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## **The Mar Menor Lagoon**

Current knowledge base and  
knowledge gaps



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## Summary

The Mar Menor, a hypersaline lagoon located in a semi-arid arid region of southeast Spain, is one of the largest coastal lagoons in the Mediterranean, covering an area of approximately 135 km<sup>2</sup>. The importance of the lagoon and its salt marshes in terms of biodiversity has been recognised in numerous international protection schemes: it has been a Ramsar International site since 1994; it is considered a Special Protected Area of Mediterranean Interest (SPAMI), established by the Barcelona Convention in 2001; and a Site of Community Importance (SCI) to be integrated in the Nature 2000 Network (EU Habitats Directive). This zone is also a Specially Protected Area (SPA) for the nest building, migration and wintering of aquatic birds, and is protected by European legislation (Birds Directive 79/409/CEE).

The lagoon and the associated watershed areas comprise a whole variety of human uses including large tourist resorts and intensively irrigated agriculture. During the last decades these human activities in the area have promoted several changes in the environment, including planktonic changes, macrophyte species substitution, and undesirable jellyfish blooms.

Although numerous studies have been carried out in the Mar Menor, a better understanding of the consequences of biodiversity losses and the increase of eutrophication in the lagoon is still necessary. The consequences of global climate change in the area and the possibility of aggravated eutrophication in the Mar Menor lagoon needs to be addressed in order to develop successful management strategies in the area to protect this valuable ecosystem and its services.

The Mar Menor is managed within a complex legislative and policy context, with a wide variety of institutions and actors involved in the use and management of the lagoon. It is therefore necessary to develop a framework of common objectives and management guidelines in order to promote a more sustainable development in the area and protect its natural resources and biodiversity, especially facing the expected consequences of future global climate change.

Our understanding of the interactions between the processes in the watershed areas and the lagoon functioning and its 'health' is crucial to design successful strategies in the Mar Menor, and to reduce or palliate the possible consequences and impacts of future global climate

change in the area. There is a crescent need for new strategies to promote a more sustainable development of the area in order to reduce human impacts on the valuable ecosystem goods and services provided by the lagoon, including biodiversity.

# 1. Introduction

The Mar Menor, as other coastal lagoons, is defined primarily by its shallow depth. In these systems, most of the seafloor lies within the photic zone, which allows benthic primary productivity. As a result, shallow lagoons and bays tend to be dominated by benthic producers such as seagrasses, perennial macroalgae and microphytobenthos, rather than by phytoplankton.

Due to its location between land and sea, the Mar Menor lagoon is subject to an elevated rate of dynamic changes in the natural environment that result in high biological productivity and diversity. As a highly productive system, the lagoon shows marked abundances of macrofaunal species. It also supports fish populations, many of great commercial importance, and constitutes essential zones for the nest building, migration and hibernation of aquatic birds (Figure 1). The relevance of the Mar Menor coastal lagoon in terms of biodiversity has been recognised in numerous international protection schemes.



Figure 1. The Mar Menor lagoon and its associated salt marshes constitute essential zones for the nest building, migration and hibernation of aquatic birds.

The lagoon and the associated watershed areas comprise a whole variety of human uses including large tourist resorts and intensively irrigated agriculture. However, as many other coastal lagoons, the Mar Menor can be considered as particularly vulnerable to eutrophication and other pollution related environmental problems due to the shallow depth and restricted exchange with the adjacent ocean. During the last decades these human activities in the area have increased the amount of nutrients and other substances entering the lagoon and promoted several changes in the environment. As a consequence of increased inputs, the waters of the Mar Menor have experienced rising nutrient levels that have led to planktonic changes in the lagoon (Gilabert, 2001, Pérez-Ruzafa et al., 2005). These changes have also favoured the proliferation of the jellyfish species *Cotylorhiza tuberculata* and *Rhizostoma pulmo* with severe consequences for touristic activities in the area (Pérez-Ruzafa et al., 2002). Furthermore, modified light conditions of the lagoon waters might have favoured the expansion of *Caulerpa prolifera* on the bottoms of the lagoon as well as the confinement of the traditional phanerogam *Cymodocea nodosa* to small patches in shallow areas. These changes have caused a progressive deterioration of the sediments through the accumulation of organic matter and subsequent appearance of anoxic conditions and the production of toxic acid volatile sulphides, all of which have diminished the water quality in several zones of the Mar Menor lagoon (muddy bottoms, bad smell, etc.). In addition, the local fishing industry is negatively affected by decreased populations of commercial fish, as these species, mainly Sparidae and Mugilidae, prefer feeding on patches of the phanerogam or unvegetated bottoms, which are now covered by a dense and continuous bed of the macroalga *C. prolifera* (Verdiell-Cubedo et al., 2007).

## 2. The Physiogeographical Story

### 2.1 Physical conditions of the lagoon and the drainage basin

The Mar Menor is a hypersaline coastal lagoon located in a semi-arid region of southeast Spain. The lagoon occupies a surface of approximately 135 km<sup>2</sup> and a total volume of 610x10<sup>3</sup> m<sup>3</sup> (Arévalo 1988). Maximum depth in the lagoon reaches 6.5 m with an average depth of 3.6 m. According to the geomorphological classification of Kjerfve (1986), the Mar Menor constitutes a restricted littoral lagoon relatively isolated from the adjacent Mediterranean Sea.

The lagoon is isolated from the Mediterranean Sea by a 22 km long and 100 to 900 m wide sandy bar (La Manga), crossed by three shallow channels (Marchamalo, Encañizadas del Ventorillo y La Torre and El Estacio). In the early 1970s, one of these channels (El Estacio) was dredged and widened to make it navigable. Since then, it has become the lagoon's main connection with the sea. The enlargement of El Estacio channel led to a substantial increase of water renewal rates from the Mediterranean, as well as subsequent changes in water temperatures and salinities. These changes favoured the colonisation of the lagoon by numerous marine species as lagoonal temperatures and salinities reached less extreme values (Pérez-Ruzafa et al. 1991).

Before the dredging of El Estacio channel salinities in the lagoon reached values of over 52 and temperatures ranged from 6 to over 30° C. Nowadays, salinity ranges from 42 to 47 and temperatures are less extreme ranging from 10° C in winter to almost 30° C during the summer (Figure 2).



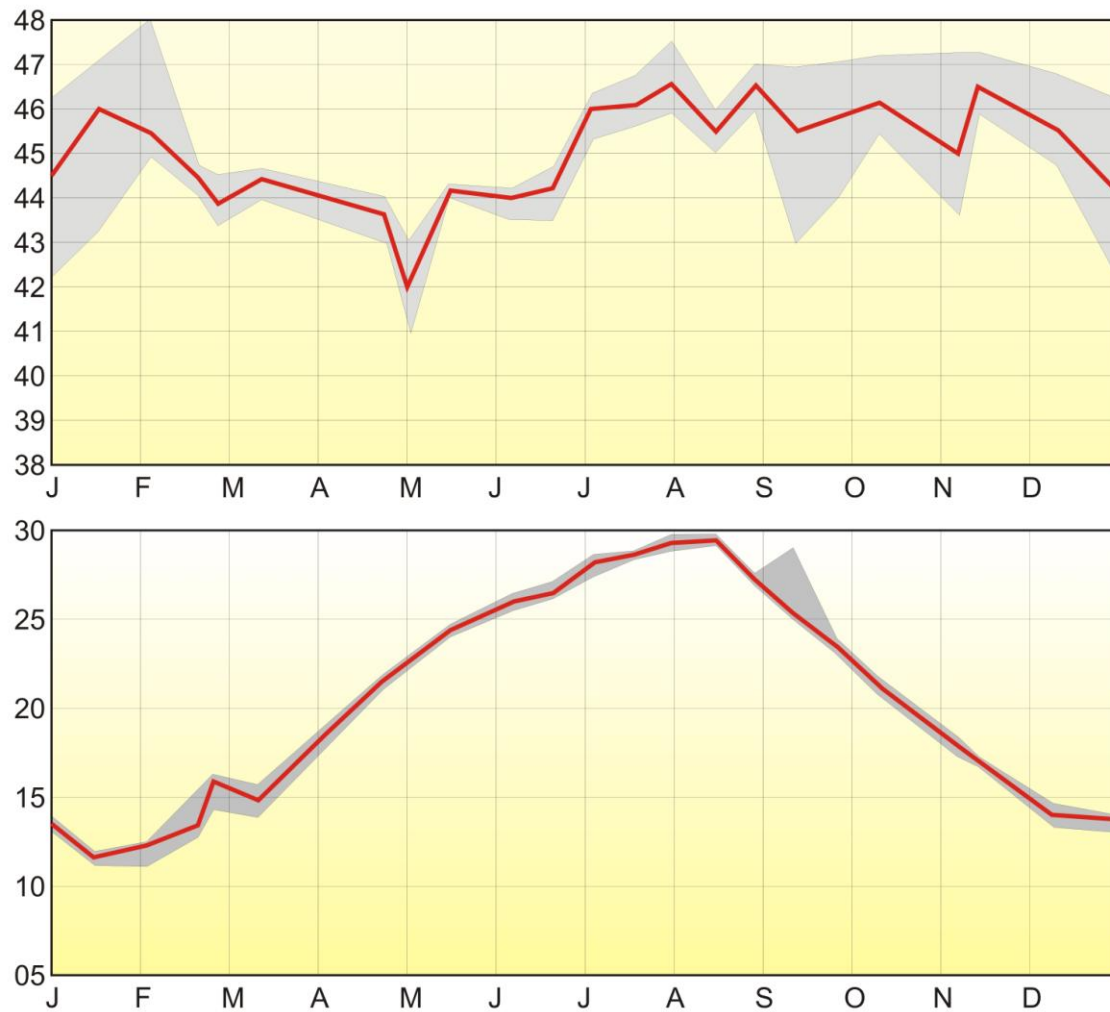


Figure 2. Annual values of salinity (up) and temperature (bottom) measured in the Mar Menor lagoon in 2003. The red line represents averaged values for each variable (Data from Perez-Ruzafa et al. 2005 and Lloret et al. 2005)

Water exchange with the adjacent Mediterranean Sea mainly occurs through El Estacio channel. Small tides, mainly diurnals, are responsible for high frequency dynamics through the channel, but the main force agent is, by far, the variations in atmospheric pressure (Arévalo 1988). Winds are responsible for main water circulations within the lagoon, which, in average, shows an anti-clockwise circulation pattern. Water residence time in the lagoon has been estimated as  $0.79 \text{ yr}^{-1}$ .

The lagoon is situated at the end of a watershed delimited by a group of mountain ranges (Escalona, Algarrobo, Cartagena) that surround the Campo de Cartagena, an extense plain of about  $1,440 \text{ km}^2$ . Freshwater inputs into the lagoon are restricted to six ephemeral

watercourses called ‘wadis’ or ‘ramblas’. These wide, shallow gullies are generally inactive, but can carry great quantities of water and sediment during flood episodes. The torrential nature of the supplies is aggravated by the impermeable soils and scarce vegetation cover of the watershed areas (Figure 3).

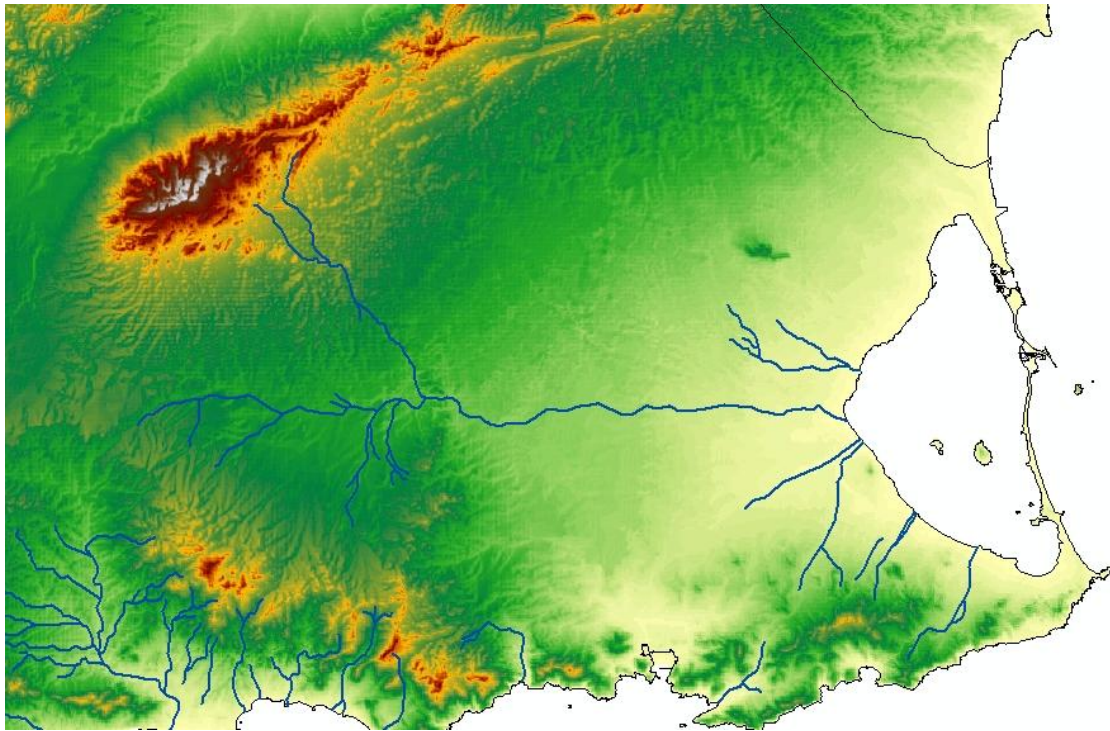


Figure 3. Digital Elevation Model of the study area showing the main mountain ranges and wadis.

Three of these wadis are located on the west margin of the lagoon. Los Alcázares wadi has a diffuse network of channels and reaches the Mar Menor at the town of Los Alcázares. El Alujón wadi constitutes the largest watercourse and drains the adjacent agricultural area Campo de Cartagena. Miranda wadi presents two main channels that converge diffusely in El Carmoli salt marsh. The other three wadis that reach the lagoon are El Beal, Ponce and Carrasquilla wadis. These originate in the mountains located south of the Mar Menor lagoon, and, during episodic rain events, carry metal wastes and mineral deposits from the mining areas located there (Figure 4).

