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Centro de Estudos Sociais
Universidade de Coimbra

IMPACT OF A SANDY SHORE MORPHOLOGY ON OVERTOPPING

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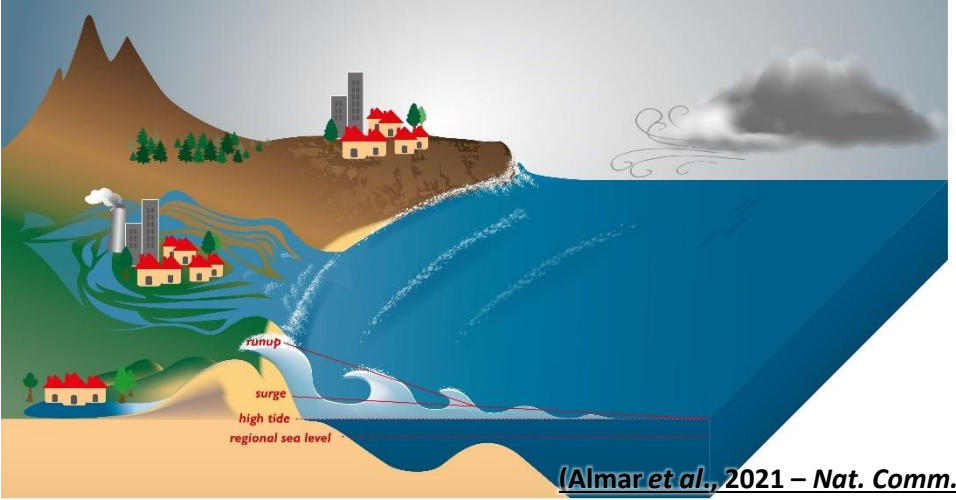
Presentation outline

- **Motivation**
- **Study area and Research question**
    - *Figueira da Foz downdrift coast*
    - *Impact of the beach and shore morphologies on modelled overtopping*
- **A local overtopping model based on XBeach**
    - *Short and long waves validation*
    - *Overtopping model validation*
- **Overtopping exposure and morphological changes**
    - *Impacts of seasonal intertidal beach cycle*
    - *Impacts of riprap removal in 2021*
- **Lessons learnt**

Motivation



(Almar *et al.*, 2021 – *Nat. Comm.*)

- Exposure to coastal overtopping is increasing worldwide

- A tool for mapping the hazard associated with combined wind-waves and storm surge was developed:
  - ***Based on XBeach – surfbeat, 2DH –***
  - ***For planning (mapping) and in early warning system purposes***

→ There is a need to assess its sensitivity to ***natural*** and ***anthropogenic changes*** in ***shore and nearshore morphologies***

Study area

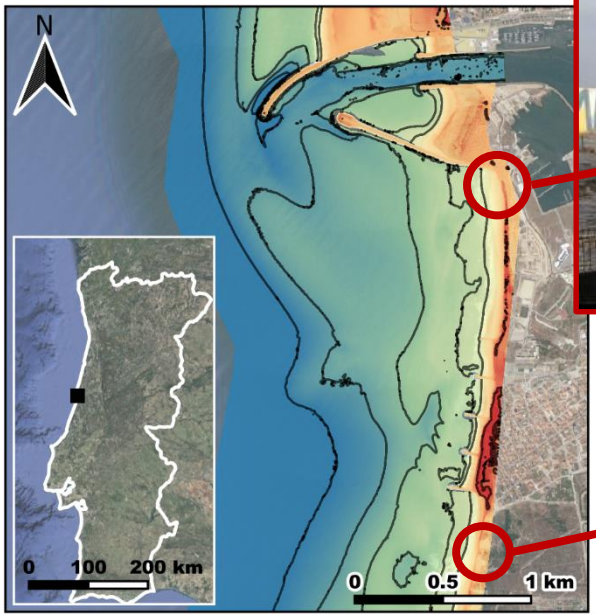
- The downdrift coast of Figueira da Foz harbour:

