

Studies to support the European Green Deal

Lot 1 Shellfish and algae

Inception Report

Date : 2021/12/14



Project presentation

This study is commissioned by the European Commission (EC) to support the European Green Deal

It is a study of Operational Research (OR) to potentially increase shellfish and algae farming and seabed restoration for decreasing the level of harming nutrients (recycling nutrients) and reducing greenhouse gas emission, while not affecting fisheries.

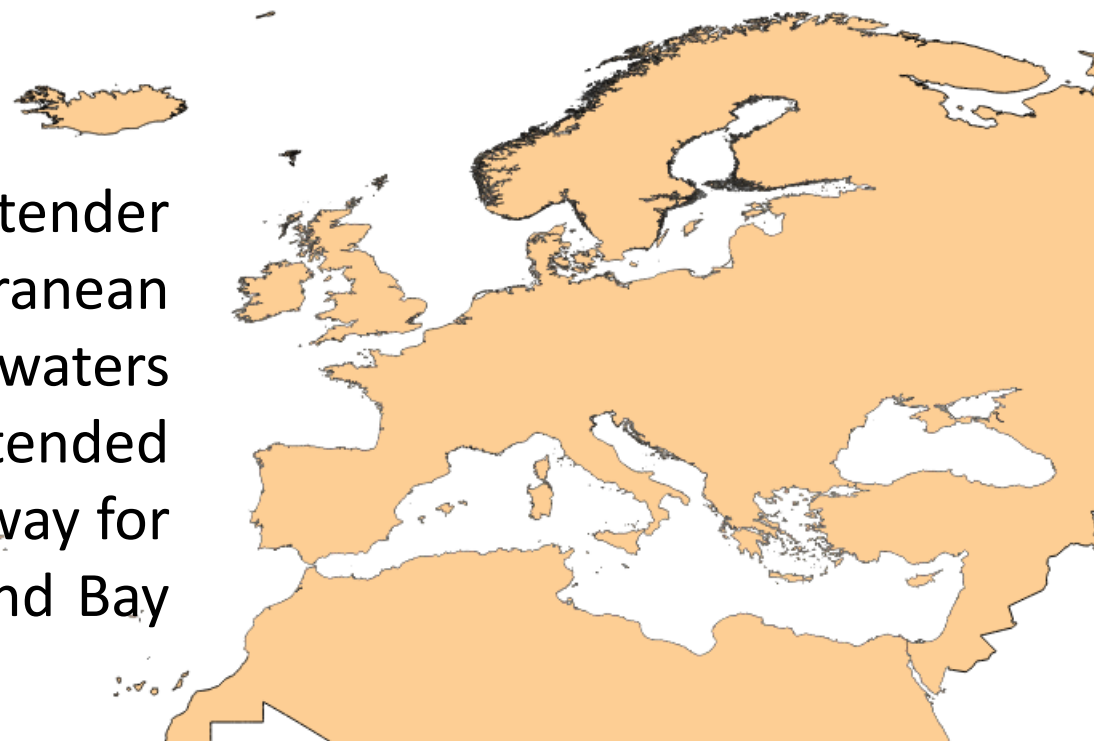
It is a matter of balance between benefits and drawback, using mathematical modelling and optimization. This type of study is core policy drafting and decision making.

This project will provide important insight into how increasing low-trophic level aquaculture and could be planned in the future to contribute to the blue economy under the EU's Green Deal.

In summary, the general objective is to produce digital raster maps of European marine waters that help plan and analysis of marine aspects of the Green Deal; the specific objective is to assess the potential of shellfish and algae to recycle nutrients and to estimate the greenhouse gas emissions generated by their production.

Project presentation

The study will cover the entire area required by the tender i.e. complete coverage of the Baltic, Black, Mediterranean and North Seas; – coverage of jurisdictional waters (including continental shelf and claimed extended continental shelf) of EU Member States, UK and Norway for the North East Atlantic (Celtic Seas, Iberian Coast and Bay of Biscay, Macaronesia, Norwegian Sea).



