

# Supporting co-development phase of Nature Based Solution by combined use of Earth Observation and modeling



## OPERANDUM

OPEn-air laboRAtories for Nature baseD  
solUtions to Manage hydro-meteo risks

**Silvia Maria Alfieri**, Fatemeh Foroughnia, Beatrice Pulvirenti, Paolo Ruggieri, Margherita Aguzzi, Roderik Lindenbergh, Nunzio De Nigris, Maurizio Morelli, Fabrizio Tavaroli, Silvia Unguentoli, Andrea Valentini, Paola Robello, Carlo Cacciamani, and Massimo Menenti.

EGU 2021

NH1.4- Nature-based solutions for hydro-meteorological risk reduction

28/04/2021



# Introduction

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- Co-design, co-development and deployment of NBS solutions to reduce storm surge risk in the Emilia Romagna coast is one of the objectives of the H2020 project OPEn-air laboRAtories for Nature baseD solUtions to Manage environmental risks (OPERANDUM)
- Main impacts associated to the **storm surge** events: coastal erosion and **flood** inland areas.
- (Vegetated) artificial coastal dunes have been identified as the most suitable NBS to prevent erosion and flooding due to storm surge events.
- Co-design of NBS should take into account their efficacy in reducing both erosion and flooding
- Evaluation of the mitigation of erosion by NBS is being evaluated with both models (S-Beach , X-Beach) and laboratory experiments on dune resistance to erosion.
- In this study a methodology combining remote sensing data and modeling is proposed as an initial step in the design of a system of dunes to prevent coastal flood
- Simplified modelling approach based on elevation and water (entry) points

