SMARTLAGOON

DELIVERABLE 4.1

Technical brief on the environmental, economic, social and legislative conditions and constraints of the Mar Menor region and thematic maps to be used in task 3.2

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SMARTLAGOON

Innovative modelling approaches for predicting Socio-environmental evolution in highly anthropized Coastal LAGOONs

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Abstract

This report provides a review of the current legislation related to water use and water quality in the Mar Menor basin in Spain, encompassing a specific analysis of local and regional strategies as well as an overview of historical socio-environmental statistical data, going back the last decade.

The analysis provides background information about the environmental, economic, social, and legislative conditions influencing the current socio-environmental dynamics in the Mar Menor catchment.

This report is meant also to feed into other deliverables of SMARTLAGOON, specifically the socio-environmental modelling of WP4. This content serves as a preparatory work for the development of the system dynamics conceptual model and the group modelling workshops with key stakeholders in task 4.2.

The report has an analysis of the current socio-environmental situation of the Mar Menor; the current legislation analysis and a compilation of thematic maps (both existing and self-produced cartography to be used within the project).

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Introduction

Purpose of the deliverable

The aim of this deliverable is to provide a technical overview on the main environmental, economic, social, legislative conditions and limitations related to the environmental and socio-economic conditions of the Mar Menor lagoon in Spain, as well as to set out the cartographic information to be developed and used during the SMARTLAGOON implementation.

To be able to identify and define in detail these multiple dimensions, this report includes an initial analysis of the current state of the Mar Menor lagoon and the relationships that exist between the various dimensions. It summarises the regulatory framework and the main regional planning strategies, emphasising those that generate a change in use and activities, which in turn determine the environmental quality of the water.

The report also puts forward a description of the main cartographic products (already available or created for the project during its first-year time lapse).

Structure

The deliverable contains four parts:

- An introduction that includes an overview of the regulations accompanied by a brief explanation, ranging from the international to the local level.
- A diagnostic analysis of the current situation of the Mar Menor.
- An in- depth analysis of the most relevant regulations influencing water quality.
- A section including relevant cartography (thematic maps).

List of regulations

This report encompasses the results of the total or partial review of the following documents, all of them related to the legislative framework, planning strategies and projects developed in the context of the conservation of the environmental status of the Mar Menor as well as the sectoral policies that can generate an impact on the Mar Menor lagoon and its surroundings.

The most significant documents of the following list are analysed in depth in the upcoming sections.

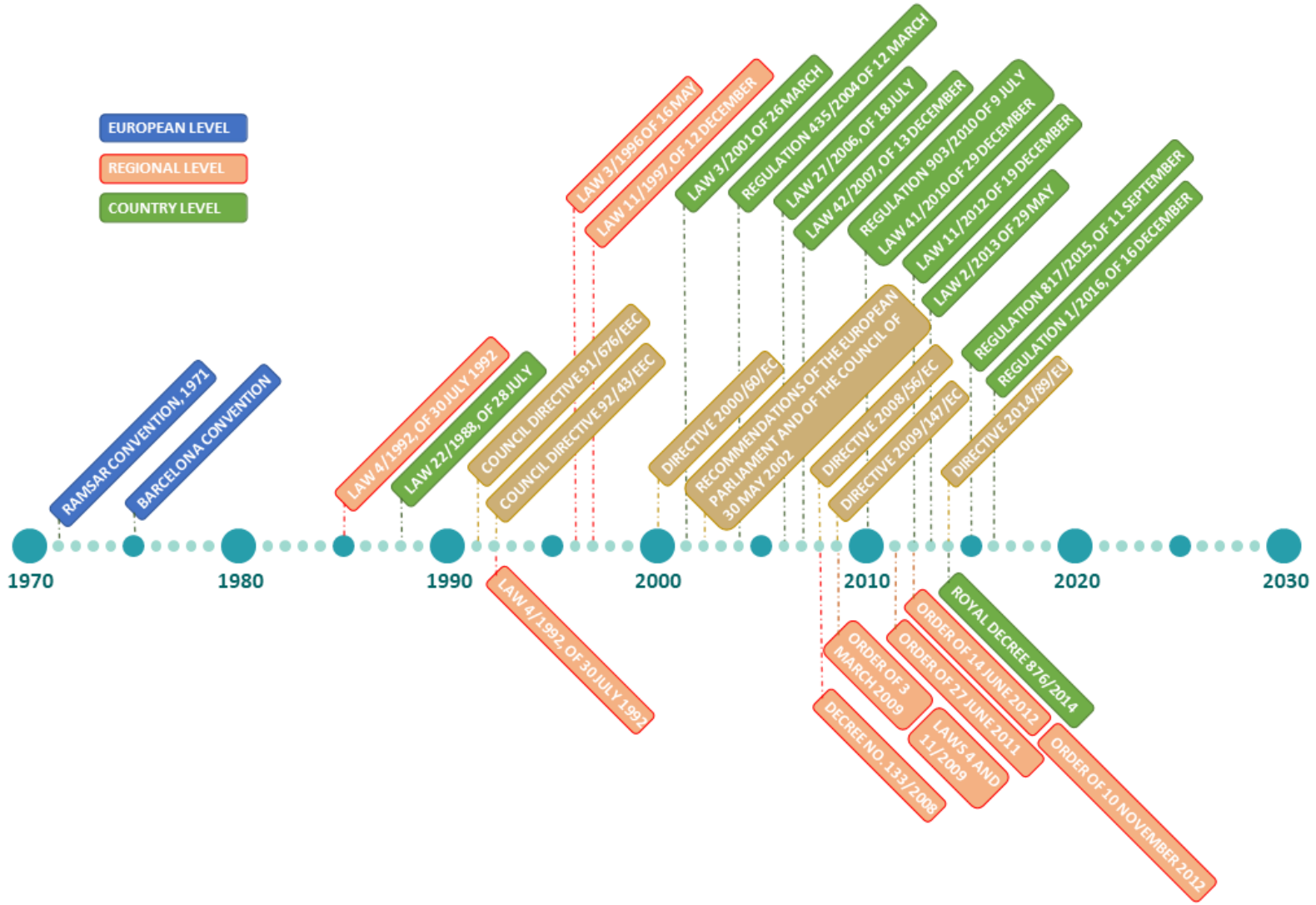

Figure 1. Timeline of the main regulations related to the Mar Menor at international, European, state, and regional level. Source: Authors.

INTERNATIONAL POLICIES

Convention on Wetlands of International Importance (Ramsar Convention, 1971). The Mar Menor is one of the 76 sites in Spain that have been included in the Ramsar Convention. The date of inclusion was 4th October 1994. The implications of the convention are regulated by the: Instrument of 18 March 1982 of Spain's membership to the Convention, especially for water birds, held at Ramsar on 2 February 1971.[1] The inclusion of the Mar Menor lagoon to the Ramsar Convention implies, among other things, that the management plans must be formulated and implemented to promote and prioritize its conservation.

Convention for the protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention). The general duties imposed by the Convention are:

- To take appropriate measures, individually or jointly, to prevent, reduce, address and, as far as possible, eliminate pollution in the Mediterranean Sea area and to protect and enhance the marine environment and to contribute to its sustainable development.
- To protect the environment and to contribute to the sustainable development of the Mediterranean Sea area.
- To implement the Convention's protocols, procedures, and standards.
- To promote, within the competent international bodies, measures concerning the implementation of programmes for sustainable development, protection, conservation and restoration of the environment and natural resources in the Mediterranean Sea area.

The Mar Menor lagoon is affected by the Protocol concerning Integrated Coastal Zone Management in the Mediterranean (Almeria, 2008) (ICZM Protocol), adopted in 2008, in force since 2011, ratified by Spain in 2010.

EUROPEAN POLICIES

Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. This Directive implies several duties for the Member States to comply with in relation to the nitrate pollution from agricultural sources:

- Identification of waters affected by nitrate pollution from agricultural sources, or likely to be affected in the absence of measures or action programmes.
- Designation of vulnerable zones.
- Establishment of action programmes and monitoring of their effectiveness.
- Drawing up a monitoring programme and report every four years.
- Development of a code of good agricultural practices.
- Provision of training and information to farmers, where appropriate.

Many of the recommendations and commitments established by this Directive will be detailed by legislation passed at state and regional level, and even specific regulations to the Mar Menor. An example is the application of the good practices code of the Region of Murcia, according to Law

[1] *Instrumento de 18 de marzo de 1982 de adhesión de España al Convenio relativo a Humedales de importancia internacional, especialmente como hábitat de aves acuáticas, hecho en Ramsar el 2 de febrero de 1971.*

1/2018 of 7 February. There are also references to the Directive in the Law 3/2020 for the protection of the Mar Menor lagoon.

Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. It established the need to carry out a National Inventory on the types of Habitats included in the Annex I of the Directive and implied the establishment of the different Sites of Community Importance (SCI) and Special Areas of Conservation (SAC) belonging to the Natura 2000 network in the area surrounding the Mar Menor.
In the catchment area of the Mar Menor, we can find these SCIs and SACs:

FIGURA	SITE CODE	SITE NAME	Surface area (ha)
SCIs	ES6200044	Sierra de los Victorias	208.81
	ES6200040	Cabezos del Pericón	493.95
	ES6200002	Carrascoy y El Valle	11,833.25
	ES6200048	Valles submarinos del escarpe de Mazarrón	154,081.66
	ES6200015	La Muela y Cabo Tiñoso	78,860,903.24
	ES6200001	Calblanque. Monte de las Cenizas y Peña del Águila	28,506,834.24
	ES5212012	Sierra de escalona y dehesa de campoamor	4,781.91
	ES5213033	Cap roig	4,686.50
SACs	ES0000175	Salinas y Arenales de San Pedro del Pinatar	82,89229.64
	ES6200013	Cabezo gordo	22,94559.80
	ES6200029	Franja litoral sumergida de la Región de Murcia	13,6828,571.03
	ES6200030	Mar menor	135,825,722.69
	ES6200006	Espacios Abiertos e Islas del Mar Menor	12,476,960.41

Table 1. List of SCIs and SACs in the Mar Menor catchment area. Source: Authors based on layer published by the Natural Environment General Directorate (CARM).

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. A Community framework for action in the field of water policy was established and came into force on 22 December 2000. Annex V as amended by Directive 2014/101/EU.

The transposition of Directive 2000/60/EC in Spain was done by Law 62/2003, of 30 December, on fiscal, administrative and social measures, which includes, in Article 129, the amendment of the revised text of the Water Law, approved by Regulation 1/2001, of 20 July, which transposes Directive 2000/60/EC into Spanish law, establishing a Community framework for action in the field of water policy, which also includes control measures based on the criteria of other Community standards such as Directive 91/676/EEC, which establishes concentrations of 50 mg/L of nitrate as a key and reference criterion for identifying waters affected by pollution.

Recommendations of the European Parliament and of the Council of 30 May 2002 concerning the implementation of Integrated Coastal Zone Management in Europe. This document, published in the Official Journal of the European Communities, states that *"each Member State concerned, in partnership with the regional authorities and inter-regional organisations, as appropriate, should develop a national strategy or, where appropriate, several strategies, to implement the principles for integrated management of the coastal zone."* In this sense, Spain has adopted the strategy for integrated management of coastal areas in the Mar Menor lagoon and its environment.

Directive 2008/56/EC of 17 June 2008 on Marine Strategy. Promotes, inter alia, a thematic strategy for the marine environment. It requires Member States to take the necessary measures to achieve or maintain a good environmental status of the marine environment by 2020 at the latest. To this end, each Member State must draw up a marine strategy for each marine region or sub-region (or a smaller subdivision that each state may determine).

Spain's five marine demarcations are established within the framework of this Directive. In the context of the Mar Menor, the Marine Strategy for the Levantine-Balearic demarcation applies.

Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds. The special protection areas for birds (SPAs) adopted in the area surrounding the Mar Menor have their origin in this Directive. These SPAs can be found in the Mar Menor catchment area:

FIGURA	SITE CODE	SITE NAME	Surface area (ha)
SPAs	ES0000269	Monte El Valle y Sierras de Altaona y Escalona	14,814.25
	ES0000264	La Muela - Cabo Tiñoso	10,938.43
	ES0000508	Espacio marino de Tabarca-Cabo de Palos	126,067.87
	ES0000260	Mar Menor	14,550.25
	ES0000175	Salinas y Arenales de San Pedro del Pinatar	828.92
	ES0000464	Sierra Escalona y Dehesa de Campoamor	10,407.36
	ES5213033	Cap Roig	4,686.50

Table 2. List of SPAs in the Mar Menor catchment area. Source: Authors, based on layers published by the Natural Environment General Directorate (CARM).

Directive 2014/89/EU of the European Parliament and of the Council of July 23, 2014, establishing a framework for the management of marine spatial planning. Aimed at setting a framework for marine spatial planning to promote the sustainable growth of maritime economies, the sustainable development of marine spaces and the sustainable use of marine resources.

In the context of the integrated maritime policy of the Union, the framework provides Member States the possibility to identify and implement maritime spatial planning to contribute to the objectives listed in Article 5, considering land-sea interactions and the improvement of

transboundary cooperation, in accordance with the relevant provisions of the United Nations Convention on the Law of the Sea.

This Directive has been implemented into the Spanish legal system through Royal Decree 363/2017, of April 8, which establishes a framework for maritime spatial planning[2].

COUNTRY-LEVEL POLICIES

Law 22/1988, of 28 July 1988, on Coasts.[3] This is the law that aims to determine, protect, use, and control the maritime-terrestrial public domain and especially the seashore. According to the provisions of this law, the Mar Menor belongs to the maritime-terrestrial public domain of Spain and therefore, its perimeter is affected by the protection easements defined by this law.

Royal Decree 261/1996 of 16 February 1996 on the protection of water against nitrate pollution from agricultural sources.[4] Transposes Directive 91/676/EEC.

Law 3/2001 of 26 March 2001 on State Maritime Fisheries.[5] This sectoral law contains the legislation applicable to the whole country in relation to maritime fishing but does not contain specific regulations for the Mar Menor area.

Royal Decree 1/2001 of 20 July 2001, approving the revised text of the Water Law.[6] This is the law that regulates the public water domain, and the competences attributed to the State in matters related to this domain. It does not contain specific regulations for the Mar Menor, but these regulations affect the watercourses that flow into it and the competences of the Segura River Basin Authority.

Royal Decree 435/2004 of 12 March 2004 regulating the National Inventory of Wetlands.[7] It is the law that regulates the elaboration of the national inventory of wetlands in Spain, and therefore, the characteristics that derive in the inclusion of the Mar Menor within it, as a zone (Ramsar A).

Law 27/2006, of 18 July, which regulates the rights of access to information, public participation, and access to justice in environmental matters.[8] The purpose of the Law is to regulate public participation in environmental matters in Spain and, among other things, it sets the framework for managing the rights to:

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[2] *Real Decreto 363/2017, de 8 de abril, por el que se establece un marco para la ordenación del espacio marítimo.*
[3] *Ley 22/1988, de 28 de julio, de Costas.*
[4] *Real Decreto 261/1996, de 16 de febrero sobre protección de aguas contra la contaminación por nitratos procedentes de fuentes agrarias.*
[5] *Ley 3/2001, de 26 de marzo, de Pesca Marítima del Estado.*
[6] *Real Decreto Legislativo 1/2001, de 20 de julio, por el que se aprueba el texto refundido de la Ley de Aguas.*
[7] *Real Decreto 435/2004, de 12 de marzo, por el que se regula el Inventario nacional de zonas húmedas.*
[8] *Ley 27/2006, de 18 de julio, por la que se regulan los derechos de acceso a la información, de participación pública y de acceso a la justicia en materia de medio ambiente.*

- Access environmental information held by the public authorities or by others who hold it on their behalf.
- Participate in decision-making procedures on matters that directly or indirectly affect the environment, and the preparation or approval of those that correspond to Public Administrations.
- Request administrative and judicial review of acts and omissions attributable to any of the public authorities that involve violations of environmental regulations.

The regulatory and planning documents on environmental matters have been subjected to rigorous public participation processes in accordance with the indications of this law.

Law 42/2007, of 13 December 2007, on Natural Heritage and Biodiversity.[9] This is the law that establishes the basic legal regime for the conservation, sustainable use, improvement and restoration of the natural heritage and biodiversity, and therefore it takes part of the legislative framework for any restoration initiative in the Mar Menor.

Royal Decree 903/2010 of 9 July 2010 on flood risk assessment and management.[10] This is the national law that regulates the management and assessment of flood risk, as well as the preparation of hazard and risk maps and flood risk management plans in Spain. It is therefore a sectorial water regulation that could be related to the possible risk of flooding in the Mar Menor environment.

Law 41/2010 of 29 December 2010 on the protection of the marine environment.[11] This is the law that establishes the legal regime governing the adoption of measures to maintain an adequate environmental status in the marine environment, through planning, protection, conservation, and improvement.

Among the most important provisions that affect the Mar Menor lagoon, we recall the following:

- This law defines the common criteria to be followed to draw up planning strategies for the marine environment.
- It defines the marine regions, sub-regions, and demarcations, including the Levantine-Balearic Marine Demarcation, to which the Mar Menor belongs.
- It constitutes the network of marine protected areas in Spain, defining the objectives, criteria for inclusion in this network, the functions and competences of the administration, and the means for monitoring and evaluating the habitats and species present in these areas.
- It also contains a list of indicators and characteristics to define the marine environment, its pressures and impacts, and qualitative descriptors to determine "good environmental status".

[9] *Ley 42/2007, de 13 de diciembre, del Patrimonio Natural y de la Biodiversidad.*
[10] *Real Decreto 903/2010, de 9 de julio, de evaluación y gestión de riesgos de inundación.*
[11] *Ley 41/2010, de 29 de diciembre, de protección del medio marino.*

Law 11/2012 of 19 December 2012 on urgent environmental measures.[12] The importance of this law in relation to the Mar Menor lies, above all, in its article 56, relating to Groundwater Bodies at risk of not reaching good quantitative or chemical status, since within the framework of this law one of the groundwater bodies in Campo de Cartagena has been declared at risk, specifically the one called MASUB 075.052.

Law 2/2013 of 29 May on the protection and sustainable use of the coastline.[13] This law aims to strengthen preventive protection mechanisms and establish new environmental control mechanisms to protect certain areas belonging to the Spanish coastline, as well as to regulate the uses and activities that take place in the public domain and in the protection easement zone.

Royal Decree 876/2014, of 10 October, approving the General Coastal Regulations.[14] This is the regulation adopting the Spanish General Coastal Regulation, which is intended to be an effective instrument for achieving the principles that inspired the amendment of the coastal legislation concerning coastal protection and legal certainty.

Royal Decree 817/2015, of 11 September, establishing the criteria for monitoring and evaluation of surface water status and environmental quality standards.[15] The purpose of this regulation is to establish:

1. The basic and homogeneous criteria for the design and implementation of programmes for monitoring the status of surface water bodies and for the additional monitoring of protected areas.
2. Environmental quality standards (EQS) for priority substances and for other pollutants to achieve good surface water chemical status. Establish EQS for preferred substances and set the procedure for calculating EQS for specific pollutants to achieve good ecological status of surface waters or good ecological potential of surface waters, where appropriate.
3. Reference conditions and status class boundaries for indicators of biological, physic-chemical and hydromorphological quality elements for classifying the ecological status or potential of bodies of surface water.
4. The minimum provisions for the exchange of information on water status and quality between the General (National) Administration and the administrations with competencies in the field of water, to comply with legislation regulating the access rights to information and public participation.

[12] *Ley 11/2012, de 19 de diciembre de medidas urgentes en materia de medio ambiente.*
[13] *Ley 2/2013, de 29 de mayo, de protección y uso sostenible del litoral.*
[14] *Real Decreto 876/2014, de 10 octubre, por el que se aprueba el Reglamento General de Costas.*
[15] *Real Decreto 817/2015, de 11 de septiembre, por el que se establecen los criterios de seguimiento y evaluación del estado de las aguas superficiales y las normas de calidad ambiental.*

Regulation 1/2016, of 16 December, adopting the revised text of the Law on Integrated Pollution Prevention and Control.[16] Aims to prevent or reduce/control the air pollution, water, and soil by establishing a system of integrated pollution prevention and control. It also regulates land-sea discharges.

Royal Decree 363/2017 of 8 April 2017 establishing a framework for the management of maritime space.[17] This Regulation aims to establish the regulatory framework for maritime spatial planning and to promote the sustainable growth of maritime economies and the sustainable use of marine resources.

REGIONAL POLICIES

Order of 3 March 2009, of the Regional Ministry of Agriculture and Water.[18] establishing the action programme for the vulnerable zone corresponding to the Quaternary and Pliocene aquifers in the area defined by the eastern irrigation area of the Tagus-Segura Transfer and the coastal sector of the Mar Menor.

Order of 27 June 2011, of the Regional Ministry of Agriculture and Water.[19] amending the Order of the Regional Ministry of Agriculture of 3 March 2009, which establishes the action programme on the vulnerable area corresponding to the Quaternary and Pliocene aquifers in the area defined by the eastern irrigation area of the Tagus-Segura aqueduct and the coastal sector of the Mar Menor.

Order of 14 June 2012, of the Regional Ministry of Agriculture and Water.[20] Establishing a special timetable for the setting of fishing gear in the area delimited for bathing in the Mar Menor.

Law 3/2020, of 27 July, on the recovery and protection of the Mar Menor.[21] **This is the regional law that has been drawn up with the specific aim of protecting the Mar Menor lagoon**. It contains numerous articles dedicated to regulating the uses and activities in the lagoon environment, the planning of the different instruments and strategies related to the protection of the lagoon, the penalties mechanisms, and it also deals with the creation of the necessary administrative bodies in terms of governance, etc.

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[16] *Real Decreto Legislativo 1/2016, de 16 de diciembre, por el que se aprueba el texto refundido de la Ley de prevención y control integrados de la contaminación.*
[17] *Real Decreto 363/2017, de 8 de abril, por el que se establece un marco para la ordenación del espacio marítimo.*
[18] *Orden de 3 de marzo de 2009, de la Consejería de Agricultura y Agua por la que se establece el programa de actuación sobre la zona vulnerable correspondiente a los Acuíferos de Cuaternario y Plioceno en el área definida por la zona regable oriental del Trasvase Tajo-Segura y el Sector litoral del Mar Menor.*
[19] *Orden de 27 de junio de 2011, de la Consejería de Agricultura y Agua, por la que se modifica la Orden de la Consejería de Agricultura de 3 de marzo de 2009, por la que se establece el programa de actuación sobre la zona vulnerable correspondiente a los acuíferos cuaternario y plioceno en el área definida por zona regable oriental del trasvase Tajo-Segura y el sector litoral del Mar Menor (BORM viernes, 5 de agosto de 2011, núm. 179).*
[20] *Orden de 14 de junio 2012, de la Consejería de Agricultura y Agua por el que se establece un horario especial de calamento de las artes de pesca de la zona delimitada para el baño en el Mar Menor.*
[21] *Ley 3/2020, de 27 de julio, de recuperación y protección del Mar Menor.*

REGIONAL SECTORAL POLICIES

Law 4/1992, of 30 July 1992, on the planning and protection of the territory of the Region of Murcia.[22] This regional law was drafted with the aim of establishing the basic principles and creating the necessary instruments to enable the coordination of the Region's territorial policy, as well as to allow territorial planning in accordance with the rational use of the Murcian space and all its resources, contributing to the improvement of the quality of life of its citizens and the socio-economic balance of its regions.

Law 3/1996 of 16 May 1996, on Ports of the Autonomous Community of the Region of Murcia.[23] This is the law in charge of regulating the construction and operation of ports and port facilities on the coast of the Region of Murcia, aimed at covering the services demanded by sports and fishing boats.

Resolution of 28 July 2000 ordering the publication of the agreement of the Council on the designation of sites of Community importance in the Region of Murcia.[24] The Region of Murcia, within the process coordinated by the State Administration, after an exhaustive analysis of the territory and applying the scientific and technical criteria emanating from the respective directives, proposed the list of 50 Sites of Community Importance (SCI), which is included in this resolution.

Law 3/2000, of 12 July, on Sanitation and Purification of wastewater in the Region of Murcia and implementation of the sanitation canon.[25] It establishes the powers in the field of urban wastewater drainage and treatment, as well as the implementation of a drainage charge to finance the operation and, where appropriate, the execution of infrastructures of this nature.

This law regulates: the construction of public facilities for the purification of wastewater from locally owned sewerage networks, as well as general collectors linking the sewerage networks to the facilities, and the management and operation of public sewerage and wastewater treatment facilities from municipal sewerage networks.

Order of 20 December 2001 designating the areas vulnerable to nitrate pollution from agricultural sources in the Autonomous Community of the Region of Murcia.[26] Designates the area corresponding to the Quaternary and Pliocene aquifers in the area located in the eastern irrigable area of the Tagus-Segura transfer canal and the coastal sector of the Mar Menor as a vulnerable

[22] *Ley 4/1992, de 30 de julio, de ordenación y protección del territorio de la Región de Murcia.*
[23] *Ley 3/1996 de 16 de mayo, de Puertos de la Comunidad Autónoma de la Región de Murcia.*
[24] *Resolución de 28 de julio de 2000 por la que se dispone la publicación del acuerdo de Consejo de Gobierno sobre designación de los lugares de importancia comunitaria de la Región de Murcia.*
[25] *Ley 3/2000, de 12 de julio, de Saneamiento y Depuración de aguas residuales de la Región de Murcia e implantación del canon de saneamiento.*
[26] *Orden 20 de diciembre de 2001, por la que se designan las zonas vulnerables a la contaminación por nitratos procedentes de fuentes agrarias en la Comunidad Autónoma de la Región de Murcia.*

zone to pollution by nitrates of agricultural origin in the Autonomous Community of the Region of Murcia.

Order of 3 December 2003, of the Regional Ministry of Agriculture, Water and Environment, adopting the code of good agricultural practices of the Region of Murcia.[27] It adopts the code of good practices for the agricultural sector within the Region.

Law 2/2007, of 12 March, on Maritime Fisheries and Aquaculture of the Region of Murcia.[28] Its purpose is to regulate:

- Sea fishing in inland waters, as well as protection of the ecosystems in which this activity takes place.
- Management of the professional fishing sector and recreational fishing.
- Shellfishing, aquaculture, algae farming, as well as any other form of industrial farming.
- Management of the commercial activity of fishery products.
- Fishing and aquaculture research.
- Control, inspection and system of infringements and penalties in the matters regulated in this Law.

Law 4/2007, of 16 March, on Cultural Heritage of the Region of Murcia[29] The aim of this regional law is the protection, conservation, enhancement, research, knowledge, dissemination and promotion of the cultural heritage of the Region of Murcia.

Decree No. 133/2008 of 30 May 2008 on Projects and Execution of Coastal Development Works.[30] The purpose of this Decree is to regulate the procedure for the preparation, processing and approval of public utility works projects permitted by spanish coastal legislation in the Murcia region.

Law 11/2009, of 11 March, on Maritime Passenger Transport in the Region of Murcia.[31] It regulates the maritime transport of passengers between ports or points of the Autonomous Community of the Region of Murcia without connection with ports or points of other autonomous communities,

[27] *Orden de 3 de diciembre de 2003, de la Consejería de Agricultura, Agua y Medio Ambiente por la que se aprueba el código de buenas prácticas agrarias de la Región de Murcia.*
[28] *Ley 2/2007, de 12 de marzo, de Pesca Marítima y Acuicultura de la Región de Murcia.*
[29] *Ley 4/2007, de 16 de marzo, de Patrimonio Cultural de la Comunidad Autónoma de Murcia.*
[30] *Decreto Nº 133/2008, de 30 de mayo, sobre Proyectos y Ejecución de Obras en Materia de Ordenación del Litoral.*
[31] *Ley 11/2009, de 11 de marzo, de Transporte Marítimo de Pasajeros de la Región de Murcia.*

in vessels that have mechanical means of propulsion and/or are propelled by sail, duly authorised, for payment, and regardless of the direct or indirect economic considerations.

Law 4/2009, of 14 May, on Integrated Environmental Protection.[32] Sectoral law establishing the legal regime and integrated procedures for administrative intervention to which plans, programmes, projects and activities that may affect the environment must be followed.

Order of 10 November 2012, of the Regional Ministry of the Presidency on the integrated planning of the Natural Spaces of the Region of Murcia.[33] Its aim is to facilitate knowledge and publish the basic planning guidelines of the Integrated Planning Areas of the Region of Murcia, those related to the protected areas of the Natura 2000 Network in the Region of Murcia. One of the highlights of this order is the definition of 14 Integrated Planning Areas (API) for all the protected areas of the Region of Murcia, being the Mar Menor the "API02 Mar Menor and coastal strip of the Region of Murcia".

Law 12/2013, of 20 December, on Tourism in the Region of Murcia.[34] This is the regional law that aims to regulate tourist activities in the Region of Murcia. It includes the promotion of tourism activities, regulation of tourism companies and establishments, regime of rights and duties in the provision of tourism services, tourism inspections and tourism discipline.

Law 13/2015, on territorial and urban planning in the Region of Murcia.[35] The purpose of this law is to regulate spatial planning, coastal planning, and urban development activities in the Region of Murcia.

MUNICIPAL (LOCAL) REGULATIONS RELATED TO THE MAR MENOR

The local regulations of all the town councils located in the Mar Menor catchment area have been reviewed. The following is a list of the municipal by-laws that might/can affect the Mar Menor:

- **Alahama de Murcia:** No regulations related to the Mar Menor.

- **Cartagena:**
  1. **By-law on occupation of public streets for hotel business and seasonal facilities on beaches**[36] **(By-law adopted by the Plenary on 30 December 2006 and published in the Official Gazette of the Region of Murcia nº. 300 of 27 January 2007; partial modification BORM nº. 236, of 10 October 2016).**

[32] *Ley 4/2009, de 14 de mayo, de Protección Ambiental Integrada.*
[33] *Orden de fecha 10 de noviembre de 2012, de la Consejería de Presidencia sobre la planificación integrada de los espacios Naturales de la Región de Murcia.*
[34] *Ley 12/2013, de 20 de diciembre, de Turismo de la Región de Murcia.*
[35] *Ley 13/2015, de ordenación territorial y urbanística de la Región de Murcia.*
[36] *Ordenanza del 30 de diciembre de 2006, de 'Ocupación de vía pública para usos de hostelería e instalaciones de temporada en playas'.*

The object of this by-law is to regulate the use of temporary covered terraces or analogous installations in terrestrial public domain spaces. It affects the beaches and islands of the Mar Menor environment.

2. **By-law of use and exploitation of beaches.[37] (By-law approved by the Plenary on 8 February 2007 and published in the Official Gazette of the Region of Murcia nº. 134 of 13 June 2007).**

   The object of this by-law is to regulate the correct use of Cartagena's beaches. It has several articles where prohibitions are described. It is forbidden to:

   - Park or circulate through the beach with non-authorised vehicles.
   - Boat navigation in exclusive bath zones.
   - Fishing from the shore and submarine fishing during the bath season between 10 am to 9 pm.
   - Pets access to water, bath areas and promenades.
   - Physiological evacuation in the sea or on the beach.
   - Wash up in the water using soap, gel shampoo or similar products
   - Throw on the beach or in the sea of any kind of waste.
   - Make a fire directly on the beach soil, sand or rocks.
   - Use of gas bottles or flammable liquids.
   - Bathing, fishing and bathers stay in designated areas for grounding and boat transit, ports and Mar Menor channels access, as well as pedal boats and jet skis.

3. **Municipal By-Law for the Protection of the Environment against the emission of noise and vibrations.[38] (By-Law adopted by the Plenary on 17 December 2020 and published in the Official Gazette of the Region of Murcia nº. 134 of 22 January 2021).**

   The object of this By-Law is to regulate municipal action for the protection of citizens and environment against disturbances produced by noise and vibrations. In what affects the Mar Menor and its environment, the noise levels coming from beach bars, kiosks and other analogous establishments installed in beach areas and promenades are regulated by this by-law.

- **Fuente Álamo de Murcia:** No regulations related to the Mar Menor.

- **La Unión:** It has regulations governing activities on beaches, but they are not related to the Mar Menor.

[37] *Ordenanza de uso y aprovechamiento de las playas.*
[38] *Ordenanza Municipal de 'Protección del medio ambiente contra la emisión de ruidos y vibraciones.*

- **Los Alcázares:**
  1. **By-law regulating temporary installations[39] (By-law approved by the Plenary on 6 April 2000 and published in the Official Gazette of the Region of Murcia nº. 80 of 6 April 2001).**
     The object of this by-law is to regulate the operation of temporary installations. In what affects the Mar Menor, the installations located in the maritime terrestrial public domain or easements will be regulated by this By-law.

- **Mazarrón:** It has regulations related to activities on beaches, but they are not related to the Mar Menor.

- **Murcia:** No regulations related to the Mar Menor

- **San Javier:**
  1. **By-law regulating urban hygiene and waste management in the whole municipality, including beaches and therefore the Mar Menor.[40] (By-law adopted by the Plenary on 6 April 2002 and published in the Official Gazette of the Region of Murcia nº. 72 of 27 March 2002).**

     The object of this by-law is to regulate the situations and activities aimed towards keeping cleanliness in public and private spaces, storage, collection, and treatment of urban and municipal waste; to protect public health and the environment. This document has no specific regulations over the Mar Menor, except the prohibition of the spill of residual water coming from industries to the Mar Menor or any stream.

