

Defence of Venice littoral islands - IT

1. Policy Objective & Theme

- ADAPTATION TO RISK: Managing impacts of climate change and safeguarding resilience of coasts/coastal systems
- SUSTAINABLE USE OF RESOURCES: Preserving coastal environment (its functioning and integrity) to share space

2. Key Approaches

- Knowledge-based
- Technical

3. Experiences that can be exchanged

The measures adopted are the most important protected beach nourishment projects ever implemented in Italy on an eroding coastline with sea wall, according to the most advanced techniques of modern coastal engineering, attributing great importance to the protected nourished beaches for their capacity to dissipate wave energy in a resilient way.

4. Overview of the case

The coastal barrier between the Adriatic Sea and the lagoon is constituted by the littorals of Jesolo, Cavallino, Lido, Pellestrina, Sottomarina and Isola Verde. The lagoon communicates with the sea through the three inlets of Lido, Malamocco and Chioggia. Over time, the coastal strip has lost its defensive function. The built-up areas closest to the sea are ever more often at risk. These problems have been faced through a complex programme of interventions, including the reinforcement of the coastline. The measures adopted have been developed from international experienced reshaped for the particular coastline.

5. Context and Objectives

a) Context

Venice is located in a lagoon protected from the Adriatic Sea by a coastal barrier that stretches for a total of about 60 km. The coastline is made up of strips of land: the coastal strips of Jesolo and Cavallino, the two inlands of Lido and Pellestrina and the sand beaches of Sottomarina and Isola Verde. The lagoon is in contact with the sea through the three inlets of Lido, Malamocco and Chioggia. For centuries, the entire coastline was subject to erosion, putting the historical urban centres and lagoon settlements at risk of erosion and flooding. Over time, the coastal strip has lost its resilience. The causes of the erosion of the coastline are many: lack of river sediment transport, natural phenomena such as eustasy as well as subsidence, wave destructive forces. To reinforce the coastal strip, in the 18th century strong sea wall defences, called "murazzi", were built causing a lack of resilience to the system apart from only incomplete protection being afforded with the breaking during the 4 November 1966 storm surge.

In recent times this strip of beach has undergone much erosion and has been reduced, and the dune area has almost disappeared due also to the tourist pressures. After the dramatic flood of 1966, the need to reinforce the coastlines becomes more and more urgent. From 1995, these problems have been tackled through a specific programme of interventions including the reinforcement of the coastline.

b) Objectives

The measures adopted aim at defending the Venice littoral affected by erosion, protecting the lagoon and inhabited areas near

to the sea from sea storms. In addition, the programme enhances landscape with environment improvement, through the reconstruction of protected beaches and dune strips, supporting also the intense tourist use of that area.

6. Implementation of the ICZM Approach (i.e. management, tools, resources)

a) Management

After the dramatic flood of 1966, an exceptional body of legislation, including both ordinary and special laws, was created. The safeguarding of the Venice lagoon has been defined as a matter of "pre-eminent national interest" and it is constituted by a complex system which links the physical protection to the restoration of environmental balance and socio-economic development as a whole. The laws addressed the threat that high waters, sea storms, erosion, pollution, socio-economic changes, fragile urban structures impose on the well-being of the lagoon and its populated areas. Those activities of safeguarding Venice and the lagoon ecosystem have been delegated by the Special Law to the State and are implemented by the Ministry for Infrastructure and Transport - Venice Water Authority, through the Consorzio Venezia Nuova. Therefore, the Consorzio Venezia Nuova on behalf of the Ministry of Infrastructure - Venice Water Authority has been implementing an extensive system of measures throughout the Venice lagoon area, including the project for the coast reinforcement of the littoral. The interventions have been carried out in agreement with regional and municipal authorities with the supervision of an international Committee.

b) ICZM tools

The coastal defence measures consist of beach nourishments which are protected by groynes and submerged breakwater together with the restoration of the dune area. These measures were designed primarily as defence structures against sea storms. Nevertheless, the newly protected beaches and the dunes restoration programme have contributed to restore typical elements favouring habitat for protected species. A series of studies and experiments have been carried out in order to develop advanced techniques to reinforce and reconstruct extensive sections of the Venice coastline.

