VALLE SMARLACCA LAGOON - ITALY

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The Valle Smarlacca lagoon is located on the North western Adriatic coast of Italy, in the Emilia-Romagna region. The lagoon is part of the Valli di Comacchio lagoon system (44.58°N, 12.23°E), a wide complex of shallow water impoundments (see the Valli di Comacchio information sheet). Valle Smarlacca is located in the southeast corner of the Valli di Comacchio, close to the Reno River. It has a surface area of about 2 km^2 and a mean water depth of 0.8 m. The surficial sediment is mainly composed of organically enriched silts. This organic layer is 10-20 cm thick and overlies a deeper clay layer. The aquatic phanerogam *Ruppia cirrhosa* forms patchy meadow, alternating between areas of dense canopy and areas devoid of plants.

Salinity is relatively stable (22 to 24 psu) but can rise to 25-30 psu in summer due to evaporation. The lagoon is surrounded by embankments and is completely separated from the other basins of the Valli di Comacchio system. Valle Smarlacca receives freshwater and nutrient inputs from the adjacent Reno River through artificially-regulated sluices. The lagoon is exploited for fish farming of european seabass (*Dicentrarchus labrax)* and gilthead seabream (*Sparus auratus)* and water fluxes are artificially regulated with two replacements per year of approximately half the water volume, in October and February. In spring and summer the lagoon is completely isolated except for small water inputs to compensate for evaporation.

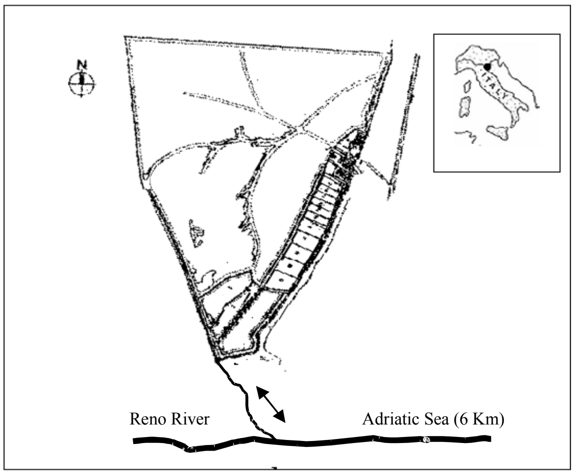

Figure 1: *Location and map of Valle Smarlacca lagoon*

The climate is mediterranean with some continental influence. Precipitation is approximately 600 mm per year, with late spring and autumn peaks.

The lagoon is regularly subjected to dystrophic crises during summer, a phenomenon widely described in other European shallow water lagoons. During the warmest summer months, the emerging *Ruppia* fronds become covered by dense tufts of epiphytic algae, whose decomposition leads to a significant oxygen uptake as well as sulphide accumulation in the water column.

Figure 2: *An overview of Valle Smarlacca at sunset*

The lagoon was object of wide investigations in the period 1996-1999 in the context of 2 EU Project: ROBUST (ENV4-CT96-0218) and NICE (MAS3-CT96-0048). In this period, biogeochemical cycles and primary producers dynamics were investigated along with macro- meiobenthos community.

In 1997, the growth dynamics of the residual *Ruppia cirrhosa* meadow of Valle Smarlacca were monitored over an annual cycle and related to the cycling of iron, sulphur and phosphorus in the rhizosphere sediments (Azzoni *et al.,* 2001). The *Ruppia* biomass and rates of gross primary production increased during spring and early summer, but declined rapidly thereafter. This biomass decline was particularly evident for the below ground biomass. Microelectrode profiling demonstrated a clear seasonal trend in sediment redox potential, with the sediments becoming increasingly reduced during spring and summer. In addition, high concentrations of toxic free sulphides (up to 7 mM) were detected in the porewater during summer and autumn. Radial oxygen release by the seagrass roots rather than iron precipitation appears to be the principal detoxification mechanism for sulphides in the rhizosphere. However, in summer, this system becomes saturated leading to the accumulation of free sulphides. This results in a positive feedback regime, with the sulphides causing root/rhizome mortality, which further reduces oxygen release to the rhizosphere and thereby favours sulphate reduction activity and further accumulation of sulphides.

The production and consumption of sulfide and its influence on phosphorous cycling were studied in summer 1998 (Hejis *et al,* 2000). These investigations were used to shed light on the virtually complete disappearance of *Ruppia* from other lagoons of the Valli di Comacchio. The elevated concentrations of free sulfide observed in the sediment and in the water were the result of high rates of sulfide production due to the abundant availability of organic matter in combination with a saturated chemical buffering capacity towards free sulfide. The potential rate of biological sulfide oxidation was high, but the actual rate was low due to a shortage of oxygen in the sediments and the overlying water. Under simulated natural conditions, an high release of phosphate from the sediment was observed in parallel to high sulphide concentrations. An enhanced phosphate availability could stimulate growth of primary producers, eventually resulting in an even higher rate of sulfide production. The radial loss of oxygen from the roots of Ruppia becomes insufficient to prevent exposure of roots and rhizomes to elevated concentrations of free sulfide and the plants die.

Nitrogen fluxes and water column concentrations are regulated by assimilation by seagrasses and their epiphytes, which is the dominant N-cycling process (Dalsgaard, 1998; Welsh *et al.,* 1999). At this site, losses of nitrogen via denitrification were small in terms of the overall N-budget. The absence of water exchange allows the remineralisation of the produced biomass *in situ*, regenerating inorganic N.

All these points indicate a low capacity of the system to loose nutrients which therefore tends to accumulates in the system causing increase in eutrophication state.

The modifications and the following recovery of meiobenthic communities caused by induced hypoxic/anoxic disturbance were investigated in Valle Smarlacca by Guerrini *et al.,* (1998). A field experiment was carried out by incubating, for three days, portions of seagrass meadow and adjacent unvegetated muddy sediment patches with dark benthic chambers. On the small scale of that experiment, meiobenthic communities appeared highly resilient and influenced by the plant coverage. On bare sediment, community structure followed the natural evolution of the control habitat while, in the *Ruppia* meadow, community recovery showed more complex patterns according to the different behaviour of phytal and infaunal species.

Using data from 1997, a biogeochemical budget for the Valle Smarlacca was constructed following LOICZ approach (Giordani & Viaroli, 2001). Due to the peculiar hydrology, the mean water exchange time estimated approximates to a year and water exchange time is particularly long in spring and summer (1,060 and 430 days, respectively).

LaguNet (http://www.dsa.unipr.it/lagunet/) is a scientific observational network studying the fluxes of nutrients and other contaminants from lagoon catchments to the near coastal environment. The objectives of LaguNet are to support and encourage co-operation of research groups studying lagoons, wetlands and saltmarsh systems situated along the Italian coast and to evaluate the application of the LOICZ (Land Ocean Interactions in Coastal Zones, a core project of IGBP) biogeochemical flux model and typology classification to such sites.

The methodology has been applied by LOICZ to approximately 170 coastal environments worldwide; it is based on a mass balance approach and provides important information on the flux of nutrients and ecosystem functions; the approach used is applicable to a majority of coastal ecosystems with data that are normally available from conventional monitoring campaigns. In this way it is possible to compare and to group aquatic systems having different characteristics based on properties related to biogeochemical cycles and to the ecosystem functions that result from these processes.

On the basis of this experience and considering the paucity of LOICZ sites in the Mediterranean and Southern Europe it was decided to apply this methodology to a series of Italian coastal environments where sufficient data are available.

***Figure 3:** LaguNet sites around the Italian peninsular*

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