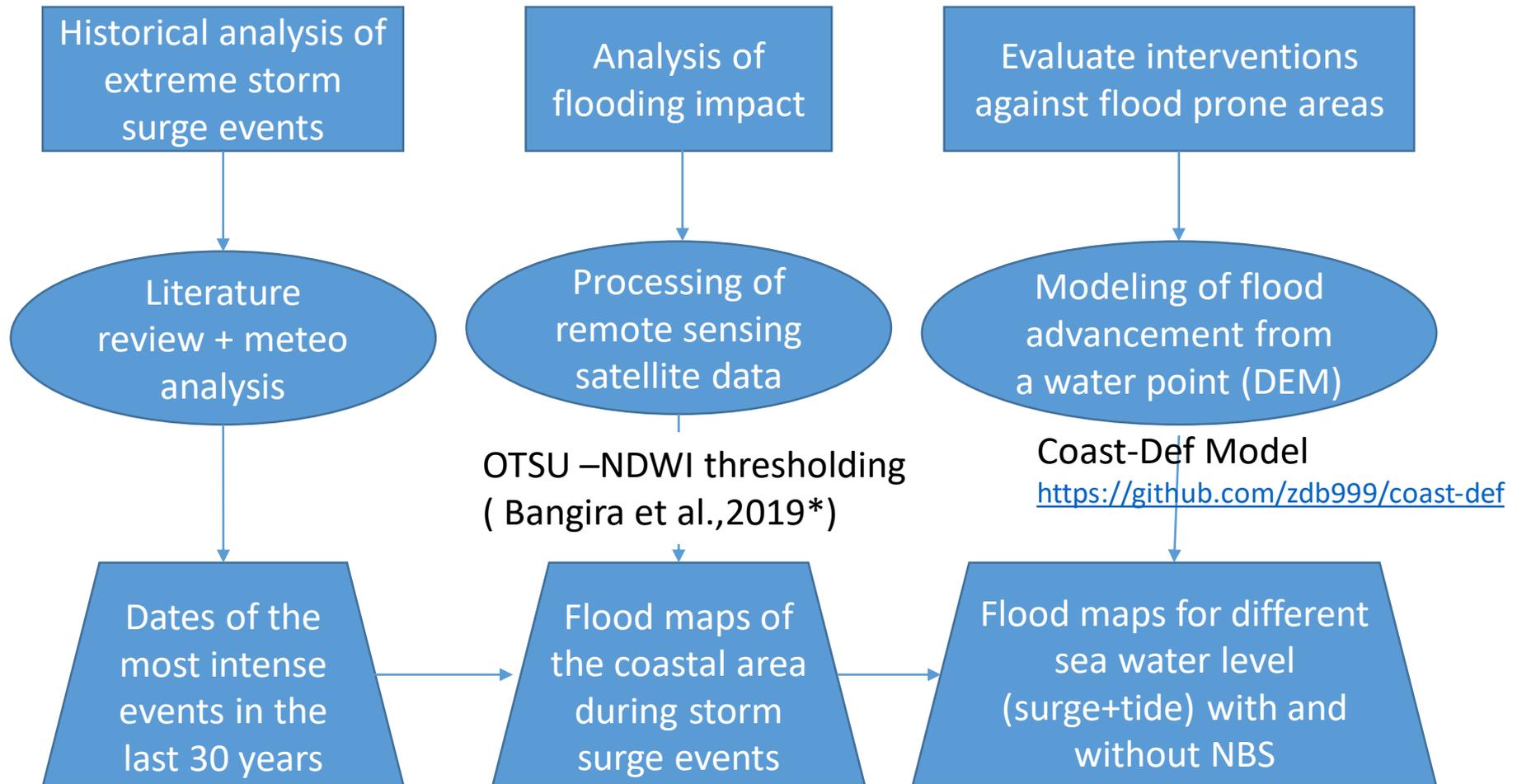
# Materials

The historical analysis of storm surge events and relative impacts (1946-2018) shows that the first two main vulnerable area are **Lido di Volano** and **Lido di Spina sud** (more than 30 events with impacts mainly condisting in erosion and flood )\*.



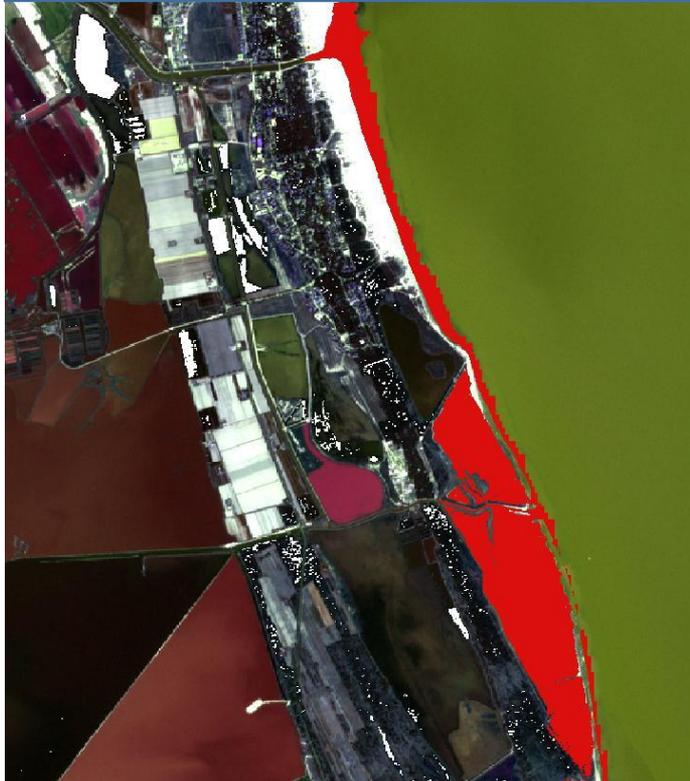
\* From Perini, L., et al. "Le mareggiate e gli impatti sulla costa in Emilia-Romagna 1946-2010." (2011).

