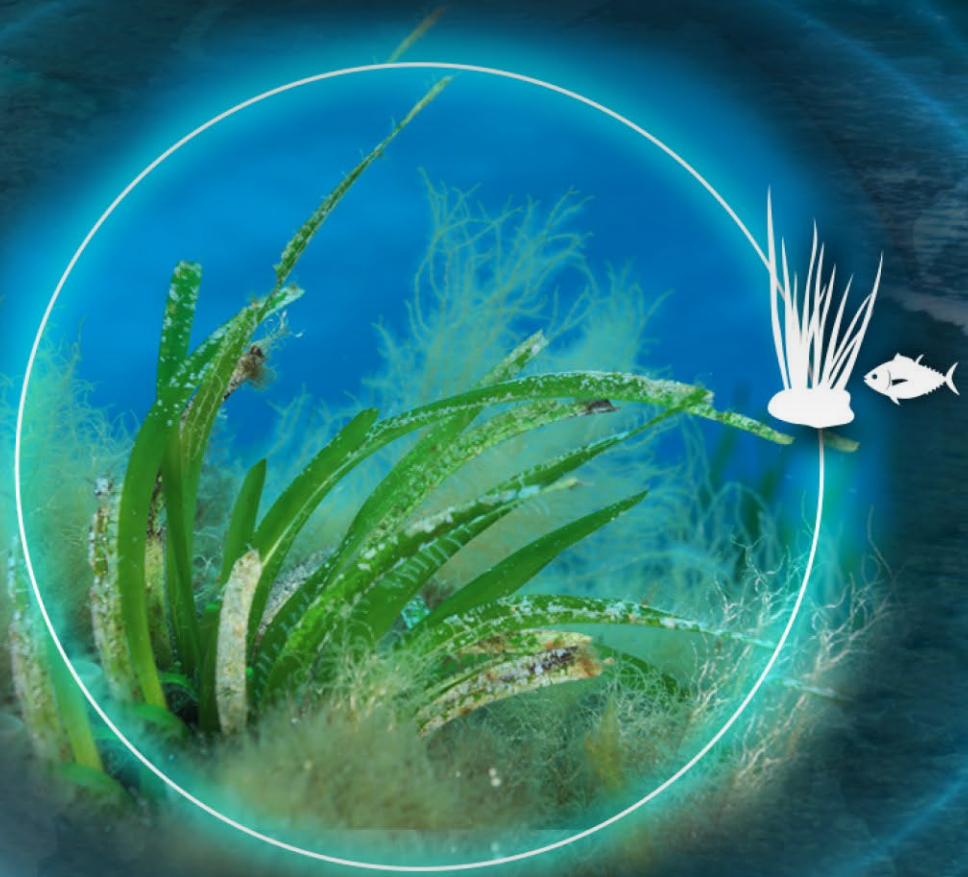
BiCOME - Biodiversity of the Coastal Ocean: Monitoring with Earth Observation

# Biodiversity from remote sensing of coastal areas for science and societal applications



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## BiCOME GOAL

To develop and to demonstrate that Essential Biodiversity Variables (EBVs),

relevant for scientific and monitoring applications,

**can be obtained** from state-of-the art **remotely sensed reflectance**

**close to the shoreline**

**and can be scalable globally.**

***Addressing relevant scientific and societal problems.***

## COASTAL OCEANS

Provide many ecosystem services such as climate regulation, food provision, recreational services

Difficult to measure marine biodiversity due to cost, ocean and weather conditions, time intensive, dangerous.

Measurements often not standardized!

***Indicators (EBVs) need to be measurable, affordable, easy to access, consistent, comparable***

# Knowledge gaps (IPBES, 2019)

We need new, more automated observing methods.

These require collaboration between science and policy sectors

to improve capacity around the globe.

(Miloslavich et al. 2018)

| Sector | Knowledge gaps (in data, indicators, inventories, scenarios) |
|---|---|
| Data, inventories and monitoring on nature and the drivers of change | • Data on ecosystem processes (including rates of change) that underpin nature's contributions to people and ecosystem health<br>• Data from monitoring of ecosystem condition (generally less well represented than ecosystem extent) |
| Gaps on biomes and units of analysis | • Inventories on under-studied ecosystems: freshwater, Arctic, marine/ocean, seabed, and wetlands |

