volcanic islands giving the landscape a high quality.

Wetlands in the shore of the Mar Menor constitute ecological systems of high natural value acting as intermediate systems between the marine and the terrestrial environments (Martínez and Esteve 2003). The Mar Menor coastal wetlands, located along the boundary between the lagoon and the watershed, constitute a key element because of their functionality at landscape scale to retain and eliminate nutrients and organic matter loaded from the Mar Menor river basin. Their contribution to the overall biodiversity of Mar Menor is also remarkable. From South to North, several wetlands associated to the lagoon shoreline are found: the *Marchamalo* salt mines, the *Lo Pollo* sands and salt marshes, the Marina *del Carmolí* sands and salt marshes, the *Playa de la Hita* salt marshes and the San *Pedro del Pinatar* salt mines. The total area of these protected wetlands is around 1,000 ha.

2. THE CATCHMENT

2.1 Hydrologic features

Floods and big rainfall events characterize the climate and hydrology of the Mar Menor River Basin. The surface hydrology of Campo de Cartagena is reduced to some riverbeds whose natural flows are scarce and highly variable depending on big rainfall events. The main ephemeral channels (called *ramblas*) are Rambla del Albujón and Rambla de Miranda. However, although the usual functioning of the watercourses is conditioned by the sporadic and torrential rainfall regime, the significant increase in irrigation in the Campo de Cartagena has changed the water regime of some watercourses such as the Rambla del Albujón, which now maintains regular flows.

In relation to sub-surface hydrology, the hydro-geological unit of Campo de Cartagena consists of 5 aquifers of which the Andaluciense and Pliocene aquifers stand out. They are constituted by limestones, sandstones and marls (Conesa 1990). The rest of aquifers correspond to formations of conglomerates (Cuaternary aquifer), sandstones and conglomerate (Tortonian aquifer) and carbonated materials (Triassic aquifer). Regarding water quality, the Pliocene and Quaternary aquifers present high nitrate values. The increase in water resources coming from the Tagus-Segura water transfer has led to an increase in the phreatic level, due to the increased agricultural drainages.

2.2. Pollution loadings

The tourist development and especially the population increase during summer have led to a sustained increase in water consumption and, hence, in the amount of wastewater. This, joined to important deficiencies in the wastewater treatment plants has generated point pollution problems due to direct spillages into the lagoon. This has caused local problems of high levels of faecal coliforms in summer months.

Regarding non-point pollution, the new irrigated lands, in particular greenhouses and open-air horticultural crops, requires high levels of fertilizer inputs. This has affected the water quality of surface and groundwater, characterized by a high content of nutrients. Common nitrate contents are reaches around 160 mg/l in drainage channels and sub-surface flows, 60 mg/l in Rambla del Albujón and 85 mg/l in salty wastes from desalination plants. Regarding groundwater quality, maximum values of 236 mg/l in the Quaternary aquifer and 308 mg/l in the Pliocene aquifer have been found (ITGE 1996). As a result, it has been produced a significant increase in the nitrogen and phosphorous load into the complex Mar Menor lagoon-associated wetlands. Current estimated values of nutrients load reach an average of around 2,000 tons per year of nitrogen and around 60 tons per year of phosphorous (Martínez and Esteve, 2000). Big rainfall events and floods represent a significant proportion of the total water and nutrients flows, which probably have a major effect on the lagoon functioning.

A salinization process in the aquifers has also been produced and salinity values between 2000 and 6000 mg/l are found. The salinization process has led to the spread of desalination plants. All these factors have partially modified the role of aquifers in the Mar Menor watershed as a sink for agricultural pollution. During draught periods, the less than expected water resources from the Tagus-Segura water transfer has led to a sudden increase in the use of groundwater and hence, to the use of desalination plants to treat the highly saline pumped water. As a result, salty wastewater from desalination plants with high concentrations of nitrogen and phosphorous are generated and spilled into the complex Mar Menor-associated wetlands, due to the concentration process and the high nutrient content of groundwater. The desalination of groundwater in the Mar Menor basin can be interpreted as a process accelerating the connection between the local aquifers and the lagoon-wetland complex, the ultimate sink of flows and nutrients (Martínez and Esteve, 2003).

