LIFE TRANSFER

SEAGRASS TRANSPLANTATION FOR TRANSITIONAL ECOSYSTEM RECOVERY

NATURA 2000

D.5. EVALUATION OF THE SOCIO-ECONOMIC IMPACT OF CONSERVATION ACTIONS.

PRELIMINARY REPORT ON ANALYSIS OF LOCAL ECONOMY MAR MENOR (SPAIN)

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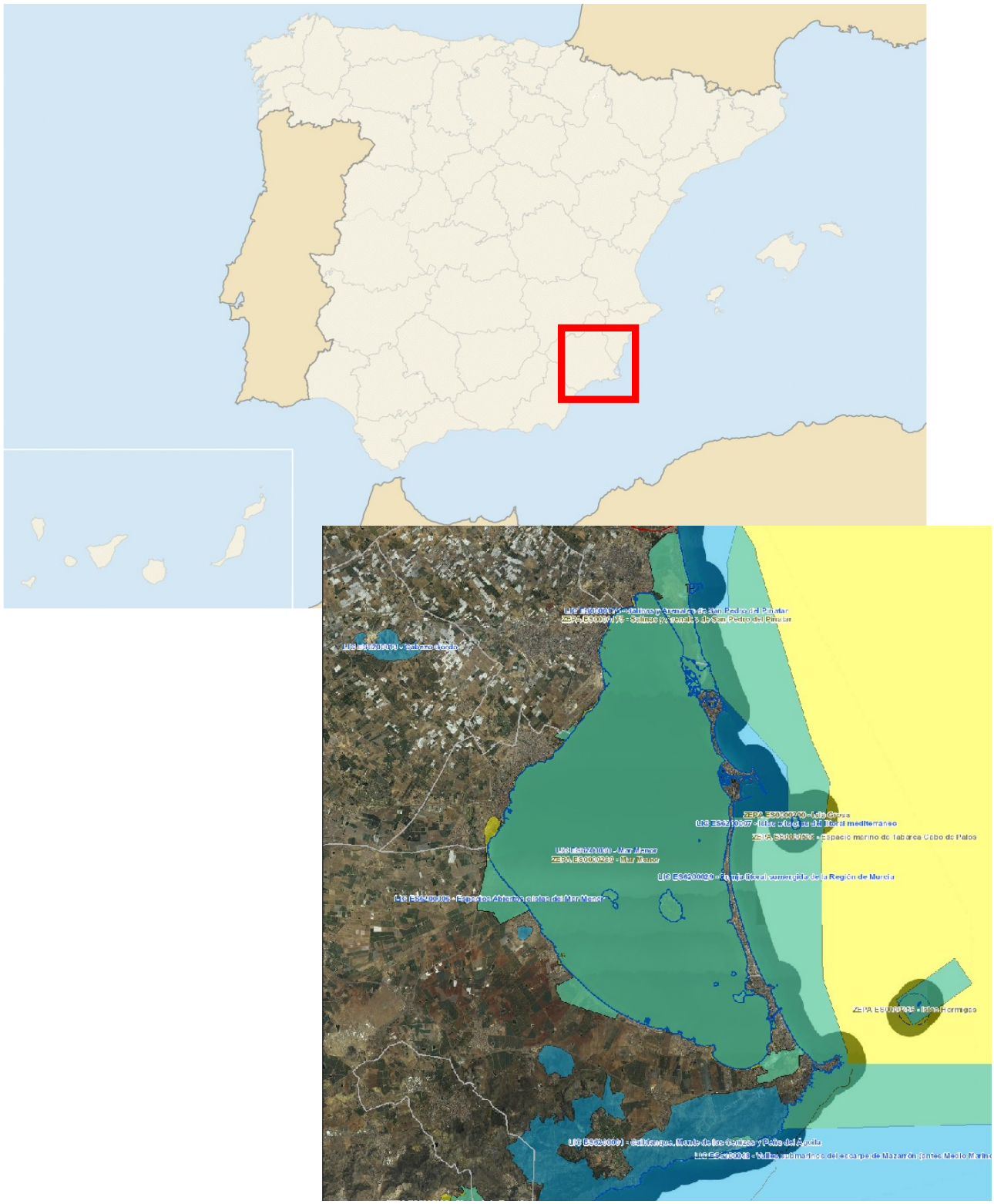
STATUS: Final

Cartagena, Murcia (Spain). August 2023

Geographical area:



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INTRODUCTION

The Mar Menor is a hypersaline coastal lagoon, with a surface of 135 km^2 , a perimeter of 59.51 km, and a mean depth of 3.6 m and maximum over 6 m. Located in the South-Western Mediterranean coastline, is part of Red Natura 2000, meaning that both the sea and interior islands are protected landscapes[1]. “La Manga”, a sandy bar 22 km long and 100 to 900 m wide, acts as a barrier between the lagoon and the Mediterranean Sea. It is crossed by five more or less functional outlets called "golas" which connect the lagoon with the sea. Four are shallow (less than 1 m depth) and one of them, “El Estacio”, was widened and dredged (5 m depth) to make it a navigational channel.

Due to run-off from agricultural lands over the last decade, there is a generalized eutrophication process. During the 1990s, agriculture started to change from dry crop farming with low amounts of nitrogen fertilizers to intensive irrigated crops with nitrogen fertilization, using waters diverted from the Tajo to the Segura river. From 1988 to 1997, nitrate concentrations increased from lower than 1 µmol N/l, throughout the year, to concentrations of up to 8 µmol/l. The regulatory mechanisms of the lagoon became broken in spring of 2016, with the loss of water quality and strong regression of benthic macrophyte meadows, producing a high socio-economic impact. The Mar Menor lagoon reached a severe eutrophic stage, in which excess nutrients caused explosive growth of unicellular algae, which gave the water a greenish color preventing the passage of light to the deep areas (visibility in the water column was reduced from around 6 m to less than 0.5 m), and consequently the photosynthesis of the vegetation, leading to the mortality of the *C. nodosa* meadows located at more than 2 m depth[2,3].

The Mar Menor has great socio-economic importance and supports a wide range of uses (including important commercial fisheries, mining, urban development, agricultural practices, sailing, health-spa services and tourism). Some activities, such as mining, have existed since Roman times, others, such as agriculture, or the opening of artificial inlets to be used for fisheries, were developed during the eighteenth and nineteenth centuries. Meanwhile, major urban development, land reclamations, widening of channels for navigation and construction of sports harbours are the consequence of tourism growth since the early 1970’s. The Mar Menor lagoon has an active, all-year-round, multi-species artisanal fishery. Some traditional gears show sociocultural and historic interest. Target species include the shrimp *Pennaeus keraturus*, and fishes as *Mugilidae*, sea bream, anguilla and sea bass.

Therefore, it is considered a key factor in regional development plans providing key tourist and recreational services and maintaining important fisheries communities. The lagoon is, however, a subject of concern due to its high rate of change over recent decades with a detrimental impact on

the structure of its biological assemblages and dynamics. Some of the changes have been induced by coastal work on tourism facilities (land reclamation, opening and extending channels, urban development, building of sports harbours, artificial beach creation, etc.), whilst others even more important due to its impact, relate to changes in agricultural practices in the watershed, that is, moving from extensive dry crop farming to intensively irrigated crops, increasing agricultural wastes and nutrient input into the lagoon. As impact of those changes, the colonization and expansion of the algae *Caulerpa prolifera* took placed which conforms extensive and dense meadows affecting the distribution of *Cymodocea nodosa* and producing changes in the nature of substrate and in species composition, decreasing biodiversity and fisheries[4].

It is not always easy to distinguish between services, goods and benefits which, together with the variety of methodologies and measurements, makes environmental and economic accounting difficult[5,6]. Moreover, the literature on goods and services related to coastal lagoons is very scarce and suffers from a great heterogeneity of approaches and methodologies. As said before, coastal lagoons play an important ecological role by providing a broad set of goods and services: fishery, shellfish harvesting, aquaculture, tourism, nautical sports, swimming, and thalassotherapy. However, the perception of these benefits is not always well recognized and may depend on the cultural context or stakeholder characteristics[7]. Regarding the ecosystem services and societal goods and benefits offered by the lagoon, the most valued were tourism, followed by landscape and its role as refuge and nursery for different species, with average scores of 6.96, 6.80, and 6.56 out of 10, respectively. The least valued services were resources provisioning and farming, with scores of 3.81 and 4.14[7,8]. Besides, the provision of food and tourism recreation, together with transport and habitation and their role as a wildlife refuges, were considered by scientists as the most important services provided by most of the 32 coastal lagoons studied worldwide[8]. However, some ecosystem services and societal goods, such as fisheries or tourism, are easier to identify and be assigned a monetary value than others, such as erosion or pollution control. The latter have been neglected because they are difficult to identify, or the lack of available data, or it is difficult to assign an economic value. Moreover, the ecological and sociological characteristics of coastal lagoons are dynamic, and in the way in which people use coastal lagoons are expected to change, as will the ecosystem services provided by lagoons. Therefore, it is important to find strategies to incorporate this dynamic nature in the methodologies used to evaluate them.

For all these reasons, the Mar Menor has always been an economic engine in the Region of Murcia, although with a clear seasonal nature in its activity and in the in the attention that has been paid to it by the social and economic sectors.

The LIFE-TRANSFER project plays a remarkable role in the conservation of the Mar Menor biodiversity and productivity through the restoration of their natural structure and function transplanting *Cymodocea nodosa* and *Ruppia cirrhosa*. The loss of 85% of grasslands caused trophic imbalances and increased the oxygen demand for the decomposition of the organic matter of the bottom[9].

Besides, an study considering the data on nitrogen demands for the meadows of both macrophytes in the Mar Menor suggest an important contribution of these habitats in controlling the inputs of this nutrient into the lagoon. We conclude that *C. nodosa* meadows can play a key role as a sink for dissolved inorganic nitrogen in temperate coastal lagoons, being an important mechanism of resistance to eutrophication[6].

Therefore these meadows are essential for the recolonisation and future recovery of the lagoon and, consequently, LIFE-TRANSFER has a very positive economic impact on the area where the Mar Menor is an economic engine.

OBJECTIVES and METHODOLOGY

To analyse the impact of LIFE-TRANSFER project on the local economy, the methodology and the number of steps followed are described below:

1. Objectives definition: determine the specific objectives of the economic impact analysis.
2. Data collection: Gather relevant data on the LIFE project and the local economy.
3. Identify key economic sectors: Determine the most relevant sectors that reflect the impact of the project on the local economy.
4. Establish a baseline: Analyze pre-project economic data to establish a baseline. This involves understanding the economic situation before the LIFE project is implemented and determining previous economic trends.
5. Consider external macroeconomic situation: Take into account the national and international economic framework in order to be able to isolate its influence and to contextualize.
6. Consider environmental disasters that may have affected: for instance, the especially virulent floods on September 2019 caused by an Isolated Depression at High Levels (DANA).
7. Attempt to use economic models: Use economic models and analysis techniques to assess the long-term economic impact of the LIFE project. These models may include input-output

models, general equilibrium analysis or regression analysis, depending on data availability and the complexity of the study.

8. Consider qualitative aspects: In addition to quantitative analyses, it is also important to consider the qualitative impacts of the LIFE project. This may include changes in quality of life, environmental conservation, environmental education or public awareness.

MACROECONOMIC FRAMEWORK

It is essential to understand the international and national economic context in which the Mar Menor area was involved, as it will inevitably be influenced. Two main crises can be highlighted, the financial crisis that began in 2008 and the COVID-19 crisis that occurred in 2020. Both events produced by different and difficult to predict causes, have a very important influence on the economy of the Mar Menor. In this sense, some data might not only reflect the economic impact of the environmental deterioration of the area, including the regression of the seagrass meadows, but also the effects of these crises.

Therefore, both crises and their effects will be briefly described, as they will be mentioned in different sections during the analysis of the economic impact of LIFE-TRANSFER in this document.

The international financial and economic crisis (2008-2009)

International economy.

The first signs of the international financial crisis began to be observed in mid-2007, initially in a relatively modest segment of the US mortgage market, the subprime mortgages. However, their effect spread rapidly around the world, in a context in which the previous period of long global economic growth had been accompanied by a generalised underpricing of risks, which had pushed both real and financial asset prices and private sector, financial and non-financial, indebtedness to very high levels.
This led to a significant tightening of financing conditions for the private sector, first in the United States and then in other economies, mainly among advanced economies, including those in the euro area and specifically in Spain.

Developments in the Spanish economy.

By mid-2007, when the first turbulence in international financial markets began to be observed, the Spanish economy had already entered a slowdown phase linked to the maturation of the expansionary cycle itself. The slower growth of household wealth and the rise in interest rates contributed to moderating the expansion of household consumption and, above all, of residential investment.

Between mid-2008 and the end of 2009, real GDP contracted by 4.6% .The adjustment was concentrated in domestic demand, which fell by 7%, with cumulative declines of 4.5% in private consumption, 27% in equipment investment and 21% in construction investment.

Thus, investment in new housing fell by 35% between 2007 and 2010, and employment in the construction sector fell by nearly one million people, with the consequent knock-on effect on the rest of the economy.

Finally, the INE later recorded a fall in GDP for 2011 as a whole of 1%. For its part, employment fell at a faster pace, dropping by 3.7% and bringing the unemployment rate to 23% at the end of 2011. The adjustment in the real estate sector intensified, with the volume of housing sales falling by 30% and prices by 11% compared with the previous year.

Recrudescence of the crisis (2012-2013)

International environment

In 2012, global economic activity slowed down again, reflecting both the complex macroeconomic and financial environment in EMU and a further deceleration in the pace of growth in emerging economies, leading to a significant decline in world trade growth. The sluggishness lasted until mid-2013, after which global growth began to pick up, mainly in advanced countries, as the emerging and developing bloc maintained moderate growth rates. Overall, in 2012 and 2013, global GDP grew by 3.5% and 3.3%, respectively, clearly lower than during the expansionary period of the late 1990s and early years of the current century.

The Spanish economy

The worsening of the political problems in Greece in the first half of 2012 accentuated tensions in EMU as a whole, as investors' perception of the risk of reversibility of the single currency increased. In this context, the recession of the Spanish economy intensified throughout 2012, showing a high vulnerability, stemming from the persistence of macroeconomic and financial imbalances built up during the expansionary phase, doubts about the soundness of some parts of the banking system and the parts of the banking system and the sharp deterioration in public finances and employment.

The COVID-19 pandemic has had a significant economic impact on Spain as a whole, including the Mar Menor area in the Region of Murcia. Spain implemented strict measures to contain the spread of the virus, including lockdowns, travel restrictions, and the closure of businesses and tourist activities. These measures had both immediate and long-term effects on the economy.

Tourism and Hospitality: Spain, known for its vibrant tourism industry, experienced a severe blow due to the pandemic. The Mar Menor area, which relies heavily on tourism, was particularly affected. Travel restrictions and lockdowns led to a sharp decline in tourist arrivals, hotel bookings, and restaurant visits. Many hotels, restaurants, and small businesses in the tourism sector faced financial challenges, closures, and job losses.

Employment and Income: The pandemic caused a significant increase in unemployment rates across Spain, including the Mar Menor area. Many businesses, especially those in the tourism, hospitality, and retail sectors, had to lay off employees or reduce working hours. This led to a decline in household incomes and consumer spending, impacting the local economy.