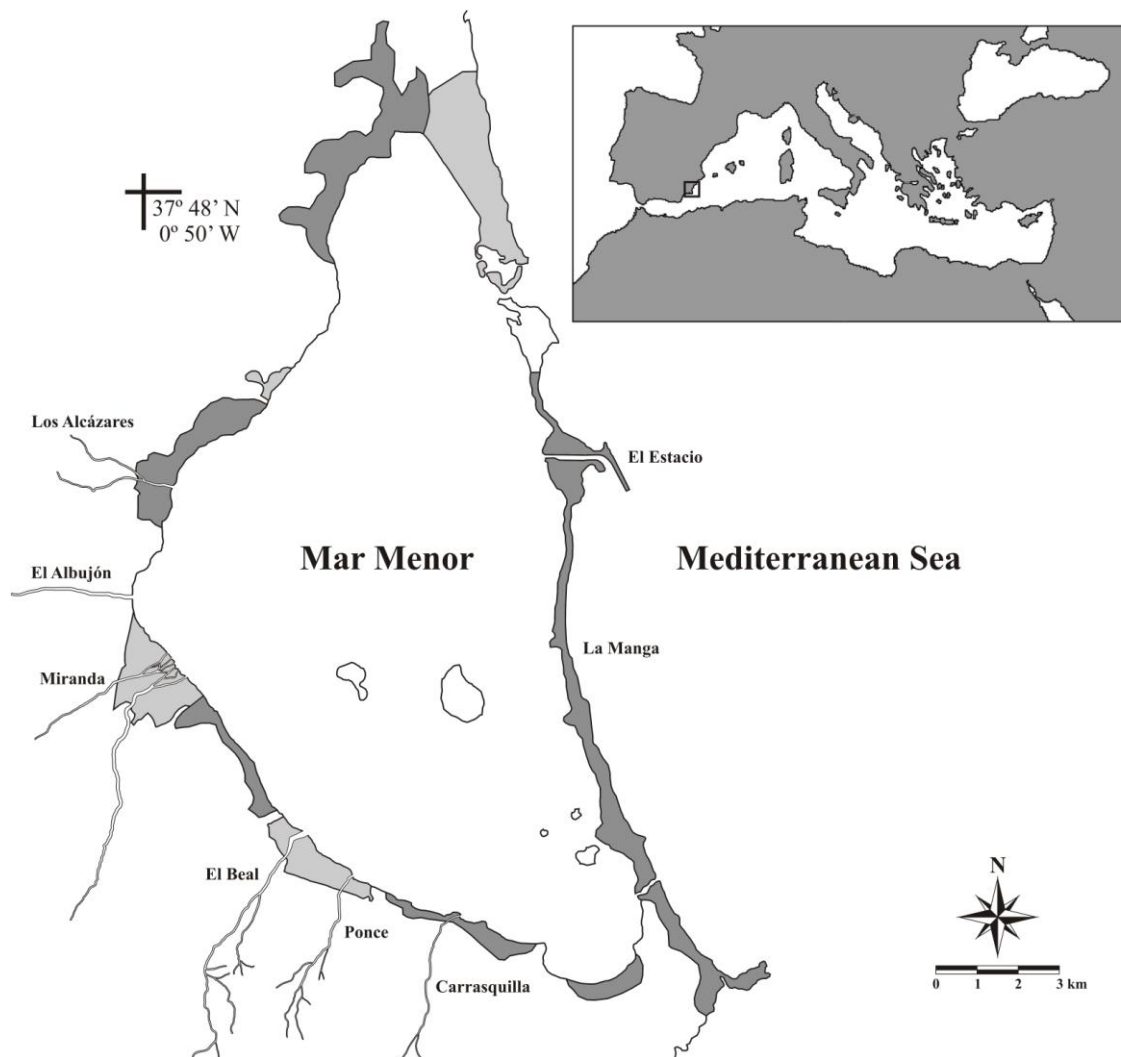


Figure 4. Map of the Mar Menor coastal lagoon showing the location of the main urban areas (dark grey), salt marshes (light grey) and watercourses.

El Albuñón wadi is the principal watercourse responsible for major inputs of organic and inorganic nutrients that flow into the lagoon (Velasco et al. 2006, García-Pintado et al. 2007). It drains a surface of 441 km<sup>2</sup>, about one third of the total surface of the adjacent agricultural area (Campo de Cartagena). The principal source is drainage from irrigated crops, but sometimes waste-water treatment plants located in the watershed area discharge large amounts of untreated or insufficiently treated water into the channel (Figure 5).

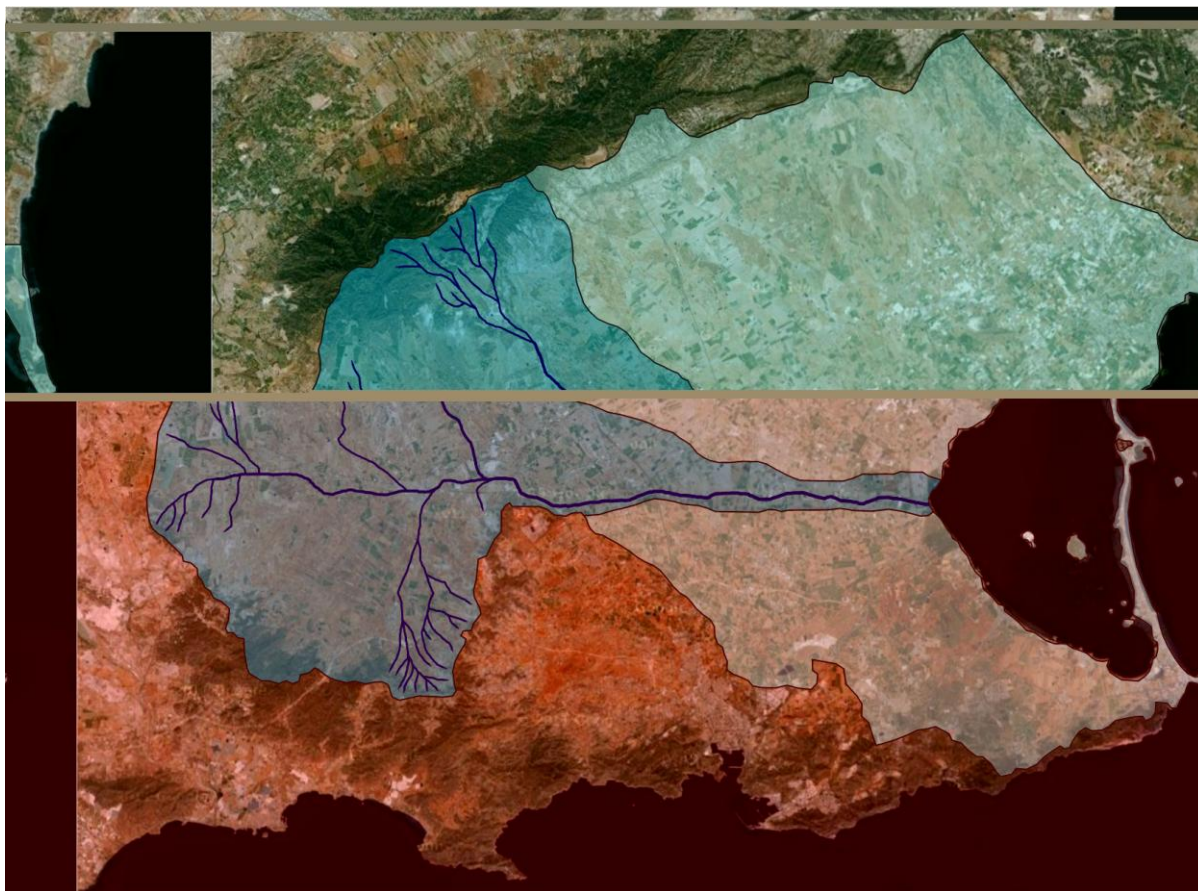


Figure 5. Satellite view of the agricultural area of Campo de Cartagena (light blue area) and El Albuñón watershed (dark blue area).

## 2.2 Climate, natural resources and land-use

### 2.2.1 Climate

The area presents a subdesertic Mediterranean climate, characterised by warm and dry weather conditions. Mean annual temperatures range from 17 to 21° C. Winters are mild, with temperatures around 10-13° C. Summer temperatures reach values above 25° C (Figure 6).

The area is characterised by scarce precipitation ( $<300 \text{ mm yr}^{-1}$ ), which mainly occurs during storm events in autumn and winter (Figure 6). Precipitation is almost zero during July and August, when maximum evaporation rates are observed.



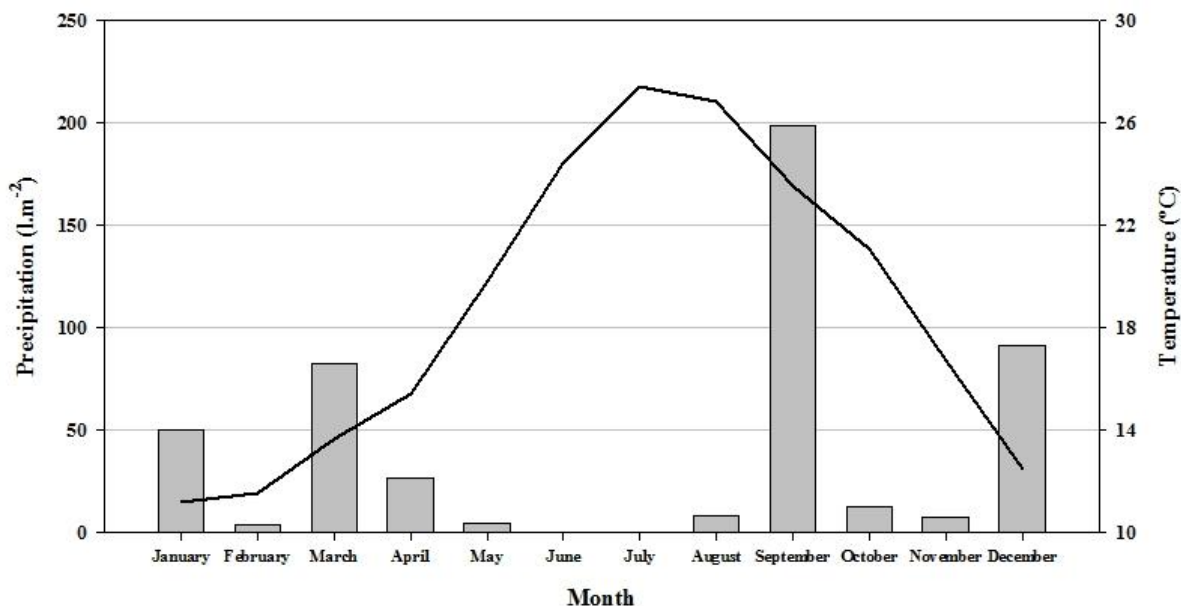


Figure 6. Averaged monthly precipitation and temperature in the Mar Menor area in 2009 (Source: Anuario estadístico de la Región de Murcia 2009).

Wind regimes in the area are dominated by the first and second quadrants with a marked seasonal pattern. Winds from the west dominate during the autumn and winter, while those from the northeast and southeast dominate during the spring and summer.

## 2.2.2 Natural resources

The Mar Menor lagoon constitutes one of the most singular and studied environments in the region. Its values in terms of biodiversity have been recognised by numerous protection schemes. At a regional level it is a Regional Park and Protected Landscape. It has been a Ramsar International site since 1994; it is considered a Special Protected Area of Mediterranean Interest (SPAMI) established by the Barcelona Convention in 2001; and a Site of Community Importance (SCI) to be integrated in the Nature 2000 Network (EU Habitats Directive). This zone is also a Specially Protected Area (SPA) for the nest building, migration and wintering of aquatic birds, and is protected by European legislation (Birds Directive 79/409/CEE).

The high protection status of this coastal lagoon is due to the value of its natural environment. A total of 179 water bird and 46 fish species have been sighted in the area. It also comprises 23 habitats of Community Importance, of which nine are considered as Prioritaries.

Many water bird species use the lagoon and its associated salt marshes. Fifty water bird species have been included in Annex I of the Birds Directive 79/409/CEE (Table 1). Twenty species use the area for nest building. With regard to wintering and migration, approximately 10000 birds have been estimated during January and 5000-6000 during their migration from September to October.

Table 1. List of bird species included in the Birds Directive	
Species	National Catalogue of Endangered Species
<b>ARDEIDAE</b>	
<i>Botarus stellaris</i>	Endangered
<i>Ixobrychus minutus</i>	Special Interest
<i>Nycticorax nycticorax</i>	Special Interest
<i>Ardeola ralloides</i>	Endangered
<i>Egretta garzetta</i>	Special Interest
<i>Egretta alba</i>	Special Interest
<i>Ardea purpurea</i>	Special Interest
<b>THREKIORNITHIDAE</b>	
<i>Plegadis falcinellus</i>	Special Interest
<i>Platalea leucorodia</i>	Special Interest
<b>PHOENICOPTERIDAE</b>	
<i>Phoenicopterus ruber</i>	Special Interest
<b>ANATIDAE</b>	
<i>Tadorna ferruginea</i>	Special Interest
<i>Marmaronetta angustirostris</i>	Endangered
<i>Aythya nyroca</i>	Special Interest
<b>ACCIPITRIDAE</b>	
<i>Gyps fulvus</i>	Special Interest
<i>Milvus migrans</i>	Special Interest
<i>Circus aeruginosus</i>	Special Interest
<i>Circus cyaneus</i>	Special Interest
<i>Circus pygargus</i>	Vulnerable
<i>Hieraetus pennatus</i>	Special Interest
<b>PANDIONIDAE</b>	
<i>Pandion haliaetus</i>	Special Interest
<b>FALCONIDAE</b>	
<i>Falco peregrinus</i>	Special Interest
<i>Falco columbarius</i>	Special Interest
<b>RECURVIROSTRIDAE</b>	
<i>Himantopus himantopus</i>	Special Interest
<i>Recurvirostra avosetta</i>	Special Interest
<b>BURHINIDAE</b>	

<i>Burhinus oedicnemus</i>	Special Interest
<b>GLAREOLIDAE</b>	
<i>Glareola pranticola</i>	Special Interest
<b>CHARADRIIDAE</b>	
<i>Charadrius alexandrinus</i>	Special Interest
<i>Pluvialis apricaria</i>	Special Interest
<b>SCOLOPACIDAE</b>	
<i>Philomachus pugnax</i>	Special Interest
<i>Limosa japonica</i>	Special Interest
<i>Tringa glareola</i>	Special Interest
<i>Phalaropus lobatus</i>	Special Interest
<b>LARIIDAE</b>	
<i>Larus melanocephalus</i>	Special Interest
<i>Larus genei</i>	Special Interest
<i>Larus audouinii</i>	Special Interest
<b>STERNIDAE</b>	
<i>Gelochelidon nilotica</i>	Special Interest
<i>Sterna caspia</i>	Special Interest
<i>Sterna sandvicensis</i>	Special Interest
<i>Sterna hirundo</i>	Special Interest
<i>Sterna albifrons</i>	Special Interest
<i>Chlidonias hybridus</i>	Special Interest
<i>Chlidonias niger</i>	Special Interest
<b>STRIGIDAE</b>	
<i>Asio flammeus</i>	Special Interest
<b>ALCEDINIDAE</b>	
<i>Alcedo atthis</i>	Special Interest
<b>CORACIIDAE</b>	
<i>Coracias garrulus</i>	Special Interest
<b>ALAUDIDAE</b>	
<i>Chersophylus duponti</i>	Special Interest
<i>Melanocorypha calandra</i>	Special Interest
<i>Calandrella brachydactyla</i>	Special Interest
<b>TURDIDAE</b>	
<i>Luscinia svecica</i>	Special Interest
<b>SYLVIIDAE</b>	
<i>Sylvia undata</i>	Special Interest

The fish community in the Mar Menor lagoon is also represented by a high number of species. Many of these species are of commercial interest, such as the cyprinodontid fish *Aphanius iberus*, since they constitute an important food resource for other species such as water birds; but they also serve as indicators of the overall ‘health’ of the lagoonal environment. Mugilidae fish species are the most important ones in terms of abundance and biomass but many other species are represented in the lagoon (Table 2).

