



## Design and pre-assessment of NBS for coastal erosion and marine flooding: a case study.

**Margherita Aguzzi**<sup>1</sup>, Maurizio Bacci<sup>2</sup>, Nunzio De Nigris<sup>1</sup>, Laura Sandra Leo<sup>3</sup>, Maurizio Morelli<sup>1</sup>, Beatrice Pulvirenti<sup>4</sup>, Paola Robello<sup>5</sup>, Paolo Ruggieri<sup>3</sup>, Fabrizio Tavaroli<sup>5</sup>, Silvia Unguendoli<sup>1</sup>, Andrea Valentini<sup>1</sup>, and Carlo Cacciamani<sup>1</sup>

<sup>1</sup>Agency for Prevention, Environment and Energy of Emilia-Romagna, Hydro-Meteo-Climate Service, Italy (maguzzi@arpae.it, ndenigris@arpae.it, morellimaurizio@arpae.it, sunguendoli@arpae.it, avalentini@arpae.it, ccacciamani@arpae.it)

<sup>2</sup>IRIS Strategie per l'Ambiente sas di Firenze, Italy (bacci@irisambiente.it)

<sup>3</sup>Department of Physics and Astronomy, University of Bologna, Bologna, Italy (laurasandra.leo@unibo.it, paolo.ruggieri2@unibo.it, silvana.disabatino@unibo.it)

<sup>4</sup>Department of Industrial Engineering, University of Bologna, Italy (beatrice.pulvirenti@unibo.it)

<sup>5</sup>RINA Consulting Genova, Italy (fabrizio.tavaroli@rina.org, paola.robello@rina.org)

The natural reserve in Sacca di Bellocchio, Lido di Spina (Italy) is affected by frequent marine floods and intense erosive phenomena which threaten the freshwater ecosystem and biodiversity at the site. Floods and erosion are linked to the reduction of river sediment transport and a progressive ground subsidence and sea level rise. The persistence of these conditions and the future rise in sea level can expose neighboring anthropized areas to coastal risk.

This work presents the project of a nature-based solution (NBS) as a possible defense and mitigation action against coastal erosion and marine flooding along the Bellocchio beach. The NBS has been newly designed within the European project H2020 OPERANDUM (OPEN-air laborAtories for Nature based solutions to Manage Environmental risk) and consists of an artificial sand dune made of natural materials, such as sand, wood, geotextiles and geomembranes through naturalistic engineering techniques. On the new dune will then be inserted native herbaceous and shrubby vegetation. The dune design was supported by an accurate hydro-morphodynamic modeling of the site combined with data concerning the morphological structure, the erosive dynamics and the local climate.

This study discusses in detail the modeling techniques and the monitoring system that guided the design of the dune and that constitute a basis for the assessment of performance and effectiveness of any future NBS intervention at the site. The monitoring campaign is still ongoing and allows the collection of critical and updated information on the impacts of coastal storms, storm surges and flood events in the area. The dataset clearly highlights that the site morphology is constantly changing due to a multitude of factors, such as seasonality, the increasing incidence and/or intensity of coastal storms, sea level rise, etc. These rapid, and sometimes drastic, morphological changes pose a substantial challenge to NBS's design and, most importantly, to its deployment planning and timing phase.