  2. **By-law on safety in the use, enjoyment and exploitation of the coastline of San Javier.[41] (By-law approved by the Plenary on 6 April 2002 and published in the Official Gazette of the Region of Murcia nº. 72 of 27 March 2002).**

     The object of this by-law is to protect the public health and the environment, as well as to improve the touristic image of San Javier. In what affects the Mar Menor, several rules are described as:
     - Removing the rests of *Posidonia oceanica* must be done carefully avoiding the extraction of sand and rocks from the beach.
     - The use of soap, gel shampoo o similar products is forbidden.
     - The entrance of pets is forbidden, except guide dogs.
     - Navigation of jetskis or any kind of boat is limited close to the beach.

[39] *Ordenanza del 6 de Abril de 2000 "Ordenanza reguladora de las instalaciones temporales.*
[40] *Ordenanza del 27 de Marzo de 2002 'Ordenanza Higiene Urbana y gestión de Residuos'.*
[41] *Ordenanza 7 de Junio de 2014. Ordenanza de seguridad en el uso, disfrute y aprovechamiento del litoral de San Javier'.*

- Bathing is forbidden in the channels prepared for the boats.
- Fishing is regulated on the shore and on the breakwaters in bathing zones during high season.

- **San Pedro del Pinatar:**
  1. **By-law of use and exploitation of beaches.[42] (By-law adopted by the Plenary on 20 June 2017 and published in the Official Gazette of the Region of Murcia nº. 147 of 28 June 2017).**

     The object of this by-law is to regulate the correct use of beaches in San Pedro del Pinatar. There are not specific indications about the Mar Menor.

- **Torre-Pacheco:** No regulations related to the Mar Menor.

[42] *Ordenanza de uso y disfrute de las playas del término municipal de San Pedro del Pinatar.*

Current situation of the Mar Menor

Area of the study

To provide a better understanding of the background for the analysis conducted in this report it is essential to establish the area of the Mar Menor lagoon and its surroundings. The lagoon is in the south-eastern part of the Region of Murcia and has an approximate area of 13,534.8 ha, 4 metres average depth, 7 metres maximum depth and contains around 653 hm^3 of salty water. It is separated from the Mediterranean Sea by a thin 21 km sandy mostly urbanized cordon. Its "influence area" covers a much larger area, and this is a concept that has been widely discussed over time and has varied according to the different standards, planning or diagnostic documents on the lagoon.

One of the most important documents regarding the planning of the Mar Menor lagoon, the report named "*La Estrategia de Gestión Integrada de Zonas Costeras del Sistema Socio-ecológico del Mar Menor y su Entorno*", hereinafter EGIZCSSEMM, establishes that the term environment, in the context of the Mar Menor, can be interpreted as a much broader geographical area, which includes the main relationships that the ecosystem known as the Mar Menor maintains with other marine and terrestrial ecosystems that affect its environmental status, and above all with certain uses (human settlements, facilities, infrastructures, etc.) and human activities (urban growth and construction of infrastructures, agriculture, livestock, mining, aquaculture, fishing, tourism, leisure and recreation, etc.) that are being developed or have been developed in the past. It is precisely the cumulative effect exerted by the different uses over time that defines the current state of the Mar Menor.

Therefore, in addition to the body of water of the lagoon, the Mar Menor should include the hydrographic basins, the wadis, the aquifers, the estuary, the coastal waters, etc. It should be qualified to facilitate its management and planning by means of administrative considerations. All these elements can be divided into two categories: the terrestrial environment and the marine environment.

The terrestrial area is understood as the portion of territory that would comprise all the hydrological basins that drain into the Mar Menor and the bodies of groundwater that encounter the lagoon. It has a surface area of 169,450 ha.

Taking as a reference the definition established in the report "*Análisis de soluciones para el vertido cero al Mar Menor proveniente del Campo de Cartagena* " and the "EGIZCSSEMM", the marine area would include, in addition to the body of water that constitutes the Mar Menor lagoon itself, the inland waters until 1.6 km, in accordance with Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for Community action in the field of water policy, the entire marine reserve of Cabo de Palos, las Hormigas islands and the entire SCI "Franja litoral Sumergida de la Región de Murcia" from Cabo Negrete to Cabo de Palos, covering approximately a 10 km band of influence on the Mediterranean Sea of some 80.600 ha, with three

points of interconnection of inland waters with the Mediterranean (Las Encañizadas, El Estacio and the Marchamalo channel).

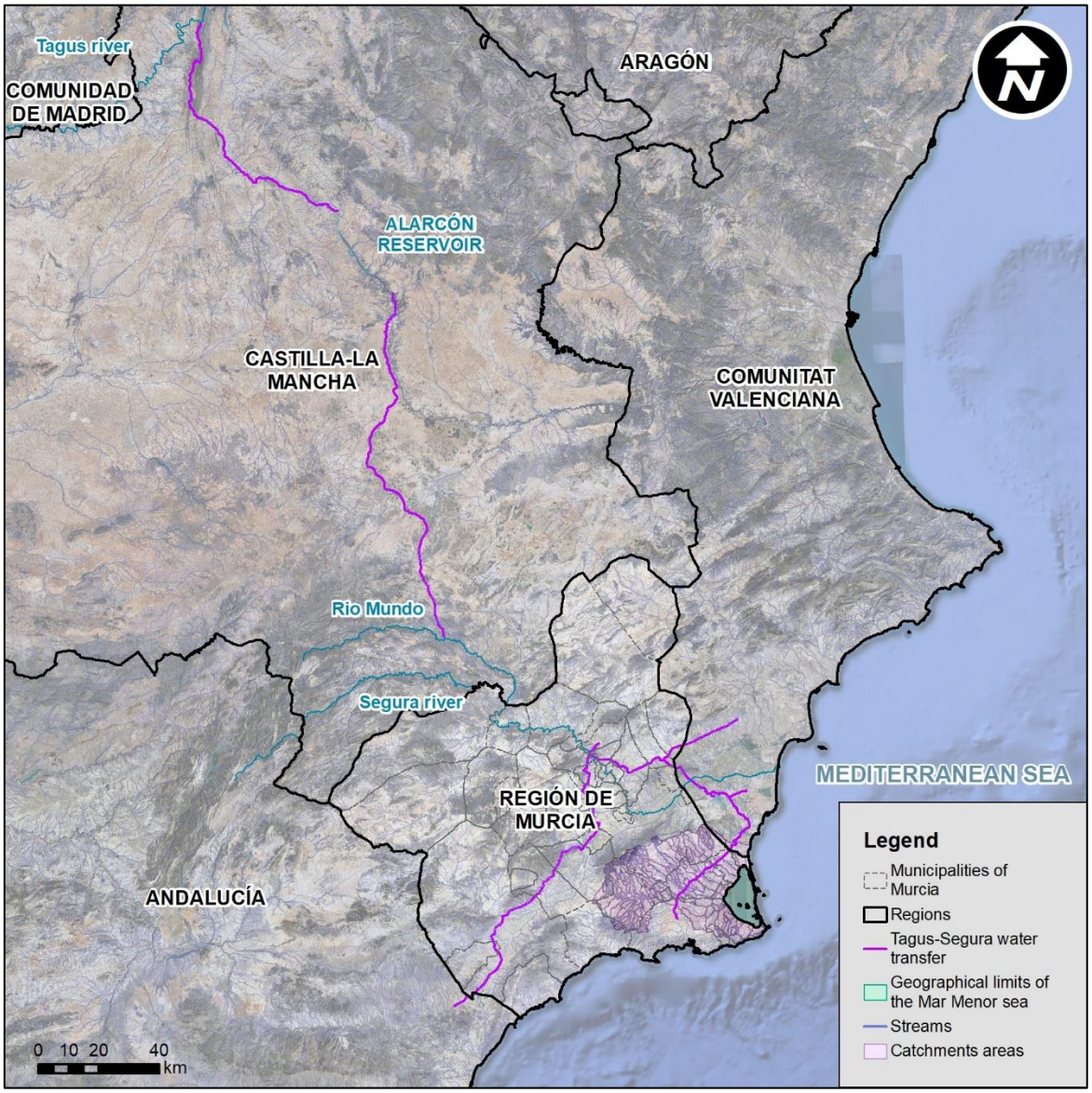

Figure 2. Catchment area of The Mar Menor lagoon. Source: Authors.

Pressures

The Mar Menor is an ecosystem that has been subjected to multiple and numerous pressures of anthropic origin over the last decades: intensive agricultural activities, livestock farming, mining, port and fishing use, sand dredging, salt industry, tourism, urban development, and even military purposes, among others. This situation has worsened over the years, affecting the quality of its waters, and has led to the current situation of deterioration of its ecosystems.

Current problems of the Mar Menor lagoon

The main problem of the Mar Menor is the state of eutrophication in which it finds itself and which has led to a situation of "ecological crisis" where there are physical-chemical conditions in which the high concentration of nitrates causes a drastic alteration of the biological communities that inhabit the environment, completely breaking the natural balance of its habitats, affecting by extension the main natural support elements, as well as the economic activities that take place.

It is important to stress that this situation has not originated only by recents event but is the result of the multiple pressures that the area of the Mar Menor has been suffering over the last few decades, which have exceeded the assimilation capacity of this ecosystem.

Taking as a reference the different diagnoses made by legislative and planning documents on the current problems of the Mar Menor, the main problems of this environment can be summarised as follows:

- The current level of eutrophication of the surface water body of the Mar Menor.
- The contribution of polluting elements through surface and groundwater from agricultural and livestock farming activities in the Campo de Cartagena.
- The temporary persistence of high levels of pollutants in the soil and, by extension, in the main bodies of groundwater.
- The interconnection of shallow and deep aquifers due to the extractions produced by wells.
- Rising water table in shallow aquifers due to external contributions to the system and because of pumping for irrigation.
- Agricultural practices causing pollution during the irrigation cycle, groundwater abstraction/desalination and disposal of brine into the environment.
- Pollution due to overflowing of urban sewerage facilities during periods of flooding.
- Carrying of soils and soil pollutants by runoff reaching the shores of the Mar Menor, including remains from unrestored mining operations located in Sierra Minera.
- Persistence of agricultural waste on the land.

In turn, these problems can be grouped according to the way they affect the lagoon: continuous supply of pollutants through surface water courses, through groundwater and less regular supply because of flood events. Or also according to their nature: pollutants from agriculture, livestock, mining, and urban waste.

Evolution of the environmental status of the Mar Menor lagoon

Over a period of time, a horizon of 50 years, the Mar Menor has undergone various changes in its physico-chemical state that have affected its environmental status and quality and whose negative effects on the system were not clearly evident until after the second half of 2015, when the environmental collapse of the Mar Menor took place.

According to the Analysis of solutions for the Zero Discharge objective. "Until the 1970s, the Mar Menor was markedly oligotrophic and primary production was mainly benthic, with meadows of the marine phanerogam *Cymodocea nodosa* predominating on the bed of the Mar Menor." This same document also states that it can be considered that between 1970 and 2015 the environmental state of the lagoon was relatively good, and that there are certain milestones that can help us understand under what circumstances the current state of the Mar Menor has been reached.

The first of these milestones is that "in 1972-73 the algae *Caulerpa prolifera* appeared due to the widening and dredging of the El Estacio channel, which caused the irreversible alteration of the bottom of the Mar Menor and the communities that inhabited it and triggered the colonisation of other allochthonous species".

It should also be noted that from the 1980s onwards, irrigation intensified in Campo de Cartagena due to the water import into the system thanks to the Tagus-Segura water transfer, leading to an increase in the piezometric level of the Quaternary aquifer due to the returns from irrigation and the generation of a base flow at the mouth of the Albujón wadi.

Together, these facts have accelerated the process of nutrient input and concentration in the lagoon, as indicated in the preamble to Law 3/20 on the recovery and protection of the Mar Menor, based on the comprehensive report on the ecological status of the Mar Menor by the Scientific Advisory Committee of the Mar Menor, "This significant expansion of irrigation - between 1988 and 2009 irrigation increased by more than 140 per cent - has significantly increased the water and nutrient flows reaching the Mar Menor and its coastal wetlands through surface, subsurface and underground flows". This same preamble also points out that from the 1960s onwards, a process of urban expansion oriented towards tourism began, which had consequences for the Mar Menor, such as the demand for its resources and the discharge of wastewater, but that "currently the latter is only due to defects in the sewage networks".

Returning to the description of the events that have led to the current state of the Mar Menor according to the Analysis of solutions for the Zero Discharge objective, in the 1990s nitrate concentrations in the lagoons were still low, remaining below 0.062 mg/L (1 µmol/L of NO_3), in the 1990s nitrate concentrations in the lagoons were still low, remaining below 0.062 mg/L (1 µmol/L of NO_3), with the main inputs of nitrate coming from runoff water in winter and of phosphorus through urban discharges, mainly in summer.

It is also known that from the years 2010-12, nitrate data reached figures above 1mg/l along the western shore of the lagoon, mainly associated with the Albujón wadi, and the Analysis of solutions for the zero-discharge objective points out that this increase is "mainly due to the process of intensification of irrigation and fertilisation".

However, from the second half of 2015, the levels of eutrophication in the lagoon experienced a strong and accelerated increase, leading to the environmental collapse of the Mar Menor.

It was then that most of the seagrass meadows, which until then covered up to 80% of the bed of the Mar Menor, began to disappear. According to data from the Spanish Institute of Oceanography, in 2016, 85% of the meadows had disappeared and the remaining 15% survived in a residual form in the shallower and more illuminated areas of the lagoon.

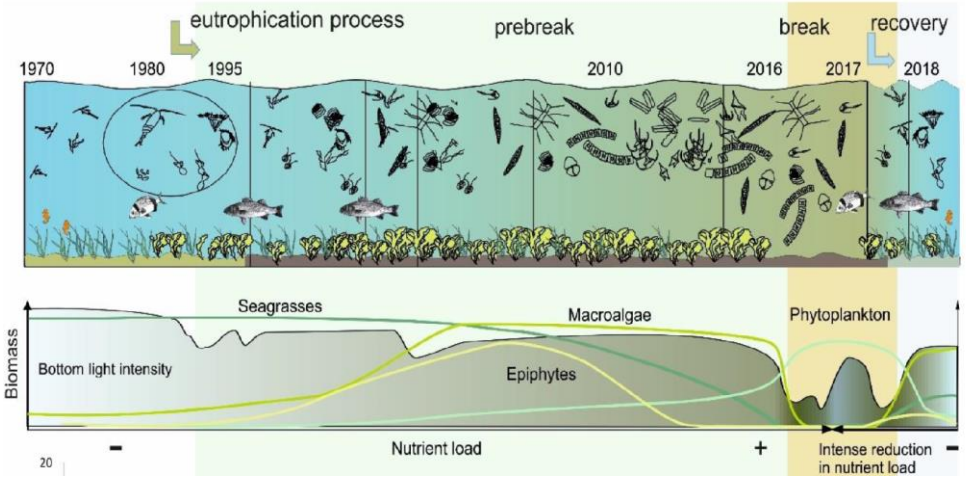

Figure 3. Phases of the process and main changes. Source: IEO.

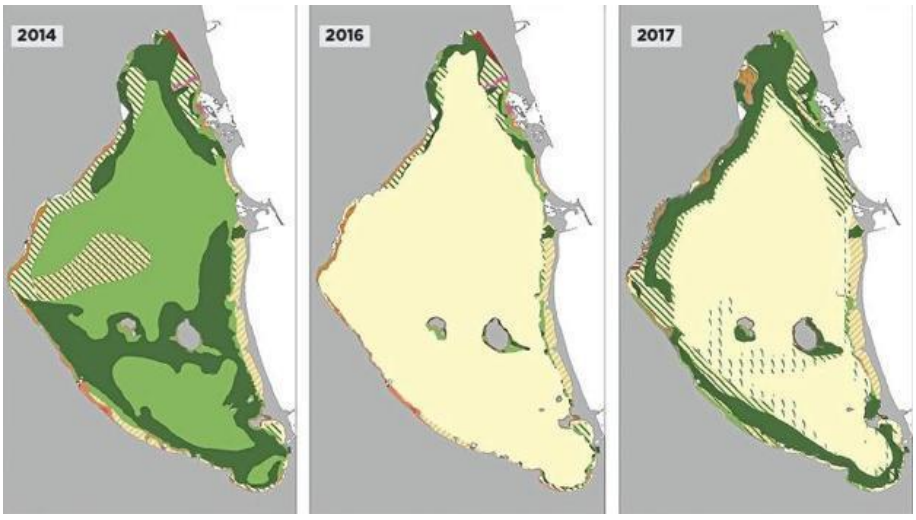

Figure 4. Macrophytes meadows evolution. Source: IEO and ANSE.

Between 2017 and 2018 the ecosystem of the Mar Menor began to recover, and a clear recovery of the benthic communities was observed, a process of recolonisation of the seabed by macrophyte meadows in the shallow areas began, and in general there was an improvement in the parameters of transparency, salinity, chlorophyll concentration and turbidity.

However, this apparent process of recovery of the Mar Menor ecosystem was interrupted in 2019, when between 12 and 14 September a heavy rainfall event known as a DANA (for the Spanish acronym for an "Isolated High-Level Depression") occurred, which triggered an ecological catastrophe that resulted in the mortality of thousands of fish, since the large mass of fresh water with sediments and organic remains dragged by the torrential rains left the marine life without oxygen. During this event, historical maximums were exceeded (>200 l/m^2) with a total accumulation in the basin of 242 hm^3 which meant the entry of 98 hm^3 into the Mar Menor, 15% of its volume. Measurements of 0.3-0.8 mg/L surface oxygen were also recorded in the area, and salinity decreased sharply to values even lower than those of the Mediterranean at some points (33 gr/L).

Figure 5: Satellite Sentinel image, from the 13th of September 2019. Source: SITMURCIA.

Due to these facts, increased efforts were made to adopt scientific, legal, and technical measures to deal with this situation, and finally, between 2020 and 2021, the Mar Menor has experienced a period of stability and progressive recovery.

Socio-economic evolution of the area around the Mar Menor lagoon

The immediate surroundings of the Mar Menor are made up of two regions: the Mar Menor region and the Campo de Cartagena region.

Excluding Murcia, the municipalities in the study area comprise a census population of more than 350,000 inhabitants. The demographic evolution shows a population increase in most of the municipalities around the Mar Menor lagoon, with Mazarrón being the only municipality with population losses, reaching up to 2,625 inhabitants, 7.4% of its population in the last 10 years. Murcia, being the capital of the region, is the municipality with the greatest population increase, some 18,058 inhabitants in the same period, and Torre-Pacheco also stands out with an increase in 2020 of up to 12.3% with respect to 2010.

MUNICIPALITIES	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	GRAPHIC
Alhama de Murcia	20.269	20.725	20.915	21.182	21.298	21.351	21.308	21.448	21.657	22.077	22.160	
Cartagena	214.165	214.918	216.655	217.641	216.451	216.301	214.759	214.177	213.943	214.802	216.108	
Fuente Álamo de Murcia	15.193	15.873	16.175	16.679	16.338	16.284	16.205	16.180	16.184	16.583	16.787	
Mazarrón	35.464	35.473	35.408	35.661	32.718	32.150	30.704	30.996	31.562	32.209	32.839	
Murcia	441.345	442.203	441.354	438.246	439.712	439.889	441.003	443.243	447.182	453.258	459.403	
San Javier	31.820	32.366	32.641	32.786	31.988	31.915	31.782	31.695	31.905	32.489	33.129	
San Pedro del Pinatar	23.903	24.093	24.285	24.102	24.091	24.339	24.660	24.903	25.167	25.476	25.932	
Torre-Pacheco	32.471	33.218	33.911	33.575	34.151	34.469	34.630	35.198	35.614	35.676	36.464	
La Unión	18.366	18.825	19.009	19.263	19.452	19.572	19.630	19.764	19.907	20.225	20.538	
Los Alcázares	15.993	16.217	16.251	16.568	15.735	15.605	15.289	15.349	15.674	16.138	16.590	
TOTAL	848.989	853.911	856.604	855.703	851.934	851.875	849.970	852.953	858.795	868.933	879.950	

Table 3: Evolution of the de facto population of the Mar Menor area Source: National Statistics Institute

In the municipalities around the Mar Menor, the population structure, in addition to showing a high density, has a population pyramid with a maximum concentration of the population in the 30-35 age bracket. It is worth noting that around 50% of the population is under 35 years of age, which reflects the degree of youth in the area.

As regards its economic sectors, the Mar Menor area is characterised by being an eminently agricultural region, with a highly specialised and competitive agricultural sector, which, as previously mentioned, has been greatly influenced by the arrival in the 1980s of water from the Tagus-Segura water transfer, which triggered a process of transformation of rainfed crops into irrigated land, which has profoundly influenced the socio-economic situation of the area.

The distribution of rainfed and irrigated crops in the Campo de Cartagena is shown in the following table:

	CROP SURFACE DISTRIBUTION IN THE CAMPO DE CARTAGENA AREA	2015	2016	2017	2018	2019	2020
ARABLE CROPS	Grain cereals	1,540	900	1,009	860	860	1,286
	Rainfed crops	686	486	534	683	683	860
	Irrigated crops	854	411	475	117	177	426
	Forage crops	86	120	96	74	74	68
	Rainfed crops	3	3	5	5	5	1
	Irrigated crops	83	117	91	69	69	67
	Industrial crops	64	110	108	101	101	155
	Rainfed crops	0	0	0	0	0	7
	Irrigated crops	64	110	108	101	101	148
	Flowers	65	60	52	47	50	50
	Rainfed crops	0	0	0	0	0	0
	Irrigated crops	65	60	52	47	50	50
	Vegetable crops	17,641	17,862	19,120	18,377	1,837	15,616
	Rainfed crops	0	0	0	0	0	0
	Irrigated crops	17,641	17,862	19,120	18,377	18,377	15,616
	Grain legumes	10	11	7	3	3	2
	Rainfed crops	10	11	7	1	1	1
	Irrigated crops	0	0	0	2	2	1
	Tubes for human consumption	3,872	3,939	3,371	3,379	3,379	3,147
	Rainfed crops	0	0	0	0	0	0
	Irrigated crops	3,872	3,939	3,371	3,379	3,379	3,147
WOODY CROPS	Citrus crops	8,036	7,847	8,139	8,068	8,117	801
	Rainfed crops	0	0	0	0	0	0
	Irrigated crops	8,036	7,847	8,139	8,068	8,117	801
	Non-citrus fruit trees	5,395	5,366	5,430	5,426	5,390	5,221
	Rainfed crops	4,361	4,349	4,349	4,340	4,346	4,420
	Irrigated crops	1,034	1,017	1,081	1,086	1,044	801
	Olive grove	689	524	463	620	620	703
	Rainfed crops	294	129	338	485	494	500
	Irrigated crops	395	395	125	135	126	203
	Other woody crops	692	484	501	496	487	486
	Rainfed crops	493	407	424	414	406	409
	Irrigated crops	199	77	77	82	81	77
	Vineyard	50	57	58	56	56	60
	Rainfed crops	7	22	21	21	21	25
	Irrigated crops	43	358	37	35	35	35
	Nurseries	98	88	89	89	90	85
	Rainfed crops	0	0	0	0	0	0
	Irrigated crops	98	88	89	89	90	85

Table 4. Crop surface distribution in the Campo de Cartagena area. Source: Murcia Agricultural Statistics; CARM, 2019.

The sector has an export orientation, with one of the largest geographical concentrations of companies in the agricultural sector in the Region of Murcia and in Spain. The value of exports due to this sector has been estimated at 4,691 M€ in 2016, representing 52% of total exports of Murcia Region.

According to the data from the geographic information system (GIS) of agricultural plots used in the analysis of solutions for Zero Discharge, in global terms, the agricultural surface area in the area surrounding the Mar Menor occupies approximately 78,008.50 hectares in 2016; with the municipalities with the largest agricultural areas being Cartagena, Fuente del Álamo and Torre Pacheco, which accounted for 68% of the agricultural surface area of the Campo de Cartagena also in 2016.

The Regional Statistics Centre of Murcia carries out the same analysis at a municipality level, indicating the distribution according to whether the fields are agricultural or irrigated. The annual data available go from 2012 to 2020, an interval in which can be seen how there is a slight increase in the surface area of irrigated crops of around 4% and a large decrease in the surface area of rainfed crops of 46%.

This table provides an overview of the evolution of cropland area (in hectares) and cropping system distribution of the surface area by municipalities and for the whole region of Murcia.

		REGION OF MURCIA	LOS ALCÁZARES	ALHAMA DE MURCIA	CARTAGENA	FUENTE ÁLAMO	MAZARRÓN	MURCIA	SAN JAVIER	SAN PEDRO DEL PINATAR	TORRE-PACHECO
2012	Rainfed	**363,884**	67	7,250	23,650	12,098	13,785	22,978	926	23	1,728
	Irrigated	**187,073**	793	8,486	11,262	4,631	6,296	19,429	3,521	831	13,219
2013	Rainfed	**357,034**	127	6,547	23,803	12,847	9,222	25,773	869	18	904
	Irrigated	**187,073**	793	8,486	11,109	4,631	6,296	19,429	3,521	842	13,219
2014	Rainfed	**359,695**	140	6,500	18,614	12,737	9,175	24,449	846	18	1,361
	Irrigated	**187,073**	791	8,486	16,342	4,631	6,296	18,429	3,521	842	12,719
2015	Rainfed	**338,633**	130	6,758	12,711	12,545	6,833	21,847	962	21	4,684
	Irrigated	**178,536**	795	8,103	13,786	4,823	6,473	18,877	3,318	901	9,332
2016	Rainfed	**259,400**	131	5,887	6,056	13,914	2,783	20,590	832	180	5,323
	Irrigated	**167,151**	782	7,973	13,882	4,698	4,504	19,191	3,310	965	8,918
2017	Rainfed	**253,269**	32	6,310	2,858	10,428	2,238	21,682	63	16	420
	Irrigated	**187,834**	885	7,847	18,276	8,582	6,046	19,133	4,097	1,133	13,865
2018	Rainfed	**218,184**	9	877	2,278	5,811	1,906	7,983	62	4	513
	Irrigated	**188,234**	502	9,781	17,139	5,519	4,589	20,816	4,012	1,043	11,228
2019	Rainfed	**222,196**	17	946	2,295	5,982	2,506	8,536	62	4	616
	Irrigated	**189,536**	510	10,010	17,443	5,635	4,464	20,800	4,082	983	11,036
2020	Rainfed	**221,258**	8	859	2,587	6,031	2,379	8,426	63	4	407
	Irrigated	**192,247**	465	9,799	15,332	6,566	5,317	19,906	3,027	932	11,098

Table 5: Evolution of cropland area by municipality and cropping system. Source: CREM. Regional Statistical Centre.

According to the annual bulletin of the economic situation of the region of Cartagena, this industry represents the fourth sector in the region of Cartagena, taking as a reference the number of companies affiliated to Social Security. Specifically, in 2020, 6.01% of the companies in the region belonged to the industrial sector, while in the Region of Murcia as a whole, this percentage is 7.83%. If we compare these values with those of the year 2019, we observe that there has been a small decrease in both cases, since in that year the percentages corresponding to the Comarca of Cartagena and the Region of Murcia were 6.17% and 8.01%, respectively.

If we take into consideration the percentage represented by the number of companies in this area in this sector compared to the region, we find that 18.17% of companies in the regional industry sector are in the region of Cartagena in 2020, compared to 18.29% in 2019. Looking in detail at the distribution of these companies within the region, almost half (49.68%) are in the municipality of Cartagena, the next most important municipalities being Torre-Pacheco, Fuente Álamo and San Javier with 12.08%, 9.52% and 9.07% respectively. At the opposite extreme is Los Alcázares with only 2.44%.

As far as the tourism sector is concerned, it is one of the most exposed to the health crisis generated by SARS-CoV-2. According to estimates by the World Tourism Organisation, 2020 has been the worst year in history, as the number of international travellers fell by 70% compared to 2019; or, in other words, in 2020 the size of international tourism demand was dramatically reduced, with a consequent reduction in income for the sector.

According to the data published in the economic situation bulletin of Campo de Cartagena, there is an evident decrease in the number of travellers and overnight stays in the Costa Cálida during the year 2020. (Figure 6).

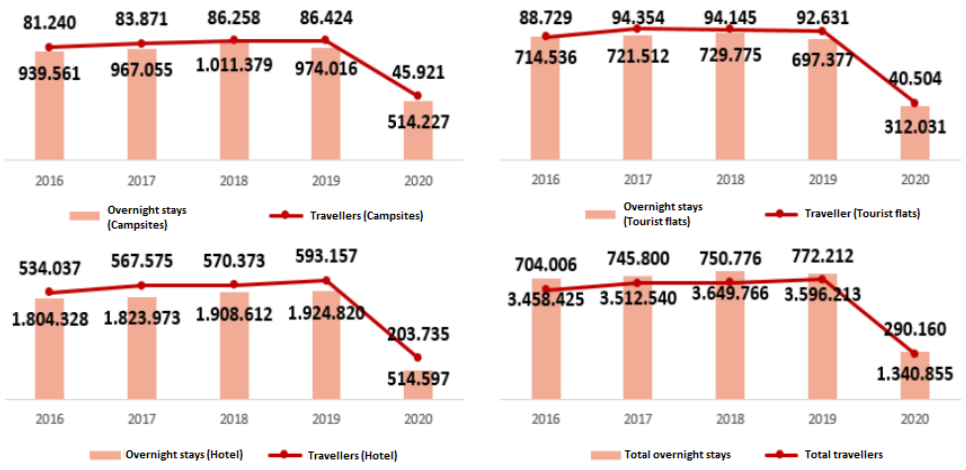

Figure 6: Hotel Occupancy Survey, in Campsites and Tourist Apartments Source: INE.[43]

[43] Based on surveys carried out by the Spanish National Statistics Institute.

Current legislation influencing the water use and quality in the Mar Menor lagoon catchment.

Evolution of the regulatory framework for the Mar Menor lagoon

Over the last 20 years, the regulatory framework of the Mar Menor has undergone numerous changes and has been modified and influenced both by the nature of the problem itself and by European environmental Directives.

Both reactionary regulatory documents have been drawn up with the aim of alleviating the main problem of eutrophication, as well as more developed studies and plans with a much broader vision, which in turn have undergone participatory and collaborative processes with the aim of bringing together the concerns of the main actors involved.

As previously mentioned, the Mar Menor is a coastal lagoon that belongs to the maritime area and as such its physical extension belongs to the state maritime-terrestrial public domain, its use being regulated in the first instance by Article 132.2 of the Spanish Constitution, which forms part of the inland waters (the part of the maritime-terrestrial public domain situated between the maritime-terrestrial zone and the territorial sea).

The maritime-terrestrial public domain is made up of the maritime-terrestrial zone, the beaches, inland waters, the territorial sea and the natural resources of the economic zone and the continental shelf, as established by the 1978 Constitution, and being the Coastal Regulation, which specifies and defines these concepts.

To protect the narrow strip that constitutes the maritime-terrestrial public domain, the coastal regulations establish a series of limitations on the adjoining land:

- The so-called transit easement, which applies to a 6 meters strip of privately owned land adjoining the public domain, the purpose of which is to allow transit along the coastline.

- The so-called protection easement, which affects privately owned land adjoining the public domain, the purpose of which is to allow transit along the coastline. Private property adjoining the public domain, in which the private ownership of the parcels and their buildings is maintained, although these properties are subject to certain limitations, due to their proximity to the seashore. These limitations mean the impossibility of executing new works or constructions contrary to the Law, which prohibits new residential, or housing uses. This easement is 20 metres wide on land that was considered as urban land before the Law on Coasts and the Coastal Law and 100 metres on land that had not been urbanised and had no acquired urban development rights.

- The access easement to the sea is determined in the urban planning instruments.

- The so-called zone of influence, which covers a 500 meters strip of land, contains guidelines for the planner to avoid the formation of architectural screens at the edge of the coast.

However, it is important to highlight that the competences in charge of managing the uses of its scope at the hydrological level are of a regional nature.

One of the first attempts to establish a regulatory framework to protect the environment of the Mar Menor was Law 3/1987 of 23 April[44], which had as its main objective to regulate four land-use planning instruments (the Land Use Planning Guidelines, the Mar Menor Sanitation Plan, the Mar Menor Use Harmonisation Plan, and the Mar Menor Coastal Planning and Protection Plan), as well as the creation of a Regional Advisory Council for the Mar Menor. This law was repealed by Law 1/2001, of 24 April, Law for the protection and harmonisation of the uses of the Mar Menor [45], due to the need to introduce a general framework of land-use planning instruments for the whole Region.

Years later, in 2017, the first law with environmental regulation rules of direct application in the scope of the Mar Menor was decreed (Decree-Law 1/2017, of 4 April, on urgent measures to ensure environmental sustainability in the Mar Menor[46]), which, subsequently was followed by Law 1/2018, of 7 February, on urgent measures to guarantee environmental sustainability in the Mar Menor. [47].

This reactionary law aims to adopt urgent measures for the planning and sustainability of agricultural activities and to guarantee their application in the environment of the Mar Menor and the protection of its natural resources, through the elimination or reduction of the effects caused by dumping, sediment dragging and any other element that may contain harmful pollutants to the recovery of its ecological state.

