

## 1. Context

**Coastal Dunes** are ecotones with an extraordinary floristic and faunistic **biodiversity**, they play a key role in coastal **sediment balance** and act as a physical **barrier** against strong onshore **wind** and marine **hazards**.

Worldwide Differently from other types, the life of **Coastal Dunes** primarily depends on **Vegetation** as it **traps** aeolian sand and **stabilize** it with the roots.

Worldwide, **70%** of sandy beaches are subject to **coastal erosion** and **Anthropic Pressures**, leading to severe a **loss** of **Dune** ecosystems.

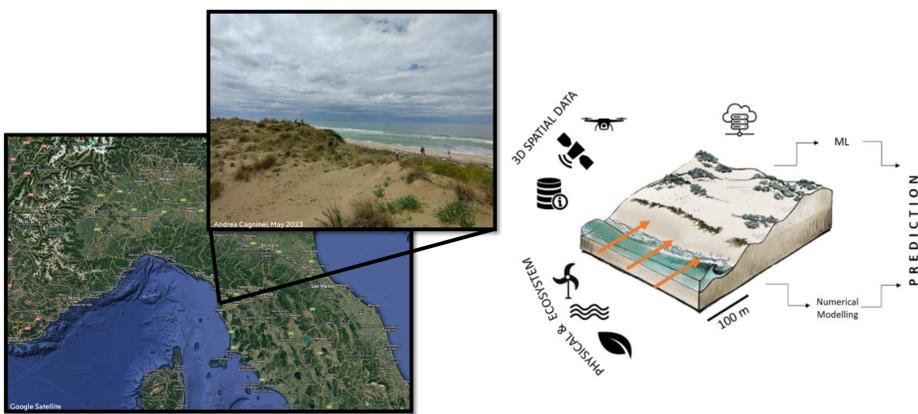
The **comprehension** and **modelling** of the complex interaction between biotic and abiotic processes for **RESTORATION** and **CONSERVATION** of **Coastal Dunes** is still at its beginning.

## 2. Objective

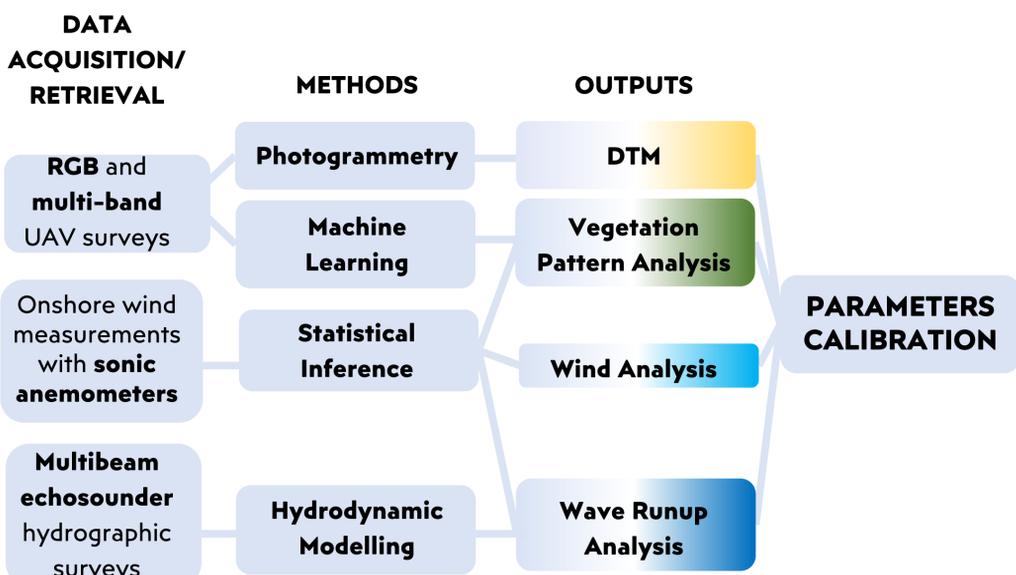
A new **stochastic Eco-morphodynamical model** is proposed to describe the evolution of the **dimensionless vegetation cover**,  $\psi$  (i.e., vegetation per unit area), under environmental forcings: **wind, flooding, sand transport, salt spray, inter/intra-species competition**.

