

# SIMBAD

A SCIENTIFIC EXPLOITATION PLATFORM FOR SENTINEL IMAGERY

THE CASE OF MAPPING *POSIDONIA OCEANICA* MEADOWS IN THE MEDITERRANEAN SEA

# Quasar Science Resources

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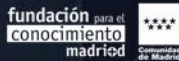
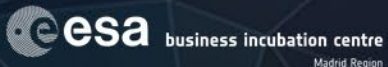
**2016**

**25 employees, a combination of Data Scientists, Software and System Engineers**

**Aerospace Sector**

**Earth Observation, Remote Sensing**

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Sentinel-2

Posidonia

Formentera

Posidonia

# SIMBAD

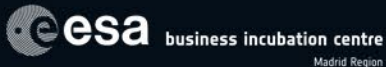
A Scientific Platform  
to Protect Earth's Ecosystems  
from Space

ENHANCE YOUR RESEARCH

**Incubation period: Oct18 – Jan21**

**Map Posidonia Oceanica Meadows in the Mediterranean Sea**

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# QUASAR

SCIENCE RESOURCES, S.L.

# SIMBAD

A SCIENTIFIC EXPLOITATION PLATFORM TO PROTECT EARTH'S ECOSYSTEMS FROM SPACE



**SIMBAD** (*SENTINEL IMAGERY MULTIBAND ANALYSIS AND DISSEMINATION*) IS A MODULE OF OUR SENTINEL DATA SEP AND PROVIDES CUSTOMIZED SENTINEL IMAGE SERVICES. SIMBAD WAS INCUBATED BY THE ESA BIC COMUNIDAD DE MADRID REGION IN 2018 AND WAS SPECIFICALLY DESIGNED TO MAP THE MEADOWS OF POSIDONIA OCEANICA IN THE MEDITERRANEAN SEA. SINCE THEN, A NUMBER OF DIFFERENT PRODUCTS HAVE BEEN, OR ARE IN THE PROCESS, OF BEING INCORPORATED INTO SIMBAD.



## QUASAR SEP

SCIENTIFIC EXPLOITATION  
PLATFORM

THE SCIENTIFIC EXPLOITATION PLATFORM (SEP) FOR SENTINEL DATA IS A QUASAR SCIENCE RESOURCES INITIATIVE FOR THE TRANSFORMATION OF RAW SENTINEL DATA INTO USEFUL FINAL SCIENTIFIC PRODUCTS TO BE USED IN DAY-TO-DAY APPLICATIONS