Subsequently, but without the status of law, it is also worth mentioning, due to its special position within environmental legislation, Decree 259/2019, of 10 October, on the "declaration of Special Areas of Conservation (ZEC)", and approval of the Integral Management Plan for the protected areas of the Mar Menor and the Mediterranean coastal strip of the Region of Murcia. It was created to respond to the need for a suitable instrument to guarantee the conservation of the protected areas, the terrestrial and marine area of the Mar Menor and the Mediterranean coastal strip of the Region of Murcia, in compliance with the Habitats and Birds Directives and the State Law 42/2007, of 13 December, on Natural Heritage and Biodiversity. Also, without the status of law, the "Integrated

[44] *Ley de protección y armonización de usos del mar menor*
[45] Repealed law, *Ley 1/2001, de 24 de abril, del Suelo de la Región de Murcia.*
[46] Decreto-Ley nº. 1/2017, de 4 de abril, de medidas urgentes para garantizar la sostenibilidad ambiental en el entorno del Mar Menor.
[47] *Ley 1/2018, de 7 de febrero, de medidas urgentes para garantizar la sostenibilidad ambiental en el entorno del Mar Menor.*

Coastal Zone Management Strategy of the Socio-ecological System of the Mar Menor and its surroundings", whose current document is a revision of a document drawn up in 2016, is also noteworthy. It is conceived as a global management framework in the public sphere, adapted to the characteristics of the social and ecological system of the Mar Menor, with the aim of achieving a balance suitable for sustainable socio-economic development in the lagoon itself and its surroundings, keeping a good environmental status.

At the present time, **the most relevant documents relating to the environmental, social, and economic framework** applied to the Mar Menor and its surroundings are:

- Law 3/2020, of 27 July, on the recovery and protection of the Mar Menor.
- The Strategy for the Integrated Management of Coastal Areas of the Socio-ecological System of the Mar Menor and its surroundings.
- Analysis of solutions for Zero Discharge into the Mar Menor from the Campo de Cartagena.
- Hydrological Plan of the Segura Hydrographic Demarcation 2022-2027.

The Law 3/2020, of 27 July, on the recovery and protection of the Mar Menor, was drawn up with the aim of protecting, recovering, developing, and revaluing the biological, environmental, economic, social and cultural wealth of the Mar Menor, articulating the public policies that affect it, in a comprehensive and sustainable manner. It is a regulatory document that aims to cover a much broader scope than Law 1/2018 of 7 February, affecting not only the agricultural sector and discharges that affect the Mar Menor, but also reaching various sectors, to solve problems such as the effects of heavy metals from Sierra Minera, etc.

Finally, it is important to highlight that, in the hydrological framework, according to the revised text of the Water Law, approved by Regulation 1/2001, of 20 July (hereinafter, Water Law), the Mar Menor is also a coastal body of water that is part of the Segura Hydrographic Demarcation, and is affected by the determinations of the Hydrological Plan of the Segura Hydrographic Demarcation 2015-2021, approved by Regulation 1/2016, of 8 January. And by the Hydrological Plan for the Segura Hydrographic Demarcation 2022-2027, which is currently being prepared.

Law 3/2020 of 27 July, for the recovery and protection of the Mar Menor lagoon "*Ley de recuperación y protección del Mar Menor*."

ISSUES ADDRESSED IN THE LAW

Law 3/2020, of 27 July, on the recovery and protection of the Mar Menor is the most recent regulatory document of environmental nature affecting the Mar Menor, together with its subsequent amendment in 2021.

Both laws (Law 3/2020 and the Law that amends it) are available on the web portal of the official gazette of the Spanish state, they can be checked from the following links[48].

As mentioned in the previous section, it is a law drafted with the aim of including measures for the protection of the Mar Menor lagoon applicable to different areas depending on the sectors that are affected. The total area affected, according to the law, would be the set of municipalities that form part of its catchment basin. This law classifies the area into two large zones that encompass most of the pack of measures but allows the different determinations of its regulations to specify a different territorial scope.

Figure 7. Measurement and zoning map of the Law 3/2020 of 27 July, "Ley de recuperación y protección del Mar Menor". Source: Authors

In terms of territorial and landscape planning and management, the law focuses on highlighting the need to adopt two major strategies: the EGIZCSSEMM and the Landscape Strategy of the Region of Murcia in the Region of Cartagena and Mar Menor. Also of note in this respect is Article 15, which

[48] Links:

- Law 3/2020: https://www.boe.es/eli/es-mc/l/2020/07/27/3
- Decree-law 5/2021: https://www.boe.es/buscar/doc.php?id=BORM-s-2021-90328

establishes a period of three years from the date of entry into force of this law to adopt the Land Management Plan for the Mar Menor Catchment[49], adapting its objectives and limits to those of the present law.

In addition, this law establishes a temporary exclusion area for new urban developments, which will not affect consolidated urban centres; and it also suspends the granting of authorisations by public interest, except for certain cases[50]. It also introduces certain provisions for new urban development, not affected by the temporary exclusion.

With regard to environmental planning, the law devotes a section to the management of the natural heritage, forestry and biodiversity of the Mar Menor, a brief section which only refers to the integrated management plan for the protected areas of the Mar Menor and the Mediterranean coastal strip of the Region of Murcia as the instrument responsible for managing the environmental planning of the Mar Menor. It also devotes two articles to forestry matters: the first refers to the preparation of a hydrological-forestry restoration plan for the Mar Menor basin, and the second to the limitation of changes in forestry use not motivated by reasons of general interest.

Also in environmental matters, a section is dedicated to the discharges management, introducing the possibility of temporarily authorising groundwater discharges, provided that the necessary treatment is carried out so that the nutrients they incorporate are below the established limits, and imposing the obligation to install separate networks for the collection and channelling of rainwater in new urban developments.

In terms of agricultural management, this law repeals Law 1/2018, of 7 February, and focuses on developing new content taking it as a starting point. It only maintains in force the " *Código de Buenas Prácticas Agrarias de la región de Murcia* ", which is a package of agronomic and livestock measures of a voluntary nature for the entire territory of the Region of Murcia and of a mandatory nature in those areas that are vulnerable to nitrate contamination. This law introduces technical improvements to the repealed regulation and imposes new requirements on farms, particularly those located in Zone 1, due to their proximity to the Mar Menor. This law reduces the deadlines for the application of agricultural measures in comparison with Law 1/2018, and specifically reduces the deadlines for the crop restitution (a measure that is intensified by limiting them even further, by Decree-Law 5/2021 amending this law), also prohibits the transformation of rainfed to irrigated land not covered by a water use right, and the creation of new rainfed crops, or expansion of existing ones, is subject to authorisation; it is extended to 1,500 metres, measured from the shore of the Mar Menor, the band limiting fertilisation; the direct application of sewage sludge is prohibited; requirements are imposed on the management of plastic waste; etc. Please check the *Table 9*.

[49] *Plan de Ordenación Territorial de la Cuenca Vertiente del Mar Menor*
[50] It will not apply in the case of actions of regional interest, projects declared to be of tourist interest or strategic projects in which it is accredited that they do not affect the Mar Menor, having been queried the Mar Menor Council.

Regarding livestock farms, the prohibition of new pig farms and their extension in Zone 1 must be highlighted as an important restriction, as does the restriction on the extension, or change of zootechnical classification in Zone 2; the reinforcement of the obligations to waterproof ponds and livestock manure storage systems; and the obligation to report the use of slurry as fertiliser through the electronic register of movements of livestock manure.

In terms of fishing, the law stresses that the Mar Menor will have its own fishing regulations and establishes in article 60 the objectives of those. In addition to this, it highlights the mention of a future census of professional fishing boats that will be able to carry out their activity in the Mar Menor under certain access conditions.

Related to port infrastructures, legal status is given to the prohibition on the construction of new marinas in the Mar Menor, already established in the Integrated Management Plan; and obligations are included for port concessionaires in relation to the control of dumping and solid waste management.

With regards to the mining activities, this law establishes regulations on enforcement for actions included in the Plan for the Environmental Recovery of Land Affected by Mining.

POLICY HIGHLIGHTS DESCRIBED

The best management practices are those set out in the following articles of Law 3/2020, with the greatest social impact, and which are frequently referred in the media, are:

- Article 16. Temporary exclusion area. For a maximum period of three years from the entry into force of this law, a temporary exclusion area is established for new urban developments that have not been adopted before the law.
- Article 20. Changes in forest use. In Zones 1 and 2, changes in the forest use of the woodlands are prohibited when they are not motivated by general interest reasons.
- Article 28. New crops or irrigation. The conversion of unirrigated land to irrigated land, which is not covered by a water use right obtained prior to the publication of the law, is prohibited in Zones 1 and 2.
- Third transitional provision. Requirement of measures applicable to existing agricultural holdings. For areas located between 100 and 500 metres from the inner limit of the shore of the Mar Menor, the prohibition of fertilisers will be enforceable immediately; and also for areas located between 500 and 1,500 metres from the shore, three months hereafter the entry into force of this law.
- Transitional provision four. Obligatory application of the Code of Good Farming Practices of the Region of Murcia on a transitional basis. In Zones 1 and 2, compliance with the Code of Good Farming Practices[51] of the Region of Murcia shall be compulsory. This code is an extensive document which can be queried in the Annex V of Law 1/2018 on urgent measures to guarantee

[51] For more information, consult Annex V of Law 1/2018, of 7 February, on urgent measures to guarantee environmental sustainability in the Mar Menor area. Link: https://www.boe.es/eli/es-mc/l/2018/02/07/1

environmental sustainability in the Mar Menor area. In the following table there are some important items of this document:

RECOMMENDATIONS OF THE CODE OF GOOD AGRICULTURAL PRACTICES OF THE MURCIA REGION	
AGRONOMIC MEASURES	Warnings and obligations in fertilizer application.
	Conditions for fertilizer application on sloping and steep terrain.
	Unsuitable periods for nitrogen fertilization.
	Conditions of fertilizer application on hydromorphic, flooded, frozen or snow-covered soils.
	Minimum distances from the hydraulic domain.
	Maximum rates for the application of nitrogen fertilizers.
	Determination of the nitrogen fertilizer application rate.
	Irrigation water quality and use.
	Efficient irrigation application and maintenance.
	Promotion of crop rotations.
	Soil tillage and erosion.
	Plant residue management.
	Soil quality management.
	Permeability and vulnerability criteria
	Abandoned crops.
	Conditions for the temporary piling of manure in the field before spreading for use as an amendment.
	Protection of bees and pollinating insects.
LIVESTOCK MEASURES	Good manure storage practices.
	Water use.
	Feeding of animals.
FOLLOW-UP PROGRAMME	
DISSEMINATION AND INFORMATION MEASURES OF THE CODE OF GOOD FARMING PRACTICE	

Table 6. Recommendations of the Code of Good Agricultural Practices of the Murcia Region. Source: Compilation based on the contents of Annex V of Law 1/2018 of 7 February.

In addition, Law 3/2020 of 27 July 2020, on the recovery and protection of the Mar Menor (Table 7), includes a wide-ranging catalogue of measures to be implemented by the regional administration in matters of governance: land and landscape planning and territorial; environmental planning and management; agricultural, livestock and fisheries planning and management; port and harbour infrastructure and management of port and navigation infrastructures; development and management of tourism and leisure activities; mining planning and management, and a sanctioning and control regime.

CHAPTERS OF THE LAW	Nº. OF ACTIONS AND ACTIVITIES
Governance	8
Environmental planning and management	3
Land and landscape planning and management	4

CHAPTERS OF THE LAW	Nº. OF ACTIONS AND ACTIVITIES
Agricultural planning and management	5
Livestock and fisheries planning and management	4
Port infrastructure and navigation planning and management	4
Tourist, cultural and leisure development, and management	1
Mining planning and management	5
Sanctioning and control system	3

Table 7. Nº of actions foreseen in the law 3/2020. Source: Mar Menor inter-administrative forum.

TOPIC	MEASURES PROVIDED FOR IN LAW 3/2020 OF 27 JUNE 2020 ON THE RECOVERY AND PROTECTION OF THE MAR MENOR.
Governance	- Inter-Administrative Commission for the Mar Menor - Collaboration agreements between Public Administrations - Mar Menor Council - Mar Menor Scientific Advisory Committee - Interdepartmental Commission for the Mar Menor - Communication and Information System for the Mar Menor: Plans or Dissemination Campaigns (Social Networks; Press; TV; Web), Website with updated information on the State of the Mar Menor, Directory for Integrated Management and Regulatory Compendium. - Open data catalogue of environmental monitoring parameters of the Mar Menor. - Annual report to the Governing Council on compliance with the Law
Spatial and landscape planning and management	- Integrated Coastal Zone Management Strategy for the socio-ecological system of the Mar Menor. - Landscape Strategy of the Region of Murcia in the Comarca of Campo de Cartagena and Mar Menor. - Territorial Management Plan for the Mar Menor Basin.
Environmental management and planning	- Integral Management Plan for the Protected Areas of the Mar Menor and the Mediterranean Coast. - Mar Menor and the Mediterranean Coastal Strip of the Murcia Region - Hydrological-forestry restoration plans and projects. - Control and improvement of rainwater networks, sewage and wastewater treatment plants - Land-Sea Discharge Regulation
Agricultural development and management	- Agri-environmental Operators Order - Action Programme on Vulnerable Zones to Nitrate Contamination from nitrate pollution of agricultural origin and a specific action

TOPIC	MEASURES PROVIDED FOR IN LAW 3/2020 OF 27 JUNE 2020 ON THE RECOVERY AND PROTECTION OF THE MAR MENOR.
	programme for the specific action programme for the Campo de Cartagena aquifer. - Creation of a label for the sustainable agriculture of the Mar Menor - Drawing up the Plan for the Inspection of Agricultural Holdings. - Draw up a programme of actions to maintain and conserve soils and prevent erosion phenomena.
Livestock and fisheries development and management	- Creation of the Electronic Register of Livestock Waste Movement. - Analysis of the density of livestock uses in the Basin. - Drawing up of a regulation on professional fishing in the Mar Menor. - Drawing up of a census of professional fishing boats.

Table 8. Measures provided for in the law 3/2020. Source: Mar Menor inter-administrative forum.

The status of these measures, according to the latest report of the Mar Menor inter-administrative forum[52], is as follows:

Governance measures:

- Decrees on the composition and functioning of the scientific advisory Committee and decree of the Mar Menor council: the allegations received during the public information process are being studied.
- Signing of a collaboration protocol with the Ministry and the municipalities for the formal creation of the Mar Menor inter-administrative commission[53]. The need for this signature has been formally reiterated by the environmental counsellor and the mayors of some municipalities.
- Dissemination plans and campaigns. In operation since 2017.
- Launch of the website "Canal Mar Menor": Link[54].
- Open data catalogue: the environmental parameters of the Mar Menor are available in the Scientific Data Server and in the Transparency Portal.[55]
- The first annual report on the degree of implementation and compliance with the Law has been drawn up.[56]

Land and landscape measures:

- The Integrated Management Strategy (EGISSEM): approved by the Governing Council on 31 March 2021 and published in the Official Gazette of the Region of Murcia on 13 April 2021.

[52] 17 November 2021, *Foro interadministrativo del Mar Menor*, [Inter-Administrative Forum Of The Mar Menor].
[53] The current Inter-administrative Coordination Forum
[54] Mar Menor official website, *Canal Mar Menor*. Link: https://canalmarmenor.carm.es/
[55] Scientific Data Server and the Transparency Portal. Link: https://marmenor.upct.es/
[56] To monitor the progress of the law month by month, it is recommended to consult the reports on the "Canal Mar Menor" web portal. Link: https://canalmarmenor.carm.es/comunicacion/forointeradministrativo/

- The Landscape Strategy of the Region of Murcia in the Campo de Cartagena and Mar Menor Region: the field work is completed and it is currently in the phase of defining landscape quality objectives and drafting the final document. The publication of the draft and the start of environmental processing is planned for the first quarter of 2022.
- Land Management Plan for the Mar Menor River Basin (POTMARME): Following the resolution of the Central Administrative Court of Contractual Resources, by order of 13 September 2021, the contract for the drafting of the work has been definitively awarded. The analysis and diagnosis corresponding to the first phase of the work is currently being carried out and work is being done on the definition of the Territorial Model to be proposed. The publication of the document and the start of the environmental processing is planned for the first quarter of 2022.

Environmental/ related measures:

- Approval of the Integrated Management Plan for the Protected Areas of the Mar Menor and the Mediterranean Coastal Strip of the Murcia Region.
- Hydrological-forestry restoration plan: draft prepared and sent to MITERD[57] for its report. Drafting of the environmental report for the Ordinary Strategic Environmental Assessment. Both the Initial Strategic Document (DIE) and the draft of the Mar Menor Hydrological-Forestry Management Plan. The documents are under legal review prior to processing.
- The CARM has foreseen in the first planning "Interventions FEADER[58] in the Strategic Plan of the CAP-Non-Productive Forestry Investments 2023-2027" aid for reforestation for 2.7 million euros.
- Programme for the control and improvement of rainwater, sewerage and WWTP networks: the scope document has been drafted. The Directorate General for Water is carrying out the Strategic Environmental Study.
- Land-Sea Dumping Regulation: To be submitted to the strategic environmental assessment procedure.

Agricultural measures:

- Inspection Plan for Agricultural Holdings. On 10 September 2021 (BORM nº 210), the Order of 6 September 2021, of the Regional Ministry of Water, Agriculture, Livestock, Fisheries and the Environment, adopts the Inspection Plan for Agricultural Holdings. There is also another inspection Plan for Agricultural Holdings for the three-year period 2022-2024, for the control of the measures provided for in chapter V and article 57 of the Article 57 of Law 3/2020, of 27 July, on the recovery and protection of the Mar Menor.
- Agri-environmental Operators Order: has been submitted to Public Information. The legal services are finalising its publication. Prior to the drafting of the preliminary version of the law or regulation, a public consultation is carried out to ensure the opinion of the subjects affected (directly or indirectly) is considered. The Draft Order to regulate agri-environmental operators,

[57] Spanish Acronym of Ministerio para la Transición Ecológica y el Reto Demográfico. [Ministry for Ecological Transition and the Demographic Challenge].
[58] Spanish Acronym of *Fondo Europeo Agrícola de Desarrollo Rural*. [European Agricultural Fund for Rural Development].

within the framework of Law no. 3/2020, of 27 July, for the recovery and protection of the Mar Menor has been submitted to a participatory process on this regulation by means of prior consultation from 28 September to 18 October 2021.

- Specific action programme for the Campo de Cartagena Nitrate Pollution Vulnerable Zone: in process. It is in the strategic environmental assessment phase.
- The Mar Menor Sustainable Agriculture Label and the Action Programme to establish technical measures for the maintenance and conservation of soils are being drawn up.

Measures for livestock and fisheries:

- The electronic register of the traceability of livestock manure movements: the order implementing the electronic register has been adopted. The electronic register is operational.
- Regulations on professional fishing in the Mar Menor: draft Order has been drawn up. The processing as a Decree has been restarted. Awaiting response from the Legal Council.
- Order regulating the census of professional fishing vessels: in the process of querying and public information. A legal report has been issued to move on to the next stage of processing.

Measures related to ports and shipping:

- The studies of the coastal dynamics of marinas, those corresponding to the ports "Los Nietos", "Los Urrutias", "Lo Pagán" and "La Isleta" are in the supervision phase, while the rest are in the preparation phase.
- All the Zero Discharge projects have been delivered by the concessionaires of the Mar Menor marinas.
- Boat access ramps: pending obtaining the DPMT occupancy title from the coastal demarcation. The State Coastal Demarcation reported with various conditions to the solution proposed, in which the incidents that have occurred in the ramps that have already been executed were corrected. The processing is left pending as it is not possible to execute the most appropriate solution.
- By means of the sole derogatory provision of Decree-Law 4/2021, of 17 June, on administrative simplification in the field of the environment, natural environment, agricultural and environmental research, and innovation published in the BORM on 22 June, Articles 64, 65 and 66 of Law 3/2020 are repealed.

Mining-related measures.

- The PRASAM[59] Committee of experts will select and prioritise actions aimed at the recovery of mining waste facilities and sites affected by metallic mining in the Mar Menor catchment area.
- Prioritisation based on 3 aspects: mining waste facilities inventoried by the IGME, wadis running into the Mar Menor and soils affected by the mining activity itself.

[59] Spanish Acronym of *Plan de Recuperación Ambiental de Suelos Afectados por la Minería*. [Environmental Recovery Plan of Soils Affected by Mining].

- The hydrographic confederation of Segura, the general directorate of mines and the universities have participated in the prioritisation.

Measures related to tourism, culture, and leisure.

- System for the recognition of the sustainability of nature tourism (SRSTNRN): The forms for joining the system have been completed for two protected areas, SPAs/SCIs "Salinas y Arenales de San Pedro" (May 2021) and SPA "Mar Menor" (July 2021). The ITREM[60] has informed the tourism sector and is going to draw up a list of tourism companies likely to join the SRSTNRN.
- Good practice manual for tourism companies: The Directorate General for the Natural Environment has contracted the work for the elaboration of up to 5 Good Practice Manuals and for the preparation of the training programmes and materials that will serve as a basis for the training for tourist agents.
- Tourism promotion plan. The ITREM has included the Mar Menor as a strategic project in the framework of the General Tourism Promotion Plan of the Region of Murcia. Within this framework, sporting events of national and international repercussion are being held in the Mar Menor and its surroundings, such as a stage of *the Vuelta Ciclista a España* (Cycling tour through Spain), Madison Beach Volley Tour, Sailing Championships, and other sporting events. All this in collaboration with the business sector, associations, and other institutional bodies of the municipalities of the Mar Menor.

DECREE-LAW 5/2021, OF 27 AUGUST, AMENDING LAW 3/2020, OF 27 JULY, ON THE RECOVERY AND PROTECTION OF THE MAR MENOR. "*DECRETO-LEY 5/2021, DE 27 DE AGOSTO, DE MODIFICACIÓN DE LA LEY 3/2020, DE 27 DE JULIO, DE RECUPERACIÓN Y PROTECCIÓN DEL MAR MENOR.*".

This regulation consists of an explanatory section in which it briefly sets out the current problems of the Mar Menor lagoon and an operative section structured in a single article.

The reform of this law introduces extraordinary modifications such as further reducing the processing times for crop restitution proceedings to restore farms without irrigation rights to their natural state and sanctioning proceedings for non-compliance with the obligations imposed in this law, to prevent the entry of nutrients into the Mar Menor from agricultural activities.

It also stresses the need to implement the measures contained in the Analysis of solutions for Zero Discharge into the Mar Menor from Campo de Cartagena, and in particular measures 5, 6 and 9 of this plan, focused on preventing and stopping the entry of nutrients into the Mar Menor, and suggests that it is time to prohibit the input of nutrients in Zone 1; to increase sustainable actions and behaviour in the entire catchment area; and to reduce as far as possible the time taken to process the proceedings for the Restitution of Cultivation and Penalties so that the Mar Menor reaches a favourable conservation status as soon as possible.

The most important articles included in this decree are as follows:

[60] *Instituto de Turismo de la Región de Murcia.* [Institute of Tourism of the Region of Murcia].

Article 33. to reduce pollution caused by nutrients of agricultural origin and its effect on the protected areas existing in the Mar Menor and its surroundings, the competent Regional Ministry for the control of nitrate pollution will require the restoration of the land to its natural state.

a) eliminate all irrigation installations or infrastructures.
b) remove all signs of cultivation.
c) preventing the soil from becoming bare.
d) adopt additional soil conservation measures.

Article 34. Restitution procedure - establishes deadlines and coercive purposes.

Article 81. Infringements - the use of fertilisers containing inorganic or synthetic nitrogen in zone 1, under the terms of the thirteenth additional provision, constitutes serious administrative penalty for non-compliance with the agricultural measures required in zones 1 and 2; Thirteenth additional provision - Limitation of the use of nitrogen fertilisers in zone 1 - agricultural fertilisation in zone 1 shall be limited for two years, or until the infrastructure for channelling the aforementioned run-off is in place, as follows:

a) The use of fertilisers containing entirely inorganic or synthetic nitrogen is prohibited.
b) The use of organic fertilisers containing nitrogen in their composition, such as soil conditioners authorised in organic farming, or solutions based on micro-organisms such as atmospheric nitrogen fixers or similar, or capable of increasing their populations in the soil, is permitted at the maximum doses laid down in the various provisions of the Law.

Cultivation techniques that totally prevent leaching, such as hydroponic cultivation with recirculation systems, are excluded from the limitation laid down in this provision. This precept is applicable to areas located less than 1,500 metres from the Mar Menor, as they have the same specific restrictions contained in Article 29.4 of this Law.

EXPECTED IMPACT OF POLICY FOR THE NATURAL ENVIRONMENT

The decree-law aims to regulate the socio-economic activities that coexist in the Mar Menor to reduce pressures on the ecosystem by dividing the area into two zones.

One of the most important measures is the immediate ban on the use of fertilisers within 500 metres of the seashore, as well as a ban on the direct application of slurry. The “Confederación Hidrográfica del Segura” (CHS) estimates that at the time the law was adopted there were only 136 hectares of irrigated land out of a total of 60,000 hectares in the basin. This ban will be extended to a 1,500 metres strip 3 months after the approval of this law. It also limits the number of crops, establishes a register of farms, systems for monitoring the use of irrigation water, control and monitoring of mineral fertilisation in irrigation, and creates collaborating entities for inspection and monitoring.

In total, more than 390 hectares will be worked, and 216 hectares of lamination will be established, as well as the restoration of 13 kilometres of watercourses. However, although the use of fertilisers, non-composted manure or green manure will be prohibited within 1,500 metres, as well as the establishment of new greenhouses or the extension of existing ones, dry farming, organic farming and "sustainable precision agriculture" will be permitted in the consolidated areas, provided that the use of fertilisers does not exceed 170 kilograms of nitrates per hectare per year.[61]

EXPECTED IMPACT OF THE POLICY FOR THE ECONOMY

The new law has pleased neither environmentalists, who consider it entirely insufficient, nor farmers, who maintain the law will drive agriculture from the area. Natalia Corbalán, director of the Ingenio Foundation, which represents approx. 10,000 farmers and 50 agro-industrial companies in the Campo de Cartagena, claims that 70% of the law blames the agricultural sector, and that its implementation will not solve the problem but will have a huge negative impact on the sector.

While she recognizes that agriculture “has an impact on the lagoon,” she warns that the measures will make the sector unviable in the area. Meanwhile, the main agricultural producers’ organizations, such as COAG, UPA and ASAJA, have issued a joint statement in which they recognize the existence of these unlicensed irrigation systems and “condemn them without reservation”, but warn that linking all solutions for the Mar Menor to restrictions on agriculture is irresponsible and will not improve the environment unless other issues such as urban waste and motorized water sports are also taken into consideration, as well as flood prevention measures.

OTHER EXPECTED IMPACTS OF THE POLICY

The CHS identified about 8,500 hectares of irrigated land with signs of illegal water use and opened a file of penalties for more than 7,800 hectares of that land. Almost half a thousand files have been submitted so far, 207 of which have been sent to the Supreme Prosecutor of Murcia and a hundred to the territorial government.

SUMMARY OF RESTRICTIONS INCLUDED IN THE LAW

[61] Article 29. Law 3/2020. *Limitación de la actividad agrícola en terrenos próximos al dominio público marítimo-terrestre.* [Limitation of agricultural activity on land near the maritime-terrestrial public domain].

SCOPE OF APPLICATION	LOCATION WHERE THE RESTRICTION APPLIES	RESTRICTIONS
Spatial and urban planning	Temporary exclusion area	For a maximum period of three years from the entry into force of the law 3/2020, a temporary exclusion area is established for new urban developments that have not been adopted before this law.
	Zone 1 and 2	New urban developments shall contain the following measures: 1. Introducing permeable paving 2. Water evacuation by means of separate networks for rainwater and wastewater, establishing rainwater reuse systems. 3. Implementation of Nature Based Solutions (NBS) and Sustainable Urban Drainage Systems for those soils with special runoff (SUDs). 4. Adoption of circular economy measures, recycling of construction waste, energy efficiency, etc., in all urban facilities.
Control of discharges into the sea	Mar Menor Lagoon	Discharges of any kind from land into the Mar Menor are generally prohibited, with the exception of rainwater discharges and groundwater evacuation through drainage pipes, in those cases where there is not technically, economically and environmentally viable alternative for their elimination by other means.
Agricultural development and management	Zone 1 and 2	Conversion of rainfed land to irrigated land is forbidden
		All agricultural holdings are obliged to subscribe to the registry of Agricultural Holdings of the Region of Murcia.
		The calculation of the nitrogen balance, in accordance with the applicable action programme and the Code of Good Farming Practice.
		The provision of information on the actual volume of water supplied and the monitoring of its application to irrigation shall be mandatory.
		Obligation to plant conservation vegetation structures and vegetation strips.
		It shall be compulsory to allocate 5 per cent of the area of each agricultural holding in Zone 1 and 2 to nutrient retention systems in order to reduce diffuse pollution.
		All cultivation operations shall follow the contour lines according to the orography of the terrain.
		Only one or two annual crops are allowed.
		Greenhouses with a waterproof plastic covering shall be provided with rainwater harvesting structures.
		Mandatory implementation of the action programme for areas vulnerable to nitrate pollution from agriculture
	Zone 1	Only sustainable, precision farming is allowed.
		The direct application of slurry without prior treatment in an approved treatment plant is prohibited.
		The installation of sensors to support efficient water management is mandatory throughout the soil profile affected by irrigation and the use of drippers with unit flow rates of more than 2.2 L/h is prohibited for horticultural crops.
		No bare ground in autumn and winter
	Land which is not considered as forest	The creation of new areas of unirrigated land, or the extension of existing ones, is subject to authorisation by the regional administration.

SCOPE OF APPLICATION	LOCATION WHERE THE RESTRICTION APPLIES	RESTRICTIONS
	In the area within 500m of the Mar Menor lagoon	The application of all types of fertilisers is prohibited.
	In the area within 1,500m of the Mar Menor lagoon	The reserve areas for nutrient retention shall be 20 percent of the surface area of each farm and must be used for one of the actions provided for in the Mar Menor lagoon protection law or for the creation of forest areas.
		The application of all types of fertilisers is prohibited. Except organic, sustainable and precision farming crops complying with the restrictions of Law 3/2020.
		The installation of new greenhouses and the extension of existing greenhouses is prohibited.
livestock farms	Measures applicable to livestock holdings within the area of Law 3/2020	The obligation to impermeabilize the store systems of manures in farms.
	Zone 1 and 2	Slurry and manure must be delivered to an approved rendering or animal by-product management facility not intended for human consumption.
		Prior notification and validation of livestock manure movements through the electronic livestock manure movement register shall be compulsory
	Zone 1	The establishment of new livestock facilities and the extension of existing holdings is prohibited.
Planning and management of professional fisheries	Policy area of law 3/2020	It is planned to draw up a regulation on professional fishing in the Mar Menor. It will regulate the conditions for obtaining authorisation to fish.
Development and management of port infrastructures	Mar Menor lagoon	Prohibition of the construction of new marinas and negative effects on coastal dynamics.
		Expansion of existing ports will only be possible when it is considered within the framework of an environmental conversion programme.
	Mar Menor lagoon	Navigation in the waters of the Mar Menor will be limited, allowing only vessels that comply with the list of characteristics specified in Law 3/2020 to navigate.

SCOPE OF APPLICATION	LOCATION WHERE THE RESTRICTION APPLIES	RESTRICTIONS
Planning and management of navigation		• Those vessels that are physically prevented from discharging sewage or grey water into the marine environment. • Those vessels of first registration, if they have an ECO certificate. • All types of vessels whose main propulsion is by sail.
		It shall be prohibited to navigate two-stroke, high-speed, inboard or stern drive inboard engines without integral exhaust, jet skis, outboard engines and stern drive inboard engines with integral exhaust whose noise emissions exceed the values specified in law 3/2020
		Two-stroke jet skis prohibited
		Two-stroke injection engines shall use biodegradable oils.
		Vessels must have black and grey water tanks installed, if they are more than 8 metres in length. If it is not possible to install the grey water tank due to lack of space, the grey water shall be discharged into the black water tank.
		In areas with depths of less than 4 m, 5 knots shall not be exceeded. Elsewhere, 20 knots shall not be exceeded, except in authorised speed zones.
		The anchoring of boats in the Mar Menor is prohibited, except in the areas permitted by the Integral Management Plan for the protected areas of the Mar Menor and the Mediterranean coastal strip of the Region of Murcia, and under the conditions established therein.
		The placement of anchoring elements for boats by means of concrete structures is prohibited.

Table 9. Summary of restrictions of the Law. Source: Authors

Integrated Coastal Zone Management Strategy of the Socio-ecological System of the Mar Menor and its surroundings *"Estrategia de Gestión Integrada de Zonas Costeras del Sistema Socio-ecológico del Mar Menor y su Entorno." (EGIZCSSEMM)*

ISSUES ADDRESSED IN THE STRATEGY

The EGIZCSSEMM is a public technical-scientific planning instrument at a strategic level, adapted to the characteristics of the socio-ecosystem of the Mar Menor, and which aims to become the foundation on which a "cascade" planning of the set of operational plans and programmes will subsequently be developed. It is a legally valid document first published in 2016, and subsequently updated in the current year 2021 on its adoption by Decree no. 42/2021, March, "*Estrategia de Gestión Integrada de Zonas Costeras del Sistema Socio-ecológico del Mar Menor y su Entorno.*".[62]

In addition to being a key document that defines the roadmap for future actions to achieve and maintain a good environmental status of the Mar Menor, its goal is to "*achieve a management model in the public sphere of action adapted to the special characteristics of the SSEMM, in close inter-administrative cooperation, inspired by principles of governance and committed to citizen participation*."[63] (EGIZCSSEMM, p81. March 2021).