**Table 2. List of fish families and their relative abundance**

Family	Abundance (%)
Mugilidae	47.16
Gobiidae	25.67
Atherinidae	10.71
Sparidae	7.38
Sygnathidae	4.73
Cyprinodontidae	2.20
Bleniidae	1.61
Moronidae	0.33
Labridae	0.07
Callyonimidae	0.05
Belonidae	0.02
Soleidae	0.02

### 2.2.3 Land use

Since the appearance of the first eneolithic settlements in the area, the Mar Menor has been exploited with increasing intensity as an urban and industrial area as well as for fishing, agriculture, mining, boating activities, and as a landscape and tourist resource. Military uses are also represented in the lagoon by an air force military base on the western part of the lagoon close to the town San Javier.

Most of the land in the immediate area surrounding the lagoon is currently occupied by urban areas that have experienced a large development in order to accommodate the increasing number of tourists that visit the area every summer. The towns of San Pedro del Pinatar in the north, San Javier, Los Alcázares, El Carmolí, Los Nietos and Los Urrutias on the western side, and, especially, La Manga located on the sand bar that isolates the lagoon from the Mediterranean Sea experience a ten-fold increase of their populations every summer (Figure 7). Large tourist resorts are also present in the southern part of the lagoon.



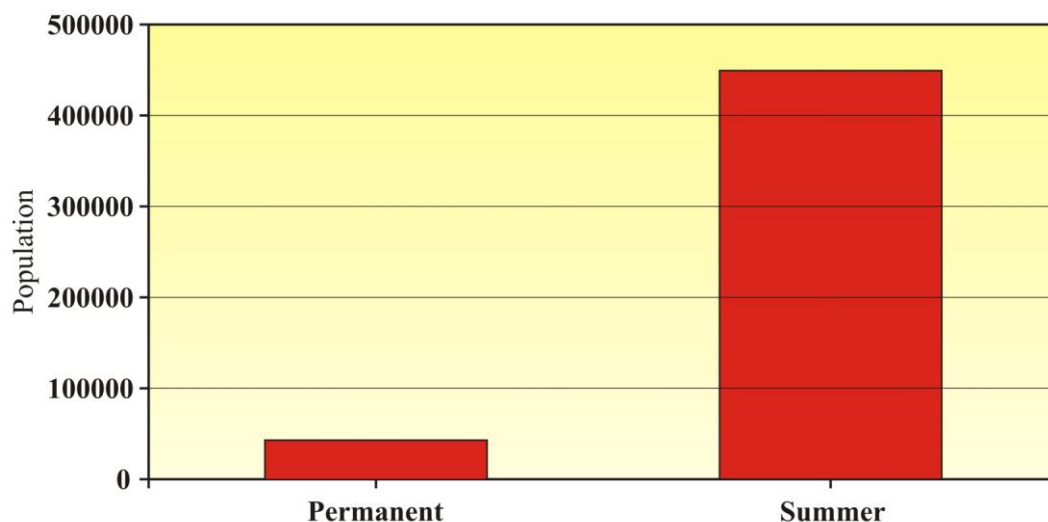


Figure 7. A comparison between permanent residents and summer population in the Mar Menor coastal lagoon.

In the watershed area, Campo de Cartagena, intensively irrigated agriculture constitutes the main use of the land (more than 80 %). The surface occupied by irrigated crops has increased since the late 70s, after the increase of water resources provided by the Tajo-Segura river diversion (Figure 8).

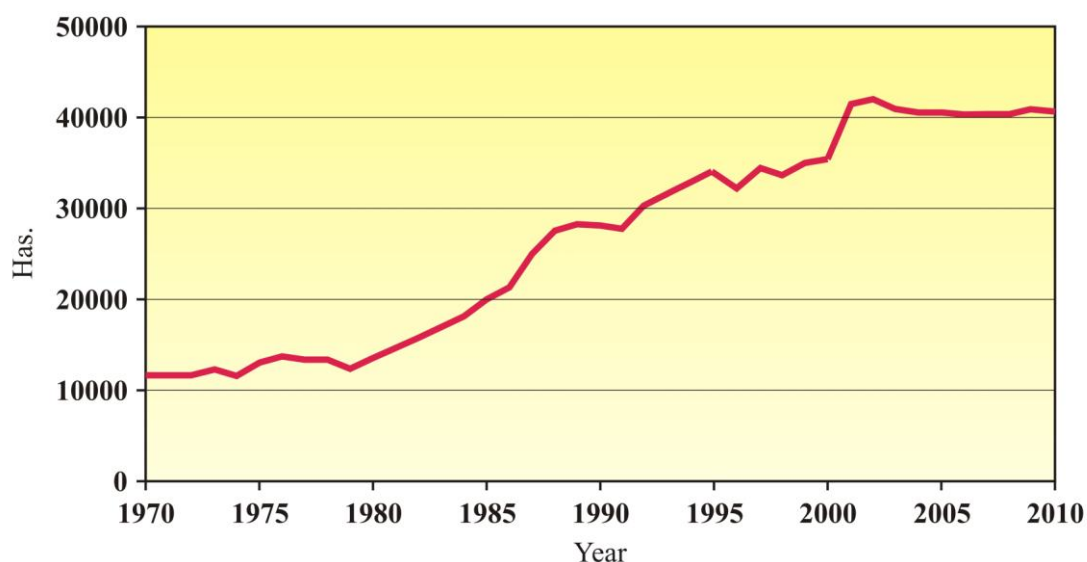


Figure 8. Evolution of the area occupied by intensively irrigated crops (Has.) in the adjacent agricultural area Campo de Cartagena from 1970 to 2010 (Redrawn from Martínez-Fernández and Esteve-Selma, 2005 and completed with data available at [www.carm.es](http://www.carm.es)).

Natural and semi-natural salt marshes are mainly represented by the salt pans of San Pedro del Pinatar in the north of the lagoon, El Carmolí on the west shore of the lagoon and Marchamalo in the south (Figure 9).

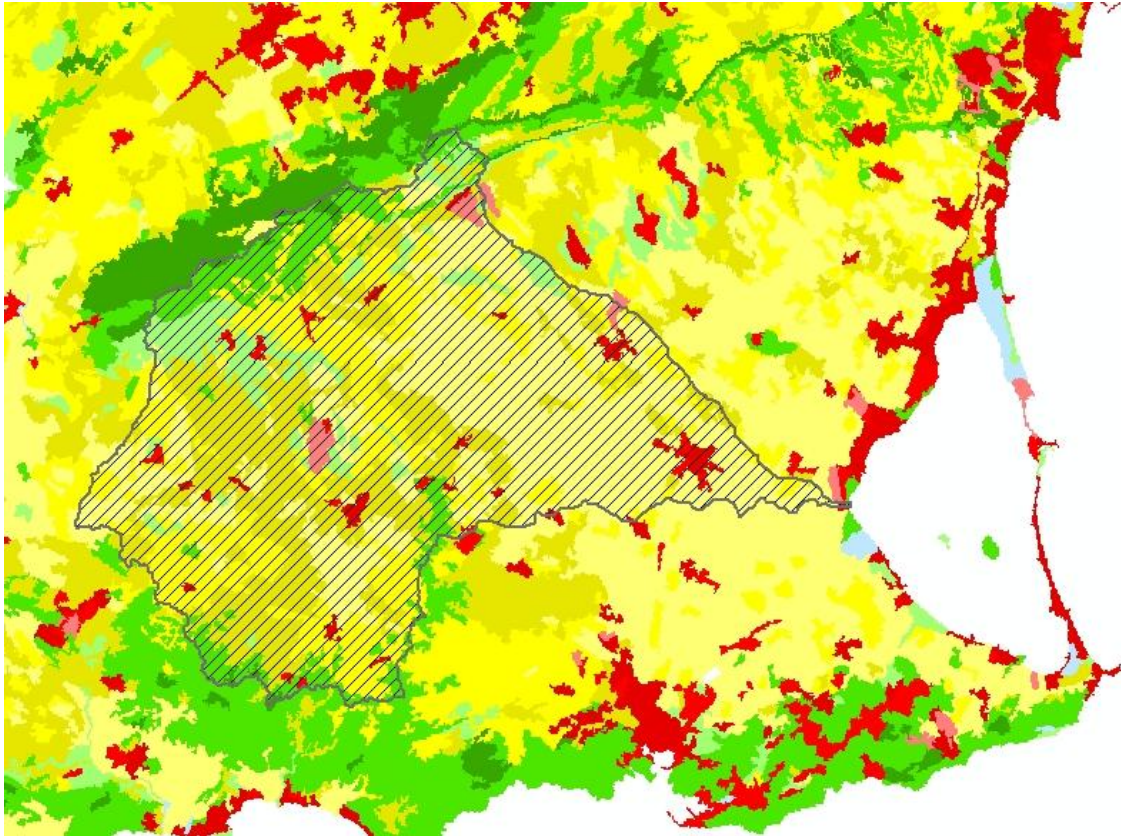


Figure 9. Land uses in the Mar Menor area and El Albuñón watershed. Urban areas are represented in red, agricultural areas in yellow, forests and vegetated areas in green and wetlands in light blue (Source: CORINE Land Cover 2006).

## 2.3 Main ecological and environmental problems

### *Pollution of the lagoon*

The Mar Menor lagoon receives drainage inputs from the adjacent plain Campo de Cartagena and presents high levels of organic residue, fertilizer, pesticide and heavy metal pollution.

Water pollution in the lagoon is a result of human activities in the area, mainly due to the inputs derived from agricultural drainages resulting from the irrigation of crop fields. However, the lagoon also receives inputs of urban wastewaters that are insufficiently treated, mainly through El Albuñón wadi.

Contamination by nitrate is associated with point sources, fertilization and land irrigation practises. A large part of the nutrients contained in the agricultural soils of the Campo de Cartagena enters into the lagoon through superficial or underground drainage. Wastewater is another major source of nitrogen.

Agriculture is the greatest contributor of non-point source (NPS) pollution to streams where intensive agriculture occurs by surplus nitrogen applications from fertilizers and manure sources.

The high anthropogenic pressure in the surrounding watershed of the Mar Menor has led to an increase in nutrients and pollutants flowing through the watercourses into the lagoon. In the Albuñón rambla, nitrate is the predominant N form. Nevertheless, during summer months, it is common to find high phosphate and ammonium concentrations due to an increasing discharge of wastewater (Ruiz & Velasco, 2010).

In the Campo de Cartagena, increased irrigation of crops as a result of the Tajo-Segura water transfer has increased agricultural drains. Some of these drains reach the Mar Menor and its associated wetlands, such as the Marina del Carmolí. These increased water flows into the wetlands have modified the natural habitat, originating losses on the natural saline steppe, a rare habitat of conservation priority according to the Habitats Directive, at the expense of the expansion of reeds (Figure 10), a habitat without interest from the point of view of the directive ([http://www.um.es/oserm/salinidad\\_agua.html](http://www.um.es/oserm/salinidad_agua.html)).

The construction of the Tajo-Segura diversion caused both qualitative (changes from dry-crop farms to intensively irrigated crops) and quantitative (increasing area) changes in the local traditional agriculture (Pérez-Ruzafa et al., 2002). Since the overexploitation of groundwater has decreased, changes have led to rising phreatic levels. As a result, some watercourses, such as the Albuñón wadi, now maintain a regular flux that is fed by groundwater with high nitrate levels, which is responsible for major inputs of organic and inorganic nutrients entering the lagoon (Velasco et al., 2006). The nutrient load is one of the main factors driving the long-term evolution of the ecological conditions of the Mar Menor lagoon, and emerges as a key factor in all relevant scenarios and management options for the Mar Menor site. Velasco et al. (2006) estimated the annual inputs into the Mar Menor lagoon

from the nearby agricultural area of Campo de Cartagena at 640–3136 tonnes of dissolved inorganic nitrogen and 43–251 tonnes of soluble reactive phosphorus per year, considering the Rambla del Albuñón as the main contributor and conditioned by flood events. The eutrophication process could cause serious changes to the Mar Menor lagoon, affecting not only its ecological state and biodiversity values, but also current socioeconomic activities, especially tourism and fishing.

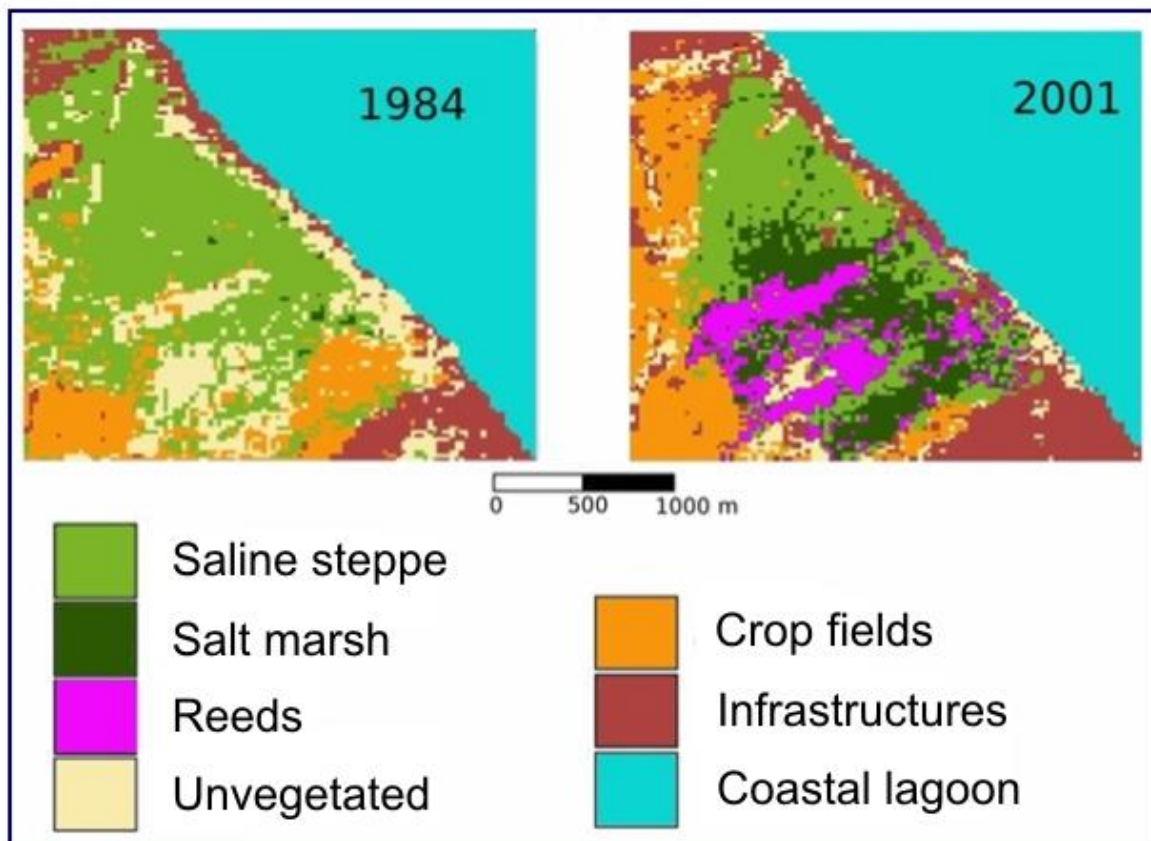


Figure 10. Evolution of the vegetation in Marine del Carmolí (Source: Sustainability Observatory of the Murcia Region (OSERM))

The new urban-tourist developments have also generated a degradation of the landscape, loss of biodiversity and fertile soils as well as serious environmental problems related to waste management, waste water, and traffic, which will require new water treatment facilities and infrastructures. The increase of impervious surface runoffs and flood risk have increased the urban and agricultural pollution reaching the lagoon.



