SAFI: Supporting our Aquaculture & Fisheries Industries

Session de formation et d'information Copernicus - Atelier Applications Côtières, Paris, 24 novembre 2017

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Partenaires du projet SAFI

ACRI ST (coordinateur)

UCC University College Cork, Ireland Coláiste na hOllscoile Corcaigh

COFREPECHE France Aquaculture

ipma instituto português do mar e da atmosfera

Instituto de Investigación y Formación Agraria y Pesquera
CONSEJERÍA DE AGRICULTURA, PESCA Y DESARROLLO RURAL

Daithi O'Murchu Marine Research Station

ACRI EC

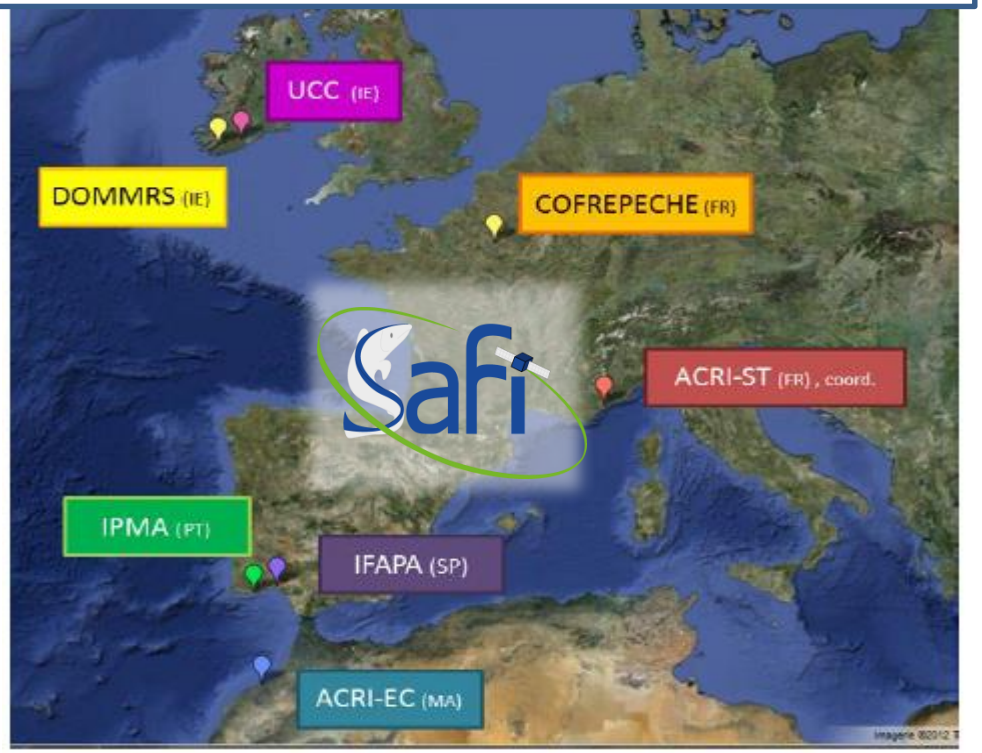
Transfert de connaissance

Expertise level in Earth Observation

SAFI Service suppliers → Intermediate users → SAFI users

Final users of SAFI

Expertise level in Aquaculture and Fishery



Advances under the SAFI Project

- Expected results
- Data available and exploited
- The SAFI indicators developed
  - for Aquaculture
  - for Fishery
- The SAFI services
- Demonstrations of the tools

Reminder on Expected Results

Services to be developed by the project

Fisheries

- Small pelagic fish
- Bivalves

a) Abundance and
b) Recruitment
c) Ecological Niche and potential Habitat
d) Maturation

a) Recruitment and Abundance
b) Maturation

Aquaculture

- Optimal Site Location
- Near-Real Time Monitoring

a) Shallow waters bathymetry
b) Optimal aquaculture zones (salmon, mussel, seabass, seabream...)

Near-Real Time monitoring of the environment

Data collected within SAFI

CHLOROPHYLL-A CONCENTRATION (CHL1)

A proxy for the quantity of phytoplankton

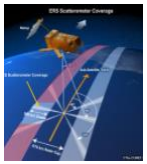
global coverage | 1 or 4km resolution

Daily 1997-NRT | GSM, L4 & OC5 algos

82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 12 14

TURBIDITY (NTU)

A proxy for the concentration of suspended matter



global coverage | 1 or 4km resolution

Daily 1997-NRT | GSM & Ifremer algo

82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 12 14

SECCHI DISK DEPTH – WATER TRANSPARENCY (ZSD)

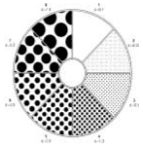
A proxy of water column vertical visibility

global coverage | 1km or 4 km resolution

Daily 1997-NRT | Globcolour algorithm

82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 12 14

SIZE DISTRIBUTION OF PLANKTON (NANO, PICO, MICRO)) A proxy of particle (plankton) distribution/size



global coverage | 25km resolution

Monthly 1997-2012 | Doron & AV algorithm

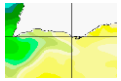
82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 12 14

Data **selected, collected, prepared by SAFI, analysed and validated** for exploitation in the SAFI services developed

Complementarity of models and Earth Observation available in Copernicus

SURFACE TEMPERATURE

The temperature at the base of the diurnal thermocline



Global | 1km or 2km resolution

Daily 08-NRT | Piolle *et al.* 2010

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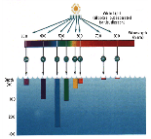
COLOURED DISSOLVED MATTERS ABSORPTION (CDM)

A proxy for salinity (inversely correlated) and marker for estuarine waters



global coverage | 1km or 4km resolution

Daily 1997-NRT | GSM algorithm

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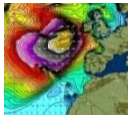
SIGNIFICANT WAVE HEIGHTS

Wave data from WaveWatch-III wavemodels.



global coverage | 18.5km or 10 km (NRT) resol.

Daily 1990 (2003) -NRT | Ardhuin *et al.* 2010, FNMOC

82 84 86 88 90 92 94 96 98 00 02 04 06 08 10 12 14

Satellites :

- ✓ Sentinel-2A/B
- ✓ Sentinel-3

Models :