# Methods

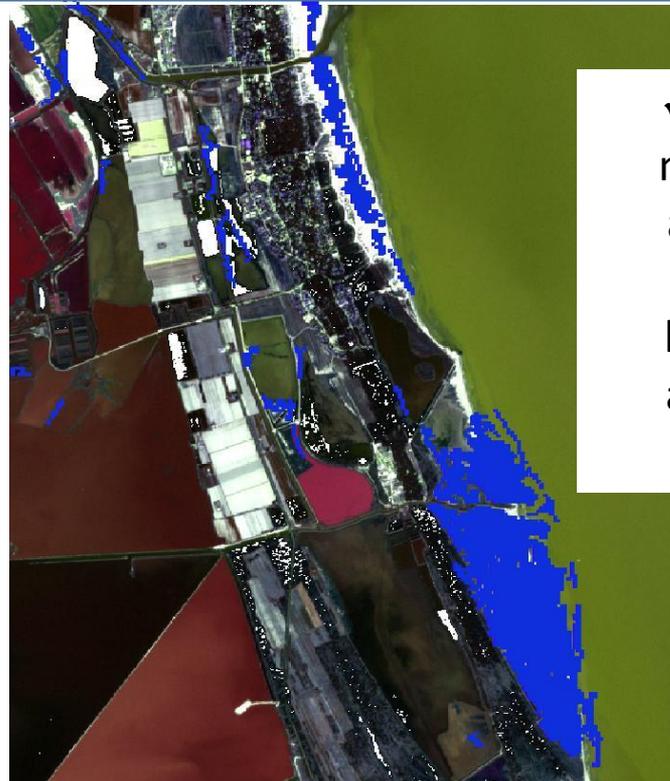


# Results: Lido di Spina beach (Bellocchio)

Flood map (Coast-def model)



Observed flood map (RS data)



✓ Coastal flood model results show agreement in both spatial extent and location of flooded areas observed by remote sensing

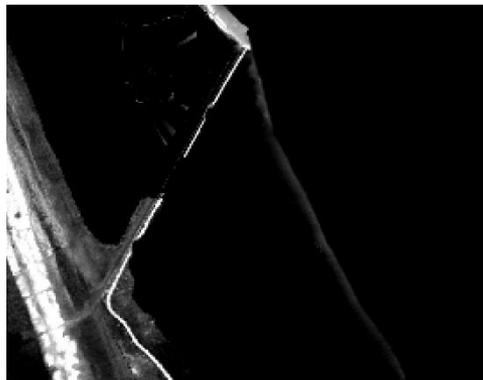
Modelled flood (SL :0.44 m)  
Critical sea level (storm +tide) =0.7 m

Observed flood: Landsat 5  
(18/01/1996)

