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EUTROPHICATION IN COASTAL AREAS OF THE MAR MENOR LAGOON: THE MITIGATION ROLE OF THE SALT MARSHES.

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INTRODUCTION

The Mar Menor lagoon is one of the largest coastal lagoons (135 km^2 surface) of the Mediterranean basin. It receives runoff waters coming from the nearby intensive agricultural area of Campo de Cartagena, which have led this lagoon to be declared as a sensitive area for eutrophication in June 2001 under European Directive 91/271/EEC and as a vulnerable zone for nitrates contamination in December 2002 under Directive 91/676/EEC. Moreover, the existence of mining activities (nowadays discontinued) in the nearby area of Sierra de Cartagena-La Union has caused the spread of metal polluted wastes into the Mar Menor lagoon and its salt marshes. As a consequence, huge coastal areas are buried by metal enriched wastes, and although most of them have been colonized by vegetation, others remain bare and exposed to erosive agents (e.g. wind, water). At the same time, the Mar Menor and its salt marshes have been included in the Ramsar Convention on Wetlands. Also, it is a Special Protected Area of Mediterranean Interest (SPAMI), a Specially Protected Area (SPA) under the EU Wild Birds Directive and a Site of Community Importance (SCI) to be integrated in the Nature 2000 Network (EU Habitats Directive). In addition, the Campo de Cartagena- Mar Menor zone hosts important economic activities related with agriculture, fisheries and tourism (Conesa and Jiménez-Cárceles, 2007). Hence, the habitat conservation and the uses of the territory must be compatible and overcome the environmental problems of the zone.

This paper summarizes several studies carried out in the Mar Menor area from year 2000 till nowadays. The methodologies followed in these works were based on international scientific and technical protocols. The research included field and lab experiments. The first ones had the goal of answering questions such as *what*, *where*, *when*, by means of descriptive field survey studies (Álvarez-Rogel *et al*., 2000, 2001, 2006b, 2007a y c, Álvarez-Rogel *et al*., 2006a, 2007b; Jiménez-Cárceles, 2007; Jiménez-Cárceles *et al*., 2006; Jiménez-Cárceles and Álvarez-Rogel, 2008; Egea *et al*., 2011). Afterwards, the research had the goal of explaining *how* the processes occurred, by means of experimental set ups not included here (greenhouse experiments, columns, lab, etc.).

This chapter deals with the field survey studies in order to describe the nutrient dynamics and eutrophication risks in the coastal areas of the Mar Menor lagoon.

METHODS

Monitoring programs are being developed in order to characterize the levels and variability of the nutrients contents in several watercourses flowing into the Mar Menor, as well as identify the consequences of these impacts, and the role of coastal wetlands as green filters against the eutrophication of the lagoon.

The Marina del Carmolí salt marsh (37º42' N, 0º51' W) is the largest wetland (3.2 km^2) on the coast of the Mar Menor lagoon (Figure 1). This marsh receives water from two surface watercourses: the *Rambla del Miedo* and the *Rambla de Miranda*. The first one, which comes from the mining area of Sierra de Cartagena-La Unión, transports mine wastes and receives waste water from an urban wastewater station. The second one flows across areas with intensive agriculture and receives nutrient enriched waters. A third watercourse, the *Rambla del Albujón*, reaches the Mar Menor on the northern border of the salt marsh, but does not discharge water into it.

Sampling points were located as it follows (Figure 1): 1) just before the points where the *Rambla del Miedo* and *Rambla de Miranda* flow into the salt marsh. Here, water samples were collected directly from the riverbed and flow discharges were measured during several years. Samples were also collected from the mouth of Rambla del Albujón; 2) within the salt marsh, sampling plots were located along two transects oriented perpendicular to the shoreline, from the upper to the lower part. In each plot, a PVC pipe was installed at a depth of between 1.5 and 2 m in order to collect groundwater samples. Surface water was also collected when the plots were flooded. In addition, three sub-samples of soil solution were extracted, with vertical porous Rhizon ® glassfiberepoxy type samplers (length 10 cm), and pooled to provide a composite sample for each plot. When the soil was moist enough, field soil redox potential (Eh) and pH were measured bimonthly in the upper 15 cm of the sampling plots (three repetitions). In addition, two undisturbed rhizospheric soil cores of 4.5x30 cm (considered as duplicates) were taken from each sampling plot. More details of the methodology has been shown in Álvarez-Rogel *et al*. (2006a, 2007b); Jiménez-Cárceles *et al*. (2006); Jiménez-Cárceles, (2007); Jiménez-Cárceles and Álvarez-Rogel (2008); Egea *et al*. (2011).