The generalized problem of nitrate pollution in the aquifers of the Mar Menor river-basin and the high amounts of fertilizers being used by the intensive irrigated lands led in December 2001 to the designation of Campo de Cartagena as area with vulnerability to pollution caused by nitrate coming from the agricultural activities, in application of Act 261/1996. This, among other things, requires the implementation of an action programme to reduce the input of nitrate in the agricultural activities.

3. LAGOON

3.1. Hydrography

The lagoon is almost closed and the connection with the open sea is very reduced. Dominant currents are generated by the Mediterranean water coming into the lagoon through the natural channels called *golas* such as the Estacio and the g*olas* of La Torre and Ventorrillo, in the Encañizadas area. The exchange of water through the Estacio is considerably higher than through the rest of channels. Available data on exchange through this channel indicate a high fluctuant regime of currents with a frequent inversion of the direction of flows (Arévalo, 1988). After the enlargement of the Estacio channel in 1973, the total water exchange between the Mediterranean and the lagoon has increased, reaching a value around 1.6 Hm^3/day, which represents a high turnover rate for the estimated total lagoon volume, around 580 Hm3 (Arévalo, 1988).

The average water temperatures usually vary between 10 and 30 ºC in winter and summer respectively, with some small differences depending on location and depth. The available data series on water temperature show some changes after 1975 (Mas, 1996), once the Estacio channel was enlarged, which significantly increased the volume of water exchanged between the Mar Menor and the Mediterranean. As a result, the extreme temperatures have been moderated.

The salinity range has also varied due to the enlargement of El Estacio (Mas 96, Perez-Ruzafa *et al*. 1991) and also probably due to the increased water inflows from the watershed. Maximum salinity values have decreased from 52 PSU to around 46 PSU. Salinity values show a north-south gradient. The northern sub-basin shows lower mean values than the southern sub-basin.

3.2. Water quality

The Mar Menor waters are in general clear and relatively oligotrophic. Turbidity and suspended solids are very variable, ranging between 2 mg/l of suspended solids in calm water conditions on rocky bottoms, and 3.8 g/l in shallow waters on muddy or sandy bottoms under the action of waves. Nutrient levels are generally low. It is possible to distinguish two well-defined situations. The first one is characterized by clear waters and low content of nutrients and chlorophyll, situation that stays nearly all the year. The second one is a turbid water situation and corresponds to the end of summer, as a consequence of the increase of productivity (Pérez Ruzafa 1996). Despite of the general olligotrophy of the water, some areas show nitrophilic algae proliferations because of the nutrient inputs.

Dissolved oxygen values show a high range of variation, oscillating between anoxic conditions and concentrations lower than 2 mg/l in areas with dense meadows on muddy bottoms, to values around 11 mg/l. Light transmission is usually good. Under calm conditions 87 % of the incident light at the surface is registered at 2 m depth. In general, light is not a limiting factor for biological productivity (Pérez Ruzafa 1996).

In general, the nitrogen and phosphorus concentrations in the water column were low. However, an important increase in nitrogen content has been observed during the last years. Values observed in 1997 were almost ten times higher than those of 1988, always below 1 μg-atm $N\text{-}NO^{-}{}_{3}\ l^{-}$ (Perez-Ruzafa *et al.* 2002). This nitrogen increase has been caused by the substantial increase in irrigated lands and fertilizers occurred in the watershed.

