

The urban metamorphosis of La Manga and the “mediterraneanisation” process of the Mar Menor (Spain)

J. L. Miralles i Garcia¹ & S. García-Ayllón Veintimilla²

¹*Departament of Urban Planning,
Polytechnic University of Valencia, Spain*

²*Departament of Civil Engineering,
Polytechnic University of Cartagena, Spain*

Abstract

La Manga del Mar Menor is an ancient dune line located in the Murcia Region (Spain). This area had an accelerated urbanization process starting in the 1960s which has had several powerful impacts on the coast, the landscape and the marine ecosystem. Among these impacts, the so-called process of “mediterraneanisation” of the inland lake is particularly interesting. The Mar Menor is a salty lagoon of more than 170 km² and uniform drafts about 5 meters deep. This lagoon is a former bay of the Mediterranean Sea closed in a natural way by the sandbar of La Manga with a length of about 20 km. In 1950, this sandbar was a desert land. In around 1960 there was a tourism project to host up to 60,000 people. At present, it receives up to 250,000 people in the summer, mostly of Spanish origin. The urbanization process changed the system water flows between the inside and the seawater through channels called “golas”. The changes affected the coastal dynamics, the longitudinal profile of the coast and the lagoon ecosystem. Three processes in particular have caused major environmental impacts: land filling of water areas for the construction of infrastructure and building, connecting islands with routes and expanding channels and building ports for use by recreational vessels. Fifty years after the initial process, this paper analyzes the current coastal pathologies and how the urbanization process has caused them.

Keywords: coastal dynamics, coastal ecosystems, urban planning, coastal public works.



1 Introduction

La Manga del Mar Menor is a dune line over 20 kilometers in length and a width ranging from 500 meters, at the beginning, to 80 meters at the end. It is a unique topography in the Mediterranean Sea. La Manga is located between the Mediterranean Sea and the Mar Menor. The Mar Menor is a salty lagoon of over 170 km² and uniform drafts 4 or 5 feet deep.

In 1959, the Spanish government was on the brink of defaulting. To obtain foreign credits it was forced to implement an economic development plan. This plan provided for the promotion of tourism. La Manga zone was selected to promote a great project of tourism development which began in 1962. At present, most of La Manga is heavily urbanized.

This case of urban development for holiday resorts on the Mediterranean coast is paradigmatic and has been investigated by a PhD thesis [1]. This paper explains the conclusions of this research about the changes on coastal landscape and marine ecosystems.



Figure 1: La Manga in the 1950s. (Images of Paisajes Españoles.)

2 Geomorphologic characteristics of La Manga

The Mar Menor is a very special ecosystem because of its high degree of salinity and temperature. This geological environment is the result of the closure of a large old bay. The closure occurs because of several small islands generated by tectonic movements in the Tertiary period. Volcanic eruptions came from the seabed and generated these small promontories as small islands; in particular, Calnegre massif, Grossa Island and the Island of Baron. Subsequently, the large amount of sediment from the country of Cartagena have filled the interstitial spaces to generate, some five thousand years ago, a small enclosed sea with numerous communication channels (called “golas” in Spanish) with the

Mediterranean Sea. So the usual coastal sea current from the north collides with this natural barrier formed by small islands and the flow sand of north–south is interrupted. The sand is deposited in the row of small islands generating a sand arm of low height which closes the bay.

So the inland sea of Mar Menor is a special ecosystem which has water with a high degree of salinity and temperature. The balance between the internal waters of the Mar Menor and the waters of the Mediterranean Sea is maintained by the regulating actions of three communication channels which allow the water flow between them. These three channels are the “gola de Marchamalo”, the channel of “Estacio” and the “encañizada del Charco”. These three channels are navigable and, historically, have been used for fishing.

3 The coastal “developmentalism” in the 1960s: areas and centres of the National Tourist Interest Act

From 1959 to the economic crisis of 1972 in Spain, the government prioritized economic growth. This paradigm is called “developmentalism”. The term means to promote at each moment economic development above all else.

Until 1959 Spain lived in an economic autarkic regime. But from 1959, the new vision facilitated all kinds of economic development to attract foreign currency [2]. So, in 1962 a new Act was approved for the areas and centres of National Tourist Interest. As says Galiana and Barrado [3], it was used as a simple and flexible legislative tool to promote quickly big tourism resorts with public funding and grants.

