ESTADO ECOLÓGICO DEL MAR MENOR, ENTRE LA HOMEOSTASIS ECOSISTÉMICA Y LA INCAPACIDAD HUMANA

Angel Pérez-Ruzafa *Universidad de Murcia*

ACTUACIONES PARA LA RECUPERACIÓN DEL MAR MENOR - (SD-12)

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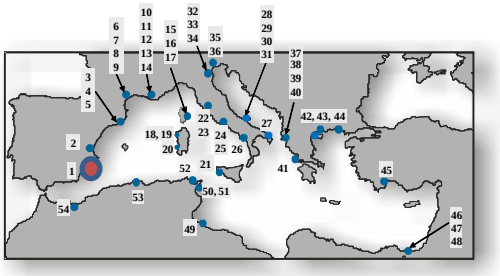
Índice

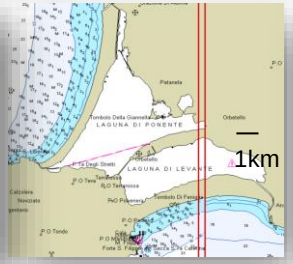
Mediterranean Coastal lagoons

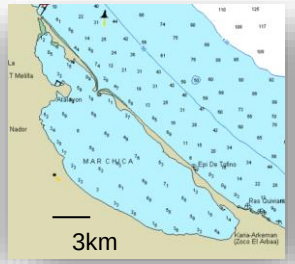
In the Mediterranean there are more than 400 lagoons. The **Mar Menor** is one of the largest coastal lagoons in Europe and shares with the others being



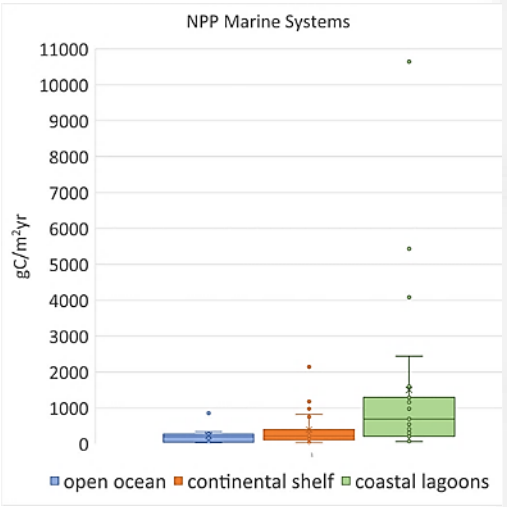
1 Mar Menor
2 Albufera
3 Encañizada
4 Tancada
5 Buda
6 Thau
7 Salses-Leucate
8 Vaccarès
9 Canet-Saint-Nazaire
10 Arnel
11 Berre-Vaine
12 Prevost
13 Mejean
14 Mauguio
15 Biguglia
16 Diana
17 Urbino
18 Cabras
19 Mistas
20 S'Ena Arrubbia
21 Stagnone di Marsala
22 Burano
23 Orbetello
24 Fogliano
25 Caprolace
26 Fondi
27 Alimini
28 Cesine
29 Margherita de Savoia
30 Lesina
31 Varano
32 Scardovari
33 Comacchio
34 Pialassa Baiona
35 Venecia
36 Sacca di Goro
37 Patok
38 Butrinti
39 Karavastas
40 Narta-Valona
41 Messolongui
42 Agiasma
43 Vistonis
44 Porto-Lagos
45 Koycegiz-Dalyan
46 Bardawil
47 Manzala
48 Burullus
49 Biban
50 Korba
51 Kélibia
52 Tunis
53 Mellah
54 Mar Chica

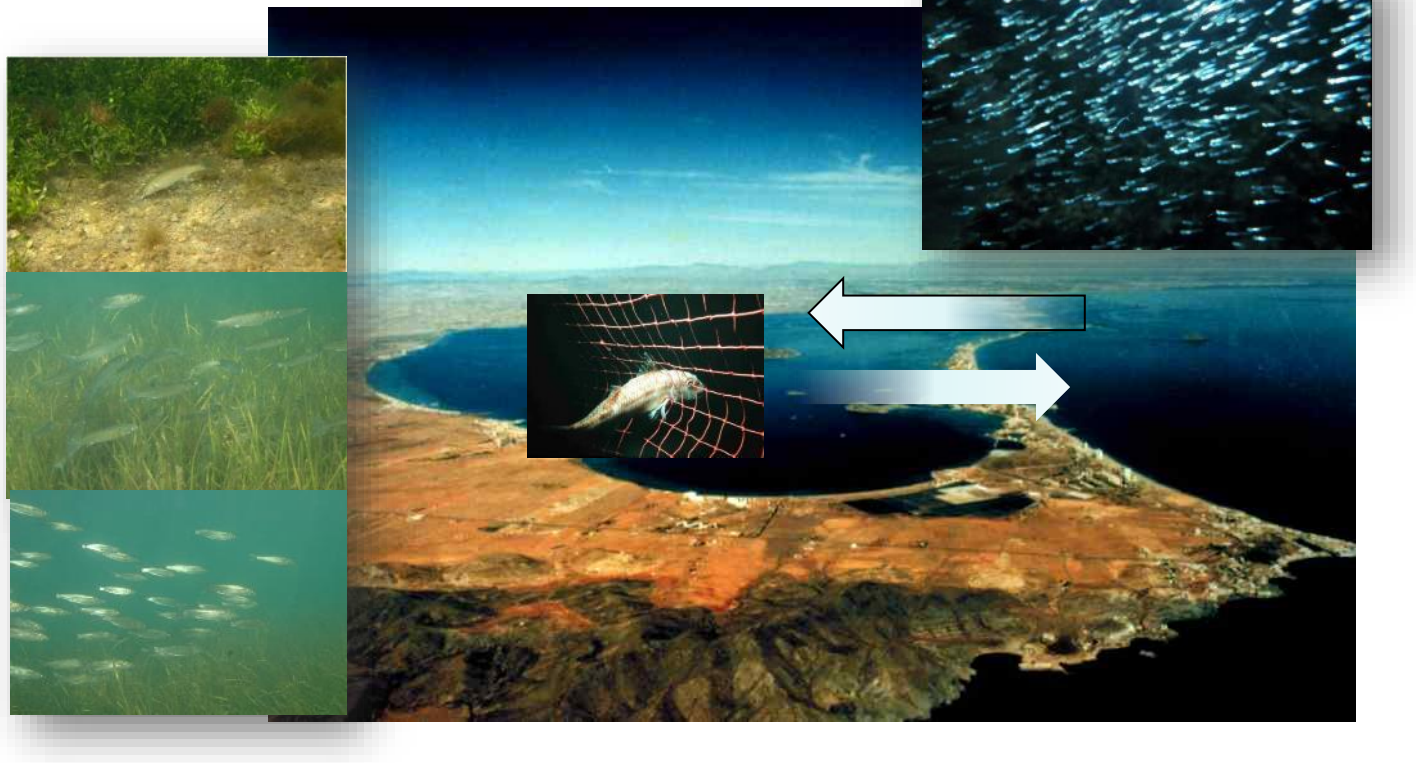
ecosystems in the transition between land and sea, and are characterized by being shallow, relatively isolated from the sea and containing a high number of boundaries with strong physical-chemical and biological gradients (UNESCO, 1981).





Due to their characteristics, coastal lagoons are among the ecosystems with the highest biological productivity, higher than that of outcropping areas, and act as a breeding ground and recruitment area for numerous species of estuarine and migratory fish that penetrate into them looking for shelter and food.





All of this makes them able to provide a wide variety of uses and are subject to intense anthropic pressure. Most of the lagoons offer similar ecosystem services and have common uses




Marsala (Sicily)

Mar Menor (Murcia)



Atanosovsko (Bulgary)

Burgas (Bulgary)


Mar Menor (Murcia)



Figueira (Portugal)


Atanosovsko (Bulgary)

Many of them are areas of special protection due to their biodiversity of communities and species

Fishing being the oldest and most common activity in all of them, using similar fishing gears and devices...


ORDINI
IN PROPOSITO
DELLA PESCA DEL PESCE NOVELLO
ESTESI
In relazione a' Sovrani Decreti dell' Eccellentissimo Senato 17. Maggio, e 4. Giugno 1760.
Dagl' Illustriss., ed Eccellentiss. Signori
PROVEDITORI SOPRA LA GIUSTIZIA VECCHIA, INQUISITOR SOPRA VIVERI, E GIUSTIERI VECCHI
COLLEGIO DELEGATO;
Approvati con Decreto dell' Eccellentissimo Senato 29. Settembre prossimo passato,
PUBBLICATI LI 3. OTTOBRE 1760. E REPUBBLICATI LI 22. FEBBRARO 1774. M. V.
Stampati per li Figliuoli del qu. Z. Antonio Pinelli, Stampatori Ducali.