# Results: Lido di Spina beach (Bellocchio)



Intervention: dune construction



Digital Elevation Model (Lidar) –Geoportale Regione ER

## WITHOUT INTERVENTIONS



## NBS: DUNE CONSTRUCTION

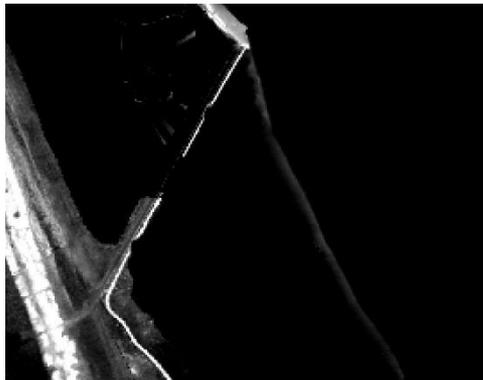


Critical sea level during extreme storm surge events (storm +tide) =0.7 m

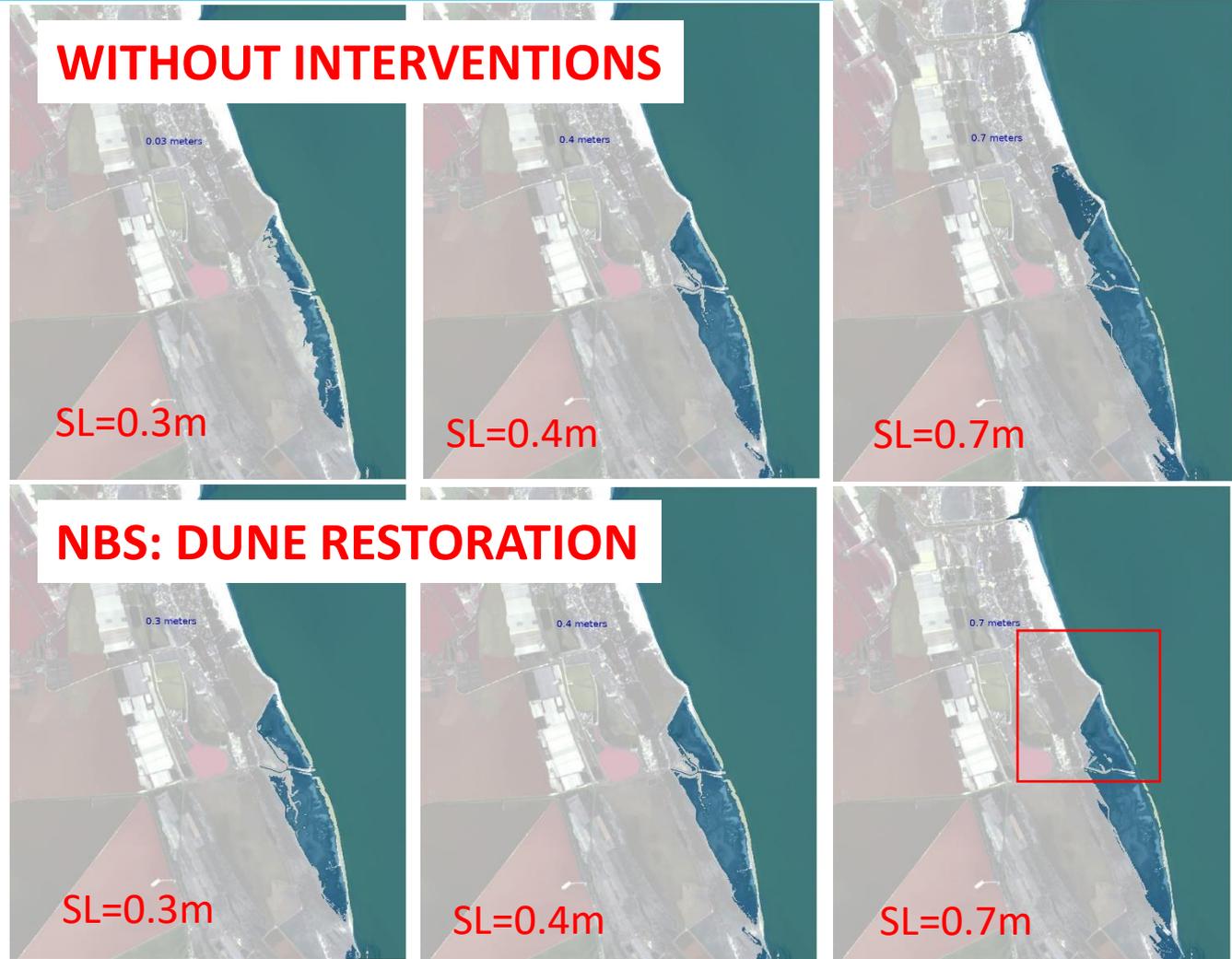
# Results: Lido di Spina beach (Bellocchio)



Intervention (NBS): pre-existing dune restoration



Digital Elevation Model (Lidar) – Geoportale Regione ER



Critical sea level during extreme storm surge events (storm + tide) = 0.7 m

# Results: Volano beach

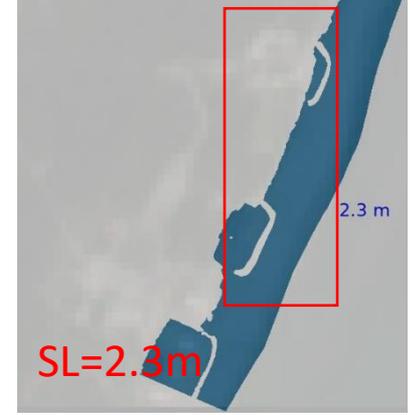
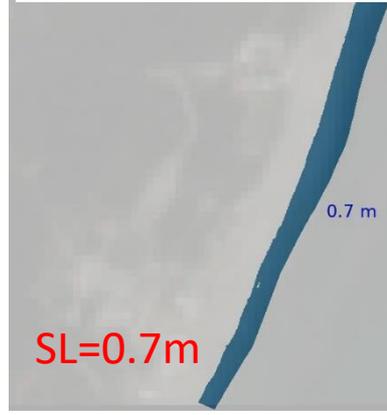