Based on this law many tourism resorts were launched in inhabited areas such as La Manga in Murcia, Canela Island in Huelva, Campoamor in Alacant or Sotogrande in Cadiz. Also boosted many areas had already begun the development of tourism, such as a Marbella in Malaga, Bahía Nova and Son Parc in the Balearics or the Teresitas’s beach in Tenerife.

At this time there was no environmental regulation. Environmental regulation in Spain started from about the Democratic Constitution of 1978. After this year environmental constraints in land use began to be applied under the new laws.

But in historical cases of “developmentalism” such as La Manga, the land was well transformed. The urbanization process converted the old coastal dunes to a completely anthropized landscape. This lineal urban area produces enormous pressure on the salt lake, the largest lagoon in Spain.

Many actions associated with urbanization processes have changed the ecosystem of La Manga. Some of the more significant are: the construction of marinas, widening the natural channels for the passage of yachts, the landfills to gain land from the sea and road for connecting islands with the dune line. These actions and other minor ones have modified the coastal dynamics and sediment flow. The changes have altered the ecosystem creating effects for many years. The results of the change can be seen today.





Figure 2: Aerial image, coastal land of the Mar Menor in Murcia, Spain. (Image of Cartamur.)

4 Environmental impacts on coastal dynamic of La Manga

If you see the land use on the Murcia coast, you can see that the northeast coast, Mar Menor zone, is highly urbanized while the southeast coast is very natural and undeveloped. So the urban impacts are concentrated on the northwest coast, that is, in the area of Mar Menor. By contrast, a large coastal zone of the southeast is in almost a natural state, with few tourist villages. Thus, paradoxically, the coast of Murcia is one of the least urbanized Mediterranean Spanish coasts.

This situation has occurred because of the so-called “drain effect”. The southeast area is not protected nor has there been a territorial policy against the tourist resorts in this area. In fact, the initial success and fame of La Manga resort initiative attracted investment in the area. So other areas were left without investment.

La Manga zone focuses many performances that have altered coastal dynamics. The first intervention that caused significant environmental impact was the new road built along the dunes as a structural axis. In some places, the road was built over the sea thereby modifying the beaches.

The most significant work that has altered the flow of sediment along the dunes has been: the landfill of Viveros lagoon and the roads between different small islands and the line dune.

Table 1: Percentage of urban land on the Mediterranean Spanish coast. (Ministerio de Agricultura, Alimentación y Medio Ambiente [1, 4].)

Area	Coast km	Artificial uses on coastal fringe 2 km, %
Girona	260	25.0
Barcelona	161	54.0
Tarragona	278	28.2
Castelló	139	23.5
Valencia	126	28.7
Alacant	244	49.4
Murcia	274	13.6
Almeria	249	13.1
Granada	81	10.6
Málaga	308	49.3
Mediterranean Spanish coast	2,029	28.8

The Viveros lagoon was a natural small lagoon inside the Mar Menor with a function of being a natural fishpond. This lagoon was filled in for building purposes.

Among the roads built is the interesting case of the road to Ciervo's island. After a long and complicated trial, the connection's road has been dismantled. The trial showed that the road had led to significant environmental impacts on the ecosystem and the equilibrium dune.

However, other equally controversial actions were consolidated as the silting or pending sentence as the marina Puerto Mayor. Sometimes it is very difficult to prove a cause and effect relationships between actions and impacts.

In particular, all along the Spanish Mediterranean coast, there is a flow of sand from the north to south. This sand's flow keeps the beaches in balance.

The main origin of the sands comes from rivers. When an obstacle interrupts the flow of sand, so sands typically accumulate in the north of the obstacle and erosions occur in the south. In La Manga zone, the sand's flow is about 60,000 m³/year. However, the coastal dynamics are not known precisely, since sands should accumulate in the north of Palo's Cape (natural obstacle) but, in fact, they do not.

In the Mar Menor area, interrupting the flow of sand is mainly due to the construction of dikes and breakwaters and urbanization of the dunes. In a natural situation, the sands are moved by the combined effect of coastal currents in the sea and the wind in the dunes. The interruption of these two flows produces

synergistic and extensive effects of coastal erosion. The beaches lose sand and retreat. This results in the public administration periodically making contributions of sands and regenerating beaches (and paying the associate costs).



Figure 3: The Viveros lagoon before and after being filled in – 1963 and 2007. (Images archive VECOS Company.)