# Scientific questions

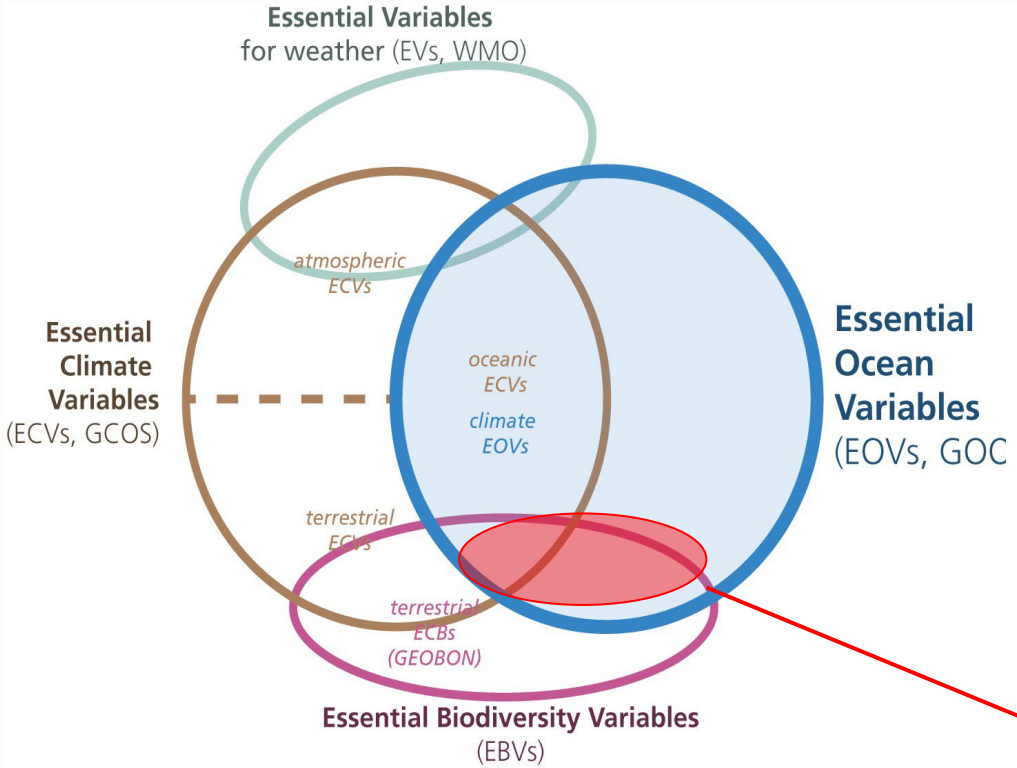
What is the status of biodiversity?

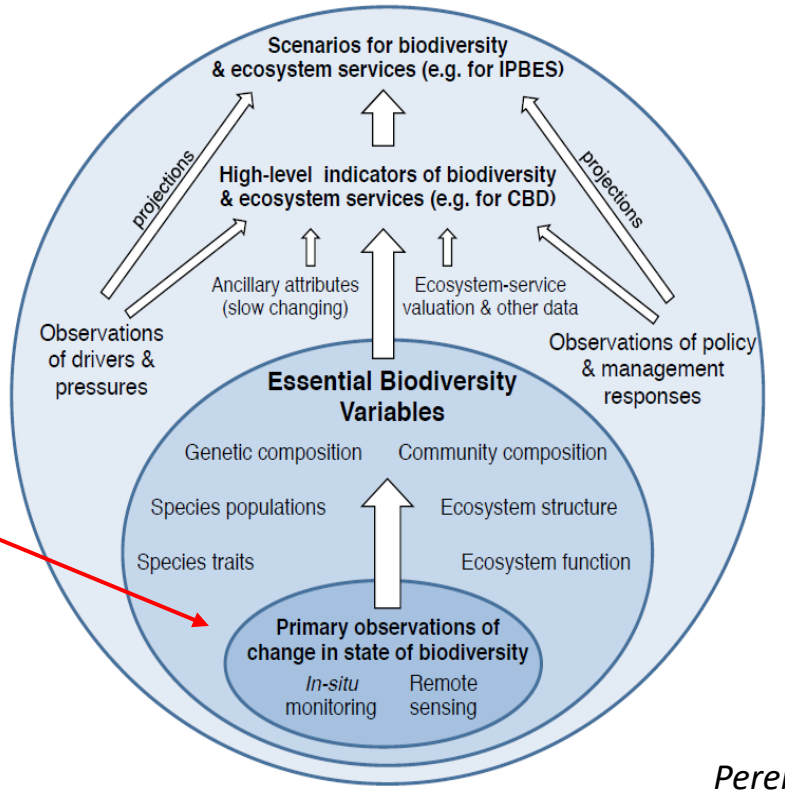
How does biodiversity change with time?

Which pressures can we identify remotely?