3.3. Sediments

As compared with other coastal lagoons, the Mar Menor bottoms are quite varied (Pérez-Ruzafa & Marcos 2004). Although muddy sediments are the dominant bottoms, sandy areas can also be found. There also some rocky outcrops close to the islands. Muddy bottoms have been covered by meadows of *Caulerpa prolifera*. Sandy bottoms are frequent in areas close to the Mar Menor shore. The historical sedimentation rate has been estimated in around 2 mm/year during the last 80,000 years (Díaz del Río 1990).

Between 1972 and 1986 the average organic matter content in sediments increased from 2% to 7% (Mas 1996). This increase, joined to other factors, has contributed to the extension of muddy bottoms. Seasonally, from Autumn to Winter, an increase in the organic content of the sediment is observed due to the contribution of the fronds of the green algae *Caulerpa prolifera* and the phanerogam *Cymodocea nodosa (*Pérez Ruzafa 1996).

3.4. Major biological aspects

In the phytoplancton community, the most frequent species correspond to dinoflagelates, in particular *Ceratium*, *Peridinium* and *Gonyaulax* (Ros & Miracle 1984a, 1984b). The structure and composition of phytoplancton communities have considerably varied during the last decades (Moreno 1975; Ros & Miracle 1984a, 1984b; Gilabert 1992). Since the enlargement of the Estacio channel, the zooplancton communities have also varied and species typical of ports and less salty lagoons have been favoured (García Rodríguez, 1985a,b).

Benthic vegetation on the soft bottoms of the Mar Menor mainly consists on monospecific *Cymodocea nodosa* and *Calulerpa prolifera* meadows and mixed meadows of Cymodocea *nodosa-Caulerpa prolifera*. In the shallowest and calm zones there are spots of *Rupia cirrhosa* and *Cymodocea nodosa*. These meadows dominated the Mar Menor bottoms before 1970. However, the smoothing of extreme temperatures has favoured the expansion of *Caulerpa prolifera* at the expense of the *Cymodocea nodosa* monospecific meadows (Pérez-Ruzafa *et al.* 1991, Pérez-Ruzafa 1996). Invertebrate communities characterizing sandy and muddy bottoms are found associated with *Cymodocea nodosa* and *Caulerpa prolifera* meadows.

When compared to other coastal lagoons, the fish community in Mar Menor is characterized by a higher species richness (Mas 1996). Main species include species the mujilidae family, *Sparus aurata*, *Engraulis encrasicholus*, *Solea vulgaris*, *Atherina bolleri* and several species of *Gobius* genus. In the last years the number of fish species has doubled.

During the last decades the hydrographic changes have favoured a general species enrichment (Pérez-Ruzafa *et al.* 1991) and also sudden changes regarding the composition and dominant species in the different communities. For example, and regarding the zoobenthic community, a massive colonization of *Ostrea edulis* took place during the mid 1980s and early 1990s (García García *et al*. 1989, Rosique, 1994) which later disappeared.

The increased water and nutrient flows have begun to affect the Mar Menor in several ways, including some signs of an initial eutrophication process of the Mar Menor. The summer proliferation of two species of jellyfish (*Rhizostoma pulmo* and *Cotylorhiza tuberculata*), with a total population reaching more than 40 millions individuals in summer (Pérez-Ruzafa & Marcos 2004), constitute an important symptom of the ecological changes affecting the lagoon. The jellyfish blooms have not only environmental but also socio-economic effects due to their impact on the quality of bath and therefore on the tourist activities in the Mar Menor.

The Mar Menor lagoon is an important site for wintering and breeding waterfowl. The typical, “open water” bird guild, includes fish and invertebrate feeders that exploit the water column and the benthos by diving: Great Crested Grebe (*Podiceps cristatus*), Black-necked Grebe (*Podiceps nigricollis*), Great Cormorant (*Phalacrocorax carbo*) and Red-breasted Merganser (*Mergus serrator*). The Red-breasted Merganser is one of the most representative species of the lagoon, usually the main site for this duck in Spain (Hérnández & Robledano, 1997; Martí & Del Moral, 2002). Counts of these species are made within winter waterfowl census scheme, which has been in operation in the Mar Menor since 1972 (Hernández & Robledano, 1997). During summer, terns such as the little tern (*Sterna albifrons*) and the common tern (*Sterna hirundo*) are found (Esteve *et al.* 1995).

