ECOTRANSEAS PROJECT

Estrategias para minimizar la transferencia de contaminación portuaria producida a través de las aguas de lastre

Convocatoria 2021 - «Proyectos de Transición Ecológica y Transición Digital»

MINISTERIO DE CIENCIA E INNOVACIÓN

Financiado por la Unión Europea NextGenerationEU

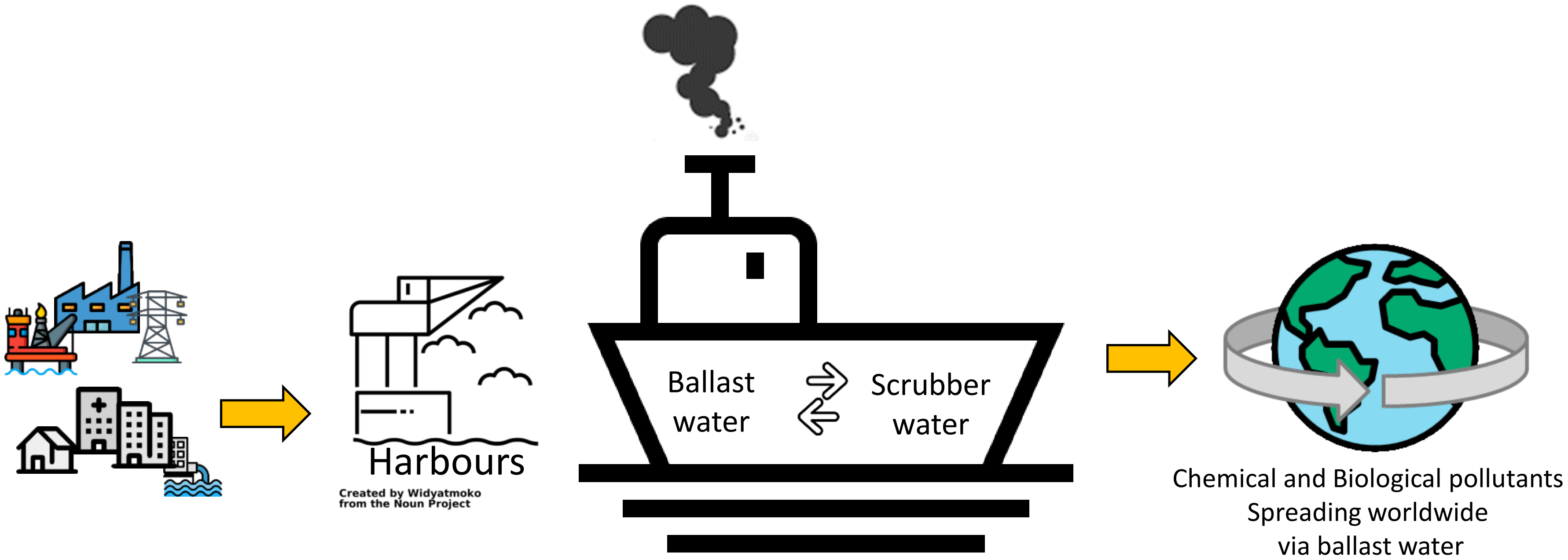
Plan de Recuperación, Transformación y Resiliencia

AGENCIA ESTATAL DE INVESTIGACIÓN

Proyecto coordinado entre tres universidades:

- Universidad del País Vasco: **Diagnosis de tres puertos españoles (Algeciras, Valencia y Bilbao)**
- Universidad de Cádiz: **Prevención de la contaminación microbiológica**
- Universidad Politécnica de Valencia: **Eliminación de contaminantes químicos**

ECOTRANSEAS PROJECT



Harbors are over-exploited ecosystems highly influenced by anthropogenic perturbations. They are **recipient bodies from different effluents** (industrial or urban wastes) since they are commonly located close to urbanized and industrialized areas. In parallel, maritime transport makes use of specific water currents, such as ballast water, that involve their release and spread worldwide.

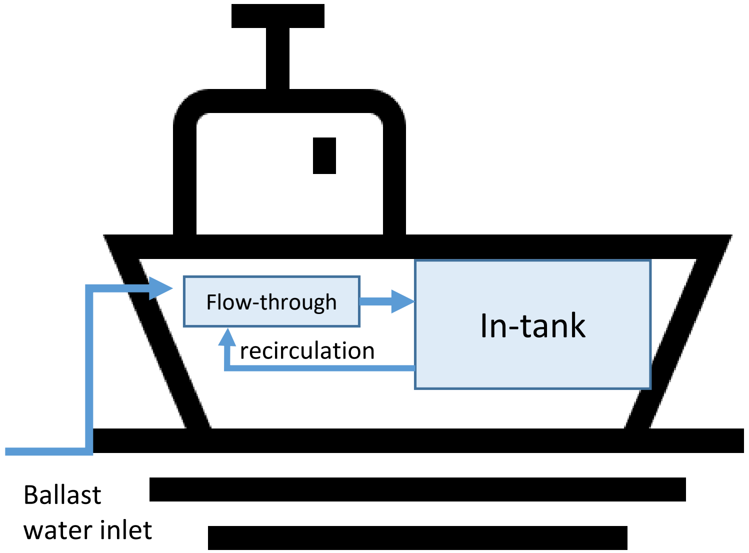
Being necessary a **multidisciplinary study**, including biological, chemical and ecotoxicological disciplines, for a better understanding of the **environmental concern of the port waters pollution**.

