Testing storm impact modelling at São Pedro de Moel beach

Paulo Cabrita

Andreia Ferreira

Conceição J.E.M. Fortes

Óscar Ferreira

Paula Freire

a54406@ualg.pt

Coastal storms

- Coastal storms can have harmful consequences.
- Climate changes and increase in population in coastal zones will increase the risk
- Numerical modelling → predict and understand the impact of coastal storms

Fuseta, 2010

XBeach

- Hydrodynamic and morphodynamic model
- Wave runup, overwash and beach morphodynamics in a small area.
- Calibration and validation for each coastal area.

São Pedro de Moel

- Located on the Portuguese west coast
- Impacted by high energy/storm events every year
  - Runup, flooding or coastal erosion
- Structure → Seawall

Methodology

- Topographic and bathymetric data
  - From EMODnet Bathymetric portal + LIDAR 2011 + Field campaigns (February 2019)
- Wave and tide conditions
  - Offshore→ ECMWF Centre
  - Nearshore→ SWAN model
  - Tide→ WXTide 32
- Empirical formula (Mase *et al.*, 2013)
- XBeach
  - Non-hydrostatic setup – overtopping events
  - Surf beat setup – erosion events

Methodology - XBeach

- Sensibility test
  - Non-hydrostatic → *bedfriccoef*, *CFL*, *nhlay*, *maxbrsteep*, and bathymetry resolution
  - Surf beat → *alpha*, bathymetry resolution, *bermslope*, *beta*, *CFL*, *delta*, *dryslp*, *dtheta_s*, *dzmax*, *facua*, *gamma*, *gammax*, *hswitch*, *lws*, *morfac*, *n*, *thetamax*, *thetamin*, *turb and wetslop*
- Calibration
  - Non-hydrostatic (Elsa Storm (2019))
    - Runup extension – estimated values (Internet videos and news report)
    - Overtopping discharge – Coastal engineering manual (CEM) critical values
  - Surf beat (February 2019 Storm)
    - Post-Storm beach profiles
- Extra simulation
  - Hercules storm (2014)

Results – Empirical formula

- Overtopping values at the crest of the seawall
  - Elsa Storm (2019) - 4.27×10^{-06} $m^3/s/m$
  - Hercules Storm (2014) - 4.05×10^{-05} $m^3/s/m$

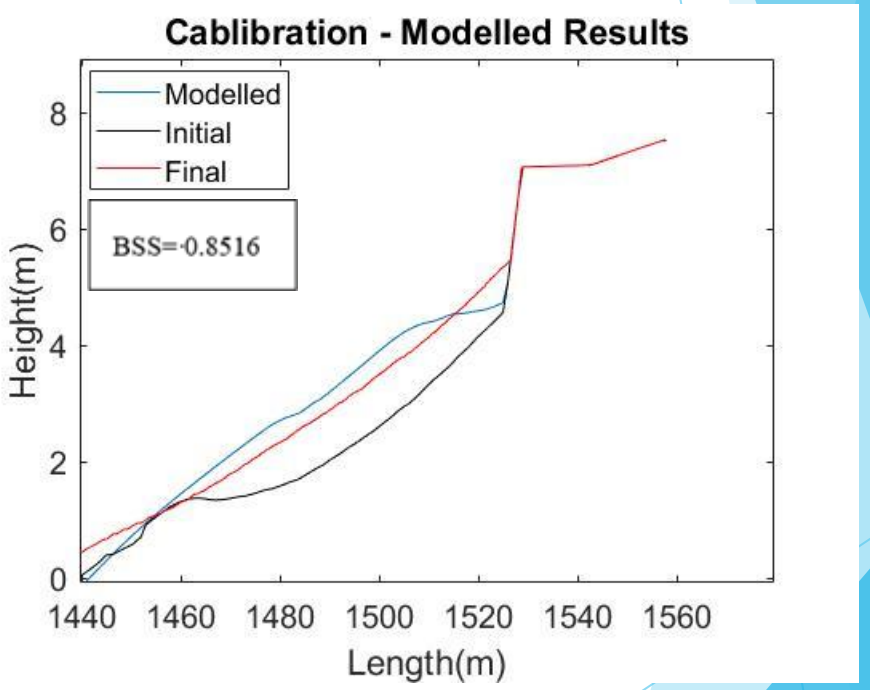
Xbeach – Non-hydrostatic

- Most sensitive parameters- *nhlay, bedfriccoef*, *maxbrsteep* and the bathymetric resolution
- Less sensitive parameters - CFL
- Best parameter setup - *bedfriccoef*=0.0195, *nhlay*=0.33, *maxbrsteep*=0.6 and a bathymetric resolution of 0.5 m