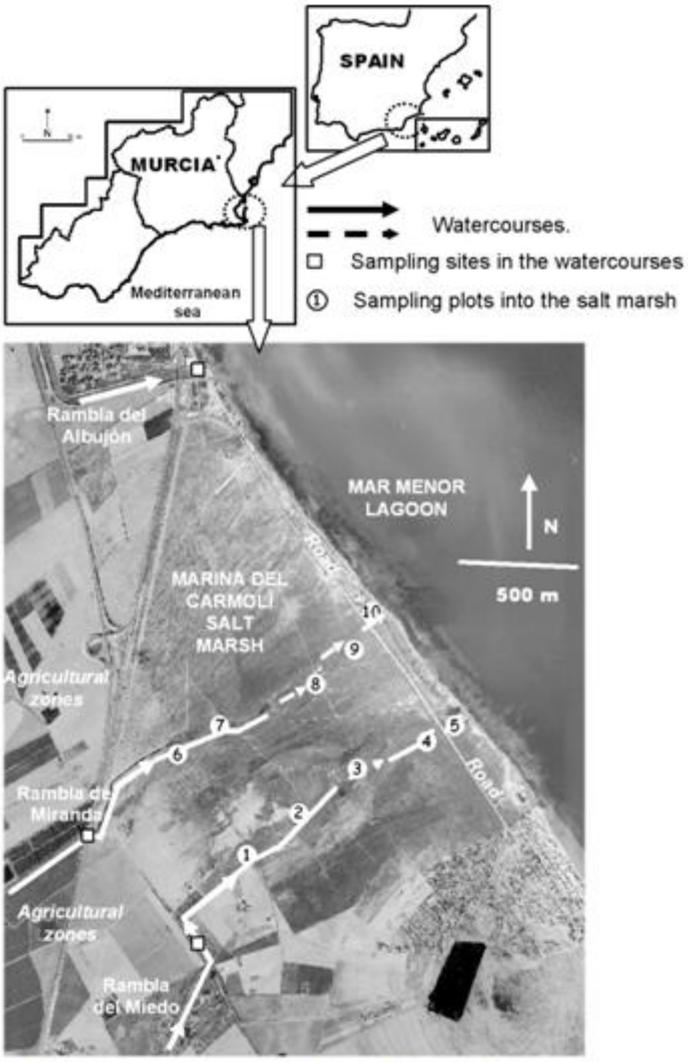

Figure 1. Location map of the Marina del Carmolí salt marsh and sampling sites in the watercourses and sampling plots within the marsh

QUALITY OF WATERCOURSES

Water samples from the *Rambla del Miedo*, and to a lesser extent from the *Rambla del Albujón*, were enriched in phosphorus (maximum 12 mg PO_4^{3-} L^{-1}) and dissolved organic carbon (maximum 45mg L^{-1}). The concentration of NO_3^- reached the highest levels (until 200-250 mg L^{-1}) in the *Rambla del Miranda* and *Rambla del Albujón*. Most of the NO_3^- inputs occurred in autumn and spring coincidental with the peaks of agricultural activity in the *Campo de Cartagena*; however, concentrations of phosphorus and organic carbon tended to be higher in the summer, when the population in the region increases during the high tourist season.

FLOW DISCHARGES AND NUTRIENT LOADS

We identify two different regimen of discharge: base flow and storm events (Egea *et al*., 2011). The base flow sustained an important discharge of surplus water of agricultural origin enriched in dissolved organic carbon (12.7 T y^{-1}) and nitrogen (78.3 T y^{-1}, 85 % N-NO_3^- and 15% organic-N) into the salt marsh, while inputs from wastewater-treatment plants were of much lower (5.5 T y^{-1} of dissolved organic carbon and 4.1 T y^{-1} of nitrogen, 57 % N-NH_4^+ and 43% organic-N). The annual loads of phosphorus of agricultural origin and from urban wastewater were 1.87 T y^{-1} and 0.97 T y^{-1}, respectively.

SOILS WITHIN THE SALT MARSH

The concentrations of NO_3^- were high in plots 6 and 7 (maximum ≈200 mg L^{-1} in surface and soil solution water), although they decreased (until 95%) towards the lower parts of the salt marsh closer to the lagoon, i.e. plots 9 to 10. Based on the physical-chemical conditions in the soils and in other experimental studies (González-Alcaraz *et al*., 2010), de-nitrification was the main mechanism responsible for nitrate removal from the water. The highest contents of PO_4^{3-} occurred in the surface water in plot 1 (8.74 mg L^{-1}) but the concentration decreased sharply between plots 2 and 3. The highest concentrations of P in the soils were also obtained in plot 1, coincidental with the site in which phosphorous-enriched water flows into the marsh. Hence, the soil can be considered as a sink for phosphorous, contributing to decrease the risk of eutrophication into the Mar Menor (Álvarez-Rogel *et al*., 2007b; Jiménez-Cárceles and Álvarez-Rogel, 2008).

