

Venice Lagoon

Pilot Fact Sheet

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Ecosystem type

The Venice lagoon, spanning $\pm 550 \text{ km}^2$, is a complex ecosystem, showing features of transitional waters in the inner brackish areas, while presenting the characteristics of a coastal marine bay elsewhere, either in terms of salinity regime and of habitat types. The complexity of the lagoon results in a mosaic of coastal habitats including salt marshes, seagrasses, wetlands, mudflats, islands, and eutrophic lakes.

Key habitats

Target Habitats: 1140 – Mudflats and sandflats not covered by seawater at low tide, 1150* Coastal lagoons, 1310 – *Salicornia* and other annuals colonising mud and sand, 1320 – *Spartina* swards (*Spartinion maritima*), 1410 – Mediterranean salt meadows (*Juncetalia maritimi*), 1420 – Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*), 1510* Mediterranean salt steppes (*Limonietales*), 3150 – Natural eutrophic lakes with Magnopotamion or Hydrocharition.

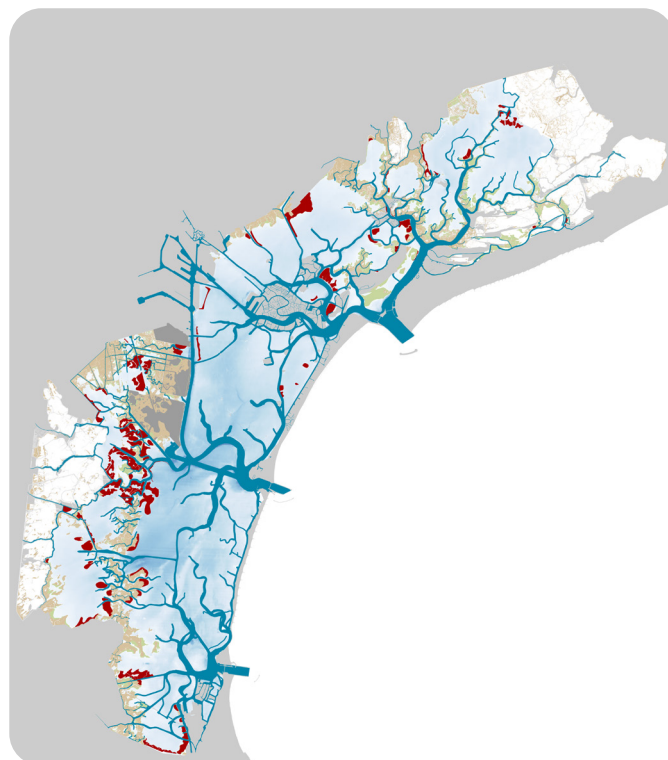
Country: Italy

Area: Drainage basin: $\pm 2.068 \text{ km}^2$

Lagoon: $\pm 550 \text{ km}^2$

Geographic coordinates of the site centroid point: Long: 12.319794, Lat: 45.418696

Reference system: WGS84 EPSG:4326



Artificial salt marshes and mudflats

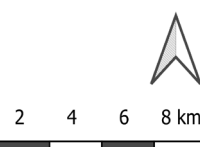
Natural mudflats

Natural salt marshes

Reclaimed areas

Land

Lagoon channels



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Key species

Marine seagrasses: *Cymodocea nodosa*, *Zostera marina*, *Zostera noltei*.

Fishes: The fish assemblage of the Venice lagoon is made up of 94 species of which marine stragglers is the most abundant category (55 species), followed by marine migrants (16 species), and lagoon residents (15 species). Of these, four species are of EU importance included in the Habitat Directive: Twait shad (*Alosa fallax*), Mediterranean killifish (*Aphanius fasciatus*), Adriatic dwarf goby (*Knipowitschia panizae*), Canestrini's goby (*Pomatoschistus canestrinii*). Other species, for instance Gilt-head bream (*Sparus aurata*), European seabass (*Dicentrarchus labrax*), Flounder (*Platichthys flesus*), Common sole (*Solea solea*), Thinlip grey mullet (*Chelon ramada*), Goldfish mullet (*C. auratus*), Leaping mullet (*C. saliens*), Thinklip grey mullet (*C. labrosus*) and Flathead grey mullet (*Mugil cephalus*), which are concentrated in the Venice lagoon at the juvenile stages, represent important stocks exploited for fishing purposes.



Glasswort plant *Salicornia veneta*



Seagrass *Zostera marina*



Dunlin *Calidris alpina*



Sandwich tern *Sterna sandwicensis*

Birds: The lagoon of Venice is the largest Important Bird Area (IBA) on a national scale, counting the highest number of species of Community importance to be preserved. A total of 140 breeding species have been recorded in the lagoon, representing around 55% of the known species for Italy, moreover, many of the breeding aquatic species have a restricted areal distribution linked to wetlands, or small populations, whose survival is threatened.