Paranzas, Mar Menor (Murcia, España)

Spironi (Venezia, Italia)

Köycegiz (Turquía)

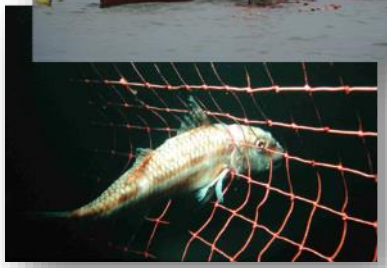
Bizerta (Túnez)

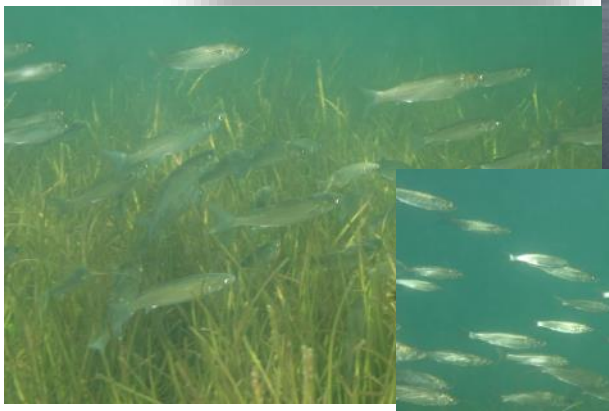
Cabras (Cerdeña)

Agiesma (Grecia)

Mar Menor (Murcia)

Oristano (Cerdeña): PescaTurismo






MAR MENOR
Paranza
Corral
Travesia

Fishing the same species…



Urbino (Córcega, Francia)

Eratino (Grecia)






…elaborating same products




Eratino (Grecia)

Mar Menor (Spain)

Köycegiz (Turquía)







Cabras (Sardinia, Italy)

Mar Menor (Spain)

…and sharing similar biological problems

Venecia (Italia)

Eratino (Grecia)

Mar Menor (Spain)

In general, these ecosystems, due to their characteristics, are considered simple and homogeneous, with intense environmental fluctuations and tend to have turbid waters and present frequent dystrophic crises.

Cabras (Cerdeña)

Eratino (Grecia)

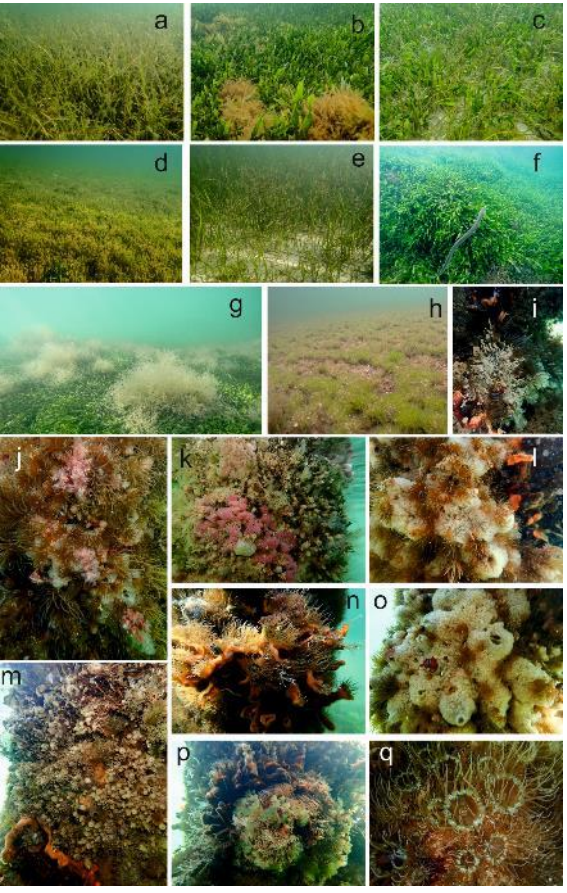
Venecia (Italia)

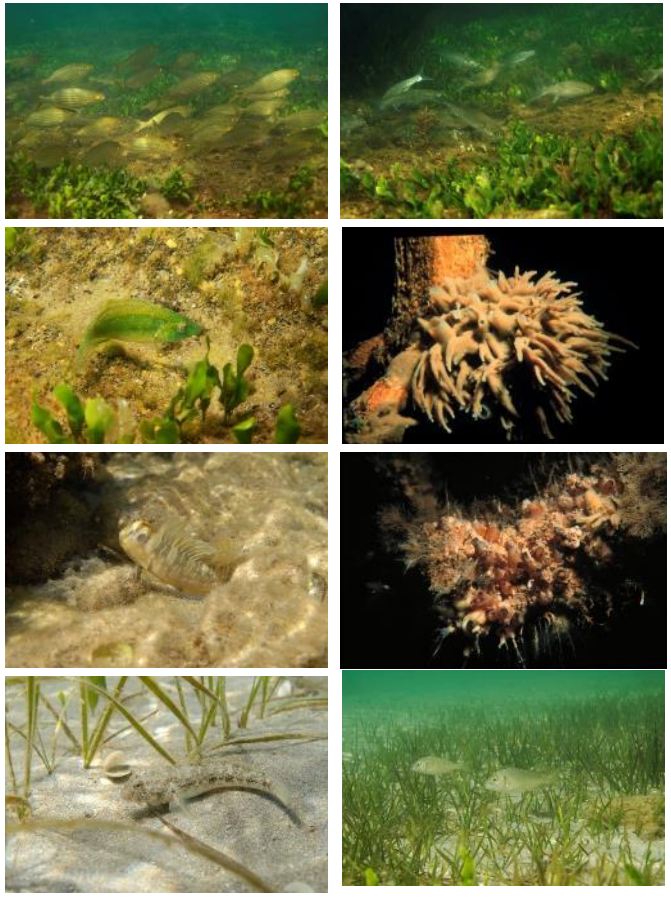
Bizerta (Túnez)

Oristano (Cerdeña)

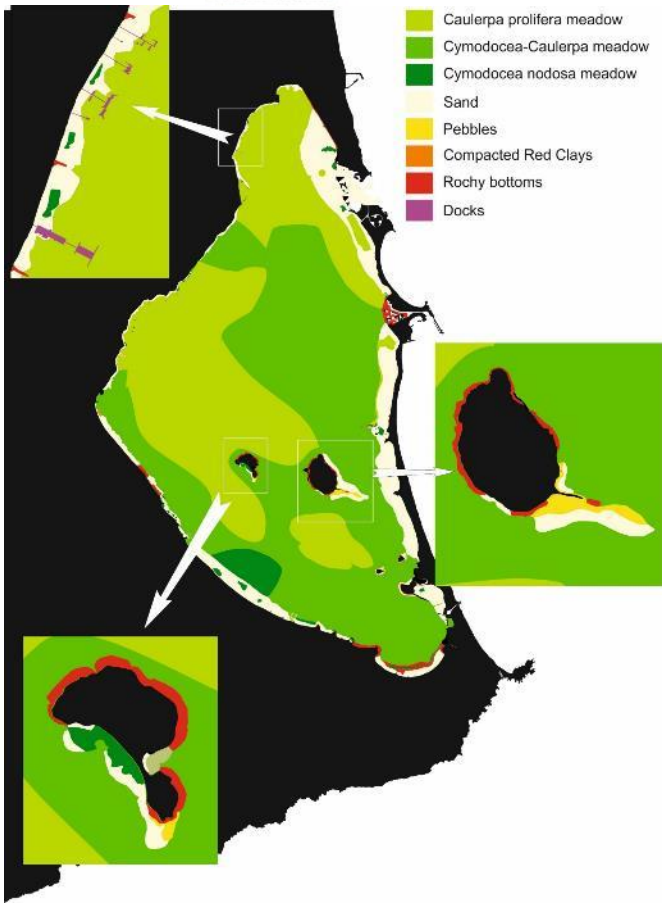
But the Mar Menor, however, has always had transparent waters

…hosting a great environmental heterogeneity and biological diversity





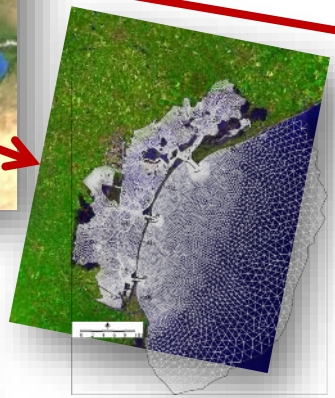
Can an oligotrophic coastal lagoon support high biological productivity? Sources and pathways of primary production

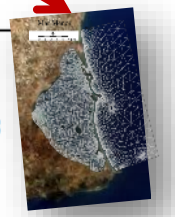


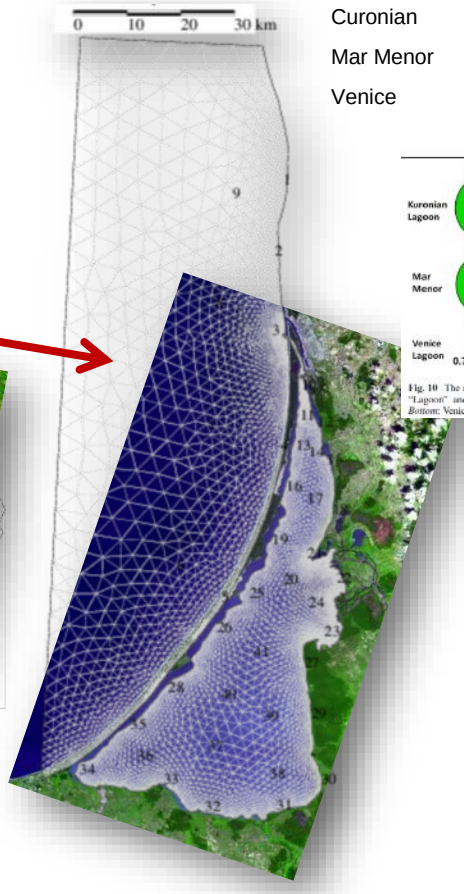
which allows it to maintain leisure activities, bathing, water sports and thalassotherapy, and an important tourist activity, which together with fishing make it an economic resource of the first magnitude.

These singularities are due to the restrictions to the connectivity regarding other lagoons that give rise to a great spatial and temporal heterogeneity of its hydrographic conditions and its biological assemblages and a great complexity of its trophic network.