- Harbour breakwaters

- Large ebb-tidal delta

- Sub- and intertidal travelling sandbars

- Local defence scheme



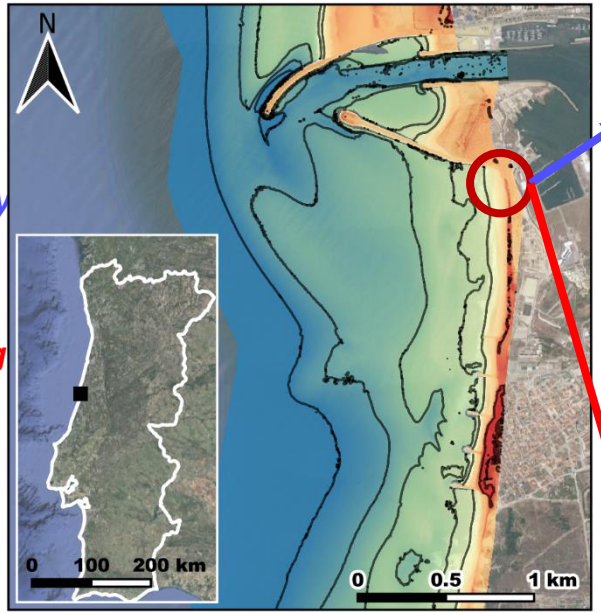
- **Recurrent dune overtopping behind intermediate beaches**

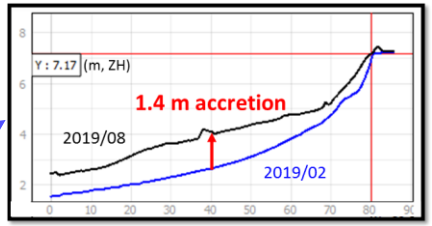
Research question

- The downdrift coast of Figueira da Foz harbour:

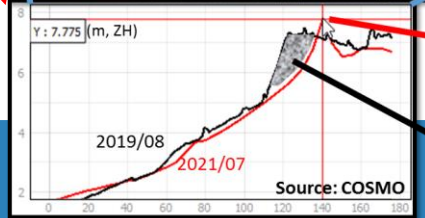
- Up to 1.4 m of beach accretion from February to August 2019

- Riprap removal during 2021 spring





*"How do **natural** and **human-driven morphological changes** impacted the **exposure to overtopping?**"*