Historical mining in the area originated an increase of heavy metal contents in the lagoon's sediments. Although mining activities ceased several decades ago, some wadis such as El Beal and Ponce, carry great quantities of heavy metals especially after rainfall events (Figure 11).



Figure 11. Water run-offs during the rainy season can introduce great quantities of heavy metals into the lagoon.

The negative effects of wastes from the old mining activities are still evident because of scarce but intense rains that can relocate large volumes of mining wastes from the southern mountains into the lagoon. Several studies indicated the presence of metals (Zn, Pb, Ar) in the sediments and food chains in the lagoon (Marin-Guirao et al. 2005a, 2005b; Marin-Guirao et al. 2007; Marin-Guirao et al. 2008). The presence of heavy metals in the food chains constitutes an important concern not only for animals but also for human health. Therefore, it seems necessary to monitor the levels of metals in the biota in order to prevent possible metal transfer to humans, since commercial and leisure fish activities are very popular in the area.

Despite its high recovering capacity, all these sources of contamination can alter the sensitive and vulnerable environment of the Mar Menor lagoon. There is, however, a clear responsibility from public institutions to preserve the ecological values of the lagoon and its associated salt marshes.

#### *Ground water pollution*

Intensively irrigated agriculture constitutes the main source of contaminants for groundwaters in the area which show high nutrient and pesticide concentrations. In addition, livestock farms are one of the main sources of ammonia that infiltrates the soil. Golf resorts also contribute to the amount of fertilizers that contaminate the groundwater.

Management and reduction of groundwater pollution is often a very difficult task. However, environmental education and the improvement of agricultural technologies could help reducing the amount of pollutants reaching the groundwater.

#### *Ground water overexploitation and marine intrusion*

Although most of the groundwater masses in the area are not overexploited due to the increase of water resources in the area originated by the Tajo-Segura river diversion, the Las Victorias groundwater mass is currently overexploited. However, at times when rates of water diverted are low, water extraction from aquifers increases and can cause that, during draught periods, extracted water can exceed resources. This situation has led to marine water intrusion into the aquifers with a deleterious increase in water salinities and the subsequent decrease in water quality.

#### *Impact on natural protected areas*

Natural protected areas present a high number of endemic species and provide habitat for species of interest at a regional, national and international level. However, these areas are threatened by the impacts of human activities that occur close to their limits, mainly agriculture, mining, and urban development, but also by those occurring within the protected area, such as visitors, fishing and others.

The maintenance of these protected areas requires not only the correct management of human activities but also rehabilitation measures.

### *Invasion of the Public Domain*

The invasion of the marine-land public domain constitutes a risk against natural disasters.

Human settlements, especially those related to tourism, have progressively occupied those spaces located close to the ocean that belonged to the public domain (Figure 12)..



Figure 12. The occupation of La Manga is one of the clearest examples of the uncontrolled urban development of the public domain.

Furthermore, due to the natural characteristics of the drainage area, the invasion of terrains located close to the wadis supposes a huge risk against floods during the torrential rains that occur in this particular area.



The characteristic dune systems and broad beaches, typical for La Manga, have been severely damaged by urban development, and over 60% of the surface area of the sand stretches has disappeared during the last 30 years (ESA, 2003).

#### *Increase of surface run-offs*

Waters from the Tajo-Segura river diversion have originated a surplus of water resources in the area and caused a rise in phreatic levels. As a result some wadis have lost their natural temporary character and now maintain a regular flux of water (Figure 13).

This situation alters plant and animal populations that inhabit the area.



Figure 13. The Albuñón wadi has lost its temporary character and now maintains a regular flux of water.

## **2.4 Knowledge gaps**

The sum of the impacts of mining, agriculture and urban development in the Mar Menor area during the last decades has clearly affected the lagoonal ecosystem (Conesa and Jiménez-Cárceles, 2007). Although many studies have been carried out in the lagoon, many of them addressing recent environmental problems (see Cabezas and Martinez 2009 for a review), there are still some aspects that require efforts in order to better understand lagoonal response to environmental stressors and overall ecosystem functioning.



With the increase of agricultural and tourist activities in the area, the lagoon has developed moderately eutrophic characteristics. Some of the most important symptoms of the changes are the appearance of a dense monospecific bed of the macroalga *Caulerpa prolifera* (Forsk.) Lamouroux that covers most of the lagoon's bottom, and the massive proliferations of two allocthonous jellyfish species from the nearby Mediterranean Sea, *Rhizostoma pulmo* and *Cotylorhiza tuberculata*.

Nowadays, both jellyfish species are considered a plague, affecting the lagoon's image as a tourist destination. The number of jellyfish has been estimated at around 47 million individuals every summer (Pérez-Ruzafa et al. 2002). Although apparently these proliferations can be associated to the eutrophication process that is taking place in the lagoon, it is not clear yet how these proliferations can be predicted, estimated or even prevented; neither is it clear what the main factors provoking their growth are. Furthermore, the role of these jellyfish species in controlling phytoplankton proliferations and improving water quality in the lagoon deserves particular attention in order to assess ecosystem resistance to eutrophication impacts.

In the lagoon, the high benthic macrophyte biomass contrasts with the low phytoplanktonic density and the relative oligotrophy of the waters (Gilabert, 2001; Lloret et al., 2005). This fact highlights the existence of a benthic control of the system, since benthic production is more important than planktonic production (Terrados and Ros, 1991; Lloret et al. 2008; Lloret and Marin 2009; Lloret and Marin 2011). However, despite the confirmation of the role of benthic production in controlling and modulating ecosystem response to eutrophication, recent studies pointed out that the expected consequences of climate change in the area could have a deleterious impact on macrophyte production, and therefore increase the risk of eutrophication and ultimately cause the collapse of the system with the appearance of severe eutrophication events (Lloret et al. 2008). A clearer understanding of the consequences of climate change in the area is therefore necessary.

Salinity changes after the enlargement of El Estacio channel have also affected the traditional fishing activities (Serra-Raventós, 2007; Pérez-Ruzafa, 1989; Pérez-Ruzafa et al., 1991). The stocks of traditional specie have suffered an important decrease (Conesa and Jiménez-Cárceles, 2007). This alteration of fish assemblages has also modified the structure of food chains within the lagoon. It is necessary to improve our knowledge about the effect of this

gradual species change on the stability of the ecosystem, and the impacts of urban and tourist development on lagoonal biodiversity.

In conclusion, the Mar Menor lagoon ecosystem is under a continuous modification due to the impacts of mining, agriculture and urban development. The application of EU Water Framework Directive, should not consider the Mar Menor lagoon as an 'immobile' ecosystem, but as one that changes constantly.

## 3. The Management Story

### 3.1 Socio-economic, livelihood and political issues

#### 3.1.1 Municipalities and population

In the Mar Menor watershed, the municipality of Cartagena is the greatest area and population presents, followed in descending order of extension, the municipalities of Torre Pacheco and Fuente Alamo, being Los Alcázares the smallest (Table 3). By number of inhabitants, Cartagena, Torre Pacheco, San Javier, San Pedro del Pinatar and Fuente Álamo respectively.

Table 3: Surface and population (census 2011) of municipalities of the Mar Menor basin

Source: National Institute of Statistics

Municipality	Surface (km <sup>2</sup> )	Total Population	National	Foreign
Cartagena	558.3	214.918	185.575	29.343
Fuente Álamo	273.5	15.873	10.730	5.143
Torre-Pacheco	189.4	33.218	23.373	9.845
San Javier	75.1	32.366	22.626	9.740
La Unión	24.8	18.825	16.542	2.283
San Pedro del Pinatar	22.3	24.093	17.725	6.368
Los Alcázares	19.8	16.217	9.535	6.682



Figure 14. Municipalities surrounding the Mar Menor lagoon and its watershed area.

There was an increase in the last four decades of foreign-born population, with a strong seasonal dynamics, due to the expansion of tourism. Many of the municipalities of the Campo de Cartagena-Mar Menor area are above the regional average in terms of the foreign population. Examples: Los Alcázares (30.14%), Fuente Álamo (26.68%), Torre Pacheco (20.52%), San Javier (19.7%) (National Institute of Statistics).

### 3.1.2 Economic activities

In the Campo de Cartagena-Mar Menor area there are two main economic sectors: agriculture and urban-tourism (in which a special reference can be done to the golf-resort sub-sector). However, other sectors are also present and a special attention is paid to fishing, due to its relevance to the Mar Menor lagoon.

The main land-use in the Mar Menor watershed is agriculture and, more specifically, irrigated lands. Drylands and traditional crops were replaced in the last decades by open-air horticultural crops, citric trees and greenhouses, favored by the Tajo-Segura water transfer. The other main activity is the urban-tourist development, in which housing and the tourist

activities are closely related. These two economic sectors generate the main pressures to the lagoon. Current trends of urban and tourist development, especially through the spread of golf-resorts and associated urbanisations, is the most relevant factor.

### Agriculture

The Campo de Cartagena, one of the main horticultural producers of Europe, is a lowland plain (1440 km<sup>2</sup>), slightly inclined to the Mar Menor, of clayed soils dedicated to intensive agriculture with irrigated horticultural, especially for open-air horticultural crops and greenhouses (principally melon and lettuce) and citrus fruits.

Around the late 70s, water derived from the Tajo-Segura river diversion, generated a profound transformation of the agricultural practises in the Campo de Cartagena, that changed from extensive dry crop farming of cereals, olives, almonds and carob beans to intensively irrigated crops (Tables 4 and 5). At the present, Campo de Cartagena is one of the most productive and profitable agricultural areas in Europe, and the use of water, fertilisers and pesticides has increased dramatically.

*Table : Evolution of agriculture lands (in ha) in the municipalities of the Campo de Cartagena. D: Dryland agriculture; I: Irrigated agriculture*

	2006		2007		2008		2009		2010	
	D	I	D	I	D	I	D	I	D	I
<b>MURCIA Region</b>	<b>377.928</b>	<b>188.695</b>	<b>376.609</b>	<b>188.534</b>	<b>373.015</b>	<b>188.464</b>	<b>367.912</b>	<b>187.289</b>	<b>367.175</b>	<b>187.189</b>
Los Alcázares	22	1.048	22	1.048	22	1.048	198	875	67	793
Cartagena	24.327	11.785	24.327	11.762	23.650	11.262	23.650	11.262	23.650	11.262
Fuente Álamo de Murcia	14.083	3.457	14.083	3.455	14.083	3.447	13.835	3.695	13.935	3.595
San Javier	818	3.826	826	3.826	826	3.819	926	3.719	926	3.719
San Pedro del Pinatar	25	943	25	898	27	861	36	852	22	822
Torre-Pacheco	2.382	13.227	2.382	13.226	2.382	13.219	2.382	13.219	1.728	13.219
La Unión	221	399	221	399	274	322	274	322	274	322
<i>Data of 2009 and 2010 are provisional..</i>										
<i>Source: Consejería de Agricultura y Agua. Dirección General de Industria Agroalimentaria y Capacitación Agraria</i>										

*Table :Surface of crops with drip irrigation (in ha)*

2010							
	TOTAL	Herbaceous	Cítric	Almonds	Vineyards	Olive	Others
<b>MURCIA Región</b>	<b>122.466</b>	<b>39.618</b>	<b>35.552</b>	<b>5.481</b>	<b>12.840</b>	<b>6.673</b>	<b>22.302</b>
Los Alcázares	269	99	165	0	0	4	1
Cartagena	8.584	4.387	3.896	200	4	60	37
Fuente Álamo de Murcia	3.386	1.828	1.115	345	5	30	63
San Javier	2.941	1.584	1.179	1	70	22	85
San Pedro del Pinatar	687	476	193	0	0	2	16
Torre-Pacheco	9.363	6.995	2.057	182	8	67	54
La Unión	276	252	20	1	0	3	0
<i>Provisional data</i>							

*Source: Consejería de Agricultura y Agua. Dirección General de Industria Agroalimentaria y Capacitación Agraria*

Irrigated crops represents three-quarters of farms in Campo de Cartagena, with the drip irrigation method used mostly and mainly surface water source, followed to a lesser extent of groundwater, waste-water treated and desalinated waters. Irrigated agriculture uses a minimum 6000 m<sup>3</sup>/ha/year.

Since 1952, the Community Irrigation Field Cartagena (CRCC) is the agency responsible for managing water for irrigation in the Campo de Cartagena ([www.crccar.org](http://www.crccar.org)). It comprise 41090 has and 9444 users. Water resources of the CRCC, are those from the Tajo-Segura water transfer (122 hm<sup>3</sup>), Segura basin (4.2 hm<sup>3</sup>), WWTPs (13.2 hm<sup>3</sup>) and desalination plant of Mojón (2.2 hm<sup>3</sup>), whose drain water comes from the Irrigation Area, preventing pollution of the Mar Menor. Total water resources are 141.6 hm<sup>3</sup>, although the real needs are between 180 and 200 Hm<sup>3</sup>, being the situation of a permanent deficit of water resources, because the great irregularity of the supplies of the Tajo-Segura water transfers. A main channel “The Canal Cartagena Field” of 64 km long, with a capacity of 300,000 m<sup>3</sup> and a maximum flow of 25 m<sup>3</sup>/s transports and distributes the resources stored in the reservoir of La Pedrera until each irrigation sector (Figures 15 and 16).