To achieve this goal, the EGIZCSSEMM was elaborated as a model focused on strategic planning with a solid base of citizen participation, also assigning in detail to each administration its responsibilities of leadership and execution, establishing a hierarchical scheme in terms of decision-making.

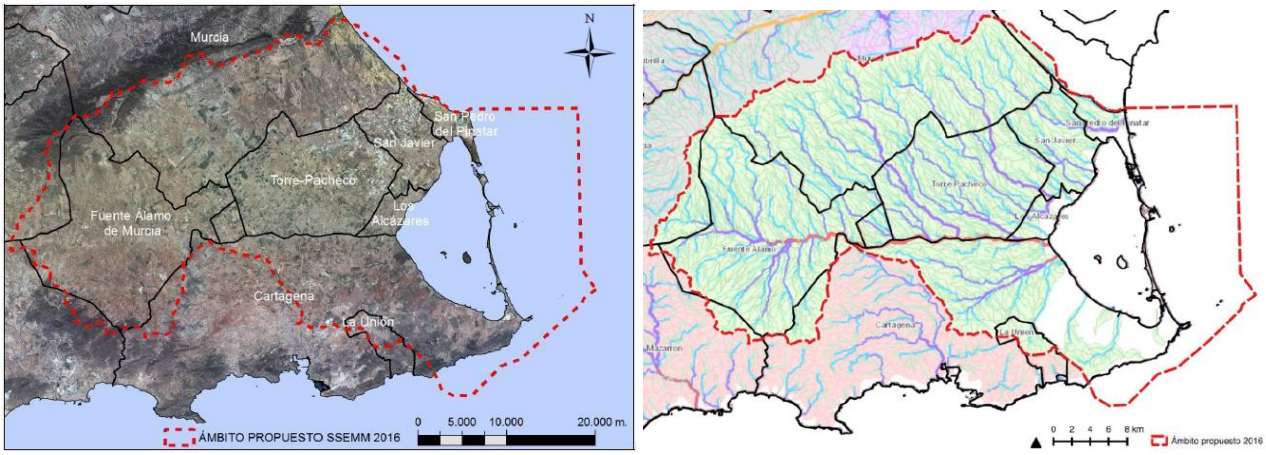

Figure 8. Scope of EGIZCSSEMM 2016. Source: EGIZCSSEMM.

[62] The updated document can be consulted through the web portal of the Territorial Information System of the Region of Murcia (SITMURCIA). Link: https://sitmurcia.carm.es/estrategias-territoriales

[63] *Alcanzar un modelo de gestión en el ámbito público de actuación adaptado a las especiales características del SSEMM, en estrecha cooperación interadministrativa, inspirado en principios de gobernanza y comprometido con la participación ciudadana.*

HIGHLIGHTS OF THE STRATEGY

The Strategy is divided into two distinct parts:

The first corresponds to the participatory diagnosis and, in the form of an information report, includes the formal aspects of the document, the characterisation of the socio-ecological system of the Mar Menor, the strategic diagnosis of the area and the definition of the bases for the development of the Strategy.

The second part corresponds to the proposal phase of the Strategy and contains the different strategic and operational actions and instruments, the definition of the institutions and bodies that must lead and execute them, the design of the Action Plan to carry out the Strategy and the system of indicators.

The most important issues of this Strategy include, in its participatory diagnosis phase, are:

- The characterisation of the SSEMM, a section of the strategy dedicated to the delimitation of the scope and the diagnosis of the driving forces and pressures that intervene in this system with consequences for human well-being.

- The strategic diagnosis, structured in the form of a decalogue, dedicated to analysing the action of the public authorities about the social and economic needs in the field of the Mar Menor.

- The establishment of the bases for the Socio-ecological system of Mar Menor (SSEMM) strategy, where a synthesis of the previous sections is made, considering the main problems that appear in the SSEMM, their possible causes and their impact on the components of human well-being (security, obtaining resources, health, and social relations). Subsequently, the main weaknesses, threats, strengths, and opportunities of the SSEMM are assessed and finally the goals of the strategy are established.

In its propositional phase, the actions and instruments outlined in the strategy are defined, many of which have already been approved due to the difference between the date of initial publication (2016) and approval of the strategy (2021). The list of actions and instruments according to the goals of the strategy is set out below. In total, there are 27 strategic actions and instruments and 9 operational instruments.

Strategic actions and instruments:

I. Build a system of alliances with the main social and institutional actors to develop a new public policy oriented towards the long term and based on the orientations of the Strategy.

1) To have a starting point for a new regional public policy with the philosophy and content of the Strategy.
    1. Adopt the Mar Menor Integrated Coastal Zone Management (ICZM) Strategy.
    2. Publish the Mar Menor ICZM Strategy.
    3. Declaration of the Mar Menor.
2) Deepen and improve institutional coordination and cooperation procedures.
    4. Proposal to initiate operational and sectoral plans.
    5. Mar Menor Coordination Unit
    6. Interdepartmental Commission for the Mar Menor. (Implemented by Law 3/2020).
3) To ensure that the management of the SSEMM stands out as a model of social participation.
    7. Mar Menor Council (formerly the Mar Menor Participation Committee).
    8. Directorate for the integrated management of the Mar Menor. (Implemented in law 3/2020).
    9. Communication and information system of the Mar Menor. (Implemented in law 3/2020).

II. Manage the SSEMM with appropriate and specific instruments, within the framework of an integrated management model.

4) To have adequate administrative legal support.
    10. Law for the recovery and protection of Mar Menor
    11. Compendium for the management of the SSEMM
    12. Special Commission on the Mar Menor
5) Create or adapt ICZM instruments
    13. Office for the Integrated Management of the Mar Menor
    14. Scientific Advisory Committee for the Mar Menor. (Implemented by Law 3/2020).
6) Creating or adapting tools for ICZM
    15. Mar Menor ICZM operational plan
    16. Criteria for the management of the Protective easement area (ZSP) and Maritime land public domain (DPMT).
    17. Monitoring and evaluation system of the Strategy
    18. Revision of the General Plans, integrating sustainability, mobility, and climate change adaptation criteria in their urban planning regulations.

III. To have the necessary resources (economic, knowledge, training, educational) to implement an integrated management model in such a way that public administrations are more efficient in their tasks and resolve conflicts that affect the conditions of human well-being within the scope of the Strategy.

7) Obtaining financial resources for the financing of the Strategy.
    19. ITI Funds
    20. Fund for the improvement and conservation of the Mar Menor
8) To have a technical team prepared for the ICZM of the SSEMM

21. Improve the Monitoring system of the Mar Menor
22. Training for the ICZM
23. Technical conferences on the Mar Menor

9) Educating for the sustainability of the SSEMM
24. Classroom of the Mar Menor
25. Our Mar Menor has a future
26. Fair of the Mar Menor

10) Have a sufficient technical and scientific expertise knowledge to take on all challenges set by the Strategy.
27. Mar Menor Observatory

Operational actions and instruments:

1. Integral management plan for the protected areas of the Mar Menor and the Mediterranean coastal strip of the Region of Murcia.[64] (Adopted in October 2019).
2. Plan for the development, promotion and control of facilities and activities in the Mar Menor. (Unwritten).
3. Plan for the reduction of pollutant inputs into the lagoon. (Unwritten).
4. Land management plan for the Mar Menor catchment area. (Unwritten).
5. Landscape, tourism, and cultural heritage programme. (Unwritten).
6. Hydrological plan of the Segura River basin in the Mar Menor catchment area. (Unwritten).
7. Plan for the recovery and conservation of the mountain ranges bordering the SEMM. (Unwritten).
8. Management plan for the control of islands and fishing reserves. (Unwritten).
9. Plan for adaptation to climate change of the Mar Menor coastal area. (Unwritten).

In terms of strategy implementation, the main document includes an action plan which states that the three phases to be considered during the implementation of the strategy are:

1) Leadership Programme (Tactical Phase One).
2) Approach Programme (Tactical Phase Two).
3) Deployment and Consolidation Programme (Tactical Phase Three).

The Leadership Programme (Tactical Phase One). It should initiate, drive, and lead the start-up of the Strategy. This is a relatively short phase (less than a year) and includes actions that from the strategy's point of view are absolutely feasible and lack institutional complexity. During this phase, the aim is to communicate that the CARM is willing to lead the search for a better way of managing our resources and activities in the Mar Menor area.

[64] *Decreto n.º 259/2019, de 10 de octubre, de declaración de Zonas Especiales de Conservación (ZEC), y de aprobación del Plan de gestión integral de los espacios protegidos del Mar Menor y la franja litoral mediterránea de la Región de Murcia.* [Decree no. 259/2019, of 10 October, declaring Special Areas of Conservation (SAC) and approving the Integrated Management Plan for the protected areas of the Mar Menor and the Mediterranean coastal strip of the Region of Murcia]. Link: https://www.borm.es/services/anuncio/ano/2019/numero/6450/pdf?id=780567

Approach Programme (Tactical Phase Two). During this phase, the aim is to lay the institutional and social participation foundations, and to set out the most important programmes to be developed.

Deployment and Consolidation Programme (Tactical Phase Three). This is the most complex from an operational point of view. It requires a greater number of resources, both human and material, and takes longer (several years) to carry out the corresponding actions.

The distribution of actions and instruments according to the tactical phase in which they are to be developed according to the Action Plan is shown below.

Figure 9. Distribution of actions in the different tactical phases of the Action Plan. Source: EGIZCSSEMM.

EXPECTED IMPACT OF THE STRATEGY

Although the strategy is not expected to have a direct influence on the quality of the water in the Mar Menor, many of the operational instruments that are intended to be implemented based on the strategy's action plan will have a direct impact on the quality of the water in the Mar Menor.

In addition, it is expected that this strategy will improve institutional cooperation procedures, consolidate social and scientific participation in the management model, provide legal support for specific bodies and institutions, and advance environmental awareness.

In this regard, it should be noted that the strategy has a section dedicated to the self-assessment of its impact through a system of indicators (p119, EGIZCSSEMM.)[65]. Establishing, for each of its objectives, actions and instruments, several indicators (including ecological ones) that measure ecosystem services.

[65] Link: https://sitmurcia.carm.es/documents/13454/23299500/EGIZC+SSEMM/caa39127-cbe3-46f5-b230-dc502f5756f7

Analysis of solutions for Zero Discharge into the Mar Menor from the Campo de Cartagena. *"Análisis de soluciones para el vertido cero al Mar Menor proveniente del Campo de Cartagena."*

ISSUES ADDRESSED IN THE PROJECT

The analysis of solutions for the objective of Zero Discharge into the Mar Menor from the Campo de Cartagena[66] is the largest public initiative created with the aim of addressing the needs to tackle the most pressing environmental problems that exist in the ecosystem of the Mar Menor, providing solutions to achieve a balance between the use of natural resources of Campo de Cartagena based on agriculture and maintenance, and the recovery of the natural values of the Mar Menor.

The initial project document dates from 12 July 2016, and is a document drawn up within the framework of the protocol adopted on 4 October 2013 between the Ministry of Agriculture, Food and the Environment and the Autonomous Community of the Region of Murcia, whose objective was to create a stable framework for collaboration and coordination between both administrations to carry out integrated management in the Mar Menor environment within the framework of the legislation on water, coasts and land use planning, marine spatial planning and environmental protection.

At present, the analysis of zero discharge solutions has several documents ranging from its informative project to its respective environmental impact study, approved by the environmental impact declaration of the project which is the Resolution of 4 September 2019, of the Directorate General for Biodiversity and Environmental Quality, formulating the environmental impact statement for the project Analysis of solutions for the objective of Zero Discharge into the Mar Menor from the Campo de Cartagena (Murcia).[67]

This project interprets the concept of <<zero discharge>> not as a zero-discharge flow to the Mar Menor in terms of the volume of water inputs, but as a trend towards the reduction and elimination of polluted water inputs (mainly nutrients) that reach the lagoon, either surface or underground, and which have contributed for decades to its eutrophication. To this end, the project proposes a set of actions consisting of infrastructures, works and interventions in the terrestrial and marine environment, as well as administrative and regulatory measures, with a level of specificity corresponding to an analysis of alternatives.

This project is structured in two parts, a first section in which a diagnosis is made of the existing problems in the environment of the Mar Menor, as well as the possible solutions for each problem, and a second phase in which the characteristics of the different actions are detailed.

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[66] *Análisis de soluciones para el vertido cero al Mar Menor procedente del Campo de Cartagena.*

[67] *Resolución de 4 de septiembre de 2019, de la Dirección General de Biodiversidad y Calidad Ambiental, por la que se formula declaración de impacto ambiental del proyecto Análisis de soluciones para el objetivo de vertido cero al Mar Menor proveniente del Campo de Cartagena (Murcia).*

As defined in its environmental impact statement, the project is envisaged in the following three scenarios:

- the zero or trend scenario
- the adaptive or temporary scenario
- the target scenario

The project is configured with the development of the alternatives in a cumulative manner, each alternative containing the measures included in the previous one, with alternative A of each alternative corresponding to the baseline scenario, and therefore, the alternative that only considers compliance with current regulations.

For example:
Action 1: Improvement of fertilisation.

- 1.A: Compliance with current regulations.
- 1.B: Compliance with current regulations. Monitoring and control.
- 1.C: Compliance with current regulations. Monitoring and control. Reduction of fertilisation doses.
- 1.D: Compliance with current regulations. Monitoring and control. Reduction of fertilisation doses. Implementation of new, more restrictive guidelines.

Only actions 4, 5, 6 and 18 are those in which the alternatives presented are mutually exclusive, following their analysis in the environmental impact study. The environmental impact assessment identifies 4.B, 5.B, 6.B and 18.B as the most important actions from a water management point of view.

According to the environmental impact statement, to carry out these actions it is necessary to declare the groundwater body as being at risk of not achieving good chemical status and additionally at quantitative risk for the deep levels of the aquifer formations, as well as the establishment of the corresponding exploitation programmes and the constitution of the groundwater user communities.

As concerns the implementation of these actions, currently the Governing Board of the Segura River Basin Authority has approved the declaration of the Campo de Cartagena groundwater body at risk of not reaching good quantitative and chemical status by means of an official announcement in the official state gazette, as of 1 August 2020. This declaration establishes a zoning of the area of the body of water and approves a series of precautionary measures in relation to abstraction and protection of water quality. Later, on 13 November 2020, a second announcement was published by the Segura River Basin Authority to extend the perimeter of the area quantitatively affected by the previous declaration.

The aim of these actions is to intervene in the quaternary aquifer with the estimated extraction of 12 hm^3, by means of drains close to the coastline with the Mar Menor, with two clear objectives: on the one hand, to prevent the massive arrival in the lagoon of water rich in nutrients from the aquifer (an extraction of 12 hm^3/year is planned) and, on the other, to make the resource available to users for irrigation with guaranteed quality after its desalination treatment.

The extracted flows will be channelled to two treatment plants: El Mojón in the north and Arco Sur in the south, for desalination of the volumes transported and denitrification of the rejection before discharge by means of underwater outfalls, one at each treatment plant.

The current exploitation of groundwater in the body of water declared at risk is being converted to a system of 99 centralised wells interconnected by pipelines, the volumes extracted from which are channelled back for desalination.

At the same time, within the framework of these actions, the aim is to draw up a programme for the closure of uncontrolled wells causing cross-contamination between the different levels of the aquifer formations of the groundwater body. The identification and decommissioning of unauthorised wells by the competent administration will be carried out prior to groundwater resource management actions.

PROJECT HIGHLIGHTS AT A GLANCE

Among the most outstanding issues of this analysis are the different actions proposed to solve each of the problems diagnosed, with striking measures such as extracting groundwater from the quaternary aquifer, which is currently polluted due to irrigation returns.

Table 10 provides a summary of the actions proposed by the analysis of solutions for the objective of Zero Discharge into the Mar Menor from the Campo de Cartagena. These actions are classified in the analysis into actions to prevent pollution reaching the Mar Menor, actions to solve other existing problems in the Mar Menor area and actions to contribute to its recovery.

ACTIONS TO SOLVE THE ARRIVAL OF POLLUTANTS INTO THE MINOR SEA FROM THE CARTAGENA COUNTRYSIDE VIA SURFACE AND GROUNDWATER.		
Problems		**Actions to solve these problems**
Pollution	Excessive fertiliser application	Improvement of mineral and organic fertilization
	Pollution of the aquifer by infiltration due to deficiencies in excreta storage facilities.	Adaptation of the production model
		Adequacy and overhaul of storage facilities

<table>
<tr><th colspan="4">ACTIONS TO SOLVE THE ARRIVAL OF POLLUTANTS INTO THE MINOR SEA FROM THE CARTAGENA COUNTRYSIDE VIA SURFACE AND GROUNDWATER.</th></tr>
<tr><th colspan="2">Problems</th><th colspan="2">Actions to solve these problems</th></tr>
<tr><td rowspan="4">Groundwater</td><td rowspan="4">Incorporation of pollutants into groundwater.
And over-elevation of the water table in the quaternary aquifer due to irrigation returns.</td><td colspan="2">Establishment of the exploitation regime of the groundwater body</td></tr>
<tr><td rowspan="2">Groundwater abstraction for Quaternary aquifer drainage, treatment, and utilisation.</td><td>Direct abstraction of groundwater for aquifer drainage</td></tr>
<tr><td>Groundwater abstraction by well extraction</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td rowspan="4">Surface water</td><td rowspan="3">Runoff and sediment transport</td><td rowspan="2">Runoff control and transport of contaminated sediments</td><td>Adjustments at plot level</td></tr>
<tr><td>Adjustments at catchment area level</td></tr>
<tr><td colspan="2">Hydrological-forestry restoration of mining basins</td></tr>
<tr><td>Inadequacy of the sanitation system</td><td colspan="2">Improving sanitation systems</td></tr>
</table>

ACTIONS TO SOLVE OTHER PROBLEMS WITH AN IMPACT ON THE SITUATION OF THE MAR MENOR.	
Problems	**Actions to solve these problems**
Lack of optimisation of sewage treatment systems	Expansion and improvement of treatment system and facilities
Deficient management of agricultural waste	Agricultural waste management
Poor livestock manure management	Livestock waste management
Concentration of intensive livestock farms	Management and dimensioning of livestock activity on a regional scale
Pollution from solid urban waste	Adaptation and improvement of controlled landfills
Lack of connectivity and functionality of agricultural drainage network	Adaptation and extension of agricultural drainage systems
Cross-pollution between aquifers	Closure or adaptation of wells involved in cross contamination between aquifers.
Pressures from different uses on the water body	Improvement in the environmental integration of uses

ACTIONS TO CONTRIBUTE TO THE RECOVERY OF THE MAR MENOR.	
Problems	**Actions to solve these problems**
Alteration of the physic-chemical conditions of the lagoon	Improvement of the physic-chemical conditions of the lagoon.
Alteration of the ecological status of the water and associated habitats	Recovery of coastal areas of great ecological value.

Table 10. Summary of the problems and the actions proposed by the analysis of solutions for the objective of zero discharge into the Mar Menor from the Campo de Cartagena. Source: Policy study, Analysis of solutions for zero discharge into the Mar Menor from the Campo de Cartagena.

In addition to the study of the problem, the presentation of the different solutions to tackle the problems of the Mar Menor, one of the sections that stands out most in the analysis of solutions for zero discharge is the summary of the water balance of the Mar Menor. (Table 11).

WATER BALANCE		hm^3/year
System entries	Rainfall	359
	Groundwaters	66.14
	Tagus-Segura inter-basin transfer	49
	Desalting machines	8.2
	Surface water concessions	0.14
	Infiltration of precipitation	76.2
	Irrigation returns in cultivated areas	18.2
System outputs	Evapotranspiration	422
	Direct runoff	29.7
	Groundwater pumping	88.2
	Quaternary aquifer drainage to watercourses	18.3
	Surface inputs to the Mar Menor	34.7 and 37.7
	Groundwater discharge to the Mar Menor lagoon	5-68
	Transfer to deep aquifers	37.9

Table 11. Water balance of Mar Menor. Source: Policy study, Analysis of solutions for zero discharge into the Mar Menor from the Campo de Cartagena.

Important Topics Scheme according to Segura River Basin (CHS) Authority

ISSUES ADDRESSED IN THE STRATEGY

The main object of "The Important Topics Scheme" is to identify, define and propose solutions for the main problems found in CHS in relation with water for both, present and future. The aim is to analyse relevant constraints to achieve the objectives of the hydrological planification.

The document is developed in two phases:

- Firstly, important topics are defined, assessed, and raised alternatives for the Important Topics, along with their possible solutions and the main stakeholders.
- Secondly, after a public evaluation, guiding principles are defined. So, this document is a key starting point to understand the current state of the Mar Menor and to identify possible causes of its degradation.

The Spanish Ministry of Ecological Transition and Demographic Challenge is developing a Special Plan called "Plan Nacional de Depuración, Saneamiento, Eficiencia y Reutilización (DSEAR PLAN)".This document is based on the previous planification period. Related documentation is stored in a national database (Figure 10).

Figure 10. Website to access previous period database. Source: Ministry for Ecological Transition.

The document "*Estudio General sobre la Demarcación*" is available at the CHS website. It gathers pressures and impacts in a general way in the Segura Demarcation (which contains Mar Menor).

The European Commission has developed a document assessing if Spanish hydrological planification have reached European duties in that sense.

HIGHLIGHTS DESCRIBED

Topics

Topics are classified in 4 categories:

- Fulfilment of environmental objectives
- Attending demands and rationalisation of water use
- Security against extreme weather events
- Knowledge and governance

Topics haves been redistributed since the 2º planification cycle, making it more coherent and comprehensive. The following tables shows important topics in relation with the Mar Menor lagoon:

2º cycle topics	3r cycle topics	Comments
Pollution due to nitrates, pesticides and decrease of physicochemical quality in "Campo de Cartagena". (Affection to Mar Menor).	Important Topic 2: Diffuse pollution due to nitrates and other products	This relevant topic refers to affections by pollution caused by nutrients, conductivity, and plant-protection products to surface and ground water
Eutrophication of Mar Menor, pointed out as vulnerable	Important Topic 4: Improvement of the Mar Menor environmental status and management of their catchment area.	This was already considered in the 2º cycle, now is expanded to consider management of Mar Menor basin.
Pollution due to nitrates, pesticides and decrease of physicochemical quality in "Campo de Cartagena". (Affection to Mar Menor).		
Necessary adjustments of discharges from residual waters to environmental requirements	Important Topic 14: Pollution due to punctual discharges	This topic is maintained in the 3r cycle

Table 12. Important topics in relation with the Mar Menor lagoon.

Sustainable management of ground water

Regarding the sustainable management of ground water, in CHS, irrigation in crops have been sustained by overusing ground water supplies. It is leading to a situation where superficial water bodies are losing connection with ground water bodies. The livestock industry has a remarkable role overusing ground water, also relevant agriculture, and human settlements. Climate change is particularly relevant in that sense: a reduction in rainfall will reduce recharge of ground water supplies and longer drought periods could imply higher volumes of water extractions.

Diffuse pollution

Regarding the diffuse pollution, 30% of the superficial water bodies are affected by this problem and also the 33% of ground water bodies. Nitrates content reaches 250 mg/l, when water legislation defines a threshold of 50 mg/l. These contaminant agents have their origin in products employed in agriculture (irrigated and no irrigated). In the context of "Campo de Cartagena", pollution from

crops ultimately arrive to the lagoon. Streams, in their ending areas play a role as conductions from the "Campo de Cartagena" quaternary aquifer to Mar Menor lagoon. This aquifer cumulates the pollutants and then discharges them to the lagoon. Some other direct pollutant discharges are gathered by streams also.

Campo de Cartagena has been identified has a *Very Affected Area* by nitrates: 1.464 t N/year are discharged in the Mar Menor Lagoon, due to a charge of 331 kg N/ha/year. Nitrates content of the water discharged by the aquifer are measured in 244 mg/L, while maximum admitted by legislation is 50 mg N/l.

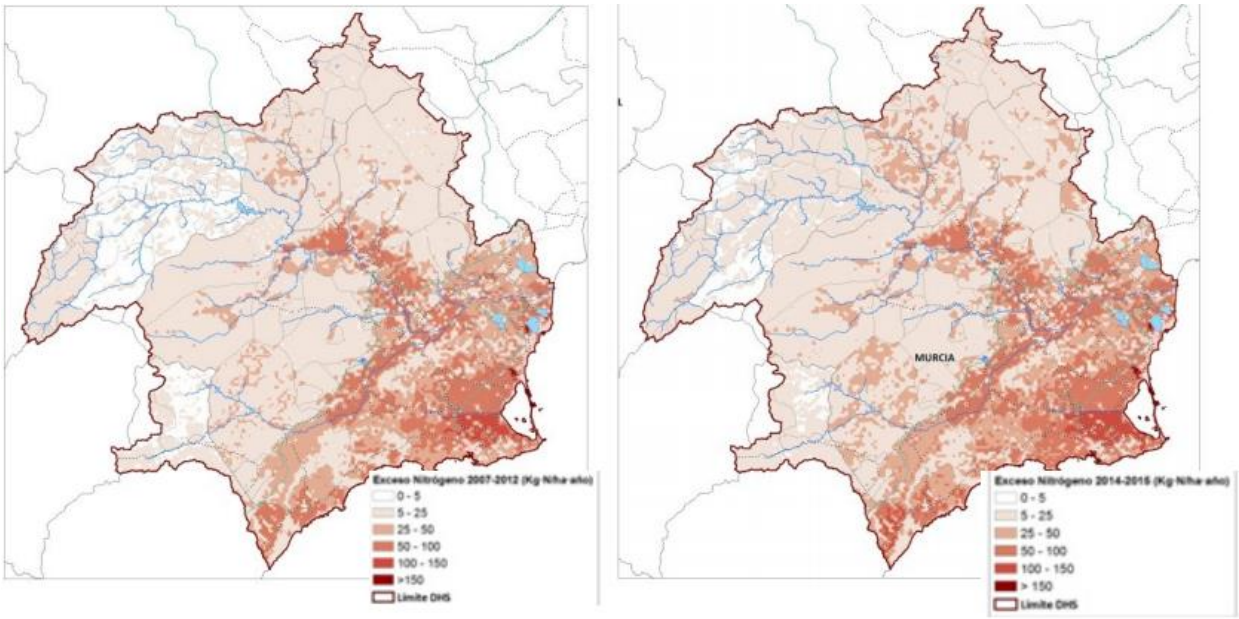


Figure 11. Nitrogen excess in soil (kg/N/ha/year) as average value for periods 2007-2012 (left) and 2014-2015 (right). Source: General Study of the Segura River Basin District (EGD).

Regarding the vulnerability of the surface of CHS, 2.533 km^2 are catalogued as Vulnerable Areas, mainly in the surroundings of Mar Menor (Campo de Cartagena) as it is shown in (Figure 12Figure 11).

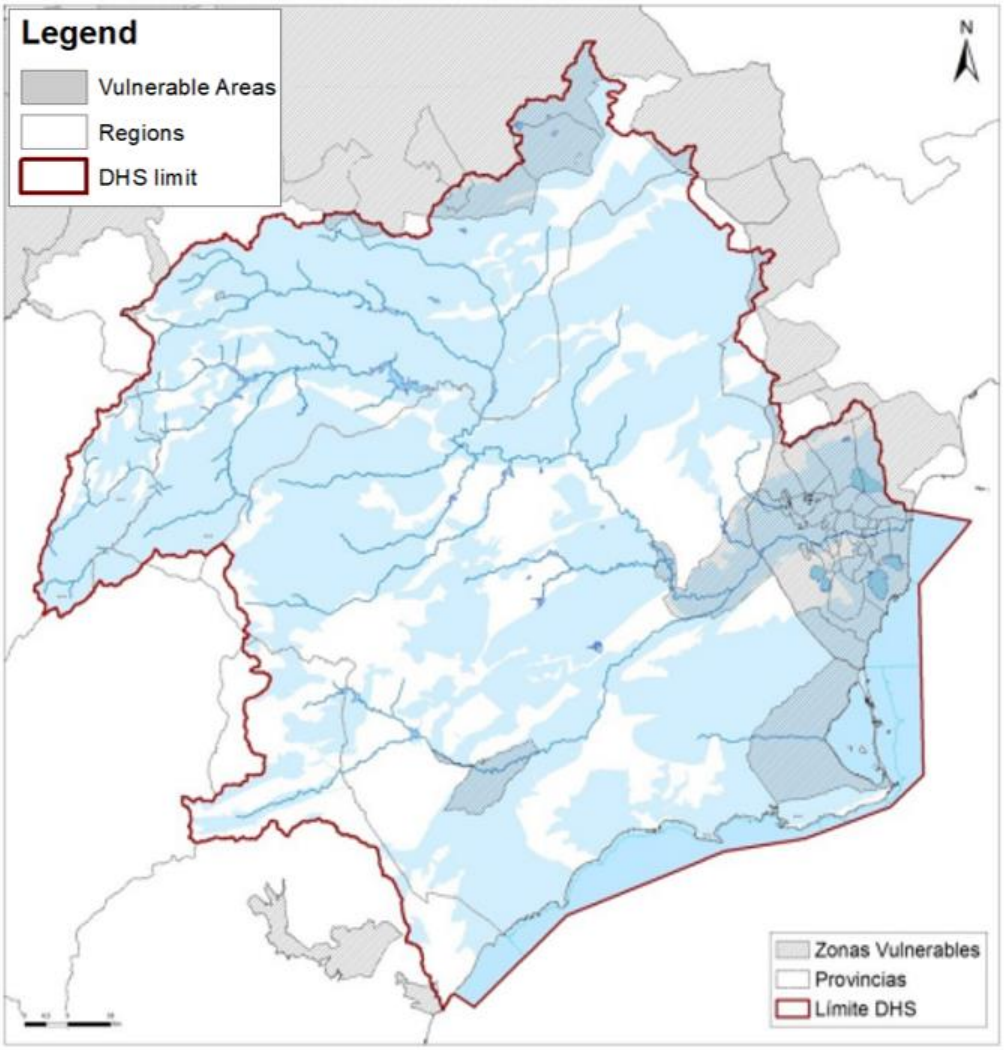


Figure 12. Vulnerable Areas in Segura Hydrological Domain *(Surroundings of Mar Menor lagoon are identified as vulnerable). Source: General Study of the Segura River Basin District (EGD).*

Regarding the quality of groundwater, several water bodies are defined in a bad state. In relation with Mar Menor lagoon, it could be observed the bad state of surrounding water bodies.

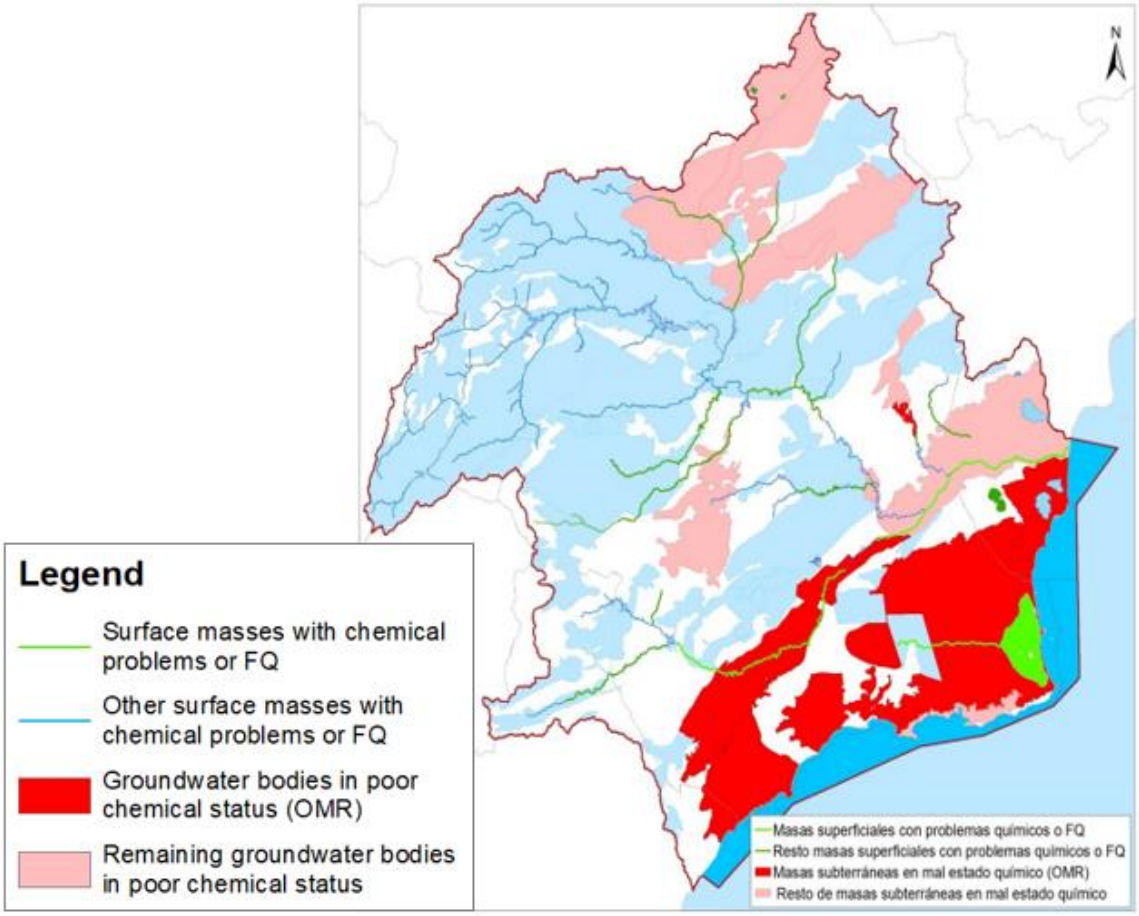
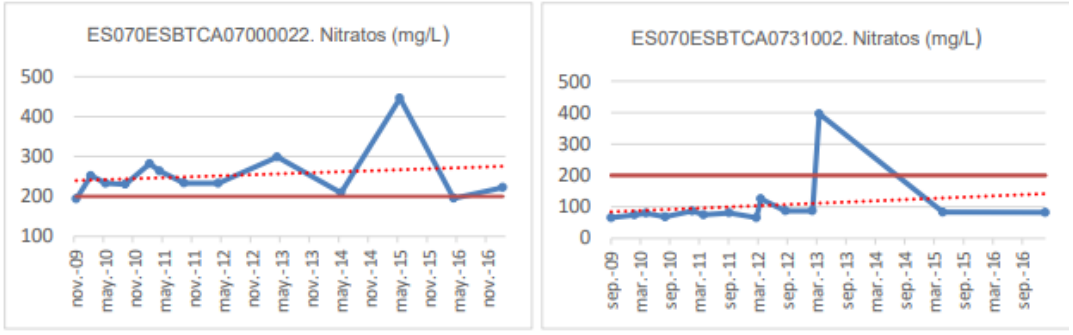


Figure 13. Ecological state of groundwater bodies in CHS. Source: Source: General Study of the Segura River Basin District (EGD).