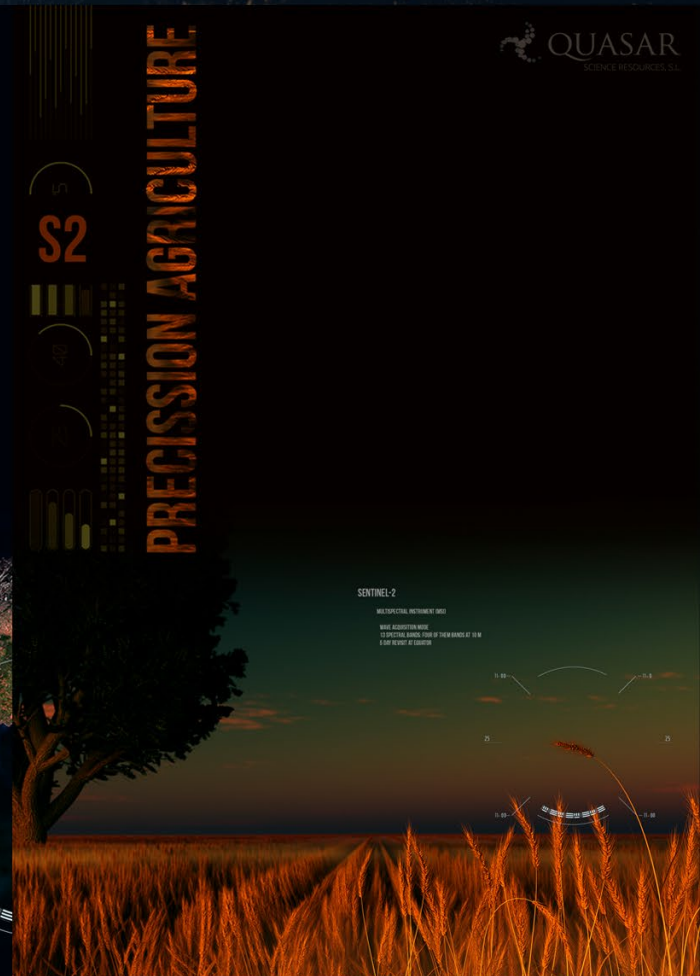
Boat Detection  
**SIMBAD**

Wildfire  
**SIMBAD**

Posidonia  
**SIMBAD**

Water Quality  
**SIMBAD**

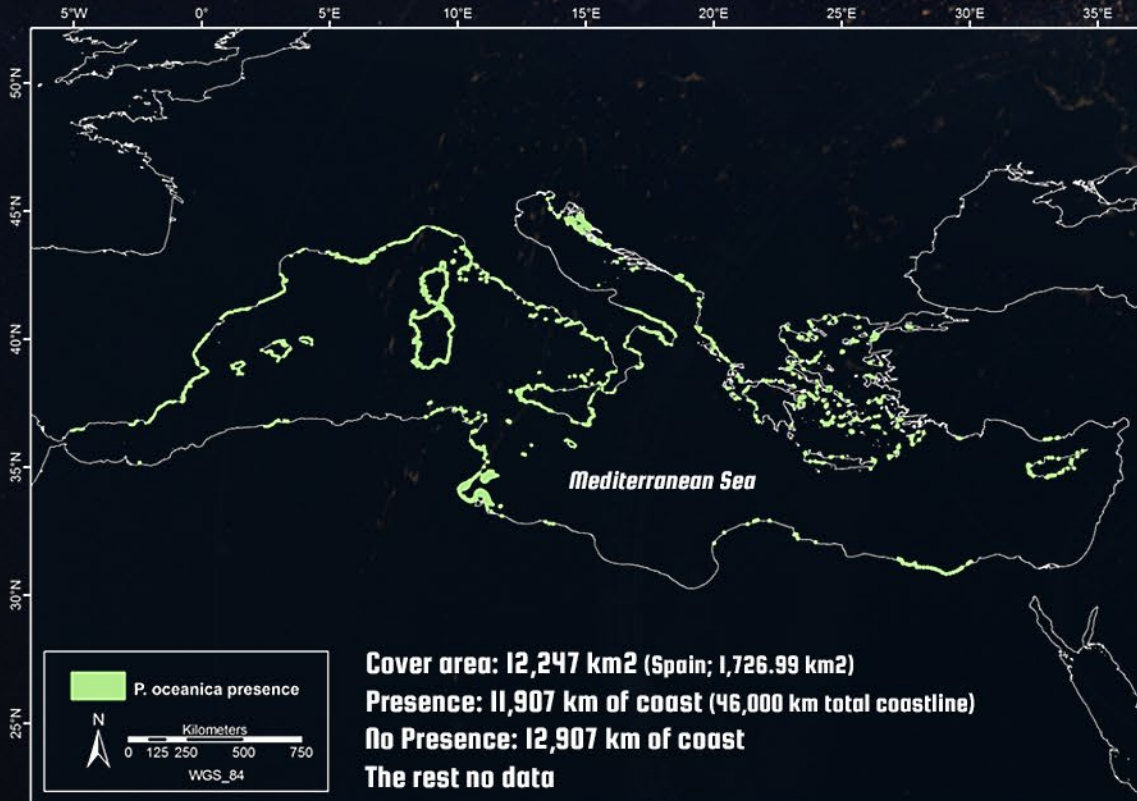
Agriculture  
**SIMBAD**



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SCIENCE RESOURCES S.L.

# What is *Posidonia oceanica* ?

## Current global knowledge about the presence of PO



Telesca et al. 2015

## Mediterranean Sea Endemic Seagrass Species

forms extensive meadows (20-45 m depth), habitat to 20% of know species  
(Boudouresque et al., 2012)

important source of carbon sequestration (blue carbon)

(González-García et al., 2022)

## Posidonia meadows are subjected to multiple threats

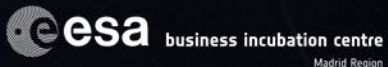
salinity and turbidity changes, sedimentation rate and anthropic pressure  
(Pergent et al., 2012)

extremely slow growth rate (10 - 100 cm every 100 years), hard to recover

(Boudouresque et al., 2012)



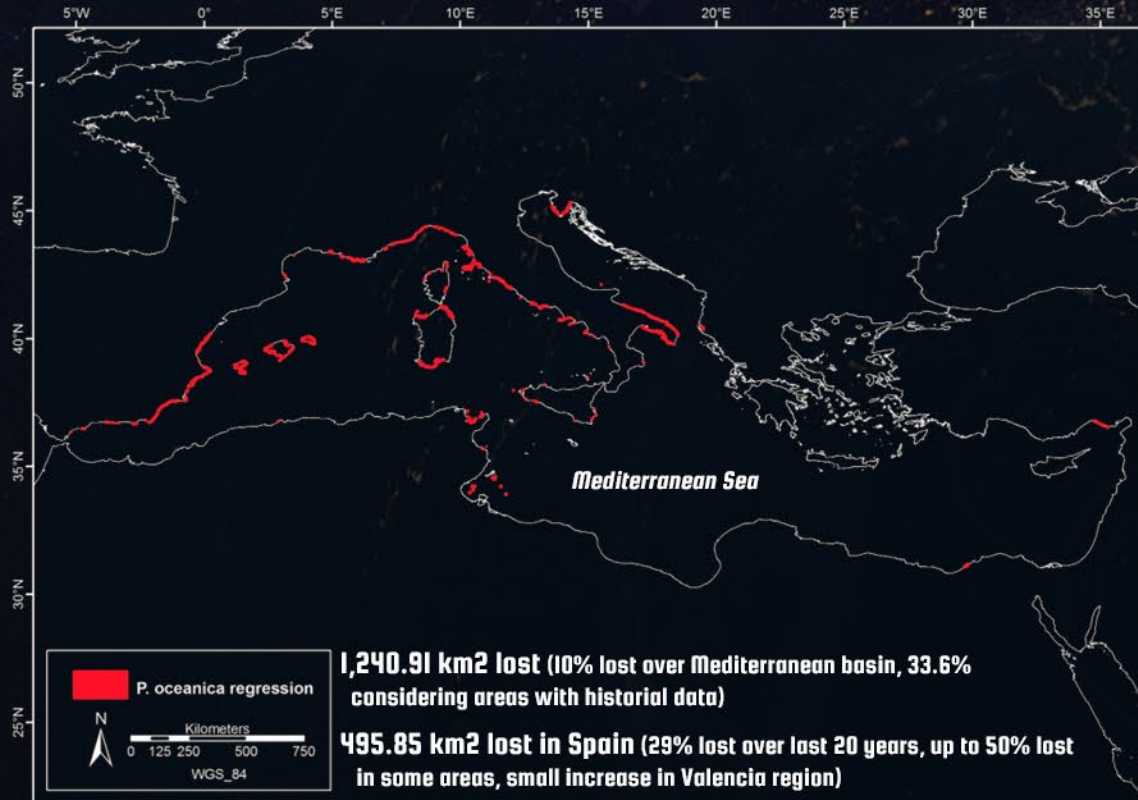
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# Protecting the PO Ecosystem