- ✓ Salinity
- ✓ Global Current

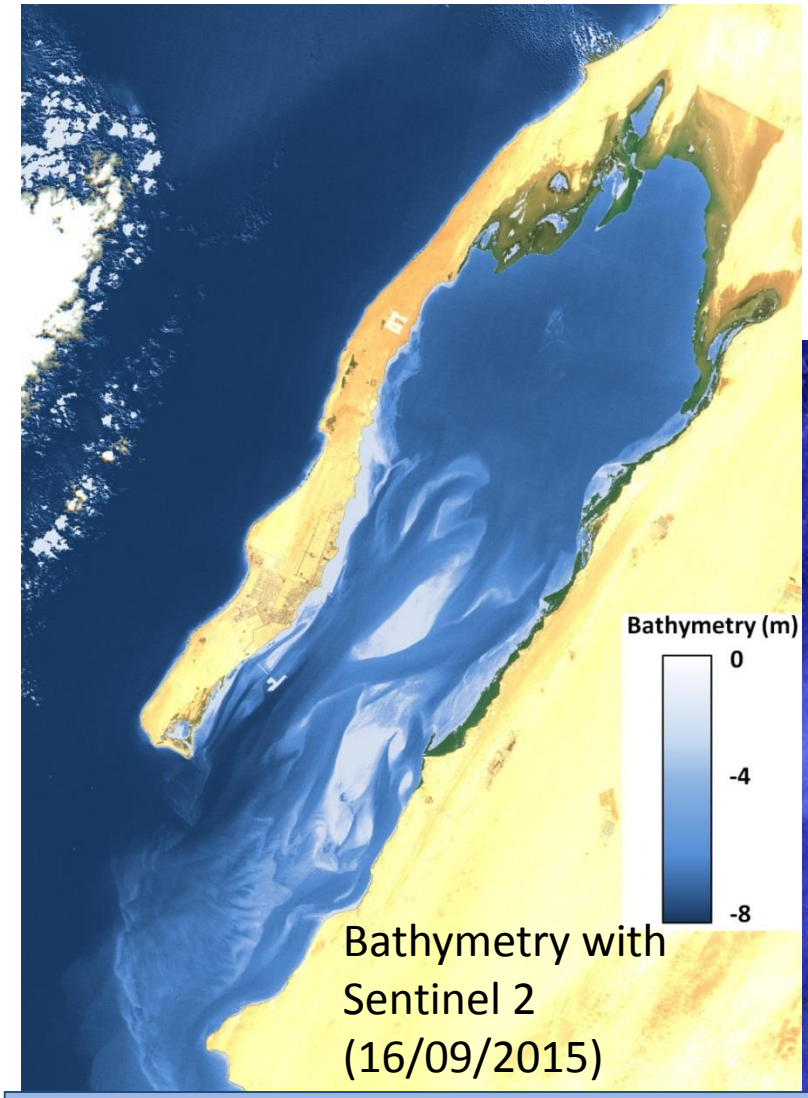
SAFI Indicators Developed

1. Shallow Water Bathymetry
2. Sea Surface Temperature Fronts
3. Harmful Algal Bloom Detection – Red tides (*Karenia mikimotoi)*
4. Harmful Algal Bloom Detection – Green tides (*Lepidodinium chlorophorum)*
5. Mussel Farming Site Selection
6. Mussel Growth Indicators
7. Salmon Aquaculture Site Selection
8. Sea Bass/Sea Bream Aquaculture Site Selection
9. Small Pelagic Spawning
10. Bivalve Maturation Indicators

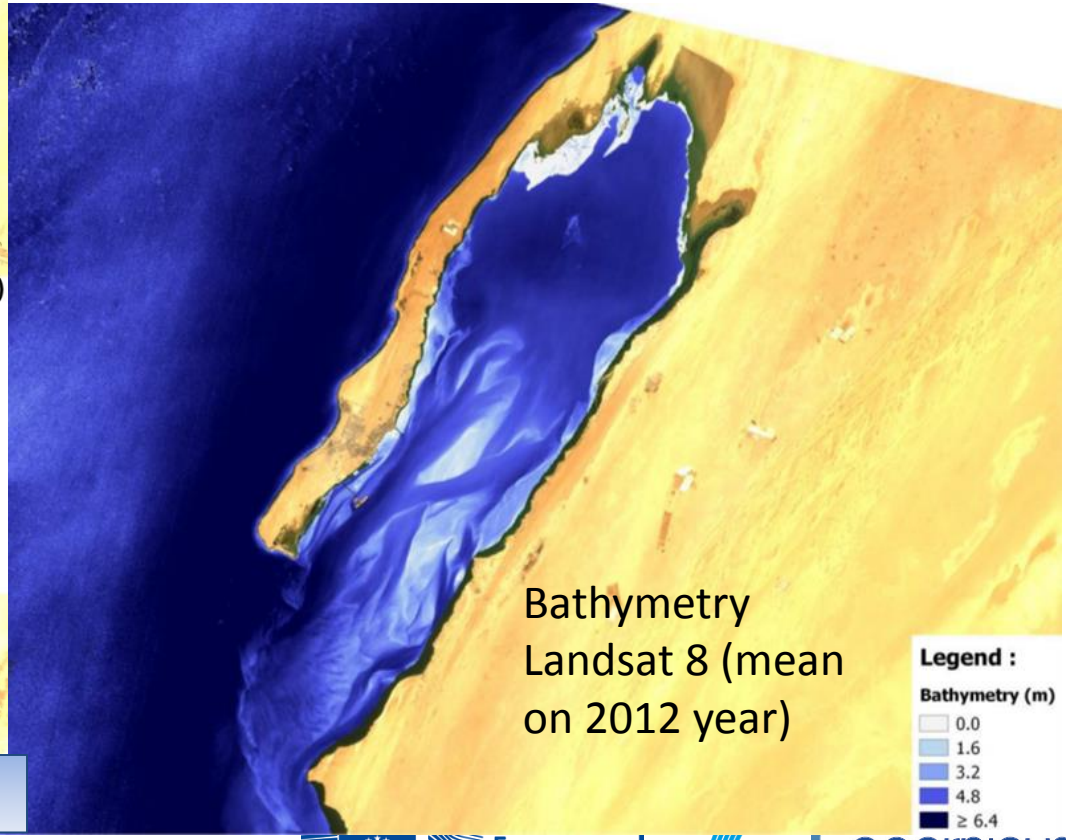
SAFI Indicators: Shallow Waters Bathymetry

Dakhla Bay in Morocco :

- ✓ Dynamic area in terms of sedimentary processes (dredging strategy required)
- ✓ Depending on the tidal time, water is clear enough to allow bathymetry retrieval down to 6 to 8m depth.
- ✓ Satellites used: Landsat 7 (2002), Landsat 8 (2014) and Sentinel-2 (16/09/2015)



Bathymetry with Sentinel 2 (16/09/2015)



Bathymetry Landsat 8 (mean on 2012 year)

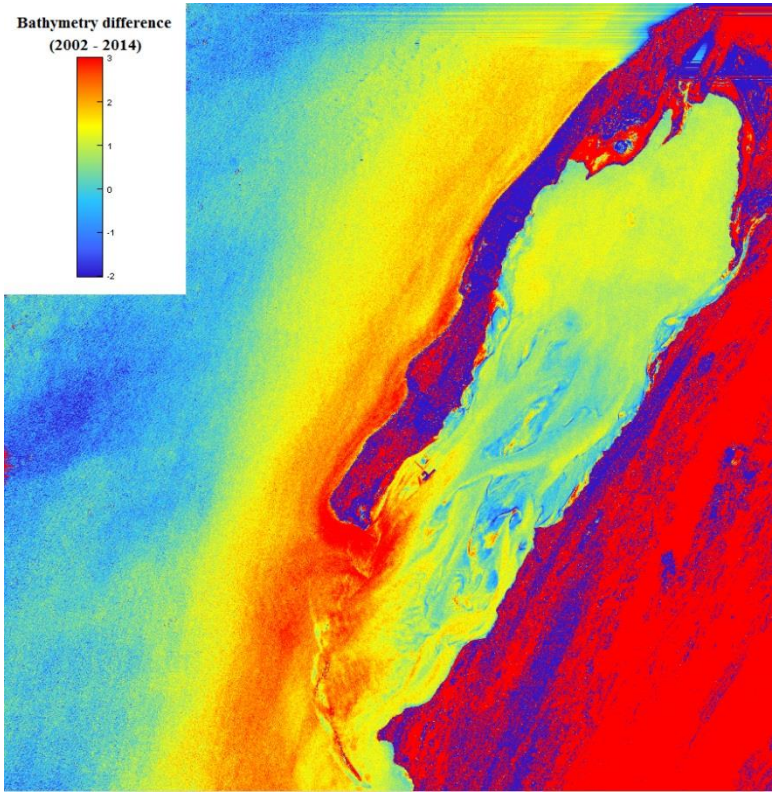
Copernicus data used: Sentinel-2 data

SAFI Indicators: Shallow Waters Bathymetry

Application:
- For areas with **little monitoring,** where measurements are difficult to make (e.g. **too shallow**) or not recently updated.
- to **estimate the sedimentary processes** comparing two estimated bathymetries

Availability : Processing is not automated – specific studies required to adapt the algorithm to the area of interest.

Limitations : only valid for **shallow waters** (limit depth depending on water transparency) – as we need to see the bottom from space. Optic remote sensing is **not exploitable in cloudy conditions**.