Agriculture and Fisheries: The Mar Menor area is also known for its agricultural and fishing activities. While these sectors were relatively less affected compared to tourism, they still faced challenges. Disruptions in supply chains, export restrictions, and a decrease in demand resulted in financial difficulties for farmers and fishermen.

Small and Medium Enterprises (SMEs): SMEs form a significant part of the Mar Menor area's economy. Many of these businesses, including local shops, boutiques, and family-run establishments, faced financial strain or had to close temporarily or permanently. Lack of customer footfall and reduced purchasing power affected their revenue and viability.

Government Support and Recovery Measures: The Spanish government implemented various support measures to mitigate the economic impact of COVID-19. These included financial aid, loan guarantees, and temporary employment protection programs. Additionally, stimulus packages and investments in infrastructure and tourism were initiated to aid in the economic recovery of the region.

RECENT RELEVANT NATURAL DISASTERS AND CHANGES CAUSED BY HUMAN ACTIVITY

The Mar Menor has experienced several remarkable changes, affecting pollution episodes over the years. Its effect on the local economy must be noted as it is undeniably linked to the environmental health of the Mar Menor. Some of the most notable episodes include the following:

1972: the enlargement of the Estacio Channel produced an increase in the water renewal rates, decreasing salinity and lower extreme temperature, thus permitting access to new, mainly benthic and nectonic colonizers, in the process of mediterranization of the lagoon[4]

1990s: nitrate concentration in the waters of the Mar Menor recorded average concentrations of around 8 mg/m^3 [10].

1997: a major pollution episode occurred in the Mar Menor due to the outflow of the Rambla del Albujón river, which transported a large amount of sludge and sediment into the sea. This event caused a significant reduction in water quality and negatively affected marine life and coastal ecosystems[4].

2004: another pollution episode was recorded in the Mar Menor due to the proliferation of the green algae "Ulva" in its waters. This algae developed under eutrophication conditions, where high levels of nutrients, especially excess nitrates and phosphates, favored its growth. The massive bloom of the green algae affected the transparency of the water and had negative consequences for the aquatic ecosystems[2].

2016: the Mar Menor suffered a massive pollution episode known as the "green soup" or "green tide". This event was caused by a combination of factors, including poor agricultural management, intensive irrigation practices and torrential rains. The rain-washed fertilizers and agricultural residues into the lagoon, leading to an explosive proliferation of harmful algae, such as "*Ostreopsis cf. ovata*". This caused serious environmental problems, including fish kills and loss of biodiversity[10,11].

2019: Unfortunate events of especially virulent floods caused by an Isolated Depression at High Levels (DANA) generated enormous entrance of fresh water to the lagoon, causing massive fish mortality due to the generation of anoxia conditions. Indicators changed in transparency (5.17->3.2m), turbidity (1.44->10.06FTU), chlorophyll (0.3->7.59µg/l), salinity (43.47->38.46PSU)[9,11].

KEY ECONOMIC AREAS

Since 1970, eutrophication has become a widespread problem for marine conservation, coinciding with the increased use of nitrogen fertilisers Thus, marine eutrophication processes and excessive algal overgrowth events (HABs) cause important economic losses to the fishing industry, marine recreation and sporting activities and tourism demand[10]. Considering all available information and data, the main economic sectors in Mar Menor are tourism, fishing, real state and agricultural sector. These sectors are discussed below:

Tourism is one of the most important economic pillars in this Spanish coastal area. The beaches, pleasant climate and cultural richness attract millions of visitors each year. Income generated by tourism includes lodging, restaurants, transportation, recreational activities and local commerce. Hotels are built and renovated and restaurants are established to meet the needs of visitors, generating employment and contributing to the local economy. Besides, tourism activity generates a large amount of employment. Hotels, restaurants, stores, travel agencies, and other tourism-related businesses provide both temporary and permanent employment opportunities.

Moreover, it is worth to highlight sports and recreational activities. Coastal areas offer an ideal environment for a wide range of sports and recreational activities, such as surfing, sailing, diving, adventure tourism, and other water sports. These activities generate income through specialized tourism services and attract enthusiasts and tourists.

Fishing sector: Fishing plays a significant role in the coastal economy. Spain has a large fishing fleet and a constantly developing aquaculture industry. These activities generate direct and indirect employment, as well as income from seafood exports.

Real state sector: this sector has a great economic importance in the Mar Menor area due to its impact on urban development, employment generation and tourism attraction.

Agricultural sector: since the Mar Menor is a coastal lagoon that is located in an area rich in fertile soils and has a favourable climate for agriculture is essential to assess the economic impact of LIFE-TRANSFER in this sector. The agricultural sector in this area is characterised by the production of a wide variety of crops, including fruit, vegetables, citrus fruits and horticultural products in general.

Tourism sector

From a socio-economic perspective, the Mar Menor is an iconic area for national and international seasonal tourism, and it has become an engine of economic and social development for the Region of Murcia. In 2020, the Mar Menor lagoon attracted 80% of the tourists visiting the Costa Calida (the name given to the coastal zone), and it accounted for 37% of tourists' overnight stays in the region[12]. Thus, this is one of the sectors most affected by the environmental deterioration of the marine environment.

The characteristics of the environmental setting in which tourist activity takes place are decisive in explaining the long-term movement of tourists. The effect of marine pollution on visitor growth is non-linear, i.e. a higher degree of environmental deterioration is associated with a higher rate of adjustment in the number of tourists. This phenomenon is due to the fact that when pollution exceeds a certain threshold, tourists are able to perceive its effects more clearly and decide to change their destination more destination more quickly than they would if the level of pollution was moderate or non-existent[10].

There is also an study regarding the influece of water pollution in Mar Menor in the Airbnb (a service that lets property owners rent out their spaces to travelers looking for a place to stay) prices. The results show a significant impact of high levels of marine water pollution in this lagoon reducing Airbnb listing prices in this zone. Therefore, urgent actions are needed to improve the status of Mar Menor[13].

Analysing the data regarding the number of tourist and tourism places in the Costa Cálida (the area studied is a little bit wider than just Mar Menor) there has been a very sharp fall probably due to the COVID-19 crisis. Although the numbers have not recovered in 2023, it is most likely due to the fact that not all of this year's tourist flow, especially strong in the summer season, has been accounted yet (Figure 1).

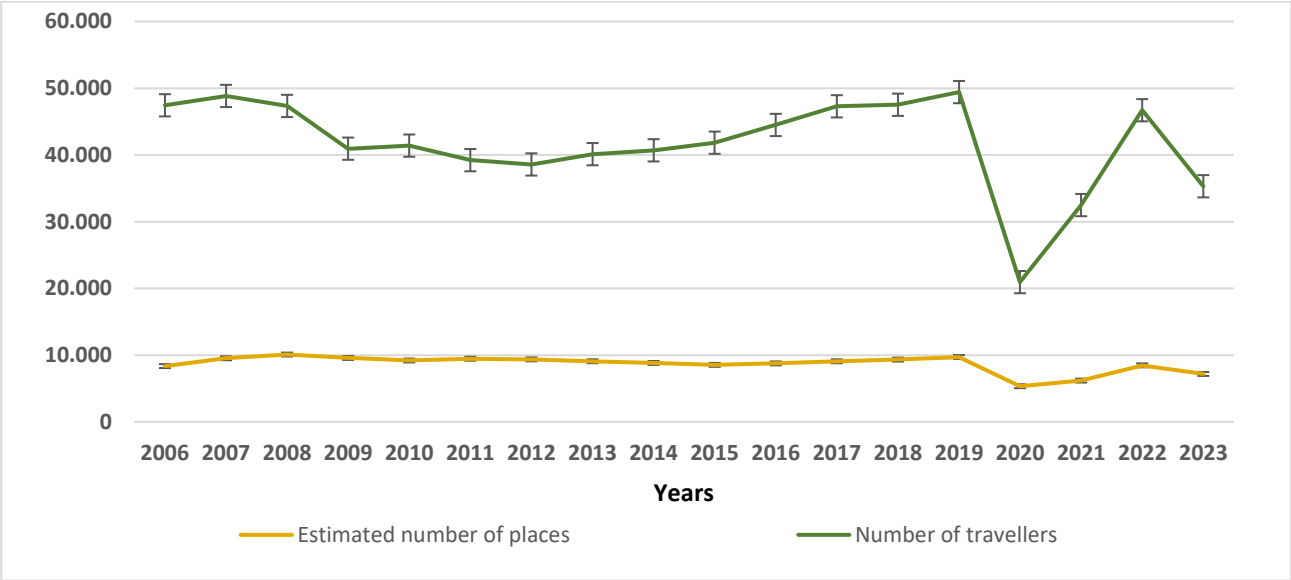

Figure 1. Estimated number of tourist bedplaces and travellers in the Costa Cálida since 2006. National Statistics Institute.

According to the National Statistics Institute of Spain, the most significant drop occurs in 2020 and it is logical to associate it with the COVID-19 crisis. In the following years there has been a gradual recovery in the figures, although they have not yet reached pre-COVID levels (Figure 2, Figure 3, Figure 4 and Figure 5).

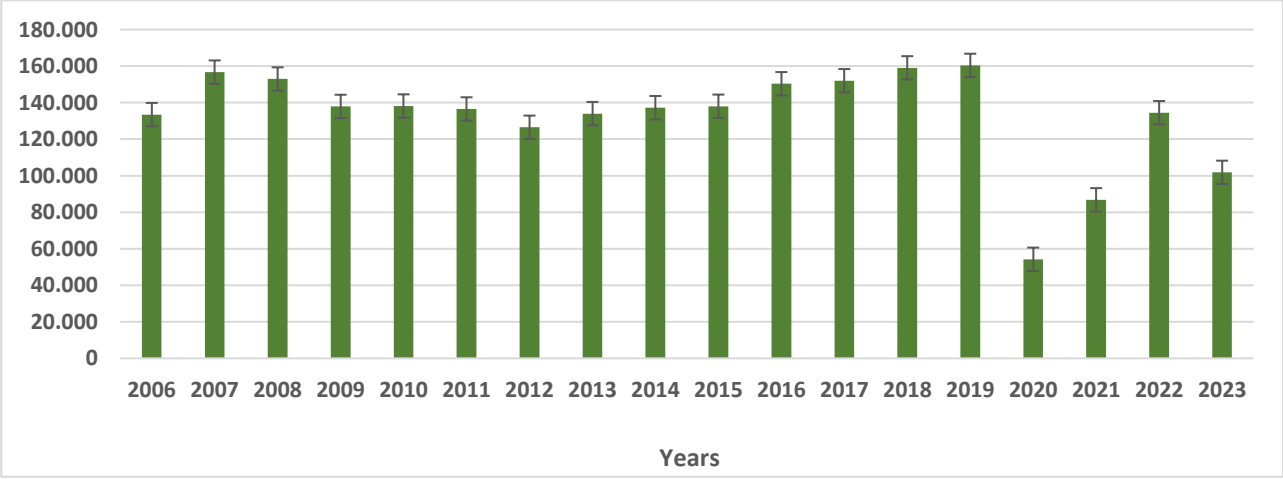

Figure 2. Average value of tourist overnight stays in the Region of Murcia since 2006. National Statistics Institute.

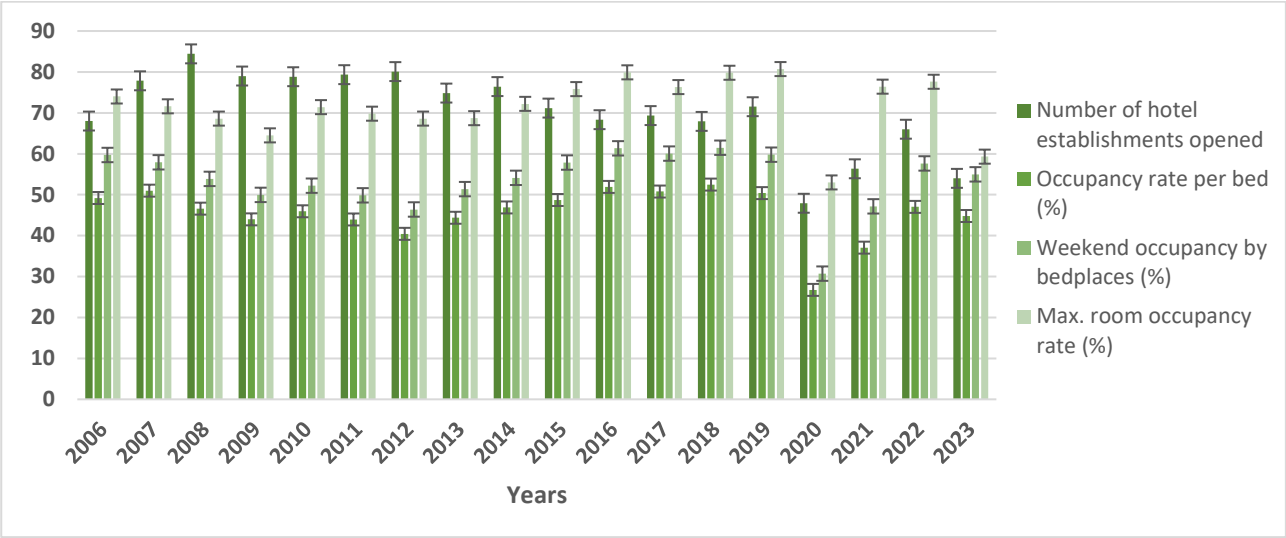

Figure 3. Average value of number of hotel establishments opened, occupancy rate per bed (%), weekend occupancy by bedplaces (%) and maximum room occupancy rate (%) in the Region of Murcia since 2006. National Statistics Institute.

It is worth noting slight decreases in different values of the tourism sector data (occupancy rate per bed, staff employed in the tourism sector or tourist overnight stays) which, given the dates on which they occurred (2008-2009), could be related to the global financial crisis suffered during the last decade (see MACROECONOMIC FRAMEWORK).

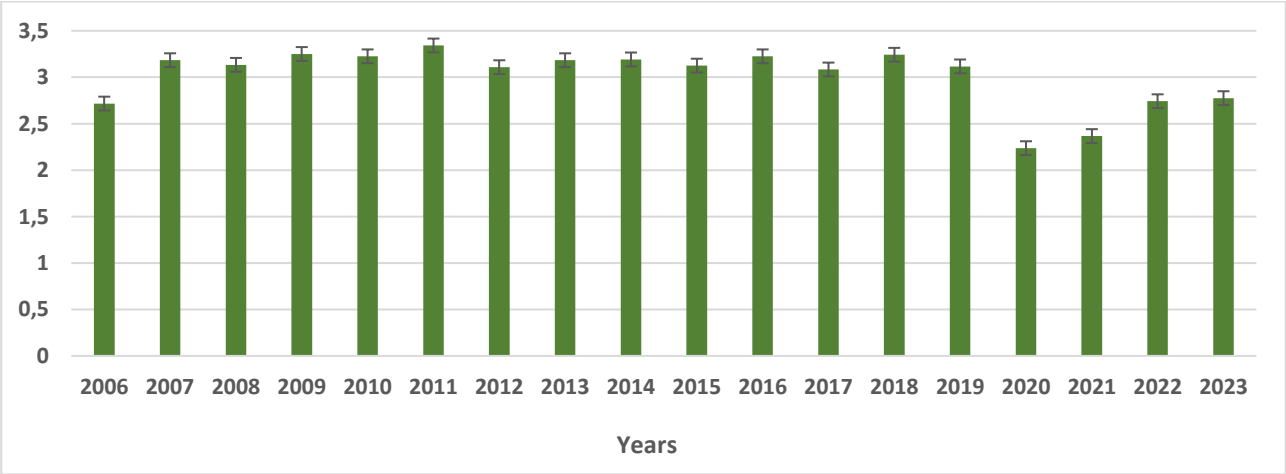

Figure 4. Average number of tourist overnights in the Region of Murcia since 2006. National Statistics Institute.