As early as 1980

## P. oceanica meadows loss across the Mediterranean Sea over the last 50 years



Telesca et al. 2015

## European Level

### Habitats Directive

The Directive 92/43/EEC of the European Council of 21 May 1992 aims at the conservation of natural habitats and wild fauna and flora ("Posidonia Meadows", priority habitat 1120)

### Water Framework Directive (2015/2021/2027)

The 2000/60/EC Directive of the European Parliament and of the Council of 23 October 2000 Includes, the protection of coastal waters. Posidonia meadows is one of the elements of biological quality recommended in the Mediterranean

### European Regulation Concerning Fishery

Regulation (EC) n° 1967/2006 of the European Council of 21 December 2006 (2012) Deals with the physical pressures likely to impact this sensitive and specific habitat (Art. 4)

### Marine Strategy Framework Directive

The Marine Strategy Framework Directive - 2008/56/EC (MSFD), adopted by the Parliament and the Council of the EU on 17 June 2008, provided a framework for the Member States on how to take all necessary measures to achieve or maintain a Good Environmental Status (GES) of European Seas by 2020 at latest (review by mid-2023)

It is under this directive that the pressures generated by anchorage and anchorage activities can be taken into account by the Member States

### Barcelona Convention

In 1995, the Barcelona Convention became the "Convention on the Protection of the Marine Environment and the Coastline of the Mediterranean"

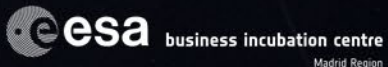
In 1999, the Contracting Parties adopted an «Action Plan for the Conservation of Marine Vegetation in the Mediterranean», which focuses on Posidonia (and other plant species)

2016 validation by Contracting Parties to the Barcelona Convention

## Freedom is given to member states in the steps and means to implement directives

Spain: Posidonia oceanica meadows (habitat type 1120) is protected according to Royal Decree 12/7/1995, BOE n° 310.

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# PO Mediterranean Roadmap



<https://medposidonianetwork.com/>

## Mediterranean Posidonia Network

Protection of *Posidonia oceanica* threatened by various pressures such as anchoring. The objective is to increase each country's capacity building to better protect *Posidonia oceanica* and prevent its future degradation.

**Concrete Solutions to protect 100% of PO meadows in the Mediterranean Sea by 2030**

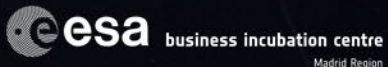
## How do we do this ?

**Detailed contemporaneous and geo-referenced distribution maps of *P. oceanica***

**Reliable and accurate time evolution information for regression studies**



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# PO Monitoring

Despite *P. oceanica* being one of the most protected important and well-studied Mediterranean species, there has been to date a limited effort to combine all the spatial information available and provide a synthesis of the current distribution and the total area of beds

## *In situ* campaign

Aerial photography & Submarine observation

High resolution commercial satellite data

Free satellite data

mostly sparse

locally

locally

a few scientific studies are available

Scattered quantitative data, limited spatial extent and/or low resolution

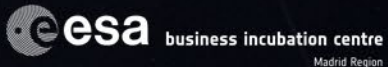
Most of these methods need human & economic resources

Difficult to maintain for routine observations

Complicated to obtain a global view of the population of *P. oceanica*



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# Sentinel-2

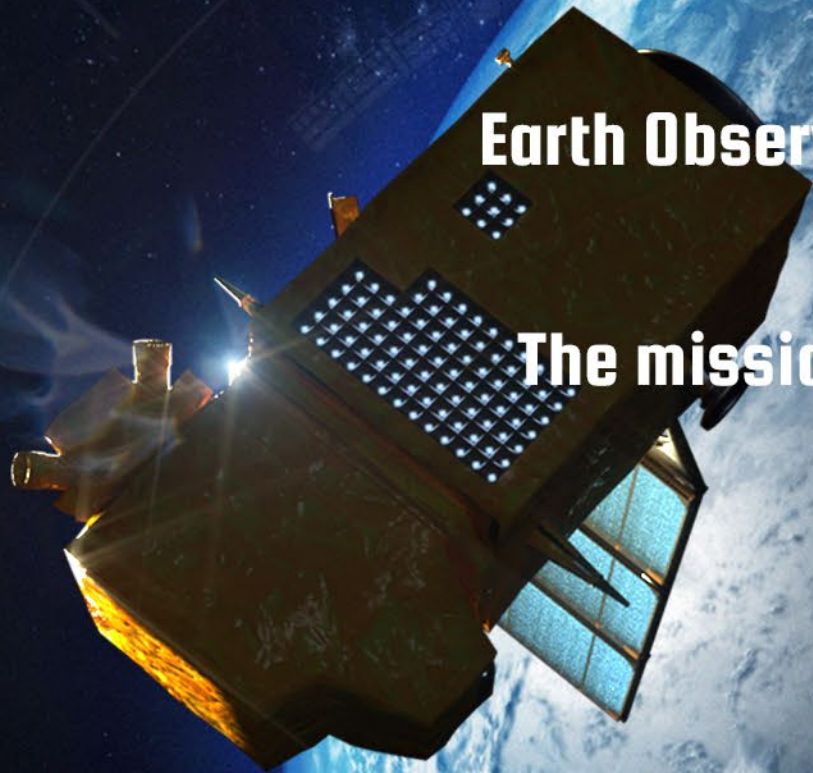
**Earth Observation mission from the Copernicus program**  
(European Commission and European Space Agency)

**The mission is a constellation with two twin satellites**  
(Sentinel-2A launched in 2015 and Sentinel-2B launched in 2017)

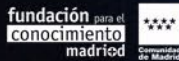
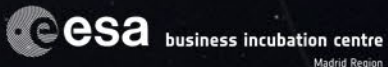
**Spatial resolution of 10 m, 20 m and 60 m**