ECOTRANSEAS PROJECT

General Objetives

ECOTRANSEAS **pretends to know the environmental state of three Spanish Ports**, using the DPSIR (Driving Forces, Pressures, State, Impact, Response) framework strategy and, in function of the obtained results, to **propose different treatment strategies as responses to prevent and minimize both biological and chemical pollution in harbors and its spreading via maritime transport.**

Therefore, ECOTRANSEAS project will contribute to reach a more sustainable maritime transport in the framework of the Ecological Transition



ECOTRANSEAS PROJECT

General Objetives

With the aim of avoiding the transfer of aquatic pollutants *via* maritime traffic, we propose to study different treatment technologies and strategies that could be able to decontaminate these transferring waters:

i) Flow-through strategy: Ballasting and de-ballasting procedures implies high flow-rates and the need of implementing **flow-through ballast water systems**, which can sometimes lead to insufficient disinfection and not be able to degrade recalcitrant pollutants. However, to enhance the effectiveness, ballast water treatment systems can be improved by incorporating **intensive processes**, such as those based on newly UV sources (UV-C LEDs, vacuum UV) or ozone and combining them with green reagents such H_2O_2.

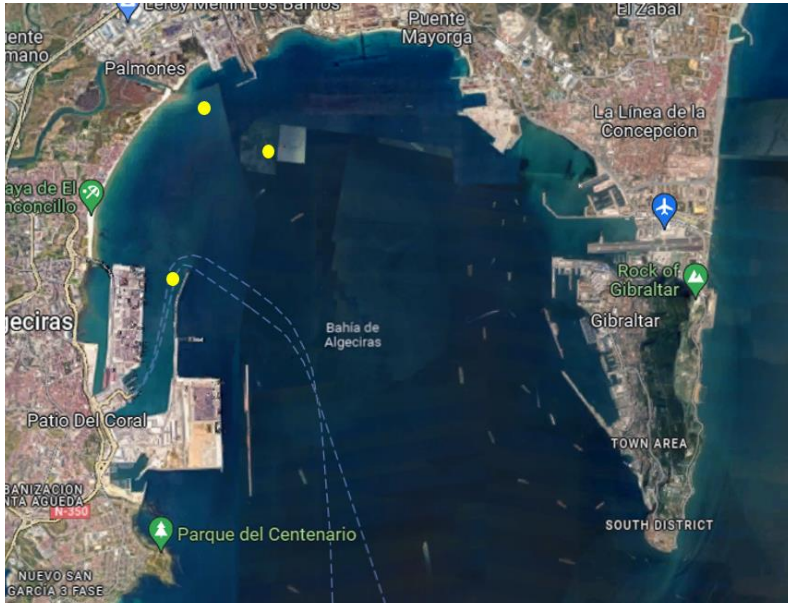
ii) In-tank strategy: We hypothesize that it is possible to apply some **treatments in the ballast tank** itself, counting with all the travel time for its greater effectiveness. For example, mild-**Fenton treatments** are slow, but can be effective over hours or days.

iii) Recirculation strategy: Another strategy to be evaluated is the combination of scenarios i) and ii), **recirculating the ballast water from the tank to the flow-through equipment** during the voyage and so get more efficient removal of biological and chemical pollutants.

Sampling in three Spanish ports

Puerto de Bilbao

Puerto de Valencia



Puerto de Algeciras

Chemical pollutants

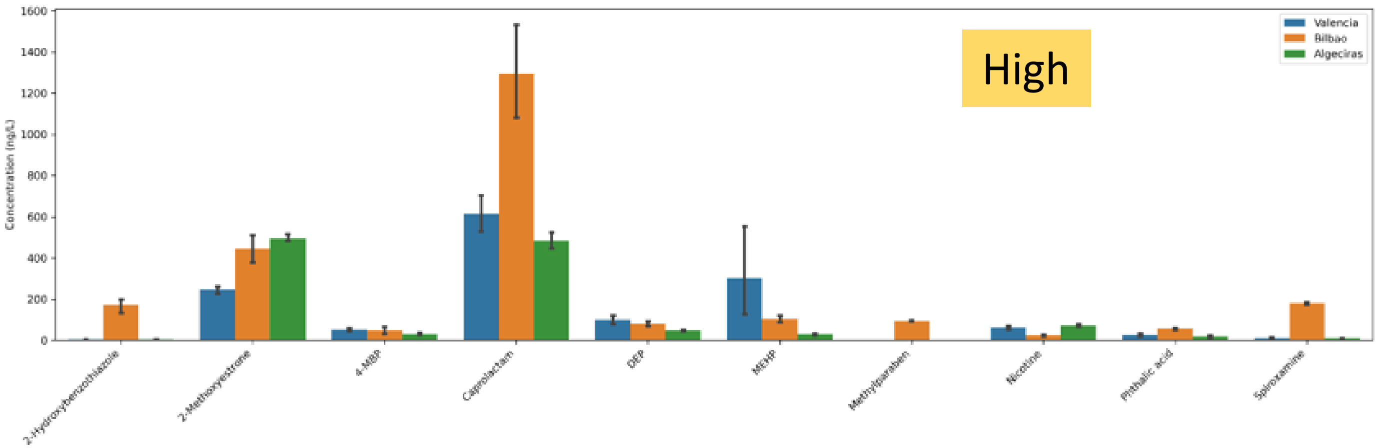
The compounds detected are diverse, ranging from pharmaceuticals, personal care products, pesticides, plasticizers, and other industrial chemicals.