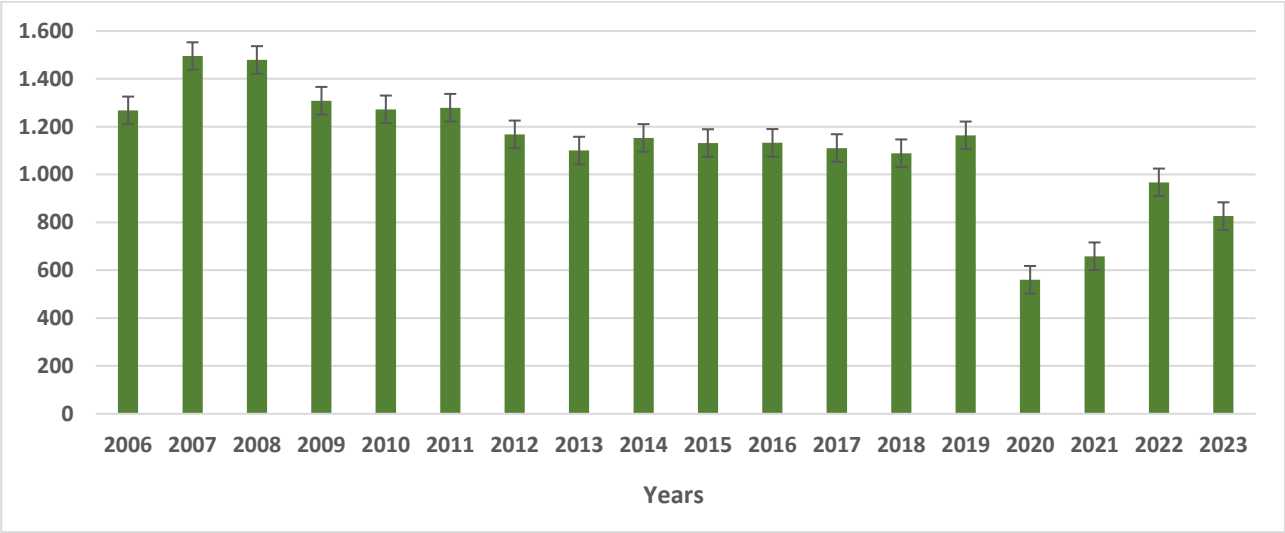

Figure 5. Average number of staff employed in the tourism sector in the Murcia Region since 2006. National Statistics Institute.

In general, the data analysis shows that there has been a reduce in the number staff employed in the tourism and the number of hotel establisment opened (Figure 3 and Figure 5) which could demonstrate a correlation between relevant economic variables of the tourism sector and Mar Menor environmental status. Furthermore, there is abundant peer-reviewed information and scientific publications such as those cited above, which demonstrate that the environmental deterioration of the Mar Menor has a negative impact in the tourism sector.

Fishing sector

Fishing in the Region of Murcia has been an important socio-economic activity since ancient times. The coastal municipalities with Fishermen's Guilds have a strong link with fishing activity, traditionally being one of its driving forces for development. Despite this, in recent decades it has been losing importance. Nevertheless, and in general, fishing continues to be essential to the local economies of many territories, given society's demand for marine products. In addition, it should be noted that for every job at sea, up to four indirect jobs can be generated after the arrival of the catch at a port[14].

The main commercial species are fish of the *Sparidae*, *Mugilidae*, *Anguillidae*, and *Moronidae* families[15], which are present in more than 75% of Mediterranean lagoons[16] although prawns, shrimps, crabs and mussels, oysters, and clams may also be very important. The total annual yield of coastal lagoon fisheries in the world was 694,195.9 tons/yr , with a mean productivity of 137.4 (±21.6 SE) kg/ha year. Of this amount, 191,534.3 tons/yr corresponds to the 169 Mediterranean

lagoons included in the mentioned review. Fishing in coastal lagoons accounts for 10% of fish production and 30% of demersal fish in the Mediterranean area[15].

The loss of relevance of the fishing activity within the economic activities of this coastal area is reflected in the reduction of fishing boats and, therefore, on the population dedicated to this activity. To understand this change and its current situation, four basic statistical variables have been evaluated in the main Mar Menor ports: the evolution of the number of vessels, the census of fishermen, the volume of fish landed and their value:

- Evolution of the number of vessels (Figure 8).
- Census of fishermen (Figure 9).
- Volume of fish landed and their value (Figure 6 and Figure 7).

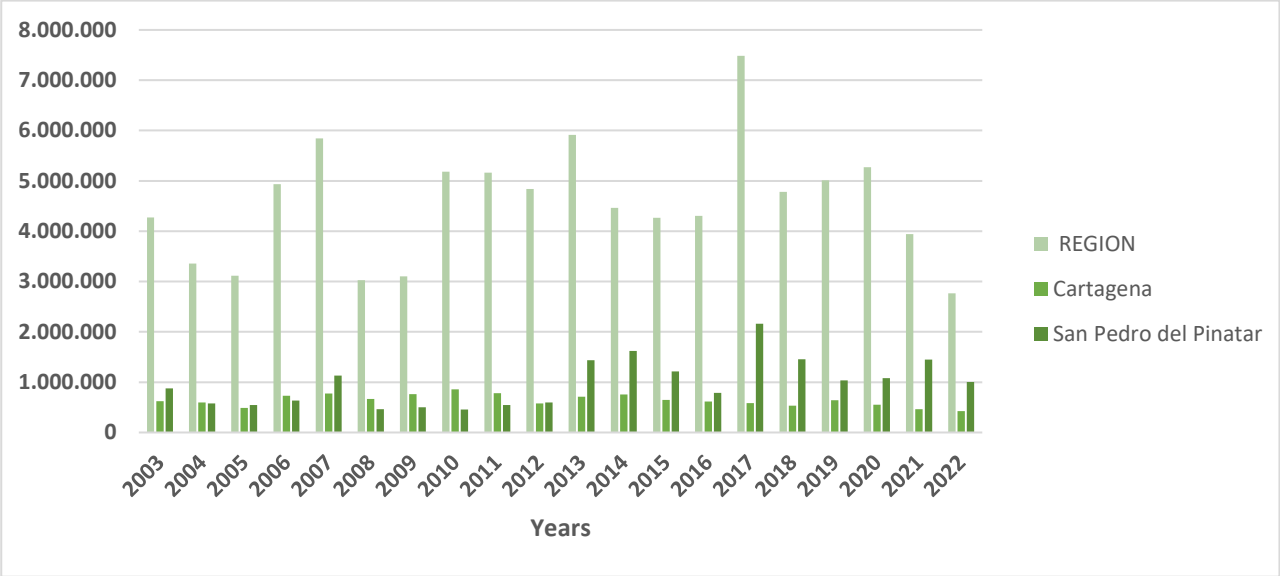

Figure 6. Evolution of the volume of maritime fisheries landed according to ports/regions (kg) in the Region of Murcia and specifically in Cartagena and San Pedro del Pinatar ports. Regional Ministry of Water, Agriculture, Livestock and Fisheries. Directorate General for Livestock, Fisheries and Aquaculture.

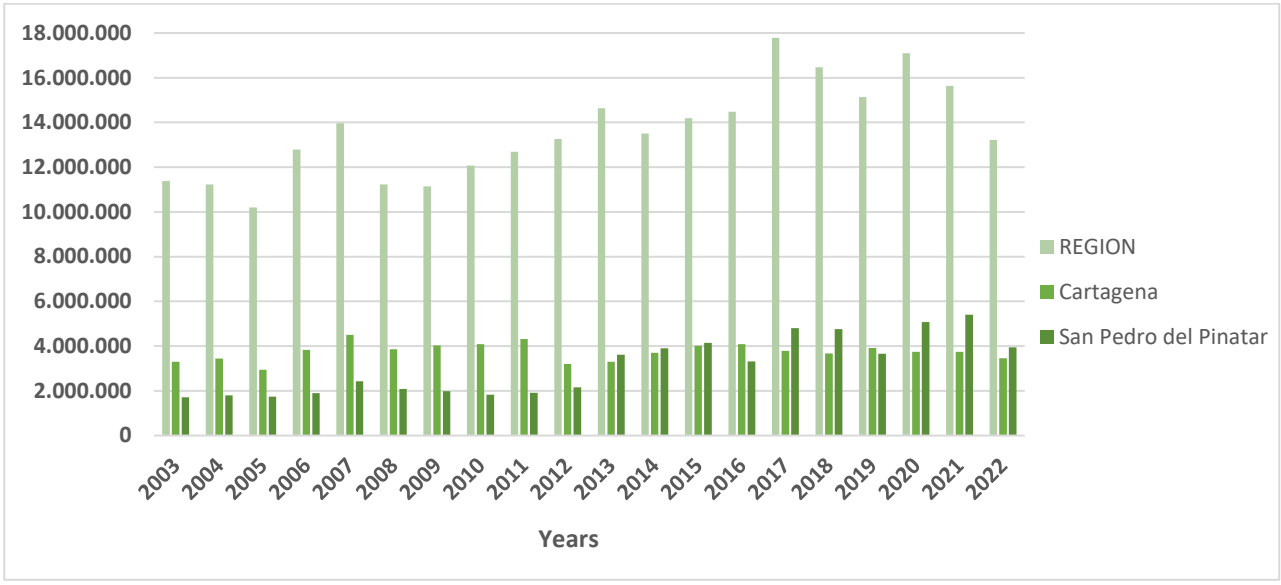

Figure 7. Evolution of the amount of catches of maritime fisheries landed according to ports/regions (€) in the Region of Murcia and specifically in Cartagena and San Pedro del Pinatar ports. Regional Ministry of Water, Agriculture, Livestock and Fisheries. Directorate General for Livestock, Fisheries and Aquaculture.

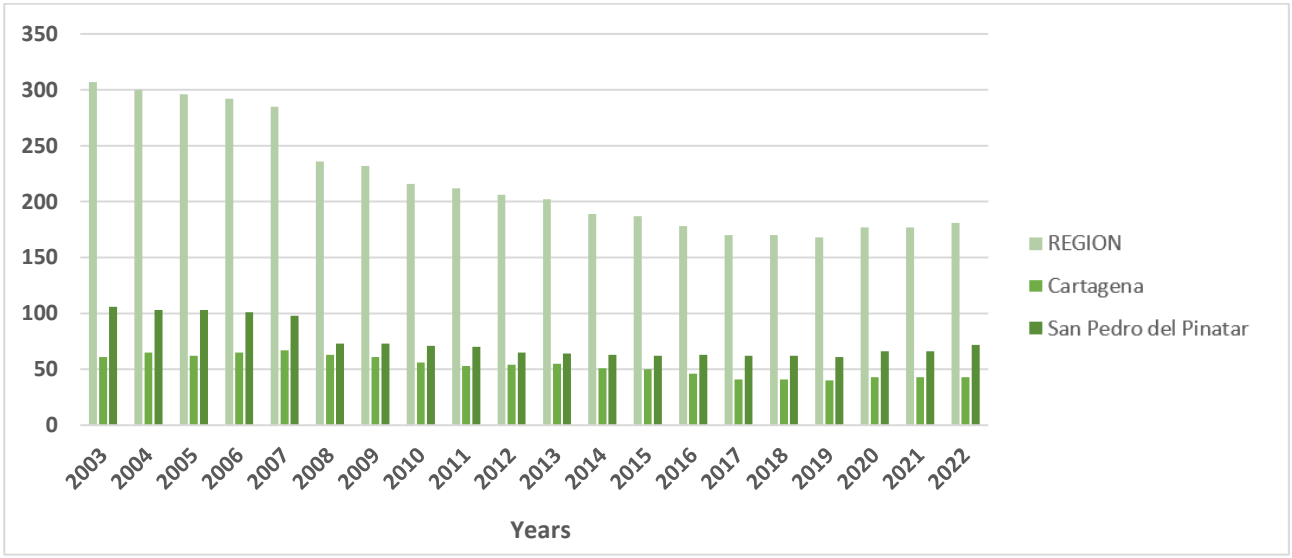

Figure 8. Evolution of the number of fishing vessels in the Region of Murcia, in the municipality of Cartagena and in San Pedro del Pinatar. Regional Ministry of Water, Agriculture, Livestock and Fisheries. General Management for Livestock, Fisheries and Aquaculture.

The data show that the reduction in the number of vessels and in the workers in maritime fishing is a constant in the Region of Murcia over the last 20 years (Figure 8 and Figure 9). In this sense, it is appropriate to investigate the causes that have led to this fact:

- The fishing industry is not unaffected by the impact of higher fuel prices, which are leading to higher costs for shipowners.
- The consolidation of tourism and construction as basic pillars of the economies of coastal municipalities: changes in the production model.
- The measures set by the European Union (EU): this body plays an essential role in fisheries, as the Common Fisheries Policy (CFP) sets the guidelines for the development of the activity. The reform introduced long-term management of fishing activities, through multi-annual recovery plans for stocks below the safe biological threshold and the biological safety threshold and multi-annual management plans for other stocks.
- Perception of fishing as a low status job by society. Fishing is an activity in which one cannot count on a fixed wage but depends on the volume of catches landed and their price at auction.
- Coastal lagoons act as nursery areas and feeding grounds for opportunistic marine estuarine fishes, most of them of real or potential fishing interest but, at the same time, the intense relation with the terrestrial ecosystem boundary makes these environments especially vulnerable to human impact and terrestrial and freshwater inputs[15].

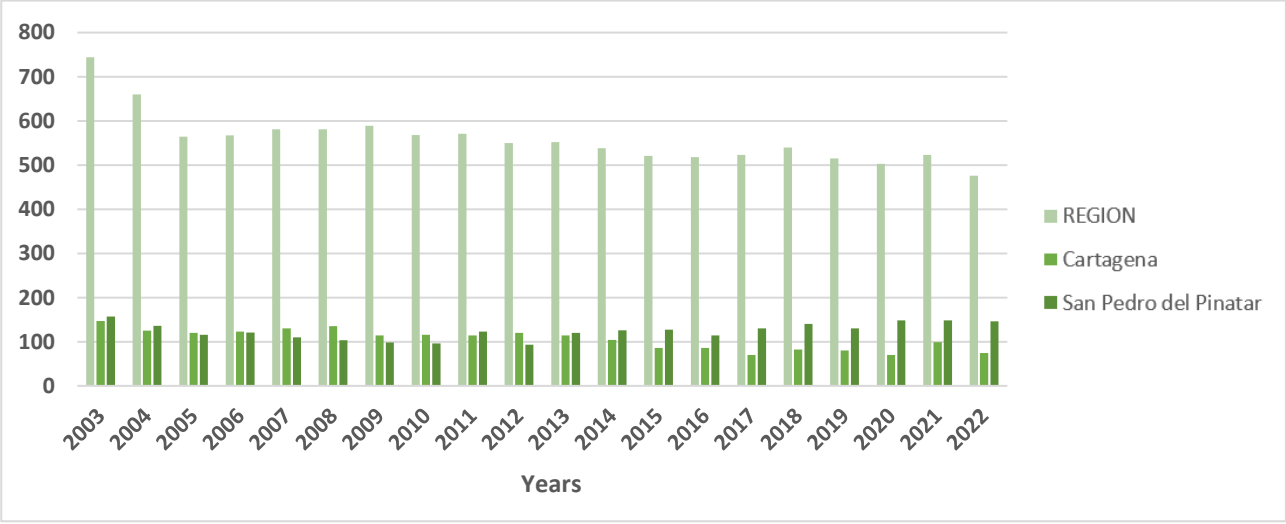

Figure 9. Evolution of the number of workers in maritime fishing according to the fishermen's guilds. Regional Ministry of Water, Agriculture, Livestock and Fisheries. General Management for Livestock, Fisheries and Aquaculture.