**Covers the entire Mediterranean Sea**

**Revisit 5 days under cloud-free conditions**  
(2-3 days at mid-latitudes)



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# Sentinel-2

**Open access and free data**

**Highly cost effective**

**Cover huge areas in very little time**  
(revisit time of 2-3 days)

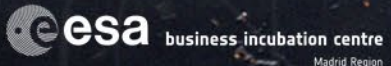
**Yearly and Seasonal maps**

**Historical evolution**

**Monitoring + Alert System**

**10 m resolution**

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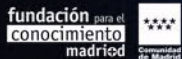
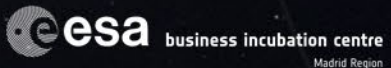
# Detecting Posidonia from Space



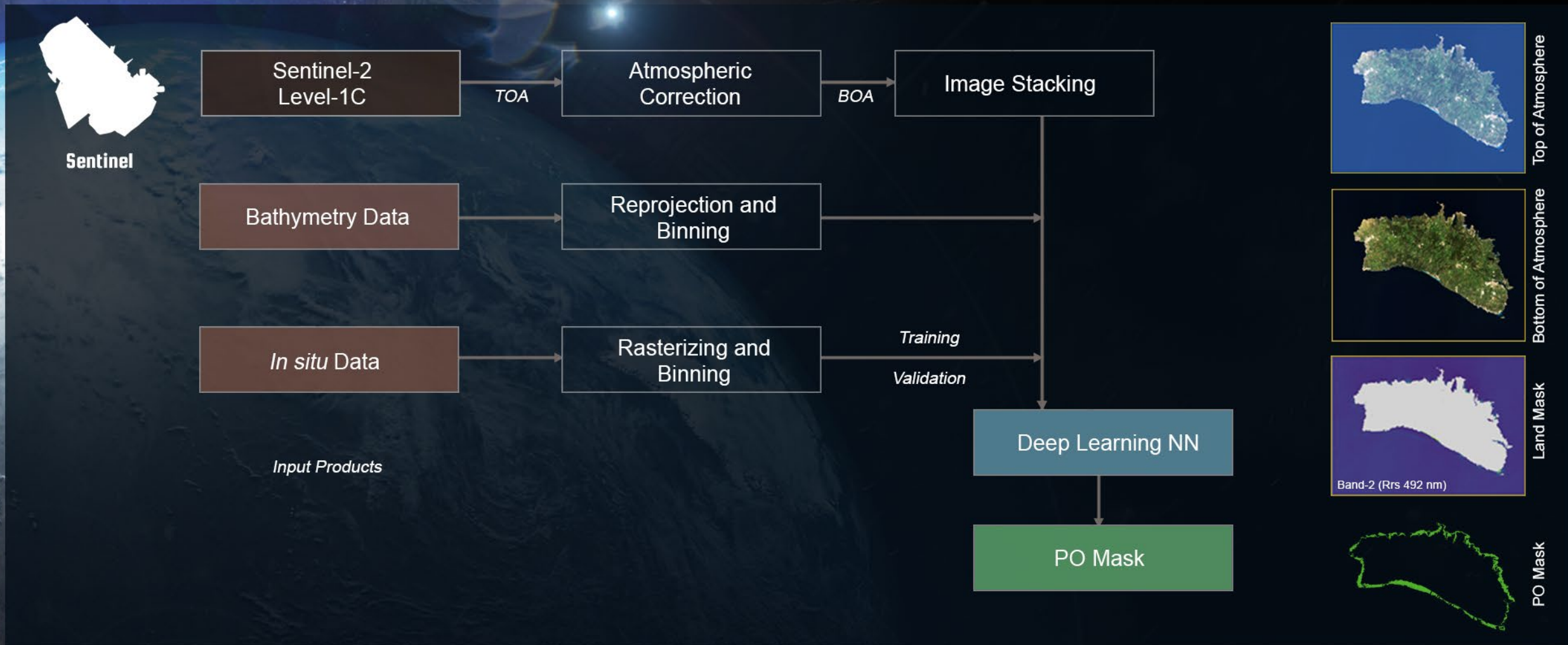
## Habitats

Dimosthenis Traganos & Peter Reinartz (2017)

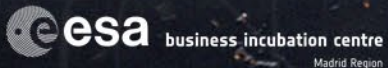
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# From Sentinel-2 to Posidonia