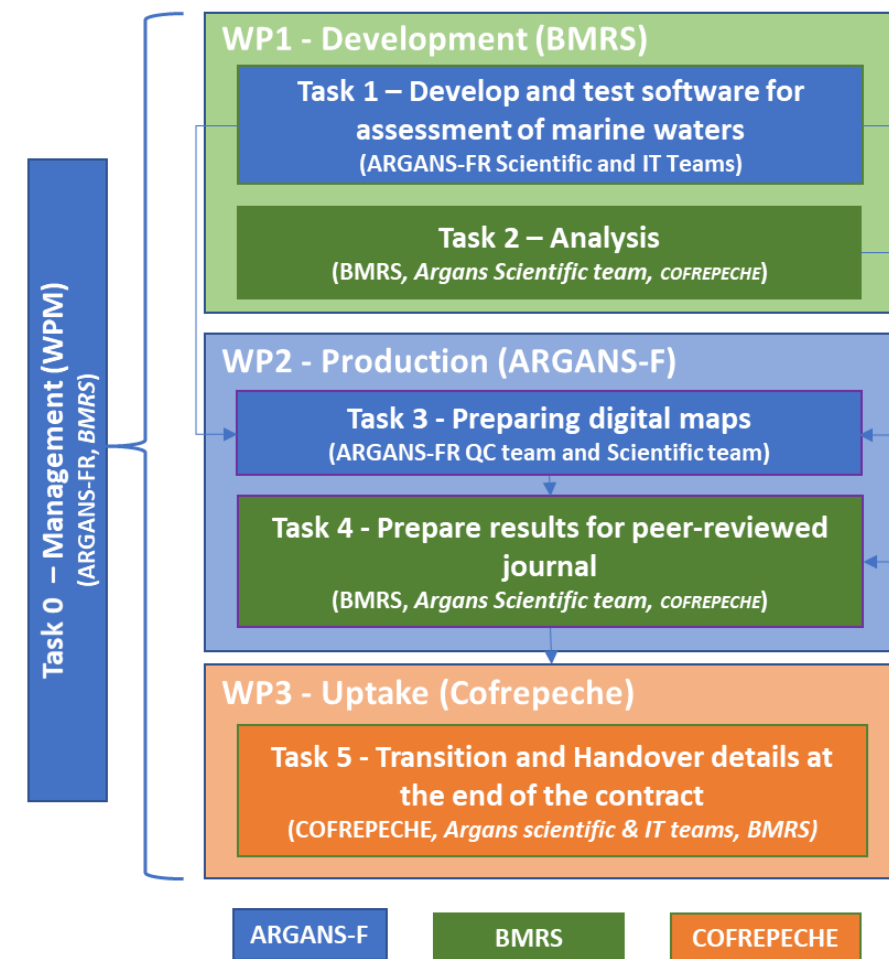
Project presentation

This project is divided into 4 Four Work packages

- ❖ **WPM: Management** Led by ARGANS with BMRS support, for effective project direction and management..
- ❖ **WP1: Development** led by BMRS
 - ❖ **Task 1** : development and test of the software – led by ARGANS
 - ❖ **Task 2** : Analysis – led by BMRS

Task 2 will provide specifications in ATBD (Algorithm Theoretical Basis Document – Norm generally used remote sensing application by spatial agency) documents to Task 1 to develop the software.
- ❖ **WP2 : Production** led by ARGANS
 - ❖ **Task 3** : preparing digital maps – led by ARGANS
 - ❖ **Task 4** : prepare results for peer-reviewed journal – led by BMRS

The maps produced by Task 3 will be qualified and analyzed to produce the paper(s) required in Task 4.
- ❖ **WP3 : Uptake** corresponding to the Task 5 (led by COFREPECHE), will receive information from all the WPs and Tasks.



In blue the works led by ARGANS-FR, in green those led by BMRS, in orange those led by COFREPECHE.

Consortium presentation

Three SME's

The consortium will be comprised of **three SME's** with a large background in international projects (FP7, H2020, Interreg, ESA project ...) in relation with the tender..

Policy, blue economy



Expertise in fishery management and national, supra-national and European support for governmental policies in integrated coastal zone management.

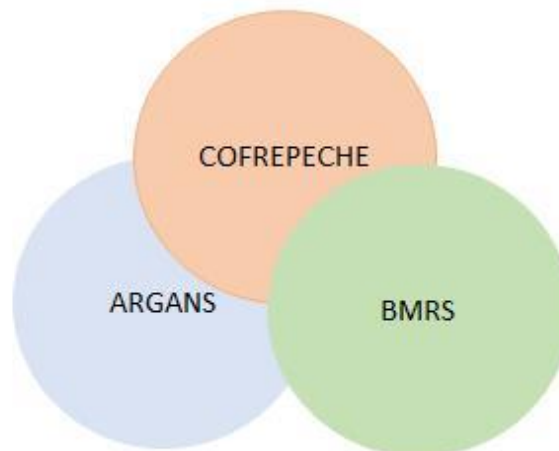
Geo-information, IT



Geo-information

Earth Observation. Oceanographic data analysis. Software development. Operational production to support institutional directives (MFSD, WFD, OSPAR) as well as aquaculture and fishery support

Policy, blue economy



Farming, ecology

Our strength

The multi-expertise approach

Farming, ecology



R&D driven aquaculture SME focused on delivery of marine biomass, bio-based products and knowledge of associated processes.