Lagoon	mean WRT [days]	es
Curonian	127.49	± 7.22
Mar Menor	307.69	± 8.47
Venice	10.71	± 0.86







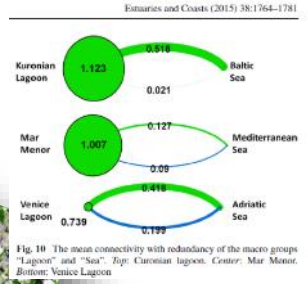


Fig. 10 The mean connectivity with redundancy of the macro groups "Lagoon" and "Sea". *Top*: Curonian lagoon. *Center*: Mar Menor. *Bottom*: Venice Lagoon

Estuaries and Coasts (2015) 38:1764–1781
DOI 10.1007/s12237-014-9908-0

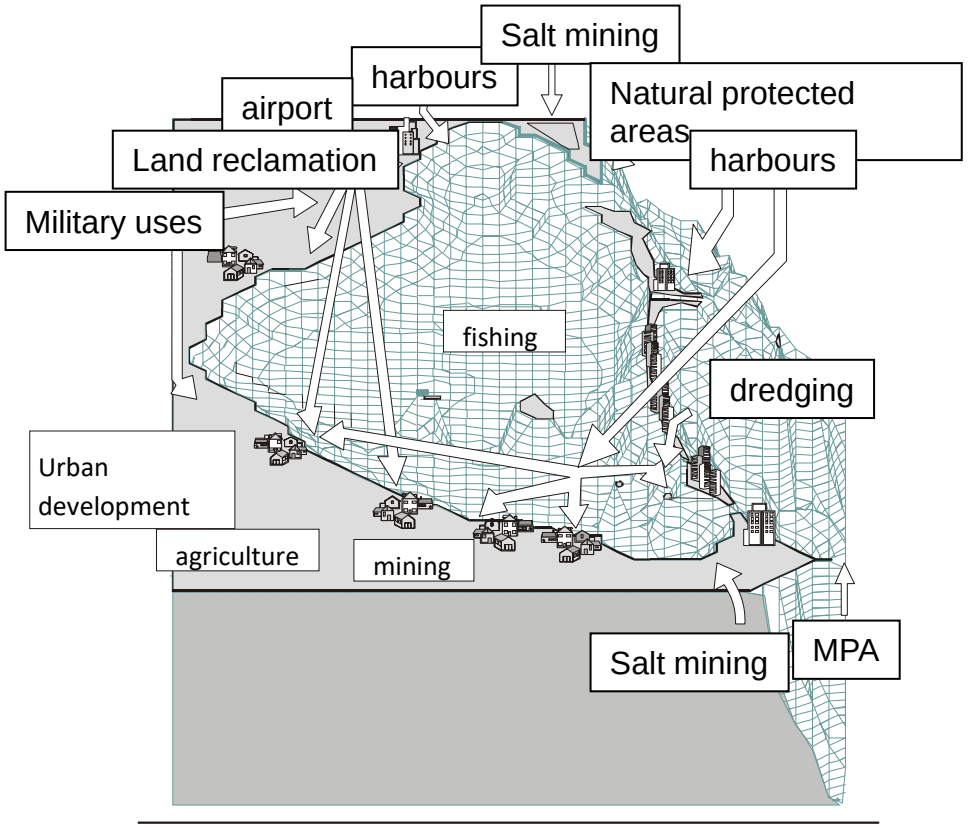
Connectivity in Three European Coastal Lagoons

Michol Ghezzo · Francesca De Pascalis · Georg Umgiesser · Petras Zemlys · Marco Sigovini · Concepción Marcos · Angel Pérez-Ruzafa

0 50

Km

Coastal lagoons: a system under human pressure

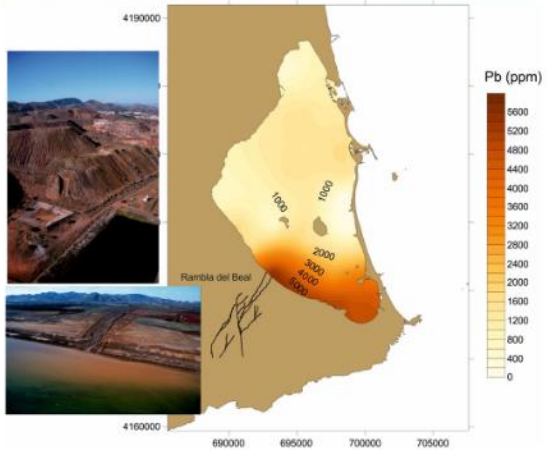


The results is that coastal lagoons play an important role in regional economies and many interests may conflict, from fisheries to tourism, and from aquaculture to harbor facilities or urban development.

Despite of this, the importance of lagoons has not always been well understood and their ecological functioning must be analyzed and evaluated.

The anthropic aggressions on the Mar Menor go back to the mining activities that began with the Phoenicians and Romans and that were maintained until the 1950s, leaving high concentrations of heavy metals retained in the sediments. But the main changes in the lagoon ecosystem occurred in the 1970s with the dredging and widening of the El Estacio channel to make it navigable and build a marina.

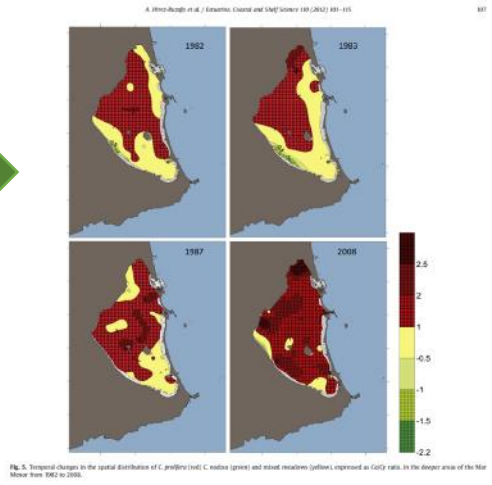
Mining activities since Phoenicians to mid XXth c.



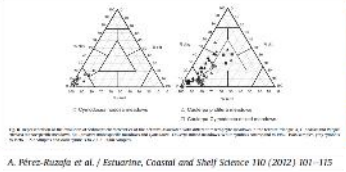
Dredging and enlargening the inlets

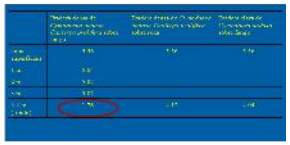
1970s

invasion of the *Caulerpa prolifera* algae



Caulerpa prolifera contributes organic matter, produces sludge and reduces the oxygen content of the sediment



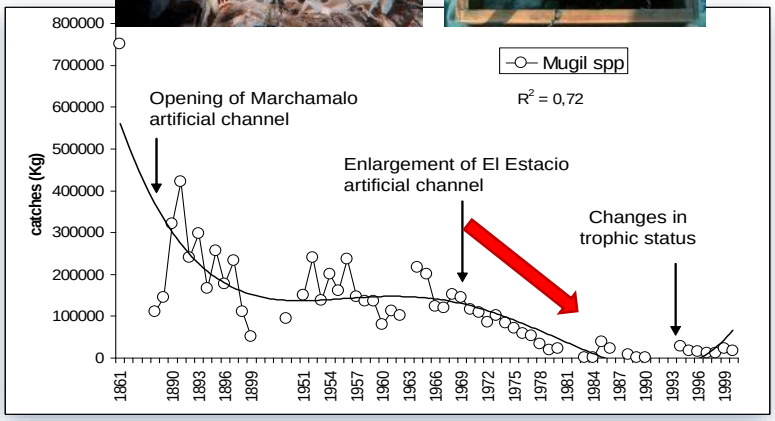


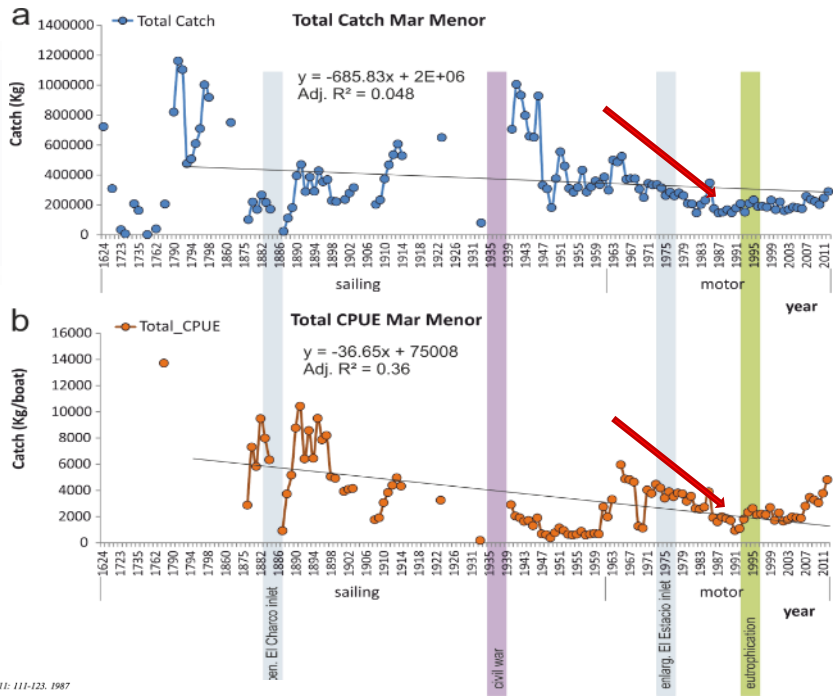
Land reclamation, harbors and beach creation

Wrong beaches maintainance

Urban development 1960-1980s

The spreading of *Caulerpa prolifera* dominated meadows after the enlargement of the Estacio inlet contributed to the drastic fall of the Grey Mullet fishery





Cuad. Marisq. Publ. Téc., 11: 111-123. 1987

Los sustratos arenosos y fangosos del Mar Menor (Murcia), su cubierta vegetal y su posible relación con la disminución del mujol en la laguna

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Departamento de Ecología, Facultad de Ciencias. Universidad de Murcia