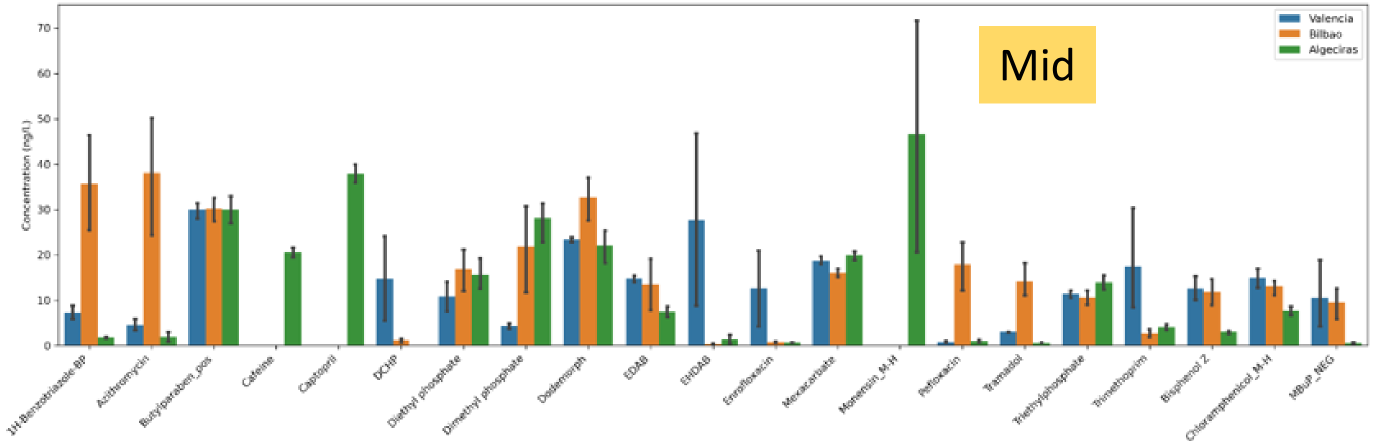
Caprolactam, 2-Methoxyestrone, as well as two plasticizers (MEHP and DEP) appears to be dominant contaminants in all three ports.

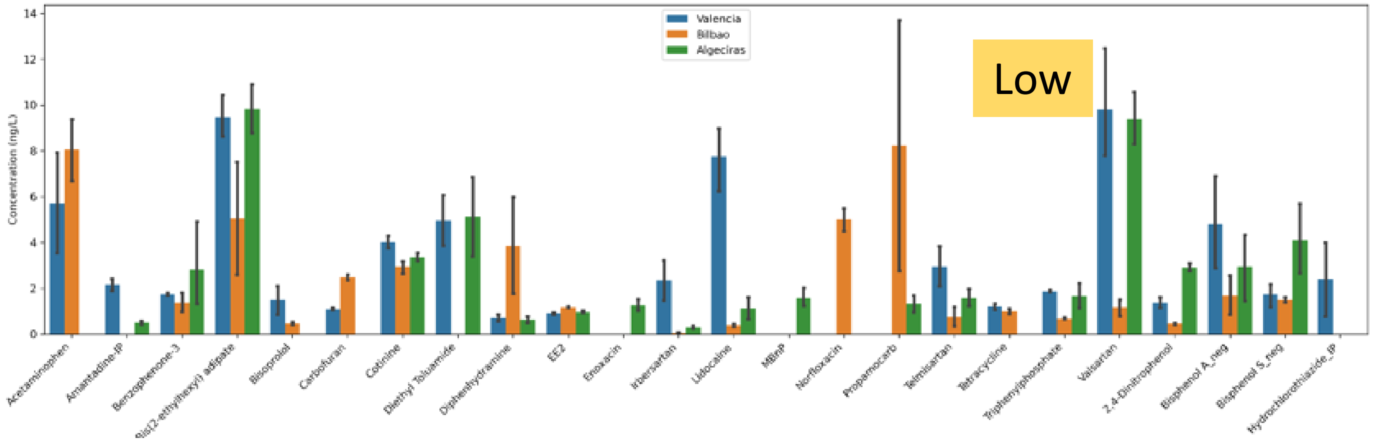
The **high concentration group** seems to contain more **compounds associated with plastics**,

The **mid concentration group** contains a **mix of pharmaceuticals, pesticides, and industrial chemicals**,

The **low concentration group** is associated with pharmaceuticals and **personal care products**