Partner presentation

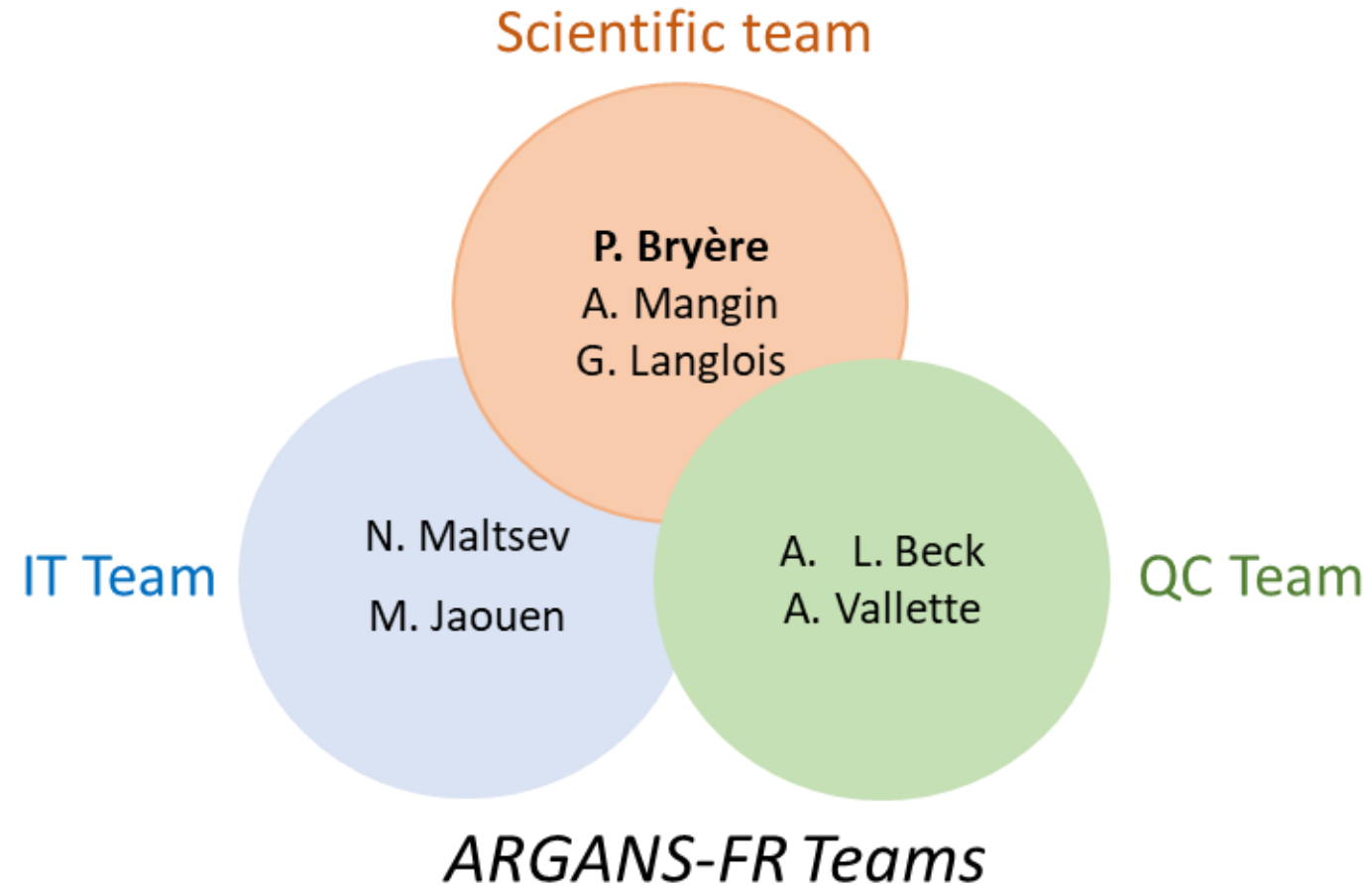


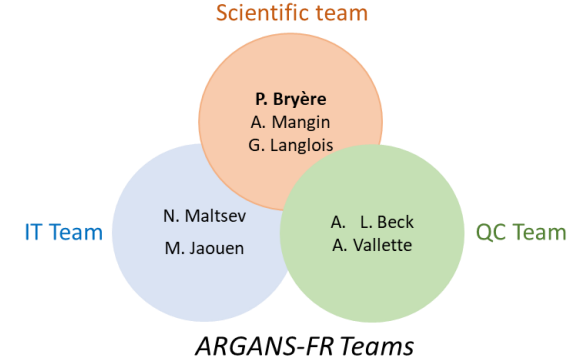
ARGANS, is a UK-registered company (<https://argans.co.uk/>) with headquarters based in Plymouth UK, offices in Sophia-Antipolis and Brest, and staff located in London and Southampton.

We are specialists in satellite-based Earth Observation, remote-sensing applications and services, and geographical information systems used to map and monitor the marine, atmospheric and terrestrial environments.

ARGANS is dedicated to environmental operations that foster a sustainable future and lead to improvements in the communities where we do business. ARGANS will continually maintain compliance with all local, state and federal environmental regulations and will strive to reduce our impact on the environment.

ARGANS leads the project (task 0 – WPM - Management), the WP2, the tasks 1 and 3 and will be involved in all the other ones.





Scientific Team & Management



Philippe Bryère (PhD): Project manager with more than 30 years of Earth Observation projects in support to water quality directives and aquaculture & fishery. He joins ARGANS in 2011 and works mainly on Ocean Colour (OC) thematic closely with IFREMER and French naval hydrographical service (SHOM) to calibrate/validate OC algorithms and generate end users products. He was involved in several national and ESA/EU projects (e.g. MyOcean, MCGS, SAFI, HiSea, IMPAQT, Nunataryuk, RanTrans, ...) for the generation of end users products, e.g. aquaculture, water quality and marine environmental assessment. Moreover, he has a strong software background.