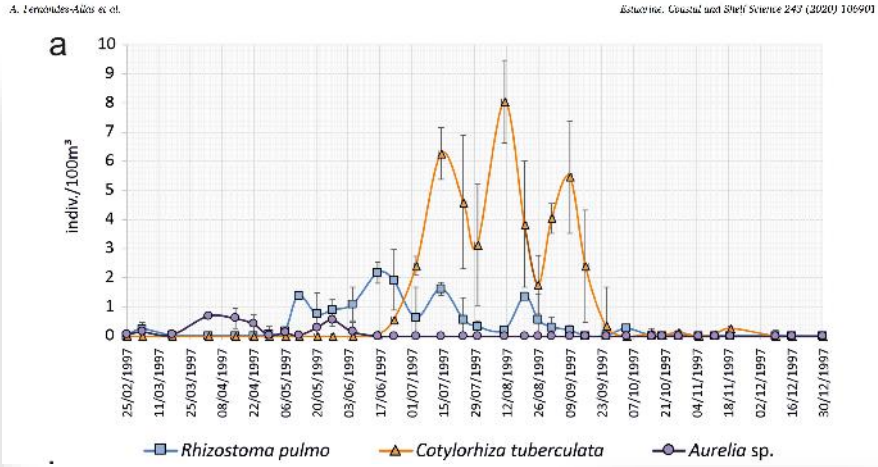
Concepción MARCOS DIEGO
Departamento de Edafología, Facultad de Biología. Universidad de La Laguna

Rev Fish Biol Fisheries (2015) 25:689–713
DOI 10.1007/s11160-015-9397-7

Long term evolution of fisheries in a coastal lagoon related to changes in lagoon ecology and human pressures

Concepción Marcos · Inmaculada Torres · Antonio López-Capel · Angel Pérez-Ruzafa

1990s first jellyfish proliferations



1993


OPINION

Medusas en el Mar Menor

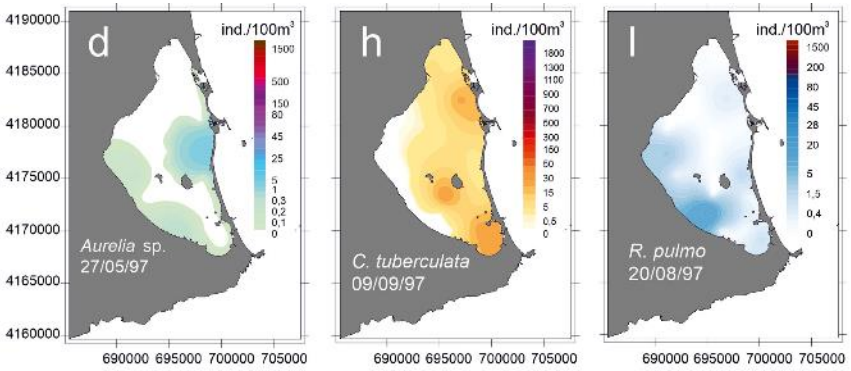
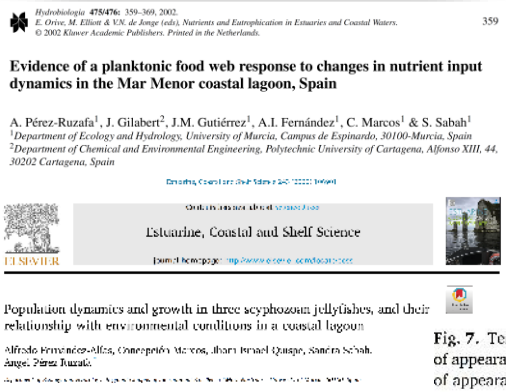


Fig. 7. Temporal dynamic of the spatial distribution of the medusa phase of the three species of jellyfish in the Mar Menor; the first date corresponds to the moment of appearance of the first cohort of the year. a d) *Aurelia* sp.; e h) *Cotylorhiza tuberculata*; i l) *Rhizostoma pulmo*, in this species the four figures correspond to the date of appearance of the respective cohorts.



Hydrobiologia 475/476: 359–369, 2002.
E. Orive, M. Elliott & V.N. de Jonge (eds), Nutrients and Eutrophication in Estuaries and Coastal Waters. 359
© 2002 Kluwer Academic Publishers. Printed in the Netherlands.

Evidence of a planktonic food web response to changes in nutrient input dynamics in the Mar Menor coastal lagoon, Spain

A. Pérez-Ruzafa[1], J. Gilabert[2], J.M. Gutiérrez[1], A.I. Fernández[1], C. Marcos[1] & S. Sabah[1]
[1]Department of Ecology and Hydrology, University of Murcia, Campus de Espinardo, 30100-Murcia, Spain
[2]Department of Chemical and Environmental Engineering, Polytechnic University of Cartagena, Alfonso XIII, 44, 30202 Cartagena, Spain

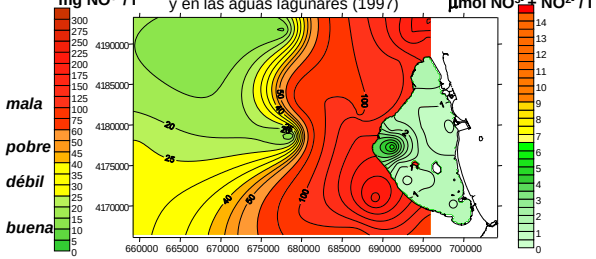
Estuarine, Coastal and Shelf Science

Population dynamics and growth in three scyphozoan jellyfishes, and their relationship with environmental conditions in a coastal lagoon

Alfredo Fernández-Alías, Concepción Marcos, Jihan Ismael Quispe, Sandra Sabah, Ángel. Pérez Ruzafa

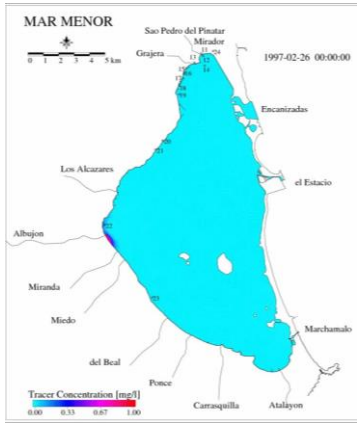
In the 1990s, the establishment of a sanitation plan, with sewerage and purification plants, significantly reduced urban water inflows, but simultaneously the change in agricultural regime, from rainfed to irrigated land, with the inflow of brines from the desalination concentrated in nitrates, marked the beginning of a eutrophication process that manifested itself in the massive proliferation of jellyfish.

Concentraciones medias de nitratos en las aguas subterráneas (1995-99) y en las aguas lagunares (1997)



Calidad de las aguas

Calidad de las aguas
European Environmental Agency, 1999



through jellyfish proliferations and trophic web regulation

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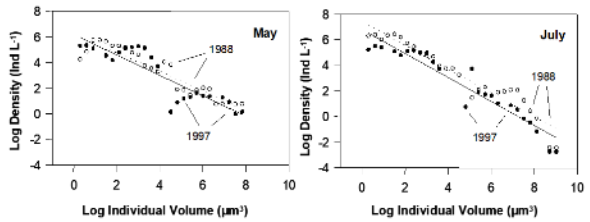
Aurelia aurita *Rhizostoma pulmo* *Cotylorhiza tuberculata*

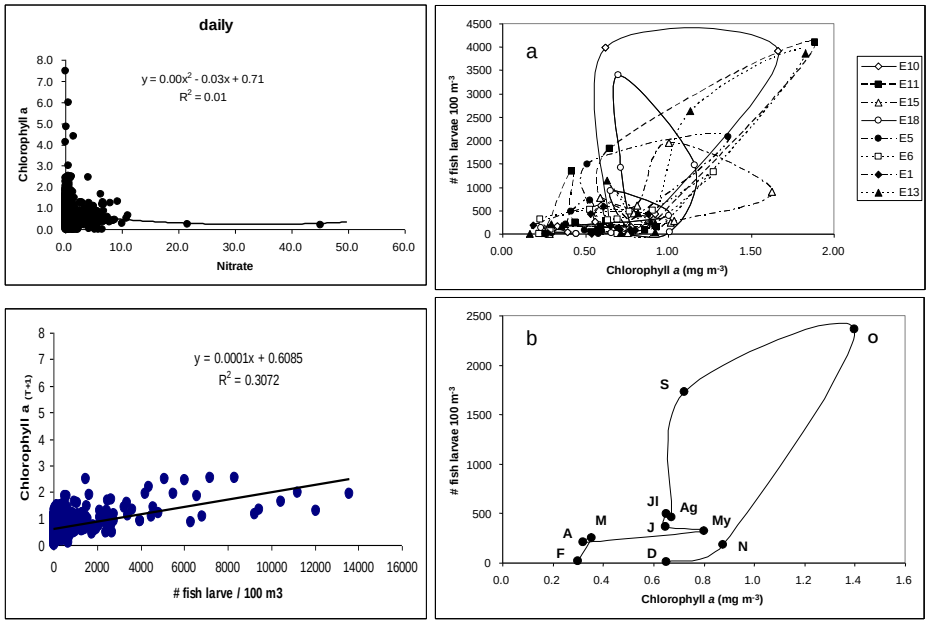


Top-down control

In that period, our research group detected and warned about these changes, …

Showing a negative relationship between the concentration of Chlorophyll a and the concentration of Nitrates in the water and a positive relationship with ichthyoplankton...

and a **limit Cycle** in the seasonal relationship between the abundance of fish larvae and the concentration of chlorophyll a in the water.