Real state sector

There is a report of the Bank of Spain regarding the monetary impact of the deterioration of the Mar Menor lagoon ecosystem on the real estate sector. This document provides an analyse the evolution of the price per square metre of dwellings belonging to the coastal municipalities of the Mar Menor, in comparison with dwellings in the municipalities of the neighbouring province of Alicante. The results of this research reveal a divergent evolution between the prices of dwellings of houses in the Mar Menor, compared to similar houses not affected by the environmental catastrophe. Although the prices of homes in the Mar Menor show a 45% lower revaluation in the less revaluation in the period 2015-2021 than homes in the south of the coast of Alicante coast. In monetary terms, per m^2, the houses of the Mar Menor would cost up to 500€ less than those in the south of Alicante at the end of the period. The overall quantification of this loss of value in real state due to the environmental deterioration is quantified in 4,150 million euros[17].

The conclusions drawn in the mentioned Bank of Spain report can also be visualised in the official statistical data of the Ministry of Transport, Mobility and Urban Agenda (Figure 10). There was a decrease in the price of dwellings due to the worldwide financial crisis during 2009-2014. Subsequently, prices rose gradually in Spain although remained low in Region of Murcia, being the most likely explanation the environmental problems in the Mar Menor.

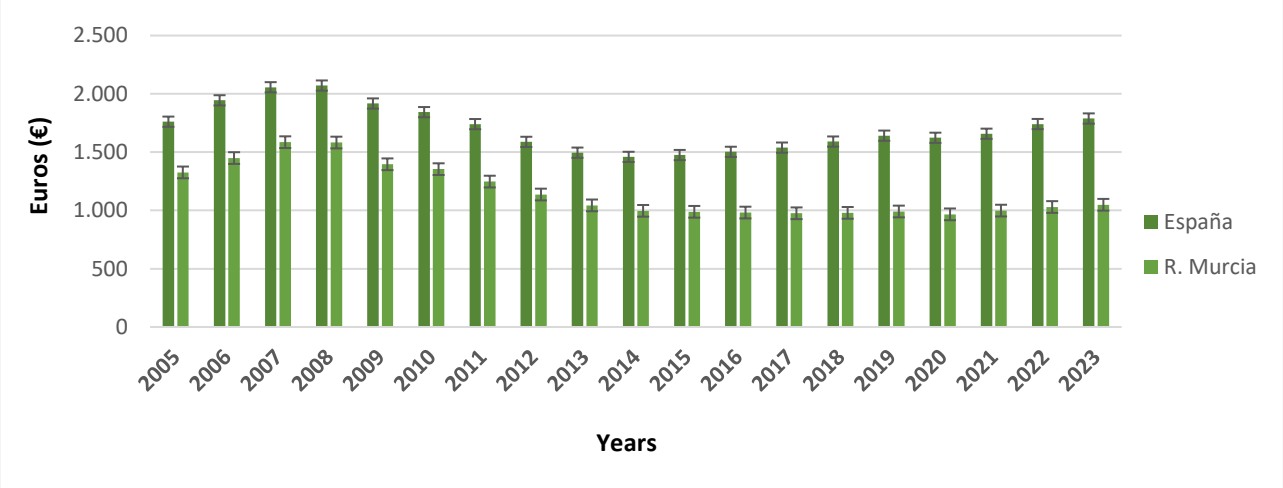

Figure 10. Evolution of house prices in Spain and in the Region of Murcia (€/m^2) according to the assessed value of free and subsidised housing. Ministry of Transport, Mobility and Urban Agenda. Statistics on the Assessed Value of Housing.

Agricultural sector

Currently, the marine ecosystem is profoundly damaged due to the economic activity, mainly agriculture. The input of nutrient-enriched waters (mainly nitrates and phosphates) from agricultural irrigation near the lagoon seems to be one of the main causes of these episodes. Consequently, eutrophication processes have increased in frequency and severity in the lagoon, leading to the extreme event of anoxia in the autumn of 2019, causing the massive death of flora and fauna[18]. Therefore, the recovery of the lagoon through the implementation of the project would alleviate social pressures on this crucial economic sector.

As can be seen in Figure 11, there has been a shift from non-irrigated to irrigated crops in the whole Region of Murcia. Taking into account only the municipies of Region of Murcia closer to Mar Menor area, the mentioned shift has been even higher (Figure 12). As a consequence, aquifer recharge has increased, which in turn increased the discharge of submarine groundwater (SGD) into the lagoon and led to the transformation of the lower reaches of the ephemeral watercourses (called ramblas) into permanent flow. Intensive fertigation and the addition of manure resulted in the pollution of surface and subsurface waters with nitrates[19] .

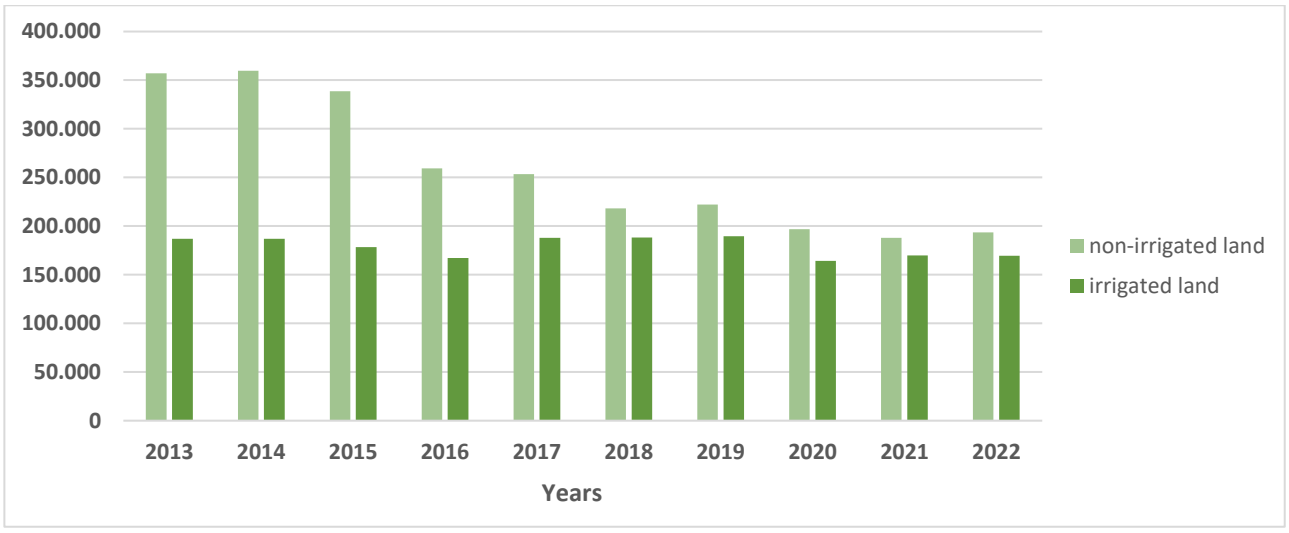

Figure 11. Evolution of the area (hectarea) of arable land according to whether it is non-irrigated or irrigated crops in the Region of Murcia. Regional Ministry of Water, Agriculture, Livestock and Fisheries. Regional Agricultural Statistics.

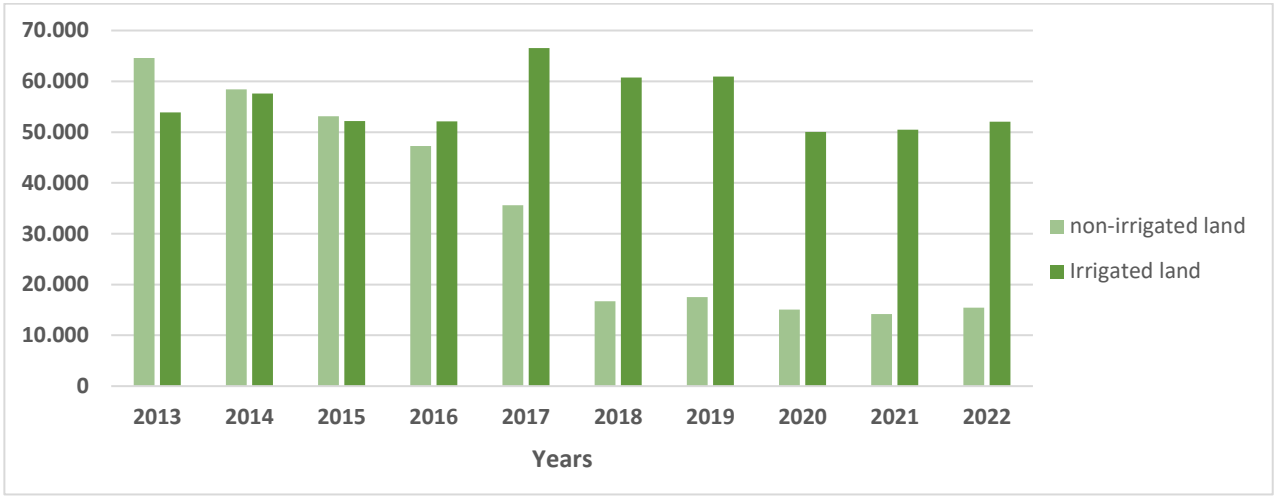

Figure 12. Evolution of the area (hectarea) of arable land according to whether it is non-irrigated or irrigated crops in the municipies of Mar Menor. Regional Ministry of Water, Agriculture, Livestock and Fisheries. Regional Agricultural Statistics

In total, the amount of land used for agriculture has clearly decreased. However, production remains more or less the same, with some ups and downs (Figure 13). This could be interpreted as an increase in crop yields, which could be very positive unless this is due to an increase in the use of fertilisers and other similar compounds that contribute to the eutrophication of the Mar Menor and damage its seagrass meadows. Therefore the LIFE-TRANSFER transplants could mitigate these damaging effects without the agricultural sector having to reduce its economic activity.

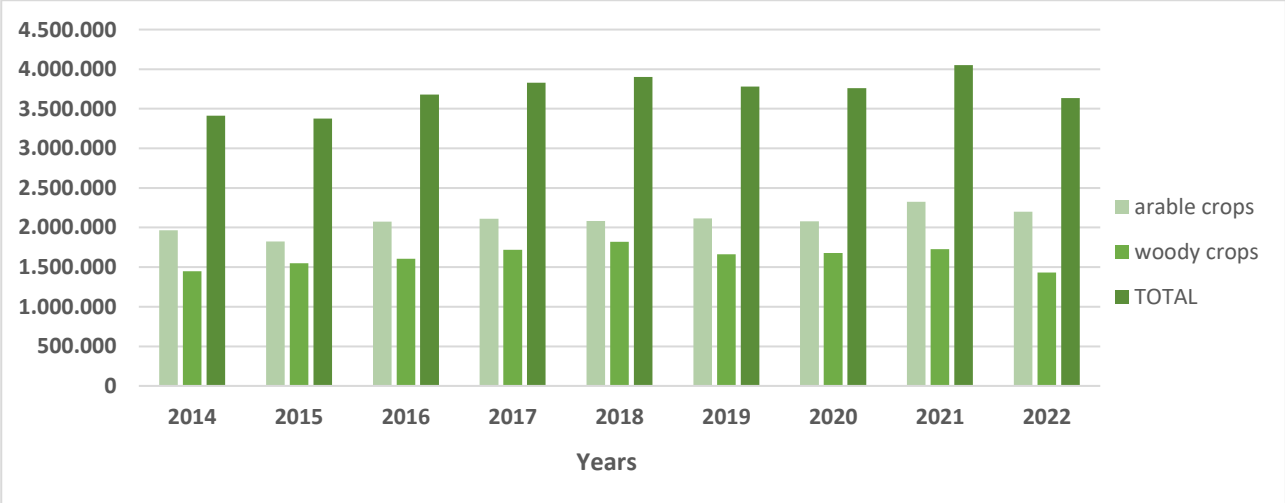

Figure 13. Evolution of agricultural production (tonnes) in the Region of Murcia according to type of crop. Regional Ministry of Water, Agriculture, Livestock and Fisheries. Regional Agricultural Statistics.

General economic indicators: wages and employment

There are several general economic indicators, besides the specif ones described before, that will reflect the health of the labour market and the capacity to generate employment in the area. In this sense, employment is a key indicator to assess the economic vitality of the area, such as employment rate, unemployment rate, number of contracts signed, sectoral distribution of employment and average wages (see Figure 14 to Figure 29).

It is worth to highlight the study on the probability of bankruptcy of companies located around the Mar Menor accoding to seawater pollution. The study concluded that this probability increases by 5.5% when seawater pollution, measured by Chl. a content, increases by 1 mg/m^3. Specifically, it has been found that the sectors of Industry and Construction, Finance and Real Estate, Wholesale and Retail Trade, and Hotels and Restaurants are impacted by ecological degradation in the Mar Menor. In fact, the probability of failure of these activities increases from 8.4% to 14.4% when seawater pollution increases by 1 mg/m^3. Furthermore, it is observed that other sectors like Agriculture and Transport have little incentive to preserve the marine aquatic environment, as their probability of business failure decreases due to their location close to the Mar Menor, and they are not affected by pollution[18].

In addition to the enlightening study presented, relevant economic information has been collected from Murcia regional statistics centre[20] and the State Public Employment Service[21] (Figure 14 to Figure 29). Taking into account the average income in the Mar Menor area and comparing it with the Region of Murcia (Figure 14 and Figure 15, respectively), there has been a gradual increment, being the first one lower than the second one.

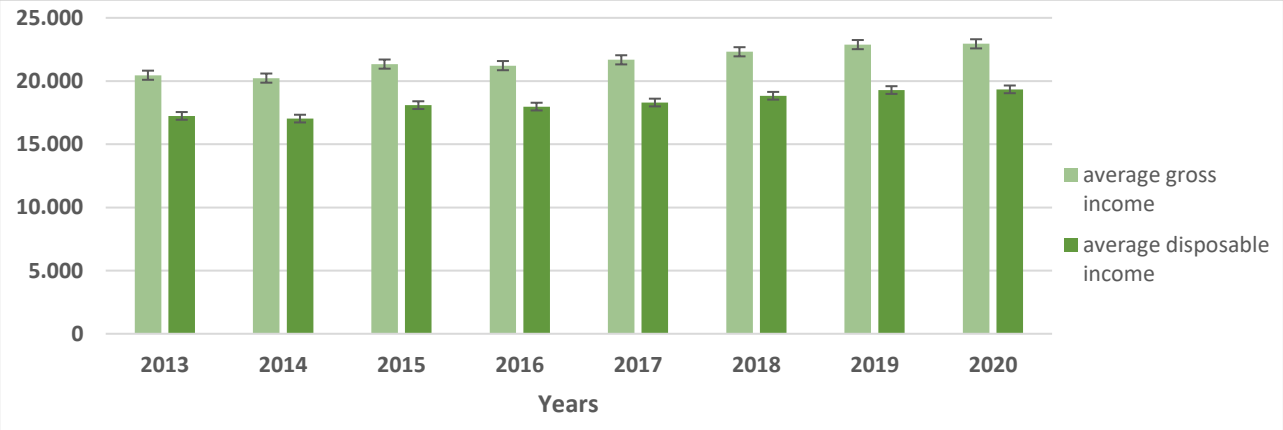

Figure 14. Evolution of average gross and disposable incomes in the municipies of Mar Menor (€). Murcia regional statistics centre.