Scientific Team



Antoine Mangin (PhD): Graduated in fluid mechanics obtained at Orsay in 1990 on the vortex flows. He has more than 25 years in the EO application domain and has a large experience in water quality assessment from satellite-based data, based on numerous projects in which he played a key role as scientific and/or technical coordinator (e.g. MARCOAST2, AQUAMAR, European Environment Agency). He has recently been involved in a study for the analysis and variability of transfer of nutrient in the Mekong delta. He managed the ESA-Innovator SMART and the SAFI (EU-FP7) projects, exploiting EO information to support aquaculture.



Gilbert Langlois (PhD): Senior Scientist specialist in Ocean Modelling. Expert in oceanographic numerical modelling, he worked for 6 years as a civil engineer at the French Oceanography service (SHOM), working on remote sensing of Sea surface temperature. In ARGANS since 2019, he works to the current/waves modeling, states of the art and data fusion for several project.

Scientific team

P. Bryère
A. Mangin
G. Langlois

IT Team

N. Maltsev
M. Jaouen

A. L. Beck
A. Vallette

QC Team

ARGANS-FR Teams

Partner Team



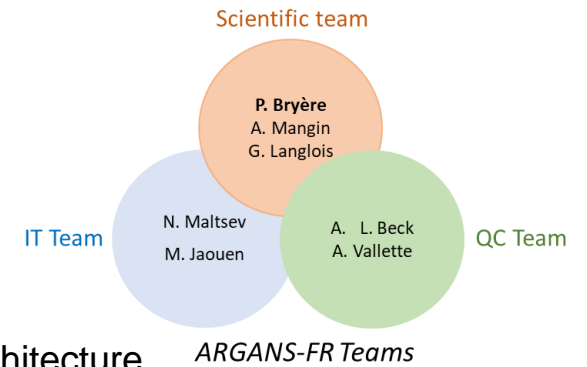
IT Team



Nikolai Maltsev : Engineer specialized in web and software development. Software architecture Manager. Expert in designing and building data management systems or solutions for distribution with different methods, he operates ARGANS web services. He Joins ARGANS in 2019.



Maël Jaouen : Research engineer specialized in Mathematics and software development, he joins ARGANS in 2020,