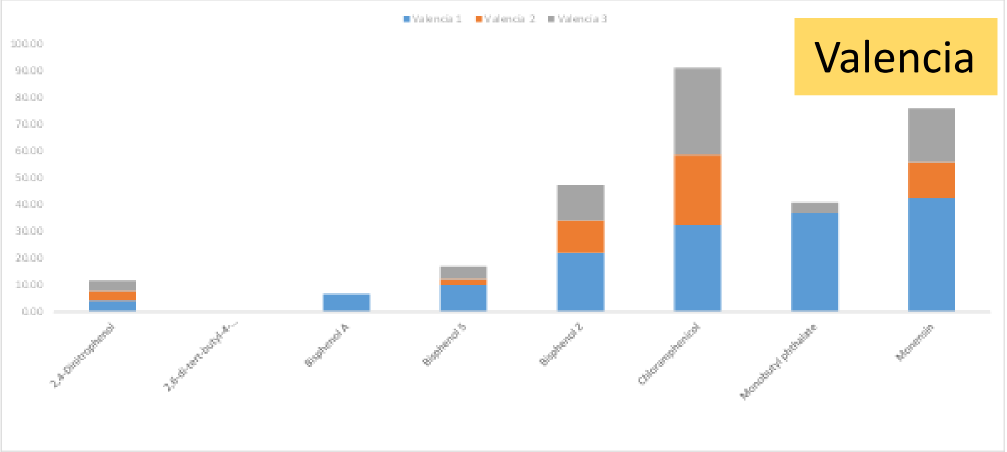
Chemical pollutants

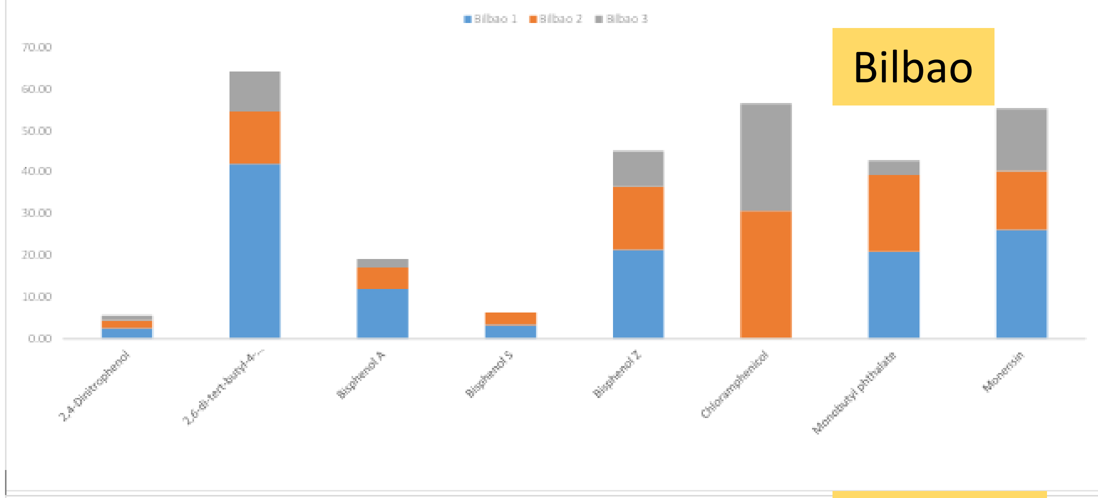
Bilbao and Valencia ports generally shows higher concentrations for most of the compounds compared to Algeciras, with the exception of 2-Methoxyestrone and Nicotine.

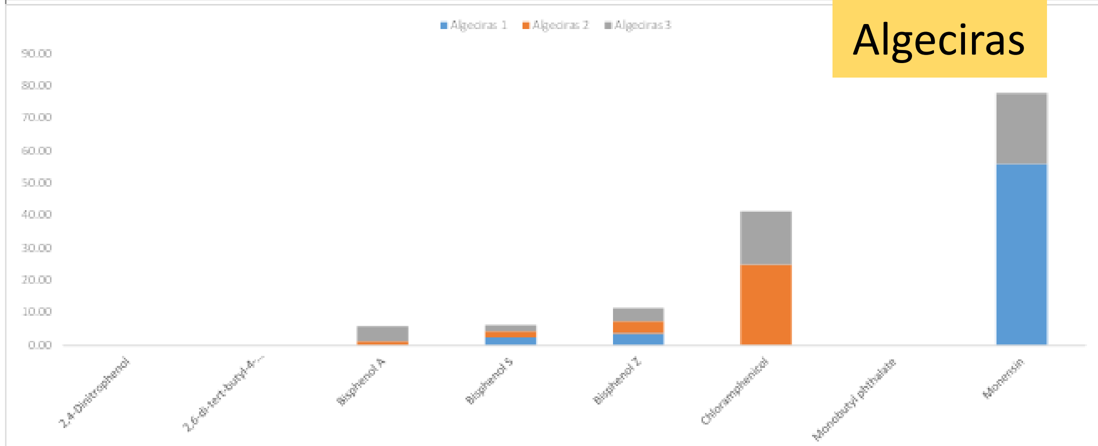
For instance, Caprolactam has the highest concentration in Bilbao (1294 ng/L), which is more than double its concentration in Valencia (615 ng/L), and almost triple its concentration in Algeciras (483 ng/L).

Similarly, Bisphenol Z has relatively consistent concentrations in Bilbao and Valencia (12 ng/L and 13 ng/L, respectively), but a lower concentration in Algeciras (3.00 ng/L).