Among the species of conservation interest, included in the Birds Directive (Annex I), are Kentish plover (*Charadrius alexandrinus*), Little tern (*Sternula albifrons*), Common tern (*Sterna hirundo*), Sandwich tern (*Sterna sandwicensis*), Western marsh harrier (*Circus aeruginosus*), Montagu's harrier (*Circus pygargus*), Hen harrier (*Circus cyaneus*), Pied avocet (*Recurvirostra avosetta*), Black-winged stilt (*Himantopus himantopus*), Eurasian bittern (*Botaurus stellaris*), Little bittern (*Ixobrychus minutus*), Little egret (*Egretta garzetta*), Great egret (*Ardea alba*), Purple heron (*Ardea purpurea*). Other species characteriz-

ing the lagoon ecosystem in the wintering period are Dunlin (*Calidris alpina*), Grey plover (*Pluvialis squatarola*), Eurasian curlew (*Numenius arquata*), Common redshank (*Tringa totanus*), and the Common shelduck (*Tadorna tadorna*).

Organisation responsible for the pilot

CORILA, CMCC, University Ca' Foscari of Venice, University of Padua, Provveditorato Interregionale per le Opere Pubbliche per il Veneto, Trentino-Alto Adige e Friuli-Venezia Giulia (Ministry of Infrastructure).

Pressures, threats and issues

The ecological functionality, the "dynamic balance", as well as the biodiversity of the Venice lagoon are threatened by a number of factors, both natural (including climate change, subsidence and sea level rise) and anthropogenic processes (i.e. the la-



Little tern *Sternula albifrons*



Kentish plover *Charadrius alexandrinus*



Eurasian curlew *Numenius arquata*



Eurasian oystercatcher *Haematopus ostralegus*

agoon alterations caused by the modifications at the lagoon inlets and the excavation of deep channels that contribute to the erosion of the natural lagoon habitats, the low amount of sediments entering the lagoon, the chemical pollution of water, the waves generated by motor boats associated to wind, marine litters and Invasive Alien Species IAS).

Biodiversity loss

Within the lagoon of Venice, there are unique valuable habitats of conservation importance (e.g., natural salt marshes, mudflats and seagrasses) that play a fundamental role both as regulators of the lagoon hydrodynamics and as habitat for many wildlife species, also providing a huge number of ecosystem services. However, such habitats are currently threatened by the aforementioned factors leading to habitat degradation/disappearance and biodiversity and ecosystem services loss. As an example, several bird species of conserva-

tion interest that are characteristic of the lagoon of Venice (for instance kentish plover, little tern and sandwich tern) are facing a population decline due to the loss of the nesting habitat because of the increase in mean sea level and the enhanced frequency of high tide events in the summer period with consequent loss of their brood.

Natural impacts

Combined with eustatic Sea Level Rise (SLR), between 1972 and 2002 subsidence has further increased relative sea level rise by ± 1.5 mm yr⁻¹. In the past century the combination between natural and induced (groundwater withdrawal) processes, together with eustasy, have caused 23 cm of land subsidence. The city of Venice is also periodically subjected to sudden and frequent high tides, the so called "acqua alta", leading to significant damages to residential structure, economic activities, cultural heritage and transport facilities.

Future projections for multiple hazards indicate that at least 75% of the North Adriatic region could be affected by one or more climate hazards, with highest concentrations near the coastline. Depending on the climatic projections, sea level rise will range between 32 and 100 cm by 2100, temperature is expected to increase with 2 - 2.5 degrees Celsius by the middle of the century, while the intensity of storm surges is expected to decrease. Moreover, in the future, a variety of activities taking place in the Venice lagoon will be adversely impacted by climate change. For instance, increasing occurrence

of heat waves and low primary productivity is expected to increase mortality and thereby negatively impact fishery resources.

Anthropogenic impacts

The Venice lagoon is a complex, heterogeneous, and dynamic system that continuously evolves in response to modifications from stressors. During the last century, the lagoon has experienced general degradation including the deepening of tidal flats and the reduction of salt marshes. Many changes are deeply rooted in human interventions, such as the diversion of rivers, construction of sea defenses, development of industrial areas and dredging artificial channels.

Main historic anthropogenic factors include:

- Land-based interventions (such as agriculture, industrial activity, and sewage inputs) loading nutrients in the lagoon,
- Industrial activities producing heavy metals and chemical pollutants,
- Maritime traffic,
- Fishing and aquaculture,
- Alterations to physical and morphological features of the lagoon forcing driving exchanges with the sea and warming climatic conditions due to climate change.