Hydrobiologia (2005) 550:11–27
P. Viaroli, M. Mistri, M. Troussellier, S. Guerzoni & A.C. Cardoso (eds),
Structure, Functions and Ecosystem Alterations in Southern European Coastal Lagoons
DOI 10.1007/s10750-005-4356-2

Spatial and temporal variations of hydrological conditions, nutrients and chlorophyll *a* in a Mediterranean coastal lagoon (Mar Menor, Spain)

Angel Pérez-Ruzafa[1,*], Ana Isabel Fernández[1], Concepción Marcos[1], Javier Gilabert[2], Jhoni Ismael Quispe[1] & José Antonio García-Charton[1]

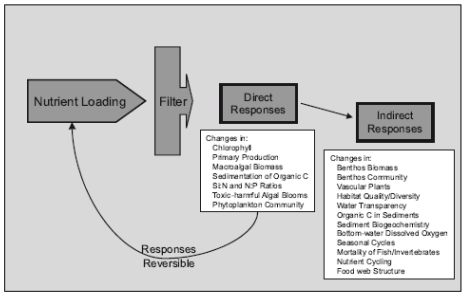
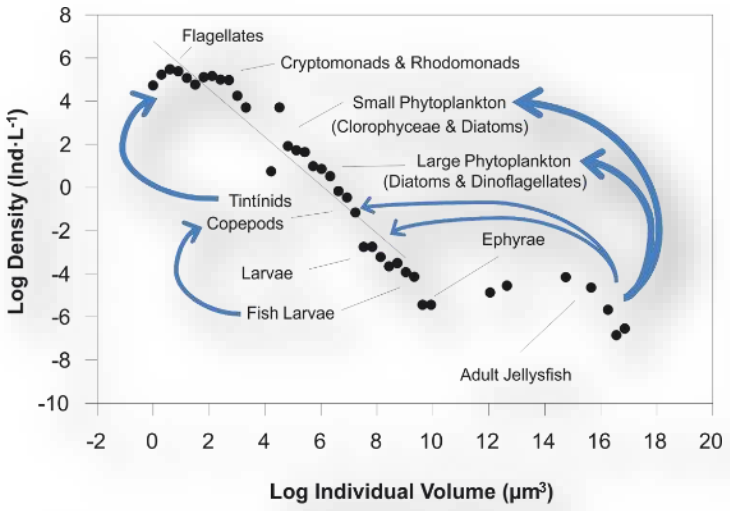


Fig. 22. Schematic representation of the contemporary (Phase II) conceptual model of coastal eutrophication. Advances in recent decades include explicit recognition of (1) a complex suite of both direct and indirect responses to change in nutrient inputs; (2) system attributes that act as a filter to modulate these responses; and (3) the possibility of ecosystem rehabilitation through appropriate management actions to reduce nutrient inputs to sensitive coastal ecosystems

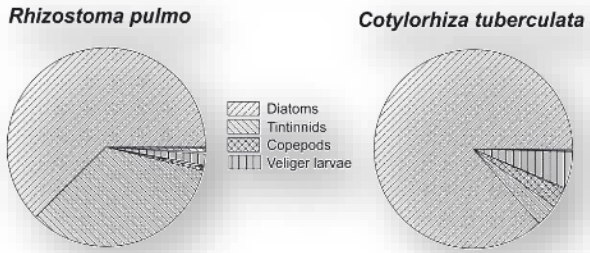
Cloern, 2001. *Mar Ecol Prog Ser* 210: 223–253.

Water quality was maintained thanks to complex regulation mechanisms

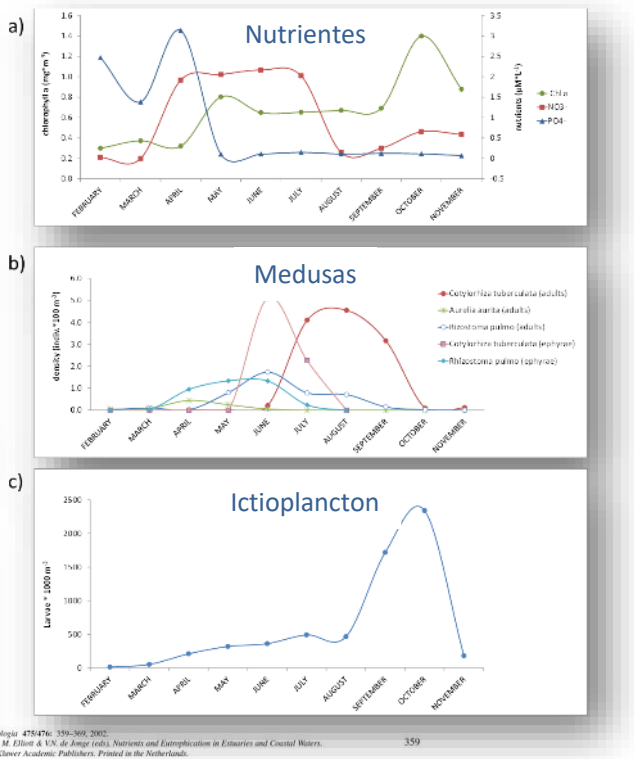
Relaciones tróficas en el espectro de biomasa del Mar Menor



b) Contenido digestivo de las medusas del Mar Menor



Ciclos anuales en el Mar Menor



Hydrobiologia 475/476: 359–369, 2002.
E. Orive, M. Elliott & V.N. de Jonge (eds), Nutrients and Eutrophication in Estuaries and Coastal Waters.

Evidence of a planktonic food web response to changes in nutrient input dynamics in the Mar Menor coastal lagoon, Spain

A. Pérez-Ruzafa[1], J. Gilabert[2], J.M. Gutiérrez[1], A.I. Fernández[1], C. Marcos[1] & S. Sabah[1]

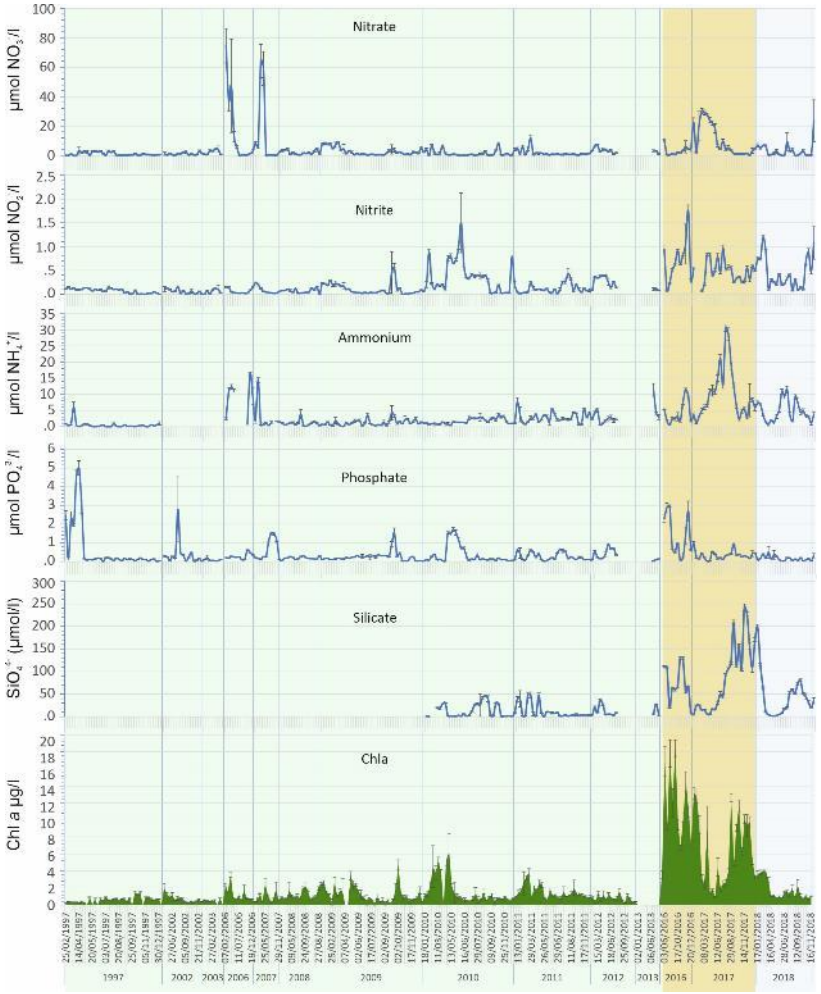
but from different environments it was stated that the proliferation of jellyfish was general in the Mediterranean and associated with climate change. This made the administration focus on fishing for jellyfish…



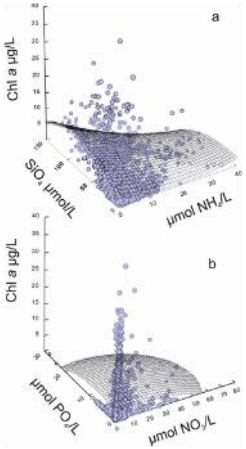
instead of regulating agricultural activities and developing a plan and infrastructure for water management and treatment as had been done for urban waters. Ignoring the fact that jellyfish were the ones that maintained the quality of the water.

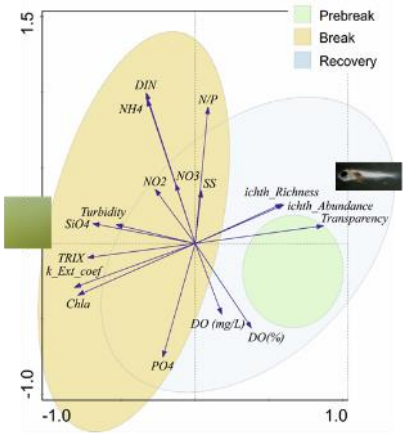


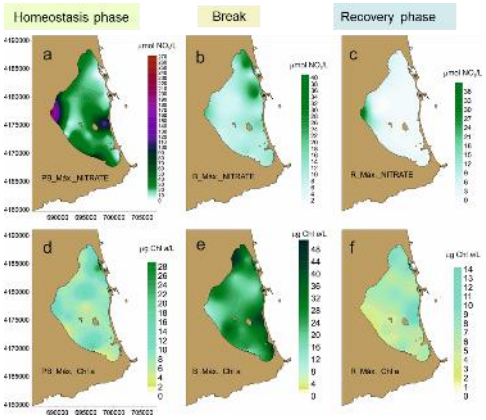
For 30 years, the ecosystem was able to maintain the quality and transparency of the waters thanks to the complexity of its food web, but in 2015, the observation of the parameters of the ecosystem led us to warn that the breakage of the ecological balance could be imminent, which happened a few months later, in the summer of 2016.