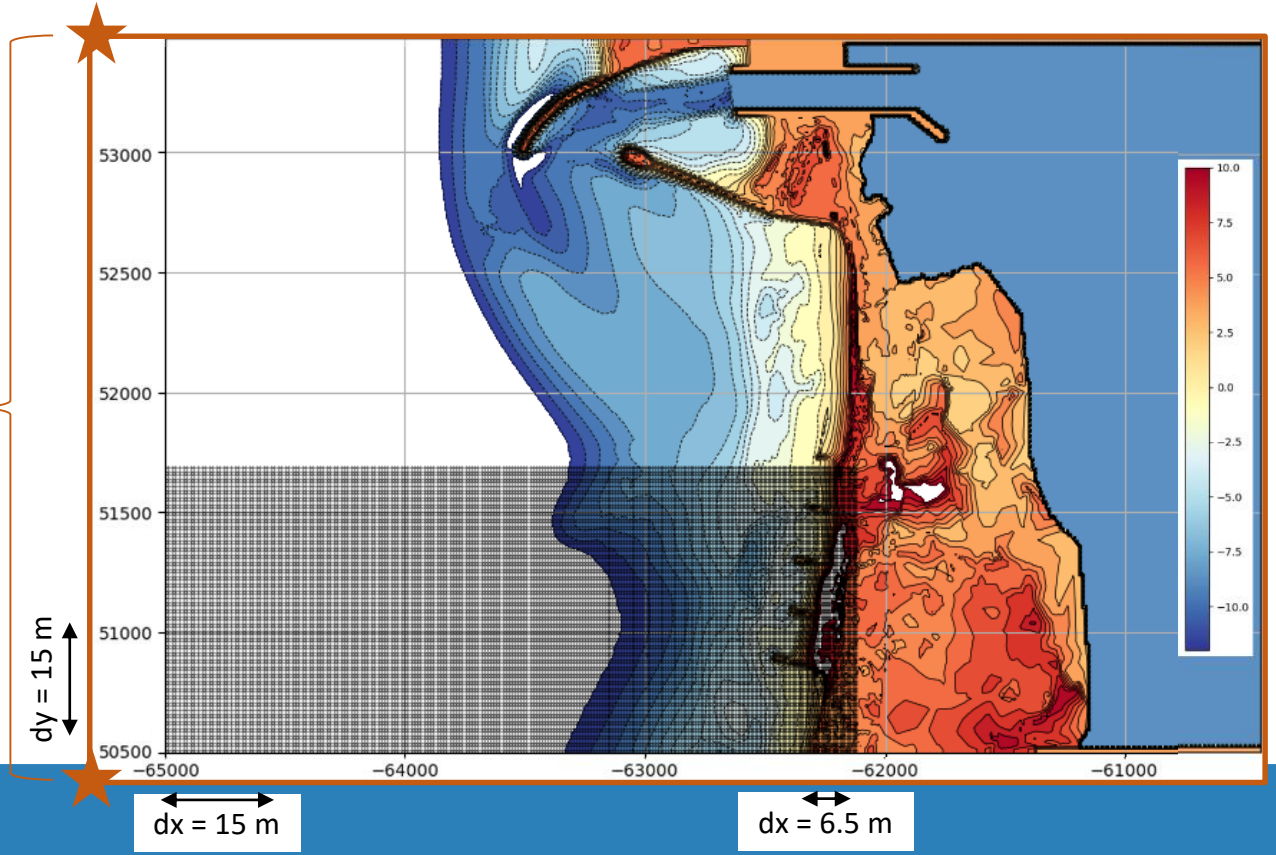


Higher sandy dune

Riprap removal

Local Xbeach model: *surfbeat, 2DH*

Forced with downscaled bi-dimensional wave spectrum and elevations

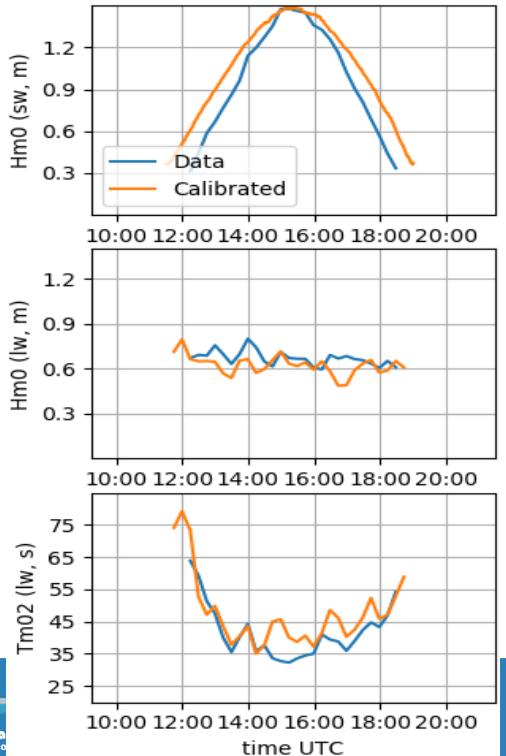


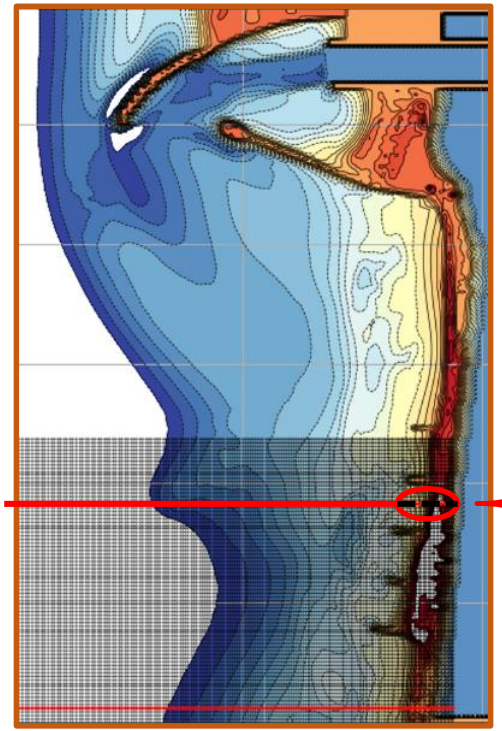
- Grid with 200 x 400 nodes:

→ it runs in less then 20% of real time on 64 CPUs (in less than 10% on 80 CPUs)

Local model validation: *surfzone waves*

- Surfzone mean parameters -





- *Non-default* 2DH parameters:

- $H_{max} = \gamma'(h + \delta H)$
  with $(\gamma', \delta) = (0.41, 0.5)$
  → *Hm0,sw equal as to better than the default* $(\gamma', \delta) = (0.52, 0.0)$