3.5. Pollution

Some studies on pesticides content in the Mar Menor lagoon have been carried out. Values are in general low, although small residuals of organ-chlorine substances were found in a 70% of studied samples (Pérez-Ruzafa *et al.*, 2000). Due to its high persistence, residuals of DDT were found in some samples of the analyzed organisms and sediments.

In the past, the Mar Menor received mining waste rich in heavy metals through the *Rambla del Beal*. As a consequence, the sediments of the Mar Menor, especially in the southern area, present a high content of heavy metals. High contents of Pb and Zn have been found in molluscs (De León *et al.* 1982), while values in water column and fish were similar to those found in other areas in the Mediterranean.

The main contribution to the hydrocarbons content of Mar Menor lagoon is the motor oil and petrol spillages from boats. Average values in water fall with the range 0.4-0.9 ppb, depending on the season. The sediments show higher contents, with average values between 1 and 5 ppb. As compared to the Mediterranean, the Mar Menor lagoon is slightly polluted by hydrocarbons.

There are 33 station points in the lagoon for faecal pollution monitoring. Although there is not a generalized problem with bacteria of sanitary concern, there are important deficiencies in the management of wastewater of cities and urban settlements around the Mar Menor. Scarce and inadequate wastewater treatment plants and frequent breakdowns lead to direct spillages of wastewater into the lagoon, especially during the summer due to the seasonal dynamics and the highly increased tourist population. This generates local sanitary problems because of high levels of faecal coliforms during some days in the summer months.

Current rules regarding pollution and water quality are key to prevent the pollution of Mar Menor lagoon from the urban and tourist activities and to protect the water quality. Joined to the extensive regulations regarding wastewater treatment plants and sewage, in June 2001 the Mar Menor lagoon was designated as *sensible area*, in application of Act 11/95, which establishes the applicable rules for the treatment of sewage.

5. MAIN ECONOMIC AND SOCIO-ECONOMIC ASPECTS

5.1. Population

Population in the area of influence of Mar Menor has shown a very high increase since the last four decades due to the expansion of tourist activities. This process of population increase in the Mar Menor area is still active. Between 1970 and 1998 the population density in San Javier, a municipality located in the Mar Menor area, increased by 65%, reaching 233 inhab/km^2, a very high value compared to the average in Murcia autonomous community, which during the same period only increased by 34% reaching 99 inhab/km^2. In addition, there is a strong seasonal dynamics, leading to very high increases of total population during the summer. This seasonal dynamics generates problems to manage wastes.

5.2. Traditional activities

The human activities developed in the lagoon and its influence area along its history include mining, agriculture, fisheries, saline industries and tourism. Mining is one of the oldest activities developed in the Mar Menor area. This activity has been maintained until recent times and has generated, as a consequence, the increase in the content of heavy metals in the sediments wasted through the watercourses flowing into the Mar Menor. Since 1950, the wastes were deviated to Portman bay and the heavy metals concentrations remain constant

Fishing is another traditional activity which is still an important economic activity in the Mar Menor lagoon, although the dominant species have varied along time. While the catch between 1951 and 1962 was dominated by species typical of the lagoon, during the period 1962-1972 the dominant species became *Atherina sp* and during the decade of 1980s the catch was characterized by the presence of new species coming from the Mediterranean. Main fish species caught in the lagoon include *Anguilla anguilla*, *Mugil sp*, *Sparus aurata*, *Lithognatus mormyrus*, *Engraulis encrasicolus*, *Atherina sp.* and *Mullus barbatus*. Fishing in the Encañizadas, by means of rectangular receptacles made in canes, is a traditional fishing system carried out in one of the main natural communication channels between the lagoon and the Mediterranean. It was started by Arabian populations in the XIVth century. Although this activity ceased during the past decades, in the last years has begun again.