Partner Team



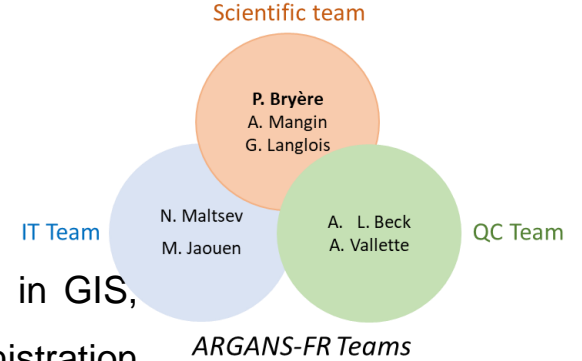
QC Team



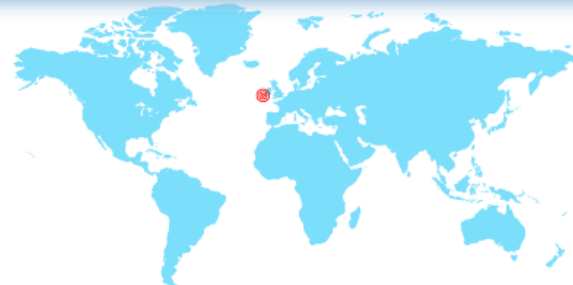
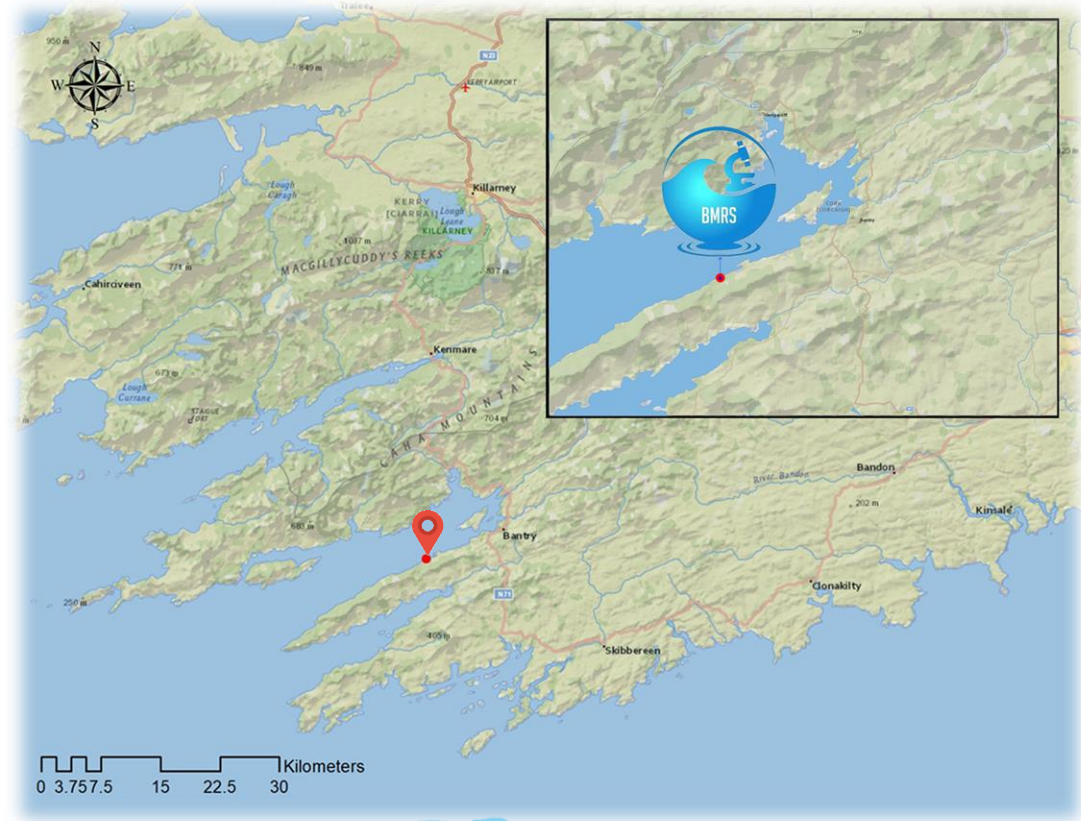
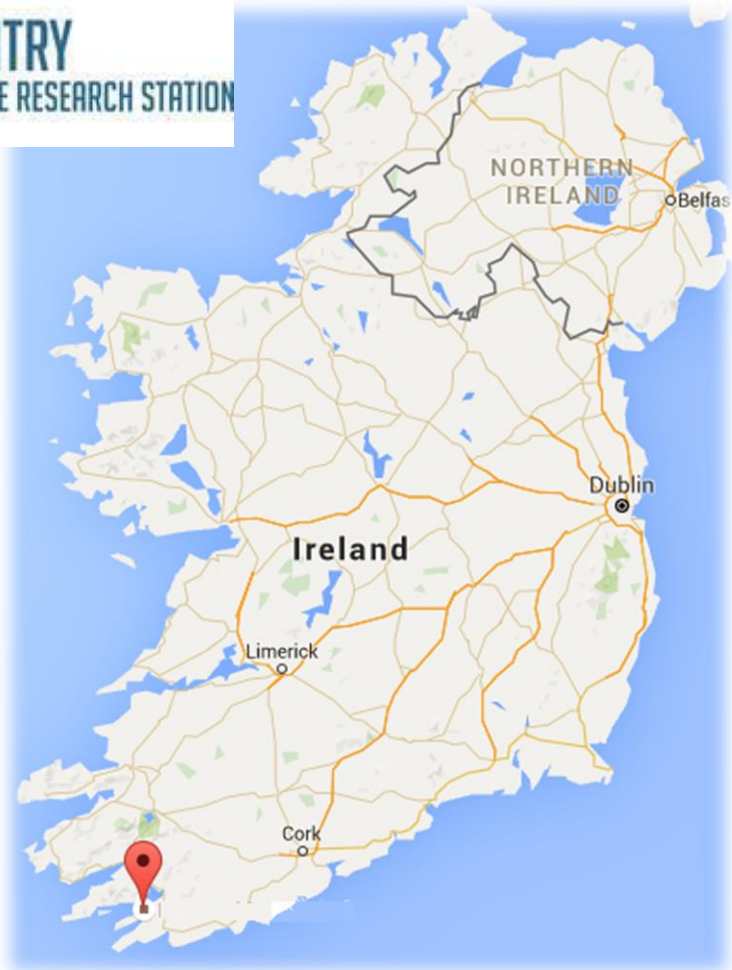
Anne Vallette (PhD): Graduated in geography and land use planning with an option in GIS, modelling and remote sensing. She will help in the project management and administration tasks. In ARGANS group since 2010, she was involved in various studies including the detection and cartography of mangrove swamps from VHR satellite images for ADB/ESA. She is the Litter-TEP project manager.



Anne Laure Beck: Graduated from the ENSG, Paris (Ecole National des Sciences Géographiques), specialized in geomatics and remote sensing. In ARGANS since 2019, she is working as technical lead for the Coastal Erosion from space project and as python developer support for the CCIER project. These experiences provide her a complete and significant background on data fusion, spatial analysis and cartography.



Partner presentation



Partner presentation



6 Hectare sea site
• For seaweed culture in Bantry Bay

Multi-species aquaculture licence
Awarded by the Dept of Agriculture

4.6 Hectare sea site
• For sea urchin and oyster culture in Dunmanus Bay

Animal Experimentation
• Awarded by HPRA

Partner presentation



*(Seaweed hatchery in
conjunction with Cartron Point
Shellfish and BIM)*



Cartron Point Shellfish Ltd.