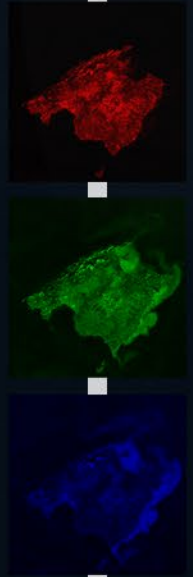
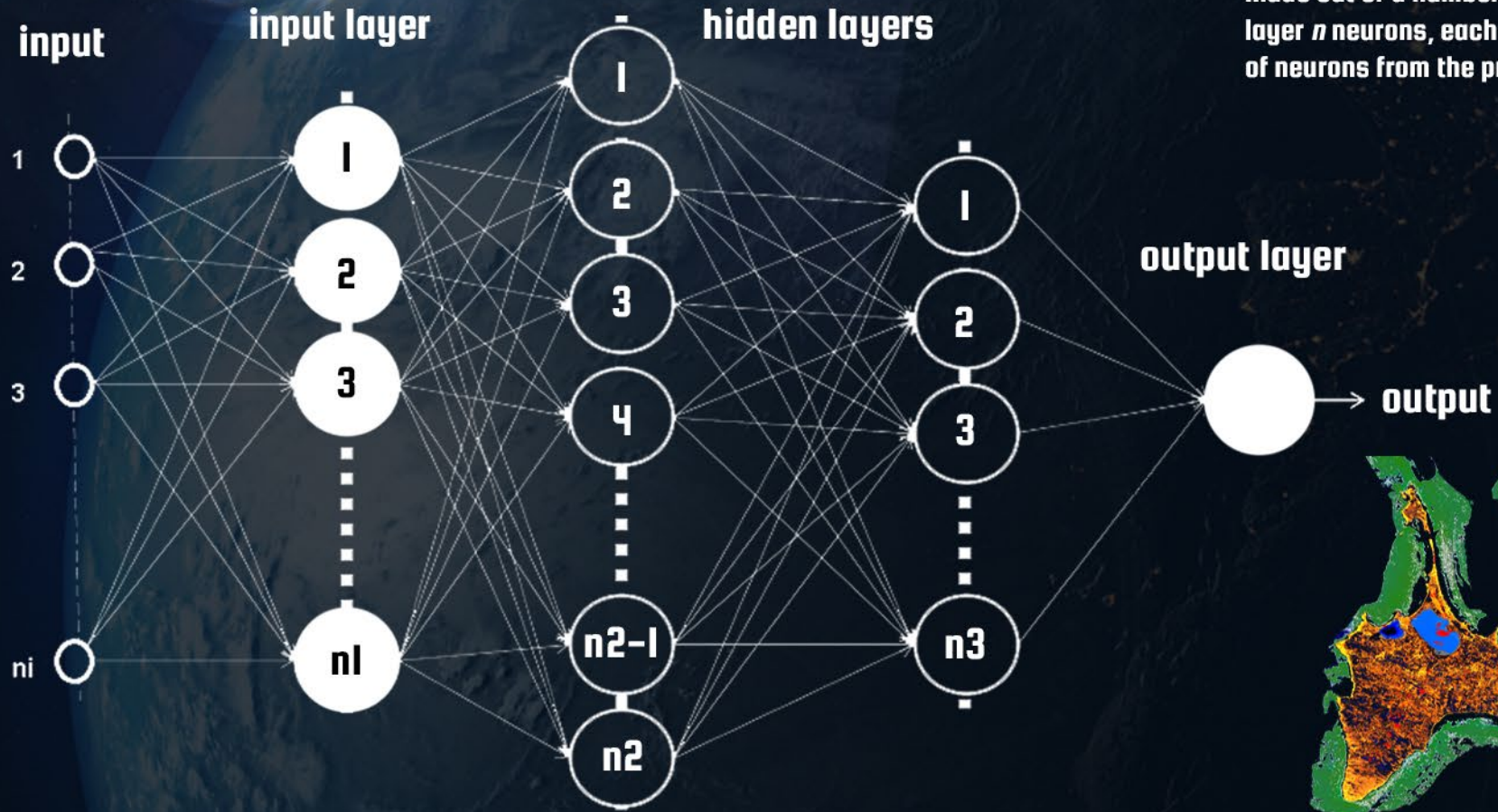


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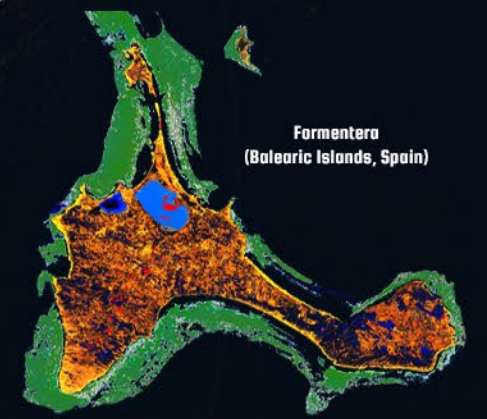


# ML: Neural Network

## Deep Learning



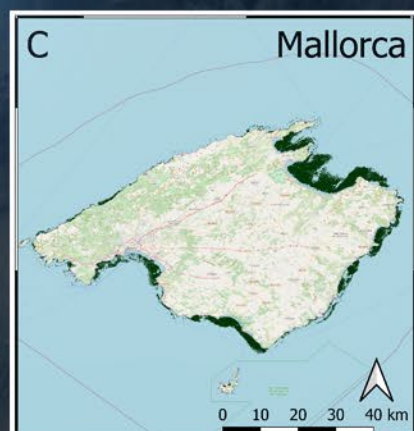
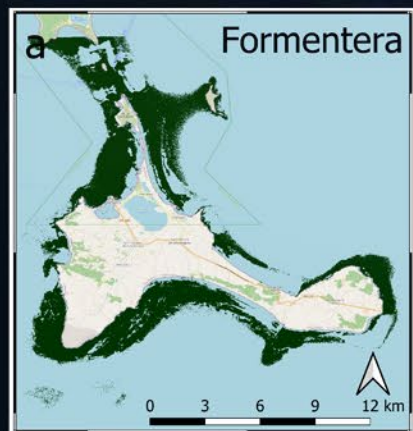
Red  
Green  
Blue



Formentera (Balearic Islands, Spain)

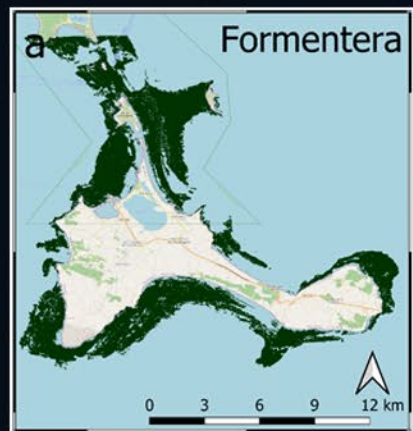
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# Case Study: Balearic Islands (2020 cartography)



Balearic Islands (Spain)

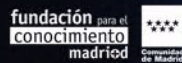
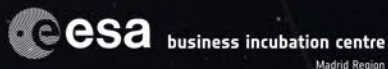
Satellite