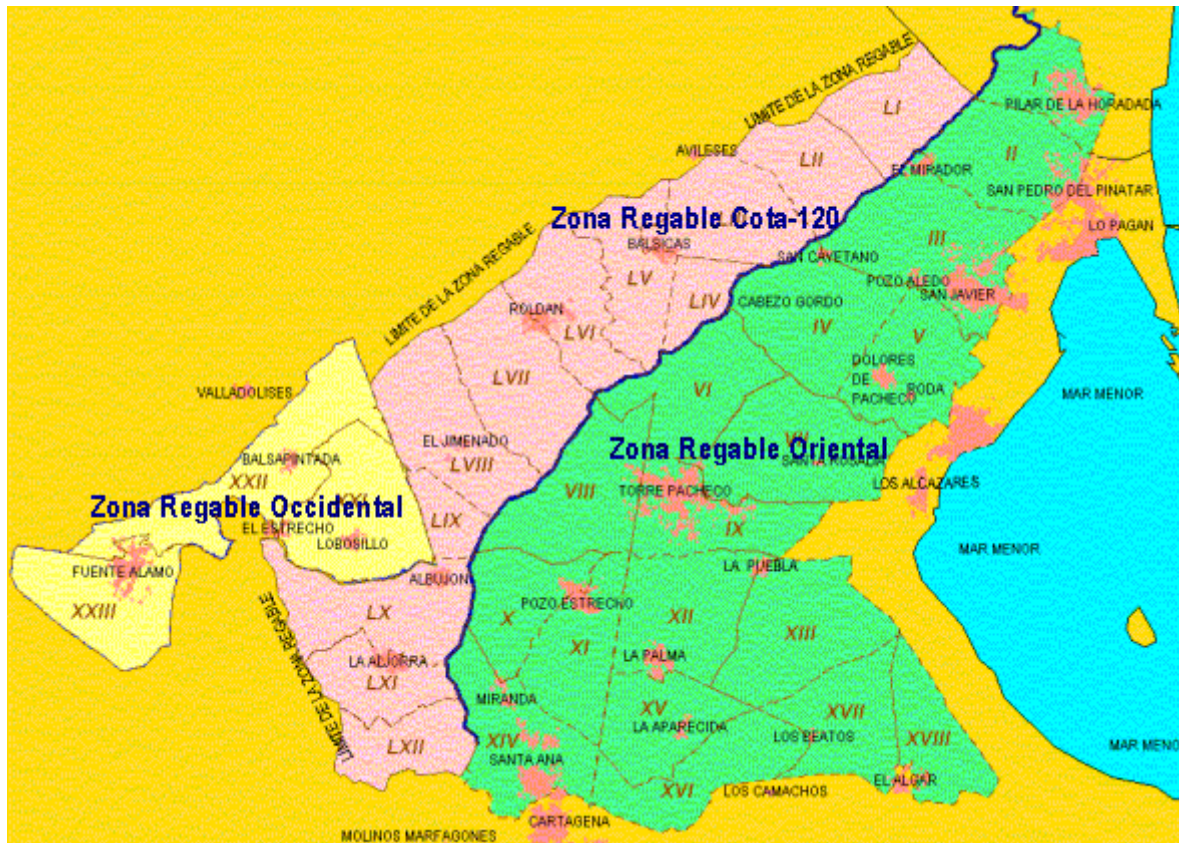


Figure 15. Map of irrigation area from the Campo de Cartagena. Source: [www.crccar.org](http://www.crccar.org)

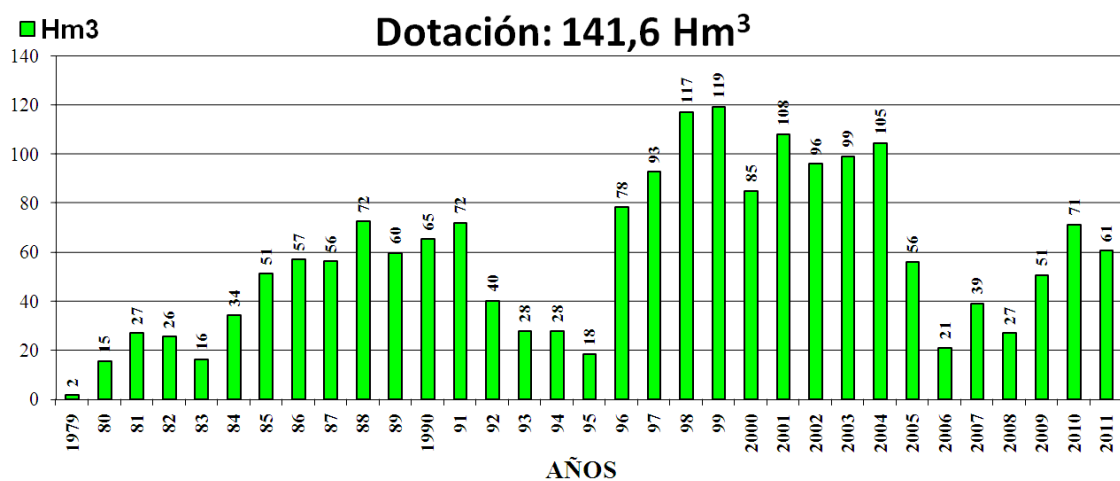


Figure 16. Water annual volumes distributed for irrigation by the CRCC. Source: [www.crccar.org](http://www.crccar.org)  
(2011 data are until August).



## Livestock

Worth mentioning the great importance of pig farming in the study area, like as in the Murcia region (Table 6).

Table: Number of livestock units per species

	2009						
	BOVINE	OVINE	CAPRINE	PORCINE	EQUINE	POULTRY	MOTHER RABBITS
<b>MURCIA Región</b>	<b>37.159</b>	<b>48.264</b>	<b>15.072</b>	<b>412.432</b>	<b>2.192</b>	<b>41.511</b>	<b>419</b>
Cartagena	4.522	4.442	720	21.221	257	1.909	19
Fuente Álamo de Murcia	236	6.334	502	89.233	70	5.934	90
San Javier	3	1.274	19	66	32	0	
San Pedro del Pinatar	3	74	3		10	0	
Torre-Pacheco	1.538	5.589	43	2.705	124	3.062	12
Unión (La)	354	131	1		7	326	

Source: INE. Censo Agrario

## Fishing and port facilities

Fishing is another economic activity of importance in the Mar Menor characterised by the quality and quantity of captures mainly Sparidae and Mugilidae species (Figure 17). Most of the fishing activity was developed in ‘Las encañizadas’ in the northern side of La Manga.





Figure 17. Traditional fishing boats in the Mar Menor coastal lagoon.

Due to the widening and dredging of the channel "El Estacio" connecting the Mediterranean Sea and Mar Menor in the early 70s, during the eighties, new fish species coming from the Mediterranean. While catches between 1951 and 1962 were the typical of the lagoon, during the period 1962-1972 the dominant species became *Atherina* sp. Actually, the principal fish catches are: *Anguilla anguilla*, *Mugil* sp, *Sparus aurata*, *Lithognatus mormyrus*, *Engraulis encrasicolus*, *Atherina* sp. and *Mullus barbatus*.

Highlighting the fishing gear as the principal fishing type and the lack of importance has shellfishing. There is a downward trend in the fishing fleet and catches (Tables 7, 8 and 9) and an increasing trend to recovery of traditional arts and unique to the area "las encañizadas". It consists of the construction of fences with reeds in the gullets or inlets that connects the Mediterranean with the Mar Menor coastal lagoon. These fences or walls lead to enclosed areas where fish are collected by fishermen (Figure 18).



Figure 18. Traditional fishing arts in ‘Las encañizadas’, located in the inlets connecting the Mar Menor with the adjacent Mediterranean Sea.

Table: Evolution of catch landed (kg) in the main ports of the study area

	2008	2009	2010
<b>Cartagena</b>	<b>665.786,19</b>	<b>758.456,09</b>	<b>858.253,98</b>
Fish	560.362,54	670.761,74	766.660,63
Crustaceans	38.312,40	33.326,15	40.998,00
Molluscs	67.111,25	54.368,20	50.595,35
<b>San Pedro del Pinatar</b>	<b>464.579,26</b>	<b>499.645,12</b>	<b>453.322,82</b>
Fish	451.270,23	484.431,17	441.691,17
Crustaceans	7.477,55	8.987,65	8.121,25
Molluscs	5.831,48	6.226,30	3.510,40

Source: *Consejería de Agricultura y Agua. Dirección General de Ganadería y Pesca*

Table: Evolution of the number of fishing boats for fishing types

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<b>Cartagena</b>	<b>65</b>	<b>64</b>	<b>61</b>	<b>65</b>	<b>62</b>	<b>65</b>	<b>67</b>	<b>63</b>	<b>61</b>	<b>56</b>
Trawling	11	11	10	11	11	10	10	11	10	8
Fishing gear	42	41	40	43	40	44	46	44	42	39
Seining	5	6	6	6	6	6	6	4	4	3
Longline	6	6	5	5	5	5	5	4	5	6
<b>San Pedro del Pinatar</b>	<b>105</b>	<b>106</b>	<b>106</b>	<b>103</b>	<b>103</b>	<b>101</b>	<b>98</b>	<b>73</b>	<b>73</b>	<b>71</b>
Trawling	1	1	1	1	1	1	1	1	1	1
Fishing gear	96	97	97	94	94	93	92	68	68	66
Seining	7	7	7	7	7	6	4	3	3	3
Longline	1	1	1	1	1	1	1	1	1	1

Source: *Consejería de Agricultura y Agua. Dirección General de Ganadería y Pesca*

Table : Evolution of catches by fishing types

	2008	2009	2010
<b>Cartagena</b>	<b>665.786,19</b>	<b>758.456,09</b>	<b>858.253,98</b>
Trawling	324.374,55	300.916,20	307.937,35
Fishing gear	131.172,97	228.830,40	329.173,92
Seining	38.433,00	51.458,09	47.803,24
Longline	171.805,67	177.251,40	173.339,47
<b>San Pedro del Pinatar</b>	<b>464.579,26</b>	<b>499.645,12</b>	<b>453.322,82</b>
Trawling	537,35	723,25	155,40
Fishing gear	255.725,53	259.722,06	246.503,71
Seining	203.307,61	236.449,51	202.406,71
Longline	5.008,77	2.750,30	4.257,00

Source: *Consejería de Agricultura y Agua. Dirección General de Ganadería y Pesca*

Due to its high biological productivity and the high economical value of its products the Mar Menor lagoon has been always an attractive location for aquaculture. However, most attempts to develop aquaculture in the lagoon only reached an experimental phase. There is not aquaculture within the lagoon, although there are some facilities in neighboring marine areas, located offshore (primarily intended for fattening seabass, seabream and tuna).

### *Salt-production*

Salt mining has been traditionally the main economic activity on the marginal salt marshes associated to the lagoon, although most mines have been currently abandoned and refilled for other uses. Nowadays, salt mines are considered as a landscape resource of enormous relevance for the conservation of many species including aquatic birds that use these areas for the nest building, migration and wintering.

Mining activities in the metal-rich southern edge of the lagoon, in Sierra de Cartagena-Portman, have been carried out for centuries in the search for lead, zinc and iron. Mining in

the area started 2,500 years ago reaching a maximum during the XIX-XX centuries, originating huge amounts of mining wastes that were transported into the lagoon through the southern wadis of El Beal, Ponce and Carrasquilla.

#### *Urban and Tourism and recreational activities*

The urban growth in Murcia is among the most intensive in Spain, which in turn is the most intensive in Europe (Fernández Durán, 2006). This situation has been promoted by the Soil Law adopted by the regional government in April 2001, that declares urbanized soil everything that is not strictly protected. In 2004, the regional government approved Management Guidelines of Littoral that declares developable 85,000 ha in the littoral (capable of housing 1.1 million of new houses). In the Campo de Cartagena, large areas of irrigated production and traditional crops have been reclassified to urban use, like as in other Mediterranean areas. Since 2003, the golf-resort model for residential use is quickly spreading over the Mar Menor watershed. There are around 16 golf-resorts, each one of them including between 800 and 2,000 new houses (Martinez et al. 2007). This urban model of second individual residence of low density is the biggest consumer of water ( $\approx 400$  liters per person and day).

The distinctive environment of the lagoon has long been attractive for visitors, with the first tourist settlements dating from the first half of the 19<sup>th</sup> century. However, a surge in tourist activities has taken place in the area since the early 1970s, characterised by intense urban development along the lagoon perimeter to accommodate the growing seasonal population. The marked seasonality of tourism in the area (July to September) is evident when comparing the numbers of the permanent local population of about 45,000 inhabitants to the tourist population that reaches about 450,000 during summer months.

Natural landscape, as well as traditional uses and structures in the area, constitute one of the most interesting resources in the Mar Menor. Many artists have found a source for inspiration in the Mar Menor lagoon. However, the aesthetical values of the lagoon have been mostly used as a reclaim for tourists and other consumerist uses.

### 3.1.3 Wastewater treatment plant infrastructures

During the last decades, the principal urban point source of pollution to the Mar Menor was the effluent of Los Alcázares wastewater treatment plant, which insufficiently treats sewage from a population over 100,000 habitants in summer. Urban wastewater discharges into a channel that go to the Albuñón rambla 2km upstream of its mouth in the Mar Menor.

Regional Law 3/2000 of Sanitation and wastewater treatment in the Region of Murcia creates the Regional Entity Sanitation (ESAMUR), which handles the treatment plants in the region.

In the last years, within the Integrate Sanitation Plan of the Mar Menor area, with the goal of "zero discharge" of wastewater to the lagoon, the construction of the new treatment plants Los Alcazares and San Javier, with tertiary treatment, will treat up to 30,000 m<sup>3</sup> per day, equivalent to 160,000 people, have improved effluents quality. The Sanitation Plan also planned the construction of a perimeter Mar Menor Collector that can catch any spillage flow circumstantial treated or not, and direct them to the emissary of the Mar Menor South, already built, that pour to Mediterranean Sea, to prevent flooding and hauling materials to the Mar Menor in case of torrential storms.

