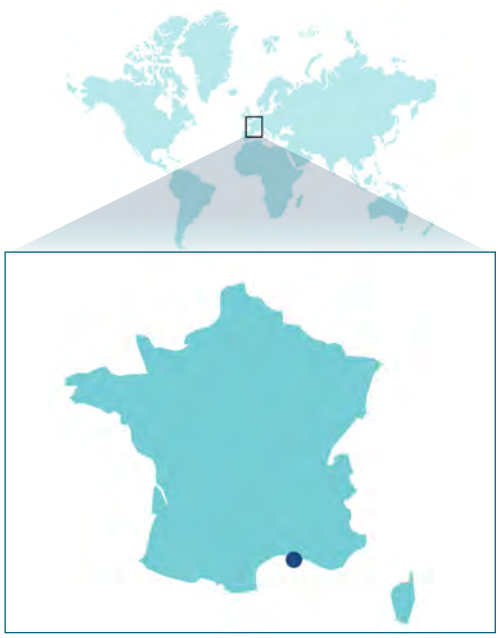
Case study 3

Adaptive management of the lagoons and marshes of the former Camargue saltworks – France

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Camargue, Provence-Alpes-Côte d'Azur Region, France *Source: Base map by UN Maps (2025).*

Societal challenges

Types of NbS

EbA | Eco-DRR | EE | ER | EbMgt | AbC

Types of biomes

F3 – Artificial wetlands **FM1 –** Semi-confined transitional waters **MT1 –** Shoreline **MT2 –** Supralittoral coastal **MT3 –** Anthropogenic shorelines **MFT1 –** Brackish tidal

Stakeholders

Further information is available here.

Main objectives

The overall aim was the reconversion and restoration of an exceptional coastal site by means of a multidisciplinary and integrated approach. The objectives of the restoration are to:

- Re-establish a more natural hydrological regime by reconnecting the site with surrounding hydrosystems (Vaccarès Lagoon, Mediterranean Sea, and Rhône River via an agricultural hydraulic system);
- Reconstitute the characteristic ecosystems of Mediterranean coastal lagoons and sandy seafronts (dunes, saline grasslands, dry grasslands);
- Maintain or increase the site's holding capacity for colonial waterbirds;
- Implement an adaptive management approach to the rising sea level by a controlled, progressive retreat from the coastline in areas subject to erosion;
- Integrate local economic development by promoting sustainable, environmentally friendly ways to visit the lagoons and marshes of the former Camargue saltworks.

Setting the context

From 2007, the Salins company wanted to sell part of its Camargue operating site for industrial and financial reasons. Developed mainly between the 1950s and 1970s for salt production, it was characterised by a strong artificialisation of the water cycle (diversion of fresh water, use of protective dykes and pumps), salinities close to those of sea water or very high (up to 150 g/L depending on the ponds), and a disconnection of the lagoons from the sea (Britton & Johnson, 1987; Tour du Valat, 2012). Conservatoire du Littoral (the French Coastal Conservancy) then acquired 6,500 ha between 2008 and 2012. In view of the severe coastal erosion in the area concerned, the Salins and the Conservatoire du Littoral decided not to maintain the seafront dyke, the cost of which was disproportionate to the expected benefit, since it no longer protected industrial installations (BG Ingénieurs Conseils, 2013). As a result, and in the absence of maintenance, its deterioration, more or less rapid



In 2011: View of the northern part of the saltworks, when the area was still covered with salted mudflats *Photo: Jean Roché*



In 2019: View of the northern part of the saltworks. As a result of natural hydrology restoration, the same area is covered with typical coastal Mediterranean wetlands vegetation: tamarisk (*Tamarix gallica*), common reed (*Phragmites australis*), and glassworts (*Arthrocnemum macrostachyum, Sarcocornia fruticosa*). *Photo: Jean Roché*

depending on the segment, soon became visible, calling for a new long-term strategy addressing adaptation to sea-level rise associated to climate change. The general vision is to implement a hybrid approach that combines the restoration of a high-biodiversity value buffer zone to mitigate the effects of sea flood events, while reinforcing and adapting protection dykes located further inland. Hence, the strategy combines Nature-based Solution (NbS) and grey infrastructure (Segura et al., 2018).