Partner presentation



SEAWEED PROJECTS

**Alaria
Bioactives**

Methane

IDREEM

NetAlgae

AquaTech4Feed

Farm4More

AgRefine

Seabioplas

MABFUEL



Partner presentation



SHELLFISH PROJECTS

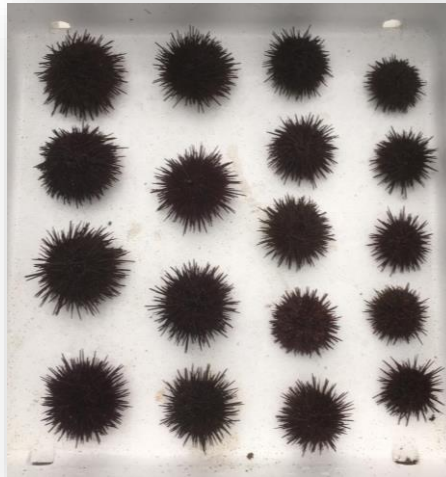
Nanoculture

Sea urchin hatchery

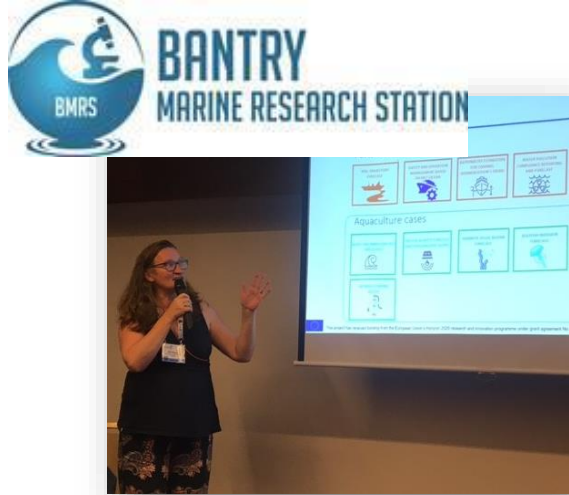
Mussel projects

Mussel larvae & acidification

Scallop projects



Partner Team



Dr Julie Maguire

Team Leader

>20 years experience of algal and shellfish aquaculture research and innovation



Dr Martin Johnson

Modeller

>15 years postdoctoral experience in marine biogeochemistry research



Dee McElligott MSc

Research Scientist

>10 years experience in marine macroalgal and related research.



Dr Simona Paolacci

Research Scientist

>10 years experience in plant science and environmental sciences research

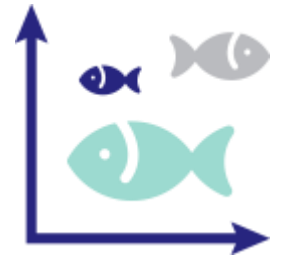
Partner presentation



COFREPECHE is one of the leading European consulting companies specialized in the fields of **fisheries, aquaculture and marine environment**.

40 years of experience in providing consulting services, undertaking studies and implementing challenging technical assistance projects in France and internationally.

COFREPECHE has developed a technical, economic and financial know-how in the fields of fisheries, aquaculture and Integrated Coastal Zone Management. Since its creation, COFREPECHE has implemented **over 750 projects in more than 70 countries** across Europe, the American continent, South-East Asia, Africa, the Middle East, the Pacific Ocean and the Indian Ocean.



Partner Team



Chloé GUILLERME joined COFREPECHE in 2020, she participates in all related management tasks and quality control in the fishery, aquaculture and marine environment sector. She has worked on multiple projects including another EU funded project on challenges faced by fisheries in the Mediterranean and Black Sea.

She graduated from a MSc in Oceanography and marine environment and MSc in Resource Management.

Chloé will be the project manager dedicated to the project at COFREPECHE and will be in charge of sub task 2.6 and Task 5.



Yéelen OLIVE joined COFREPECHE in 2018, she also participates in all related management tasks and quality control in the fishery, aquaculture and marine environment sector. She is currently in charge of four projects related to these fields in French Guyana, Sri Lanka, Mauritania and in the EU.

She graduated from a MSc in Oceanography and marine environment.

Yéelen will follow the project and take care of it in the event of Chloé absence.

Management – WPM – Task 0



Time-table

			Months	1	2	3	4	5	6	7	8	9	
	Tasks	Description	partners										
WP0	0	Management	ARG	IncR				dIR	IR			dFR	FR, D6
	1	Development and test of the software for assessment of marine waters	ARG					ATBD-IT					D3, D4
	2	Analysis :	BMRS/ARG/CFP		D1			ATBD-SC					
	2	Subtask 2.1 Seaweed and Shellfish modelling											
	2	Subtask 2.2 Farm models											
	2	Subtask 2.3 Nutrient availability model											
WP1	2	Subtask 2.4 Farm optimisation and allocation algorithm (FOAA)											
	2	Subtask 2.5 Net CO2 emissions											
	2	Subtask 2.6 impacts on fishing											
	2	algorithms for new species.											
	2	Integration of new constraints											
	2	Integration of governmental policy in coastal area management.											
WP2	3	Preparing Digital maps	ARG										D2
	4	prepare results for peer-reviewed journal	BMRS/ARG/CFP										D5
WP3	5	Transition and Handover details et the end of the contract	CFP/ARG/BMRS										

[D1]: All input data

[D2]: Digital maps

[D3]: Software to produce maps

[D4]: Instruction for using software

[D5]: A manuscript for a peer review publication

[D6]: Final review presentation

ATBD-IT describing in detail the software architecture.