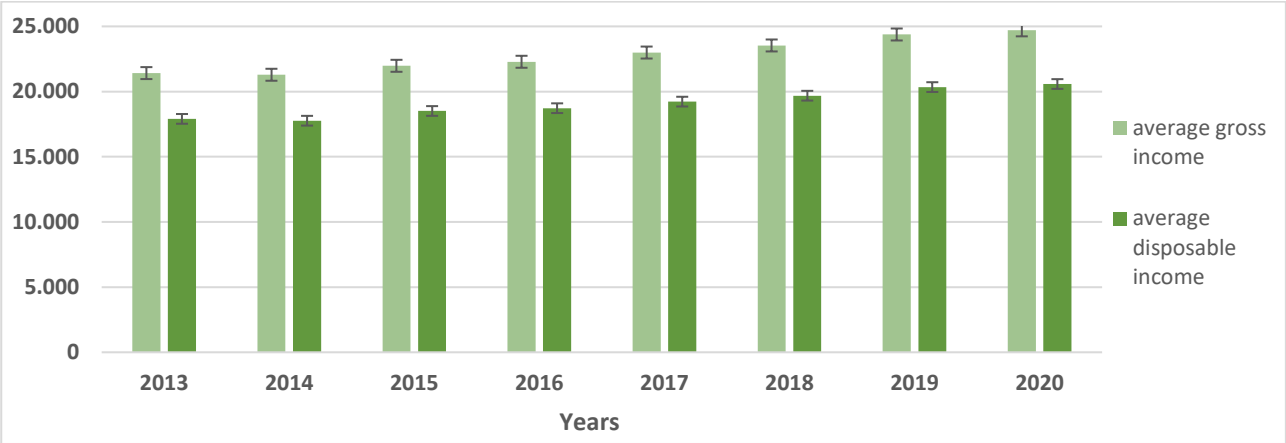

Figure 15. Evolution of average gross and disposable incomes in the Region of Murcia (€). Murcia regional statistics centre.

There are also relevant conclusions in the evolution of unemployment/employment data. The number of unemployed workers has been decreasing since 2013, probably due to the end of the most difficult period of the economic crisis (Figure 16). On the other hand, the peak observed in 2020 is probably due to COVID-19 crisis (see MACROECONOMIC FRAMEWORK).

Comparing these data with those of Spain (Figure 17) very similar trends can be observed, with the tourism sector being by far the most relevant.

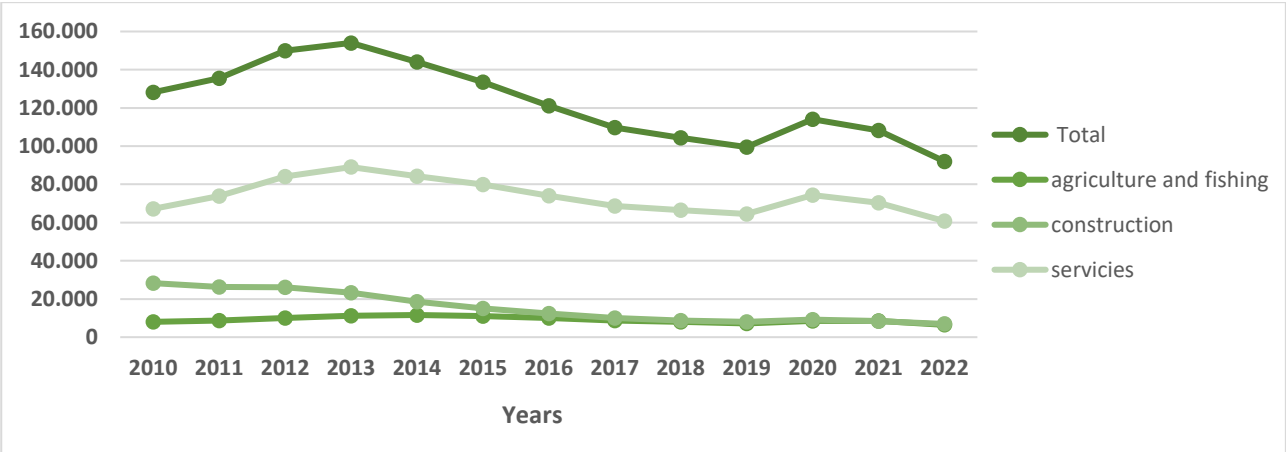

Figure 16. Evolution of unemployed people in the Region of Murcia detailing the different sectors potentially affected by the LIFE-TRANSFER project. Regional Employment and Training Service

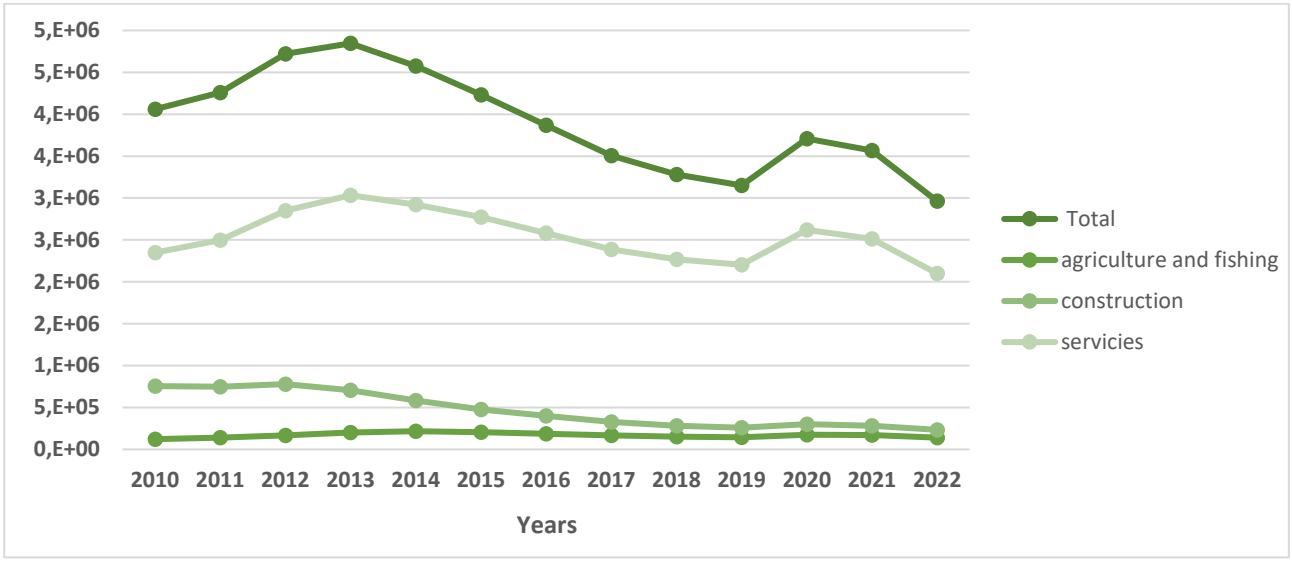

Figure 17. Evolution of unemployed people in Spain detailing the different sectors potentially affected by the LIFE-TRANSFER project. State Public Employment Service

As expected, there is a direct correlation between the number of employed and unemployed people. However, they are complementary data as there are annual changes in the total populationand the definitions of the two terms are not fully equivalent[22].

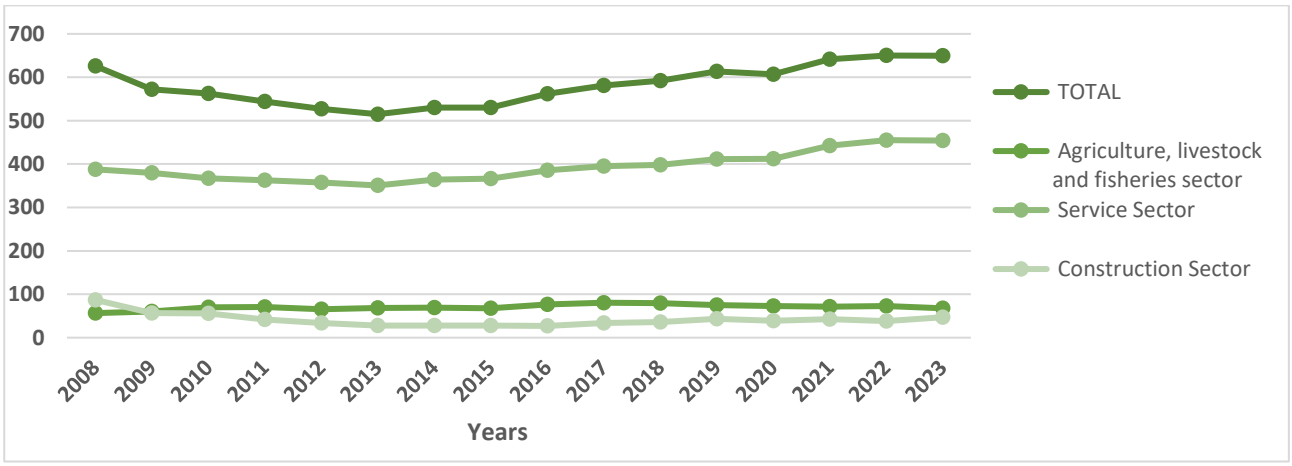

Figure 18. Employed population (thousands of people) according to economic sectors in the Region of Murcia since 2008. Murcia regional statistics centre.

Probably due to the global economic and financial crisis previously mentioned, which has been deeper and more prolonged in Spain than in other countries (see MACROECONOMIC FRAMEWORK), the number of employed population is almost the same now as it was in 2008 (Figure 18).

Analysing the employed population from a gender perspective (Figure 19), in general there have always been more men working than women. The same is true for the agriculture, livestock, fishing and construction sectors, and the opposite is true for the services sector. In the services sector, there have always been more women employed and it is also the sector that has grown (>17%) the most since the recovery from the economic-financial crisis.

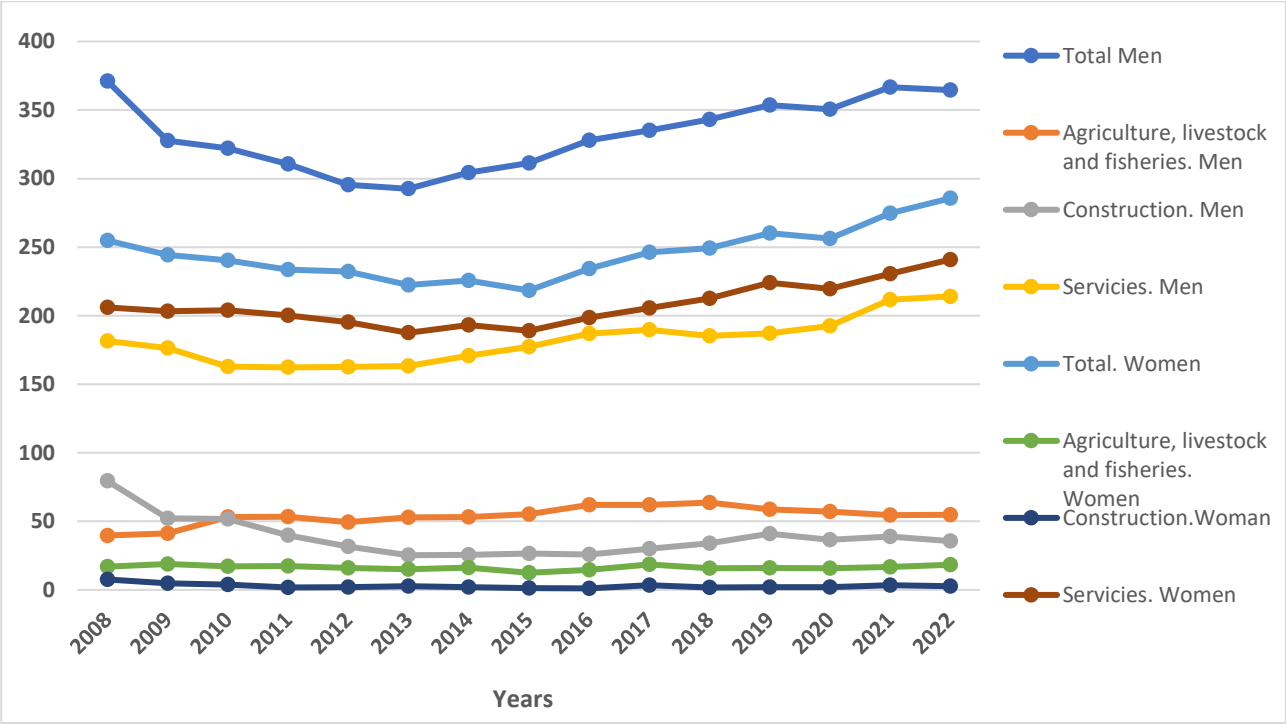

Figure 19. Employed population (thousands of people) according to economic sectors and sex in the Region of Murcia since 2008. Murcia regional statistics centre

Although it is possible to approximate the impact of the LIFE-TRANSFER project on the economic sectors of the Mar Menor region on the basis of the number of workers and the total existing population, it is also necessary to consider the contracts signed in each of these sectors. These contracts are detailed below for the Region of Murcia (Figure 20) and the concrete municipalities bordering the Mar Menor (Figure 21 to Figure 27). Before analysing these data, it is crucial to note that the current year has not finished yet. Therefore, the 2023 data are not fully complete.

Region of Murcia

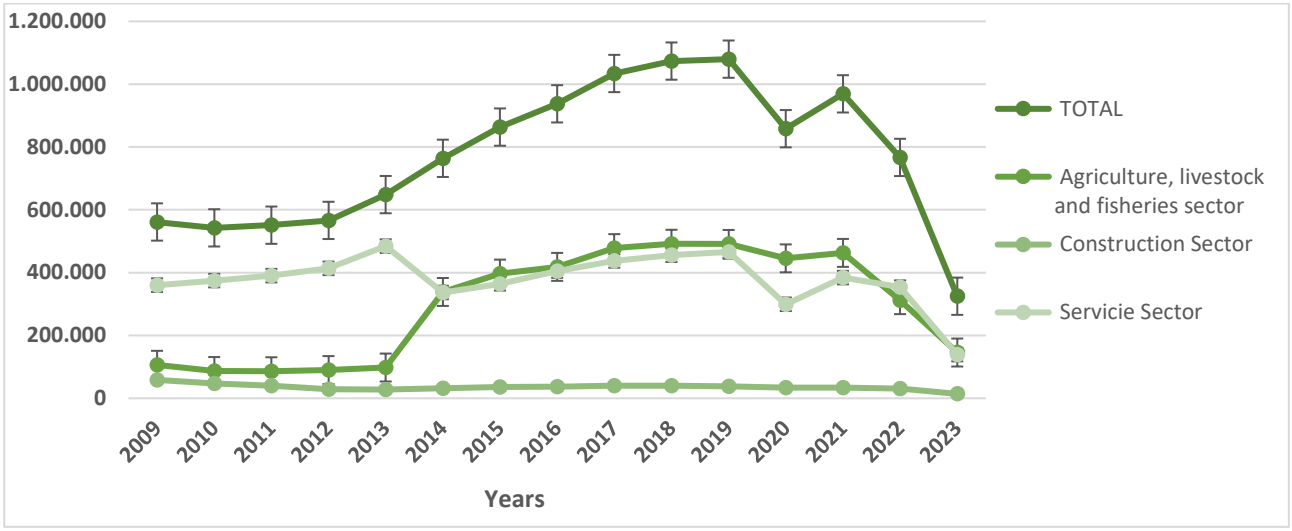

Figure 20. Evolution of the number of contracts signed in the Region of Murcia, both as a whole and by economic sectors. Murcia regional statistics centre.