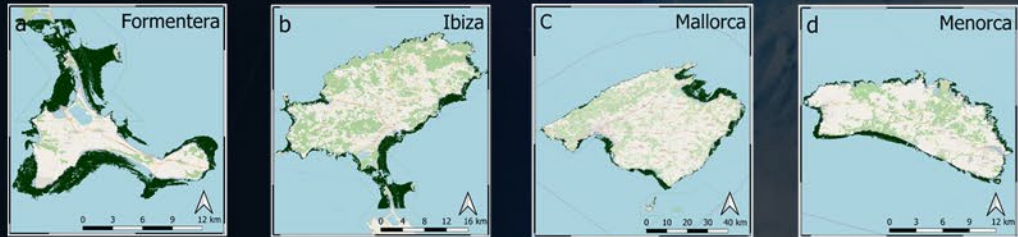
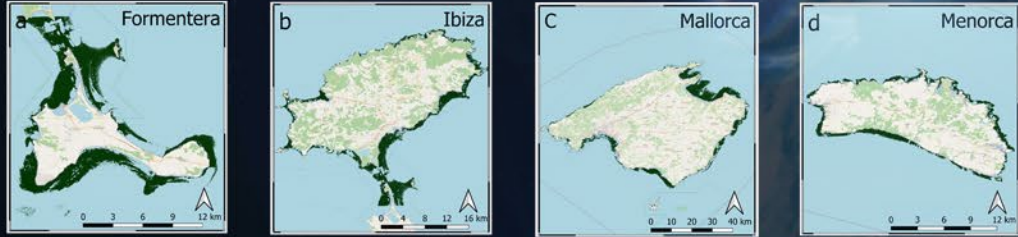
In-situ

article in preparation

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# Case Study: Balearic Islands (2020 cartography)



## Satellite - In situ

Match



NN sucessfully predicts PO

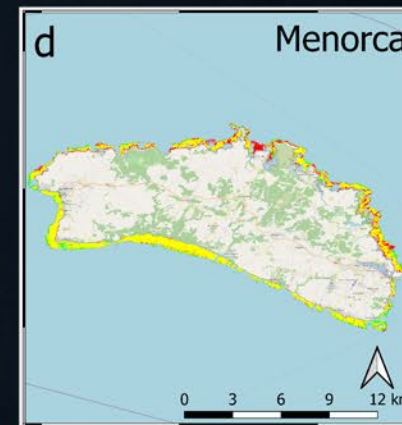
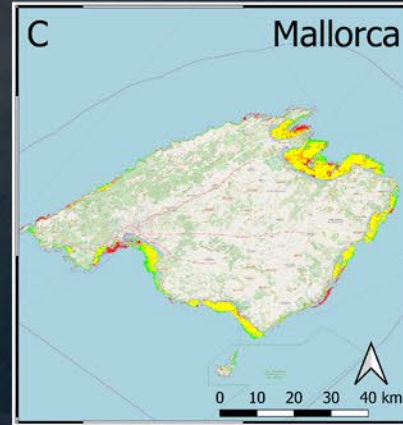
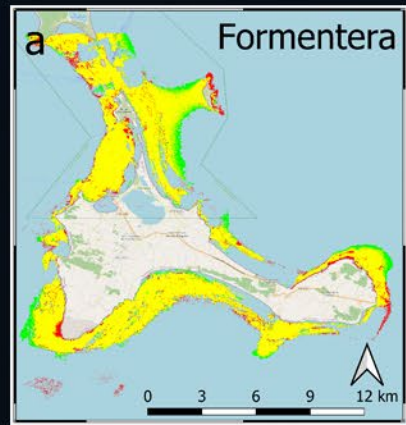
No match



NN failed to predict non-PO



NN failed to predict PO



Positive Precision

83%

Positive Recall

79%

Comparisson

article in preparation

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# Posidonia oceanica Cartography 2020

Released November 2021

NN failed to predict PO



Out of date in situ cartography ?  
Low resolution bathymetry

Formentera  
(Balearic Islands)



NN failed to predict non-PO

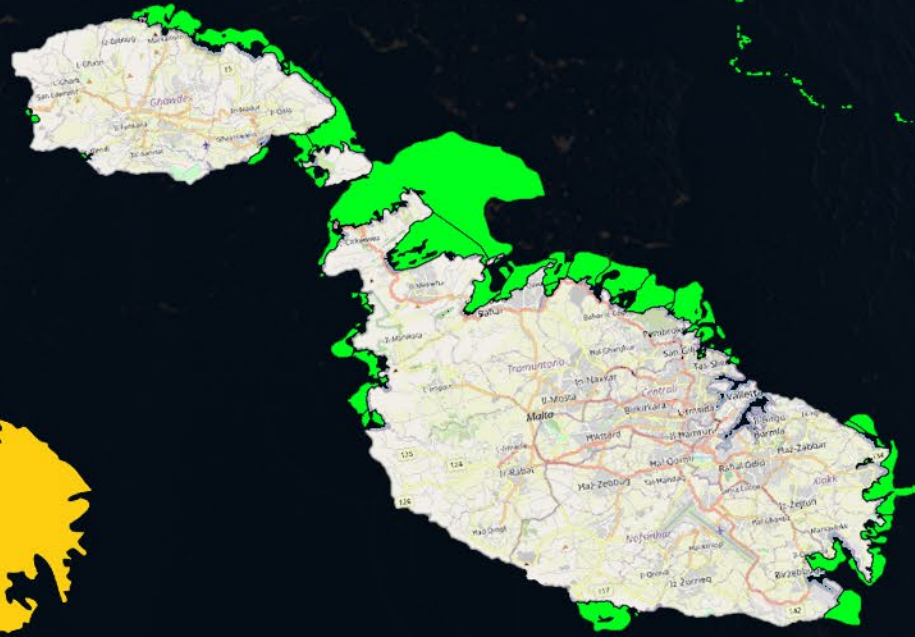
Artifacts  
Low resolution bathymetry

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# Model Transferability (Malta)