Implemented activities

After two years of studies and diagnoses on the hydrology, biodiversity (habitats and species), and socio-economic aspects, the Coastal Conservancy, in collaboration with Camargue Regional Nature Park (coordinating manager), Tour du Valat, and Société Nationale de Protection de la Nature (National Society for Nature Protection) (co-managers), launched a project to ecologically restore the area.

As breaches in the sea front dike increased, work was carried out to improve the hydrobiological exchange between the lagoons and reconnect the former saltpans:

- to the Vaccarès Lagoon system, by creating, rehabilitating, and resizing of hydraulic structures, dredging of channels and levelling dikes;
- to the Rhône River via the Canal du Japon agricultural irrigation system.

Local stakeholders were involved in a steering committee set up during the development of the first management plan for the site. They were also involved in a project to define new tourist pathways on the site and in the nearby village. More recently, during the second phase of the



Channel dredging operation implemented as part of the hydraulic reconnection programme of Camargue former saltworks
Photo: Parc naturel régional de Camargue

management plan, workshops, field visits, and meetings were organised to share the diagnosis of the site with local stakeholders. They were also involved in defining the main objectives and some of the activities to be implemented as part of the management plan.

Key results

The main results include:

- Natural formation of a shifting coastal sandbar, which helps to mitigate erosion and submersion risks at low cost (Segura et al., 2018);
- Improvement of the ecological status of a part of the lagoon habitats (Tour du Valat, 2022) such as the direct reconnection of some lagoons to the sea that has led to increased species richness for both aquatic vegetation and benthic invertebrates. As a result of the hydraulic works, the salinity of another lagoon located further inland was significantly reduced, allowing colonisation by marine migratory fish. A temporary lagoon ecosystem that was completely lost is also being restored and recolonised by some rare native crustaceans species and aquatic vegetation;
- Contribution to the development of marine and lagoon fish stocks;
- Increased populations of nesting colonial gulls, terns, and waders (Tour du Valat, 2022);
- Recolonisation of bare ground by perennial Salicornia salt meadows and annual Salicornia, all habitats targeted by the European Union's Habitats Directive that have declined elsewhere in the Camargue;
- Increased quality, diversity, and naturalness of landscapes;
- Diversification of uses, including ecotourism, beach tourism, fishing, hunting, and grazing.

Application of the Global Standard for NbS Self-Assessment Tool

The results of the NbS-SAT are presented graphically in Figure 12 and discussed in the subsequent passages.

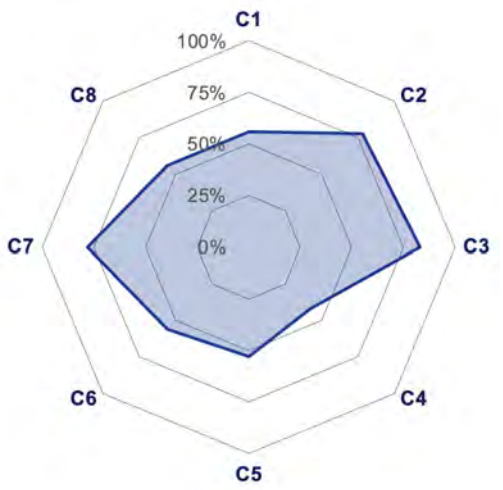


Figure 12 Overview of the Global Standard for NbS SAT results: case study 3, Camargue, France *Source: Figure prepared by the authors.*

Strongest criterion: C3 – Biodiversity net gain and ecosystem integrity

Key factors: The result is predictable as this was the main initial objective of the ecological restoration. It is a guiding principle for all lands purchased by the Coastal Conservancy and is a key mission of the Regional Nature Park, Tour du Valat, and the Société Nationale de Protection de la Nature. Significant financial resources and scientific expertise have been mobilised for that purpose.