Cartagena

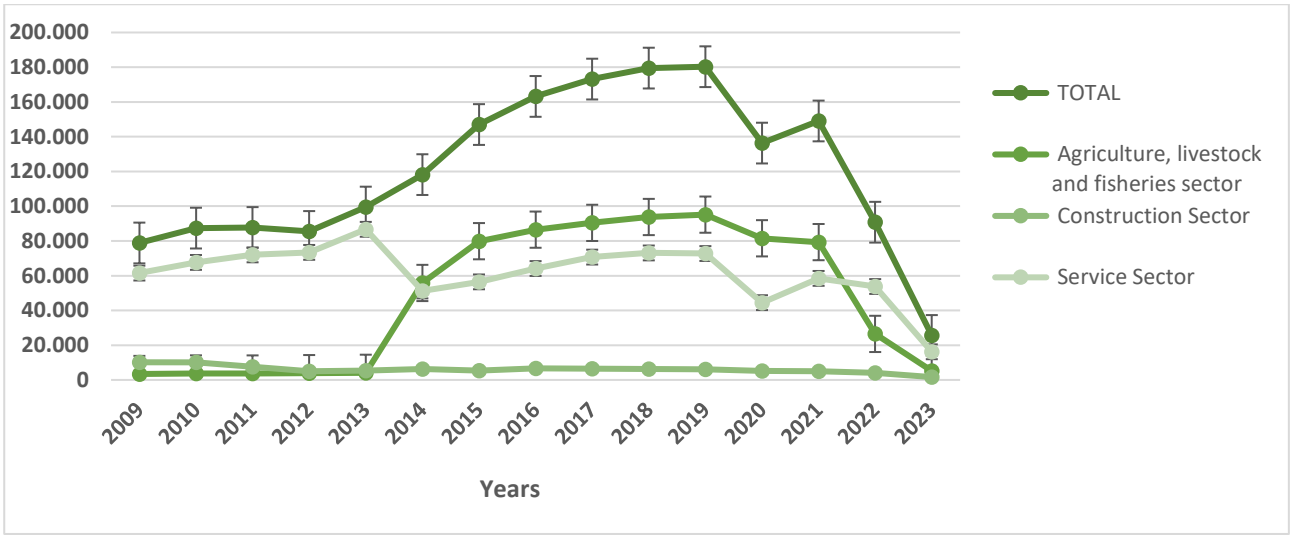

Figure 21. Evolution of the number of contracts signed in the municipality of Cartagena, both as a whole and by economic sectors. Murcia regional statistics centre.

San Pedro del Pinatar

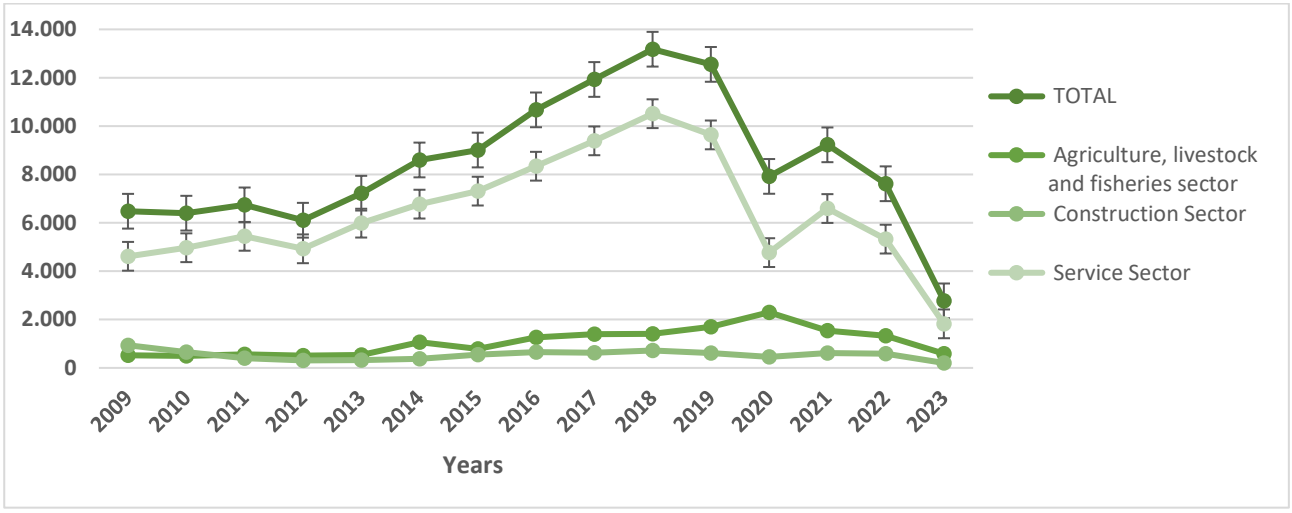

Figure 22. Evolution of the number of contracts signed in the municipality of San Pedro del Pinatar, both as a whole and by economic sectors. Murcia regional statistics centre

San Javier

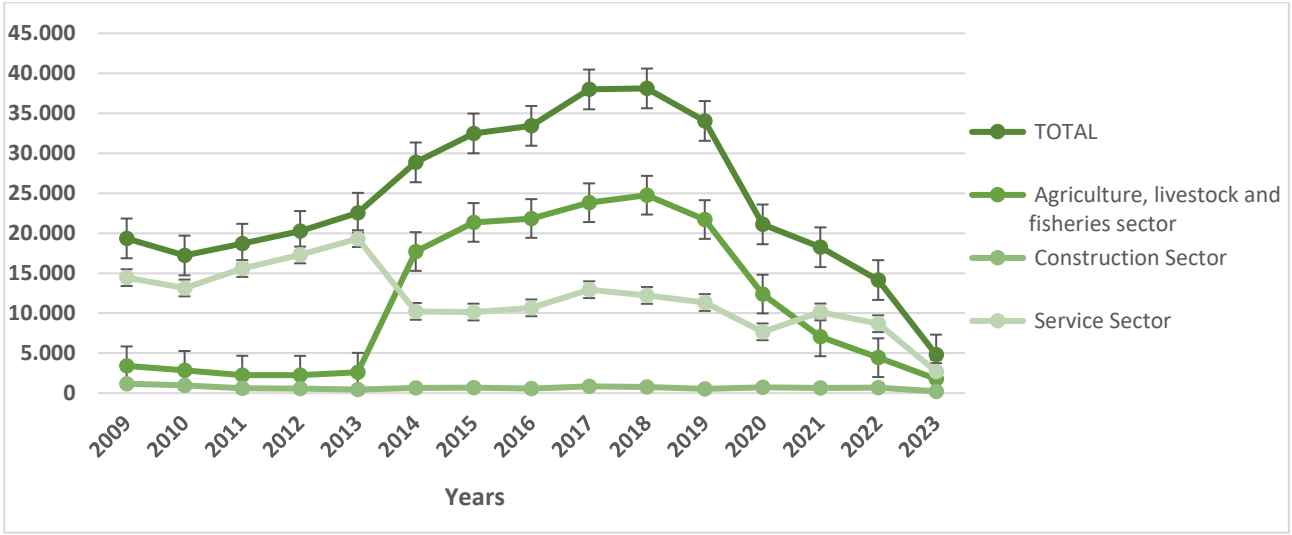

Figure 23. Evolution of the number of contracts signed in the municipality of San Javier, both as a whole and by economic sectors. Murcia regional statistics centre.

La Unión

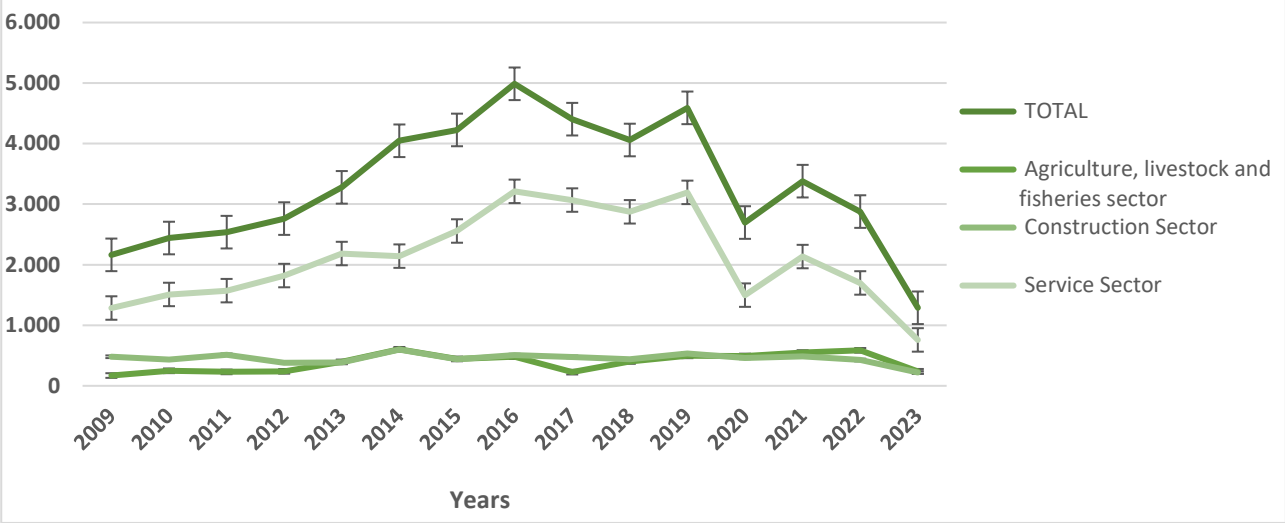

Figure 24. Evolution of the number of contracts signed in the municipality of La Unión, both as a whole and by economic sectors. Murcia regional statistics centre.

Torre-Pacheco

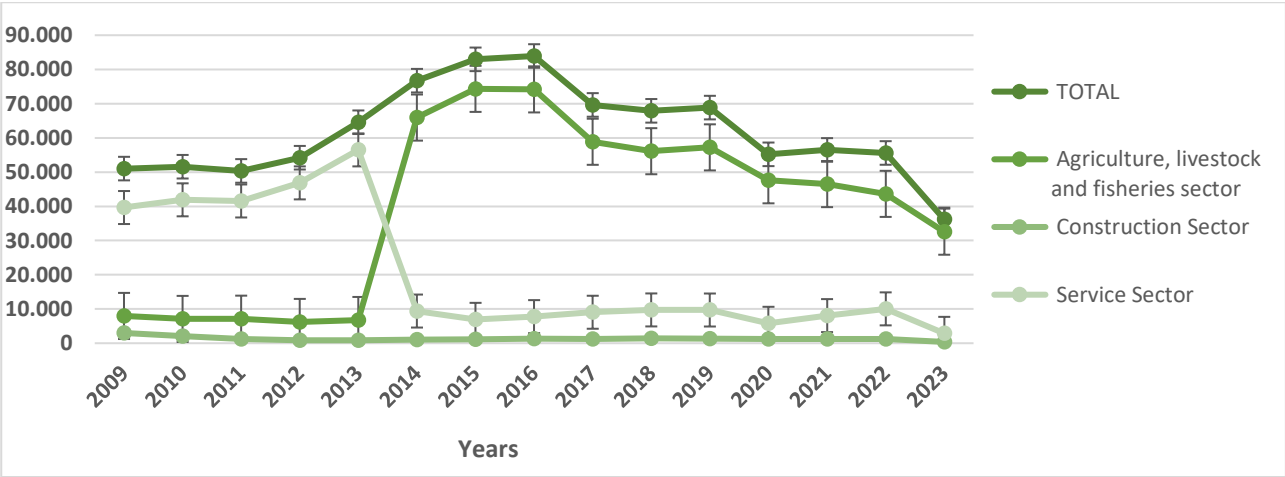

Figure 25. Evolution of the number of contracts signed in the municipality of Torre-Pacheco, both as a whole and by economic sectors. Murcia regional statistics centre.

Fuente Álamo

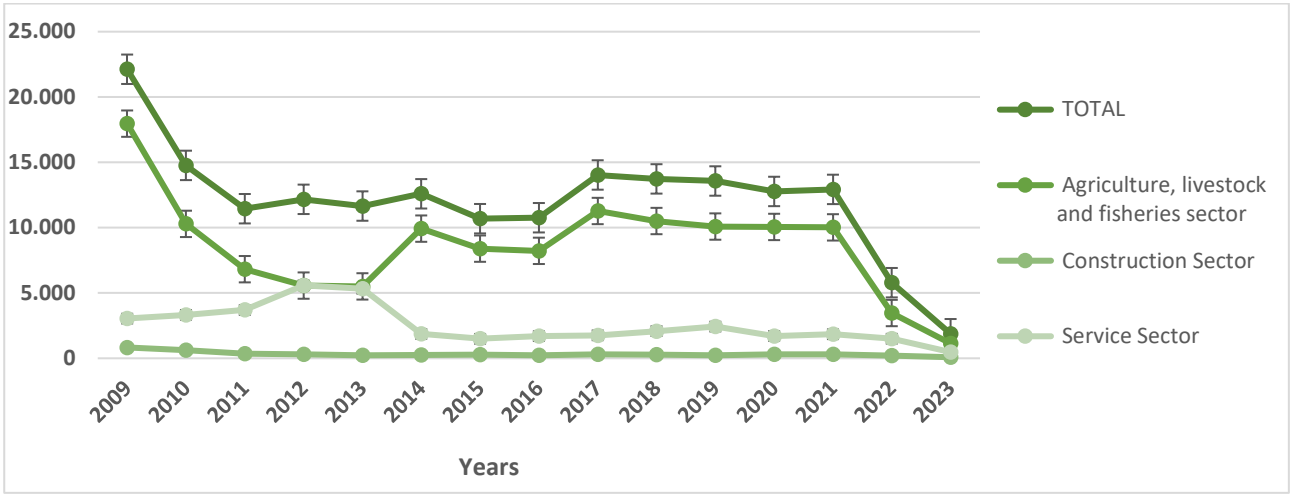

Figure 26. Evolution of the number of contracts signed in the municipality of Fuente-Álamo, both as a whole and by economic sectors. Murcia regional statistics centre.

