The relevance of sediments in eutrophic systems: a comparison of two European coastal lagoons (Óbidos and Lesina)

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Introduction: Eutrophication of coastal lagoons is a worldwide problem. Symptoms are generally the enrichment and alteration of nutrient composition, abundant biomass of phytoplankton or macroalgae, shifts on their communities, elevated oxygen consumption and dystrophy [1]. Organic loads, biogeochemical sedimentary processes, and limited exchanges with the adjacent sea are the primary factors triggering those alterations. In general, water properties and ecology of coastal lagoons vary pronouncedly in space and time. Management plans should therefore include measures that respond to the tendency for disruption events under dynamic natural variability.

The current work revisits data from two coastal lagoons, Óbidos in Portugal [2] and Lesina in Italy [3] with symptoms of eutrophication, and examines measures to prevent water and sediment degradation.

Methods: Water quality parameters and nutrients of Óbidos and Lesina lagoons were obtained from published data in the articles [2] and [3]. Five sites were surveyed seasonally over three years in the Óbidos lagoon and 12 sites were visited monthly in the Lesina lagoon.

Results: Both lagoons are shallow, and differ on the tidal influences (mainly in Óbidos) and freshwater inputs (mainly in Lesina) (Table 1). Shorter water residence time in Óbidos reflect the mesotidal regime and the smaller lagoon area.

Table 1: Morphological characteristics of Óbidos and Lesina lagoons.

	Óbidos lagoon	Lesina lagoon
Location	West Portugal	Southern Italy
Depth (m)	0.5 – 3.5	0.7 - 1.5
Lagoon area (km^2)	7	51
Residence time (day)	1 - 22	70 - 100
Tidal regime	Mesotidal	Microtidal
Macroalgal cover	x	x
Freshwater inputs	Negligible	Numerous
Major constrains	Limited exchange with sea	
	Eutrophic conditions	Dystrophic crises
Main activities	Fishing and shellfish harvesting	Fishing and aquaculture

Table 2 points to the differences on the salinity and nutrient composition between the two lagoons, considering winter and summer seasons. Water of Óbidos lagoon is more saline and contains higher concentrations of phosphorus, while Lesina water contains more silica. The ratios of DIN/P and Si/P in Lesina exceed largely the ratios in Óbidos.

Table 2: Physical-chemical water parameters in Óbidos and Lesina lagoons. Mean values (±sd).

	Winter		Summer	
	Óbidos	**Lesina**	**Óbidos**	**Lesina**
T (ºC)	12±2	10±0.8	21±3	28±0.9
Salinity	33±4	11±3	36±1	28±5
DO (%)	99±20	120±25	105±30	86±20
pH	8.1±0.1	8.7±0.3	8.3±0.1	8.3±0.3
DIN (µM)	46±41	44±47	3.8±5	3.5±4
PO_4^{3-} (µM)	1.4±0.9	0.90±1.6	2.2±2	0.08±0.2
$Si(OH)_4$ (µM)	15±8	70±71	6.6±6	20±12
Chl a ($\mu g\ L^{-1}$)	1.4±2	1.9±0.7	2.0±3	9.0±15
N/P	32±13	> 650	3.3±5	75±60
Si/P	11±3	78	4.6±4	250

Discussion: Although both lagoons show eutrophic conditions, there are remarkable differences in their nutrient composition and thus the proposed mitigation measures should also be different. As stated in [4] reduction of dissolved oxygen in the water column during the night in summer explains the excess of P in Óbidos lagoon. Phosphate is regenerated in sediments under low oxygenation periods and tends to be higher in summer than in winter. The mesotidal regime favors its dispersion to the entire lagoon. Biogeochemical sedimentary processes have presumably less impact on water quality of Lesina, since concentrations of DIN and P decrease at the same proportion in summer. In fact, the source of nutrients can be mostly ascribed to canal discharge and surface runoff from agricultural areas. Impact of nutrient fluctuation on the ecology of phytoplankton was previously described [2, 3].

Measures for Lesina should be focused on the lagoon surrounding area, reducing the major sources of organic matter. Intervention in the Óbidos lagoon should prevent low oxygenation in confined areas, which is responsible for intense sediment-water exchanges. Sediment dredging, facilitating water circulation driven by the tides, may decrease nutrient availability and consequently eutrophication.

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