CONCLUDING REMARKS

Our data support the existence of polluted water in the surface watercourses of the *Campo de Cartagena.* The risks associated with this pollution include eutrophication of aquatic and terrestrial systems. The pollution is of urban and agricultural origin, and the canalization of riverbeds such as the *Rambla del Albujón* favours the transport of nutrients into the Mar Menor, thereby increasing its risks of eutrophication. In contrast, the salt marshes acts as filters that decrease nutrient concentrations before the polluted water flows into the lagoon. Hence, the coastal marshes play an important role in controlling pollution and its conservation may provide noteworthy environmental and economical benefits.

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LITERATURED CITED

ÁLVAREZ ROGEL, J., ALCARAZ ARIZA, F. and ORTIZ SILLA, R. (2000). Edaphic gradients and plant zonation in mediterranean salt-marshes of SE Spain. *Wetlands*, 20: 357-372.

ÁLVAREZ-ROGEL, J., CARRASCO, L., MARÍN, C. M. and MARTÍNEZ-SÁNCHEZ, J. J. (2007a). Soils of a dune coastal salt marsh system in relation to groundwater level, micro-topography and vegetation under a semiarid Mediterranean climate in SE Spain. *Catena,* 69, 111-121.

ÁLVAREZ-ROGEL, J., JIMÉNEZ-CÁRCELES, F.J. and EGEA, C. (2007b). Phosphorous retention in a coastal salt marsh in SE Spain. *The Science of the Total Environment*, 378: 71-74.

ÁLVAREZ-ROGEL, J., JIMÉNEZ-CÁRCELES, F.J. and EGEA-NICOLÁS, C. (2006a). Phosphorus and nitrogen content in the water of a coastal wetland in the Mar Menor lagoon (SE Spain): relationships with effluents from urban and agricultural areas. *Water Air and Soil Pollution,* 173: 21-38.

ÁLVAREZ-ROGEL, J., JIMÉNEZ-CÁRCELES, F.J., ROCA, M.J. and ORTIZ, R. 2007c. Changes in soils and vegetation in a Mediterranean coastal salt marsh impacted by human activities. *Estuarine Coastal and Shelf Science*, 73: 510-526.

ÁLVAREZ-ROGEL, J., MARTÍNEZ SÁNCHEZ, J. J., CARRASCO BLÁZQUEZ, L. and MARÍN SEMITIEL, C. 2006b. A Conceptual Model of Salt Marsh Plant Distribution in Coastal Dunes of Southeastern Spain**.** *Wetlands,* 26: 703-717.

ÁLVAREZ-ROGEL, J., ORTIZ SILLA, R., VELA DE ORO, N. and ALCARAZ ARIZA, F. (2001). The application of the FAO and US soil taxonomy systems to saline soils in relation to halophytic vegetation in SE Spain. *CATENA*, 45: 73-84.

CONESA, H. and JIMÉNEZ-CÁRCELES, F. J. (2007). The Mar Menor lagoon (SE Spain): a singular natural ecosystem threatened by human activities. *Marine Pollution Bulletin,* 54: 839-849.

EGEA, C., JIMÉNEZ-CÁRCELES, F. J., PÁRRAGA, I., MARÍA-CERVANTES, A., DELGADO, M. J., ÁLVAREZ-ROGEL, J. and GONZÁLEZ-ALCARAZ, M. N. (2011). Storage of organic carbon, nitrogen and phosphorus in the soil-plant system of *Phragmites australis* stands from a eutrophicated Mediterranean salt marsh. *Geoderma*, in revision.

GONZÁLEZ-ALCARAZ, M. N, EGEA, C., MARÍA-CERVANTES, A., JIMÉNEZ-CÁRCELES, F. J. and ÁLVAREZ-ROGEL, J. (2010). Effects of eutrophic water flooding on nitrate concentrations in mine wastes. *Ecological Engineering.* doi:10.1016/j.ecoleng.2010.02.009

JIMÉNEZ-CÁRCELES, F. J. (2007). *Papel de los suelos de los humedales del entorno del Mar Menor en la reducción de impactos ambientales causados por aguas eutrofizadas y residuos mineros: el caso de la Marina del Carmolí*. UMI Microform 3245558. ProQuest Information and Learning Company.

JIMÉNEZ-CÁRCELES, F. J. and ÁLVAREZ-ROGEL, J. (2008). Phosphorus fractionation and distribution in salt marsh soils affected by mine wastes and eutrophicated water: A case study in SE Spain. *Geoderma*, 144: 299-309

JIMÉNEZ-CÁRCELES, F. J., EGEA, C., RODRÍGUEZ-CAPARRÓS, A. B., BARBOSA, O. A., DELGADO, M. J., ORTIZ, R. and ÁLVAREZ-ROGEL, J. (2006). Contents of nitrogen, ammonium, phosphorus, pesticides and heavy metals, in a salt marsh in the coast of the Mar Menor lagoon (SE Spain). *Fresenius Environmental Bulletin*, 15(5): 370-378.

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