ATBD-SC describing in detail the algorithms used in the analysis.

Meetings:

IncR: Kick-off meeting (presentation provided)

dIR : Draft of interim report

IR : Interim report Review

dFR : Draft of Final Report

FR : Final review

Monthly Technical meetings with partners.

A webinar could be planned at T0+7



Risk analysis

- ❖ The project is considered to be a moderate to low risk endeavour.
- ❖ Appropriate management milestones will be used to ensure that progress is made within the time-scale of the project. The co-ordinator has vast project management experience and is well aware of the needs and expectations of the client.
- ❖ Because of the small number of partners (3) involved, project co-ordination will not present a significant logistical challenge.
- ❖ All partners are experts in their field and have vast experience so there is minimum risk that all the work will not be carried out to the same standard.



Task 1: development and test of the software

Objective :

To produce the required maps with an opensource software (free of charge and free to be distributed and extended) developed in free languages, Python, R, Shell.

- **Python scripts** will be used to access the input data sources via the webservice provided by EMODnet, Copernicus and other complementary providers. It also be used to de develop the skeleton of the software.
- **R language** will be used for the statistics reports and the analysis software detailed in Task 2.



Task 1: development and test of the software : **Processing**

The diagram summarizes the *preprocessing*

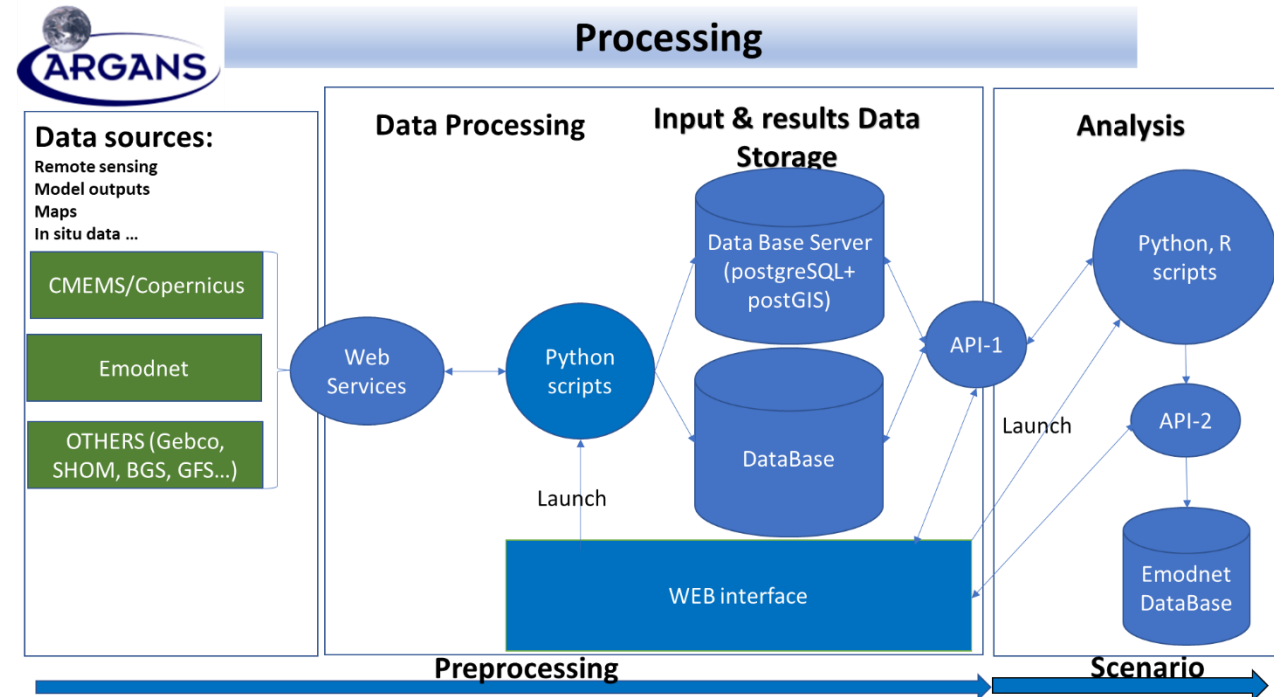
- to access the input data using the webservices
- to process them (gridding 1km*1km, testing quality, ...)
- to store the results in a local dedicated database.

The *analysis* scripts access the environmental database via an API (API-1) developed in *Python*.

Python and *R* scripts will be used to implement the analysis and scenario to provide the required maps.

A *second API* (API-2) developed in Python will upload the results in the EMODnet database. The results will also be uploaded to the local database via the API-1.