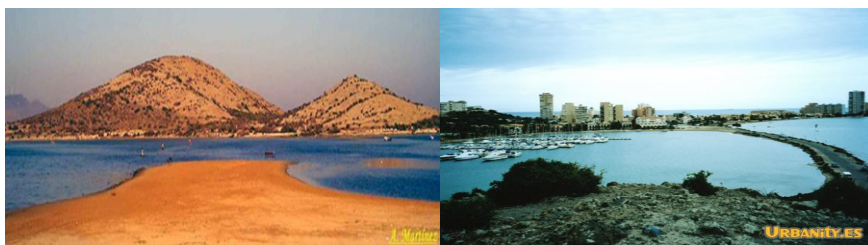


Figure 4: Ciervo's island without and with connection road – 1963 and 1989. (Images archive URBANITY Company and personal archive of A. Martínez.)

The three locations that have produced the greatest impact on the flow of sand have been San Pedro del Pinatar port, the channel north of Veneciola and Puerto Mayor.

The San Pedro del Pinatar port is a total barrier to the flow of sand. In the 1947–1957 period, the port docks were extended. So, especially since this date, sand in the north and interior of the dock has accumulated. On the other hand, beaches have eroded in the south of the dock. The effect is clearly visible in current aerial imagery.

The channels in the north of Veneciola have a more complex dynamic. They act as a drain for sediments from the sea to the lagoon and as a by-pass for sediments to the south.

On the one hand, the streams from the Mediterranean Sea to the lagoon transfer sand and sediments that settle to the bottom of the Mar Menor.

On the other hand, there is a row of small rocks at the entrance of channel by the sea which are remnants of a cemented sandy barrier. This row of rocks serves as protection against the waves of Levante's storms. At the same time, this row of rocks forms a corridor of sand flowing from north to south. This corridor and its flows allow the large beach in the south between Punta Pudrida and Punta Cocidor to be maintained. The origin of the sediments is from the north of the channel where variable erosions occur which can be very strong. For example, in the 1947–1957 period the coastal retreat had a magnitude of between 32 and 48 meters but, in the 1957–1972 period, the coastal retreat had a magnitude of about 15 meters.

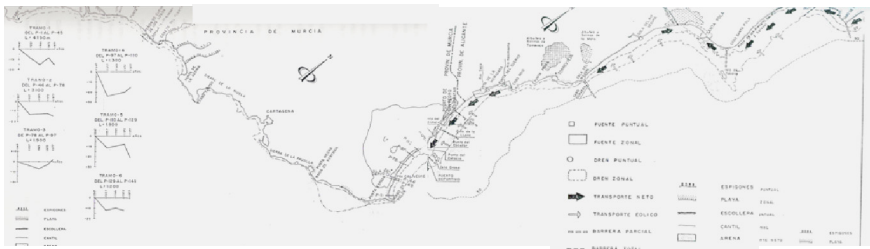


Figure 5: Historical study of coastal dynamics, Ministerio de Obras Públicas y Urbanismo [5].

5 “Mediterraneanisation” process of Mar Menor

The action which produces more impact on sand flow is Puerto Mayor. Puerto Mayor is the name for identifying the expansion of Tomás Maestre port. This is a port sport complex. The marina project is the largest in Spain. At the moment, the project is stopped by judicial sentence. So Tomás Maestre port on the inside of La Manga is complete but Puerto Mayor port on the outside of La Manga only is partially built.

The Puerto Mayor infrastructure obstructs the sand's flow and, theoretically, causes retraction of the southern beaches of La Manga. In the last few decades, these beaches have experienced a major regression.

But, in addition, there is another important environmental impact that we call “Mediterraneanisation” of the Mar Menor. Then we describe this impact.

Tomás Maestre port is located in the old channel of Estacio (“encañizada del Estacio” in Spanish). In 1973, in order to build the marina, the channel was dredged to allow passage of yachts. The increasing of the channel section has been a drain effect of sand's flows from the sea to the lagoon. The sand is originally from the nearby beaches. These beaches retreat 1.5–2 meters/year. However, the balance of the beaches is the result of the combined and synergistic effects of marine sand flows and sand flows caused by wind in the dunes. So a part of the sand's beach comes from dunes.

But, little by little, all the line dunes have appeared, so the dunes have finally disappeared. With them has disappeared the sand reserve that was feeding the equilibrium of the beaches.

In any case, substantial changes are observed in the lagoon ecosystem. The data are compelling (table 2).

Table 2: Changes in the Mar Menor ecosystem in the past 20 years [6].