  → *Improved Eta spectrum shape and Tm02,lw*

- ***Scheme = upwind_2***
  → *Improved Hm0,lw and Tm02,lw*

- ***Full, bi-dimensional wave spectrum:***
  → *Improved Hm0,lw and Tm02,lw*

- ***2DH vs. 1DH surfbeat:***
  → *Improved Tm02,lw*

Local model validation: *SB* vs. *NH*

- 2DH surfbeat (SB) vs. 1DH non-hydrostatic (NH)

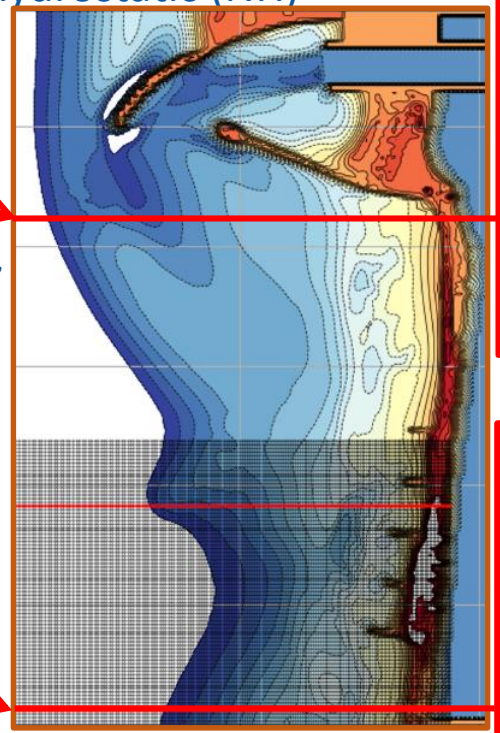
Hs, Tp, Dir., **Elev.** =
7.03 m, 21.3 s, 286°, **1.60 m**

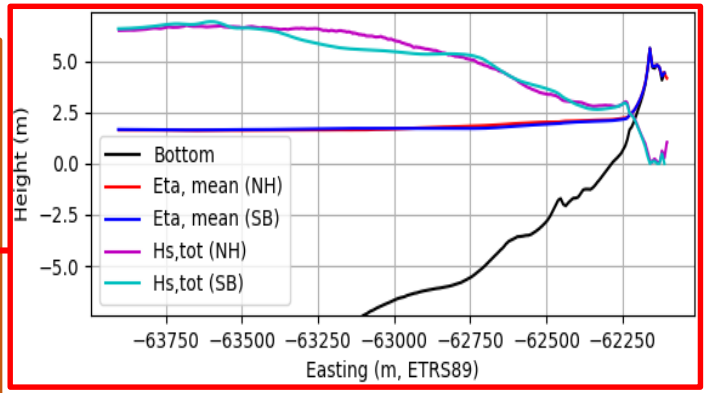
– ***In both energetic and moderate situation, similar results in terms of combined short and long wave energy:***