Difference between 2002 and 2014 (landsat):
red*=increase in sediments – lower depth*
pale blue*= no change*
dark blue*= decrease in sediments – higher depth*

SAFI Indicators: Sea Surface Temperature Fronts

SST fronts occur where colder, nutrient rich water mixes with warmer waters –

fuelling increased plant growth at the first stage of the ocean food chain

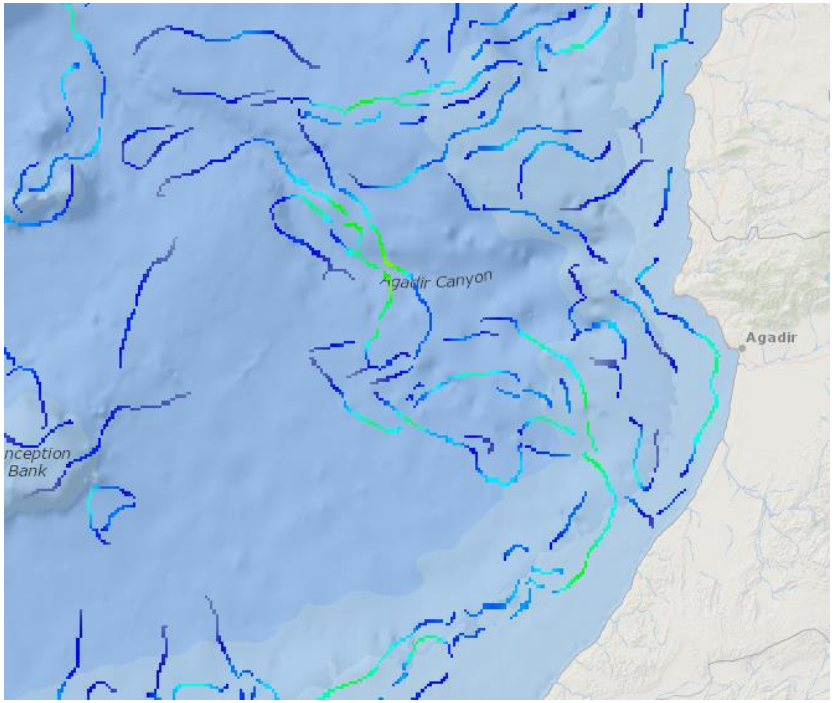
Application:

- ✓ Analysis of fish migration routes,
- ✓ assessment of local fishery recruitment,
- ✓ sea surface temperature variability.

Availability:

daily, 8-day or monthly basis

at a 1 or 2km resolution depending on area.



SAFI-SST FRONTS (COLOURS INDICATE FRONT STRENGTH IN °C/KM) PICTURED: MONTHLY SST FRONTS NEAR AGADIR, MOROCCO, SEPTEMBER 2015

Copernicus data used: Satellite SST

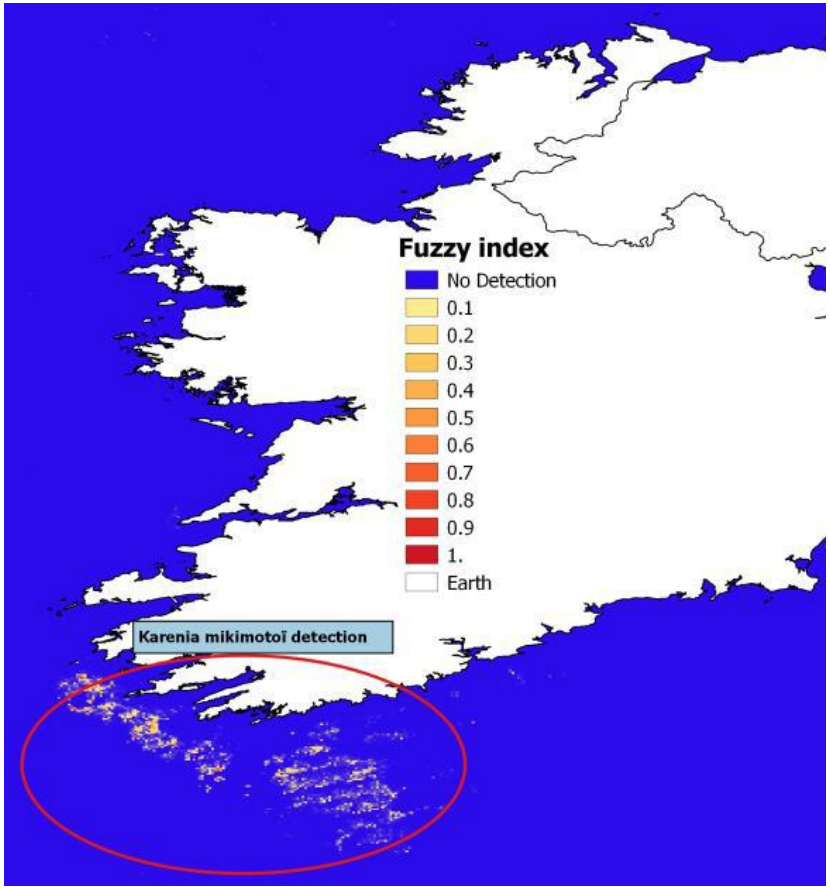
SAFI Indicators: HAB *Karenia mikimotoi*

Karenia mikimotoï – red tide blooming – potentially toxic

Application: To detect a possible toxic algal bloom and anticipate its drift into sensitive areas such as fish and shellfish farms.

Availability: Daily at 1km resolution

Limitation: Detection only possible for high biomass blooms and cloud free images.



Confirmed bloom of Karenia mikimotoï in 2015 near the Irish coasts

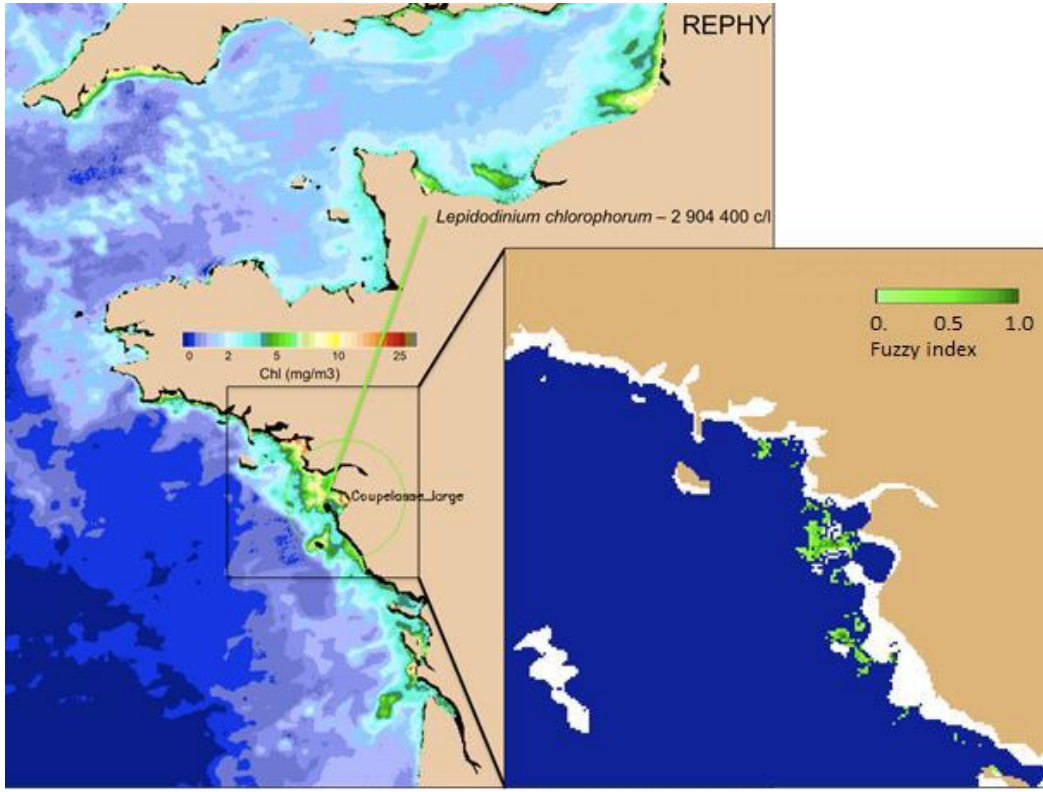
SAFI Indicators: HAB *Lepidodinium chloroph.*

Lepidodinium chlorophorum - green tide - Not toxic but harmful

Application: to anticipate bloom drift into sensitive areas such as fish and shellfish farms.