Intervention: Dune construction

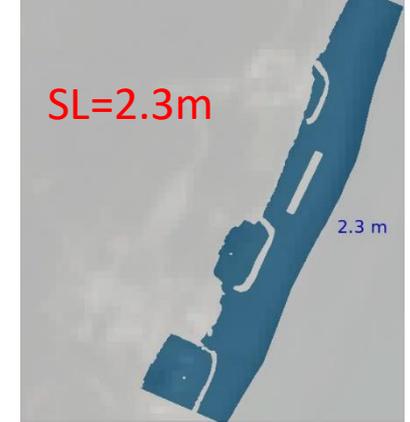
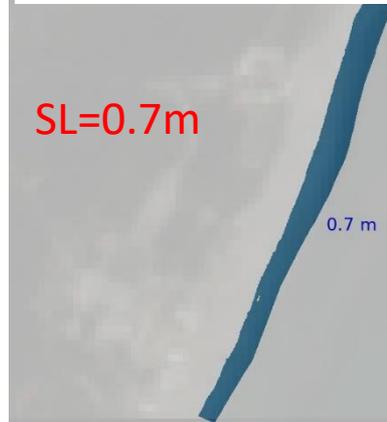


Digital Elevation Model 2019 (Lidar) –ARPA ER

## WITHOUT INTERVENTIONS



## NBS: DUNE CONSTRUCTION



Critical sea level during extreme storm surge events (storm +tide) =0.7 m

# Results: Volano beach

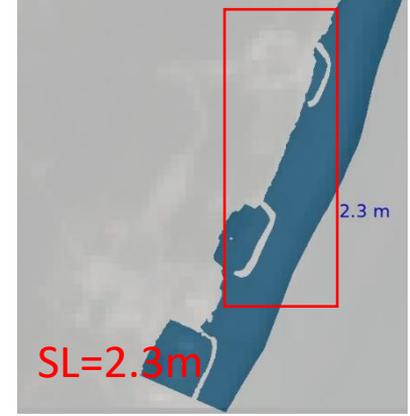
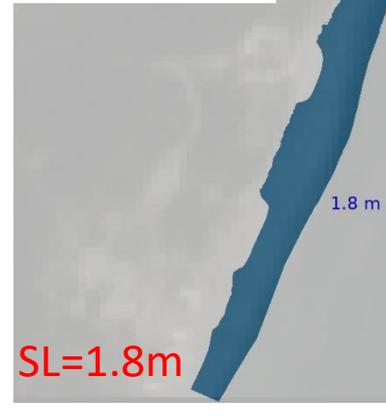
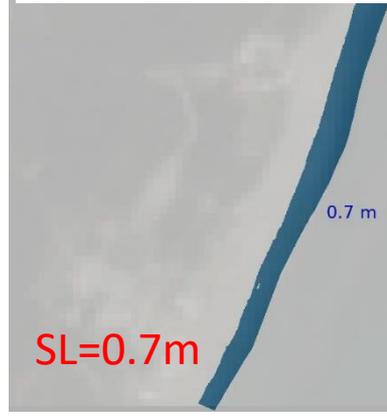


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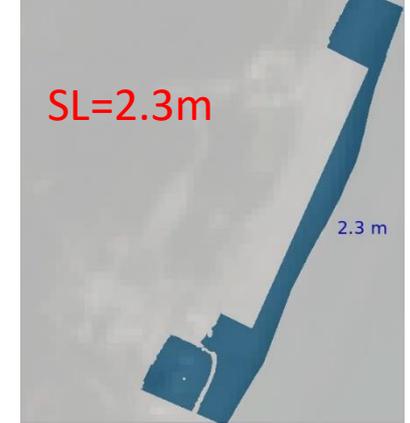