5.3. Agriculture

During the past century the Campo de Cartagena suffered an intense landscape change due to a high intensification of agricultural activities. Although some patches of areas with natural vegetation (Mediterranean scrublands) remain, agriculture is the dominant land use. More than 80 % of total area of Campo de Cartagena is used for agriculture. Although there was some small irrigated lands around wells, dryland was the dominant type of agriculture in the Campo de Cartagena until recent decades, with cereals and almond trees as main crops.

During the last decades the area occupied by irrigated lands for horticultural and tree crops substantially increased due to the pumping of groundwater and, above all, due to the Tagus-

Segura water transfer, which started in 1979. Now the landscape of the Mar Menor watershed is dominated by irrigated lands, especially open-air horticultural crops (melon and lettuce), citrus fruits and greenhouses.

Drylands, characterized by a low use of fertilizers and other inputs were transformed into highly intensified irrigated lands, requiring a high level of inputs. This has led to significant changes in relation to the hydrologic dynamics of the Mar Menor river basin and the nutrient loads into the complex lagoon-associated wetlands, with a general increase in the non-point agricultural pollution.

5.4. Tourism

The tourist activities in the Mar Menor began in the beginning of past century. The traditional tourism has had a low impact on the landscape and dynamics of Mar Menor. In fact, some constructions developed by this traditional tourism, in particular the wood structures for bathing, led to the appearance of shadow habitats, allowing the settlement and development of sciaphilic assemblages of high interest.

The intensive tourist uses in the Mar Menor started during the beginning of the decade of sixties, with the urban and tourist development of La Manga, the sand barrier closing the Mar Menor lagoon, and with the creation of a tourist harbour and a communication channel for boats between the lagoon and the open sea, through the enlargement of the Estacio. During year 1999 around 750,000 persons visited the Mar Menor during summer. The tourist activities have promoted an intensive land occupation for housing and other built-up areas during the last decades. This land occupation process has not stopped and new urban settlements are projected and carried out.

The urban and tourist development has also entailed the increase of the demand in recreational facilities, leading to a high density of yachting harbours. The Mar Menor has now 18 yachting harbours, representing the 60 % of total number in Murcia autonomous community, despite of the Mar Menor represents an smaller fraction of total coastal shore of Murcia autonomous community. Other impacts generated by the tourist activities are related to pollution by hydrocarbons coming from tourist boats and the spillage of wastewater during summer caused by the high increase in summer population.

6. NATURALISTIC ASPECTS, NATURAL AND HISTORICAL VALUES

6.1. Biodiversity

The biodiversity of the marine species of Mar Menor lagoon is relatively high. 89 vegetal species and 459 animal species belonging to 13 phyla have been inventoried (Pérez-Ruzafa & Marcos 2004). The biodiversity and ecological values of the Mar Menor lagoon and associated wetlands are well-established. Birds and natural habitats fit the standard criteria of several rules for the protection on biodidiversity at the European level (Baraza 1999, Esteve & Calvo 2000). The lagoon has several European habitat according to the Directive 92/43 EEC, such as the habitat 1110: Sands permanently covered by shallow marine water and habitat 1150: meadows of *Ruppia cirrhosa*. It also includes the species *Lebias ibera*, included in Annex II of the Directive. The Mar Menor lagoon and associated wetlands fit the criteria established by the Birds Directive for the following species: *Podiceps nigricollis, Marmarenetta angustrirostris, Himanthopus himanthopus, Recurvirostra avosetta, Charadrius alexandrinus, Larus audouinii, Gelochelidon nilotica, Sterna albifron* (Viada 1998).