Due to the incapability of matching objectives for the ground water bodies in 2027, new, less restrictive objectives have been established: 200 mg/l of NO_3 for Campo de Cartagena groundwater masses.

Following with, it is crucial to identify the level of nitrates and pollution in groundwater supplies of Campo de Cartagena, as the lagoon is closely related to them. CHS has released a report with the measurements of nitrates content in groundwater connected with Mar Menor lagoon. Key results are shown in the next Figure.



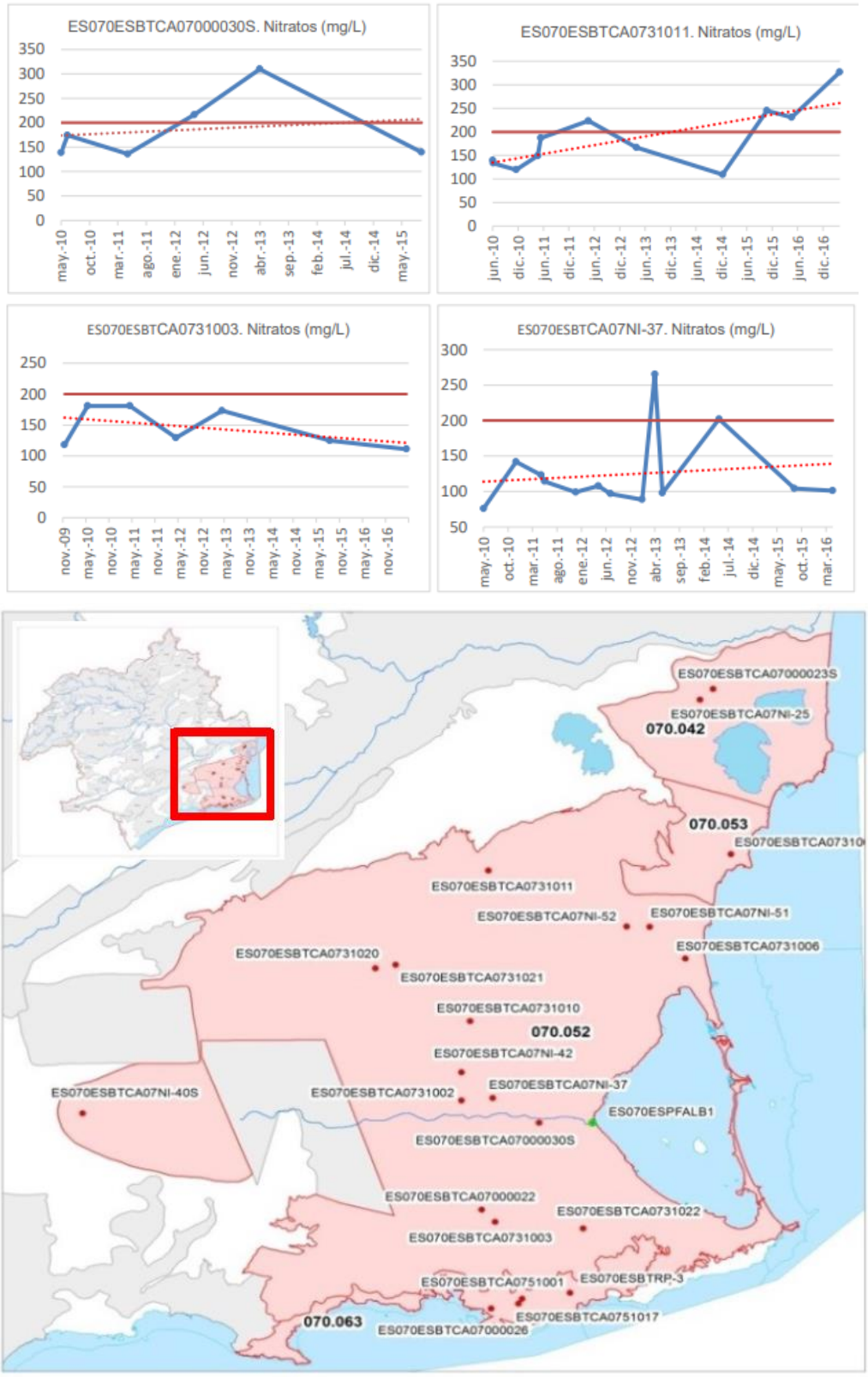


Figure 14. Nitrates content in groundwater connected with Mar Menor lagoon. Source: General Study of the Segura River Basin District (EGD). Quality control stations in Campo de Cartagena.

So, nitrates measurements in groundwater are quite higher than the stipulated value of 50 mg/l. In addition, the report reflects a certain raise of nutrient contents in water, involving the degradation

of water quality in the lagoon. As for the peaks shown in the graph on certain dates, the CHS report does not clarify whether there is a specific reason for these peaks.

Despite all the guidelines, recommendations and restrictions were applied, it will not be possible to reach good ecological state of water bodies in 2027 (deadline specified in European legislation).

Best management practices have been proposed to fix these issues, among which we recall:

- Update the action plan
- Better programs of monitoring
- Cut the pollutants from agriculture
- New actions for monitoring the state of the water and use of pollutants
- Sensibilization campaigns
- Assess the economic impact of the pollution to tourism, neighbourhoods, and protected areas.

Regarding the origin of the pollution, nitrates from agriculture combined with the absence of drainage network and treatment for the polluted water, are the reasons for the pollution levels of Campo de Cartagena and Mar Menor (Figure 15). Not only for the concentration of nitrates employed but also for the extension affected. Moreover, salinity of groundwater from Campo de Cartagena aquifer is quite high. In this regard, a study (*Estudio general de la Demarcación del Segura.* [General Study on the Demarcation], 19 January 2020)[68] has been carried out to identify causes and stakeholders concerning diffuse pollution. 90% of superficial water masses and 86% of groundwater masses are affected by agricultural pressure (Figure 16).

[68]Source: The public consultation on the initial documents of the water planning process 2022-2027.
Link: https://www.chsegura.es/es/cuenca/planificacion/planificacion-2022-2027/el-proceso-de-elaboracion/

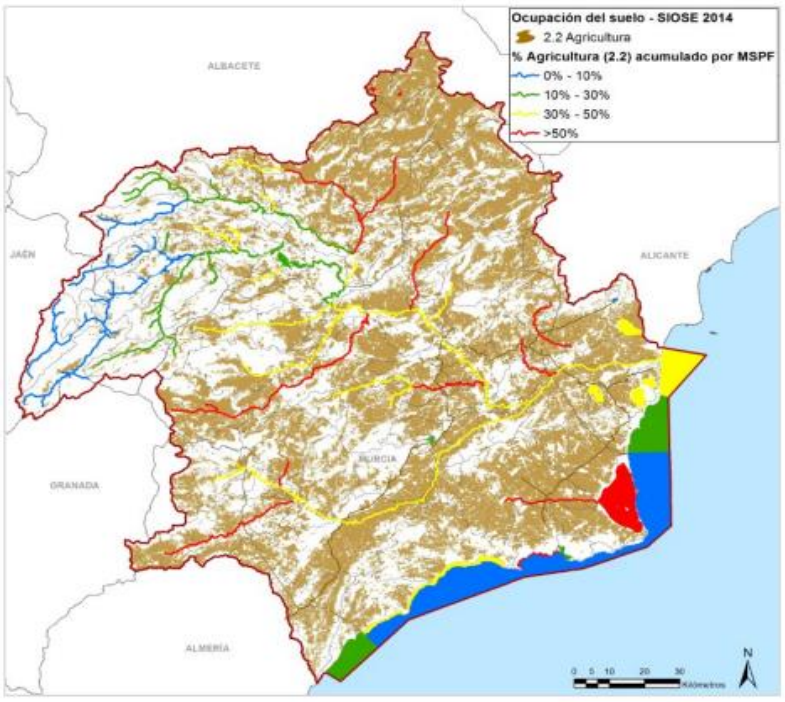


Figure 15. Superficial Water affected by diffuse pollution from agriculture. Source: General Study of the Segura River Basin District (EGD).

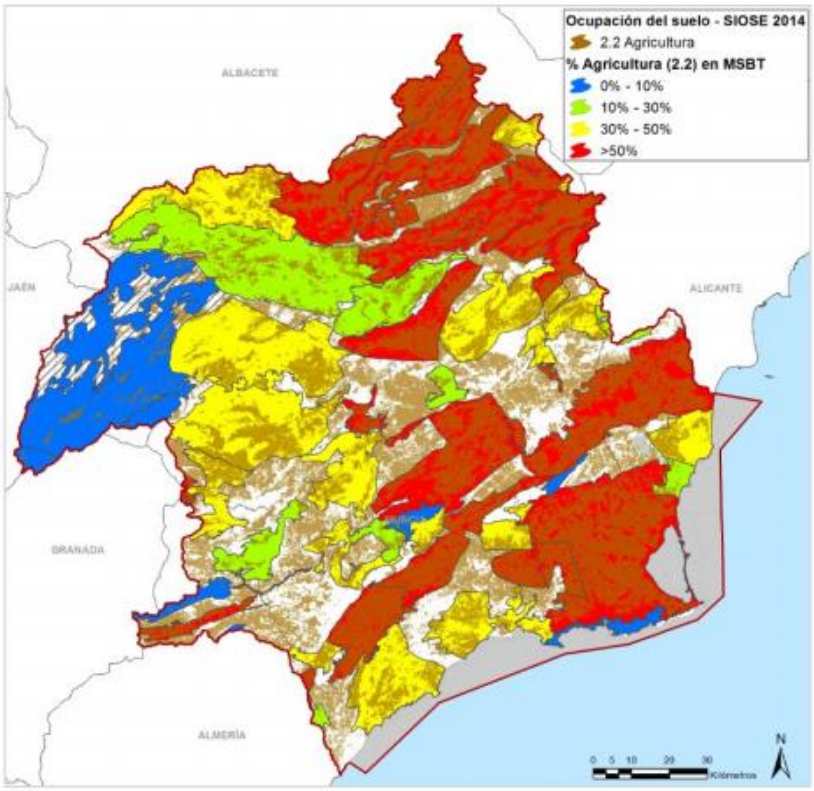


Figure 16. Ground water affected by diffuse pollution from agriculture. Source: General Study of the Segura River Basin District (EGD).

Regarding Mar Menor and Campo de Cartagena aquifer water quality, nutrients (NUTR), preferable substances (OTHE) and priority substances (CHEM) related with agriculture have been found in the lagoon.

Main stakeholder's activities:

- Irrigation agriculture: Campo de Cartagena is one of the main agricultural areas of the region, highly productive and technical farms. This kind of crop is one of the main economic activities, generating a great number of new jobs.
- Pig farms: Mainly intensive farms. This kind of business can generate a great amount of pollution.

Improvement the environmental status of Mar Menor lagoon and its catchment area.

To identify factors that affect Mar Menor lagoon, we should keep our eyes in punctual and diffuse pollution and hydro-morphological modifications. Moreover, the management of the lagoon is a controversial issue, with many interests and uses around it which have affected its ecological status and prevent administration from taking severe actions to restore it.

In 2018 it was pointed out a very poor environmental status for the lagoon, increased by the large eutrophication derived from 2019 floods which is mainly caused by a high concentration of nutrients in water dragged by massive runoff water from crops. Water status of Mar Menor lagoon is related to the nitrate's concentrations in the ground water bodies of Campo de Cartagena and the discharges from irrigation through superficial flows. There are also other activities and factors contributing to the current environmental state of the lagoon.

High dense concentration of human activities in the surrounding area of the lagoon (agriculture, urban development, sand dredging, mining, fishing, sealing…) breed significant impacts over the ecological and chemical status of the water. It is especially relevant the opening of new channels to connect the lagoon to the Mediterranean Sea, creating great alterations in their morphological and ecological systems.

Nevertheless, when the reasons for the current state of the lagoon are studied, evolution of high intensity irrigated agriculture in the catchment area of Mar Menor stands out as the primary cause. Originally, the agriculture practices were performed under a model of dry farming but nowadays it has been replaced by irrigated agriculture. When crops are fertilised under high irrigation regimes, nutrients percolate quickly into the subsoil, polluting the Campo de Cartagena quaternary aquifer, which drain into the lagoon. Finally, pollutants from agriculture are stored in the water of the lagoon, encouraging episodes of eutrophication.

In connection with eutrophication, there are also contributions from heavy precipitations through streams. In that sense, some of them now have continuous waterflows with irrigation waters, full of nitrates and pesticides that are discharged in Mar Menor. Some values of these facts are, until Los Alcázares water treatment plan was running, Mar Menor Lagoon received a range of 2.500 –

3.000 tons of nitrates and phosphates from residual urban waters and runoff waters from irrigated fields.

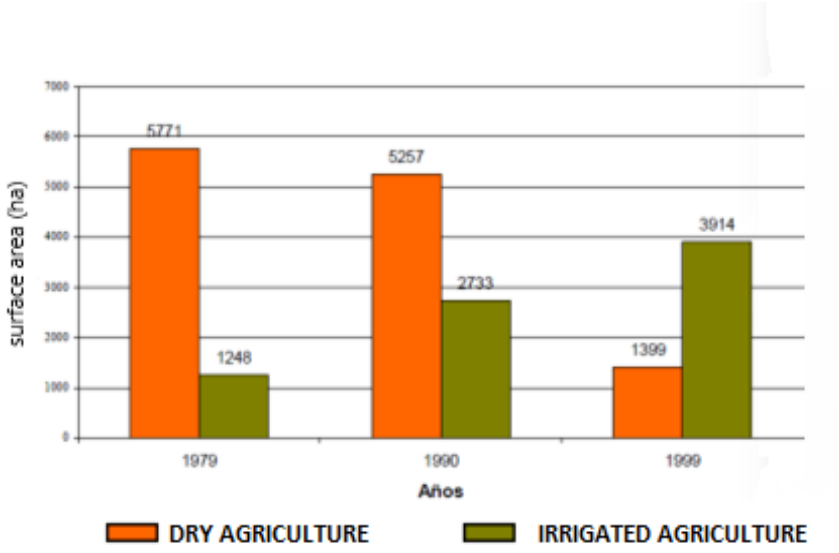


Figure 17. Crop trends in Torre Pacheco's municipalities. Source: General Study of the Segura River Basin District (EGD).

All this adds up to local problems of eutrophication, anoxia, high mortality rates of fishes and massive reproduction of some species of jellyfishes.

Following the reasons for the current state of the lagoon, sailing cause great impacts. In the lagoon area nowadays exist 10 sport marinas, with 3.973 moorings each year. Despite it is forbidden, 1.000 ships anchored in the lagoon summer of 2019 while previous years the number was even higher. Presence of ships implies waste and oil discharges and destruction of the sea floor, as ships destroy algal communities with their anchors and contribute to pollution with oil spills.

With the above-mentioned points, the lagoon is not in its optimum natural state neither a good environmental state nor physic nor chemical. 2015 was identified as a critical point for the lagoon: great amounts of phytoplankton indicated a severe eutrophication. Years before, the algal communities of *Caulerpa prolifera* acted as sink for 4.000 tons of nitrates and 420 tons of phosphorus, but degradation of the lagoon implies losses of *Caulerpa prolifera* prairies up to 85% of their initial extension. Consequently, nitrogen was not captured from water and the lagoon became eutrophic.

Even though the lagoon was under an enormous pressure, nature demonstrated its recovery capacity. In 2018 measurements of chlorophyll, ammonium and phosphates were identified under the good environmental status threshold. But, in 2019 the episode of heavy rains in Campo the Cartagena region dragged great amounts of organic matter to the lagoon. The consequences were

a new episode of eutrophication and an anoxic layer in the sea floor causing high rate of mortality in fishes and other organisms. Since 2019, the lagoon has remained in a critical ecological status.

Water quality of Mar Menor lagoon is being affected by the nitrates cumulation in groundwater masses of Campo the Cartagena and by the nutrients and pesticides that arrived at the lagoon from streams due to agricultural practices.

Origin of the pressures that are generating the problem

During the last decade many uses converge in the geographic context of Mar Menor, mainly tourism, agriculture and mining activities subduing the lagoon to severe pressures. According to the "Comité de Asesoramiento Científico del Mar Menor" report (2017), the activities carried out in the surroundings of the lagoon are as show in Figure 18; whereas the key pressures are depicted in Table 13.

PRESSURES	PUNCTUAL	- Phreatic water discharge through channels. - Urban discharges and pumped water from basements. - Several unlawful discharges.
	DIFFUSE	- Pollution by agricultural activities in Campo the Cartagena. - Marinas (10) - Sport sailing. - Residual waters discharge in the context of the lagoon. - Pollutants, sediments, and heavy metals washed out from Sierra Minera.
	MORPHOLOGICAL ALTERATIONS	- Modification of connections with other water masses (Estacio Channel) - Marinas (10) - Breakwaters (41) - Artificial beaches (8) - Training dikes (7) - Intertidal areas occupation (12) - Longitudinal defence structures (4) - Exempt dikes (4) - Protection of banks (1)

Table 13. Pressures of the Mar Menor. Source: CHS.

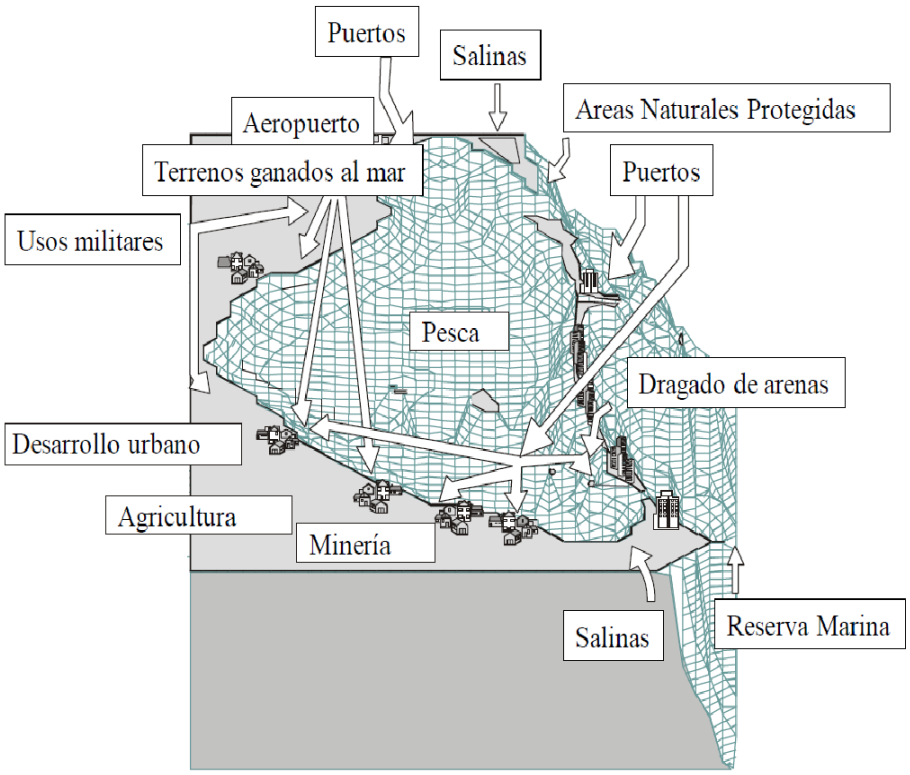


Figure 18. Activities on the Mar Menor. Source: CHS (2020).

Pressure associated with overexploitation of water resources and overuse of nutrients reaches the lagoon through Albujon stream and Campo de Cartagena Aquifer. These is caused by an irrigated extension of 43.071 ha that consumes 204 hm^3 each year. This business is quite relevant for local population, irrigated crops imply an economic activity valued in 339,6 M€ and 28.781 jobs, 1.015 M€ and 41.500 jobs if derived industry is considered.

The absence of drainage network implies that water excess of crops, polluted with high amounts of nutrients is conducted by superficial flows to Mar Menor lagoon, raising eutrophication risk. This nutrients excess has been estimated in 40 kg/ha/year.

Pig farms are also relevant in the Mar Menor catchment area, with 446 livestock farms and roughly 790.000 heads, which provide 5,800 tonnes of nitrogen/year from slurry.

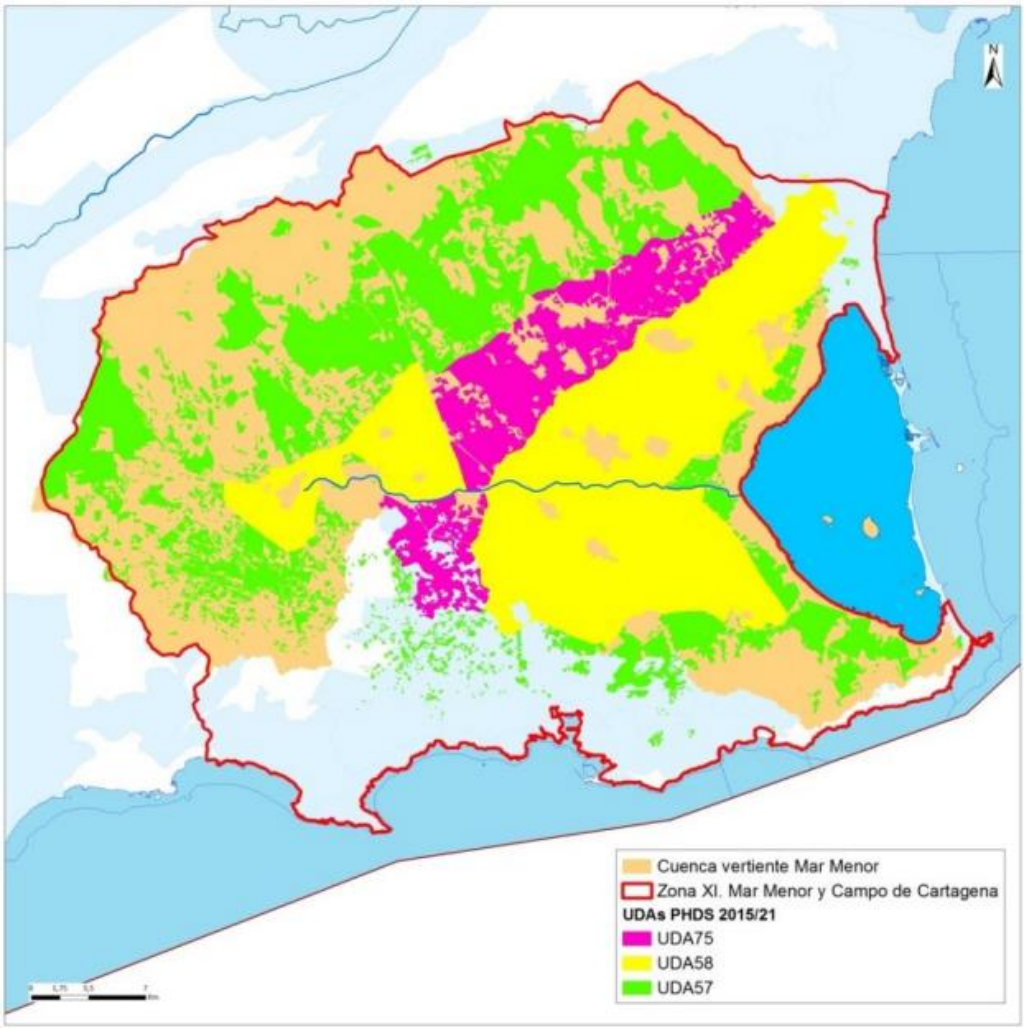


Figure 19. Zone XI "Campo de Cartagena-Mar Menor" and associated UDAs (Agricultural Demand Units). Source: General Study of the Segura River Basin District (EGD).

Regarding to urban discharges pollution, it is mainly caused by the collapse of drainage network when intense rainfall occurs. It is quite relevant also the opening of new channels for navigation, which means more boats, the entrance of new species to the lagoon and reduction of its salinity. Boats destroy algal communities with their anchors and contribute to pollution with oil discharges. And as if this were not bad enough, when intense rainfalls occur solids, sediments and pollutants as heavy metals arrive through different natural streams.

All these factors contribute to a high risk that the lagoon will not reach good ecological status as required by the EU Water Framework Directive. The described pressures result in impacts and alterations as schematized in the next table, were ORGA refers to impacts by absence of oxygen in water, NUTR refers to presence of nutrients in water, HMOC refers to hydromorphological alterations, OTHE refers to fertilizers as *Selenium* and biocides as fluorides and CHEM to priority substances.

Masa de agua		Impactos sobre el estado ecológico y químico					Tipo de presión significativa				Riesgo de no alcan-zar BE
Código	Nombre	ORGA	NUTR	OTHE	HMOC	CHEM	PUNT	DIF	MORF	CH	
ES0701030005	Mar Menor	X	X	X	X	X	X	X	X	X	ALTO

Table 14. Impact, pressures, and risk of not raising good status. Source: General Study of the Segura River Basin District (EGD).

Regulations related to the Tagus-Segura aqueduct

INTRODUCTION TO THE REGULATIONS RELATED TO THE TAGUS-SEGURA AQUEDUCT.

The Tagus-Segura aqueduct is a hydraulic engineering project commissioned in 1979 by means of which water is diverted from the Bolarque reservoir, the point where the flows of the Tagus and its tributary Guadiela, regulated by the Entrepeñas and Buendía hyper-reservoirs, meet.

This is one of the hydraulic infrastructures built which has had the greatest impact on the physico-chemical characteristics of the Mar Menor lagoon and its surroundings, due to its capacity to modify the hydrological balance of the Mar Menor hydrological basin, and the transforming effect it has had on land use. According to the analysis of solutions for zero discharge into the Mar Menor from the Campo de Cartagena (2019), it states: "*The natural regime of the Albujón wadi is altered, as it has a permanent flow throughout the year. The waters that flow continuously through the wadi come mainly from the drainage of the Quaternary aquifer as a result of the rise in the water table following the arrival of water from the Tagus-Segura water transfer, which generates an increase in irrigation returns*".

As detailed by the Segura River Basin Authority, the Bolarque intake is used by means of four suction pipes 3.50 m in diameter, which cross the massif of the dam to feed the lifting station located at the foot of the dam. The closing and protection devices of the intake pipes are in the wet parameter of the dam and are operated from its crest. The power station, equipped with four reversible groups of 203 MW of combined power, drives the water to the top of the Altomira mountain range through two metallic pipes of varying diameters between 3.15 m and 3.45 m, which cross a drop of 245 metres and a length of 1,025 metres.

The pipes are followed by a pressure gallery 5.35 m in diameter and almost 14 km long, drilled along the crest of the mountain range and equipped at its origin with a 79.50 m high balancing chimney (on foundations), and 25 m in internal diameter. The pressure gallery, lined with reinforced concrete, flows into the La Bujeda reservoir, whose reservoir is closed by three dams of loose materials, which provide a reservoir capacity of seven million cubic metres to store the pumped water.
The La Bujeda reservoir is the starting point for a pipeline which crosses 93 km to the Alarcón reservoir, by means of an alternation of canal sections, aqueducts, and tunnels.

Among the aqueducts are the Ransares and Ciguela river crossings, which, with lengths of 2,850 m and 6,200 m, respectively, founded in difficult terrain and supported by pillars up to 50 m high, are true records of their kind. Likewise, of the twelve tunnels that make up the section, the Villarejo tunnel (crossing the Guadiana-Júcar), which is 5,020 m long, deserves special mention due to the difficulties involved in its perforation.

Section III, 106 km long, is fed at source, from the Alarcón reservoir, through the El Picazo waterfall tunnel. The shared use of this conduit, as long as the volumes to be transferred allow it, means

postponing the investment necessary for the construction of a tunnel of its own, the route of which will be substantially parallel to that of the waterfall.

The first section of the water transfer canal, known as the El Picazo canal, crosses an important aqueduct, the Santa Quiteria aqueduct, which is just over half a kilometre long and is supported by 15 piers up to 30 m high.
Section IV consists of crossing the Júcar-Segura divide by means of a 31,927 m long tunnel through the Sierra de Hellín, on the southern edge of La Mancha (Albacete).
This is the longitudinal profile of the aqueduct:

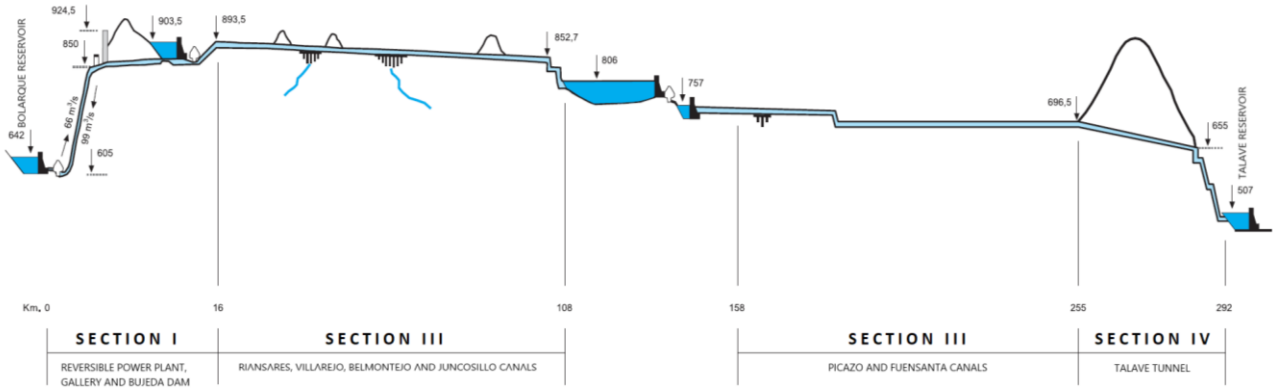


Figure 20. Longitudinal profile of the Tagus-Segura aqueduct.

Below is a graph showing the historical data of the inflows into the Tagus-Segura water transfer both in the Bujeda reservoir and in the Talave reservoir.

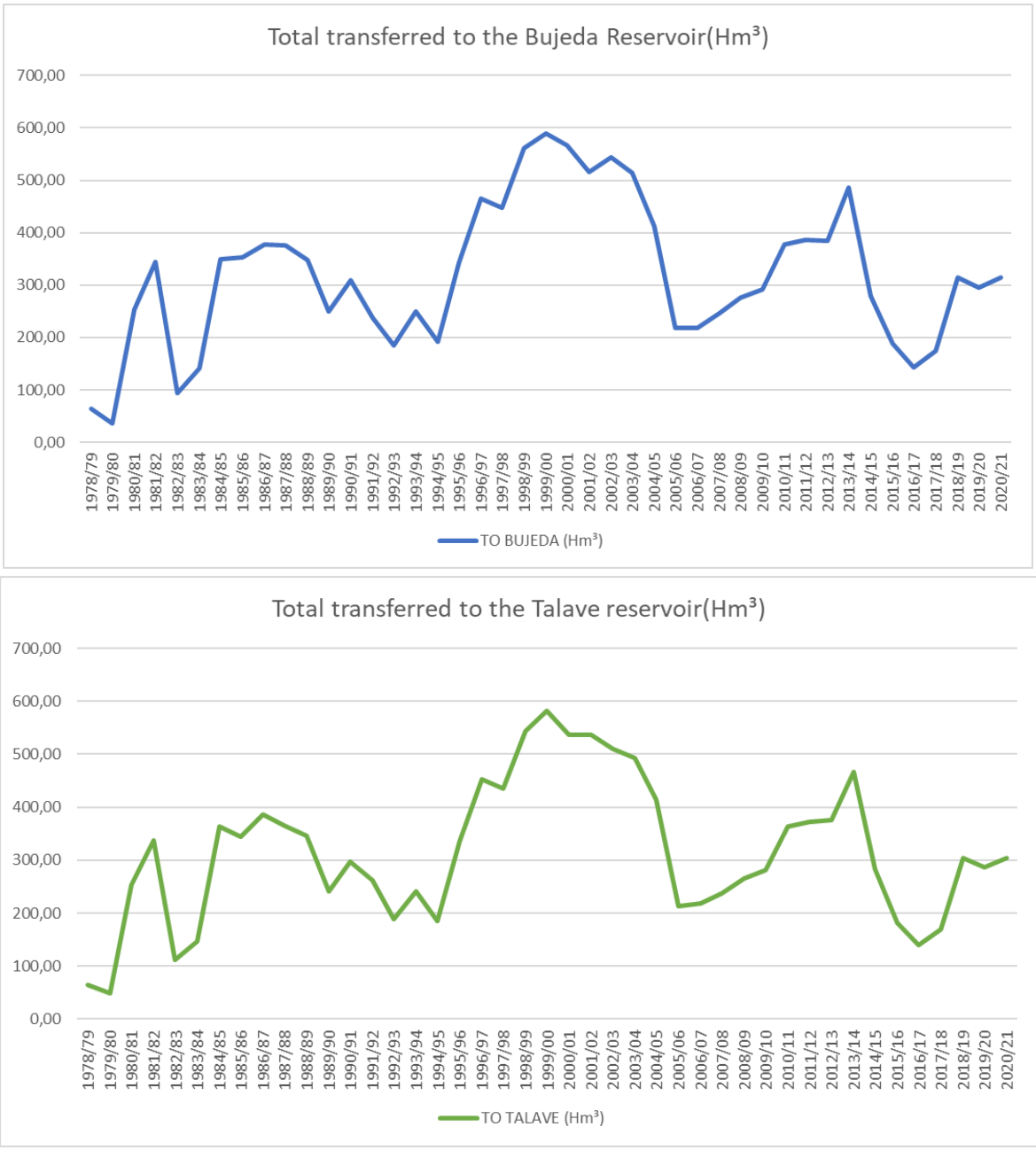


Figure 21. Historical contributions of the Tagus-Segura water transfer. Source CHS.