With the continuous incorporation of new facilities, and improvements in existing plants, has achieved a sustained improvement in water quality (Figure 19)

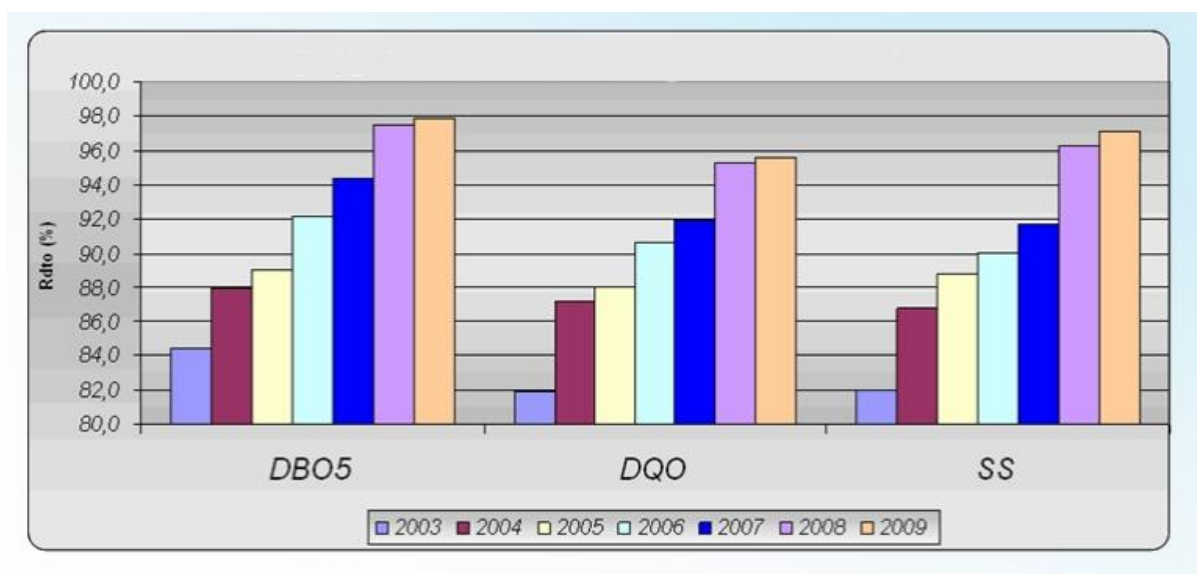


Figure 19. Evolution of water quality of effluents of wastewater treatment plants in the Murcia Region. Source: [www.esamur.com](http://www.esamur.com)

### 3.1.4 Main water management problems

New urban developments and golf resorts are in open competition with the irrigated agriculture by water resources. (Alarcón et al. 2003)

In September 2004, the Ministry of Environment presented the AGUA Programme (Actions for the Management and Water Uses) as an alternative to the Ebro River water transfer included in the National Hydrological Plan and repealed in June of the same year. The AGUA Programme will improve the management and reuse of water, principally through the construction of marine water desalinization plants in the Mediterranean littoral that will increase the supply of water obtained from a sustainable manner, ensuring the availability of water demands independent of climatic conditions.

Table 10: New water resources (in Hm<sup>3</sup>) from desalinization plants and wastewater treatment plants (Programa Agua) in the Segura basin, including the study area. Source: <http://www.chsegura.es/chs/cuenca/actuaciones/satisfacciondeficit/>

DESALINIZATION	Irrigation use	Urban use	TOTAL
Valdelentisco Plant	37	20	57
Torrevieja	60	20	80
El Mojón	4	0	4
San Pedro Pinatar II	0	24	24
REUSE TREATED WASTEWATER	Irrigation use	Urban use	TOTAL
Mar Menor North	10	0	10
Mar Menor South	10	0	10

### 3.1.5 The history of managing

#### *European Directives*

Under the European Directives 91/271/EEC and 91/676/EEC concerning urban waste water treatment and the protection of waters against pollution caused by nitrates from agricultural sources, respectively, the Mar Menor lagoon was declared a *sensitive area* subject to eutrophication in June 2001, and the Campo de Cartagena was declared a *vulnerable zone* in December 2001.



Under the European Directive 91/676/EEC, the Mar Menor coastal area was designated as Zone Vulnerable to Pollution by Nitrates from Agricultural Sources, by the Order of the Ministry of Agriculture, Water and Environment of 20 December 2001 (BORM n. ° 301, of December 31, 2001). Later, the Order of the Ministry of Agriculture, Water and Environment of 12 December 2003 (BORM n. ° 301, of December 31, 2003) approved the Action Plan for the mentioned Vulnerable Zone, according to the provisions of Article 6 of Royal Decree 261/1996. In 2003 (BORM n. ° 301 of December 31, 2003); and 2009 (BORM nº 57 of Mars 10, 2009) the corresponding four-year Action Plans for this vulnerable zone were approved. The Plan establishes the necessary actions to reduce pollution by nitrates from agricultural sources into these aquifers, permitting values of nitrate below a critical limit of 50 mg/l. Among these actions are:

- Monitoring programs for the quality of water used for irrigation.
- Disclosure of the “Code of Good Agricultural Practice for the Region of Murcia”, approved by the Order of March 1, 1998, of the Department of Environment, Agriculture and Water (B.O.R.M. 85, April 15, 1998), and forced compliance in vulnerable areas.
- Dissemination of indicative plans for irrigation and fertilization on a monthly basis for the different cultures and procedures to adapt to changing meteorological conditions.
- Courses for younger farmers and ranchers.
- Establishment of a Monitoring Commission.
- Established measures for the use of different types of nitrogen fertilizers and the maximum limits of total nitrogen for each species and irrigation system. For example, in the context of the vulnerable zone it is prohibited to apply an amount of organic fertilizer with a nitrogen content exceeding the 170 kg per hectare per year to the soil.
- The owners of intensive livestock farms in the area must have a management and production plan of manure.

### *Sustainable Development Plans*

Since the 80's, different plans and initiatives by national and regional administrations have been implemented, but so far have not solved the major environmental problems of the lagoon.

A first initiative (1982) to reconcile the socio-economic development of the area with the preservation of the natural values of the lagoon consisted in the study "Managing the territorial area of the Mar Menor and its environment ", which is, in fact, a first proposal of guidelines for achieving sustainable development in the area (Center for Studies and Environmental Management, the former Ministry of Construction and Urban Development).

The Regional Law 3/1987 "Protection and harmonized uses of the Mar Menor" initiated a dynamic process that aims to achieve a proper management of the Mar Menor area. To achieve its purpose, the Act uses four planning tools: The Regional Planning Guidelines Area of Mar Menor, The Sanitation Plan for the Mar Menor, the Protection and harmonized uses of the Mar Menor, and The Management Plan and Coastal Protection of Mar Menor.

Within the Strategic Development Plan of the Region of Murcia 2000-2006, The Sanitation Plan for the Mar Menor and the South Coast and the Integrated management of Coastal Lagoon Area Mar Menor are listed as strategic lines.

In July 2002, the Spanish authorities proposed a Coastal Area Management Program in the Mar Menor to the Spanish Mediterranean Action Program - United Nations Environment Programme (UNEP-MAP). In 2003, a project feasibility study, that was conducted in conjunction with the Autonomous Community of Murcia, was approved and in the same year, the Programme Secretariat Mediterranean Action invited Spain to carry out the project.

In September 2006, the Spanish Environmental Ministry started the project "Special Management Plan of public water, coastal and natural heritage of Campo del Mar Menor" (hereinafter, the Mar Menor PEC). It aims to contribute to the achievement of a sustainable development model, improving compatibility of human activities with the conservation of natural heritage.

The Plan is based on three main chapters:

- Integration of available information, analysis and research and development of an integrated assessment for the area.
- Information and public participation through the creation of the International Commission and Public Participation Committee Campo del Mar Menor.
- Proposed actions, implementation and monitoring and evaluation of its effectiveness.



The existence of significant pressures from human activities: urban development, fishing, intensive agriculture, etc., in an extremely fragile area of clear ecological value justifies the need for this project. These pressures and the search for solutions to reduce their impacts need to be addressed from a global perspective that integrates different sector policies at different administrative levels.

### **3.2 Institutions, laws, rights and conflicts**

The initial part of this section will consider: (i) the relevance and applicability of international conventions; (ii) the relevance and applicability of EU law, including but not restricted to the Water Framework Directive (WFD) and Marine Strategy Directive (MSD); (iii) insofar as feasible, the national and local regulatory structures and provisions. Later sections then present: (iv) findings of the preliminary stakeholder and social group mapping, an exercise conducted in order to aid the identification of the respective key stakeholder groups (e.g. fisheries groups, community based organisations, farmer associations, industry representatives, conservation groups) and any conflicts or tensions; (v) the tabulation of relevant institutions, stakeholders and entities identified so far. The information presented was collected via: (a) a desk top literature study; and (b) by the input of information and feedback from the CSA partner regarding the stakeholder list/tables generated; (c) feedback reports based on a number of focus group meetings held in the locality.

#### **3.2.1 The relevance and applicability of international law – the Regional Seas Conventions**

For the Mar Menor lagoon situated on the Mediterranean coast of Spain, The Barcelona Convention (Barcelona 1995) is applicable. Given that Spain is a member of the EU, the provisions in both the Water Framework Directive (WFD, EC 2000) and the Marine Strategy Directive (EU 2007, MSD) are of significant relevance to this CSA. The relevant international legal architecture is tied into both of these Directives although the international dimension is more important to the MSD.

The Mar Menor is in South Eastern Spain, and the Barcelona Convention (Barcelona 1995) would be potentially relevant. The 1995 revisions, which entered into force in 2004, specifically extended the title of the Convention from “...for the Protection of the Mediterranean Sea” to “...for the Protection of the Marine Environment and the Coastal Region of the Mediterranean”. The Preamble notes the Rio Conference, the UN Convention on the Law of the Sea, and the Mediterranean Action Plan amongst other relevant policy instruments. In terms of geographical scope, the Convention applies to the “maritime waters of the Mediterranean Sea proper” and may be extended to coastal areas as defined by each contracting party for their own territory. Thus as with the Helsinki Convention the Convention is potentially relevant to the Mar Menor; and as with all these instruments it applies to land-based activities; therefore its key provisions will be noted. The definition of pollution (Art.2) specifically includes pollution of estuaries.

Art.4 sets out general obligations, which include requirements to “prevent, abate, combat and to the fullest possible extent eliminate pollution” and to “protect and enhance the marine environment so as to contribute towards its sustainable development”. There is a specific requirement to implement the Mediterranean Action Plan with further reference to sustainable development principles. Other principles identified include the polluter pays, precautionary principle, the use of environmental assessment, cooperation on environmental assessment, and promoting integrated coastal zone management. There is a requirement for programmes and measures and the use of best available techniques and best environmental practices. The Barcelona Convention applies to dumping (Art.5) and incineration (Art.6) and pollution from land based sources (art.8), as well as that from exploitation of the seabed (Art.7). There is a duty to cooperate in emergencies (Art.9) and specific provision for biodiversity (Art.10) and for hazardous wastes (Art.11). There is a duty to provide access to information, much less well specified than in OSPAR, but Art.15 also provides a specific requirement regarding public participation in decision-making. There is general undertaking to cooperate regarding formulation of rules and procedures for liability. UNEP carries out the functions of the secretariat. The Barcelona Convention has the largest membership of the regional seas agreements considered here (see <http://www.unep.org/regionalseas/programmes/unpro/mediterranean/countries.asp>) including western and eastern European and north African states.

### **3.2.2 The relevance and applicability of international law – the Ramsar Convention and the Convention on Biological Diversity**

The Ramsar Convention (Ramsar 1971 [http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on/main/ramsar/1-31-38%5E20671\\_4000\\_0](http://www.ramsar.org/cda/en/ramsar-documents-texts-convention-on/main/ramsar/1-31-38%5E20671_4000_0) revised 1982) applies to wetlands, in order to protect (primarily) migrating birds. It protects designated wetlands (Ramsar sites, designated by the relevant state party) but also promotes the “wise use” of other wetlands by that state. The Mar Menor has been designated as a Ramsar site (No.706) since 1994.

The period from 2011 to 2020 is the UN Decade for Biodiversity, and the 10th Conference of the Parties established a Strategic Plan for Biodiversity 2011-2020 And The Aichi Biodiversity Targets "Living In Harmony With Nature" (<http://www.cbd.int/decision/cop/?id=12268>). In particular there is a target of 10% of coastal and marine areas to be protected sites by 2020 (target 11), and protection mandated for fish, invertebrates and aquatic plants (target 6), using ecosystem approaches. All regional and national activities in support of biodiversity in member countries should come within the general aims of the CBD. [Spain – Strat is in Spanish, Action Plan in English; (2 parts); but when opened it is called strat and undated... <http://www.cbd.int/countries/profile.shtml?country=es#thematic> Pt.2 has regional / sectoral. Pt1 has useful list of domestic and internat legal instruments. ]

### **3.2.3 EU Water law and policy: Water Framework Directive, Marine Strategy Directive, Other Relevant Directives**

#### *The EU WFD and Related Instruments*

The EU Water Framework Directive (2000/60/EC, WFD) establishes a framework for protection of inland surface waters, groundwater, transitional waters and coastal waters as defined (Art.2).

Several efforts have been made in order to implement the commitments established in the WFD, including the creation of a network of surveillance and quality control of coastal waters.

The Habitats Directive is one of the pillars of the Natura 2000 network of protected areas and Annex 1 of the Habitat Directive indicates coastal lagoons as a priority habitat type. Therefore lagoons like Mar Menor should be N2000 sites.

### **3.2.4 Institutions, stakeholders and social groups**

Since the early 1970s, tourist development in Mar Menor has increased the demand for recreational facilities, resulting in the creation of new beaches, harbours, and channels. Other commercial activities such as mining, urban development, and changes in agricultural practices have increased the waste input into the lagoon, resulting in environmental changes that have affected the biota and altered the lagoon's configuration (Pérez-Ruzafa et al, 2005). The region's natural landscape is at risk. Urbanisation due to tourism is spreading up from the coastline, whilst from the interior agricultural activity is expanding; yet, further construction sites targeting the tourist market have led to 14000 hectares of protected areas losing their legal protected status and, during the last ten years, the area of fertile agricultural land has decreased by 10 % (Schouten, 2003).

The continuous increase of tourist population particularly during the summer (with increased urban waste water discharge) coupled with a significant increase in the areas of irrigated land have increased the nutrient load to the lagoon, producing significant changes in the ecosystem with, for example, the abnormal proliferation of jellyfish during recent years (Agnetis et al, 2004). The remains of mining activities in the nearby Cartagena-La Union also impact the lagoon. Coastal lowland areas along the Spanish Mediterranean may also be impacted by sea level rise including the Manga del Mar Menor and its highly urbanised areas (Marbà and Duarte, 2010). Loss of communities, traditional uses and cultural values were also included in a similar list compiled by Da Cruz (2003). The most relevant socio-economic and environmental factors in the Mar Menor site, according to Agnetis et al (2004), are shown in Table 11.