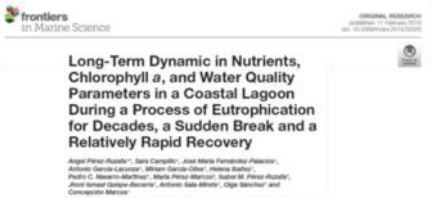


Multivariate analyses of the 30 years monitoring data of the Mar Menor ecosystem throughout the eutrophication process









From mobilization to catastrophism and the social confusion…

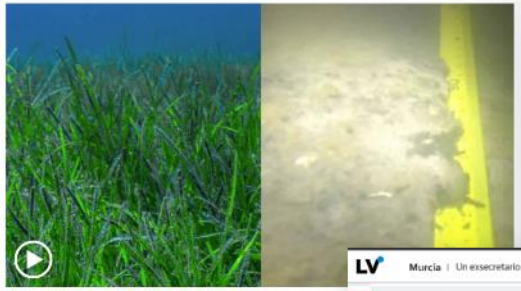
the risk of using politics and ideology vs looking for solutions…

EL PAÍS CIENCIA

El Mar Menor es un "desierto de fango"

Un estudio concluye que se ha perdido el 85% de las praderas marinas en dos añ

MARYA G. NIETO
29 NOV 2016 - 13:53 CET



Antes y después de las praderas marinas del Mar

GRANDES HISTORIAS

El Mar Menor ya es un mar muerto

La laguna más importante del litoral español, en Murcia, atraviesa uno de sus peores momentos presionada por la contaminación procedente de los cultivos, el urbanismo, el turismo náutico y los desechos mineros.

21 agosto 2016 03:05

LV Murcia | Un exsecretario de Agricultura declara sobre el Mar Menor

Región Murcia Cartagena Lorca Molina Alcantarilla Mazarrón Águilas Yecla

Un exsecretario de Agricultura declara sobre el Mar Menor

RICARDO FERNÁNDEZ
Jueves, 28 febrero 2019, 07:42

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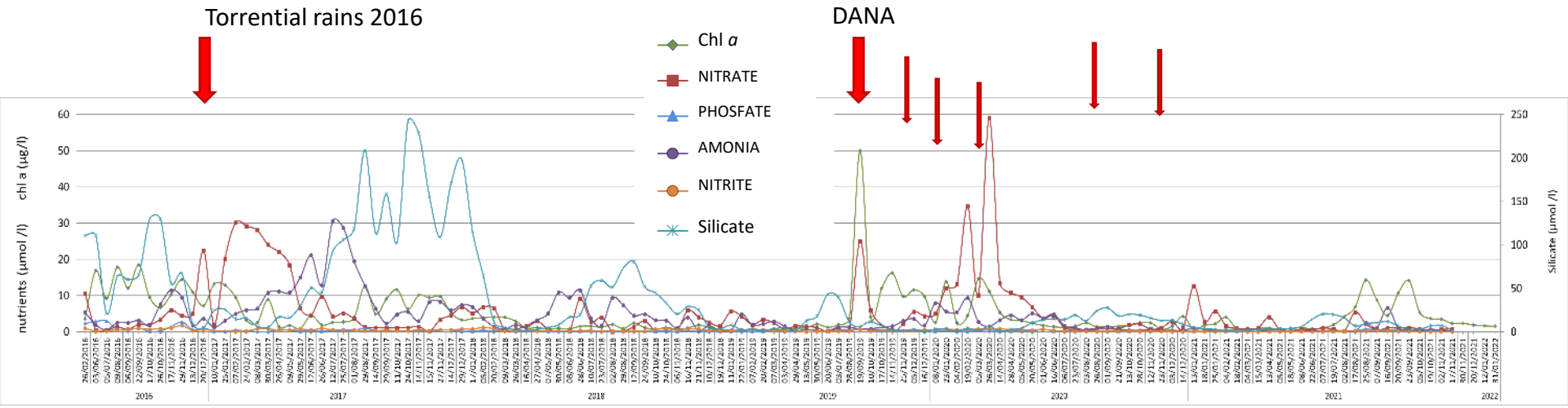
Murcia.com » Región de Murcia 19/12/2018

"El uso del Mar Menor como arma electoral"

Fuente: Pacto por el Mar Menor

Grupo de coordinación plataforma ciudadana Pacto por el Mar Menor



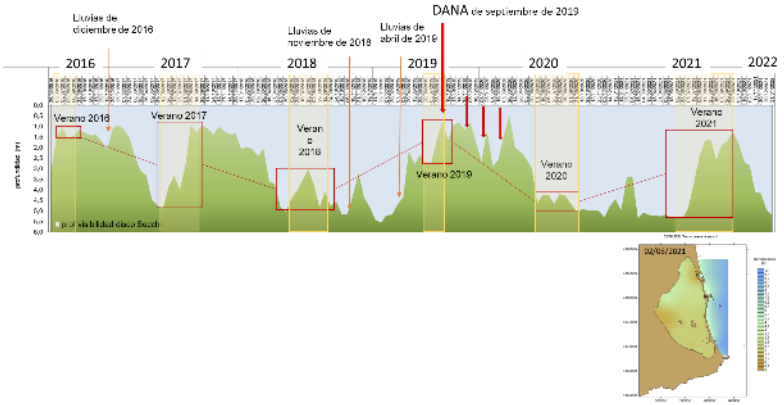
Eutrophication break

Recovery after reduction in water/nutrient inputs

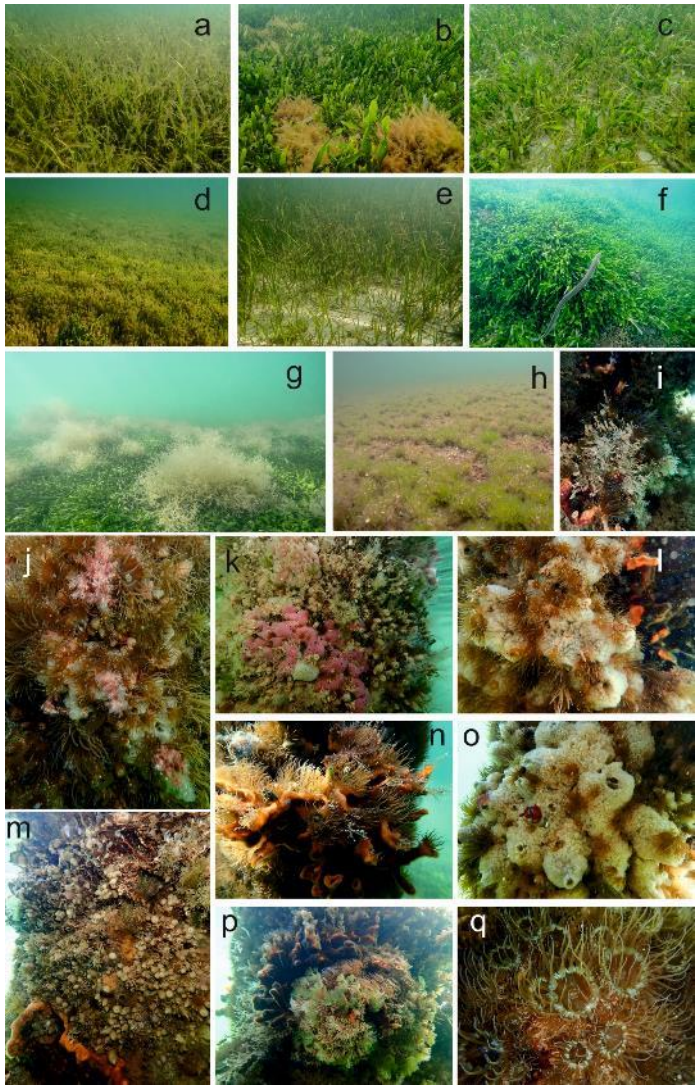
Regression after dana and new water inputs

present status

The recovery of the ecological integrity and of the homeostatic and self-regulatory mechanisms were observed, not only in the low values of nutrients and chlorophyll, but also in the damping of the amplitude of the fluctuations and the rapidity of response to sudden nutrient inputs.

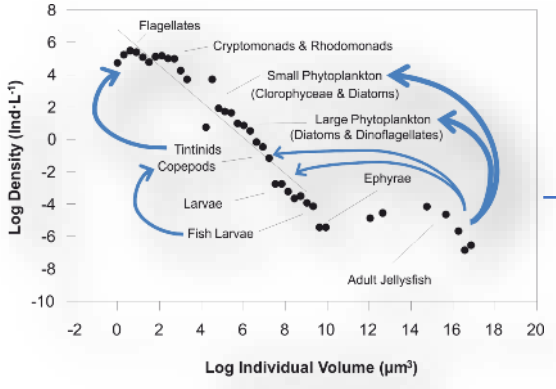


1980s vs 2018

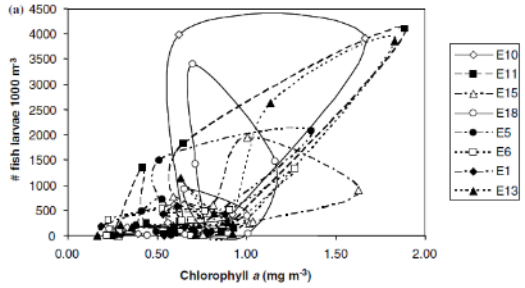


The Mar Menor has complex regulatory mechanisms

Several processes and factors, including predation, that can be a very efficient control mechanism that provides alternative routes of energy flow in the trophic network by eliminating excess biomass generated by excess nutrients, and different time scales and spatial response through the trophic network, would be an important component of the filter, sensu Cloern (2001), which modulates the response to eutrophication in coastal lagoons.