Each forcing described in the model has a characteristic **parameter** (e.g.,  $\alpha_1, \alpha_2, l_{r,c}, \dots$ ) that needs to be **calibrated** through experimental observations of the **vegetation distribution**.

$$\frac{d\psi}{dt} = f(\text{WIND, TIDES/WAVES, SAND TRANSPORT, VEGETATION INTERACTION})$$

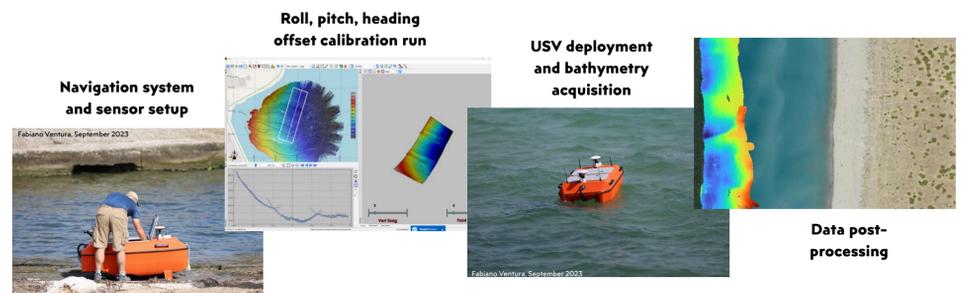


## 3. Methods



## 4. Multibeam Echosounder Hydrographic Surveys

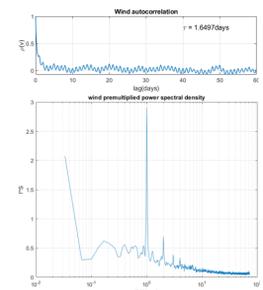
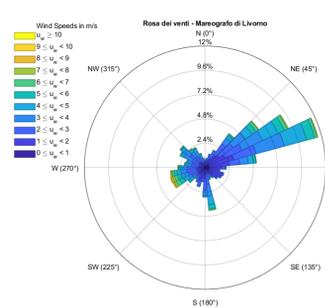
**Hydrographic** surveys have been performed with a 3D-printed prototype **USV** (Unmanned Surface Vehicle) equipped with a **WASSP S3 Multibeam Echosounder**.



## 5. Results...so far

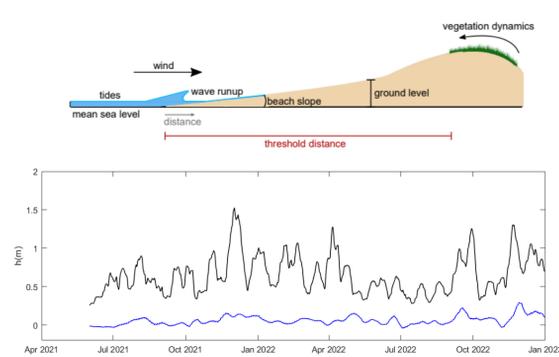
### Wind

#### Wind Speed Distribution

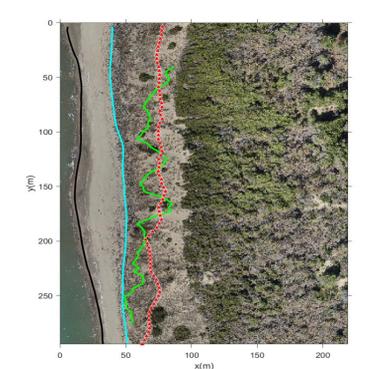


### Waves

#### Wave Runup Characterization

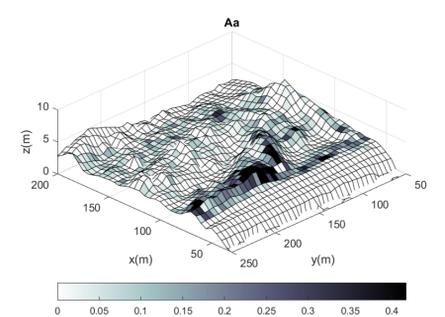
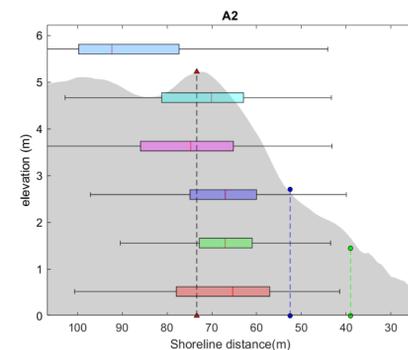


#### Wave-Vegetation Interaction

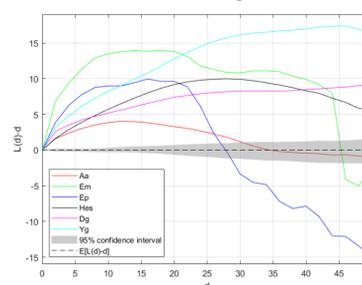


### Vegetation species-by-species pattern analysis:

#### Spatial distribution



#### Point pattern and cluster analysis



#### Geometric features characterization