The first step was to analyse the local conditions such as wave motion, currents, sand volume, sediment transport, dunes and coastal vegetation. The studies provided the evolution of the coastline.

The second step consisted in identifying the at-risk zones, with the aim to identify the most suitable strategies to adopt in order to minimise erosion and flood damage in case of extreme events. From 1995, the work has involved 7 stretches of littoral with a total of 60 km of coastline and about 9.2 million m³ of sand used for the creation of new beaches and the widening of the existing ones. In addition, 8 km of dunes have been reconstructed. The total volume of sand has been dredged from an area at sea after a preliminary investigation, and mitigation/compensation activity. To go into more details, the following 7 works have been realized:

Littoral Areas	Period	M ³ of sand	Type of works
Isola Verde	1998-2002	450,000	Beach nourishment of 2 km of littoral and the construction of 7 groynes in rocks
Sottomarina	1998-2000	100,000	Construction of a breakwater wall and the beach nourishment of 500m of littoral
Pellestrina	1995-1999	4,100,000	Creation of a new wide beach extending for more than 9 km. The new beach is protected by 18 containment groynes, connected by a submerged (-1.5 m) breakwater parallel to the coast. The submerged breakwater is 300 m from the shore and runs along the full 9 km of the coastline.
Lido	2004 - on going	0	Construction of a submerged (-1m) breakwater 60m wide, 300 m from the shore and running along 4,700 m of the coastline, with 4 new groynes connected to the submerged breakwater.

Cavallino	1995- 1997	4,100,000	- Beach nourishment widening 11 km of beach. The new beach has been protected with 31 transverse rock groynes designed with the most appropriate spacing, substituting the 65 previously existing. - Restoration of the ancient dune belt for a total of 5 km and transplantation of 800.000 specimens of <i>Ammophila littoralis</i> . Dune systems play an important role in protecting the hinterland from flooding caused by sea storms and mitigating wind action. The measures also have considerable value in terms of the landscape and environment improvement.
Jesolo	1999-2003	570,000	- Beach nourishment for 10 km of littoral, and the realization of a wide flight of steps (+2,50m) for beach access. - The restoration of dune environment close to the mouth of the Piave River and the reinforcement of the breakwaters close to the mouth of the Sile River around the light.
Cortellazo	1999-2003	351,000	The works consists of the construction of 6 groynes and the beach nourishment.
Eraclea	2003-2004	300,000	Concerning the littoral of Eraclea, the works consists of the prolongation of 9 groynes and beach nourishment within the 8 cell.

7. Cost and resources

€300,000 million

8. Effectiveness (i.e. were the foreseen goals/objectives of the work reached?)

The works have achieved the objective to reinforce and defend the littoral of Venice for every extreme event with a return period of less than 350 years (such as a storm surge of $H_s=4$ m at sea with a 2 m a.s.l.). Now the coast is able to sustain high energy storm events. The measures adopted are characterised by a high degree of adaptive capacity and resilience in order to respond to the uncertainties of climate change. 12 years after the completion of the works, monitoring shows that the interventions have been able to protect the inhabited areas against beach erosion and storm damages with a refilling need of less than 10%.

9. Success and Fail factors

Local authority agreements between State, regional and municipal authorities have been a successful element for the whole programme, allowing synergies between different interventions and tourist use of the littoral from April till September. The local population was very much in favour of the protection also for its integration with the flood barrier installation. In some cases, such as Pellestrina, disturbances were caused wind driven sand which was solved with the use of *Tamarix gallica*. The new colour of the sand was also a problem solved with the extra cost of excavating a trench and covering the new sand with the local one.

10. Unforeseen outcomes

The submerged breakwaters have increased local biodiversity with more than 180 species of fishes, microalgae and

zoobenthos. In some cases, the creation of a new beach or the widening of the existing ones caused a problem related to wind driven sand but also the development of new dune fields.

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13. Sources

- Study and intervention of Consorzio Venezia Nuova on behalf of the Ministry of Infrastructure - Venice Water Authority
- <http://www.magisacque.it/>
- <http://www.salve.it/uk/default.htm>



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