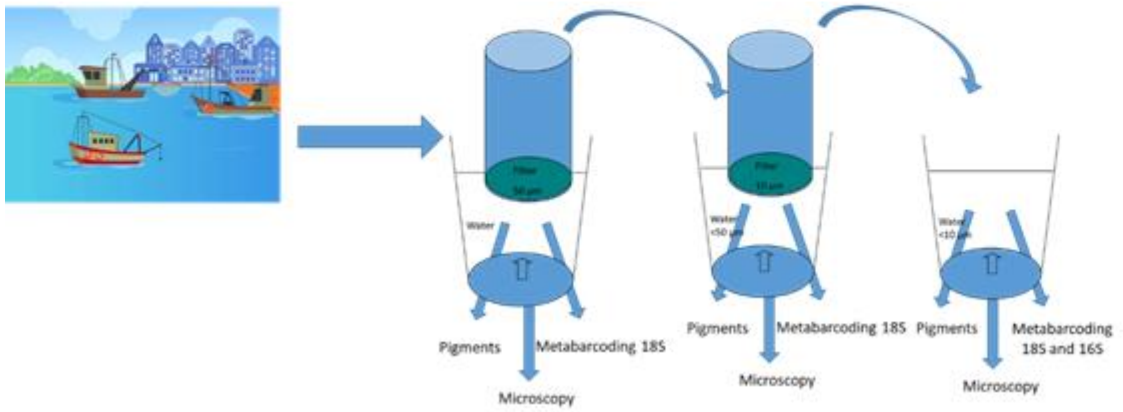
Some compounds like Amantadine and Hydrochlorothiazide are only found in Bilbao and Valencia.

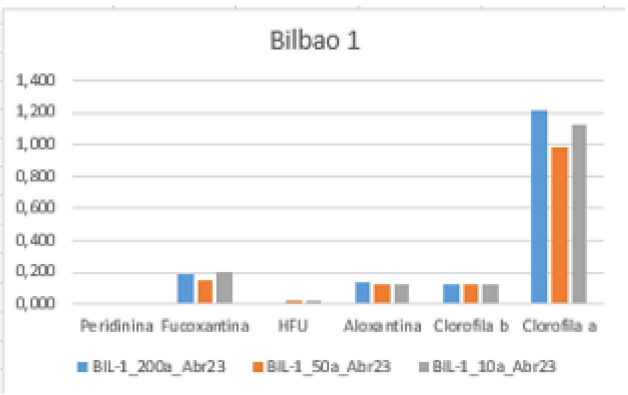


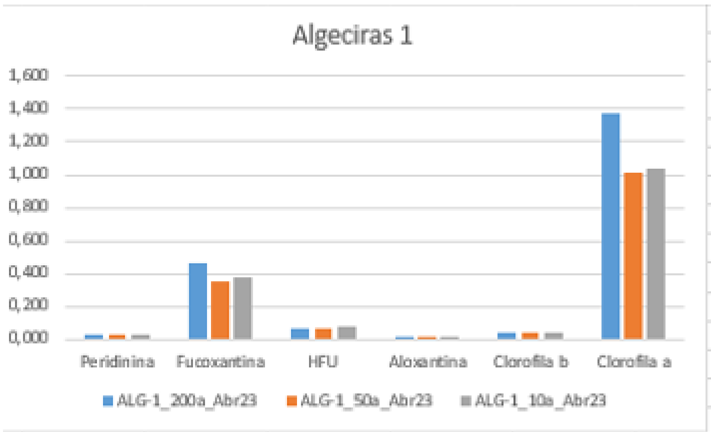


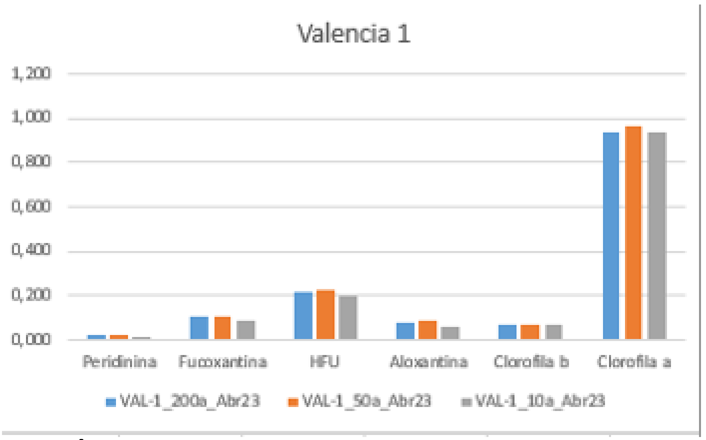


Biological pollutants: pigments









- ❑ Different pigments were analyzed in the fractions less than 200, 50 and 10 microns.
- ❑ Most of the pigments are due to the finer fraction
- ❑ Depending on the Port and also the sampling station, differences are observed regarding the distribution of phytoplanktonic organisms.
- ❑ Species identification will be performed by molecular techniques