Malta

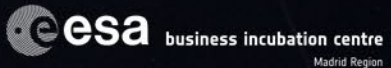


In situ PO



Model Derived

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# SENTINEL-1 SAR FOR VESSEL DETECTION

**IBIZA**  
 (BALEARIC ISLANDS, SPAIN)

## FROM RAW IMAGES TO

VESSEL DETECTIONS  VESSEL LOCATION  
 VESSEL DIMENSIONS

### VESSEL CHARACTERIZATION

Ellipse   $3\sigma$   
 Center   
 Contour 

## IDENTIFICATION OF

- MOVING TARGETS
- STATIC TARGETS
- VESSEL DENSITY
- TRAFFIC DENSITY
- POSSIBLE ROUTES

**FORMENTERA**  
 (BALEARIC ISLANDS, SPAIN)

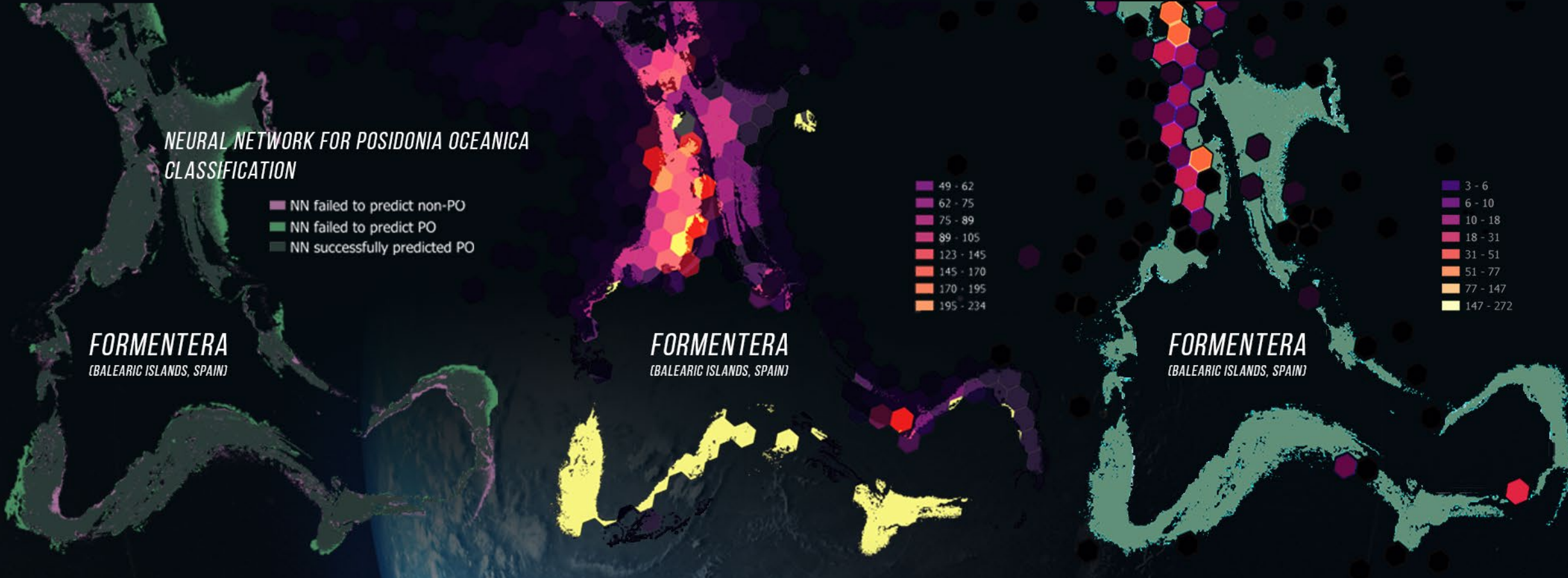
 TRAFFIC ROUTES

VESSEL DENSITY

- 0 - 1
- 1 - 4
- 4 - 10
- 10 - 15
- 15 - 19

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# AIS/SENTINEL-1 SAR DATA TO ASSESS BOAT PRESSURE OVER POSIDONIA MEADOWS



BOAT PRESSURE OVER MARINE ECOSYSTEMS  
(AIS AND SENTINEL-1 DATA)

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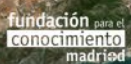