Driver	Pressure	State	Impact	Response
Intensification: Increase in total irrigated lands Increase in per hectare input of fertilizers Increase in greenhouses	Water consumption Groundwater exploitation Aquifer salinization Load of fertilizers	Area of irrigated lands Area of greenhouses Piezometric levels Water discharge Content of N and P in water	Hydrological dynamics of the watershed Increased load of nutrients Lagoon eutrophication Summer jellyfish blooms Negative effects on tourist activities Landscape degradation Changes in wetlands associated to the lagoon Changes in biodiversity of wetlands and lagoon	Designation of the watershed as Vulnerable Area to Nitrate pollution Implementation of an Agricultural Good Practices Code Reduction of the area of irrigated lands Re-use of water coming from agricultural drainages
Groundwater desalination for irrigation	Groundwater consumption Generation of salty wastewater with high content of nutrients	Amount of salty wastewater from water desalination plants Content of N and P in salty wastewater	Increased load of nutrients into the lagoon Lagoon eutrophication Summer jellyfish blooms	Restoration of natural wetlands Management of natural saltmarshes to treat salty wastewater
Urban and tourist development: Increase in seasonal population New urban developments	Freshwater consumption Soil sealing New infrastructures Increase in wastewater	Area occupied by urban and tourist infrastructures Amount of wastewater	Loss of natural habitats Occupation and loss of rural habitats Landscape degradation Load of nutrients and pollution Lagoon eutrophication Summer jellyfish blooms Negative effects on tourist activities Changes in lagoon hydrodynamics	Wastewater treatment plans
Climatic change	Changes in rainfall Increased	Runoff Water discharges	Increased load of nutrients Changes in	Restoration of natural wetlands Increase in area

	frequency of big rainfall events		wetlands	occupied by natural vegetation in the watershed
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Table 11 Relevant driving forces and impacts in the Mar Menor site using DPSIR Scheme (from Agnetis et al, 2004, p38).

In addition to the above, Perez and Montoro (2008) list the following general pressures of over-exploitation of the lagoon since the 1960s, which have changed the ecological balance: tourism; building speculation; high levels of construction, particularly in La Manga; an unbearable human pressure in the summer months; creation of artificial beaches, which necessitated the movement of hundreds of thousands of tons of sand; dredging of the weirs that communicate with the Mediterranean; construction of marinas; thousands of boats navigating on its waters; the introduction of new species of fauna and flora through channels dredged for the passage of vessels leading to the disappearance of some native species.

#### *Commission of the Mar Menor*

According to Pérez and Montoro (2008) the former Ministry of Environment established the Commission of the Mar Menor, with the aim of ensuring sustainable development throughout the territory, the lagoon and its environment. This large working group of 50 or more members includes representatives from regional and local public administrations, universities and research centres, businesses, tourism, farming, fishing, residents' associations, international, national and regional environmental associations, the European Union and the Ramsar Secretariat, and other interested parties aimed to find solutions and to agree on commitments for action. "The main objectives of the commission are not only the maintenance of environmental principles and landscape diversity, but also to take into account social and cultural parameters, and to assess environmental and socio-economic development to achieve sustainable development around the Mar Menor lagoon, without undermining the economic capacity of this area" (Pérez, and Montoro, 2008, p33). Since their formation in 2007 the commission's has met twice, but it contributed with 286 actionproposals; among them limiting in the use of boats, recovering wetlands and natural areas, creating an Environmental Monitoring System in real time, creating an interpretation center, prohibiting new marinas, building more waste-water treatment plants and 'cleaning' the ramblas that drain into the lagoon (<http://www.magrama.gob.es/es/costas/temas/el-litoral-zonas-costeras/litoral-costa-costa/murcia/comisionmarmenor.aspx>). Today, the Commission

is inoperant and there is a lack of funds to carry out the proposed actions. (<http://www.theleader.info/article/24285/mar-menor-commission-dies-a-death/>).

### *Tourism*

Tourism in the Mar Menor is intensive and highly seasonal, with the main season running from May to September. The safe shallow bathing area available in the lagoon coupled with numerous outdoor activities such as water sports golf and other land based activities, as well as the largest open-air mud-therapy area in Europe (the best known being Las Charcas de las Salinas in Lo Pagán) attracts both national and international tourists.

In an online article (published on 17/2/12) “Ryanair will bring 2 million tourists to Murcia within 3 years” according to an announcement made by the Regional Minister of Culture and Tourism (<http://www.tumbit.com/news/articles/4626-corvera-will-quadruple-visitor-numbers-to-murcia-minister.html>). The new international airport being built in Corvera within the region of Murcia was expected to be open by July 2012, however, it is now delayed until summer 2013.

### *Mining*

Mining activities in the Cartagena–La Unión Mining District started 2000 years ago. In the La Unión Municipality, which is located in the middle of this mining district, mining of ore deposits containing iron, lead and zinc was the only economic activity for hundreds of years (Conesa et al, 2007). The termination of mining activities in the district during the end of the 20<sup>th</sup> century brought a socio-economic crisis to this district resulting in the highest unemployment rate (over 20%) within the Murcia Region and mass emigration. In the meantime, the neighbouring high tourism area of ‘La Manga del Mar Menor’ stimulated the local economy.

Owners of the mines are interested in transforming the whole area into a mass tourist centre. However, Conesa et al (2007) pointed out that historic and social aspects should also be considered, not just the maximizing of monetary gains, which may result in an over-development of the site and the loss of local identity. Different development options should be considered in order to achieve a more sustainable system.



### *Irrigation and water planning*

Since the 1970s, the amount of irrigated agricultural area has increased within the Autonomous Community of the Region of Murcia, particularly in the agrarian district ‘Comarca del Campo de Cartagena’ (Cornejo and Cano, 2008) . Traditional agricultural methods used in the past did not rely on irrigation for land cultivation and had very little impact on the lagoon regarding nutrients, pesticides and other pollutants (Perez-Ruzafa et al., 2000). „However, since 1979 the Tajo-Segura river diversion has brought water for irrigation to the Campo de Cartagena, and agriculture in the watershed has changed from extensive dry crops to intensively irrigated crops. The groundwater levels increased and some previously temporary watercourses maintain a permanent flow into the lagoon” (Velasco et al, 2006, p38).

The water transfer Tajo-Segura runs from the Region of Castilla La Mancha to Valencia and Murcia and has been severely affected by periods of drought in the River Tajo during the last few years. “This project was started in 1933, the definitive project was done in 1966, and the whole public works were finished in 1979. Castilla La Mancha demands that this transfer has to be finished in 2015” (Marcos Fernández [http://www.havsmiljoinstitutet.se/digitalAssets/1333/1333882\\_spain.pdf](http://www.havsmiljoinstitutet.se/digitalAssets/1333/1333882_spain.pdf)).

The water transfer from the River Ebro to Valencia, Murcia and other Mediterranean Spanish areas was included in the 2001 National Hydraulic Plan (NHP). “Some Autonomous Communities like Catalonia and Aragón complained about this project as they understood that the River Ebro and its waters were theirs. They said that they needed all the River Ebro’s waters for themselves” (Marcos Fernández [http://www.havsmiljoinstitutet.se/digitalAssets/1333/1333882\\_spain.pdf](http://www.havsmiljoinstitutet.se/digitalAssets/1333/1333882_spain.pdf)). The 2001 National Hydraulic Plan was never implemented, following a change of government in 2004 and public opposition. Instead, the new socialist government cancelled the Ebro water transfer, swiftly replacing it with the AGUA programme (2004-2008) which predominantly consisted of the construction of water desalination plants along the Mediterranean coast and public water banks (Lopez-Gunn, 2009; Font and Subirats, 2010 ). While the construction of some desalination plants has gone ahead within the Mediterranean basin during recent years,

construction has eased off due to economic unfeasibility of desalination as an alternative solution (Font & Subirats, 2010). Table 12 outlines water planning in Spain from 1933-2009.

Date	Name	Political regime	Main strategy	Outcome
1933	Plan de Lorenzo Pardo	Second Republic	Water transfer (including Tajo-Segura water transfer and Ebro transfer)	Never implemented due to the break out of the Spanish Civil War
1939-1975		Franco regime	Tajo-Segura water transfer	Started in 1968, completed in 1975. From the planned 600 Mm <sup>3</sup> , an average of 300 Mm <sup>3</sup> has been transferred
1993	1993 National Hydrological Plan	Socialist Government	System of National Water Transfer – 4000 Mm <sup>3</sup> 600,000 ha new irrigation	Never implemented due to delay tactics and eventual rejection
2001	2001 National Hydrological Plan	Conservative Government	Ebro water transfer 420 Mm <sup>3</sup>	Demonstrations for and against depending on the region. Became law but never implemented due to change in government and public opposition
2005	AGUA Programme	Socialist Government	Desalination, reuse, modernisation: 34 desalination plants; reuse in big cities	At present, only 214 Mm <sup>3</sup> are desalinated out of the 600 planned for 2008.

Table 12 Water planning in Spain 1933-2009 (adapted from Lopez-Gunn, 2009, p383)

The Tajo-Segura transfer is a hot political issue in Spain's intensively cultivated south-east. A protest in March 2009 against the proposed end of the transfer in 2015, organised by the Tajo-Segura Transfer Irrigators, gathered more than 500000 demonstrators in Murcia along with the Socialist Party and Popular Party members of Valencia, the Region of Murcia and Andalucía, to reject the decision taken by the community of Castilla-La Mancha ([http://www.euroweeklynews.com/index.php?option=com\\_content&view=article&id=55291:mass-demonstration-to-support-tajo-segura-transfer&catid=41:costa-blanca&Itemid=63](http://www.euroweeklynews.com/index.php?option=com_content&view=article&id=55291:mass-demonstration-to-support-tajo-segura-transfer&catid=41:costa-blanca&Itemid=63)).

Furthermore, the environmental group 'Ecologistas en Acción' claim that between 5000 and 10000 hectares of new illegal irrigations are implemented in Murcia every year and while 192.000 hectares of irrigation are legal, no one has been able to confirm the precise extent of illegal irrigation (Schouten, 2003). In a recent study, Perez et al (2011) revealed the effect on

traditional irrigation systems in NW Murcia by the intrusion of new users, by seriously affecting groundwater levels and changing the structure and robustness of the traditional social-ecological systems (SES), thereby resulting in the emergence of new vulnerabilities.

In October 2011, Global Water Intelligence (GWI) highlighted that NGOs accused Spain of ‘hiding’ a river basin plan: “Spain’s environment ministry has removed a draft of the controversial Tagus river basin management plan from public sight because it reveals the unsustainability of the 600 million m<sup>3</sup> Tagus-Segura water transfer, environmentalists have claimed. The green NGOs said the draft contained data showing that annual transfers to the Segura river basin would have to be nearly halved to maintain a 10m<sup>3</sup>/s (864,000m<sup>3</sup>/d) flow rate in the Tagus. They claimed the ministry has breached EU transparency requirements by removing the document from its website only 48 hours after publication” (<http://www.globalwaterintel.com/news/2011/43/ngos-accuse-spain-hiding-river-basin-plan.html>).

The EU Commission announced in June 2011 that they were referring Spain to the EU Court of Justice for breaching two pieces of EU environmental legislation. The EU Water Framework Directive requires all Member States to publish a management plan for each river district (RBMPs), which should have been fulfilled by 22nd December 2009. Spain was required to produce and adopt a total of 25 RBMPs, but had only adopted and communicated one (the Plan de gestión del Distrito de Cuenca Fluvial de Cataluña). “Despite earlier warnings (see IP/11/91), as the plans have still not been adopted almost a year and a half after the deadline, the Commission has decided to refer Spain to the EU Court of Justice” ([http://www.rivernet.org/prs11\\_01.htm#160611](http://www.rivernet.org/prs11_01.htm#160611)). The “Confederación Hidrográfica del Segura” (CHS) is the institution responsible for water management in the Mar Menor site (AGNETIS et al, 2004).

### *Farming community*

Growing organic fruit and vegetables is a big business in Murcia: 90% of the local production is exported, most of it to Germany, bringing in 55 million euros annually to the local economy. One co-operative, Hortamira, located in the coastal flatlands outside Cartagena, “has 320 producers as members and around a fifth of its production is organic, though much of the rest is produced under the Integrated Production System, using a

minimum of chemical pesticides and herbicides”. The co-operative’s organic brand ‘Pinver’ has an annual turnover of 30 million euros. The warm, dry climate makes the region of Murcia ideal for winter cultivation of broccoli, celery, cabbage, cucumber, lettuce, peas, and citrus fruits like lemon and orange. The annual pepper season alone accounts for up to 3000 tonnes of peppers passing through Hortamira’s factory in San Javier (see: [http://www.foodsfromspain.com/icex/cda/controller/pageSGT/0,9459,35868\\_6865989\\_6908352\\_4504673,00.html](http://www.foodsfromspain.com/icex/cda/controller/pageSGT/0,9459,35868_6865989_6908352_4504673,00.html)).

According to the Managing Director for the Modernisation of Farms and Agricultural Training, Angel García Lidón, the modernisation of agriculture in the Murcia region should take into account other available options, but requires a high quantity and quality of water to do this, since for example, in the Mazarrón, Águilas, Lorca and Cartagena areas they grow tomatoes - a crop highly reliant on water. An alternative could be greenhouse crops of very early protected crops, such as early peach and nectarines, which would be ready in April, or even cherries if a suitable variety is available. (see: <http://www.fruittoday.com/articulos.php?id=1295867374102495&idioma=E>).

### *Fishing*

Recent studies of coastal lagoon fish assemblages in the Mar Menor revealed how important shallow littoral areas are as nursery areas for juvenile fish and providing habitat for adults of smaller species (Oliva-Paterna et al., 2006). The distribution of the lagoon’s benthic macrophytes has altered dramatically since the 1970s due to environmental degradation (Verdiell-Cubedo et al., 2007). While there are a number of probable factors that can contribute to jellyfish blooms, in the Mar Menor lagoon jellyfish numbers boomed after extensive habitat modification, mainly due to eutrophication and construction (Purcell et al, 2007). The lagoon’s natural habitat was altered - seagrasses were replaced by the highly intrusive algae *Caulerpa prolifera* further compounded by the introduction of oysters which provided a substrate for jellyfish polyps, increasing hypoxic conditions and a decline in fish numbers (Pagés, 2001). The traditional system, called las encañizadas, that has been used for most of the 20th century, consisting of a complex labyrinth of canes and sticks that caught the fish as they entered the lagoon from the Mediterranean Sea, has now disappeared.

Important fishing fleets are based at Cartagena, Aquilas, San Pedro del Pinatar and Mazarron. Mar Menor is also the most prominent producer of farmed fish (mainly sea bass and bream) in Spain, producing more than 11000 tonnes worth 55 million Euros in 2010. Within the area, more than 300 people are directly employed in this sector, while approximately 1500 people are indirectly employed, with the coastal areas of San Pedro del Pinatar and El Gorguel being the main fish farming areas. In El Gorguel the SELFDOTT project was launched in January 2008, where wild caught juvenile and mature bluefin tuna, an endangered species, are being reared in floating cages (<http://cordis.europa.eu/documents/documentlibrary/117900771EN6.pdf>). In Mazarron, a large tank has been built on land to try and rear tuna from eggs, which is so far proving difficult ([http://www.simplynetworking.es/calida-5360-126-117-san\\_pedro\\_del\\_pinatar\\_16\\_million\\_euros\\_ploughed.html](http://www.simplynetworking.es/calida-5360-126-117-san_pedro_del_pinatar_16_million_euros_ploughed.html)). Seven new warehouses are under construction in San Pedro del Pinatar to help the region's fish farming industry.