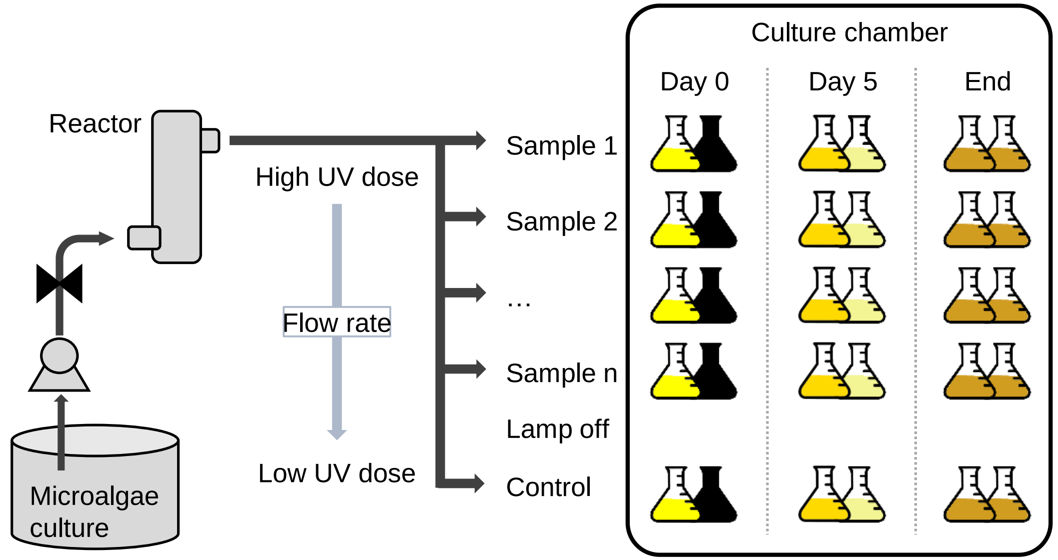
Intensive treatment processes

Continuous 40 LEDs reactor: 275 nm

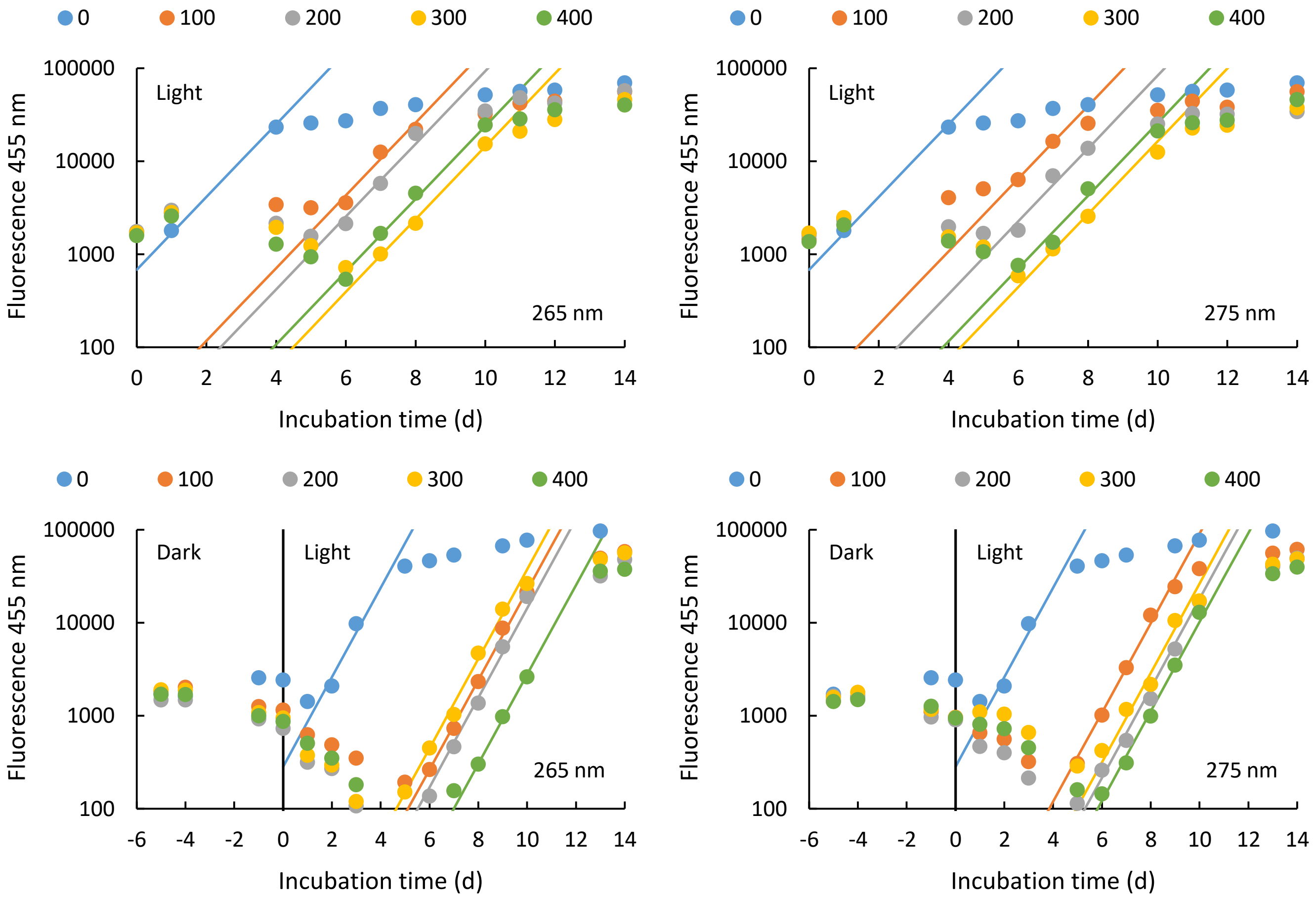
Disontinuous LED reactor: 265 y 275 nm

Intensive treatment processes

Monocultivo de *Tetraselmis suecica*



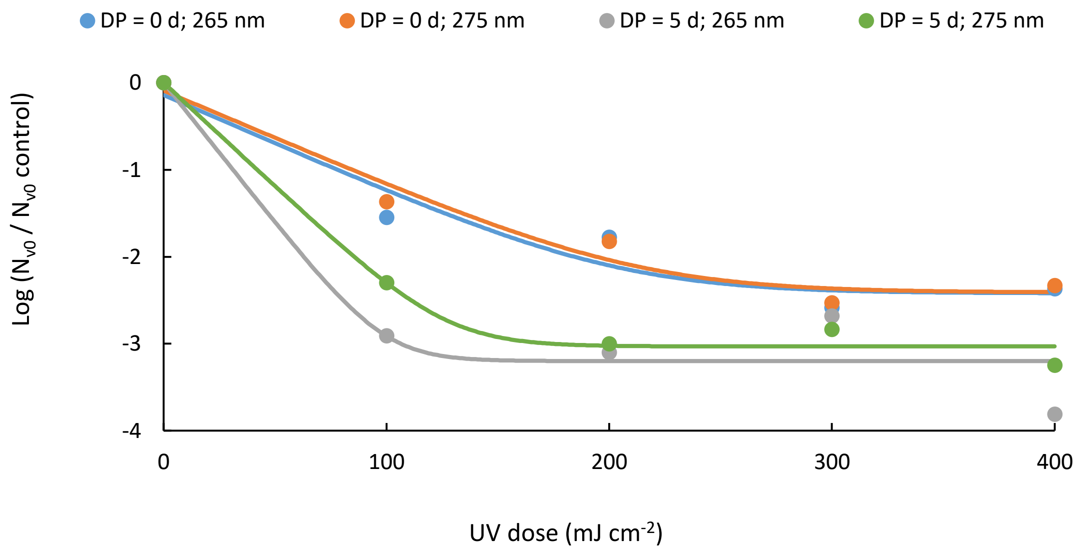
Curvas de crecimiento para dosis de 0, 100, 200 300 y 400 mJ cm^{-2}.