The protected landscape of open sites and islands of Mar Menor, including terrestrial and marine environments, have 18 European habitat, 14 of which are rare or very rare. Several terrestrial and marine habitat are considered very rare, such as habitat 1150: meadows of *Ruppia cirrhosa*; habitat 1210: Annual vegetation on accumulated marine materials; habitat 1310: Annual pioneering vegetation with *Salicornia* and other muddy and sandy species; habitat 2110: Mobile dunes and habitat 9570, Woodlands of *Tetraclinis articulata*.

The San Pedro del Pinatar salt mines have 10 European habitat, all being rare or very rare. Very rare habitats include habitat 1210: annual vegetation on accumulated marine materials, habitat 2230: Mobile dunes with *Malcomietalia* and habitat 2210: Fixed littoral dunes with *Crucianellion maritimae*.

6.2. Natural reserves, parks and protected sites

The ecological value of the environmental heterogeneity found in the Mar Menor has made the lagoon and associated wetlands to be considered in a series of rules and resolutions, at a international, national and regional level. The Mar Menor lagoon and the San Pedro salt mines became RAMSAR site in 1994. The associated wetlands have been designated as Area of Special Protection for Birds, according to the Birds Directive. The Mar Menor lagoon and the Open sites and Islands of Mar Menor, where associated wetlands are included, were designated as European Importance Areas, according to the Habitat Directive. Moreover, the Mar Menor was recently designated as Specially Protected Area of Importance for the Mediterranean Sea (ZEPIM), according to the Barcelona Agreement for the Protection of Marine Environment and the Coastal Zones on the Mediterranean Sea.

In the regional context, there are additional acts which also protects the Mar Menor lagoon and associated wetlands. The Act 4/1992, for Land Planning and Protection in Murcia Region, designated the Protected Landscape of Open Sites and Islands on Mar Menor, were the wetlands of Marchamalo, Lo Pollo, Marina del Carmolí and Playa de la Hita are included. The Act 4/1992 also designated the San Pedro del Pinatar salt mines as Natural Park. Finally, under Act 7/1995, for Wild Fauna, Hunting and Fluvial Fishing, the Mar Menor was designated as Area for Protection of Wild Fauna.

7. PREVIOS STUDIES

The Mar Menor lagoon has been extensively studied by a series of research works, mostly focused on biology and ecology topics. Many authors have studied different aspects of the Mar Menor lagoon: geochemistry and sediments (Simoneau 1973), the continental shelf (Díaz del Río 1990), salinity (Arévalo & Aravio-Torre 1969; Aravio-Torre & Arevalo 1971), the exchange between the lagoon and the Mediterranean Sea (Arévalo 1988), populations and ecology of plancton (Ros 1985, Ros *et al* 1984a, 1984b; Ros & Miracle 1987, García 1984a, 1984b; Gilabert 2001), phytobenthos (Ballester 1985; Pérez Ruzafa 1989; Terrados 1991; Terrados & Ros 1995) and zoobenthos (Pérez Ruzafa 1989), oyster banks (Rosique *et al.* 1993, Abellán 1996) and fish (Ramos *et al* 1985; Barcala 1999). Studies on jellyfish blooms and associated ecological processes have also been carried out (Pérez-Ruzafa & Más 1996; Grupo de investigación Ecología y Ordenación de Ecosistemas Marinos Costeros 1997). Some studies also include a compilation and synthesis of the available information at the moment and an analysis of the main ecological processes and environmental trends on the Mar Menor lagoon (Más 1996).

In relation to resources exploitation, studies have been focused on the fisheries in the lagoon (Navarro 1927; Lozano 1954; Esquerdo 1978; Pallares 1980; Departamento de Ecología de la Universidad de Murcia 1985; Más 1988; García-García 1997) and the oyster culture (Rosique 1994; Cano 1997).

