VALLI DI COMACCHIO LAGOONAL SYSTEM - ITALY

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The Valli di Comacchio (44.55-44.65°N, 12.10-12.25°E) are a large (115 km^2) complex of shallow-water (with depth ranging from 0.5-1.5 m) brackish lagoons located in the southernmost part of the Po River deltaic area (Figure 1). The Valli are, nowadays, constituted by three main basins, i.e. Valle Magnavacca, Valle Fossa di Porto and Valle Campo. This semi-enclosed lagoonal complex is almost completely surrounded by earthen dikes, and separated by the sea by the highly anthropogenically impacted, 2.5 km-wide Spina spit. The Valli are connected with the Adriatic Sea by three marine channels, Portocanale, Logonovo and Gobbino, but since the latter is impounded, major water exchange with the sea occurs only through the firsts two channels. The former receives also nutrient-enriched continental water from Valle Fattibello.

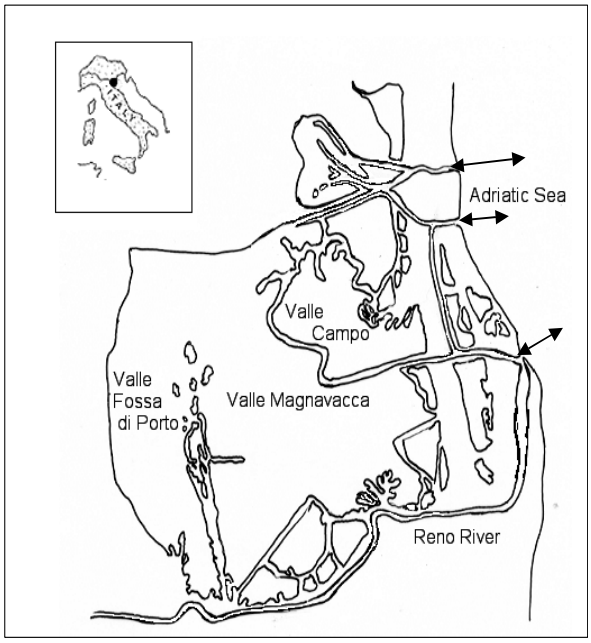

Figure 1**:** *Location and map of Valli di Comacchio Lagoon.*

Water exchange with the sea is both tidal and man-regulated. Moreover, from February to May, large amounts of freshwater are conveyed through the Reno river through two dams in the southermost parts of Valle Magnavacca and Valle Fossa di Porto. Due to the shallowness of the basins and their limited water renewal, salinity (annual range: 24-38 psu) is mostly influenced by meteorological events, such as evaporation and occasional heavy rainstorms. The bottoms of the Valli are typically muddy, but sparsely vegetated meadows of the seagrass *Ruppia cirrhosa* occur in the southern parts of the Valli Magnavacca and Fossa di Porto. These meadows are the remnants of the larger macrophytic coverage that characterized the bottom of the Valli in the early 1970s (Ferrari et al., 1972).

Figure 2: *View of Valli di Comacchio, in the typical winter weather*

In the last 50 years, the Valli underwent important anthropogenic impacts, from land reclamation to the effects of contamination on the remaining areas. The Valli have always been an area of intensive economic activity for fisheries and, by the early 1970s, for eel aquaculture. Intensive aquaculture plants located in Valle Campo, utilized the larger Valle Magnavacca as receiver and self-purification basin for waste waters. By the mid 1980s, however, productive activities and fisheries collapsed; eel yield, for instance, dropped from about 30 kg ha^{-1} to less than 5 kg ha^{-1} (Rossi & Cataudella 1998). During the 1980s, the ecosystem of the Valli changed significantly at various levels, with a drastic depletion of all planktonic and benthic components, and the dominance of picocyanobacteria (Sorokin et al. 1996). Nowadays, the Valli are characterized by such hydrologic and physical-chemical conditions (shallow water with long residence time, eutrophic marine influence and inputs of nutrient-rich continental waters, anoxic sediment layers with production of sulfides) to be considered a very harsh environment (Mistri et al. 2000).

Earlier studies, however, reported a high number of macrobenthic species at the beginning of the 1970s, on account of the elevated eterogeneity of the habitats and the large area of marine phanerogams (Colombo et al. 1977). The submersed vegetation such as *Ruppia cirrhosa*, which is dependent from the light reaching the bottom, was damaged by the increase of turbidity: rooted macrophytes started to decline and disappeared from large areas of the lagoon (Piccoli, 1998). Moreover, high reducing conditions coupled to high concentrations of free sulphide in the sediment could have accelerated the macrophytes disappearing since these rooted plants suffer such toxic compounds (Koch *et al.,* 1990). Given the economic and naturalistic importance of the Valli, a monitoring program was initiated in 1996, after the failure and subsequent closure of aquaculture activity. The aim was to check the environmental condition of the main basins, and to allow estimation of the potential, and the time needed, for

recovery of the Valli, by focusing on macrobenthic and zooplanktonic community patterns.

Figure 3: *Typical fishing house along channels of the Valli di Comacchio system*

In 1997, zooplankton community was clearly dominated by autochthonous components i.e. mero-plankton forms and the calanoid *Acartia tonsa*: a species typical of highly eutrophic coastal areas (Sei *et al*., 1998).
On the other hand, studies on the macrobenthic fauna highlighted the resistance to change of community functioning (Mistri et al., 2001) despite stresses that generate quite unpredictable abundance fluctuations (Mistri, 2002), as well as the role played by local disturbance events in structuring communities (Mistri et al., 2002). Secondary disturbance due to scarce water circulation, sharp temperature and salinity fluctuations, release of toxic substances from sediments influence animal assemblages along spatial and temporal scales. Nevertheless, clear signs of amelioration, particularly at the previuos most impaired areas, are nowadays detectable (Munari et al., 2003).

Ceccarelli *et al.,* 1998, compared macrozoobenthic communities investigated in the seventies and in the nineties, in order to point out spatial-temporal changes over about 30 years. In general, no substantial changes in species compositions occurred among these periods except for a general impoverishment induced by rooted macrophytes disappearing. This was more evident in the central part while the marginal zones become, a sort of sheltered areas by supporting more structured communities in terms of number of species and diversity.

Comacchio lagoons are recognized as an important bird area for international value for waterbirds. Ornithological survey have been regularly carried out since mid seventies (Volponi *et al.,* 1998)Using data from 1997, a biogeochemical budget for the Valli di Comacchio was constructed following LOICZ approach (Viaroli & Giordani, 2001).

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 saltmash 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.

Figure 4: *LaguNet sites around the Italian peninsula*

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 (Fig. 4).

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