LEGISLATIVE FRAMEWORK FOR THE TAGUS-SEGURA WATER TRANSFER

The main laws that have defined the legislative framework of the Tagus-Segura aqueduct are described below.

Law 21/1971 of 19 June on the joint exploitation of the Tagus and Segura rivers.[69] It is the law that adopted the execution of the works for the joint exploitation of the water resources of Central and Southeast Spain. In the first phase, it authorised the transfer of surplus flows from the Tagus River, up to a maximum annual volume of 600 hm^3.

[69] *Ley 21/1971, de 19 de junio de aprovechamiento conjunto de los ríos tajo y segura.*

Regulation 1982/1978 of 26 july on the organisation of the services responsible for managing the operation of the hydraulic infrastructure 'Tagus-Segura transfer'.[70] It assigns to the Tagus River Basin Authority the tasks of technical and economic management of the operation of the section from the intake on the Tagus River to the outlet in the Talave reservoir and constitutes the "Comisión Central de Explotación del Acueducto Tagus-Segura" as the new body in charge of supervising the exploitation regime of the "*Trasvase Tajo-Segura*", the studies and proposals related to it, and the coordination of the "Confederaciones Hidrográficas".

Law 52/1980 of 16 October 1980 on the economic regime for the exploitation of the Tagus-Segura Aqueduct.[71] This law grants the right to use the water diversion and post-transfer works for irrigation and water supply in the south-east, up to the volumes determined by the law.

These maximum volumes had the following values at destination (without considering the losses between the headwaters of the Tagus and the Segura):

Zonas	Hm^3 anuales
Para regadíos:	
Vega alta y media del Segura	65
Regadíos de Mula y su comarca	8
Lorca y valle del Guadalantín	65
Riegos de Levante, margen izquierda y derecha, vegas bajas del Segura y saladares de Alicante	125
Campos de Cartagena	122
Valle del Almanzora, en Almería	15
Total regadíos	400
Para abastecimientos	110

Table 15. The volumes to be transferred in the first phase of exploitation of the Tagus-Segura aqueduct (Hm^3/year). Source: Law 52/1980.

Regulation 2530/1985 of 27 December on the system of exploitation and distribution of functions in the technical and economic management of the Tagus-Segura aqueduct.[72] It is a short Regulation that develops the content of Regulation 1982/1978 of 26 July, defining the competences on the volumes and flows of the water transfer and the chargeable expenses.

[70] *Real decreto 1982/1978, de 26 de julio de organización de los servicios encargados de gestionar la explotación de la infraestructura hidráulica 'trasvase tajo-segura'.*

[71] *Ley 52/1980, de 16 de octubre de ley de régimen económico de la explotación del acueducto tajo-segura.*

[72] *Real decreto 2530/1985, de 27 de diciembre de régimen de explotación y distribución de funciones en la gestión técnica y económica del "acueducto tajo-segura.*

Regulation 8/1995 of 4 August of urgent measures to improve the use of the Tagus-Segura aqueduct.[73] This Regulation deals with:

- The diversion of resources from the Tagus-Segura aqueduct to the Guadiana basin.
- The reserve for supply
- The hydroelectric exploitation
- The general interest declaration of the works to be carried out and the assessment of their environmental impact.
- The economic and financial regime for the exploitation of the Tagus-Segura aqueduct.

Law 24/2001 of 27 December 1980 amending law 52/1980.[74] It deals with different fiscal measures related to the use of water from the aqueduct.

Regulation 1241/2012 of 24 August adopting exceptional administrative measures for the management of water resources to overcome the effects of the partial interruption of supply through the Tagus-Segura water transfer infrastructure in the Segura River basin[75] deals with exceptional administrative measures relating to the operation of the aqueduct.

Regulation 773/2014 of 12 September adopting exceptional administrative measures for the management of water resources to overcome the effects of the partial interruption of supply through the Tagus-Segura water transfer infrastructure in the Segura River basin.[76] This regulation established various rules regulating the water transfer via the Tagus-Segura aqueduct.

Law 21/2015, of 20 July, amending Law 43/2003, of 21 November, on Forests.[77] It establishes the monthly allocations of water transfers according to four levels with an annual maximum of 650 hm^3 (600 for the Segura and 50 for the Guadiana).

[73] *Real decreto ley 8/1995, de 4 de agosto de medidas urgentes de mejora del aprovechamiento del trasvase tajo-segura*
[74] *Ley 24/2001, de 27 de diciembre de modificación de la ley 52/1980*
[75] *Real decreto 1241/2012, de 24 de agosto de se adoptan medidas administrativas excepcionales de gestión de los recursos hidráulicos para superar los efectos de la interrupción parcial del suministro mediante la infraestructura del trasvase tajo-segura en la cuenca hidrográfica del segura*.
[76] *Real decreto 773/2014, de 12 de septiembre por el que se adoptan medidas administrativas excepcionales de gestión de los recursos hidráulicos para superar los efectos de la interrupción parcial del suministro mediante la infraestructura del trasvase tajo-segura en la cuenca hidrográfica del Segura*
[77] *Ley 21/2015, de 20 de julio, por la que se modifica la Ley 43/2003, de 21 de noviembre, de Montes*

Marine strategy for the Levantine-Balearic demarcation "Estrategia marina para la demarcación levantino-balear".

ISSUES ADDRESSED IN THE STRATEGY

This is the marine strategy applied to the Levantine-Balearic marine demarcation, which represents the marine environment in which Spain has sovereignty or jurisdiction between an imaginary line with an orientation of 128° with respect to the meridian passing through Cape Gata and the limit of the jurisdictional waters between Spain and France in the Gulf of León.

This strategy is the main planning instrument aimed at achieving the good environmental status of the marine environment in the Levantine-Balearic marine demarcation (where the Mar Menor is located) and constitutes the general framework to which the different sectoral policies and administrative actions with an impact on the marine environment must conform, in accordance with the provisions of the corresponding sectoral legislation.

The marine strategy for the Levantine-Balearic demarcation, like the rest of the demarcation strategies, consists of the following structure:

1. An initial assessment of marine waters, including an analysis of the current environmental status, the main impacts and pressures, as well as the economic and social analysis and the cost of the marine environment deterioration.
2. The definition of good environmental status, according to the 11 descriptors of good environmental status, for each marine sub-region.
3. The proposal of environmental objectives and associated indicators for marine waters, to guide the process towards the achievement of good environmental status in the marine environment.
4. The establishment of coordinated monitoring programmes to permanently assess the environmental status of marine waters.
5. The development and implementation of programmes of measures necessary to achieve or maintain the good environmental status of the marine environment.

Currently, with the approval of regulation 1365/2018, of 2 November, which adopts marine strategies, the first cycle of marine strategies has been closed. The Ministry for Ecological Transition and the Demographic Challenge, through the General Directorate for the Coast and the Sea, is immersed in the work of updating the first three phases of the marine strategies (initial assessment, definition of the good ecological status “BEA” and establishment of environmental objectives), thus initiating the second cycle that will run from 2018 to 2024.

HIGHLIGHTS DESCRIBED BY THE STRATEGY

Given the scale of implementation of this strategy, only those issues related to the Mar Menor will be mentioned in this document.

The Levantine-Balearic Demarcation, although it applies to a very large area, has identified some of the pressures. The diagnosis carried out during the first cycle of the strategy identifies it as an area with different potential risks:

1. area with moderate potential impact of sealing, due to the accumulation of pressures.
2. area with a moderate potential for modification of the hydrographic regime and/or modification of sedimentation.
3. area of high potential for land-based debris input.
4. areas of high potential for input of pollutants.

Therefore, the strategy is still at a relatively early stage of re-evaluation of its specific objectives, it has not been yet established a programme of measures that may affect the environmental conditions of the Mar Menor.

It should also be noted that some of its objectives are directly related to the Mar Menor, such as Environmental Objective B.1.3. "*Not to exceed the reference values for nitrates and phosphates more frequently than statistically expected due to hydrological variability throughout the Levantine-Balearic demarcation*".

Thematic maps

Introduction

The objective of this section is to explain the process of elaboration of the cartography generated for the model of task 3.2.

This is a set of maps prepared using GIS techniques based on the review and compilation of thematic cartography related to the main environmental, economic, social, and legislative conditions and limitations of the Mar Menor.

The cartography produced and collected will not only consist of graphic information, but due to the characteristics of GIS technology, it will facilitate the querying and analysing it during the subsequent stages of the development of the model.

The procedure followed for the preparation of the thematic maps of the Mar Menor has been structured in five steps group in two phases.

1. Information gathering phase.
   1.1. Consultation and compilation of the information.
   1.2. Classification of the information by thematic areas and map typology.
   1.3. Homogenisation of the information.
2. Elaboration of own cartography.
   2.1. Elaboration of own cartography from the treatment of the compiled cartographic information.
   2.2. Production of cartography using SENTINEL imagery.

Compiled cartography

Consultation and information gathering phase: during this phase, systematic searches were made of the main sources of geographic information at national and regional level. Specifically, cartography was downloaded from the National Geographic Institute (CNIG), the General Directorate of the Natural Environment (CARM); the Ministry of Ecological Transition and Demographic Challenge (MITECO); the Segura Hydrographic Confederation (CHS), the General Directorate of Natural Heritage and Biodiversity, the Government of the Region of Murcia, the Centre for Hydrographic Studies (CEDEX), and the National Institute of Statistics, among others.

The following table shows the abbreviations of the different sources of information and their respective links:

OFFICIAL NAME	DESCRIPTION	ABBREVIATIONS	LINK
Ministerio para la transición ecológica y reto demográfico	Ministry for Ecological Transition and Demographic Challenge	MITECO	https://www.miteco.gob.es/
Confederación Hidrográfica del Segura	Segura River Basin Authority	CHS	https://www.chsegura.es/
Dirección general del medio natural de Murcia	Directorate General for the Natural Environment	CARM	http://www.carm.es/
Instituto Geográfico Nacional	Spanish National Geographic Institute	IGN	http://www.ign.es/
El Geoportal de la Infraestructura de datos espaciales de la región de Murcia	Platform of the spatial data infrastructure of the region of Murcia	SITMURCIA	https://sitmurcia.carm.es/
Centro de Estudios Hidrográficos	Centre for Hydrographic Studies	CEDEX	https://ceh.cedex.es/

Table 16. Sources of information.Source: Authors

The total set of maps queried, and currently available for download, is shown below:

CARTOGRAPHY	THEME	SCALE	INFORMATION SOURCE	FORMAT
Agroclimatic characterisation	Social demographic	1:25.000	Ministry of Agriculture, Fisheries and Food (MAPAMA)	WMS
Aquifers	Water	1:50.000	Segura River Basin Authority (CHS)	SHP
Boundaries of the Segura River Basin Authority (CHS)	Water	N/D	Segura River Basin Authority (CHS)	SHP
Cabo Palos reserve	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP
Cabo Tiñoso reserve	Social demographic	N/D	Dirección General de Patrimonio Natural y Biodiversidad. Gobierno de la Región de Murcia	SHP
Coastal flood hazard	Water	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	WMS
Coastal flood hazard	Water	1:25.000-1:1.000	Spanish National Geographic Institute (CNIG)	Raster
Corine land cover (2018)	Land uses	1:100.000	Spanish National Geographic Institute (CNIG)	SHP
Crop maps (2000-2010)	Land uses	1:50.000	Ministry of Agriculture, Fisheries and Food (MAPAMA)	WMS
Digital elevation model (5m pixel)	Digital terrain models	5 m pixel	Spanish National Geographic Institute (CNIG)	ASCII
Digital terrain model (200m pixel)	Digital terrain models	200 m pixel	Spanish National Geographic Institute (CNIG)	ASCII
Digital terrain model (25m pixel)	Digital terrain models	25 m pixel	Spanish National Geographic Institute (CNIG)	ASCII
Digital terrain model (2m pixel)	Digital terrain models	2 m pixel	Spanish National Geographic Institute (CNIG)	ASCII
Digital terrain model (5m pixel)	Digital terrain models	5 m pixel	Spanish National Geographic Institute (CNIG)	ASCII
Ecological corridors	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP

CARTOGRAPHY	THEME	SCALE	INFORMATION SOURCE	FORMAT
Fartet recovery plan	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP
Flora recovery plan	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP
Forestry map	Social demographic	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
Geological Units Iberian Peninsula, Balearic Islands, Canary Islands, Madeira and Azores	Geology and soil	1:1.000.000	Open data (ESRI)Spanish Geological Mining Institute (IGME)	WMS
Geological Units Platform Islands Iberian Peninsula and Balearic Islands	Geology and soil	1:1.000.000	Open data (ESRI)Spanish Geological Mining Institute (IGME)	WMS
Hunting points	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP
Hydrogeological units	Water	N/D	Segura River Basin Authority (CHS)	SHP
Hydrological network	Water	N/D	Segura River Basin Authority (CHS)	SHP
Landscape units	Social demographic	N/D	Sit Murcia	WFS
LICs and ZECs (Natura 2000 network)	Social demographic	N/D	Dirección General del Medio Natural, CARM + Segura River Basin Authority (CHS)	SHP
Marine habitats	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP
Micro-reserves of flora	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP
Monumental trees	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP
Municipal boundaries	Administrative boundaries	1:25.000	Spanish National Geographic Institute (CNIG)	SHP
National census discharges	Pollution	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
National topographic base	Topographical base	1:25.000	Spanish National Geographic Institute (CNIG)	SHP
Nitrate vulnerable areas	Pollution	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
Orthophoto	Others	1:70.000	Spanish National Geographic Institute (CNIG)	WMTS
Population growth	Social demographic	N/D	Open data (ESRI)	SHP
Protected natural spaces	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP
Public domain forests	Social demographic	N/D	Dirección General de Patrimonio Natural y Biodiversidad. Gobierno de la Región de Murcia	SHP
Public maritime land domain	Water	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
Public water domain	Water	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
RAMSAR zones	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP

CARTOGRAPHY	THEME	SCALE	INFORMATION SOURCE	FORMAT
Regional boundaries	Administrative boundaries	1:25.000	Spanish National Geographic Institute (CNIG)	SHP
Riparian zones	Water	1:20.000	Spanish National Geographic Institute (CNIG)	SHP
Risk of social exclusion	Social demographic	N/D	Open data (ESRI)	SHP
River flooding hazard	Water	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	WMS
Sensitive catchment areas	Pollution	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
Sensitive zones (Lines)	Pollution	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
Sensitive zones (Polygons)	Pollution	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
SIOSE 2014	Land uses	1:25.000	Spanish National Geographic Institute (CNIG)	GEOPACKAGE
SNZCI	Water	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
Soil ecology	Geology and soil	1:100.000	Dirección General del Medio Natural, CARM	SHP
State plan for the protection of the seashore from pollution	Pollution	1:100.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
Subterranean nitrates	Pollution	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
Surface nitrates	Pollution	1:25.000	Ministry of Ecological Transition and Demographic Challenge (MITECO)	SHP
Terrestrial habitats	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP
Unemployment by municipality 2017	Social demographic	N/D	Open data (ESRI)	SHP
Urban planning	Land uses	N/D	Sitmurcia	WFS/Vector
ZEPAs (Natura 2000 network)	Social demographic	N/D	Dirección General del Medio Natural, CARM + Segura River Basin Authority (CHS)	SHP
ZEPIM zones	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP
Zones Decree-Law 2019 (Integral Protection of the Mar Menor)	Social demographic	N/D	Dirección General del Medio Natural, CARM	SHP

Table 17. Cartography consulted during the information gathering phase. Source: Authors

Part of this information has been transferred to a physical map format, assigning symbology to it. In the following section, a selection of this cartography is shown:

BASIC REFERENCE INFORMATION

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Regional boundaries	Regional boundaries	- Region names - Surface areas - Codes associated	National Geographic Institute (IGN)
Municipal boundaries	Municipal boundaries	- Municipalities names - Surface areas - Codes associated	National Geographic Institute (IGN)

Figure 22. Regional and municipalities boundaries. Source: Authors.

LEGAL SITUATION OF THE MAR MENOR

Protected areas by international instruments

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Specially Protected Areas of Mediterranean Importance	Areas protected under the Protocol concerning specially protected areas and biological diversity in the Mediterranean	- Names - Areas - Subareas - Units - Subunits - Zones - Surface areas	Natural Environment General Directorate (CARM)
RAMSAR	Protected wetlands included in the Ramsar convention	- Name - Surface areas	Natural Environment General Directorate (CARM)
LIC's and ZEC's (Natura 2000)	Protected areas to accomplish Habitats Directive	- Site names - Codes	Natural Environment General Directorate (CARM)and

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
		- Region where they are located - Surface areas	Segura River Basin Authority (CHS)
ZEPA's (Natura 2000)	Protected areas to accomplish Birds Directive	- Site names - Codes - Region where they are located - Surface areas	Natural Environment General Directorate (CARM) and Segura River Basin Authority (CHS)

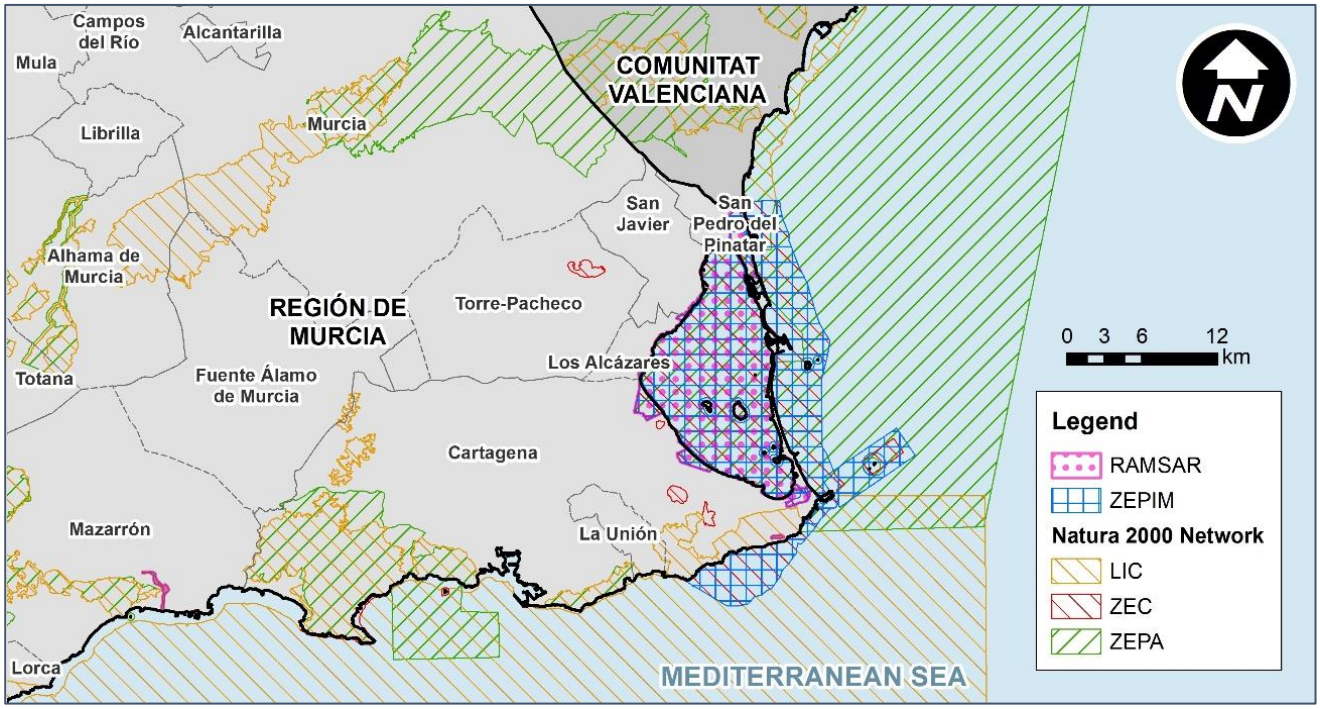


Figure 23. Protected areas by international instruments. Source: Authors.

Country level

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Maritime land public domain	Defined boundary for the maritime and land public domain, seashore, and protection easement associated	- Type of line - Validity status - Length - Alphanumeric information	Segura River Basin Authority (CHS)
Public Hydraulic Domain	Area corresponding to the alveus or natural channel of a continuous or discontinuous	- River name - Zone type - Surface areas	Segura River Basin Authority (CHS)

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
	stream covered by water at the maximum		
Nitrate vulnerable zones	Surface whose runoff flows into the affected waterbodies, or might be affected if measures are not taken, by contamination by nitrates coming from agricultural sources and those land surfaces that might contribute to this pollution	- Names - Codes - Surface areas - Date of declaration	Ministry for Ecological Transition (MITECO)
Segura river basin	Segura river basin area	- Surface area	Segura River Basin Authority (CHS)

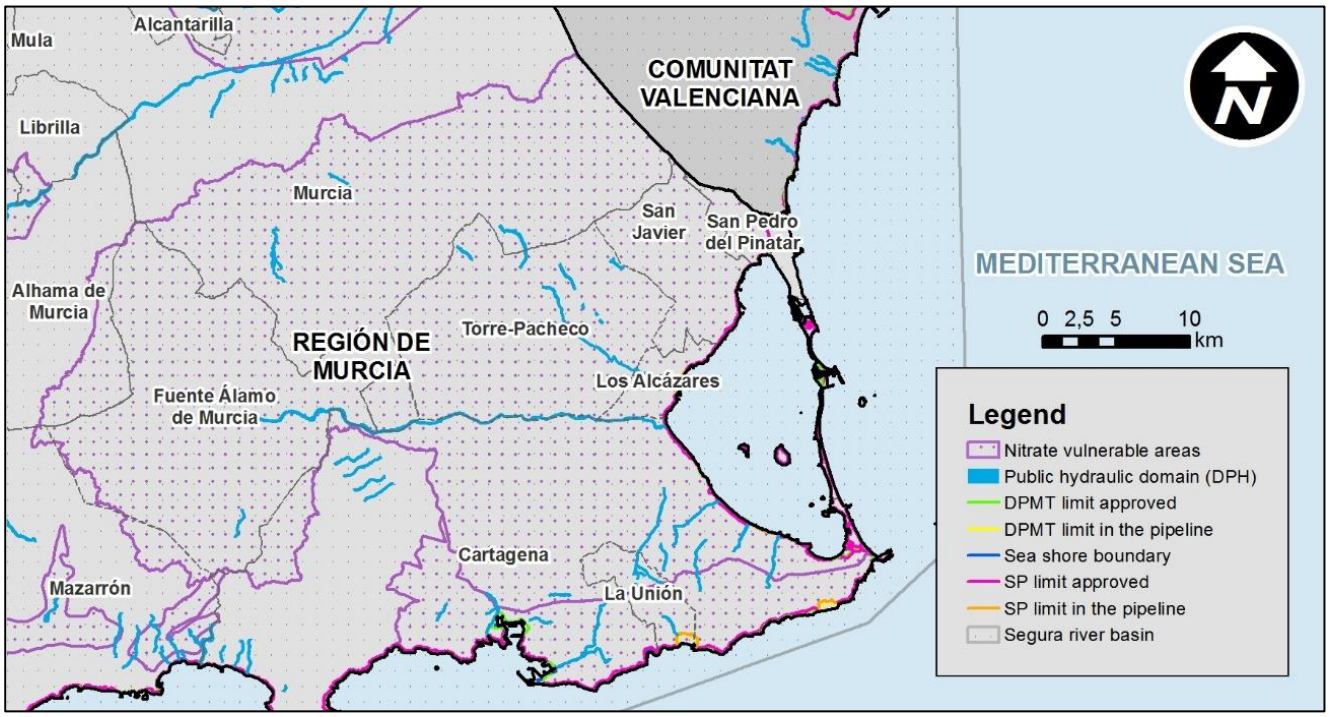


Figure 24. Relevant country level cartography. Source: Authors.

Regional Level

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Law 3/2020	Zoning in which the land use and activities are regulated differently to aim the recovery and protection of the Mar Menor	- Zones (1, 2 and temporary exclusion area)	Natural Environment General Directorate (CARM)
Fartet *(Aphanius iberus*) recovery plan	Areas where conservation actions will take place (Critical areas and Potential areas for reintroduction or expansion).	- Places names - Area codes - Type of area	Natural Environment General Directorate (CARM)
Flora recovery plans	Areas where conservation actions will take place (Critical areas and Potential areas for reintroduction)	- places names - area codes - type of area - specie subject of conservation on the area	Natural Environment General Directorate (CARM)
Natural protected areas	Regional Parks and Singular Landscapes of Regional Relevance in the Mar menor enviroment	- Name - Type of protection figure - Law by which it was declared - Surface areas	Natural Environment General Directorate (CARM)

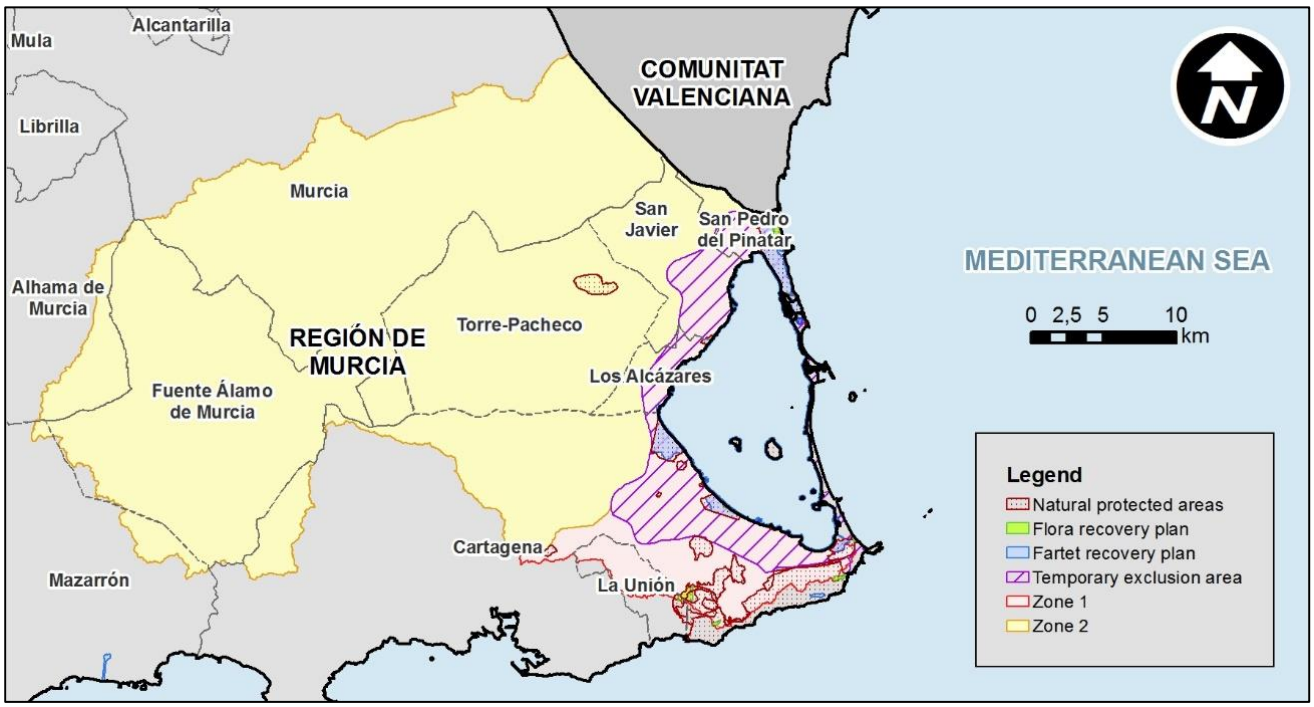


Figure 25. Relevant regional level cartography. Source: Authors.

Local Level

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Urban planning	Urban planning of the different municipalities surrounding the Mar Menor	- Soil classification - Specific uses - Surfaces exploitation - Surface areas	Territorial Information System of Murcia Region (sitmurcia)

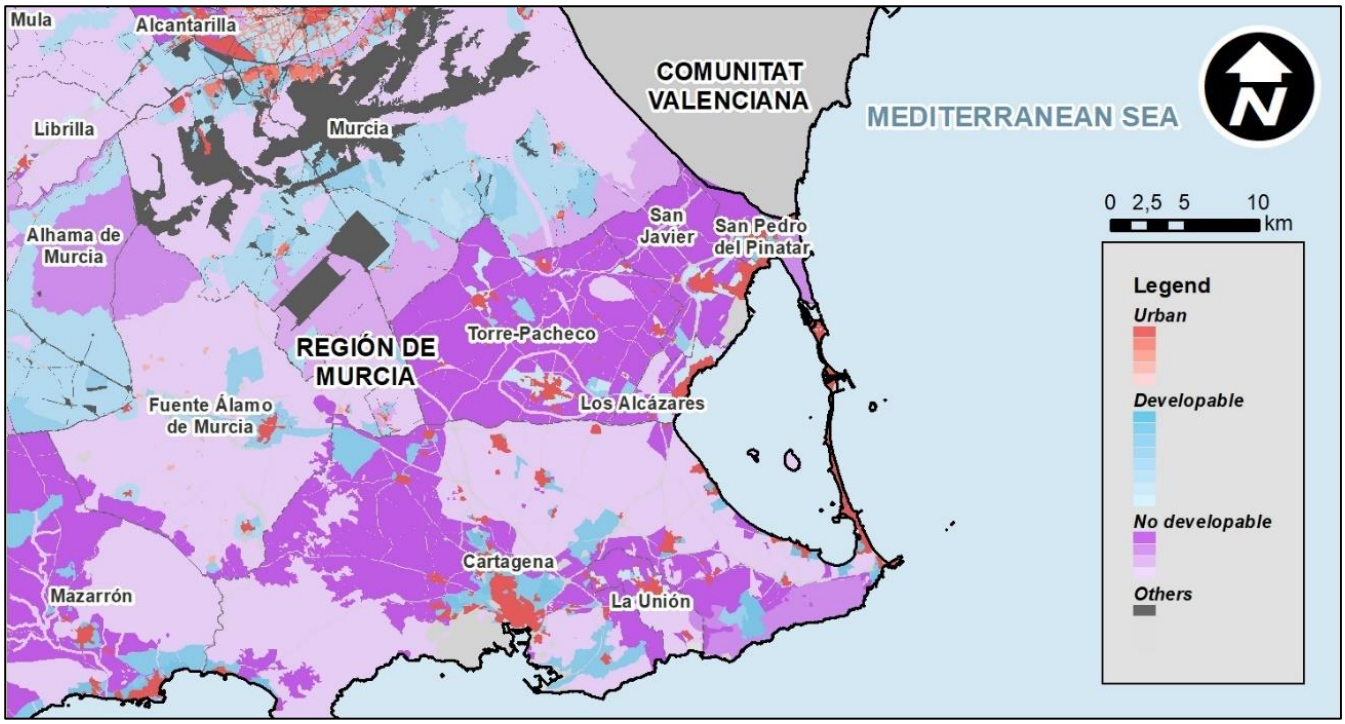


Figure 26. Urban local planning. Source: Authors.

