



REST-COAST

LARGE SCALE RESTORATION OF COASTAL ECOSYSTEMS
THROUGH RIVERS TO SEA CONNECTIVITY

EBRO DELTA



RESULTS & ACHIEVEMENTS REPORT

SUMMARY

The Ebro Delta pilot site achieved 100% implementation of all planned restoration actions, making it one of the most fully delivered pilots in the REST-COAST project. Two complementary nature-based interventions were carried out: the removal of an artificial sand barrier to restore lagoon–sea connectivity, and the construction of embryonic dune systems along 7.6 km of barrier beaches. These measures tackled a broad spectrum of pressures

— from biodiversity degradation and coastal erosion to degraded water quality, flooding risk, and climate change vulnerability — through ecological reconnection and coastal resilience-building rather than hard engineering. Stakeholders were engaged through the CORE-PLAT living-lab platform, and the project contributed to mainstreaming Nature-based Solutions (NbS) in regional coastal governance.



Funded by
the European Union

This project receives funding from the European Union's Horizon 2020 Innovation Action under grant agreement No 101037097.

THREATS AND PRESSURES ADDRESSED

The Ebro Delta faced multiple interacting pressures:

Severe biodiversity loss, due to habitat degradation, pollution and invasive species

Flooding and agricultural land salinisation

Accelerated coastal erosion

Climate change-related pressures, such as severe storms

Altered coastal morphology

Conflicting uses of water and sediment deficit

Poor water quality in coastal lagoons

Threats to socio-economic activities, such as rice farming and tourism

BASELINE CONDITION

The Ebro Delta's coastal system had been significantly altered by the presence of an artificial sand barrier that severed the lagoon from the coastal marine environment, disrupting salinity gradients, hydrological exchange, and associated habitat dynamics. Barrier beaches at the Trabucador bar

and Marquesa beach lacked embryonic dune systems, leaving them vulnerable to storm breaching and erosion. The lagoons suffered from stagnant water conditions, elevated nutrient concentrations, invasive species and declining biodiversity.

RESTORATION STRATEGY SELECTED AND WHY

The project selected nature-based restoration as its core strategy, prioritising ecological reconnection over hard engineering. Two complementary approaches were chosen:

Removal of the artificial sand barrier to re-establish cross-shore ecological connectivity between the lagoon and the sea, allowing natural coastal dynamics, saltwater intrusion pulses, and habitat diversification.

Construction of embryonic dune systems to increase coastal roughness, promote sediment retention, and reduce vulnerability to storms.

This dual approach addressed both the inland lagoon and the exposed coastal frontage simultaneously. At the Trabucador bar, an alternating alongshore dune system was built along the full 6

km length of the barrier beach, designed to allow controlled overwash and create a sediment stock that can be mobilised during storms. At Marquesa beach (1.6 km), 62 perpendicular dunes were constructed to fix sediment in the valleys and increase roughness, with a green core dune incorporating seagrass debris to increase structural strength.



Trabucador dunes – pre storm sequence in December 2022

HOW THE CHALLENGES WERE ADDRESSED AND KEY RESULTS ACHIEVED

All planned restoration actions were implemented at 100% across every challenge category.



Severe Biodiversity Degradation

Re-establishment of coastal exchange and salinity gradients produced a clear reorganisation of functional habitat groups consistent with restored hydrological connectivity:

- Submerged lagoon vegetation expanded markedly (+7–8%), indicating improved aquatic habitat conditions.
- Long-inundated marsh habitats expanded by approximately 20%.
- Glasswort scrub remained broadly stable (~2% contraction).
- Irrigation channels were reduced by roughly one third (–34%), reflecting re-naturalisation of the hydrological network.
- Freshwater emergent stands (e.g. *Typha* spp.) decreased moderately (–18–21%) in response to shifting salinity regimes.
- Embryonic dunes along the coastal fringe increased strongly (+55%), signalling active sedimentary adjustment.



Accelerated Coastal Erosion and Altered Coastal Morphology

Beach resilience against storm impacts increased substantially. At the Trabucador barrier beach, severe breaching was prevented. At Marquesa beach, the emerged beach level increased. The dune systems increased coastal roughness and promoted the development of original landscape forms.