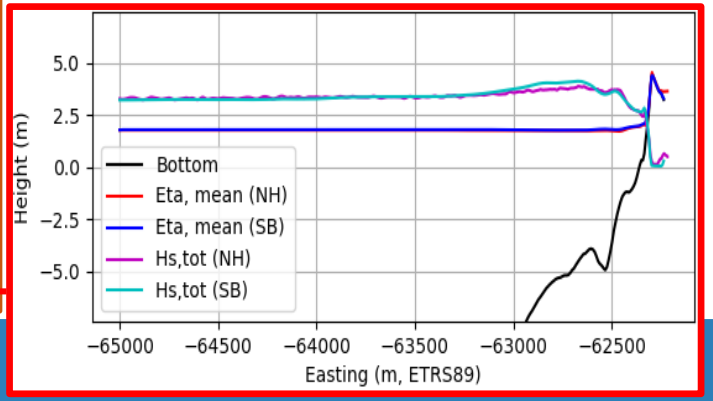
$$\left(\mathrm{Hs,tot} = \sqrt{H_{m0,sw}^2 + H_{m0,lw}^2}\right)$$

and in terms of mean surface elevations

Hs, Tp, Dir., **Elev.** =
3.25 m, 17.6 s, 278°, **1.77 m**





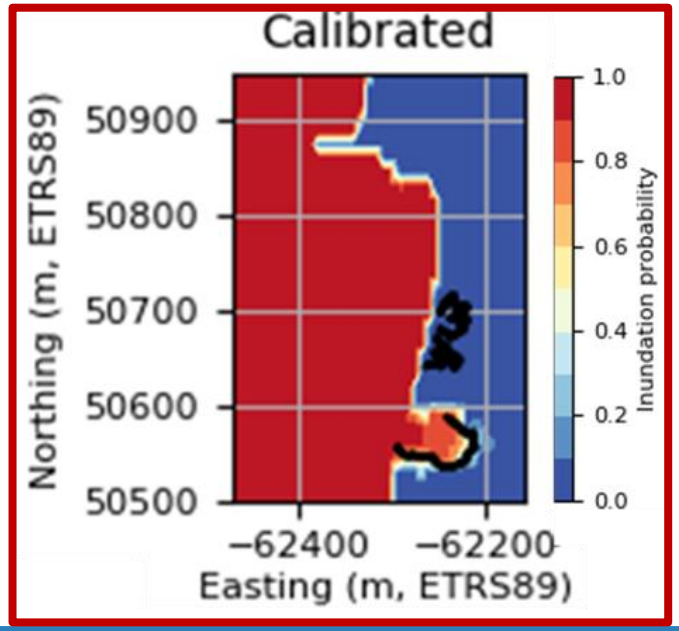


Local model validation: *overtopping*

- Validation against in-situ observations form 21 February 2019
  - **Hs**, Tp, Dir., **Elev.** = **3.25 m**, 17.6 s, 278°, **1.77 m**
  - 10 x 17 min. simulations
  - Inundated if $Eta_{max} > Z_{topo}$

→ Main overtopping extent reproduced

→ Smaller patches missing



Impacts of seasonal morphologies

- February 2019 vs. August 2019 : ***1.4 m of beach accretion*** **(Hs = 3.25 m, 7.03 m; Elev. = 2.39 m)**