Availability: Daily at 1km resolution

Limitation: Detection only possible for high biomass blooms in cloud free images.



L. chlorophorum BLOOM DETECTED BY SAFI (28/03/2013) IN THE LOIRE PLUME FRANCE (right) AND CHLOROPHYLL-A CONCENTRATION (left) ESTIMATED FROM SPACE

SAFI Indicators: Mussels Optimal Site location

Based on Sea surface temperature, chlorophyll-a concentration and significant wave heights information

Application:

- ✓ to identify or confirm areas suitable for mussel farming
- ✓ for selection of optimal farming areas
- ✓ and licencing applications.

Availability: Maps available at 1km resolution, updated yearly.

Limitations: Earth Observation present limits of detectability (and so reliability) on shallow waters areas, that prevents some close-to-the-coast identifications (where some mussels farms are located).

Copernicus data used:
Satellite SST and Chlorophyll-a.
And soon the Modelled Waves

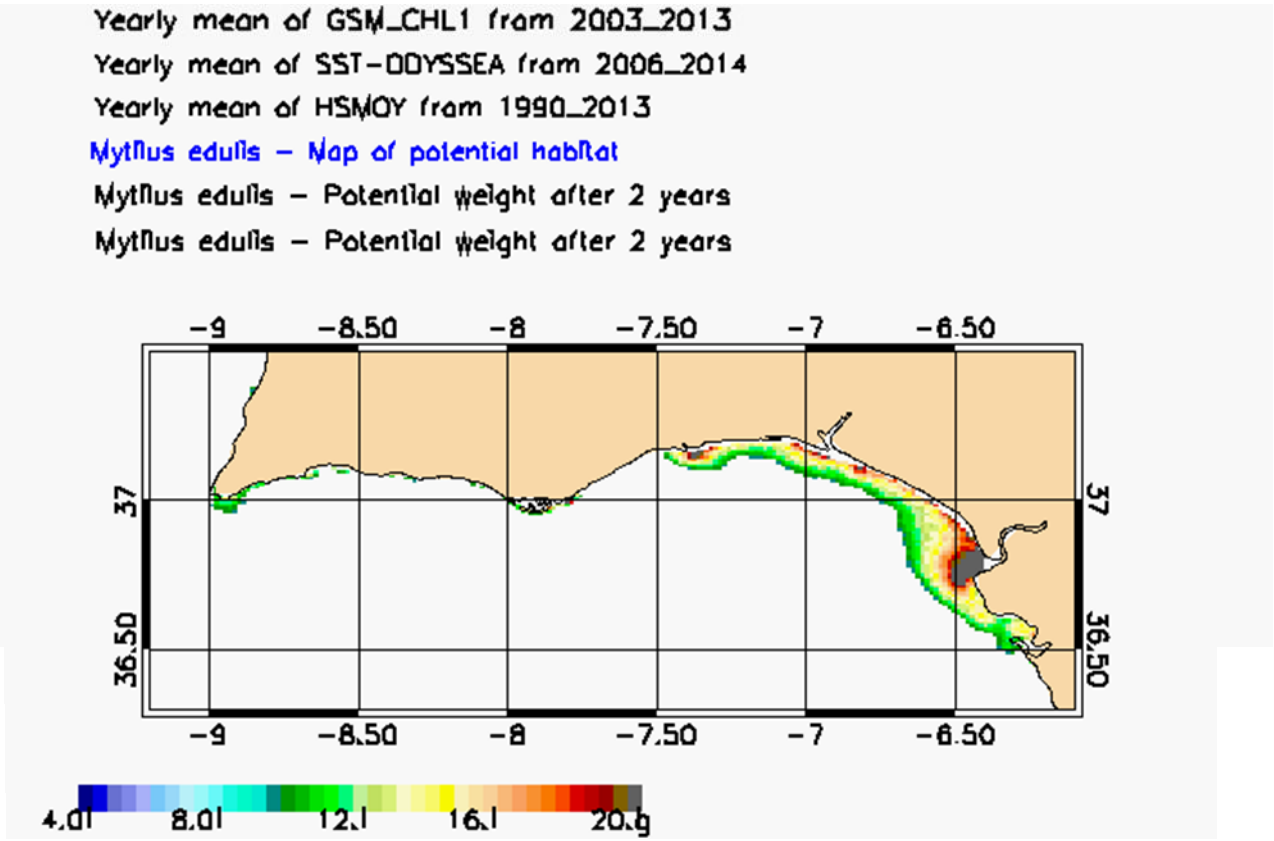
SAFI Indicators: Mussels Growth

Parameters used:

Chlorophyll-a GSM_CHL1
SST-ODYSSEA
Waves CERSAT

- Potential Habitat
- Potential weight (g)

Algorithm :
Y. Thomas et al. 2011



- Indicator setup for potential mussel (*Mytilus edulis*) growth in French Britany easily adaptable to other species with *in situ* data.

Limitations : Impact of specific events like production loss due to diseases or harmful algal bloom occurrence cannot be considered in this yearly growth estimation.

SAFI Indicators: Salmon Optimal Site location

Using Sea surface temperature, transparency and significant wave heights

Application:

- ✓ to identify or confirm areas suitable for salmon growth.
- ✓ Can also be used for projection of climate change impact on optimal site locations.

Limitation: based solely on environmental parameters (e.g. no consideration of local usages constraints at sea). Specific threats like diseases occurrences or jellyfishes presence are not considered either.