Reactores *batch* de 265 y 275 nm (LED).
Postratamiento en oscuridad de 0 y 5 días.



Intensive treatment processes

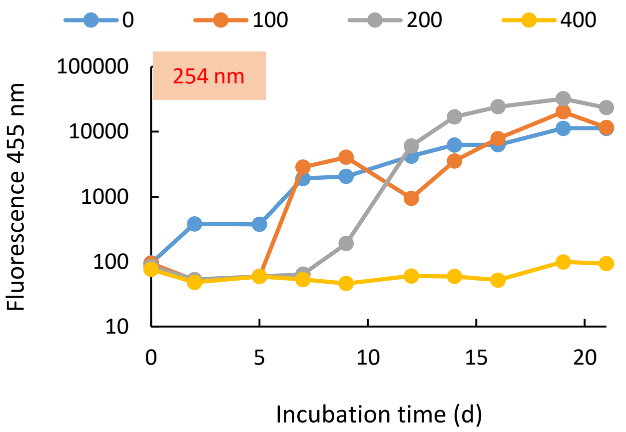
Monocultivo de *Tetraselmis suecica*

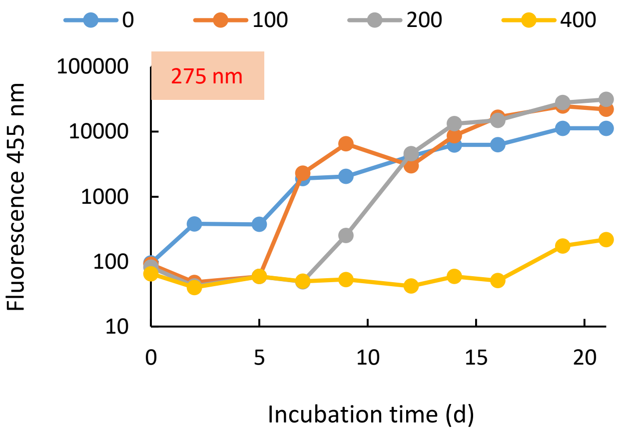
Curvas de inactivación.
Reactores *batch* de 265 y 275 nm.
Postratamiento en oscuridad (DP) de 0 y 5 días.
Modelo Log-linear + cola