Digital Elevation Model 2019 (Lidar) –ARPA ER

## WITHOUT INTERVENTIONS



## NBS: DUNE CONSTRUCTION



Critical sea level during extreme storm surge events (storm +tide) =0.7 m

# Results: Volano beach



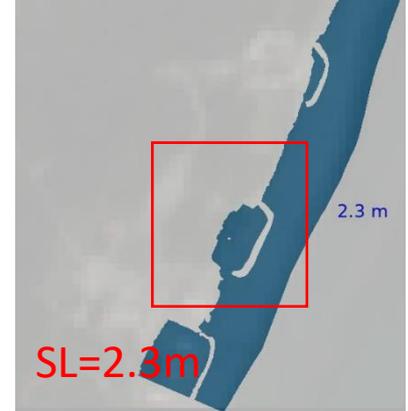
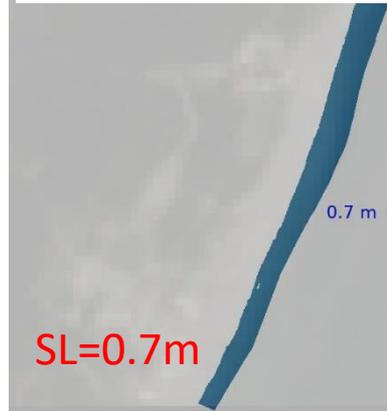
Intervention: pre-existing dune restoration



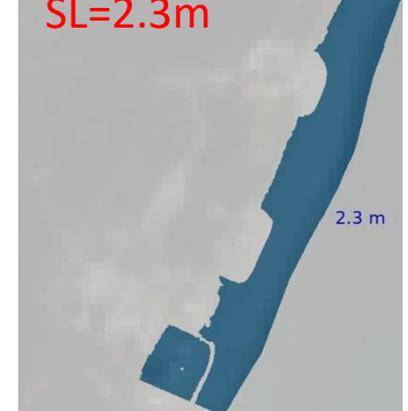
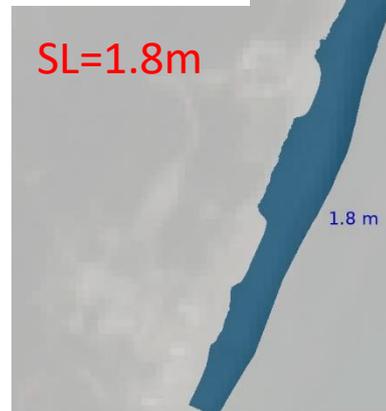
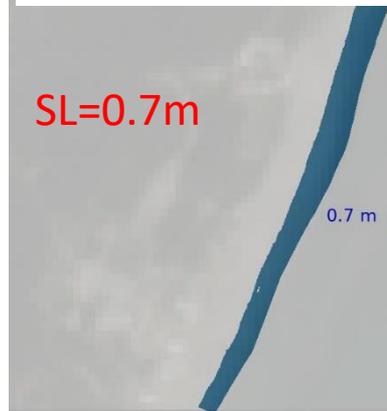
Digital Elevation Model

2019 (Lidar) –ARPA ER Critical sea level during extreme storm surge events (storm +tide) =0.7 m

## WITHOUT INTERVENTIONS



## NBS: DUNE RESTORATION



# Conclusions

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- The objective of this work was to demonstrate how the combined use of remote sensing data and modelling can be useful during co-design phase of NBS to determine position and dimension of multiple NBS by demonstrating the effectiveness in reducing flood risk during extreme storm surge events
- Different experiments have been performed in two study area located along Emilia Romagna coast (Bellocchio and Volano) where severe impacts of high flood and coastal erosion have been observed in the last 30 years.
- Remote sensing data were ingested in a bi-dimensional model simulating propagation of coastal flooding at different SL heights.
- This work demonstrated that interventions consisting of restoration of pre-existing dunes are more effective to prevent coastal flooding compared to the implementation of new dunes in both Bellocchio and Volano beaches.
- The construction of beach dunes is likely to protect inland pre-existing dunes from erosion both in Bellocchio and Volano beach and would mitigate coastal erosion.
- Coastal erosion and flood water propagation models should be applied in the co-design process.



# OPERANDUM

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[www.operandum-project.eu](http://www.operandum-project.eu)

# Thank you!

Silvia Maria Alfieri  
Delft University of Technology  
S.M.Alfieri-1@tudelft.nl