SOCIO-ECONOMIC SITUATION

Human settlements

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Location of human settlements	Population entities	- Entities names	National Geographic Institute (IGN)
National census of discharges	Authorized discharge points by the river basin authorities.	- Owner and location of the discharge. - Generating activity and characteristics of wastewater. - Qualitative and quantitative characteristics of the discharge - Environmental quality of the receiving environment. - etc…	Ministry for Ecological Transition (MITECO)

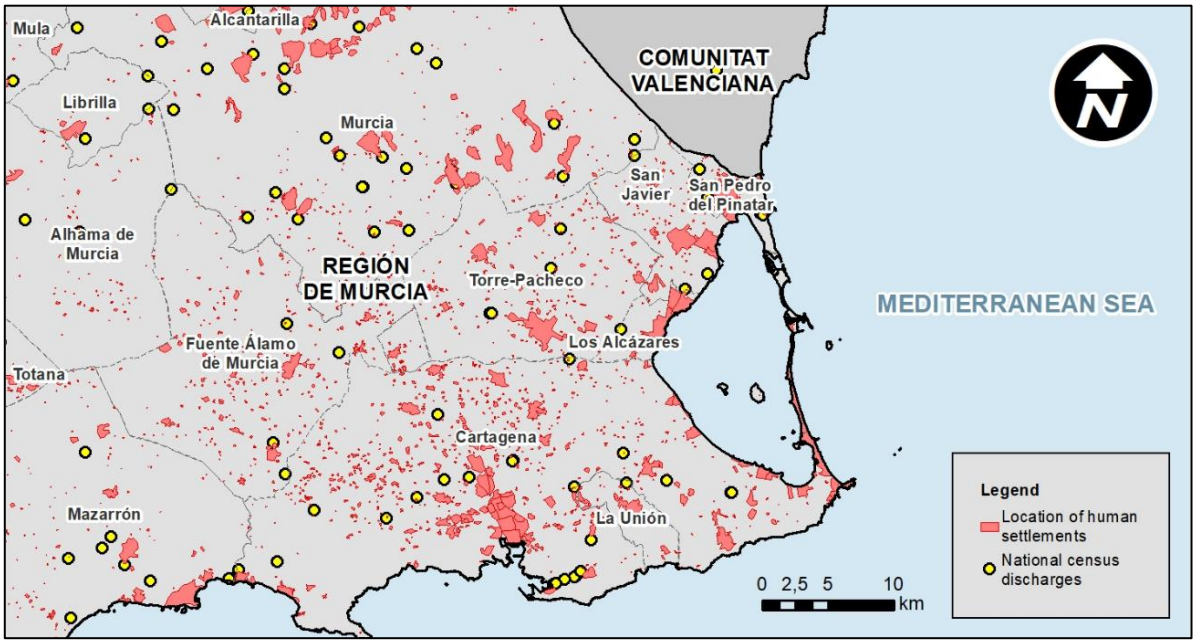


Figure 27. Human settlements and National census discharges. Source: Own elaboration.

Land uses

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
SIOSE Land uses	Land uses. Availability of dates: 2005, 2009, 2011, 2014	- Land use categories - Surface areas	National Geographic Institute (IGN)
CORINE Land cover	Land uses. Availability of dates: 1990, 2000, 2006, 2012, 2018	- Land use categories - Surface areas	National Geographic Institute (IGN)

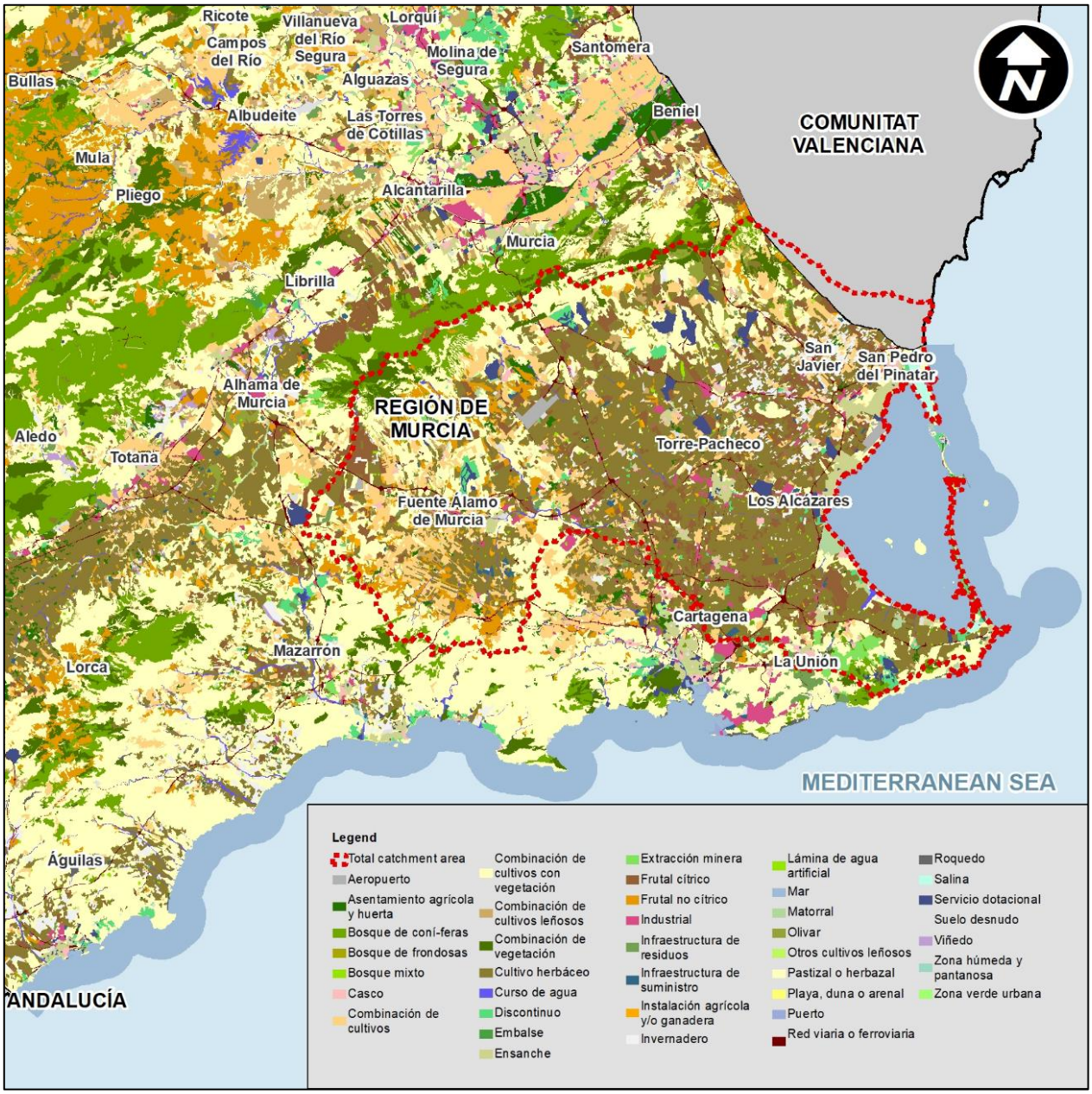


Figure 28. Land use (SIOSE 2014). Source: Authors.

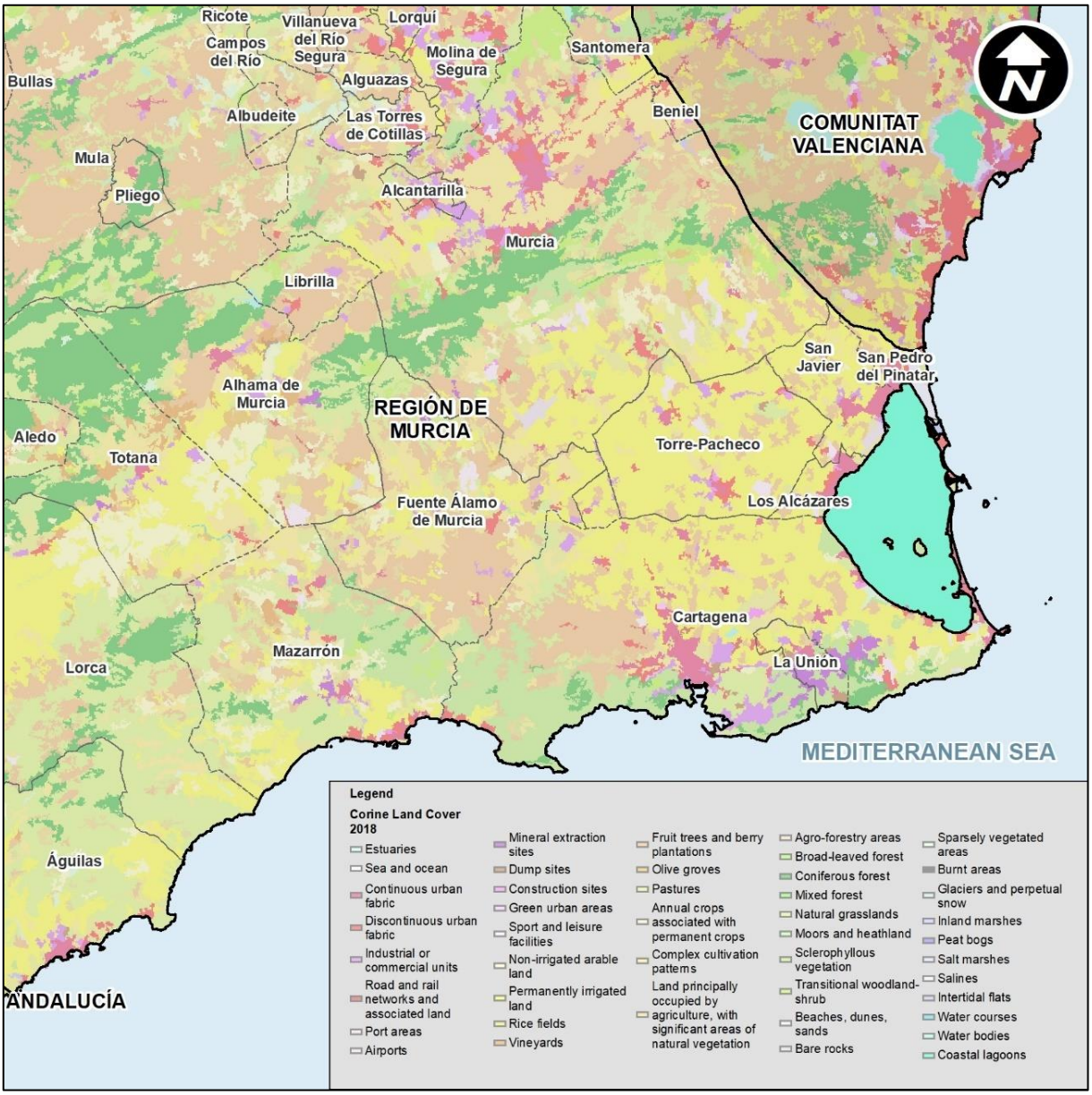


Figure 29. Land use (CORINE 2018). Source: Authors.

ENVIRONMENTAL SITUATION

Hydrological network

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Catchments	River basins that flow into Mar Menor	- Surface areas - Maximum, minimum, and medium altitude - Pfafstetter of the associated rivers	Centre for Hydrographic Studies (CEDEX)

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Streams	River streams that flow into Mar Menor	- Pfafstetter code - Longitude	Centre for Hydrographic Studies (CEDEX)
Aquifers	Groundwater bodies in the Murcia region	- Name - Surface areas - Identified overlap	Data catalogue of the CHS

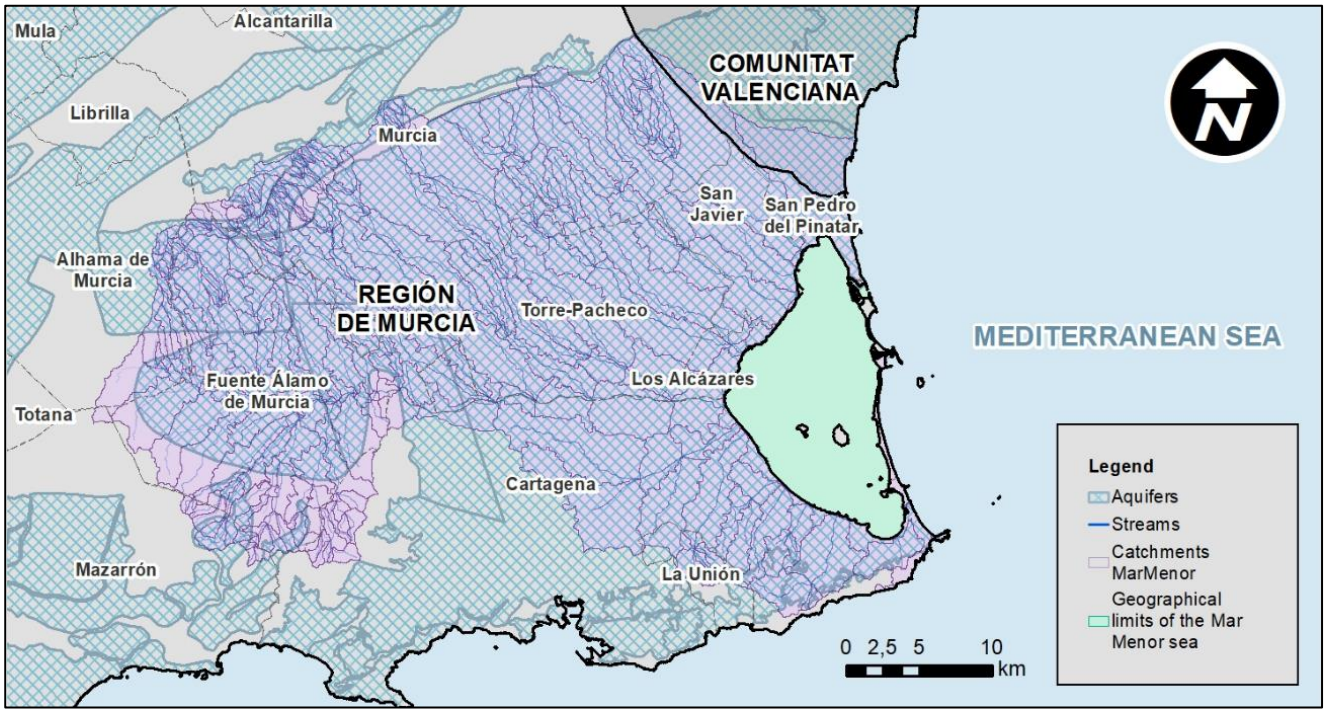


Figure 30. Hydrological network of Mar Menor. Source: Authors.

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Irrigation canals network	Network of canals and main irrigation in the region of Murcia including reservoirs.	- Protection's level - Sections' length - Name - Flow in the case of the Tagus-Segura Canal	Data catalogue of the CHS
Wells	Wells registered on the National topographic base	- Names - Coordinates	National Geographic Institute (IGN)

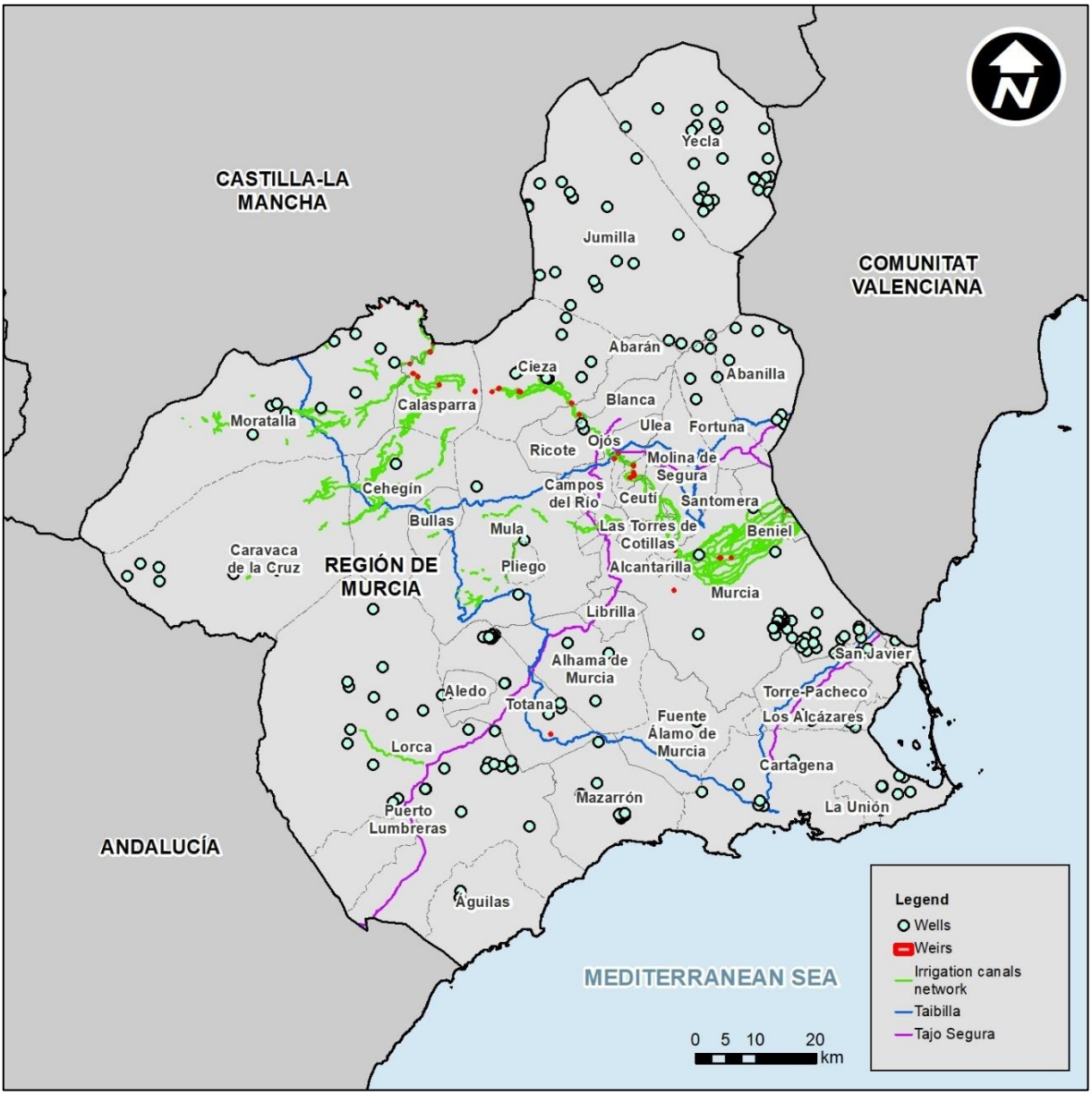


Figure 31. Irrigation canals network and wells. Source: Authors.

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Surface nitrate concentration	Control stations included in monitoring networks for nitrates in surface water in application of Directive 91/676 CE	- Waterbody names and codes - Nitrate level trends - Average values of nitrate for years between 2016 and 2019	Ministry for Ecological Transition (MITECO)
Subsoil nitrate concentration	Control stations included in monitoring networks for nitrates in groundwater in	- Waterbody names and codes - Nitrate level trends - Average values of nitrate for years	Ministry for Ecological Transition (MITECO)

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
	application of Directive 91/676 CE	between 2016 and 2019 - Maximum value for 2016-2019 period	

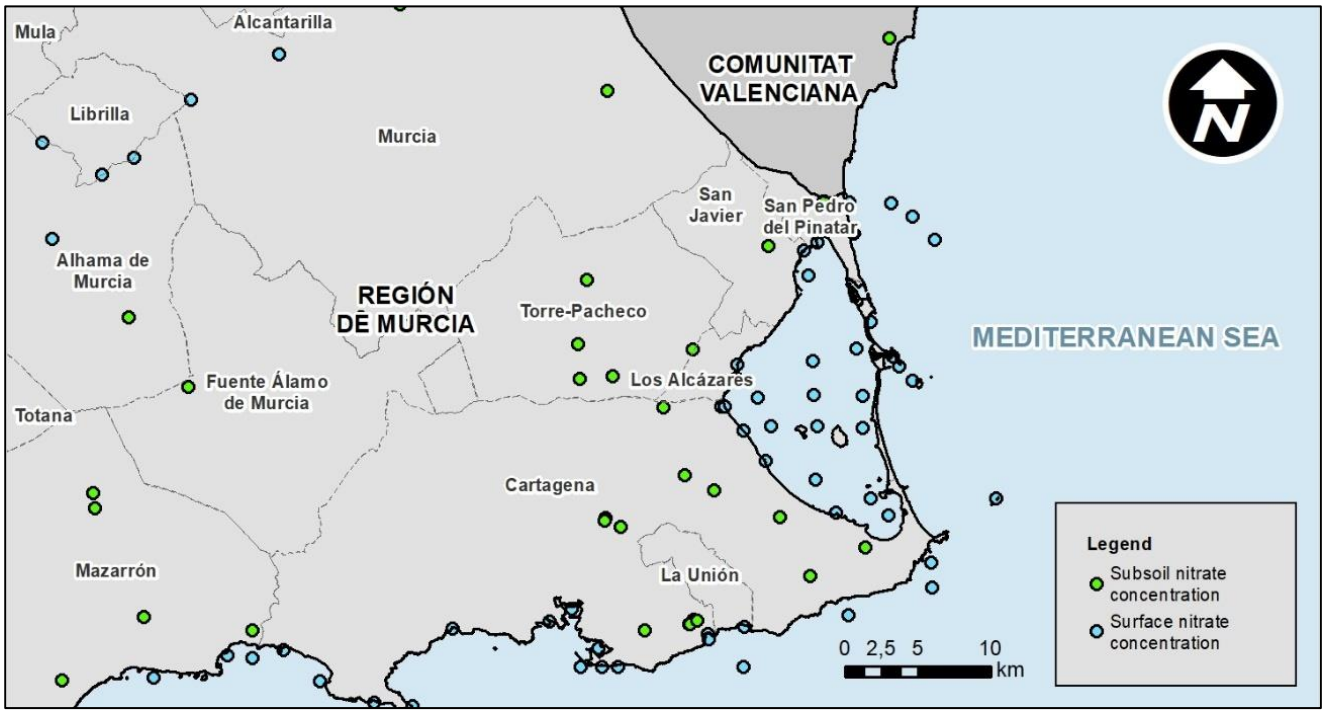


Figure 32. Surface nitrate concentration. Source: Authors.

Habitats and ecological corridors

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Terrestrial and maritime habitats	Natural and seminatural terrestrial habitats of Murcia Region.	- EU codes - LIC codes - Surface areas	Natural Environment General Directorate (CARM)
Natural habitats	National layer of natural habitats	- EU codes - Surface areas	Ministry for Ecological Transition (MITECO)
Ecological corridors	Areas with potential for natural and ecological corridors	- Surface areas - Plant associations	Natural Environment General Directorate (CARM)

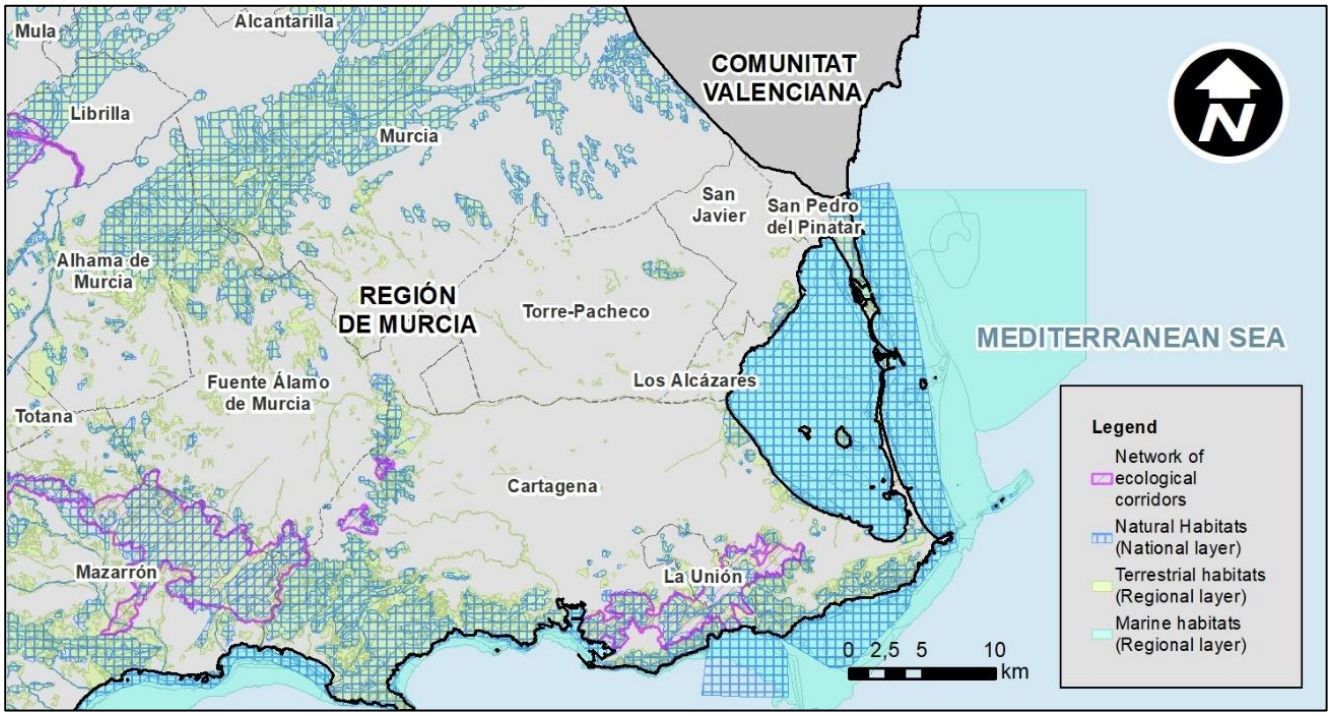


Figure 33. Natural habitats at regional and national level. Source: Authors

Pressures and hazards

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Coastal floods hazard areas	Coastal flood hazard for a return period of 10, 100 and 500 years	- Water increases in metres with a pixel size of 5x5 m	Ministry for Ecological Transition (MITECO)
River floods hazard areas	Coastal flood hazard for a return period of 10, 100 and 500 years	- Water increases in metres with a pixel size of 5x5 m	Ministry for Ecological Transition (MITECO)

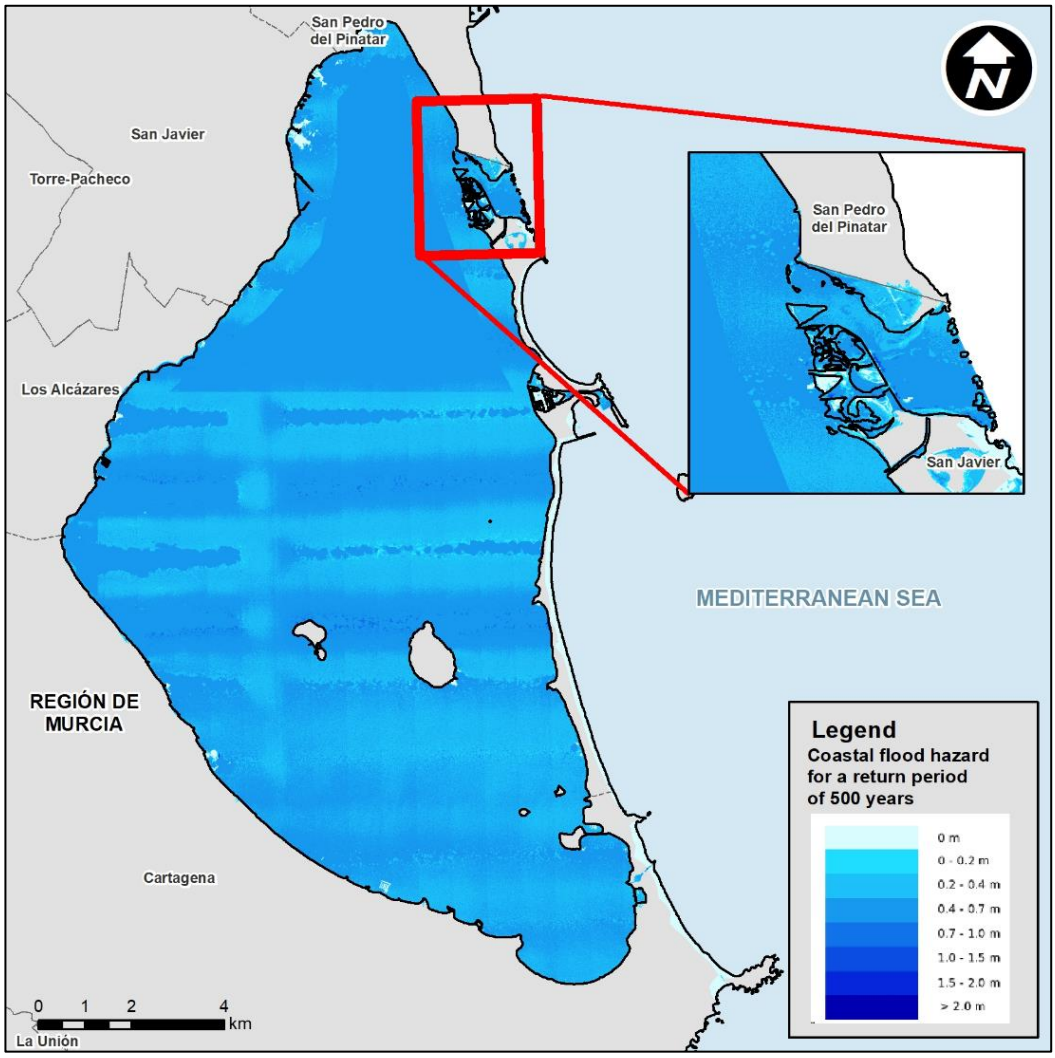


Figure 34. Coastal floods hazard areas. Source: Ministry for Ecological Transition's WMS.

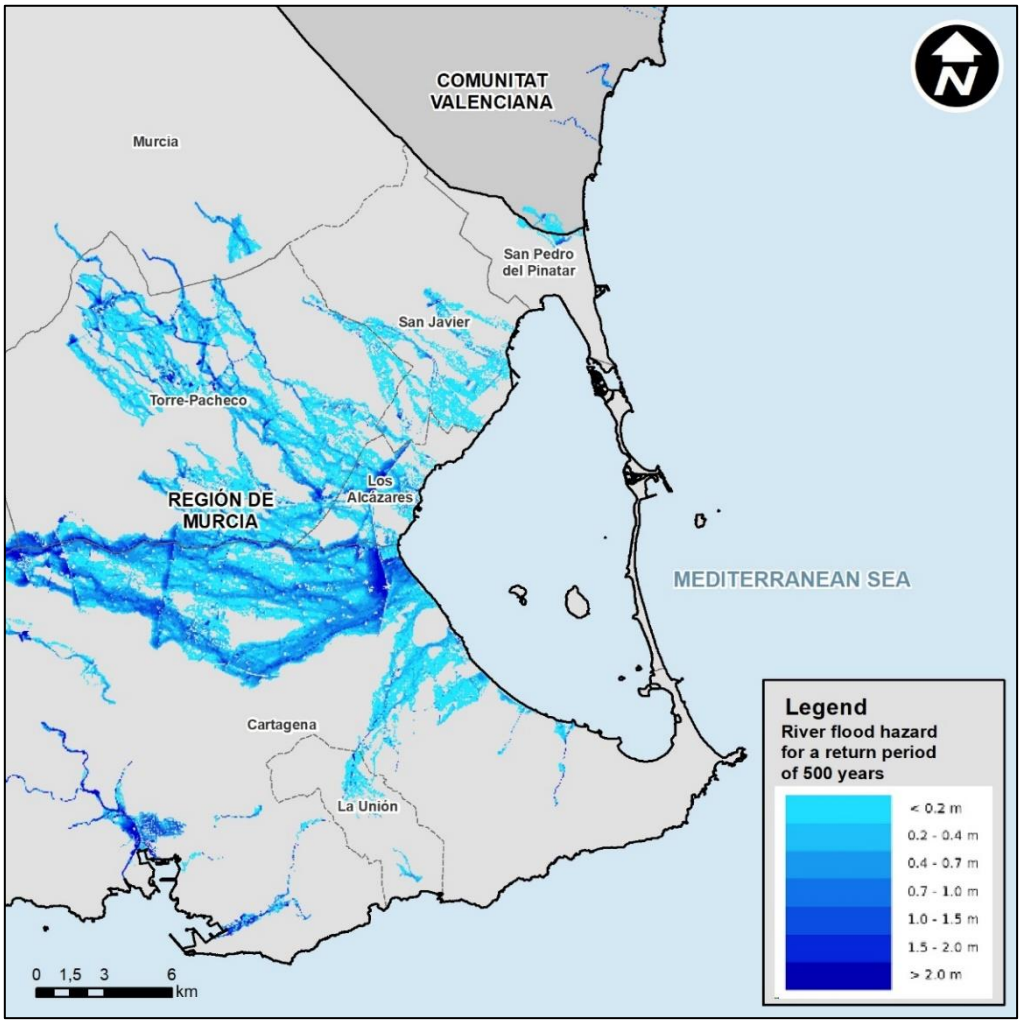


Figure 35. Coastal floods hazard areas. Source: Ministry for Ecological Transition's WMS.