Los Alcázares

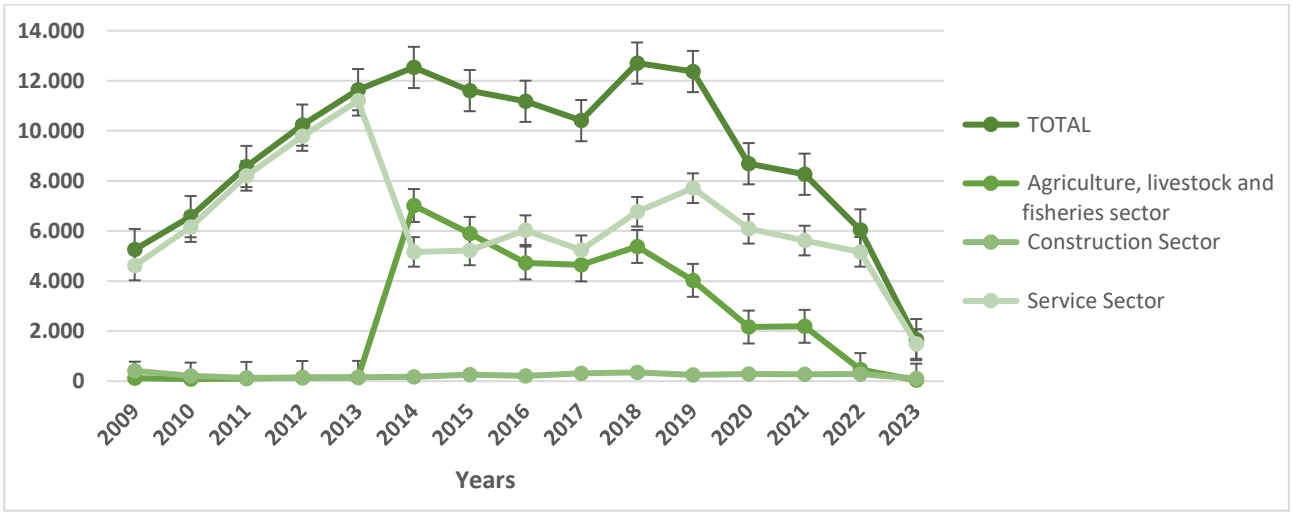

Figure 27. Evolution of the number of contracts signed in the municipality of Los Alcázares, both as a whole and by economic sectors. Murcia regional statistics centre.

The contracts signed in the munipalities of Mar Menor (Figure 21 to Figure 27), as well as those signed in Region of Murcia (Figure 20), follow a similar trend: increasing progressively after the

worst of the economic-financial crisis. Decreasing around 2018, probably due to the worsening of the environmental problems of the Mar Menor. In 2020, there was a rapid fall in the number of these contracts, most likely due to the COVID-19 crisis. It is worth highlighting the great importance of the services sector, followed by agriculture, livestock and fisheries. In some cases, such as Torre-Pacheco, this relative importance is even reversed.

As mentioned above, changes in the total population of the areas under study have a significant influence on the variables previously studied, such as number of contracts signed, employed/unemployed population, and number of people employed/unemployed. In this case the population of the Region of Murcia and those closer to the Mar Menor has increased (Figure 28 and Figure 29). This is to be expected, without assessing which segments of the population have increased the most, but assuming that it has been more or less uniform, that the number of contracts and the employed population may have increased.

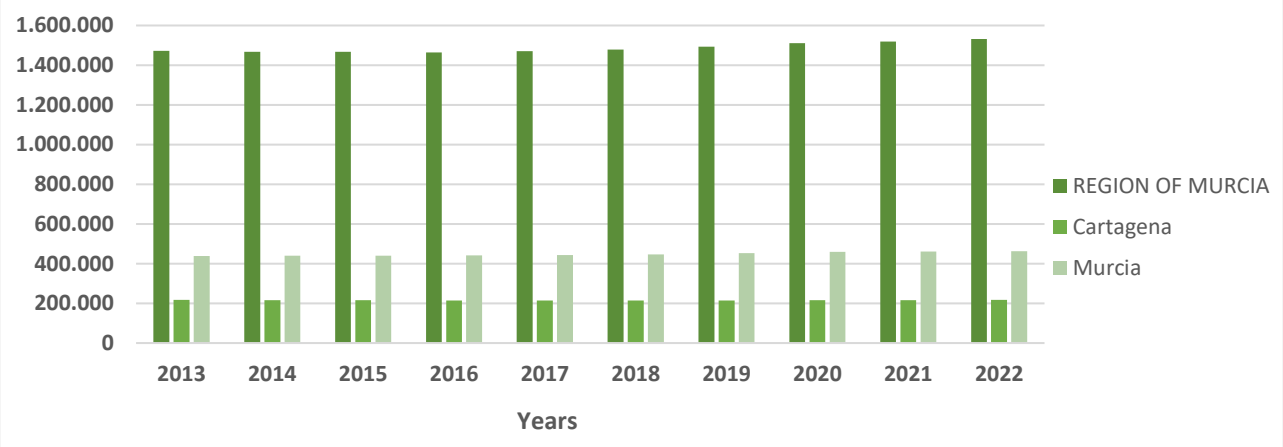

Figure 28. Population trends in the Region of Murcia and in the main municipes of this Region, Cartagena and Murcia. Murcia regional statistics centre.

Population trends in Region of Murcia increased more than 4% (Figure 28). This rise has been even greater in municipalities more affected by LIFE-TRANSFER (Figure 29), such as Torre-Pacheco (>13%).

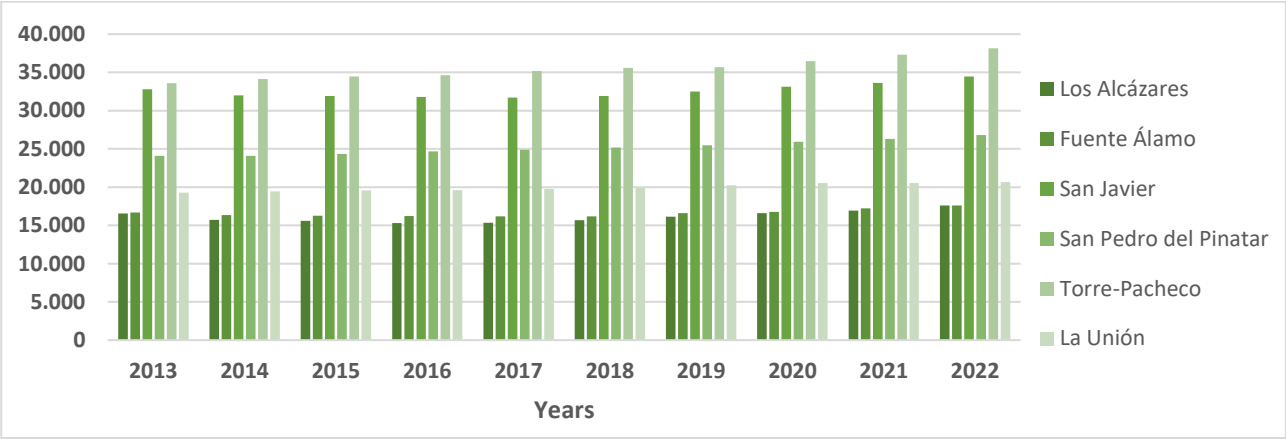

Figure 29. Population trends in the Region of Murcia municipes closer to Mar Menor, Los Alcázares, Fuente Álamo, San Javier, San Pedro del Pinatar, Torre-Pacheco and La Unión. Murcia regional statistics centre

IMPACT OF THE LIFE-TRANSFER PROJECT

LIFE-TRANSFER results

The expected results are conservation of the lagoons biodiversity and productivity through the restoration of their natural structure and function, starting from the vicinity of the areas of transplantation. The transplant configuration adopted in LIFE TRANSFER (9 sods in 100 m^2 - quadrats, 8 quadrats/lagoon) should allow the development of small structured prairies already after 3- 4 years, considering a success of transplanted sods over 80%. For the Mar Menor *Caulerpa prolifera* cover is expected to be greatly reduced of its current coverage.

The success of diffused seeding and rooting is expected in the order of 25% of the transplanting lagoon areas after 5-10 years. Finally, in 10 years, well-structured seagrass meadows should cover ca. 25- 30% of the targeted water body surface. Therefore, it is expected to achieve a good ecological status (sensu WFD 2000/60/EC).

Moreover, the diffusion of submerged seagrass meadows will contrast the erosion and the deepening of coastal lagoons caused by the synergy of climate change and anthropogenic activities through the following processes:

a) Increase the resilience of shallow waters, reducing sediment resuspension and settling, as well as sediment compactness.

b) Increase in the friction capacity of the seabed's, reducing the wave height and peaks, especially in inner areas.

Further results are CO_2 sequestration, the contribution to restore the morphologic balance of the lagoons, the reduction of erosion processes, sedimentation rates and water turbidity, the increase of autochthonous fish fauna and birds. Social and economic results: increment of ecosystem service supplies such as fish and ecotourism, training activities on the restoration techniques with transplant of phanerogams, dissemination events and environmental education activities.

In order to try to quantify the relationship between the recovery of seagrass meadows thanks to LIFE-TRANSFER by improving the monitoring parameters of the Mar Menor, and the data from the tourism sector, an analysis of the data was carried out by using Jupyter Notebook 6.4.12 (versatile and powerful tool for interactive computing, data analysis, and documentation). Data was transformed to obtain comparable datasets. In some cases, this involved calculating annual values from monthly means. When comparable datasets were not poissible to obtain, data were dismissed and not included in the analysis.

The results are detailed as follows:

	Turbidity	Oxygen	Temperature	Transparency	CDOM	Chlorophyll	Hotels	Vacancies	Travellers	OvernightStays	AverageStayDays	Staff
Turbidity	1.000	-0.075	-0.078	0.250	0.273	0.554	-0.140	-0.144	-0.109	-0.162	-0.297	-0.180
Oxygen	-0.075	1.000	-0.875	-0.287	-0.351	-0.335	0.256	0.267	0.292	0.308	0.158	0.238
Temperature	-0.078	-0.875	1.000	0.204	-0.003	0.200	-0.484	-0.483	-0.507	-0.492	-0.291	-0.429
Transparency	0.250	-0.287	0.204	1.000	0.675	-0.125	-0.194	-0.186	-0.094	-0.144	-0.162	-0.170
CDOM	0.273	-0.351	-0.003	0.675	1.000	0.052	0.550	0.558	0.571	0.529	0.408	0.595
Chlorophyll	0.554	-0.335	0.200	-0.125	0.052	1.000	-0.242	-0.233	-0.265	-0.276	-0.284	-0.244
Hotels	-0.140	0.256	-0.484	-0.194	0.550	-0.242	1.000	0.965	0.932	0.900	0.812	0.942
Vacancies	-0.144	0.267	-0.483	-0.186	0.558	-0.233	0.965	1.000	0.944	0.922	0.833	0.971
Travellers	-0.109	0.292	-0.507	-0.094	0.571	-0.265	0.932	0.944	1.000	0.976	0.755	0.961
OvernightStays	-0.162	0.308	-0.492	-0.144	0.529	-0.276	0.900	0.922	0.976	1.000	0.814	0.958
AverageStayDays	-0.297	0.158	-0.291	-0.162	0.408	-0.284	0.812	0.833	0.755	0.814	1.000	0.831
Staff	-0.180	0.238	-0.429	-0.170	0.595	-0.244	0.942	0.971	0.961	0.958	0.831	1.000

Table 1. Matrix of correlations between variables regarding Mar Menor main parameters Turbidity (FTU), Temperature (ºC), CDOM (Colored Dissolved Organic Matter in ppb) and Chlorophyll (µg/L). Also, turistic variables were included: Hotels (number of hotel establishments open), Vacancies (hotel vacancies), Travellers (number of travellers), OvernightStays (overnight stays), AverageStayDays (average tourist stay in days) and Staff (staff working in the tourism sector).

It is useful to study the sampling adequacy of the data in terms of the overall correlation structure of the variables. For this reason a matrix of correlations between variables was built (Table 1). Those variables that are strongly correlated will present more intense colours, blue or red depending on whether the correlation is negative or positive.

As can be seen (Table 1) there is a strong correlation between the turism variables. Therefore, it is necessary to select which variables will be used to build a prediction model as overly correlated variables can cause problems in a linear regression model, such as multicollinearity. The variables were selected considering the matrix of correlations (Table 1): Turbidity (FTU), Temperature (ºC), CDOM (ppb), Chlorophyll (µg/L), Travellers (number of travellers) and Hotels (number of hotel establishments open). The model was ajusted manually using an Ordinary Least Squares (OLS) linear regression model (Equation 1) and the results are detailed in the Table 2:

$$Transparency \sim Turbidity + Temperature + CDOM + Chlorophyll + Travellers + Hotels$$

Equation 1. The dependent variable Transparency calculated from the independent variables Turbidity (FTU), Temperature (ºC), CDOM (ppb), Chlorophyll (µg/L), Travellers (number of travellers) and Hotels (number of hotel establishments open)

OLS Regression Results

Dep. Variable:	Transparency	**R-squared:**	0.790
Model:	OLS	**Adj. R-squared:**	0.738
Method:	Least Squares	**F-statistic:**	15.05
Date:	Wed, 05 Jul 2023	**Prob (F-statistic):**	4.34e-07
Time:	13:19:35	**Log-Likelihood:**	-30.213
No. Observations:	31	**AIC:**	74.43
Df Residuals:	24	**BIC:**	84.46
Df Model:	6		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	-7.2972	1.463	-4.988	0.000	-10.317	-4.278
Turbidity	0.0246	0.072	0.340	0.736	-0.124	0.174
Temperature	0.1421	0.034	4.181	0.000	0.072	0.212
CDOM	0.4484	0.106	4.211	0.000	0.229	0.668
Chlorophyll	-0.2857	0.073	-3.888	0.001	-0.437	-0.134
Travellers	4.94e-05	2.05e-05	2.412	0.024	7.13e-06	9.17e-05
Hotels	-0.0563	0.031	-1.804	0.084	-0.121	0.008

Omnibus:	0.265	**Durbin-Watson:**	1.187
Prob(Omnibus):	0.876	**Jarque-Bera (JB):**	0.271
Skew:	0.190	**Prob(JB):**	0.873
Kurtosis:	2.744	**Cond. No.**	4.81e+05

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 4.81e+05. This might indicate that there are strong multicollinearity or other numerical problems.

Table 2. The output of an ordinary least squares (OLS) regression model applied to transparency levels in Mar Menor.

The main conclusions drawn from the model are:

- R^2: 0.790, which means that approximately 79% of the variability in the transparency variable can be explained using the model's independent variables.
- F-statistic: 15.05 and the associated p-value is 4.34e-07, indicating that there is a significant linear relationship in the model.
- Df Residuals and Df Model: there are 24 degrees of freedom for the residuals and 6 degrees of freedom for the model.
- Cond. No.: the condition number, really high, indicates multicollinearity.

Therefore, there is a clear problem of multicollinearity leading to problems such as low reliability of the estimated coefficients, difficult interpretation of the effects of the independent variables on the dependent variable and instability of the model.

To avoid this, it would be necessary, among other measures, to have a larger volume of data. Furthermore, the lack of data prevents the same analysis from being carried out for the rest of the economic sectors, since the tourism sector had the largest amount of data available. However, the matrix correlation (Table 1) is of great help in visualising the correlation between the state of the Mar Menor and the tourism sector in the area.

Seagrasses act as a nutrient filter by taking up phosphorus and nitrogen from the water column and sediments. Also, by mediating bacterial processes. Therefore, its presence is associated with a suite of important ecosystem services-habitat, wave modification, clearer water, genetically diverse population, nutrient cycling and carbon storage, being nitrogen removal and carbon sequestration two of the most important ecosystem services. In this sense, excess nitrogen and cabon have deleterious effects in the marine environment (harmful algal blooms, anoxia and fishery loss), thus, having a negative impact in the local economy[23].

