

## MONITORING COASTAL DYNAMICS AFTER WORKING WITH NATURE PRACTICES IN THE RHONE DELTA

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### INTRODUCTION

The site of the “Étangs et Marais des Salins de Camargue” (EMSC) is located southern France in the Rhône Delta, facing Mediterranean sea, at the heart of the Camargue Regional Natural Park. This site, formerly dedicated to salt production, is now owned by the Coastal Conservatory and co-managed by the Camargue Regional Natural Park, Tour du Valat, and the French National Society for the Protection of Nature. A habitat restoration project was initiated in 2011 and continues as part of the development of a 2023-2032 management plan and the site's participation in the European H2020 Rest-Coast project. This restoration aims to facilitate the recolonization of the area by plant (seagrass, salt marsh) and animal species, reestablishing the natural hydrological processes of the site. An adaptive coastal management strategy is also applied on this site, with the decision to no longer maintain the historical dikes of the salt production site facing the sea, leading to their gradual collapsing. Protection against the risk of marine submersion is ensured by an landward seawall, which will be elevated, as part of the coastal strategy defined for the greater Rhône Delta. Natural hydro-morphodynamic processes are reestablishing locally, creating new connections with the sea and the formation of beach and barrier areas through overwash. This results in the emergence of a natural buffer zone that will better address the consequences of climate change or storms, such as marine submersion and salinization.

### FIELD INFORMED RESULTS

To describe and understand the morphological changes in response to this coastal strategy, we conducted topographic field surveys. These surveys covered a 4-kilometer-long beach area located south of EMSC, where dikes face the sea, and the formation of overwash terraces began in 2016. Additionally, Lidar aerial campaigns were carried out in 2016, 2020, and 2022 across the entire EMSC site to provide detailed topographic and bathymetric data. For the 4-kilometer beach section, UAV flights and photogrammetric analysis were utilized to produce highly precise Digital Elevation Models (DEMs) and orthophotos with an accuracy of 0.05 centimeters. Aerial and satellite imagery were also employed to map the extent of overwash deposits and shoreline changes. Topographic profiles were measured every two months from December 2021 to February 2023 with RTK GPS.

Multi-year images illustrate rapid erosion and onshore accumulation, as well as the filling of the lagoon through overwash deposits during storms, resulting in the creation of a 400-meter-wide terrace (Figure 1). This barrier terrace formed after overstepping of the dike similar of natural barrier regrow after a large natural breach [Zainescu et al. 2019]. Topographic analysis reveals vertical accumulations ranging from 0.5 to 0.8 meters. This terrace remains relatively low, without the formation of dune ridges. This pattern is partially attributed to the strong aeolian processes driven by opposing onshore and offshore winds and the occurrence of storm surges from both the sea and the lagoon. An aeolian sediment transport study was conducted in winter 2021 to estimate the role of wind, in conjunction with the potential colonization by vegetation, in stabilizing the sand and creating elevation.

During storms, temporary small channels form across the overwash terrace. Where the dike started to collapse, a channel tends to stabilize and establishes a new connection to the sea. This inlet exhibit a seasonal dynamic driven by fluctuations in sea and lagoon water levels and are influenced by the occurrence of opposing winds, as other described case in southern France lagoons [Feyssat et al. 2021]. To investigate this dynamic and its impact on barrier stability, we conducted a seasonal analysis from aerial and satellite imagery we disposed. In November 2022, ADCP current meters were deployed in the channel of this inlet and in the lagoon to assess the hydraulic role of the inlet in lagoon water levels and potential flow/sediment transport relation for maintaining barrier stability. Current flow measurements reached speeds of up to 1.5 meters per second.

### MODELLING RESULTS AND PERSPECTIVES

A set of 2D numerical models using Xbeach were set-up. Calibration results in Xbeach demonstrate a good correlation with field data [Puigserver et al. 2023]. We conducted a long-term wave storm analysis to statistically define storm conditions and estimate potential future storms in the context of climate change. Various modeling scenarios are being explored to assess the resilience of this new barrier and attempt to identify critical breaking conditions.

The EMSC realignment and renaturation program

serves as an instructive experimental case for gathering valuable insights into this type of coastal management strategy within a Mediterranean environment. Long-term monitoring efforts have produced a rich dataset, enabling a comprehensive approach that will provide essential information for both coastal management and scientific understanding in low-elevation, lagoon environments, sensitive to future sea-level rise.

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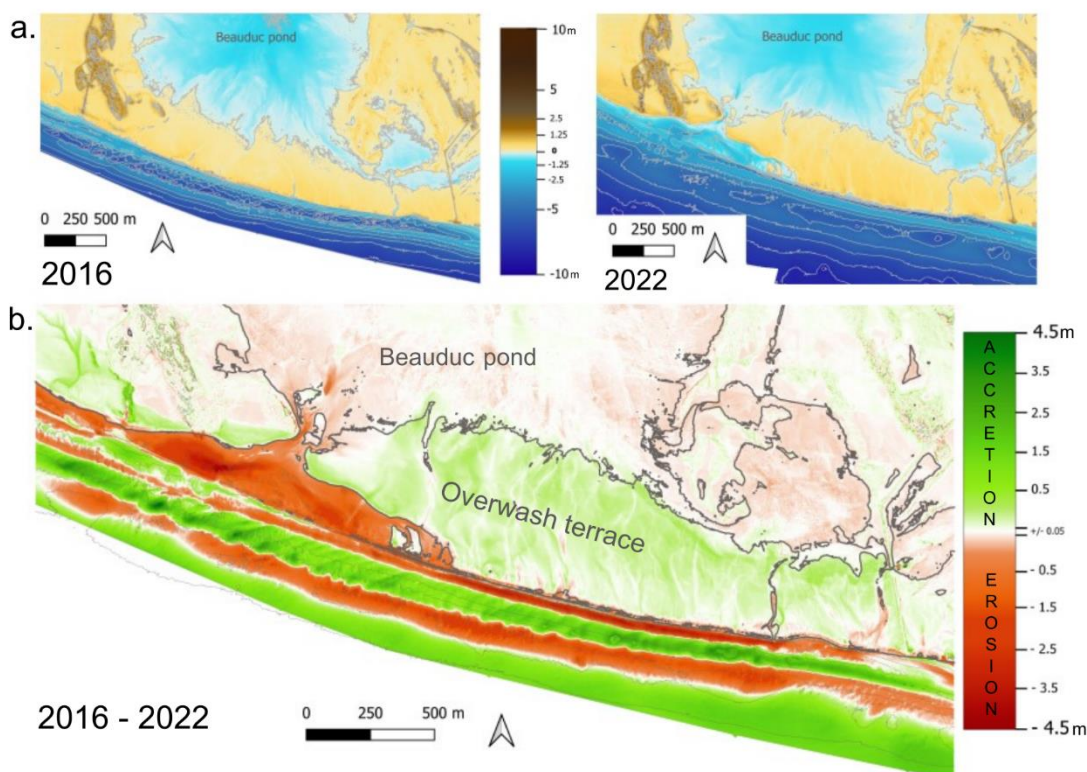


Figure 1 - Lidar data from south part of coastal site of EMSC: a . DEMs in 2016 with the extension of the wide overwash terrasse and in 2022 with opening of the inlet. b. Differential of DEMs between 2016 and 2022, showing low elevation accretion on the terrasse and erosion at the inlet mouth. (adapted from Puigserver, unpublished map)