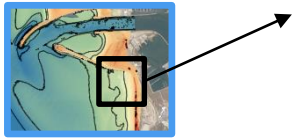
Lower beach

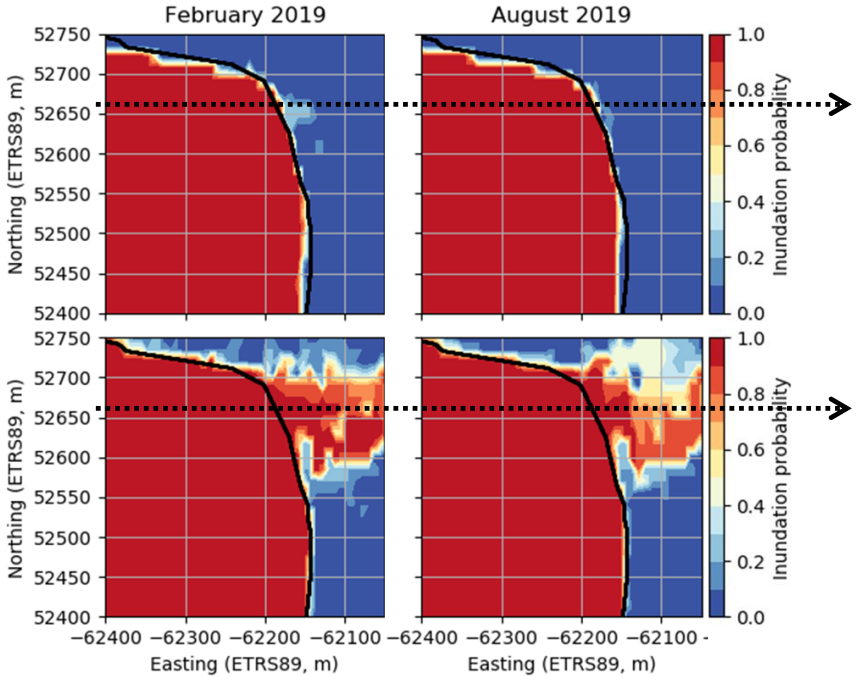
→ *Higher Hs,tot*

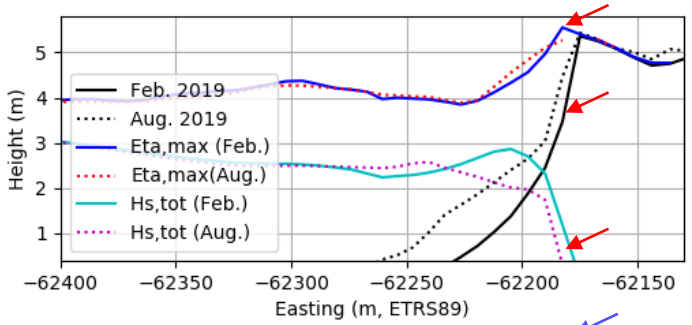
→ *Higher runup*

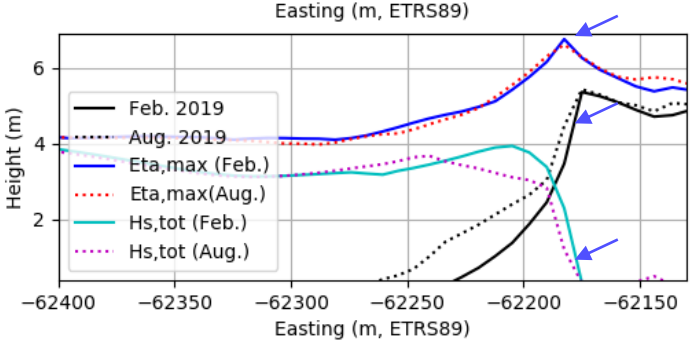
→ ***Overtopping***

Less relevant for higher waves



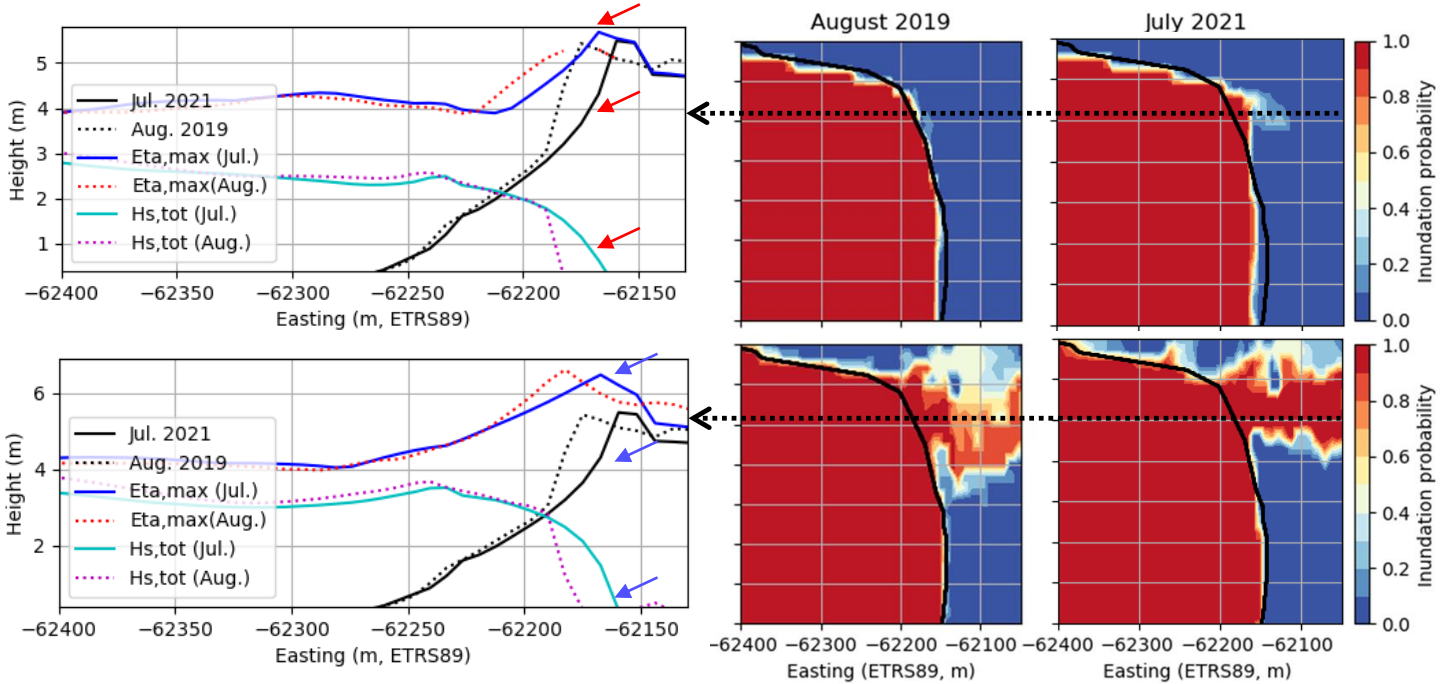






Impacts of human interventions

- August 2019 vs. July 2021 : ***riprap removal*** **(Hs = 3.25 m, 7.03 m; Elev. = 2.39 m)**



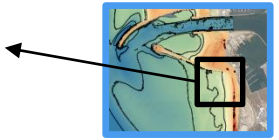
Gently slopping foredune

→ *Higher Hs,tot*

→ *Higher runup*

→ ***Overtopping***

Less relevant for higher waves, ***than the backdune morphology***



Lessons learnt

- Ongoing morphological changes are expected to increase overtopping exposure in two ways:
  - **Lower intertidal and upper beach may increase the (short) wave height at the shoreline**
  - **Gently intertidal and upper beach may serves as a ramp to longer infragravity wave**
- Ongoing work is being done to maintain intertidal beach state updated through continuous satellite monitoring
- For the upper beach and foredune state this remain an open question regarding at the available satellite products