Trophic relationships in the biomass spectra in the Mar Menor



Complex trophic web and limit cicles

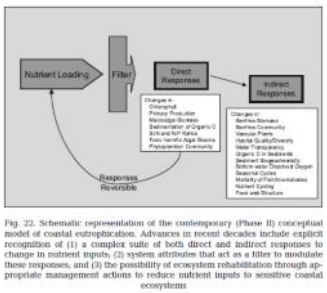
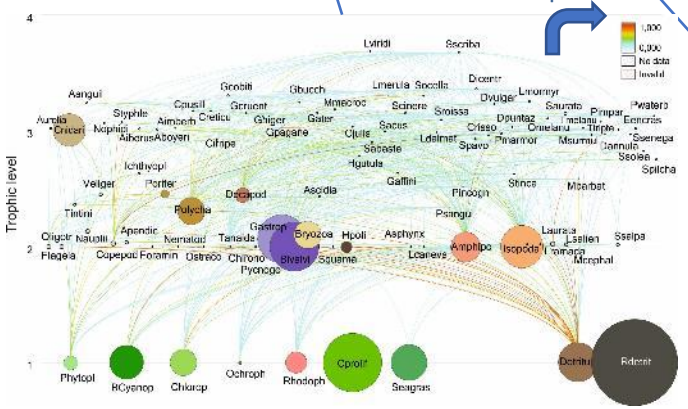
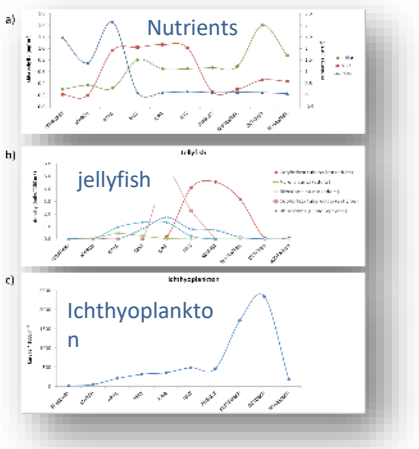


Fig. 22. Schematic representation of the contemporary (Phase II) conceptual model of coastal eutrophication. Advances in recent decades include explicit recognition of (1) a complex suite of both direct and indirect responses to change in nutrient inputs, (2) system attributes that act as a filter to modulate these responses, and (3) the possibility of ecosystem rehabilitation through appropriate management actions to reduce nutrient inputs to sensitive coastal ecosystems

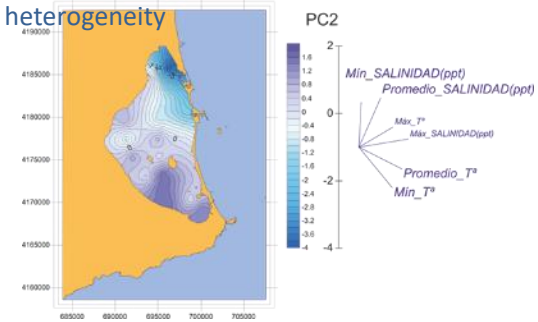
Biomass exportation



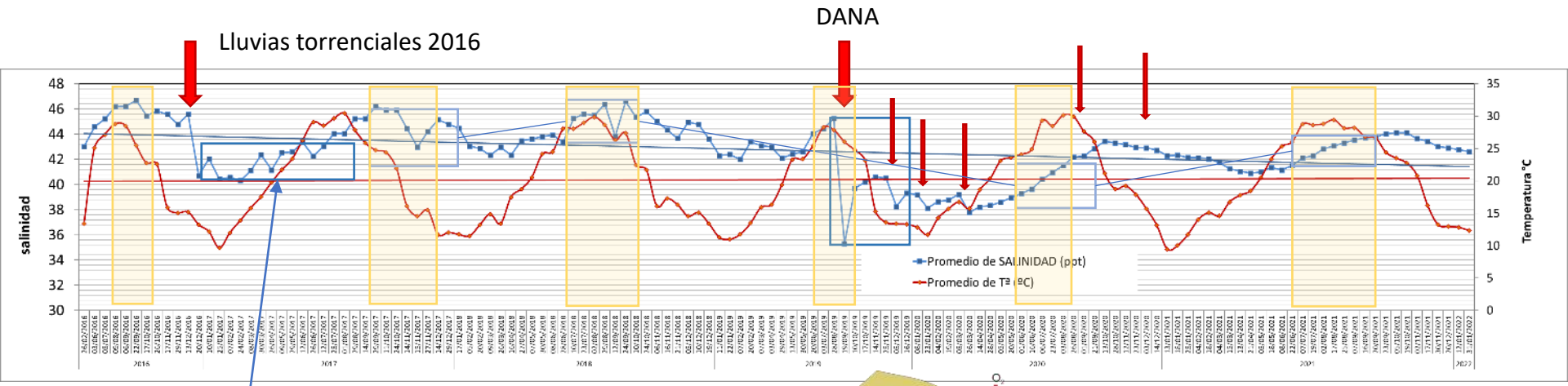
Annual cycles



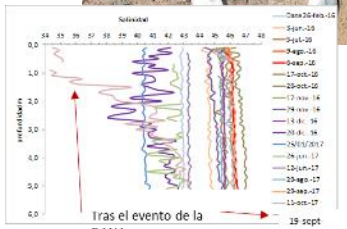
Spatial hydrological and biological heterogeneity

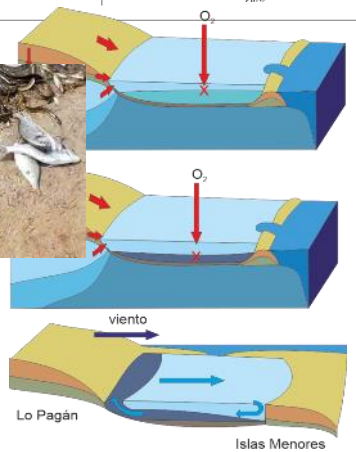


However, **the pressures are still present** and excessive freshwater inflows from the water table are maintained and due to torrential rains, which are increasing their frequency, so that despite its regulatory capacity, the ecosystem may break down again. Currently, the low salinity due to the entry of water from the basin is the main risk factor for the ecological status of the Mar Menor, added to the high entry of nutrients.



2016: Torrential rains in December and January: **holothurians mass mortality**

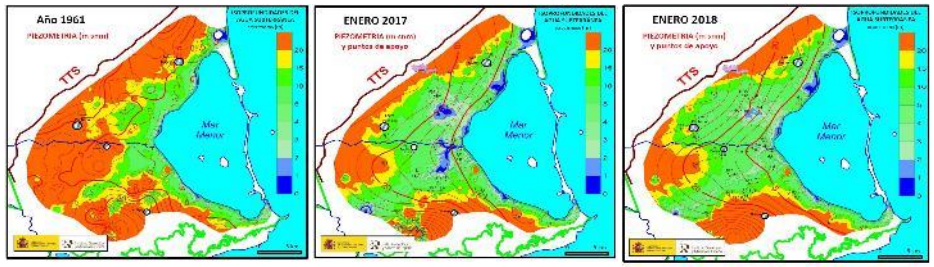




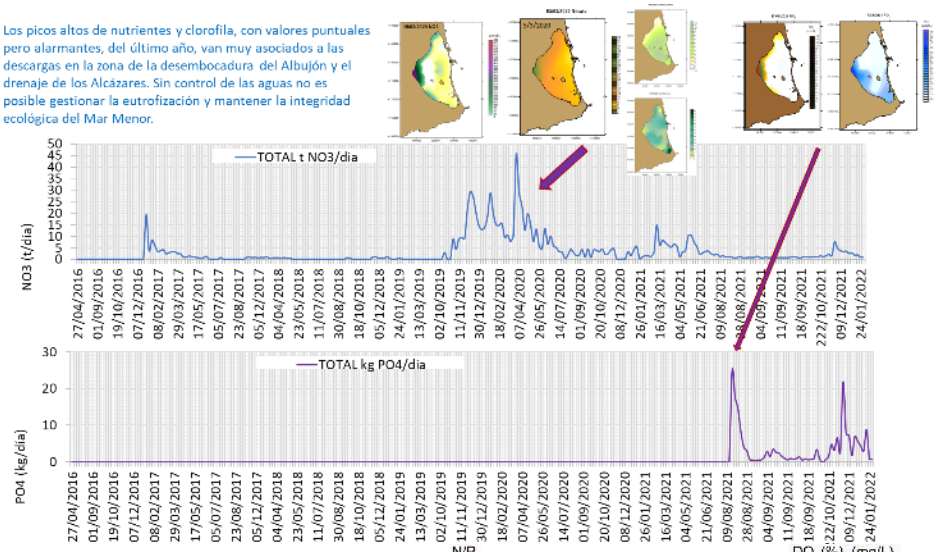
Unlike previous events, in 2017 the salinity drop was abnormally sustained over time, probably as a consequence of surface and subsurface entries in the shallow areas of the inner bank of the Mar Menor.

Low salinity can put at risk the populations of species such as Pinna that had found their refuge in the lagoon.