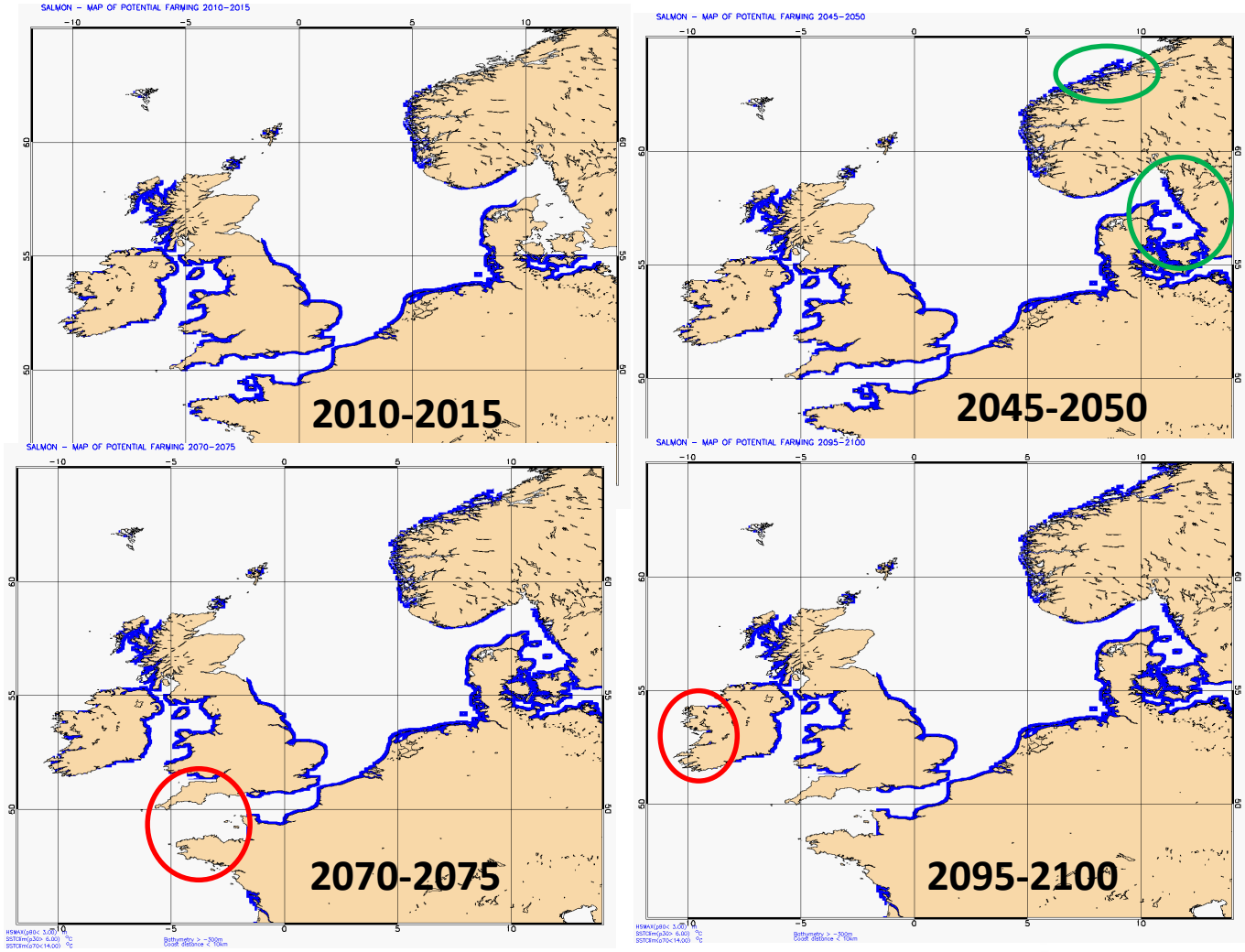
OPTIMAL SITE SELECTION (IN GREEN) FOR SALMON FARMS

Copernicus data used:
Satellite SST.
And soon the Modelled Waves

SAFI Indicators: Salmon Optimal Site location

Estimated evolution of salmon-suitable areas with increasing water temperatures

(IPCC compromise scenario)

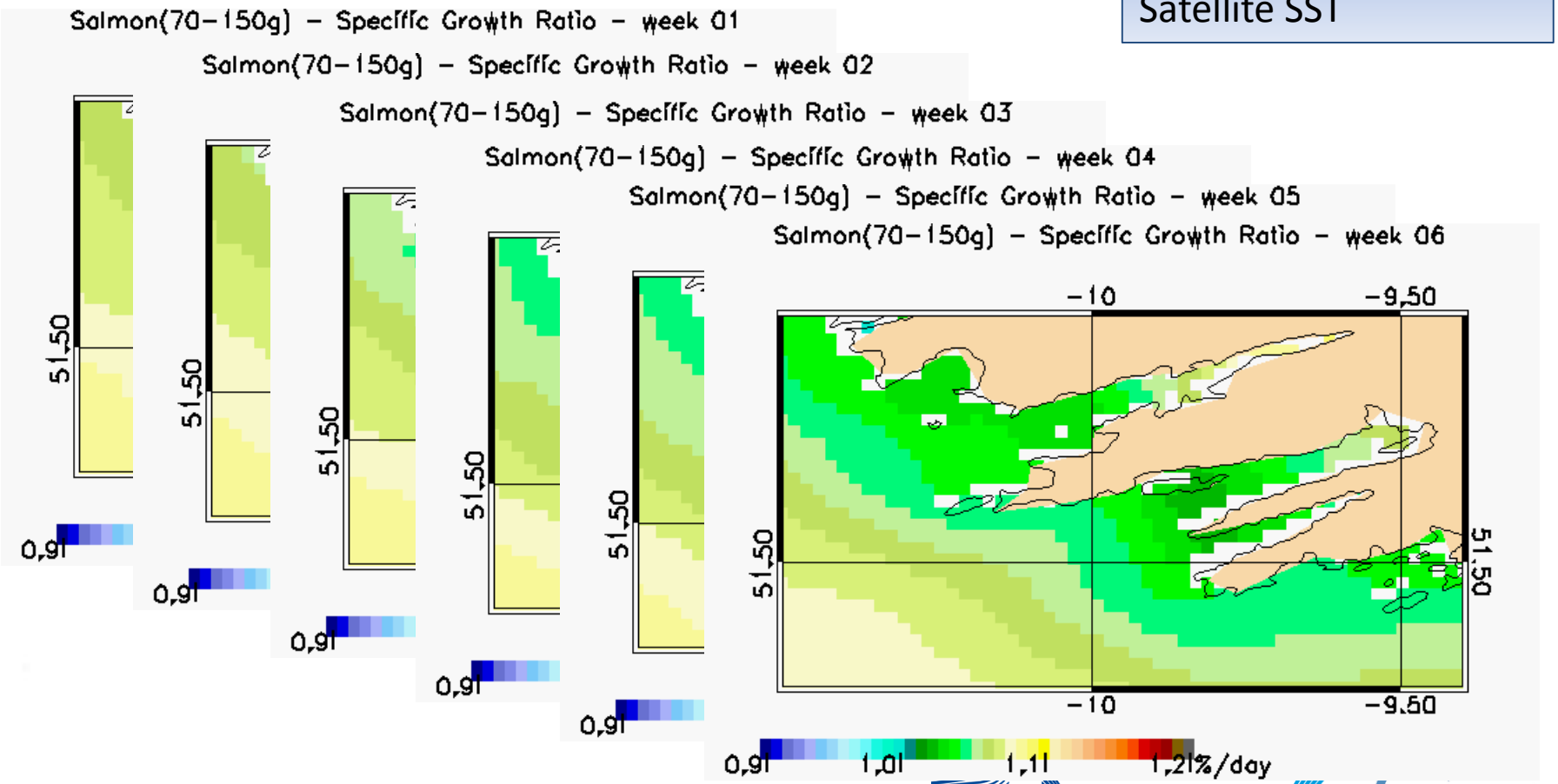


SAFI Indicators: Salmon Optimal Site location

Growth factor for juvenile salmon based on SST.

The effect of temperature and fish size on **growth** (Handeland et al.)

Copernicus data used:
Satellite SST



SAFI Indicators: Seabass/Seabream Optimal Site loc.

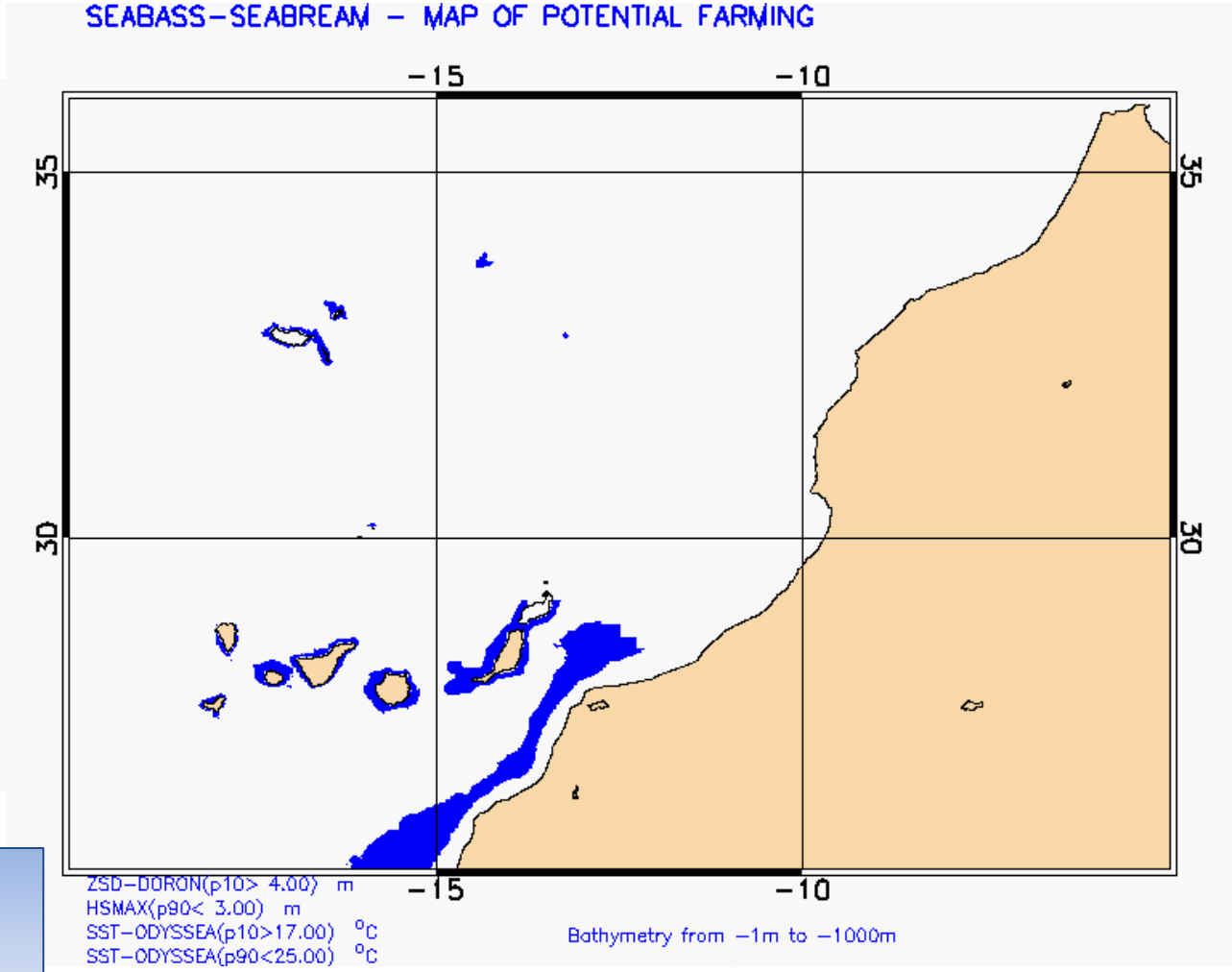
Parameters considered:

SST-max (P90)<25° (biology)

SST-min (P10)>17° (biology)

Waves (P90) <3m (cages)

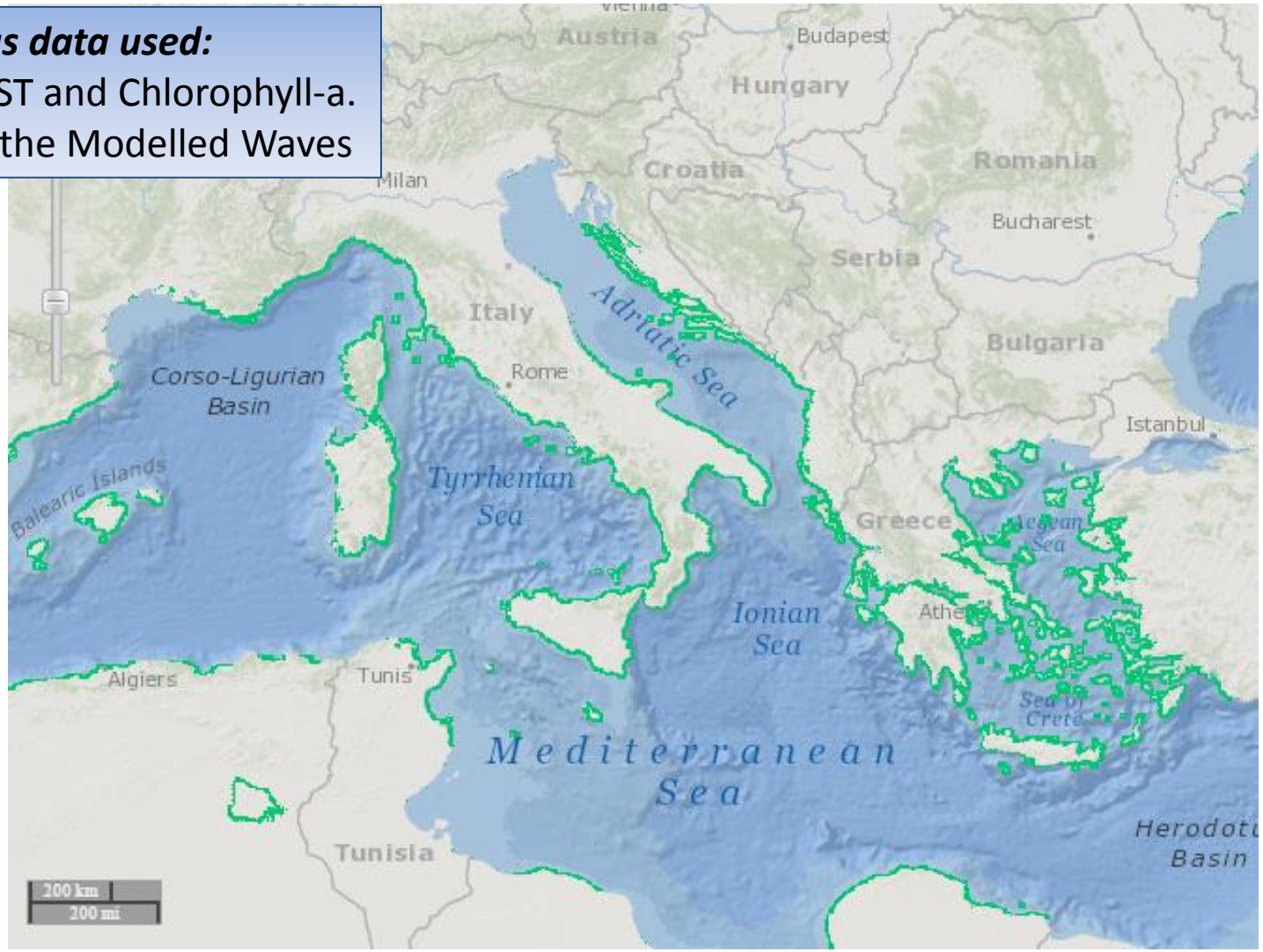
Transparency (SECCHI>4m) (water quality)



Copernicus data used:
Satellite SST
and soon the modelled Waves

SAFI Indicators: Seabass/Seabream Optimal Site loc.

Copernicus data used:
Satellite SST and Chlorophyll-a.
And soon the Modelled Waves



SAFI Indicators: Sardine recruitment and maturation

Long term forecast estimation:

estimation of the recruitment success from the past years environmental conditions

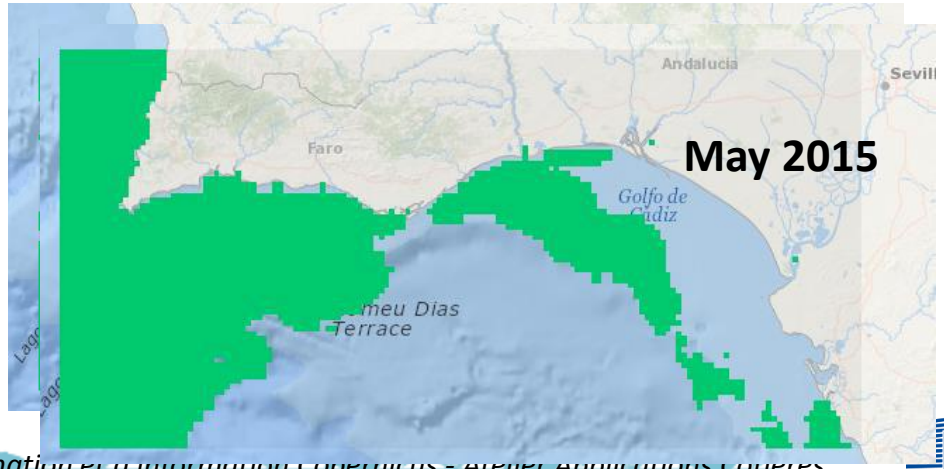
-> help to estimate sardine stocks for the next year (good or bad recruitment year) – independently from fishery pressure.

SAFI Indicators: Sardine recruitment and maturation

Short term monitoring/forecast:

Identification of suitable conditions for sardine spawning -> evolution of the maturation status of the sardines and forecast of the spawning period a couple of weeks in advance

-> help to decide closing fishery periods based on the biological status of sardines.

