiller, 2008). Data used for validation.
Validation Hydrodynamic Module

Current, temperature and salinity information from nearby buoys were used for the hydrodynamic model validation.
Validation Sediment Transport Module

Satellite images were used for the sediment transport model validation.

Total suspended sediment concentration (g/m³) for 06/03/09, model results (a) and satellite observations (b).
Validation Sediment Transport Module

Data from the satellite images at several surface points were compared to predicted data.

Total suspended concentration (mg/l) comparison for recorded (blue stars) and predicted (red) data.
Findings and Issues

• Satisfactory 1996-1997 events hydrodynamic and sediment transport model calibration.
• Satisfactory pre-operational hydrodynamic and moderately satisfactory sediment transport validation undertaken
• Issues found with watercourse data gathering
  – Operational discharge not available
  – SSC non-existing
• Data sources quality may affect accuracy results
• Future work
  • Initialisation techniques
  • Assessment of different data sources to improve results.