**SIMBAD**

MAR MENOR, MURCIA (SPAIN)  
SENTINEL-2 IMAGE  
18 AUGUST 2021



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Water Quality  
**SIMBAD**

WATER QUALITY MONITORING

MAPS OF

CHLOROPHYLL

CDOM ABSORPTION COEFFICIENT

SUSPENDED MATTER

OTHER MAPS

TEMPERATURE

TURBIDITY

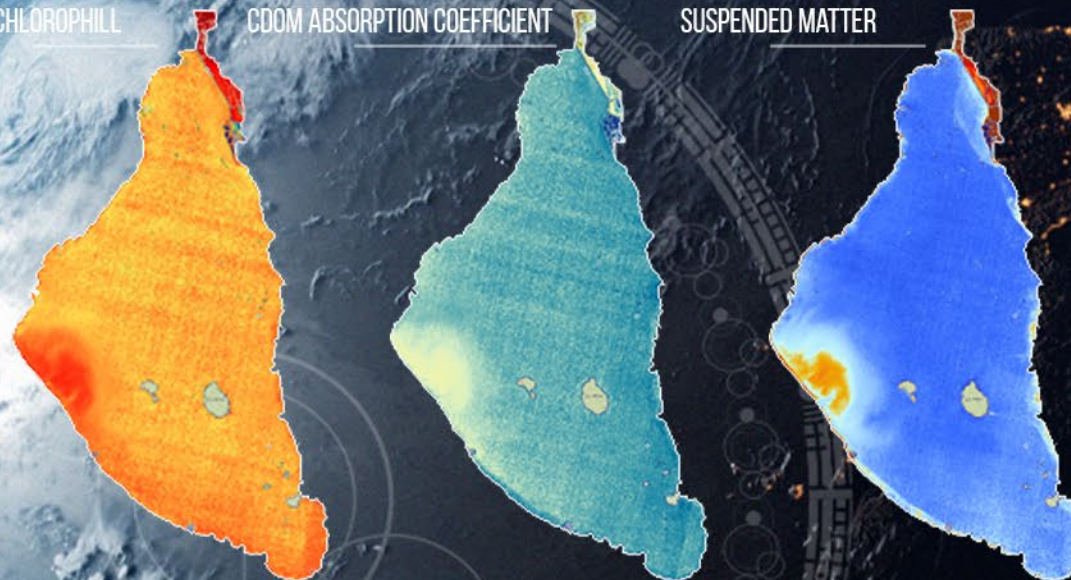
WIND VELOCITY

OCEAN CIRCULATION

APPLICATIONS

MONITORING,

- HARMFULL ALGAL BLOOMS
- PRIMARY PRODUCTION
- SEDIMENT TRANSPORTATION



MAR MENOR (SPAIN) SUMMER 2021



# Product Features



Automated batch processing by using the Scientific Exploitation Platform (SEP)

Spatial Resolution 10 m

Frequency: Seasonal and yearly cartography

## SIMBAD: Scientific Exploitation Platform at a Glance

Docker + Kubernetes for automating deployment, scaling, and management of containerized applications

SIMBAD provides,

Modular system easy to maintain and/or modify.

Configurable and scalable in terms of performance and fault tolerance.

Services are deployed as needed either locally or in any cloud environment.

Security in cloud environments.

### VISUALIZATION

Data visualization, Mask processing, Alerts and notifications configuration

### ADMINISTRATION

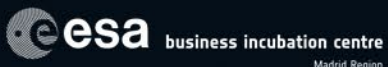
Region configuration, Download automatization, Processing automatization, Data and Images storing

### MONITORIZATION

Alerts and notifications management

Formentera

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# Future Prospects for Posidonia Cartography



**Produce routinely cartography for other potential areas, i.e. Natura 2000, Marine Protected Areas, National parks, etc.**

**Map past years or historical studies**

**High resolution bathymetry and Commercial satellite data**

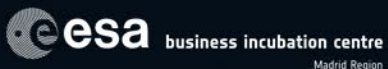
**Explore mapping other sea grass species**

**Measure carbon sequestration (future collaboration)**

**Earth observation + Quantum Computing to improve precision and/or training time (currently under definition)**

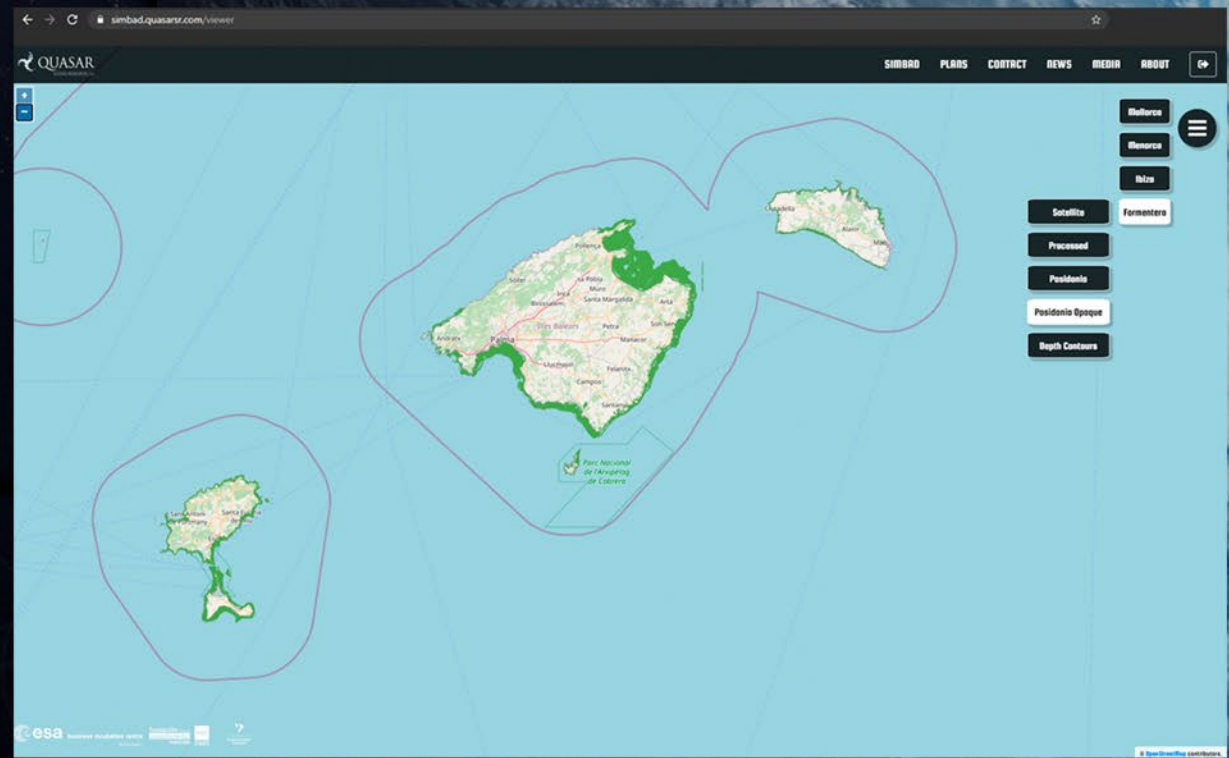
*Industrial Doctorate  
ESA project*

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<https://simbad.quasarsr.com>



**Prototype Released in Sep 2019, Updated Nov 2021**

**Products based on Sentinel 1, 2 and 3 imagery**

**Posidonia, Boat Detection, Oil spills, Wildfire, Agriculture and Water Quality**

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