	Calibration Storm Elsa		Validation Storm Hercules	
	Runup landward extension (m)	Disch. ($m^3/s/m$)	Runup landward extension (m)	Disch ($m^3/s/m$)
Estimated	~18	$[10^{-4}\ 10^{-3}[$	~29	$\geq 10^{-3}$
Results	16.1	9.74×10^{-4}	27.9	5.15×10^{-3}

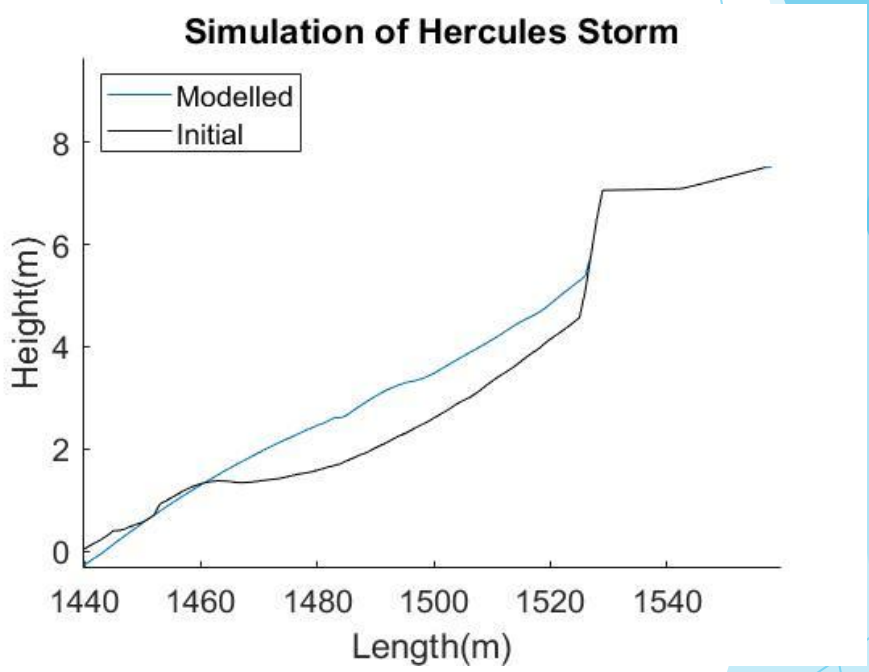
Results – Surf beat

- Most sensitive parameters- *alpha*, bathymetric resolution, *beta*, *delta*, *facua*, *gamma*, *morfac*, *n*, *lws e bermslope*.
- Calibration performed against a post-storm profile February 2019 storm.
  - This profiles shown recovery instead of erosion.
  - Parameter values used in the run with the highest Brier Skill Score (BSS)
    - *alpha*=0.8, *beta*=0.8, *gamma*=0.8, *bermslope*=0.1, *facua*=0.15, *morfac*=5 and a bathymetric resolution of 1 m.



Results – Surf beat Hercules Storm

- No data to validate this model
- However, the model shows accretion when field observations denoted severe erosion



Discussion - Overtopping

- Non-hydrostatic setup had no quantitative information.
- The empirical formulation gave 1-2 order of magnitude smaller values than the ones obtained by the model.
- Model results agree well with the CEM predictions and visual observation of inundation and discharge

Discussion – Post-storm profile

- Post-storm profile used for the model calibration shown recovery.
  - Model setup was tuned towards beach recovery
- Hercules Storm simulation using the surf beat setup showed differences for reality. Given recovery due to the calibration process.
- Good field data quality is fundamental to improve the model performance.

Conclusion

- Non-hydrostatic showed good accuracy when comparing with estimated values for the overtopping events.
  - It is necessary to have quantitative information to improve the models.
    - *In situ* measurements, vídeos or holding tanks
- Surf beat setup showed erroneous results for the Hercules storm.
  - It is necessary to have suitable field data and from a set of storms with higher energy.