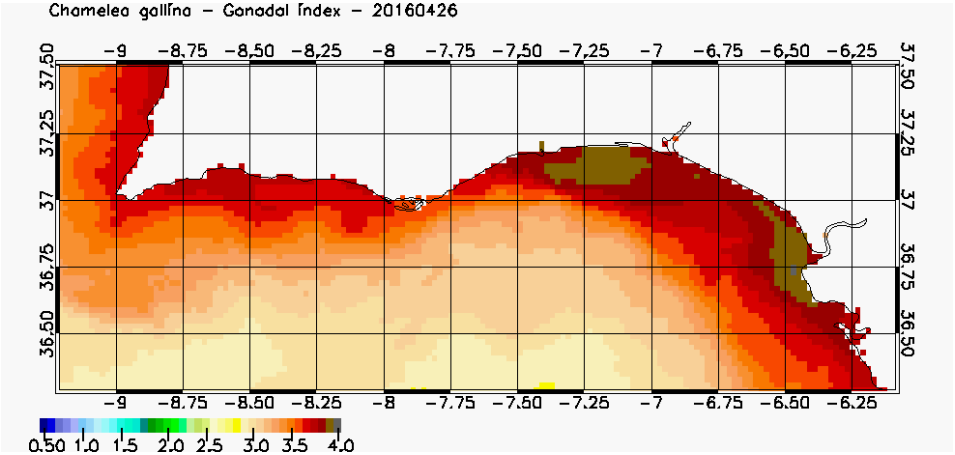


Copernicus data used:
Satellite SST and Chlorophyll-a

SAFI Indicators: Bivalve maturation

As for sardines,

Estimation of recruitment (long-term availability of resources)

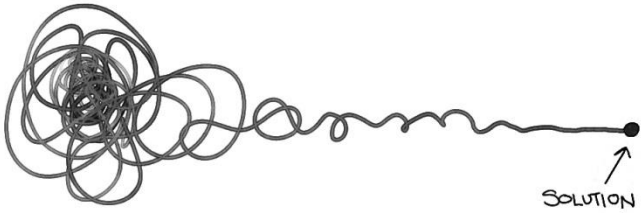


Conditions suitable for gonadal indexes levels = proxy for maturation stages of the bivalve *Chamelea galina (striped venus)*

and of maturation phase – for shorter-term closure decisions

Copernicus data used :
Satellite SST and Chlorophyll-a

Users want simple tools !



Final users

(fish farmers, fishermen, administrations…)

SAFI-PRO:
Mini-web

Web-based consultation,
focused on specific user needs

6 use cases prepared as demo

www.acri-he.fr/projects/safi

SAFI PRO Service: The Mini-Web Tool

www.acri-he.fr/projects/safi

A set of web pages customized for a user's needs

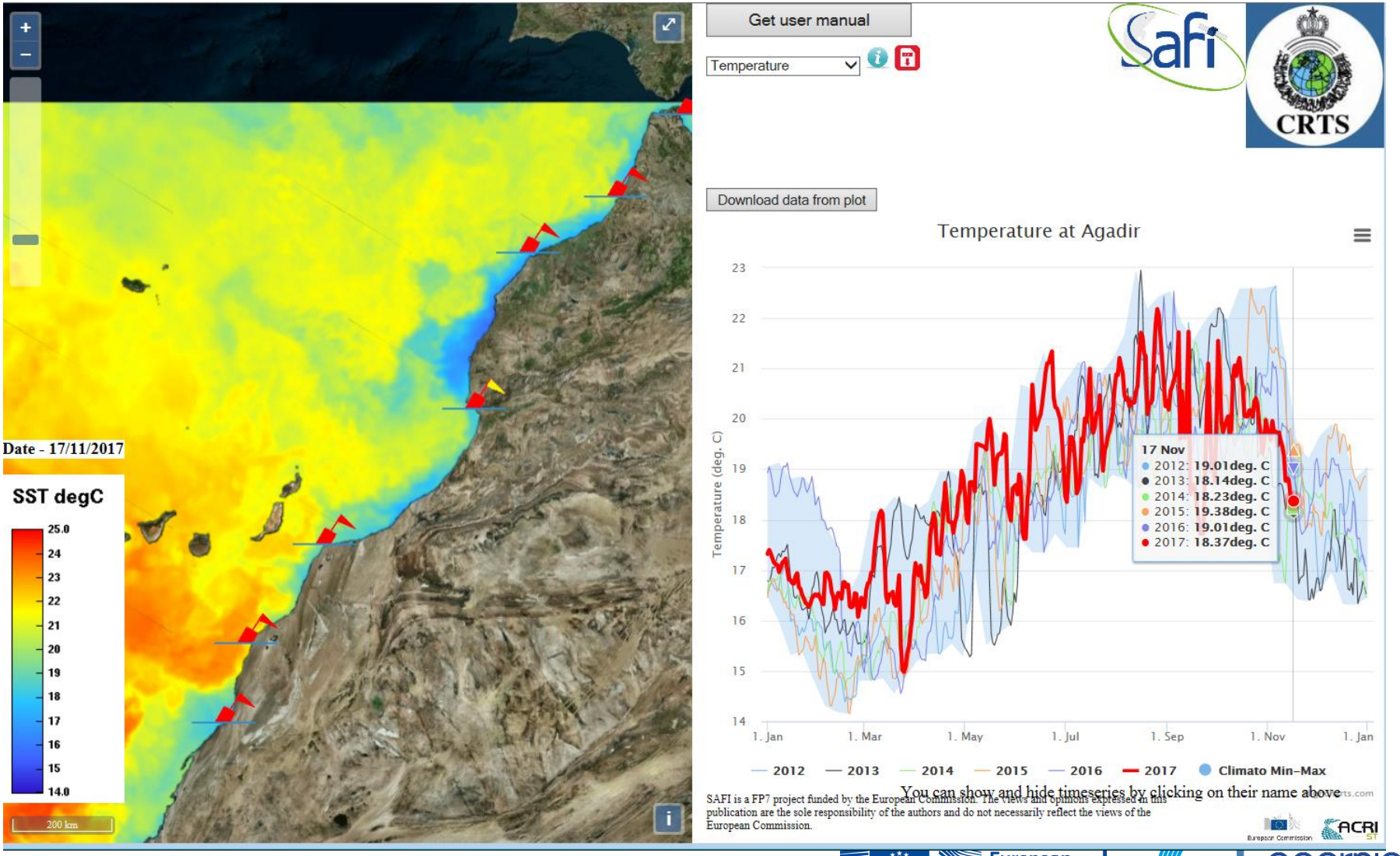
Visualisation of available data (historic, near-real time, and forecast when available)
> through maps and time series extracted on user chosen points of interests
& direct comparison with past years