AUXILIARY INFORMATION

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
DTMs (Digital terrain models)	2/5/25/200 m pixel size models	- Land heights	National Geographic Institute (IGN)

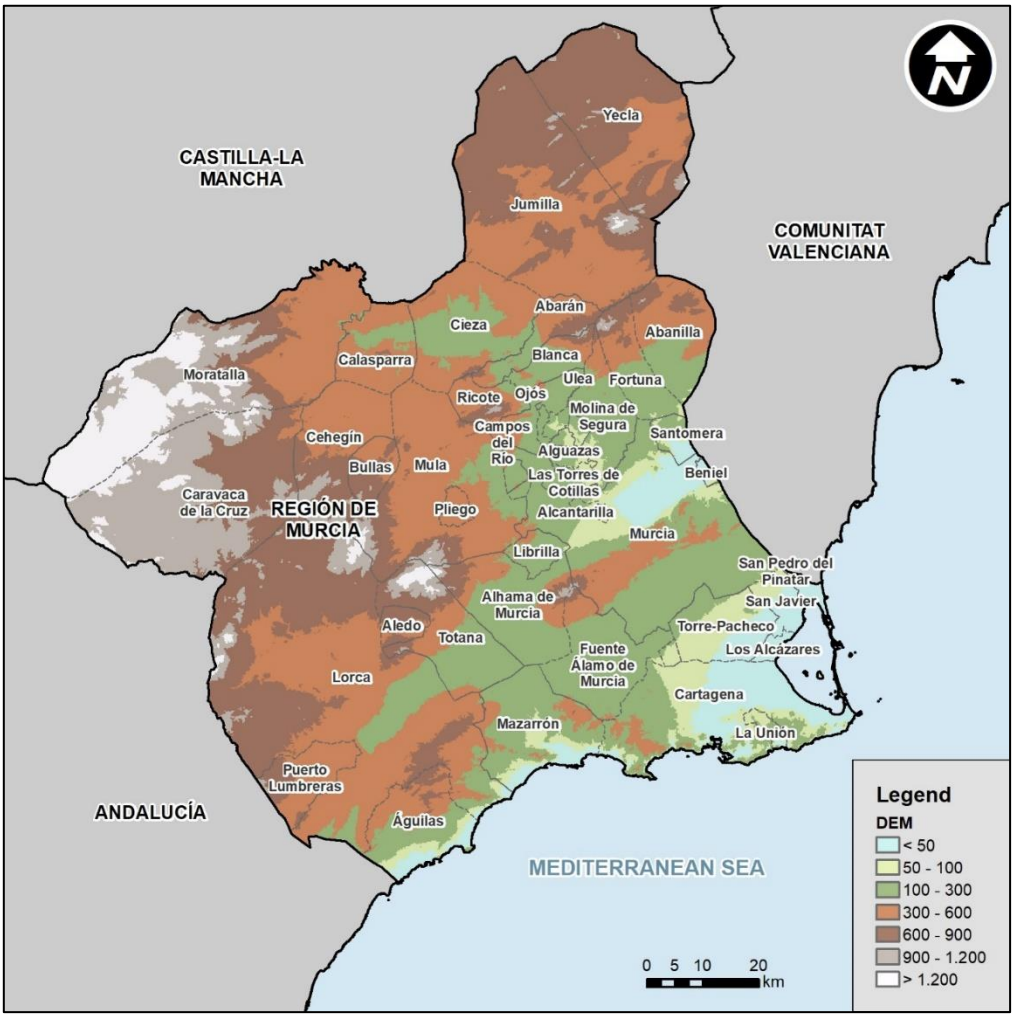


Figure 36. Hypsometric map of the region of Murcia. Source: Own elaboration.

Produced cartography

MAPPING PRODUCED FROM SENTINEL PRODUCTS

Introduction

One of the products generated by the project consists of the periodically obtention of 3 types of layers in Raster format related to water quality:

- Raster layers with the concentration of algae " Algal Pigment Concentration (CHL)".
- Raster layers with the diffuse attenuation coefficient at 490 NM "KD490 (TSRP)".
- Raster layers with the concentration of suspended matter in gm^{-3} "Suspended matters (TSM)".

These are 3 products generated from Sentinel-3 A and B images, specifically from the level 2 products of “The Ocean and land Colour Instrument” (OLCI), specially designed for water studies. With a spatial resolution of 300 m and 21 spectral bands between 400 and 1,020 nm, in particular the so-called "Ocean Products" were used.

Since the three types of raster layers, which have been generated from Sentinel, have been obtained from the same instrument, the process of obtaining the three types of raster layers is similar:

1. All available images have been collected from 01-11-2017 to the present day.
2. The raw information consists of 31 files in “.nc” format and an xml that allows its integration through the official software of the European space agency "Sentinel Application Platform (SNAP Desktop)".
3. From these files and using both Python and the "GraphBuilder" tool, the generation of layers in raster format of the specified categories has been automated.
4. Subsequently, from the images in raster format, colour maps were generated by designating reclassification values and colour palettes for each raster using the Python library "Arcpy" included with the ArcGIS desktop software.

Algal bloom (CHL)

The algal pigment concentration can be derived from two algorithms: OC4ME and Neural Network (see dedicated processing section). Each of the derived concentrations is included in a specific file: chl_oc4me.nc and chl_nn.nc, respectively. The generated rasters have been obtained from the chl_oc4me.nc file.

The following table, published on the Copernicus Sentinel missions web portal, provides the main characteristics of these variables including coverage, parameter ID, time latency, sampling and bands used in the associated product. The ancillary and auxiliary data provides the variables used during processing and are provided in Auxiliary Data Files (ADFs).

PRODUCT NAME	Algal Pigment Concentration
PARAMETER ID	CHL_OC4Me, CHL_NN. _OC4Me (_NN refer to the originating algorithm).
PRODUCT LEVEL	2
DESCRIPTION	Chlorophyll-a concentration and associated error estimates.
PRODUCT PARAMETERS	
COVERAGE	global
PACKAGING	half-orbit
LATENCY	NRT, NTC
UNITS	mg (chl a) m^{-3}
RANGE	0.01 - 100 mg m^{-3} (0.01 - 30 when restricting to Case 1 waters)
SAMPLING	Spatial: approximately 300 m x 300 m (FR) and 1.2 km x 1.2 km ; spectral: N/A
FORMAT	1-byte integer
APPENDED DATA	Error estimate (1-byte integer)
FREQUENCY	1 product per orbit
SIZE OF PRODUCT	Approx. 0.54 GB (FR), 35 MB (RR)
ADDITIONAL INFORMATION	
INPUT BANDS	OC4Me: Oa3 (443 nm) to Oa6 (560 nm) NN: Oa1 (400 nm) - Oa12 (753.5 nm), Oa16 (778.75 nm), Oa17 (865 nm), Oa21 (1020 nm)
ANCILLARY AND AUXILIARY DATA	OC4Me: Pre-computed f/Q tables, R table, Chl polynomial coefficients NN : Neural net coefficients LUT

Figure 37. Main characteristics of the Algal pigment concentration layer. Source: ESA[78].

As indicated in the table, one of the auxiliary data used for the calculation of the Algal pigment concentration is the chlorophyll concentration, which is calculated by the "OC4Me" Maximum Band Ratio (MBR) semi-analytical algorithm, developed by Morel *et al*. (Optical properties of the "clearest" natural waters) OC4Me is a polynomial based on the use of a semi-analytical model, itself based on the analysis of algal oceanic pigments measured in situ over the past decades in various oceanic regions.

It is expressed as: $log_{10} = \sum_{x=0}^{4} \left(A_x (log_{10}(R_j^i)^{10}\right)$

[78] The European Space Agency

The result of reprojecting the .nc file to ETRS89 EPSG: 25830 coordinates and exporting it to raster format can be seen in the Figure 38:

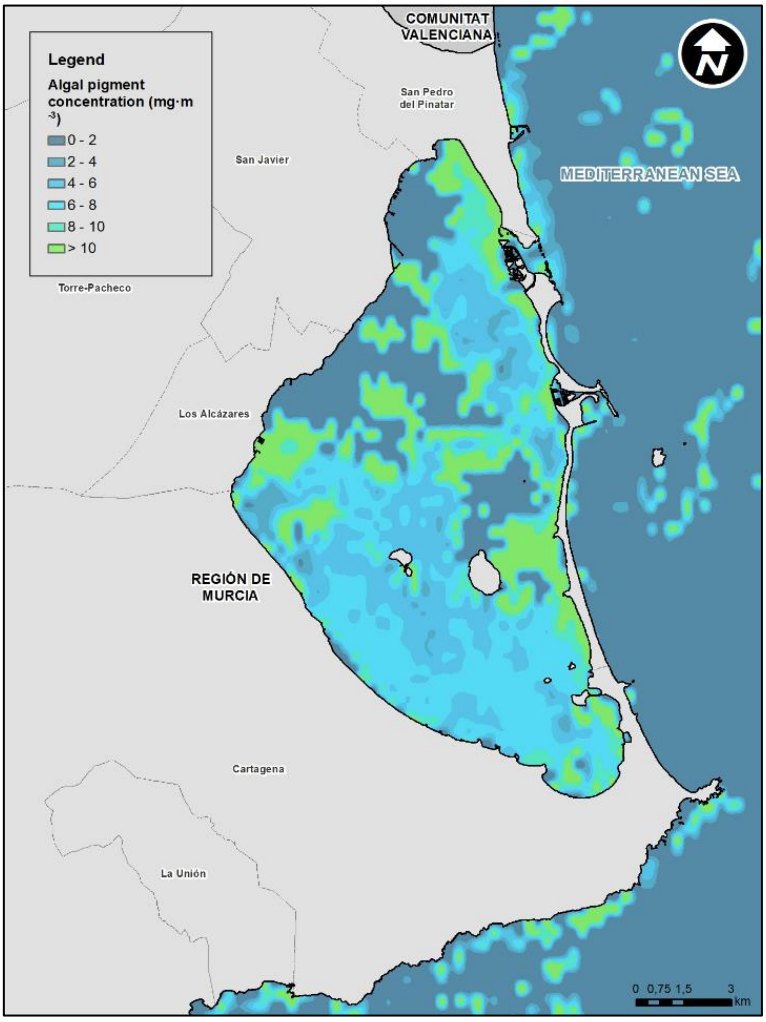


Figure 38. Algal Pigment concentration in November 2017. Source: Authors.

Diffuse attenuation coefficient at 490 nm kd490 (TRSP)

The Diffuse Attenuation Coefficient is the main variable included in the transparency.nc file providing the Transparency Properties of Water.

The following table published on the Copernicus Sentinel missions web portal, provides the main characteristics of this variable including coverage, parameter ID, time latency, sampling and bands used in the associated product. The ancillary and auxiliary data provides the variables used during processing and is provided in Auxiliary Data Files (ADFs).

PRODUCT NAME	Diffuse Attenuation Coefficient
PARAMETER ID	KD490_M07 and KD490_L05 (_M07 and _L05 refer to the originating algorithm)
PRODUCT LEVEL	2
DESCRIPTION	Diffuse attenuation coefficient for down-welling irradiance, and associated error estimates, at 490 nm
PRODUCT PARAMETERS	
COVERAGE	global
PACKAGING	half-orbit
LATENCY	NRT, NTC
UNITS	m^{-1}
RANGE	
SAMPLING	Spatial: approximately 300 m x 300 m (FR) and 1.2 km x 1.2 km (RR);; spectral: N/A
FORMAT	1-byte integer
APPENDED DATA	Error estimate (1-byte integer)
FREQUENCY	1 product per orbit
SIZE OF PRODUCT	Approx. 0.54 GB (FR), 35 MB (RR)
ADDITIONAL INFORMATION	
INPUT BANDS	Oa4 (490 nm) and Oa6 (560 nm)
ANCILLARY AND AUXILIARY DATA	

Table 18. Main characteristics of the Diffuse attenuation coefficient. Source: ESA

The algorithm that sentinel uses to calculate the diffuse attenuation coefficient is OK2-560 as described in Morel *et al.*, 2007. It is derived as the sum of the (hypothetical) value of the diffuse attenuation coefficient for pure seawater Kw (490) and a contribution linked to the biological state of the water. The latter is expressed, in log-transform, as a polynomial of the ratio of irradiance-reflectance between 490 and 560 nm, in a very similar way to the OC4Me Chlorophyll retrieval algorithm.

$$K_d(490) = K_w(490) with\ log_{10}(K_{bio}(490) with\ log_{10}\left(K_{bio}(490)\right) = \sum_{x}^{4}(B_x \cdot (log_{10}(R_{560}^{490}))^x)$$

The result of reprojecting the .nc file to ETRS89 EPSG: 25830 coordinates and exporting it to raster format can be seen in the Figure 39.

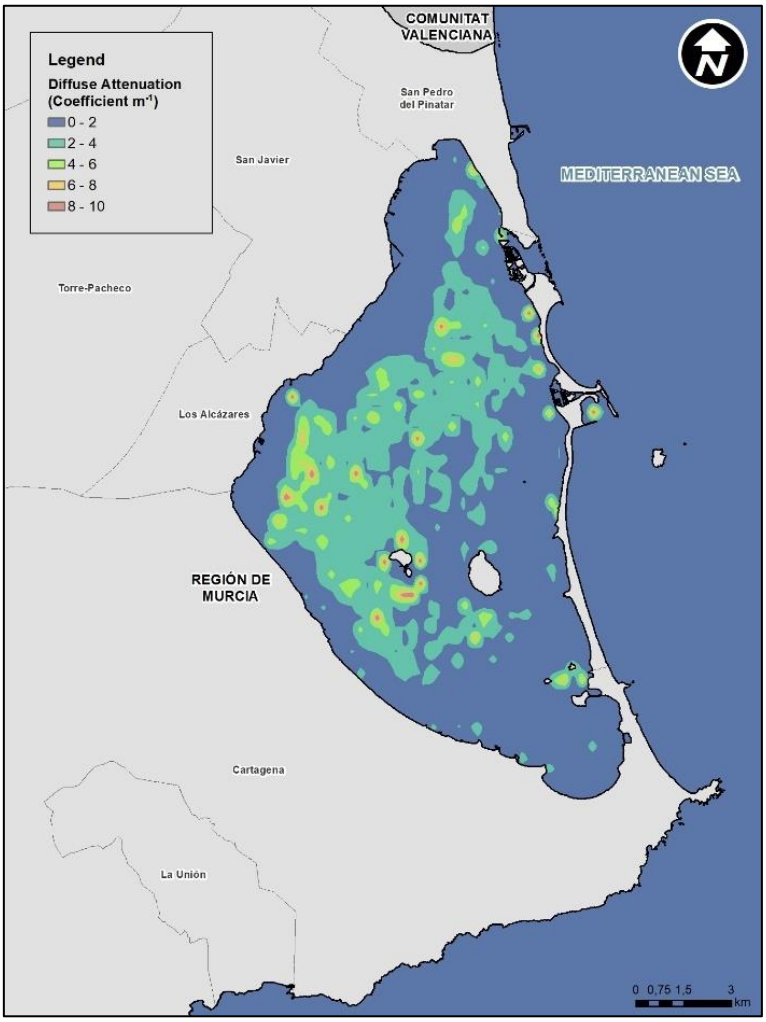


Figure 39. Total Suspended Matter in November 2017. Source: Authors.

Total Suspended Matter (TSM)

The total suspended matter concentration is the main variable included in the tsm_nn.nc file.

The following table, published on the Copernicus Sentinel missions web portal, provides the main characteristics of this variable including coverage, parameter ID, time latency, sampling and bands used in the associated product. The ancillary and auxiliary data provides the variables used during processing and are provided in Auxiliary Data Files (ADFs).

PRODUCT NAME	Total Suspended Matter Concentration
PARAMETER ID	TSM_NN and TSM_GSM (_NN and _GSM refer to the originating algorithm).
PRODUCT LEVEL	2
DESCRIPTION	Total suspended matter concentration and associated error estimates.

PRODUCT PARAMETERS	
COVERAGE	global
PACKAGING	half-orbit
LATENCY	NRT, NTC
UNITS	g m^{-3}
RANGE	0-100
SAMPLING	Spatial: approximately 300 m x 300 m (FR) and 1.2 km x 1.2 km (RR; spectral: N/A
FORMAT	1-byte integer
APPENDED DATA	Error estimate (1-byte integer)
FREQUENCY	1 product per orbit
SIZE OF PRODUCT	Approx. 0.54 GB (FR), 35 MB (RR)
ADDITIONAL INFORMATION	
INPUT BANDS	Oa1 (400 nm) - Oa12 (753.5 nm), Oa16 (778.75 nm), Oa17 (865 nm), Oa21 (1020 nm)
ANCILLARY AND AUXILIARY	OC4Me: Pre-computed f/Q tables, R table
DATA	NN: Neural Net coefficients LUT

Table 19. Main characteristics of the Total Suspended Matters. Source: ESA

This layer uses as auxiliary input the chlorophyll concentration, obtained under the same algorithm described in the algal pigment concentration section.

The result of reprojecting the .nc file to ETRS89 EPSG: 25830 coordinates and exporting it to raster format can be seen in the Figure 40.

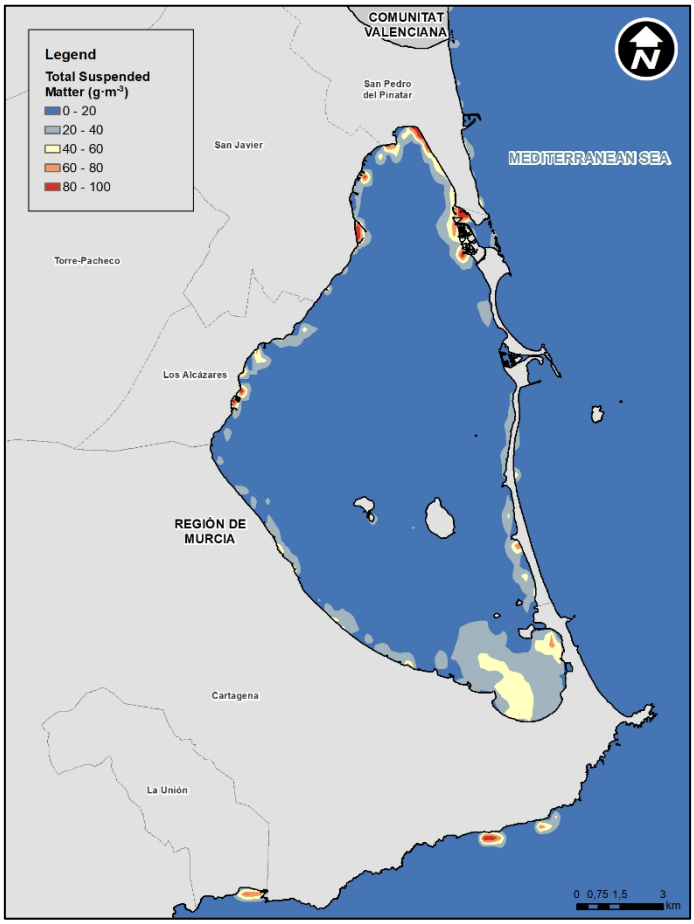


Figure 40. Total suspended Matters in November 2017. Source: Authors.

SPATIAL LOCATION OF IMPORTANT ELEMENTS THAT INFLUENCE THE DYNAMICS OF THE MAR MENOR.

Other important product generated by the project team consists of a map of relevant elements with the potential to influence the quality of the Mar Menor.

To draw up this map, a series of workshops were held in collaboration with some members of the consortium. During these workshops, the environment of the Mar Menor and the faciities of the Oceanographic Institute were visited, and a topographical map was drawn up on paper showing those elements which, according to the perception of the participants, had the greatest potential to influence the lagoon.

Figure 41. General map of the Mar Menor Lagoon. Source: Authors.

Subsequently, the comments were transferred to a vector map of important elements. This map is shown below.

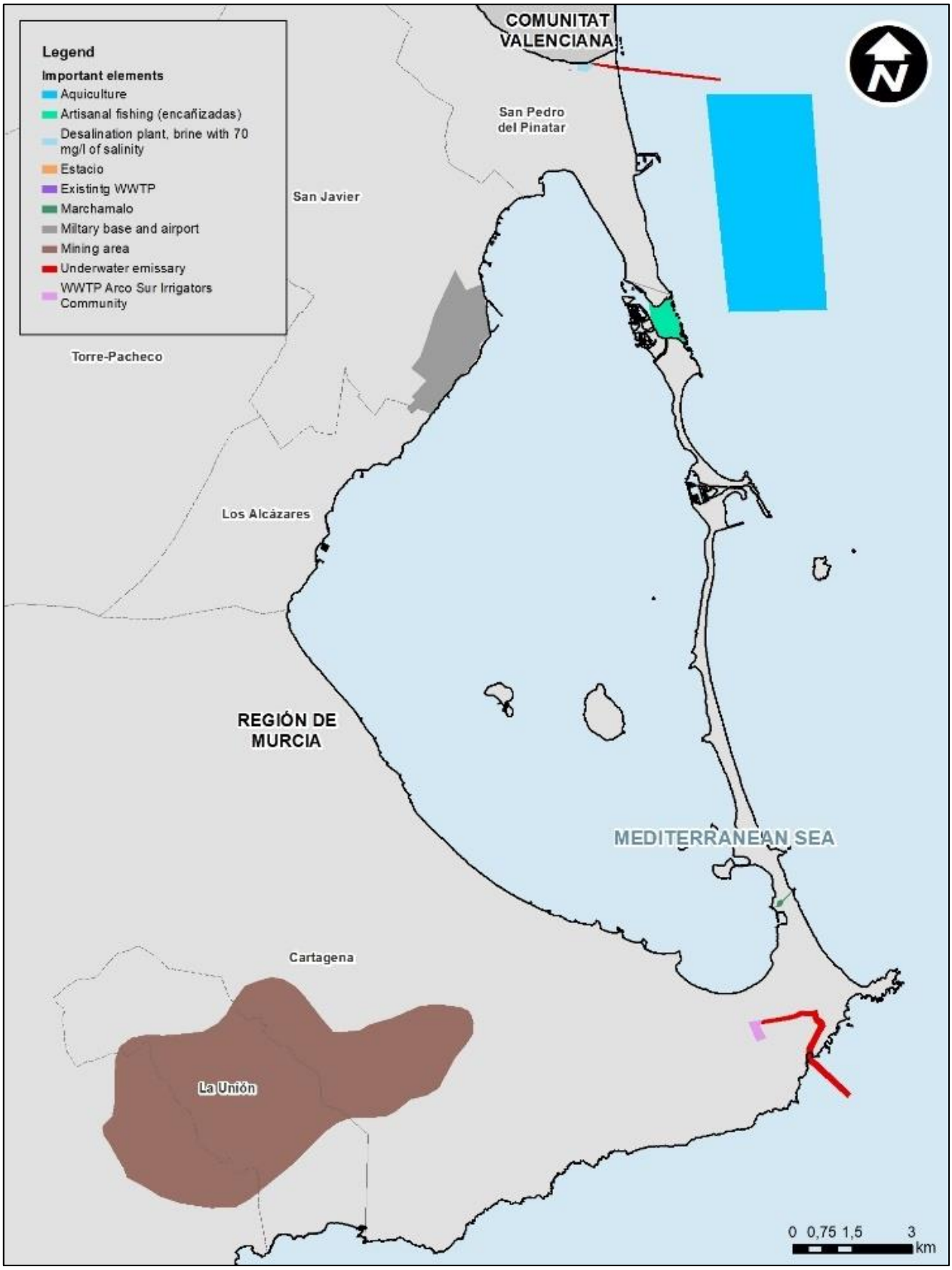


Figure 42. Spatial location of important elements that influence the dynamics of the Mar Menor. Source: Authors.

OTHER CARTOGRAPHY

Population growth by municipalities

Using data from the municipal census compiled every year by the Spanish Statistical Institute (INE) and the municipal boundaries mapping of the Spanish Geographical Institute (IGN), a vector map has been produced containing information on the population increase for the period 2000-2020.

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Population growth by municipalities	Population census for the years between 2000 and 2020, both included.	- Name of the municipalities - Codes associated - Population census for the different years	It is the union of data from the National Statistics Institute (INE) / Urban planning and the municipal boundaries of the IGN.

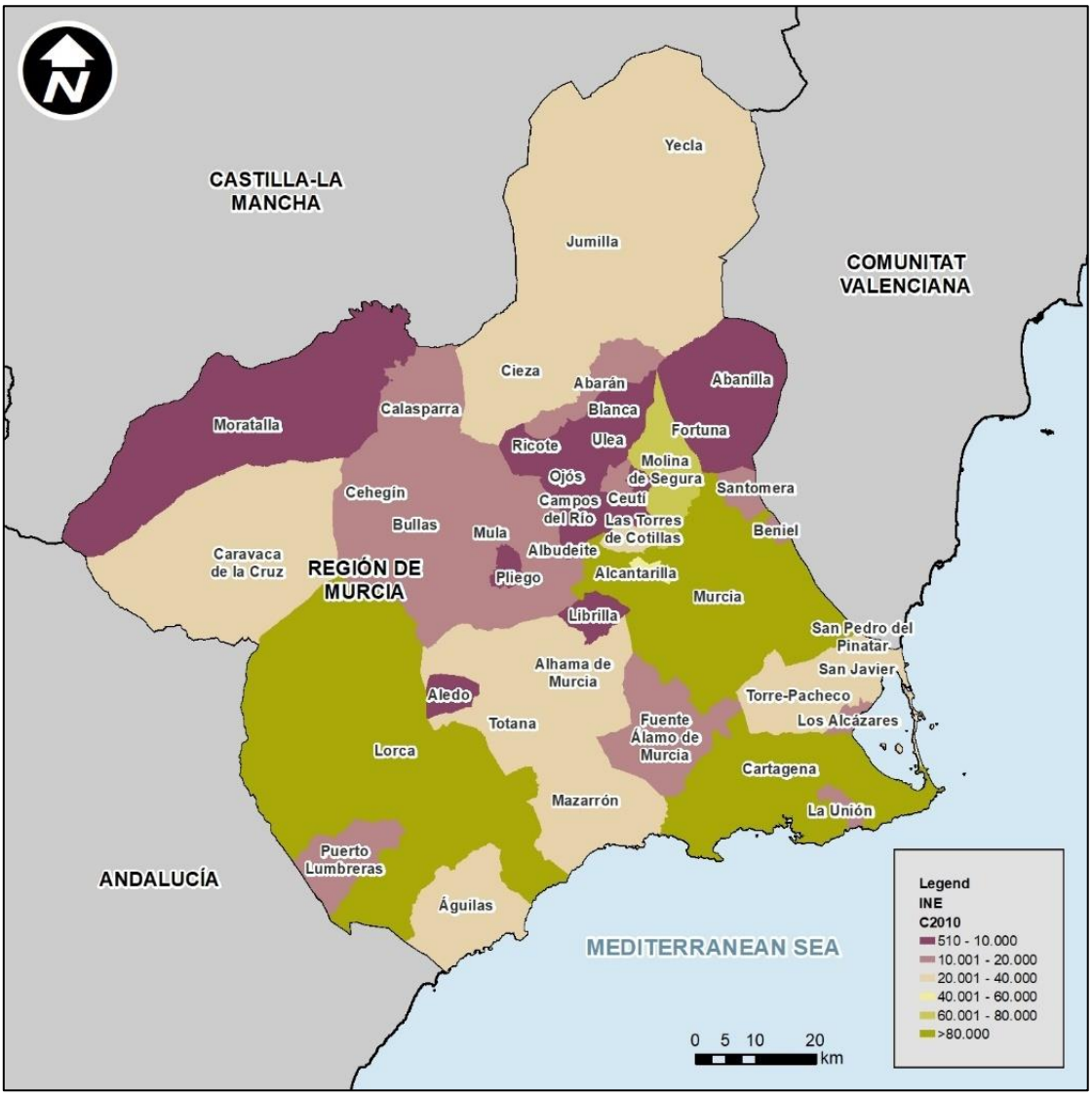


Figure 43. Population grown over the regional limits. Source: Own elaboration.

Layers suitable for hydrological modelling

Using GIS techniques for hydrological modelling, raster files have been generated with flow accumulation and flow direction data.

CARTOGRAPHY	DESCRIPTION	RELEVANT INFORMATION CONTAINED	SOURCE
Flow direction	The output of the Flow Direction tool is an integer raster whose values range from 1 to 255.	- Allows the calculation of hydrological parameters	Own elaboration based on the IGN digital terrain model.
Flow accumulation	Accumulative flow as the cumulative weight of all cells flowing into each downward sloping cell in the output raster	- Allows the calculation of hydrological parameters	Own elaboration based on the IGN digital terrain model.

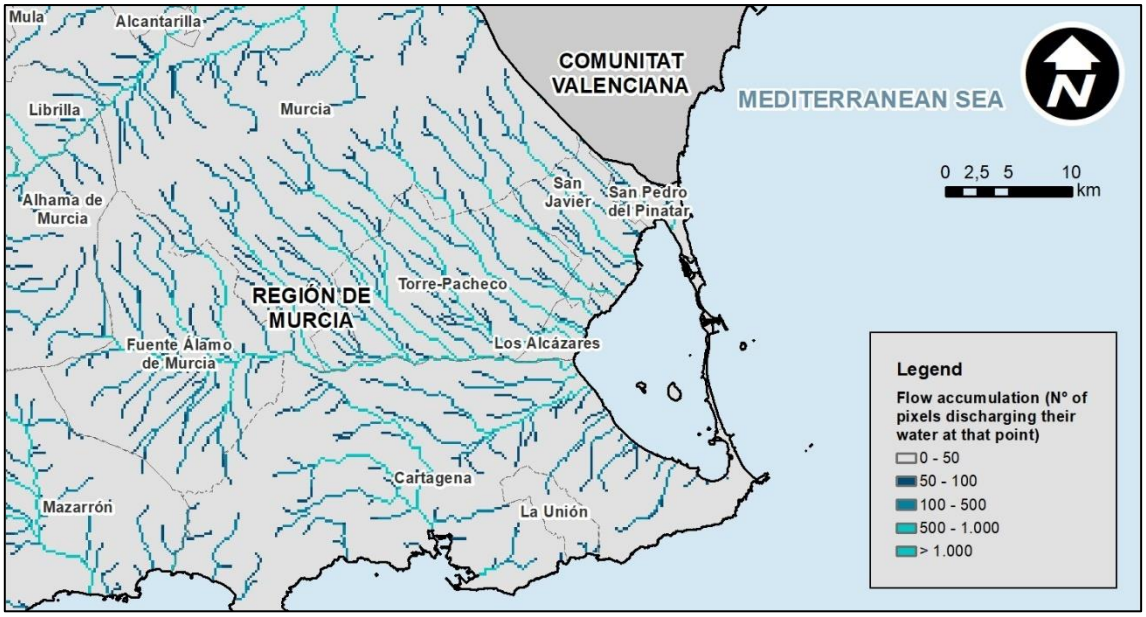


Figure 44. Flow accumulation. Source: Authors.

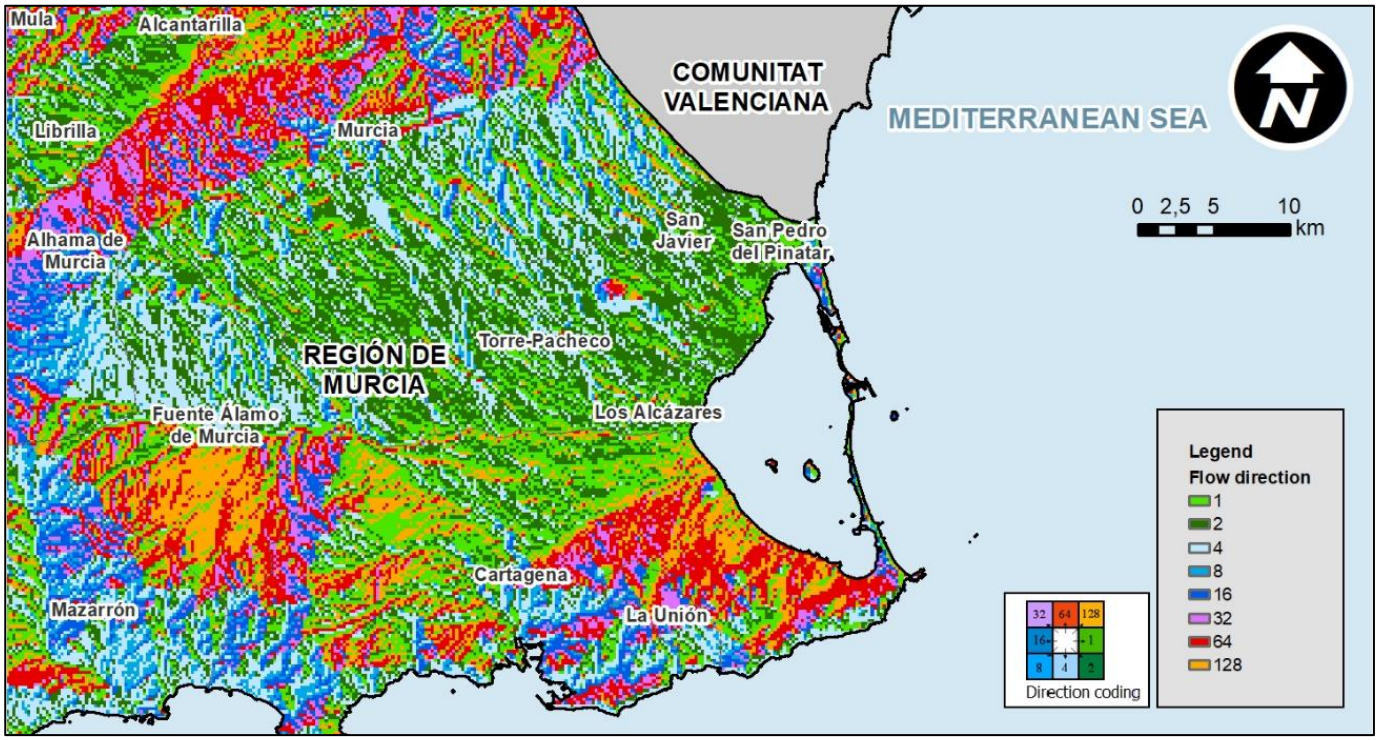


Figure 45. Flow direction. Source: Authors.

Conclusions

This report has generated background information that will be used during the project. It depicts the difficulties that arise concerning the complex regulation framework, as there are different competencies levels and different ways to tackle the Mar Menor problems. The report tries to summarize or simplify some important topics as the Best Management Practices (BMPs) and the main socio-environmental dynamics processes.

To ease the interpretation of some relevant aspects, a set of cartography is prepared. It is divided in two groups: already existing and self-produced cartography. All these data will be used in future steps within the project, as all these activities serve as preparatory work for the development of the system dynamics conceptual model that will be developed in the upcoming months.