The research studies on the Mar Menor watershed are less frequent. Nevertheless, aspects relative to its geography, hydrography, geology, climate, and vegetation (Ortiz 1975, Rodriguez & Lillo 1992) and also the water erosion and the geomorphologic effects of flood events (Conesa 1986, 1990) have been studied. Groundwater has been extensively studied, including sea intrusion (ADARO 1990), the installation of desalination plants for groundwater (García-Lozano 1995), sustainable management (Albacete et *al.* 2001), land use changes in the Campo de Cartagena (Román-Cervantes 1992), water inflow and nutrient content of main watercourses (Alvarez-Rogel *et al.* 2002a) and the nutrient loading from the watershed (Martínez & Esteve 2000, Martínez & Esteve 2003).

The Mar Menor coastal wetlands has hardly ever studied from the ecological point of view. The best-known biological communities are ornithological ones (Esteve, 1987; Robledano, 1991; Hernández, 1992). Census data of wintering and nesting waterfowl are carried out regularly (Naturaleza y Caza-ARMAN, 1994; Consejería de Medio Ambiente, Agricultura y Agua de la Región de Murcia 1995, 1996, 1997, 2000). Invertebrate communities were studied by Esteve (1987) and Giménez (1999). Research work on vegetal communities in Mar Menor wetlands are scarce (Garre, 1983). Soils-vegetation relationships were studied by Álvarez-Rogel (1997).

A general description on natural values and ecological processes in Mar Menor wetlands, and also a report on conservation diagnoses and proceeding guidelines are compiled in Varios Autores (1992), Vidal Abarca *et al*. (2001, 2003). The viability of using wetlands as filters of nutrient loads from the Mar Menor watershed was also analyzed (Vidal-Abarca *et al.* 1998). Works on Mar Menor wetland management were carried out by Robledano et al. (1987), Robledano (1995) and the Consejería de Agricultura, Agua y Medio Ambiente de la Región de Murcia (1996).

Research works implying the Mar Menor-watershed complex are scarce. Relevant studies are those of Ramírez *et al*. (1992) and the Departamento de Biología Animal y Ecología de la Universidad de Murcia (1984). Mas *et al.* (1986) includes descriptions on vegetation, fauna, soils, climate and history of the Mar Menor watershed. AMBIO (1981), EPYSA (1982) and Mateo (1996) carry out analysis of different aspects involved in the land planning in the Mar Menor area. Research works on the ecological valuation of the Mar Menor area and the implications for land planning were carried out by Martín de Agar (1982) and Esteve (1987).

Conservation and restoration approaches implying all the lagoon or the watershed are also scarce, standing out those relative to the coastal wetlands (Departamento de Biología Animal y Ecología 1989; Ramírez *et al.* 1992). A restoration project of Mar Menor wetlands was prepared by Consejería de Agricultura, Agua y Medio Ambiente (2003), where the methodological basis to achieve their integral restoration is set up.

Most of pollution research works focuse on the lagoon. Several studies to characterize the heavy metal and hydrocarbons pollution have been carried out (e.g. De León *et al.* 1982). Pérez Ruzafa *et al.* (2000) measured the concentration of pesticides in Mar Menor sediments and organisms. Likewise, indicators of organic pollution have been tested by Salas (2002). Pollution studies in the watershed are relative to insecticides (Cámara 1980) and heavy metals content in soils (Alvarez-Rogel 2002b).

The modelling background is scarce and refers mainly to a dynamic system model developed to estimate the annual load of nutrients into the complex Mar Menor-associated wetlands at a watershed scale (Martínez & Esteve, 2000, Martínez & Esteve 2003). The dynamic system model takes into account the loading of nutrients coming from the urban and the agricultural land sector. This model was also used to explore the potential effects of several scenarios regarding water availability and management.

There are now a series of research projects focusing on several aspects of the lagoon and watershed dynamics, such as the monitoring of jellyfish populations, the study of nutrients content in the water column and the lagoon sediments, the monitoring of bird communities, the study of water inflows and nutrients content of main watercourses, especially the Rambla del Albujón, the presence of pesticides in the Rambla del Albujón and in the water column and sediments of the lagoon and the hydrological dynamics of the Albujón sub-basin.

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