Download time series

A notebook (preliminary version) to keep track of specific events

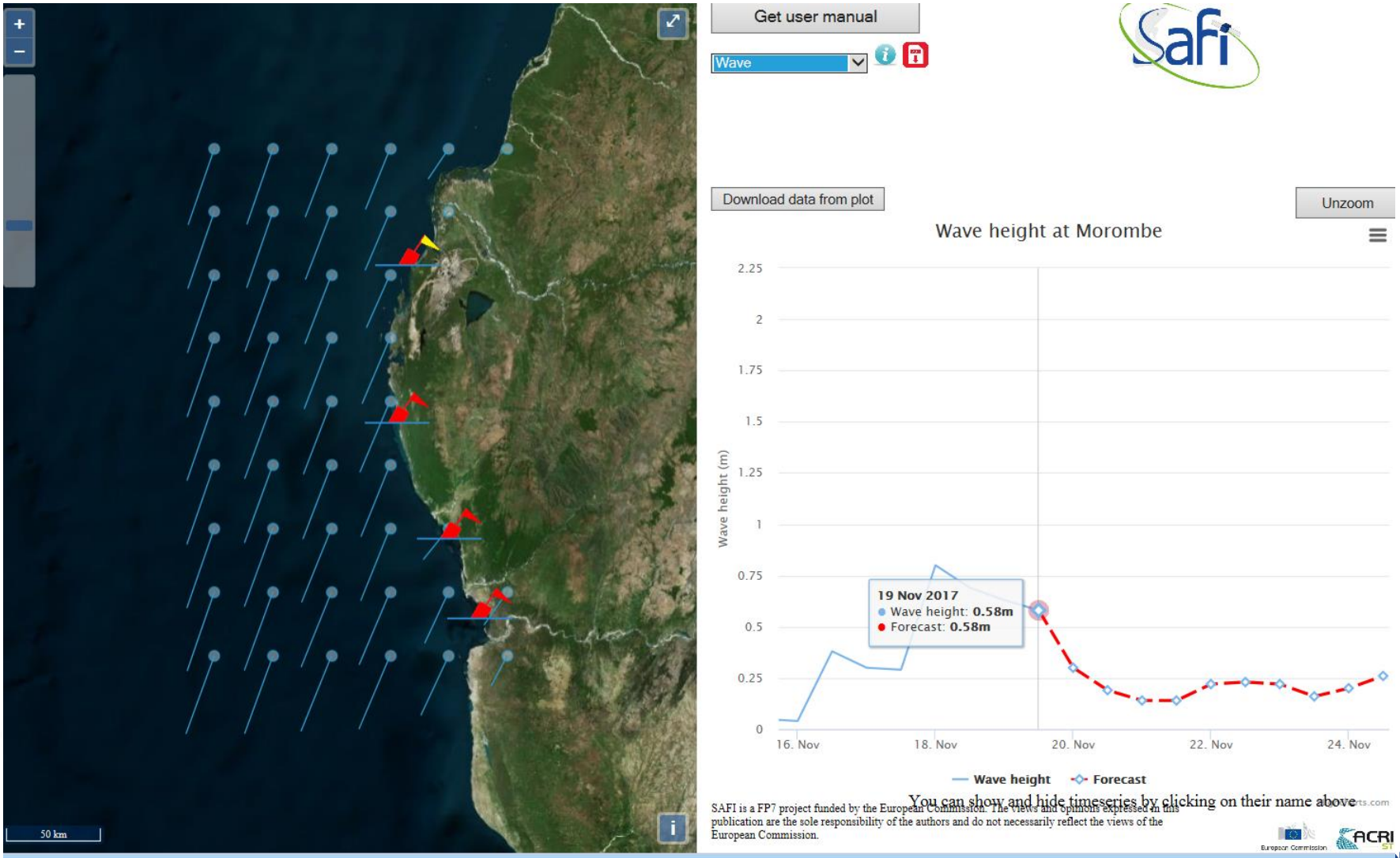
SAFI PRO Service: The Mini-Web Tool

Sea Surface Temperature maps and time series around Agadir , Morocco



SAFI PRO Service: The Mini-Web Tool

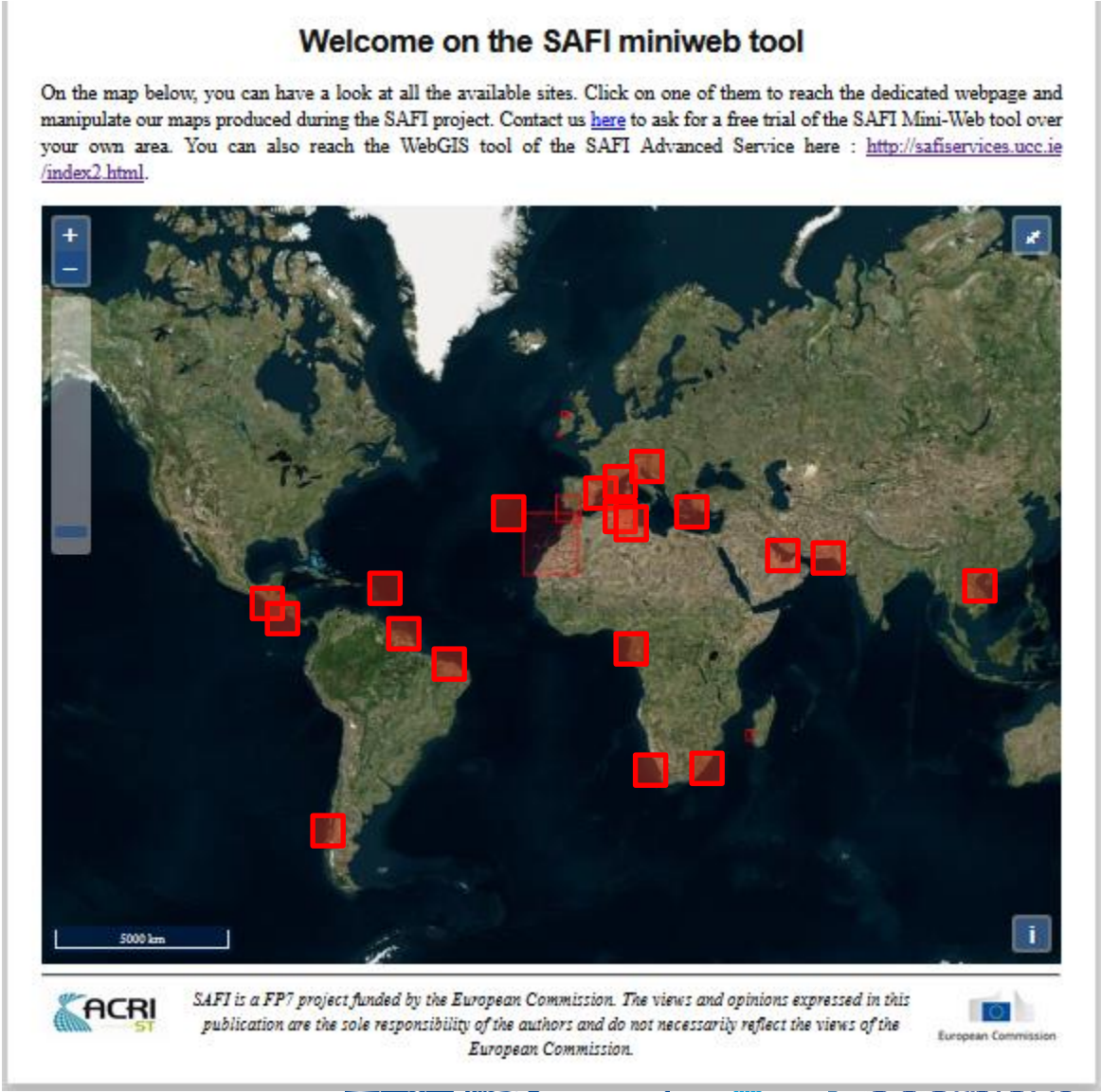
Significant wave heights maps and time series (with forecast)
Madagascar West coast



SAFI PRO Service: The Mini-Web Tool

After SAFI : External users interested !

Already about 20 requests for dedicated Mini-Webs sites in Chile, Azores, South Africa, Costa-rica, Brasil, Iran, Arabie, French Guyana, Guadeloupe, Gabon, Mediterranean Sea….



Conclusion & Perspectives

Bilan

- **Services démonstratifs ,** mis en place à partir des **besoins utilisateurs recensés**
  La discussion continue avec les groupes utilisateurs,
  Les volontaires pour discuter des indicateurs, des services proposés, ou tester le prototype d'outil sont bienvenus !
- **Exploitation des meilleures données environnementales** et **indicateurs** disponibles (notamment Copernicus – pérennité sur 25 ans)
- Lien entre experts données satellitaire et acteurs de la pêche et l'aquaculture

En cours

- **Evaluation scientifique des indicateurs** pour la pêche et l'aquaculture marine, Nouveaux indicateurs en développement pour compléter les services.
- Les partenaires ont mis en place un **business model** pour la fourniture des services SAFI **-> là aussi, discussion avec les utilisateurs potentiels**
- **Les activités de recherche et développement de SAFI ont continué** à travers de nouvelles initiatives (ex: projet Esa/Smart Innovator)

Session de formation et d'information Copernicus - Atelier Applications Côtières, Paris, 24 novembre 2017

Demonstration

SAFI Mini-Web Tools : www.acri-he.fr/projects/safi

Discussion

ANY QUESTION ?