<i>Water salinity</i>	Salinities were lowered from 53 grams per liter to the maximum current values of 47 g/l
<i>Water temperature</i>	Has softened with 2°C annual temperature extremes
<i>Alteration of biota</i>	In phytoplankton, species number was multiplied by 10 and the fish and shellfish by 2, with the appearance of new taxonomic groups, such as echinoderms.
<i>Disappearance and introduction of new species.</i>	Common species have disappeared, such as shrimp and eel or others, such as the seahorse, have spread. Other species have become invasive for space, such as <i>Caulerpa Prolifera</i> (occupying up 95% of the sandy bottom) and jellyfish <i>Pelagia noctiluca</i> , <i>Rhizostoma pulmo</i> and <i>Cotylorhiza tuberculata</i> . Jellyfish have become, in some years, a real plague reaching 60 million individuals which have saturated the salty waters of the lagoon.

According to Arévalo Díaz del Río [7], the majority of water movement between both seas occurs in the Estacio channel. In the other channels, water circulation is poor. The Marchamalo channel in the south has obstructed the mouth. And the north channels of Veneciola have little movement of water due to their shallowness. Consequently, in simplified form, it can be said that the exchange of water between the two seas is due to forces caused by tides and atmospheric agents, mainly atmospheric pressure.

Modeling the resultant force as the difference between the levels of both seas Δh , the rate of movement we can assimilate to “communicating vessels” principle. According to simple equations hydraulics, this height difference is given, in the absence of other constraints, by longitudinal and transverse velocities for Estacio stream, u and v , according to the following formula:

$$u = \frac{g \cdot W}{v \cdot L} \Delta h$$

where g is gravity and L W are the width and the length of channel.

The contrast of the model to the actual speed provides a stable water flow around 0.1 m/s from the south. With this hypothesis, the modeling of changes in the channel stream Estacio indicate that the new spring projected for Puerto Mayor port does not increase the impact actually produced by the expansion of channel in the 1960s. So this new spring does not affect the “mediterraneanisation” process of Mar Menor.

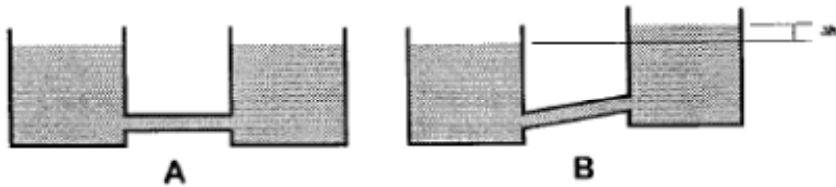


Figure 6: Modelling of watercourse between both seas by “communicating vessels” principle.

In contrast, it does affect the flow of sand from north to south amending the areas of erosion and accumulation of sand on the beaches.

But it is necessary to consider complementarities. This study is based on the working hypothesis assumed in the previous study of coastal dynamics MOPU of 1979 [5]. This historical study considers the Mar Menor as a material accumulation zone (sink effect) for the sands of the coastal north–south currents.

However, some facts established at a later date suggest that near Estacio channel, the sands flow deviates and consequently, the sink effect is not as strong.

So, on the one hand, there are observed environmental impacts caused by historical intervention. But, on the other hand, we still do not know the detail of coastal dynamics in specific areas or at a micro level. Also, it is difficult to model the impacts resulting from the effects of different historical and present interventions on complex coastal dynamics, particularly, on the flow of sand.

In any case, the most significant environmental impacts have been caused primarily by the development works carried out in the 1960s and 70s. These impacts are currently very difficult to correct.

Finally, we must say that attention to environmental issues has been fixed on the Mediterranean seafront, forgetting the other front, the façade to the Mar Menor. This has happened because of tourist interests. Specifically, the beaches of the Mediterranean coast of La Manga lose sand continuously and, in order for them to not disappear, artificial contributions of sand need to be made.

However, despite what is commonly believed, the most damaged by the absence of sediment input is the façade of La Manga to Mar Menor lagoon. This is due to the lack of input from the sand dune ecosystem since, on the one hand, dunes have disappeared due to the building process and, on the other hand, buildings generate a “screen effect” that prevents sand flow from the Mediterranean coast by the wind.

In a natural situation, La Manga was a line dune. In the area, the prevailing winds are from the east. This wind moves the sand from the beaches of the Mediterranean, through the dunes of La Manga to the beaches of the Mar Menor. So the beaches of the Mar Menor, in the west of La Manga, get their sand from dunes and beaches of the Mediterranean Sea, in the east.