The water table is rising rapidly, reaching 16 m above sea level in some areas. **The high peaks of nutrients** and chlorophyll, with alarming values, in the last year, **are closely associated with the discharges in the area of the mouth of the Albujón and the drainage of the Alcázares**. Without water control it is not possible to manage eutrophication and maintain the ecological integrity of the Mar Menor.



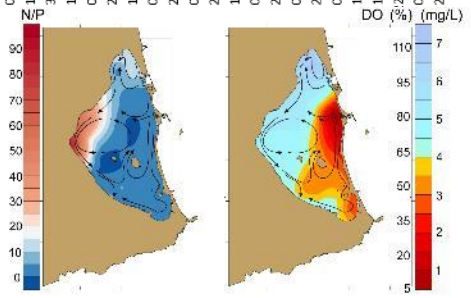
Los picos altos de nutrientes y clorofila, con valores puntuales pero alarmantes, del último año, van muy asociados a las descargas en la zona de la desembocadura del Albujón y el drenaje de los Alcázares. Sin control de las aguas no es posible gestionar la eutrofización y mantener la integridad ecológica del Mar Menor.




Science of the Total Environment

Nutrient overload promotes the transition from top-down to bottom-up control and triggers dystrophic crises in a Mediterranean coastal lagoon

Alfredo Fernández-Alías *, Teresa Montaño-Barroso, Manuel-Rosendo Conde-Caño, Sara Manchado-Pérez, Cristina López-Galindo, Jhoni-Ismael Quispe-Becerra, Concepción Marcos, Angel Pérez-Ruzafa



Measures to adopt

There is a need of **management rules of activities**, but these, **being necessary will not be sufficient** and there is an urgent need for a water management plan and regulation not only of discharges, but also of the groundwater levels. Maintaining vigilance over spills is essential, but, above all, anticipating and avoiding them.

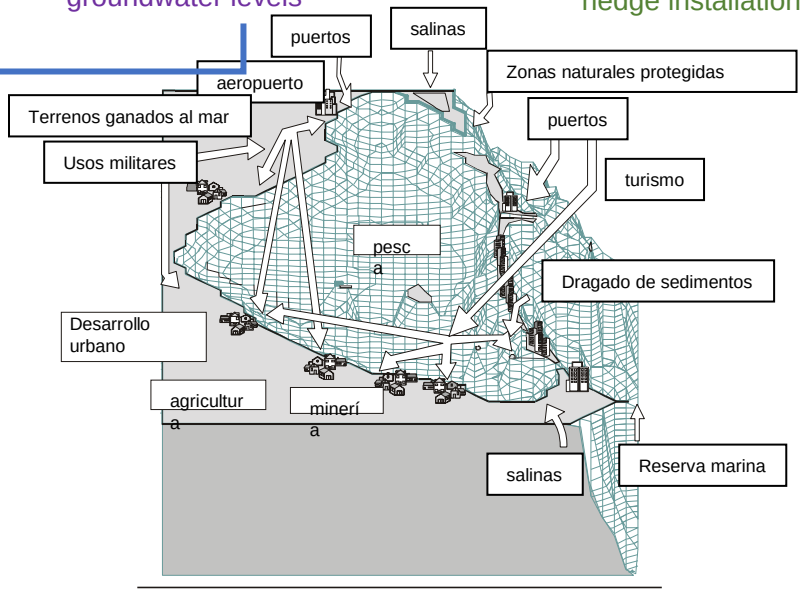
Inventory and characterization of water types, needs and resources..

Collection and channeling infrastructures

Treatment systems depending on the characteristics (brines, nutrients, contaminants) (purification, desalination, ...)

Infrastructures for reuse or evacuation depending on the characteristics of the treated water

Management of groundwater and groundwater levels



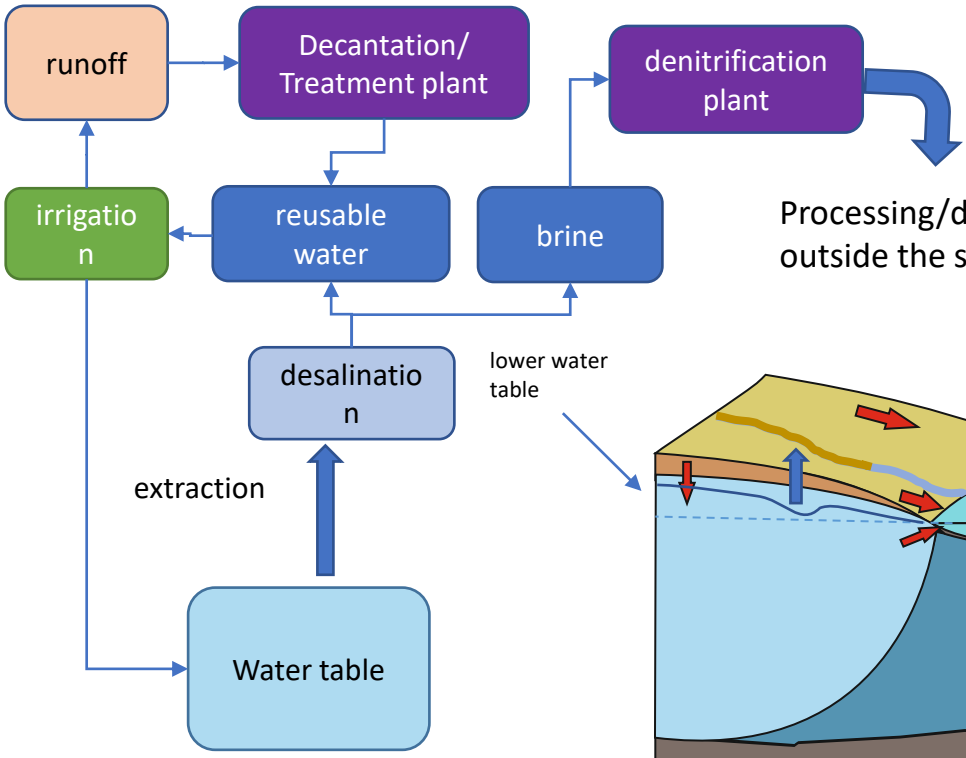
Management of Activities, land planning and zonation, uses regulations, fertilization rules, hedge installation…

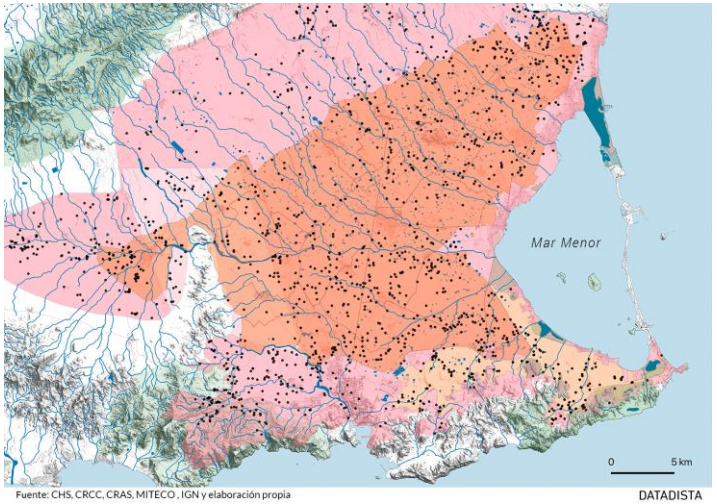
green filters,

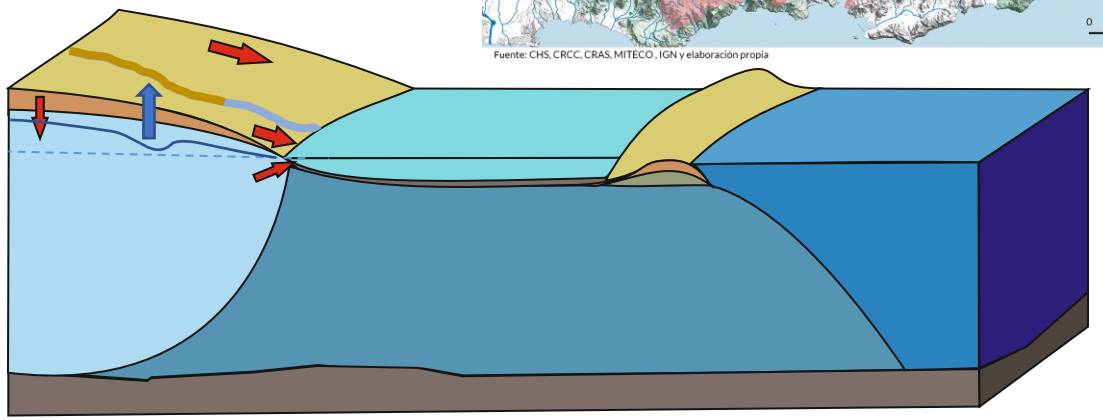
Recovery of natural areas

Seasonal/daily Management tasks, …

Addressing the problem requires multidisciplinary approaches, but if a primary sector such as **agriculture** is to be made compatible with the necessary regulations, with a traditional **fishing activity** and quality **tourism based on nature** and with the ecological integrity of the ecosystem, in a context of **blue growth** and a **green deal**, water management infrastructures are essential, which to a large extent already exist in the agricultural sector, which allow water to be extracted from the groundwater, channeling it, extracting and denitrifying the brines and reusing it without surpluses of any kind reaching the lagoon.







¡Gracias!

Angel Pérez-Ruzafa
angelpr@um.es

UNIVERSIDAD DE MURCIA

01 TÍTULO DEL APARTADO EN MAYÚSCULAS, LETRA CALIBRI 32 NEGRITA

Título de la diapositiva, letra Calibri 20

Cuerpo de texto, letra Calibri 18.
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