The Spanish ecological association ANSE, recently (Feb 2012) voiced their concern regarding overfishing in the area and its effect on biodiversity and wildlife after they logged twice as many nets in use in comparison to their last survey conducted in 2007. There have also been a number of illegal fishing incidents recently, some involving confrontations with licensed trawlers ([http://www.simplynetworking.es/news-10575-31-anse\\_concerned\\_that\\_over\\_fishing\\_is\\_damaging\\_mar\\_menor.html](http://www.simplynetworking.es/news-10575-31-anse_concerned_that_over_fishing_is_damaging_mar_menor.html)).

### *Nature/Landscape Conservation*

The ecological importance of the Mar Menor lagoon and its associated wetlands has been recognised by its inclusion in a series of protection schemes at international, national and regional levels which include: Ramsar, since 1994; Special Protected Area of Mediterranean Interest (SPAMI), established by the Barcelona Convention in 2001; Site of Community Importance (SCI) to be integrated in the Nature 2000 Network (EU Habitats Directive); Specially Protected Area (SPA) in relation to nest building, migration and hibernation of aquatic birds, protected by European legislation (Birds Directive 79/409/CEE). Under the EU Habitats Directive, the lagoon and wetlands of Mar Menor maintain eighteen habitats of European interest (Martinez et al 2007).

Located within the northern end of Mar Menor, the salt flats of San Pedro del Pinatar form the most important wetlands (Parque Regional de Salinas y Arenales de San Pedro) in the entire region. The area was declared a National Park back in 1985 and an EU Special Protection Area for bird life in 1998. Stretching some six kilometres south from El Mojon, it is an area of marshes, sand dunes, reed-beds and salt lakes of international importance.

The Visitor Centre at this regional park has recently (December, 2011) been included in the Migratory Birds for People (MBP) network, whose objective is to provide information to and increase awareness of the general public regarding the importance of protecting migratory birds and their habitats, including the wetlands within the reserve (<http://wli.wwt.org.uk/2012/06/members/europe/centro-de-visitantes-las-salinas-murcia-spain/>). Other protected natural areas at the regional level in the lagoon include: the Protected Landscape of the Open Space and Islands del Mar Menor; Regional Park Calblanque, rock and Eagle Mount of Cenizas.

A report summarizing the Operational Programme (OP) 'European Regional Development Fund (ERDF) of the Region of Murcia' for 2007-2013 ([http://www.surfnature.eu/fileadmin/SURFNATURE/Publications/MURCIAInforme\\_OP\\_report\\_Eng\\_F.pdf](http://www.surfnature.eu/fileadmin/SURFNATURE/Publications/MURCIAInforme_OP_report_Eng_F.pdf)) prepared by the partner DG for Nature Heritage and Biodiversity of the Region of Murcia highlights the following weaknesses, related mostly to the environment:

- Environment and biodiversity appear very sparsely in the SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis and over the OP.
- There is no real system for monitoring the overall environmental impact of the OP 'a priori' or 'a posteriori'. There is a low degree of exactitude of the location of the activities (no location is given), so we cannot know the actual impact of environmental 'a priori'. The activities have their own measures to reduce / prevent environmental impact following the current legislation, but overall there is no previous impact assessment of the OP.
- Lack of synergies between sectoral policies and environmental policies. The relationship between environment and sustainable development should be strengthened and more clearly reflected in the documents and actions.
- There is not sufficient funding for the protection of the Natura 2000 Network.



- Some categories of ERDF expenditure are not covered by the OP. Some categories that could have a clear impact on the environment and biodiversity have been ruled out:
- The Environmental report and environmental sustainability report are very generic and only come to examine the consistency with EU policies, environmental priorities and environmental national plans. There is no detailed analysis of the effects on the environment of the OP.
- ERDF Environmental indicators are insufficient as they do not reflect real progress in environmental protection and the effects of the ERDF funding on the environment.

Table 13 below provides a list of institutions and stakeholders for the Mar Menor, followed by a section listing other likely stakeholders.

Institution	Type	Presentation	Website
Ministerio de agricultura, alimentación y medio ambiente (included costs)	National government	Priorities is to protect and conserve the elements of the maritime-terrestrial public domain through the application of the Coastal Act, including beaches, coastal dunes and wetlands, as well as the drafting and implementation of studies, projects and works defence.	<a href="http://www.marm.es">www.marm.es</a> changed to <a href="http://www.magrama.es/">http://www.magrama.es/</a> on 20/2/12
Confederation Hydrographical of Segura Basin	Wathersed public entity that is assigned to the Ministry of environment	In charge of development and management of Segura river, control of public water and management of the uses of the water when affects more than one region.	<a href="http://www.chsegura.es">www.chsegura.es</a> (English version available)
Agriculture and Water Department	Regional government	Developing and implementing guidelines of the Governing Council in the following areas: agriculture, livestock, fisheries and water.	<a href="http://www.carm.es/cagric">www.carm.es/cagric</a>
Culture and Tourism Department	Regional government	Responsible for proposing, developing and implementing guidelines of the Governing Council in the following areas: culture, tourism, sports and any other assigned the law.	<a href="http://www.carm.es">www.carm.es</a>
Department in the protection and conservation of nature	Regional government	Competence in the natural network management environmental monitoring and inspection, environmental assessment of plans and projects, as well as those relating to climate change and encouraging environment, etc..	<a href="http://www.carm.es">www.carm.es</a>
Department of Public Works and Planning	Regional government	Responsible for proposing, developing and implementing guidelines of the Governing Council in the following areas: housing, architecture, town planning, roads and transportation, land, ports, coasts and water activities, maps and any others assigned by the legislation	<a href="http://www.carm.es">www.carm.es</a>
Los Alcazares City Council	Local government		<a href="http://www.losalcazares.es">www.losalcazares.es</a> (English version in construction)
San Javier City Council	Local government		<a href="http://www.sanjavier.es">www.sanjavier.es</a>
San Pedro del piñata City Council	Local government		<a href="http://www.sanpedrodelpinatar.es">www.sanpedrodelpinatar.es</a>
Cartagena City Council	Local government		<a href="http://www.cartagena.es">www.cartagena.es</a> (English version available)
Torre Pacheco City Council	Local government		<a href="http://www.torrepackeco.es">www.torrepackeco.es</a>

SEPRONA	Civil Guard, Service for nature protection	Ensure compliance with the provisions that tend to the conservation of nature and environment, water resources, as well as the wealth of species fish, forestry and any other related with nature.	<a href="http://www.guardiacivil.org/qu esomos/organizacion/operacion es/seprona/">http://www.guardiacivil.org/qu esomos/organizacion/operacion es/seprona/</a>
Stakeholders	Type	Description	Website
Commission of the Mar Menor	A working group established by the Ministry of Agriculture, Food and Environment (2007?)	Representatives from government public at different levels (national, regional and local), universities and research centers, business organizations, tourism, farming, fishing, neighborhood associations, environmental organizations (international, national and regional) representatives of the European Union and Ramsar.	Email address: <a href="mailto:comi_mar_menor@mma.es">comi_mar_menor@mma.es</a> Tel: 968 23 45 50
Comunidad de regantes (Irrigation communities)	Public corporations, agencies attached to the basin.	Responsible for organizing the collective exploitation of public waters, surface and groundwater that are common. They bring together farmers manage themselves in order to distribute irrigation water in an efficient, orderly and equitable among its members.	<a href="http://www.crcc.es">www.crcc.es</a>
La Salinas Arenales Regional Park			Website? Contact details? Tel: +34 968 17 81 39
The Southeastern Association of Naturalists (ANSE)	Nonprofit social organization, autonomous and independent	Its goals are the dissemination, study and defence of the natural environment and biodiversity in southeastern Spain	<a href="http://www.asociacionanse.org">www.asociacionanse.org</a> (English version available)
Ecologistas en Acción	Confederation of more than 300 environmental groups distributed by towns and cities.	Forms part of a social ecology, which means that environmental problems are rooted in a model of production and consumption increasingly globalized, which also derive from other social problems, and that we must turn if we want to avoid the ecological crisis.	<a href="http://www.ecologistasenaccion.org">www.ecologistasenaccion.org</a>
Asociación de vecinos de La Manga (La Manga neighborhood)	Local association	Aim is for the good of the community regarding all social aspects, so as to achieve a better quality of life, regardless of political beliefs, religious or socio-economic position	<a href="http://www.asociaciondevecinoslamanga.org">www.asociaciondevecinoslamanga.org</a>

association)		of individuals.	
Hostemur	Hotel industry federation	Brings together members of the hotel industry and associations within the Region of Murcia. Subsectors comprise of all those companies involved in the regional hospitality tourist area.	<a href="http://www.hostemur.es">www.hostemur.es</a>
Hostecar	Business association of hotels and tourist accommodation in Costa Calida	Business organization that gather Spanish hotel industry and hotel associations in Cartagena and its region. The subsectors that comprise it are all those companies involved in the tourism and hospitality field.	<a href="http://www.hostecar.com">www.hostecar.com</a>
La Manga Club		Sports and leisure resort located in La Manga	<a href="http://www.lamangaclub.com">www.lamangaclub.com</a>
Mar Menor-Cabo de Palos, Estación Náutica	Non-profit organization	It makes up of businesses dedicated to accommodation, water sports, restaurants and services.	<a href="http://www.enmarmenor.com">www.enmarmenor.com</a>
Sailing Association Mar Menor (SAMM)	Local Association	Its purpose is to help solve problems experienced in keeping and sailing boats in the Mar Menor and Mediterranean.	<a href="http://sailingmarmenor.com">http://sailingmarmenor.com</a>
Asociación Hippocampus (Seahorses association)	Local association	to the study and conservation of the Mar Menor in general and in particular seahorses as flagship species of the same. Included in the Programme of Action for Environmental Volunteer of the Region of Murcia	<a href="http://www.asociacionhippocampus.com">www.asociacionhippocampus.com</a>
COFRADIA DE PESCADORES DE SAN PEDRO DEL PINATAR	Public corporations, nonprofit	Organs of consultation and collaboration with the Administration, and can also perform the functions assigned to it by public administration to develop on matters of general interest for the extraction in artisanal fisheries.	Doesn't have website
Autoridad Portuaria de Cartagena (APC)	Public bodies	Management of port public property and maritime signals. Planning, project, construction, maintenance and operation of port works and services and maritime signals.	<a href="http://www.apc.es">www.apc.es</a>

Consejo de Agricultura Ecológica de la Región de Murcia (Region of Murcia – Organic Farming Council)	Public authority	The Organic Farming Council of the Region of Murcia (EACRM) is a public authority that started working in the year 2000, as the organism in charge of implementing the control system of Organic Farming in the region. This Council achieved legal status in December 2003, as a Public Law Corporation with economic autonomy and full capacity to work to carry out its functions.	<a href="http://www.caermurcia.com/index.php?idiomapost=ing&amp;m=1_0_0&amp;id=">http://www.caermurcia.com/index.php?idiomapost=ing&amp;m=1_0_0&amp;id=</a>
Club de la tercera edad (Seniors club)	Nonprofit social organization, autonomous and independent		<a href="http://clubpmlamanga.sabanet.es/index.htm">http://clubpmlamanga.sabanet.es/index.htm</a>
<b>Research Centres</b>			
Instituto Español de Oceanografía (IEO)	Public research organization	Dedicated to research in marine science, especially in relation to scientific knowledge of oceans, sustainability of fishery resources and marine environment.	<a href="http://www.ieo.es">www.ieo.es</a>
Instituto Murciano de Investigación y Desarrollo Agrario y Alimentario (IMIDA)	Public research body under the condition of an autonomous	It's priority attention is on the needs of research that requires the agricultural sector in the Region of Murcia.	<a href="http://www.imida.es/paginas/index.html">www.imida.es/paginas/index.html</a>
University of Murcia (UMU)	Public university	Located in Espinardo's Campus. Gather Sciences and human faculties.	<a href="http://www.um.es">www.um.es</a>
University Polytechnic of Cartagena (UPCT)	Public university	Located in Cartagena, gather engineering and technical careers	<a href="http://www.upct.es">www.upct.es</a> (English version available)

Table 4: Institutions and stakeholders for Mar Menor

#### *Other Mar Menor Institutions/Stakeholders*

- Central Association of the Tajo-Segura Transfer Irrigators
- Local farmers/growers – COAG Regional Association of Murcia
- Port of Cartagena – (plans for it to be a large container port – many NGOs opposed).

### **3.3 Knowledge gaps**

A variety of actors and institutions are involved in the use of the Mar Menor resources and its management, a situation that often leads to the appearance of conflicts. The observance and application of regional and national laws and policies in such a complex socioeconomic, institutional and natural environment is often challenging and requires further efforts in order to ensure the rights of the users and the conservation of this particular environment and its biodiversity.

Furthermore, international laws seem to complicate even more the scene. An area of complexity regarding the MSD is its relationship with the Regional Seas Conventions. The MSD is organised around the four regional seas (Mediterranean, NE Atlantic, Black Sea, Baltic) and incorporates the relevant regional mechanisms. Whereas in international law, regional organisations like states give effect to international obligations through supranational or national law, here the EU uses international commitments to give effect to the MSD (Hey 2009). Similarly, the relationship between international law, with EU and Spanish laws, arises in the management of biodiversity, where the Convention on Biological Diversity, (Rio 1992, CBD) and the Ramsar Convention (Ramsar 1971) interact with the provision for Natura2000 sites in EU law where relevant, and any national designations. The regional conventions now also integrate biodiversity concerns (see eg Oslo 1992 Anx IV; Bucharest 2002; HELCOM 2007; Barcelona 1995b) whilst the MSD also establishes Marine Protected Areas. The most recent Convention of the Parties to the CBD established that by 2020, 10% of marine and coastal waters should be established as protected areas.

The tensions between competing uses of the water environment (fresh, coastal and marine) in the Mar Menor and especially the needs of the ecosystem and the needs of human users, with



differing timescales and perspectives, and subsequent rich complexity of overlapping legal frameworks requires investigation.

In summary, the Mar Menor is managed within a complex legislative and policy context, with a wide variety of institutions and actors involved in the use and management of the lagoon. It is therefore necessary to develop a framework of common objectives and management guidelines in order to promote a more sustainable development in the area and protect its natural resources and biodiversity, especially facing the expected consequences of future global climate change.

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