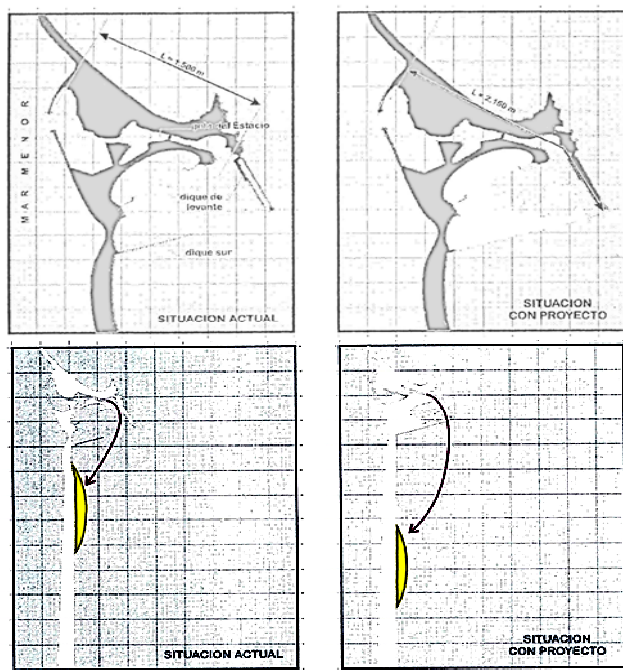


Figure 7: Changes in sand flow caused by the Puerto Mayor project, (Monsó del Prat [9]).



Figure 8: Retreat beaches in the façade of La Manga to Mar Menor lagoon.

But today, the dunes have disappeared, buildings generate a “screen effect” because they prevent the passage of wind with sand from the beaches of the east and also the eastern beaches lose sand continuously. Therefore, the western beaches lose sand continuously and owners see the approach of the salt water of the lagoon to their buildings.

6 Conclusions

The process of urbanization in La Manga starting in the 1960s has generated a great resort for a population of up to 250,000 individual visitors.

Analysis of environmental changes in the area leads to the following conclusions:

- It has altered the flow of sand in the line dunes of the Mediterranean coast of La Manga. There is a general process of regression from the beaches. It therefore becomes necessary to contribute artificially sand beaches that do not disappear. This process affects tourism negatively.
- Also it has altered the flow of sand in the line dunes of the lagoon Mar Menor coast of La Manga. This sand flow is produced by the wind that carries sand from the Mediterranean coast to the lagoon coast. This sand flow is produced by the wind that carries sand from the Mediterranean coast to the Manga coast of the lagoon. The disappearance of the dunes, the “screen effect” of buildings and reducing the sands of the Mediterranean beaches has caused a sharp decline in the flow. The lagoon water moves and has already reached some buildings that must be protected.
- Due to the complexity of coastal dynamics that act simultaneously, local effects occur which are difficult to understand and to process model. In particular, it is very difficult to predict the environmental effects of proposed projects and pending execution.
- The obvious environmental impacts generated by the process of urbanization in La Manga have produced a strong social response. Through court decisions, in some cases projects have stalled temporarily and others have forced replacements of the previous situation.

References

- [1] García-Ayllón S. En los procesos de urbanización del mediterráneo: el caso La Manga. PhD thesis, Polytechnic University of Valencia (Spain), 2012 (in process for defence).
- [2] Miralles i Garcia, J.L. Real estate crisis and sustainability in Spain. *Proc of the 5th Conf. on Sustainable Development and Planning*, eds. C.A. Brebbia and E. Beriatos, WIT Press Southampton, pp. 123-132, 2011.
- [3] Galiana L. and Barrado D. Los centros de interés turístico nacional y el despegue del turismo de masas en España. *Investigaciones Geográficas* nº39, pp. 73-93, 2006.
- [4] Sostenibilidad en España 2012; Ministerio de Agricultura, Alimentación y Medio Ambiente. Madrid, pp. 261, 2012.
- [5] *Estudio de la dinámica litoral de la costa peninsular mediterránea. Provincias de Murcia y Alicante*. Ministerio de Obras Públicas y Urbanismo (Spain), 1979.
- [6] Coastal Oceanographic Observatory of Murcia, www.oocmur.es



- [7] Arévalo Díaz del Río, L. Intercambios en el estrecho de Gibraltar y su respuesta a forzamientos meteorológicos y climáticos. Proyecto de Investigación, Universidad de Málaga, Ministerio de Educación (Spain), 2006.
- [8] *Estudio de Impacto Ambiental de Puerto Mayor*. IA Consultores, Ministerio de Fomento, 1995.
- [9] Monsó del Prat, J. L. Technical Report, 2010.