Drivers were assessed at the start of the project. Habitats and biodiversity, either positively or negatively affected by the NbS project, were reviewed.

Implemented NbS interventions responded to evidence-based assessment of the current state of the ecosystem. Aquatic vegetation, benthic

invertebrates, salinity, and water quality have all been used to assess the conservation status of the coastal lagoons. A five-year long study was implemented to assess the effectiveness of the hydraulic works carried out for the movement of migratory fish. Inventories were also conducted to assess the Branchiopoda crustaceans community of Mediterranean temporary lagoons.

Habitat mapping has been implemented to monitor the surfaces covered by native saltmarshes vegetations. Wintering waterbirds and breeding colonial waterbirds are monitored at a regular basis. Monitoring of the opening and closing of the valves, as well as the water level and salinity, is carried out in the different lagoons and drives adaptive water management. Hence, the NbS adaptive management plan includes measurable indicator variables related to biodiversity and ecosystem integrity. It is worth mentioning that migrant fish have only been monitored in the second phase of the project, and some targeted habitats and ecosystems are not currently monitored (i.e. coastal dunes and Mediterranean salt steppes).

Second strongest criteria: C2 – Design at scale and C7 – Adaptive management

Key factors

C2: The interactions between the economy, society, and ecosystems have been identified in the management plan, based on interviews with local stakeholders (associations, local authorities, private owners). The evolution of these interactions, and in particular the effects of environmental changes on all human activities (e.g. tourism, agriculture), were also highlighted during consultation workshops. As a result, climate change is a key issue well integrated in the Management Plan of the former saltwork. At the wider Rhone Delta scale, a coastal management strategy is being drafted (by the local authority in charge of coastal flooding management), and it focuses on adaptation to sea-level rise and coastal erosion.

The former saltwork management plan integrates the different public policies relevant to the Rhone Delta, including territorial planning and projects, coastal management, adaptation to climate change, management of natural resources, management of populations of migratory animal species in danger of extinction. Agreements have been signed with several users of the site, as well as with a salt industry, whose property is adjacent to the site. The management plan incorporates the official risk management documents.

C7: The management plan states intended outcomes, actions, and assumptions, with various levels of details, depending on the targeted issues. It also defines monitoring and evaluation activities to be implemented. Adaptive management was implemented, based on the monitoring and evaluation results.

Weakest criterion: C4 – Economic viability

Key factors: A basic internal rate of return has been calculated drawing primarily on direct upfront and recurring costs and direct benefits. However, there are significant gaps in accounting for indirect costs and benefits, and key assumptions have not been tested. Viable alternative solutions have been identified and their pros and cons have been partially assessed, but only limited and basic economic analysis has been conducted.

Second weakest criterion: C5 – Inclusive governance

Key factors: Consultation during the elaboration of the management plan and, to a lesser extent, with the management committees, allow grievances to be addressed, but there is currently no comprehensive mechanism in place. Provisions for the settlement of grievances only appear in agreements signed with some of the stakeholders.

Limited stakeholder analysis was conducted identifying stakeholders who may be directly affected by the NbS. In practice, there is a good knowledge of stakeholders, and many actions have been, and are, carried out to support the evolution of activities over time.



Common shelducks (*Tadorna tadorna*) in restored saltmarshes of Camargue's former saltworks *Photo: Marc Thibault*

Main lessons and challenges

It is important to better involve local communities in the initial design phase and then continuously during the implementation phase. This was done but could have been considered more thoroughly.

The fact that ecosystem restoration and risk management are linked to different public policies, implemented by different actors with different timetables, as well as regulatory and fundings constraints, bring vulnerability and complexity to the overall project. While ecological restoration leading to the restoration of a climate buffer has been completed under the authority of Conservatoire du Littoral, the reinforcement and adaptation works of an inland protection dyke have yet to be carried out by local authorities, which means that the disaster-risk reduction objective will only be achieved in a few years. Lastly, it is challenging to coordinate the planning and implementation of all the activities and policies among stakeholders from different sectors.

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