Degraded Water Quality in Coastal Lagoons

Improved water renewal and reduced stagnation periods were achieved. Salinity regimes stabilised. Post-restoration nitrate and total nitrogen values were approximately 15–25% lower than the highest pre-restoration peaks. No significant differences were observed for phosphorus.



Flooding, Land Loss Risks and Climate Change Pressures

Beach resilience against storm impacts was improved at both sites, with the prevention of severe breaching at Trabucador and increased beach elevation at Marquesa.



PERCENTAGE OF TARGET ACHIEVED

100%

across all challenge categories. Removal of the artificial sand barrier and lagoon reconnection were fully implemented, and embryonic dune restoration was completed along the full Trabucador bar (6 km) and Marquesa beach (1.6 km).

SPECIFIC SOLUTIONS IMPLEMENTED

Barrier removal

Removal of the artificial sand barrier to re-establish cross-shore ecological connectivity, enabling natural coastal dynamics and saline intrusion pulses.

Trabucador dune system (6 km)

Alternating alongshore dunes covering the full length of the barrier beach, allowing overwash and creating a storm-mobilisable sediment stock.

Marquesa dune system (1.6 km)

62 perpendicular dunes to fix sediment and increase roughness, plus a green core dune constructed using seagrass debris.

Hydrological reconnection

Restoration focused on natural exchange processes rather than mechanical water management, enabling passive improvement of water quality and coastal lagoon ecological status.

CORE-PLAT living-lab

Co-creation processes facilitated dialogue between farmers, environmental managers, and scientists, aligning ecological restoration with socio-economic needs.

KEY STAKEHOLDERS INVOLVED AND HOW

Spanish national and Catalan regional authorities, Delta de l'Ebre Natural Park managers, irrigation communities, and local stakeholders were engaged through the CORE-PLAT (living-lab) workshops across all challenge areas. This participa-

tory platform brought together actors with often conflicting interests — including farming communities and conservation managers — to co-design and validate restoration measures.

INFLUENCE ON DECISION-MAKING

The Ebro Delta pilot contributed to regional coastal restoration strategies and to mainstreaming discussions on Nature-based Solutions within the Ebro Delta governance framework. It supported the adoption of adaptive management approaches promoted by REST-COAST, feeding into the institutional framing of NbS as a legitimate tool for coastal planning at both regional and national levels.



RECOMMENDATIONS FOR FUTURE DEVELOPMENT

Biodiversity / Lagoon connectivity

Maintain connectivity, allow natural morphological evolution, expand monitoring of biodiversity indicators (halophytes, habitat mapping), and integrate with adjacent restoration areas to increase landscape-scale connectivity.

Coastal erosion / Dune systems

Monitor and maintain embryonic dunes and coastal roughness to prevent further erosion, ensuring emerged beach sand deposits remain above critical thresholds. Keep stakeholders engaged through the coastal restoration platform.

Altered morphology

Monitor and maintain enhanced coastal roughness to prevent deep breaching channels. Track sediment sources for re-nourishment and availability of accommodation space.

Water quality

Expand monitoring of water quality indicators (especially dissolved nutrients) and integrate with adjacent restoration areas for landscape-scale connectivity.

Flooding and climate risks

Monitor relative sea level rise and salinisation in back-beach areas. Regularly analyse sediment budgets and coastal morphology in relation to climatic pressures.

Governance

Strengthen participatory governance structures, evaluate ecosystem-service trade-offs, and integrate restoration into agri-environmental planning.

FINANCIAL MECHANISMS USED AND PROPOSED

Restoration actions were funded through a combination of EU Horizon 2020 REST-COAST funding and support from the Spanish National Ministry of the Environment, with public institutional support for coastal monitoring.

More broadly, wetland restoration in the Ebro Delta typically involves converting commercial properties — such as rice fields or hunting estates in-

creasingly vulnerable to salinisation and flood risk — into lagoons and wetlands. Early restoration efforts are supported through a mix of philanthropic contributions and multi-level public co-funding. Over time, long-term management responsibility is transferred to the Natural Park, which sustains these areas through tourism-based revenues and subsidy-driven funding.

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