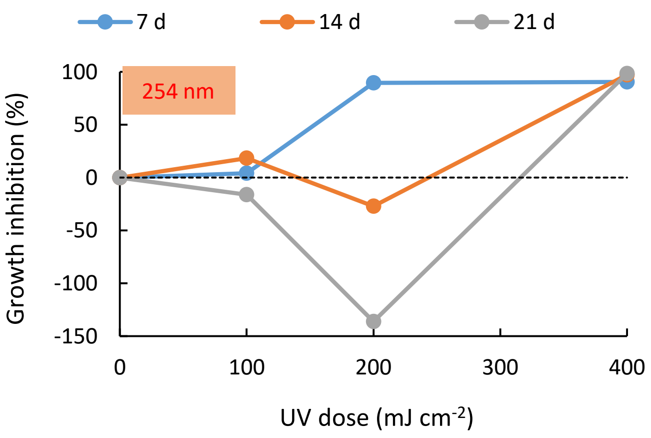
Aguas naturales (Puerto de Algeciras 25/04/2023)

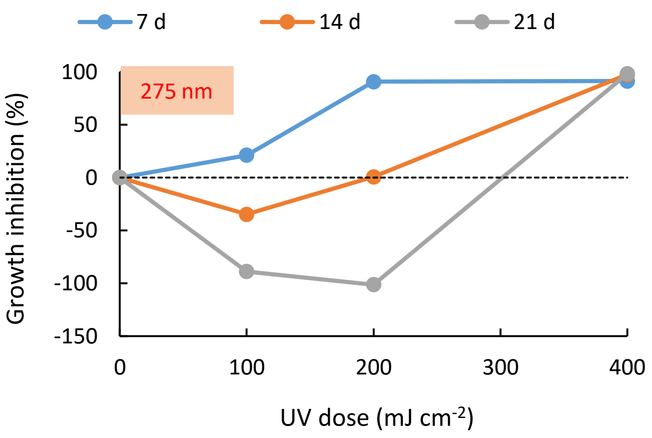
Curvas de crecimiento para dosis de 0, 100, 200 y 400 mJ cm^{-2} con reactor batch a 254 nm (LP-Hg) y 275 nm (LED).





Curvas de inhibición del crecimiento para 7, 14 y 21 días de incubación.



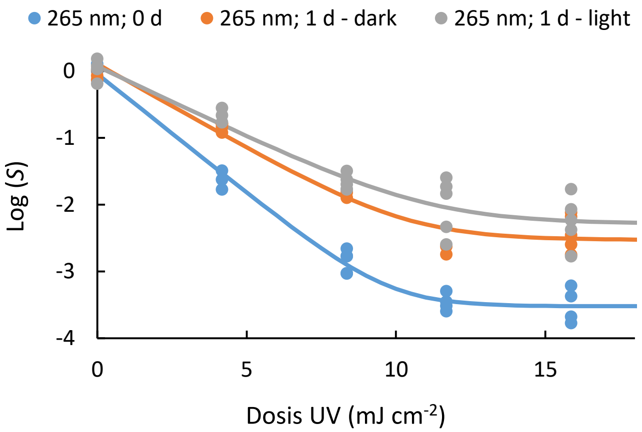


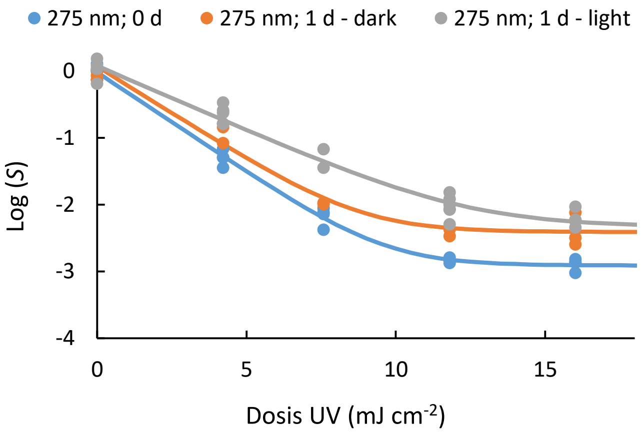
Porcentajes negativos indican un favorecimiento del crecimiento de las microalgas debido al tratamiento UV.

Una dosis UV de 400 mJ cm^{-2} garantiza una inhibición del crecimiento cercana al 100% hasta al menos 21 días después del tratamiento.

Vibrio alginolyticus

Curvas de inactivación.
Reactores batch a 265 y 275 nm (LED).
Inactivación determinada tras la irradiación y un día después en condiciones de luz y de oscuridad.





Parámetros cinéticos. k = constante de inactivación. S_{res}: supervivencia asintótica. D1: dosis UV necesaria para inactivar el 90% de los organismos. D2: dosis UV necesaria para inactivar el 99% de los organismos.

Long. de onda (nm)	Post-tratamiento	k (cm^2 mJ^{-1})	Log (S_{res})	R^2	D_1 (mJ cm^{-2})	D_2 (mJ cm^{-2})
265	0 d	0.820 ± 0.037	-3.52 ± 0.07	0.986	2.7	5.5
265	1 d - osc	0.583 ± 0.060	-2.53 ± 0.11	0.960	4.4	8.9
265	1 d - luz	0.489 ± 0.057	-2.28 ± 0.14	0.910	5.1	11.2
275	0 d	0.690 ± 0.023	-2.91 ± 0.04	0.993	3.3	6.8
275	1 d - osc	0.646 ± 0.059	-2.41 ± 0.08	0.975	3.9	8.1
275	1 d - luz	0.448 ± 0.031	-2.33 ± 0.11	0.972	5.6	12.1