A basin-scale nitrate transport simulation model developed in 2016 stablished the relationship between nitrogen application, nitrogen surplus and nitrate concentration in groundwater and surface waterbodies. The application of the model for the recovery of Mar Menor and “Campo de Cartagena” aquiifer showed that it is necessary to reduce around 80% of the current nitrogen surplus in this aquifer to recovery its good status. This situation produces a great contribution of nitrogen to the Mar Menor lake, through continuously groundwater returns to the waterbody’s surface and the precipitation events when a large amount of nitrogen is washed from soil by the rainfall[24].

The mechanism of nitrogen retention is based on its retention as plant biomass and altered sediment conditions (sources of organic matter and oxygen) that influence microbial biogeochemical processes. They also remove nitrogen from the system via denitrification, with nitrogen removal being 5 times higher in areas with mature seagrass than in areas with no vegetation at all. Seagrass meadows are also known to store four times more nitrogen in plant tissue and sediments than in areas that have not been restored[23].

The data on nitrogen demands for the meadows of both macrophytes in the Mar Menor suggest an important contribution of these habitats in controlling the inputs of this nutrient into the lagoon. It

is concluded that *C. nodosa* meadows can play a key role as a sink for dissolved inorganic nitrogen in temperate coastal lagoons, being an important mechanism of resistance to eutrophication[6].

Seagrasses use carbon in photosynthesis, store carbon for short time periods in their tissue, and more importantly store larger amounts of carbon in the sediments for decades to centuries by promoting deposition and stabilizing deposited sediments. Aditionally, it has been found that carbon stocks combined from plant tissue and sediments were two times greater in 10-year-old restored seagrass meadows than in unrestored areas[23].

A study estimated the removal nitrogen by 1,715 ha. of seagrass meadows in 170 ton/year via denitrification and sequester carbon in sediment at a rate of 630 tons carbon per year. Nitrogen and carbon stored in plant tissue would increase these values, although the storage is more temporary. Besides, retention by tissue is a difficult value to estimate, even though monitoring demonstrates that this retention is significant[23].

Since, the expected results (> 10 years) of the LIFE-TRANSFER project are to achieve 25-30% of the Mar Menor surface covered with well-structured seagrass meadows it means aprox. 3.300 ha. Assuming that the seagrass meadows of *Zostera marina* and *Cymodocea nodosa* (to a lesser extent Ruppia cirrhosa) have similar nitrogen and carbon removal capacities (the age of the meadows is similar, 8-10 years, so this would not influence them too much) it is possible to make a rough estimate: 327 ton/year and 1,212 ton/year of nitrogen and carbon, respectively would be removed from the Mar Menor.

The impact of marine pollution on the probability of business failure in the Mar Menor area was studied. The most remarkable findings were that there is a location factor showing a decreasing probability of business failure for firms located near the Mar Menor. Also, there is a higher probability of failure due to proximity to water pollution. Concretely, agricultural and transport activities benefit from being near the coast despite the quality of the water. These firms' probability of failure decreases when they are located near the sea. On the contrary, a 1 mg/m^3 increase of chlorophyll a raises the probability of business failure for accommodation services (8.4%), minor trade (9.5%), financial and real estate services (11%), and industrial and building activities (14.4%)[18]. The calculated average failure rate (companies in financial distress) was 11.6% in 2017-2020 for those companies located in municipalities of the Mar Menor area. This result is in line with the statistics at the country level available from the Spanish National Institute of Statics (INE). This agency reports an average national company failure rate of 10.6% during the same period[18].

Furthermore, the angiosperm meadow restoration also represents a direct action to contrast climate change, since the meadows contribute to permanently stock CO_2. Contrary to macroalgae, which give back stocked carbon when they decay, aquatic angiosperms are perennial that are present the whole year and therefore contribute to permanently store CO_2 in their tissues. To this CO_2 amount we must also add an equivalent quantity least by considering calcified macroalgae, bivalves, gastropods and calcified tube worms living within the meadows, as epiphytes or benthic macrofauna. At the end of their life cycle these organisms enrich sediments with carbonates that accumulated over time in the presence of oxidized conditions. In fact, the presence of angiosperm meadows contributes to keep a high pH and to facilitate the permanency of shells and calcareous incrustations which otherwise would form in a longer time or not form at all.

It is worth highlighting a thesis that collects a survey conducted in the Mar Menor area on the WTP (willingness to pay) to move from a moderate to a good ecological status in the coastal lagoon. This value was 15.23 €/year/person surveyed. Extrapolating the average WTP to the entire target population, the environmental benefits obtained from the implementation of additional measures would be approximately €17.4 million/year[25]. On the other hand, the overall quantification of the loss of value in real state due to the environmental deterioration during 2015-2021 is quantified in 4,150 million euros[17]. Although it is impossible to make accurate calculations regarding the real impact in the local economy of LIFE-TRANSFER, some approximations can be made:

- Nitrogen and carbon levels will be significantly and progressively reduced, could be achieved 327 and 1,212 ton/years, respectively, after approximately 10 years from the start of the project. There are current research objectives that focuses on the eutrophication problem of Mar Menor from a socioeconomic and management perspective in order to restore the eco-hydrological functionality.
- Cost-benefit analysis showed that the environmental benefits generated by measures to improve the ecological status of the Mar Menor coastal lagoon is really profitable as said before. Classic methods to value costs versus benefits may not be optimal as the complexity of the issues require a more enhanced approach that allows integrating environmental externalities[25].
- It would also have an effect on the real estate sector which, if the trend reported in the Bank of Spain's report continues, the annual losses would be around 600 million €[17].
- Considering that the average disposable wage is relatively low, a probability of business failure of more than 11% would have very serious consequences.
- The economic quantification of the effect of LIFE-TRANSFER on climate change through CO_2 sequestration is even more difficult to quantify but should not be underestimated.

- The approx. percentage distribution of the GVA in the Region of Murcia[26] among the economic sectors affected by LIFE-TRANSFER is:

    - Agriculture, livestock, and fishing: 5%
    - Construction: 6%
    - Services: 70.3%

  Therefore, the percentage of the local economy that will benefit from the implementation of LIFE-TRANSFER is very high (81,3%). Considering the PIB in 2021[27] (32,205 million €) the potential impact of the project could be really relevant for the local economy.

SWOT Analysis

In order to assess the impact of LIFE-TRANSFER on the tourism sector in the Mar Menor area, a SWOT analysis has been used (Table 3). SWOT is an ideal tool for a reliable diagnosis of the project. This provides a quick and easy visualisation of valuable information, identifying weaknesses, threats, strengths and opportunities[28].

The potential opportunities for the local economy in the area arising from the implementation of the LIFE-TRANSFER project are presented in the following SWOT analysis. Also the strengths that would be obtained and the present ones that will facilitate a good implementation of the project. Finally, the possible threats and weaknesses already existing and those in the process of development that could hinder the success of the project are indicated.

Table 3. SWOT analysis of the impact of the LIFE-TRANSFER project on the main economic sector in the Mar Menor area.

Strengths	**Weaknesses**
An improvement of the ecological quality of water bodies, starting from the vicinity of the areas of transplantation. The diffusion of submerged seagrass meadows will counteract the erosion and the deepening of	Problems in performing transplants. There is no specific project contingency plan to help minimize risks and mishaps in the Mar Menor lagoon.

coastal lagoons caused by the synergy of climate change and anthropogenic activities Increase the resilience of shallow waters. Decreased sediment resuspension, water turbidy and settling. *C. nodosa* meadows can play a key role as a sink for dissolved inorganic nitrogen, being an important mechanism of resistance to eutrophication. Restoration of angiosperm grasslands is key to countering climate change through CO_2 sequestration. The recovery of the lagoon and its ecosystem services in order to shift to a new model of development. To recover the environmental quality of the lagoon for its inhabitants and visitors as a more habitable and economically competitive area. Good prospects for seabed regeneration that will result in an improvement of the conservation status of the area and the lagoon.	No or low availability of species in the donor site, the donor site should not be damaged by sod/rhizome explant. It is possible that the risk is assessed too high for the rhizome-giving area, having to choose another. Scarce growth of phanerogams sods transplant. Adverse external factors, including unfavorable weather conditions. Delays in obtaining the necessary authorizations for the execution of the actions pose a risk to compliance with the schedule.
Opportunities Social structure very attached to the environment. Interest in improving. High cultural and heritage value with great potential to consolidate and facilitate the growth of tourism services. Natural area with potential for the development of multiple activities: nautical, tourism, etc.	**Threats** Weak urban planning and tourism model, subject to different pressures and interests Eutrophication of the coastal lagoon. Diffuse pollution by fertilisers and pesticides Human threat to the natural ecosystem: difficulty of the lagoon system to assimilate the pressures of human activities.

Richness and biodiversity of the marine ecosystems of the Mar Menor and its surroundings. Extent and quality of the beaches and privileged surroundings for the practice of water sports. Improve the quality of services offered to citizens like ecotourism and fishing.. New employment opportunities supported by Local Fisheries Action Group (GALPEMUR). Compatibility of agricultural and fisheries development with the values of the Natura 2000 network. Ameliorate the exploitation of artisanal fishing resources (like Las Encañizadas) Development and implementation of codes of good practice associated with fisheries, urban development, agriculture and tourism. The recovery of the lagoon and its ecosystem services to shift to a new development model.	Inadequate design of marinas in relation to coastal hydrodynamics. High seasonality of tourism, which has repercussions on the exploitation of resources and high volume of waste during summer period. Water shortage in the region and non-compliance with water quality. Deterioration of the biodiversity, the environmental conditions of the lagoon and of the landscape impact on the tourist image of the Mar Menor and a loss of quality of life. Loss of singularity and environmental, ecological and landscape identity of the Mar Menor. Decrease in marine water quality. Overfishing for some target species at certain times of the year. Structural unemployment from all economic sectors in the region, together with the low qualification of the labour force, could aggravate the social damage in a particularly sensitive sector of the population (primary sector), and particularly for women. Conflicts of interest between farmers and those responsible for good water status.

As can be deduced from the SWOT analysis, the LIFE-TRANSFER seagrass regeneration project presents a great opportunity to promote the conservation and restoration of these key marine ecosystems. The identification of strengths such as improvement of the ecological quality of water bodies and counteract the erosion and the deepening of coastal lagoons caused by the synergy of climate change and anthropogenic activities, provide a solid basis for the successful implementation

of this project. In addition, significant opportunities have been identified, such as the recovery of the lagoon and its ecosystem services.

However, weaknesses and threats have also been identified that could hinder the successful implementation of the project. The most important weakness is that transplants cannot be performed correctly or do not evolve appropriately. Threats include eutrophication of the coastal lagoon, decrease in marine water quality and conflicts of interest between farmers and those responsible for good water status.

Overall, although significant challenges exist, the LIFE-TRANSFER has the potential to achieve positive outcomes in terms of conservation and restoration of these vital ecosystems. To maximise the opportunities and overcome the identified weaknesses and threats, it is recommended to develop a comprehensive strategy that involves the main stakeholders, promotes public awareness and fosters scientific and technical collaboration between the project partners.

It is worth noting the main LIFE-TRANSFER positive effect: improvement of the conservation status of the area and the lagoon and the ecological quality of water bodies, starting from the vicinity of the areas of transplantation. It is also important to highlight a strength that may not be easily quantifiable but has a major environmental impact: the CO_2 sequestration. The angiosperm meadow restoration also represents a direct action to contrast climate change, since the meadows contribute to permanently stock CO_2. Contrary to macroalgae, which give back stocked carbon when they decay, aquatic angiosperms are perennial that are present the whole year and therefore contribute to permanently store CO_2 in their tissues. To this CO_2 amount we must also add an equivalent quantity least by considering calcified macroalgae, bivalves, gastropods and calcified tube worms living within the meadows, as epiphytes or benthic macrofauna. At the end of their life cycle these organisms enrich sediments with carbonates that accumulated over time in the presence of oxidized conditions.

CONCLUSIONS

Currently, the Mar Menor lagoon is dealing with critical situations: a serious eutrophication process, the decline of fishing production, deterioration of bathing areas and loss of water quality. Many of the consequences of these actions involve potential risks to human uses of the lagoon and local economy, since the economical activities of coastal lagoons depend closely on ecological processes.

Tourism sector

It is difficult to establish the reason(s) behind the general decline in tourism-related parameters. In this sense, in addition to environmental problems, the economic-financial crisis and the covid-19 crisis have also had a notable influence. Although, Hotels and Restaurants are impacted by ecological degradation in the Mar Menor. In fact, it has been quantified that the probability of failure in the tourism sector increases from 8.4% to 14.4% when seawater pollution increases. Also, this sector is the most relevant in the local economy (represents 70.3% of the local economy).

Fishing and aquaculture sector

Coastal lagoons act as nursery areas and feeding grounds. At the same time, the intense relation with the terrestrial ecosystem boundary makes these environments especially vulnerable to human impact and terrestrial and freshwater inputs.

The collected data shows an uneven development of volume of maritime fisheries landed and a clear decrease in the number of vessels and workers in the sector. In this case, the relationship between this sector and the environmental problem in the Mar Menor may be clearer than in other sectors.

Real state sector

The report of the Bank of Spain is conclusive about the impact on this sector of the pollution problems in the Mar Menor and therefore the importance of a successful LIFE-TRANSFER. In monetary terms, per m^2, the houses of the Mar Menor would cost up to 500€ less than those are similar and are located next to.

Agricultural sector

The use of fertilisers and other similar compounds contributes to the eutrophication of the Mar Menor damaging its seagrass meadows, among other elements. In this sense, if it is possible to mitigate this eutrophication without having to eliminate or reduce agricultural activity, this would alleviate the stress on this economic sector, which represents up to 5% of the regional economy.

General economic indicators

The main conclusions drawn from the analysis of the general economic indicators are as follows:

- The number of employed population is almost the same now as it was in 2008.

- There is a difference between salaries in the Murcia region and those in the Mar Menor municipalities.
- Unemployment has been declining as the effects of the economic-financial crisis faded, with a spike probably due to COVID-19.
- Population trends in Region of Murcia are increasing. This rise has been even greater in municipalities potentially more affected by LIFE-TRANSFER.

General conclusions

It is not possible to make accurate calculations regarding the real impact in the local economy of LIFE-TRANSFER due to the low quality and scarcity of available data. However, some approximations can be made:

- Nitrogen and carbon levels will be significantly reduced progressively and will be achieved 327 and 1,212 ton/years, respectively, after approximately 10 years from the start of the project. This is a significant part of the total annual environmental impact amount of 17.4 million €. It would also influence the real estate sector which, if the trend reported in the Bank of Spain's report continues, the annual losses would be around 600 million € (4,150 million euros in 2015-2021).

- Considering that the average disposable wage is relatively low, a probability of business failure of more than 11% would have very serious consequences.

- The economic quantification of the effect of LIFE-TRANSFER on climate change through CO_2 sequestration is even more difficult to quantify but should not be underestimated.

- The percentage of the local economy that will benefit from the implementation of LIFE-TRANSFER is very high (81,3%). Considering the PIB in 2021 (32,205 million €) the potential impact of the project could be really relevant for the local economy.

APPENDIX

It should be noted that the present document is the preliminary report on analysis of local economy in the Mar Menor area. Therefore, further modifications will be made as the LIFE-TRANSFER project is implemented, as well as those deemed necessary by the project partners for a better impact assessment. In addition, the result of this specific analysis will be used to compile the key project level indicators which has been attached to the proposal, as it was set out in the LIFE-TRANFSER application memorandum.

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