Maritime traffic



View of a natural saltmarsh

Population & Tourism

Many tourism-related activities are concentrated in the city center of Venice. The city records over 10 million tourist presences every year to which are added the "visitor" tourists (i.e., people who do not spend the night in the city), whose number is greater than 12 million/year. Other important activities are the touristic and industrial-commercial harbors (among the most important in Italy), being the Venetian port one of the most important in Italy (25 million tons of goods per year and 1.6 million passengers on cruise ships, in 2018). Livelihood industry (fish farms, aquaculture, traditional fishing) and local handcraft (glasses, crochets) are other relevant anthropic activities carried out in the lagoon. This wide range of activities and the high human pressure on the lagoon bring to the need of finding a trade-off between economy and sustainability.

Protecting Venice

The safeguarding of Venice and its lagoon is indeed of "primary national interest" according to a law issued in 1973 ("Special Law of Venice"). Huge efforts have been spent at all levels (nation-

al, regional, and local) by Public Administrations. Specific and severe limits for pollutant emissions both in water and air) have been introduced since the '90s, but the pollution effects are still present in the soil and sediments.

Since 1992, in application of the Morphological Plan, the Venice Water Authority implemented several interventions to contrast the erosion trends occurring in the lagoon. Morphological structures (i.e. artificial salt marshes and mudflats) for a total surface of 16 km² have been created, and other interventions for contrasting the loss of sediments and protecting the edges of the existing salt marshes and eroded mudflats have been done for an extension of about 40 km.

To contrast the flooding in the city (due to SLR) a mobile barrier system ("MOSE") has been built in the three lagoon inlets. This system can separate the lagoon from the sea in case of extreme high tide events. First activated in October 2020, the barriers have been raised more than 50 times in these first years.

Finally, the municipality of Venice is currently working on the "Climate Adaptation Plan".

Objectives and activities of the REST-COAST project

REST-COAST seeks to showcase the benefits of coastal restoration by illustrating how active restoration measures contribute to supporting the increasing of biodiversity and delivering Ecosystem Services (ESS), referring to the valuable contributions that ecosystems make to human well-being. The REST-COAST pilot action to be implemented in the Venice lagoon consists in the restoration of already existing artificial saltmarshes located in the central/southern lagoon. These works aim to reverse the degradation processes occurring in the area and to improve some of the features that hindered the naturalization processes of these artificial structures. By mitigating saltmarsh border erosion and fostering conditions suitable to the subsequent colonization of vegetation and wildlife species, REST-COAST actions will enhance opportunities to expand priority habitat surfaces and bolster specific biodiversity.

Within the REST-COAST project, the restoration of saltmarshes is studied to enhance the understanding of how these NBS can help to enhance ecosystem services (ESS) such as water quality purification, reduction of erosion and flood risk, climate mitigation through carbon sequestration and food provisioning, as well as biodiversity.

After the selection of a comprehensive set of indicators (e.g. marsh elevation, erosion rates, sedimentation, sediment compaction, loss on ignition, soil granulometry, vegetation cover and diversity, bird species presence, water quality, and seagrass cover and abundance), the monitoring activities started in 2023 and the first benefits in terms of ESS are expected as the naturalisation of the saltmarshes will occur. Importantly, through the analysis of previous restoration activities, which in the Venice Lagoon are going on since the '90 years of last century, and the application of high-resolution spatial models on a lagoon scale, it will be possible to assess the effects of the saltmarshes restoration with a focus on the ESS provided by this unique lagoon habitat, and to identify the up- and out scaling restoration strategy.



Piling technique to protect salt marsh edges



Big clods to protect saltmarsh edges

Stakeholders and CORE-PLAT

The main stakeholders for the Venice pilot are represented by:

- Public Administrators (State, Regions, and Municipalities), including the North Adriatic Sea Port Authority, which is directly involved in safeguarding activities;
- Universities and Research Centers;
- Other Academic and Cultural Institutions;
- Private owners of cultural heritage assets (including the Catholic Church);
- Economic operators in different sectors (though trade associations) in particular:
 - Industrial operators
 - Fishing and agricultural operators
 - Tourism and Services operators
 - Professional orders
- Civil Society Organizations and NGOs.

The overarching goal of the Coastal Restoration Platform (CORE-PLAT) for the Venice Lagoon, is to initiate a participatory process, fostering dialogue aimed at co-managing/co-designing present and future restoration efforts in the Venice Lagoon. Additionally, the platform serves to collect suggestions and “lessons learned” from various experts and previous experiences. The CORE-PLAT, currently made up of around thirty participants, has been meeting periodically since 2022.