Pressures include overexploitation, land/sea use changes, climate change, pollution

# Essential Ocean Variables and Essential Biodiversity Variables



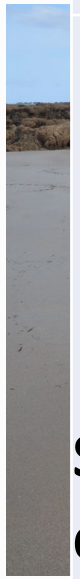

*Framework for Ocean Observing (2012)*

*Pereira et al. 2013*

*Slide from Muller-Karger MBON (2021)*

# Approach

- Mapped EOV for each environment studied to the EBV:
  - Intertidal seagrass extent and macroalgae
  - Subtidal seagrass
  - Floating vegetation
- Mapped the EBV-EOV-Environment to the observable variables
- Link to policy and monitoring initiatives
- Early Adopters



| | Research focus | Reason for monitoring | Reason for joining BiCOME |
|---|---|---|---|
| **Syndicate Mixte Baie de Bourgneuff** | Impact of recreational and **commercial clam fishing in seagrass beds**<br>**Map *Sabellaria* reefs in relation to anthropogenic pressures** | **To manage Natura 2000 site,**<br>**Water Framework Directive** | **To be able to get more and more regular data than through fieldwork (both spatial and temporal extent)** |

# Defining the products they need

EBV
Species population – Distribution – Presence/Absence for seagrass

Benthic inverts (in development)

Ecosystem structure – Live cover

Ecosystem extent

| SMBB | Current | Best | Workable | Minimum |
|---|---|---|---|---|
| Survey area | Baie de Bourgneuff | Same | Same | Same |
| Spatial resolution | One reef only<br>Fieldwork | 10 m seagrass,<br>< 1m for polychaete reefs | 20 m seagrass, 1 m for polychaete reefs | 30 m seagrass, 1 m for polychaete reefs |
| Temporal resolution | Not regular | 1 month$^{-1}$ | 1-2 year$^{-1}$ | 1 year$^{-1}$ |
| Level of detail of measurements | Seagrass extent and percentage cover, polychaete reef extent and percentage cover (one reef only) | Seagrass extent and percentage cover, polychaete reef extent and percentage cover | | |

# Subtidal case study - Mozambique

| | Research focus | Reason for monitoring | Reason for joining BiCOME |
|---|---|---|---|
| **Bazaruto Archipelago National Park** | To extend their monitoring area (currently mostly fieldwork, with some RS) | To manage seagrass beds sustainably, dugongs, cyclone damage | To be able to use RS in the regular monitoring of the research area |

EBV

Species population – Distribution – Occurrence probability for seagrass

Ecosystem structure – Live cover - Ecosystem extent

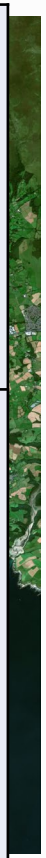
Ecosystem distribution

Ecosystem function – Disturbances - Eutrophication

| Bazaruto National Park | Current | Best | Workable | Minimum |
|---|---|---|---|---|
| **Survey area** | Small areas of BANP only | 3000 $km^2$ | 3000 $km^2$ | 1400 $km^2$ |
| **Spatial resolution** | 3 m (but fieldwork) | 5-10 m | 15 m | 30 m |
| **Temporal resolution** | 1-2 $year^{-1}$ | 4 $year^{-1}$ | 4 $year^{-1}$ | 4 $year^{-1}$ |
| **Level of detail of measurements** | Species of seagrass, dugong tracks | | | |

# Pelagic

| | Research focus | Reason for monitoring | Reason for joining BiCOME |
|---|---|---|---|
| **Lake Vembanad, India** | Extent of water hyacinth rafts and phytoplankton, zooplankton blooms linked to Cholera | To assess, monitor and manage health threats due to Cholera, and to forecast and manage WH rafts | They would like better access to RS data in formats that are easier to access |



Plymouth, UK

PML | Plymouth Marine Laboratory

# Lake Vembanad, India

EBV

Species population – Distribution – Presence/Absence

Ecosystem structure - Extent

| NERCI | Current | Best | Workable | Minimum |
|---|---|---|---|---|
| Survey area | 100 $km^2$ | same | same | same |
| Spatial resolution | 500 m | 5 m | 10 m | 20 m |
| Temporal resolution | Monthly | every 2-3 days | every 4-5 days | every 16 days but reliable |
| Level of detail of measurements | Phytoplankton, zooplankton, benthos | | | |

# To conclude

Science Policy Traceability Matrix:  Essential Ocean Variables connected to Essential Biodiversity Variables and to relevant Remote Sensing products

1. Time linking RS products to Biodiversity Monitoring and fitted to requirements

Requirements are stringent and signal the way forward for future development

High spatial and temporal resolution is needed but sensors are not specifically designed for coastal waters

Coastal biodiversity related Remote sensing products are specially challenging in optically-complex water

**Future steps**

EBV that are not dealt with within the project. e.g. community composition effects on ecosystem function

Explore new technologies such as hyperspectral sensors

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## Thank you!

HYGEOS
EO corrections lead

DLR
Sub-tidal lead

Nantes Université
Intertidal lead

PML | Plymouth Marine Laboratory

**And to all Early Adopters!**

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esa BiCOME is funded by the European Space Agency (ESA)