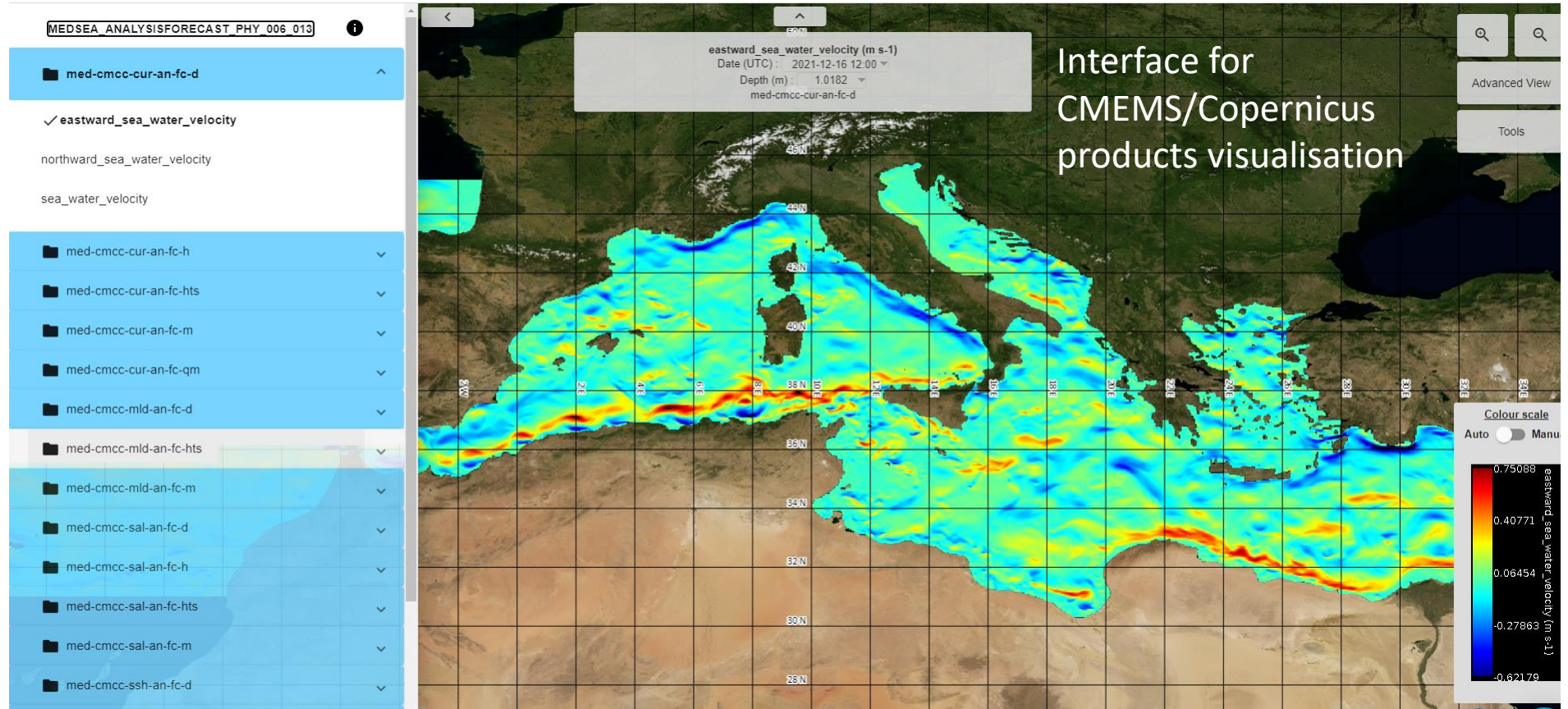
A *webapp*, based on Open Geospatial Consortium (OGC) will be developed to search, visualise and download the results of the project accessing the local database via the API-1 and the EMODnet database via webservices.





Task 1: development and test of the software : **WEB interface**

A **Web interface** will be developed to allow the users to easily **parameterize** the software and **launch** accessing, reading analysing and map generation. This Web interface will be based on Open Geospatial Consortium (OGC)-based standards.



Interface for
CMEMS/Copernicus
products visualisation



Task 1: development and test of the software : **WEB interface**



Black Sea and Plastic waste from Space

✉ BSPlastics@argans.co.uk



👤 Logout

HOME

SERVICE

TUTORIAL

DOCUMENTATION

CONTACT



Layers

Forecast request

Litter

Floating Litter

2021-12-09



▼ 📁 Sentinel 2 images

▼ 📁 Danube mouth

📅 2016/06/07

📅 2018/04/23

📅 2019/03/24

▼ 📁 Kerch strait

📅 2016/06/18

📅 2016/07/23

📅 2019/09/16

📅 2020/03/04

📅 2020/04/03

📅 2017/07/03

📅 2017/07/23

📅 2018/04/29

📅 2018/10/16

📅 2019/06/18

📅 2020/03/04

📅 2020/04/03

Tiling Grid



LITTER drift model processed with data from the **COPERNICUS Marine service information - Satellite image under ESA credits**

44.2152 28.7490

Task 2: Analysis

Summary: Scientific modelling of farm-scale seaweed / shellfish production and solving for required scenarios

2.1 Seaweed and Shellfish models

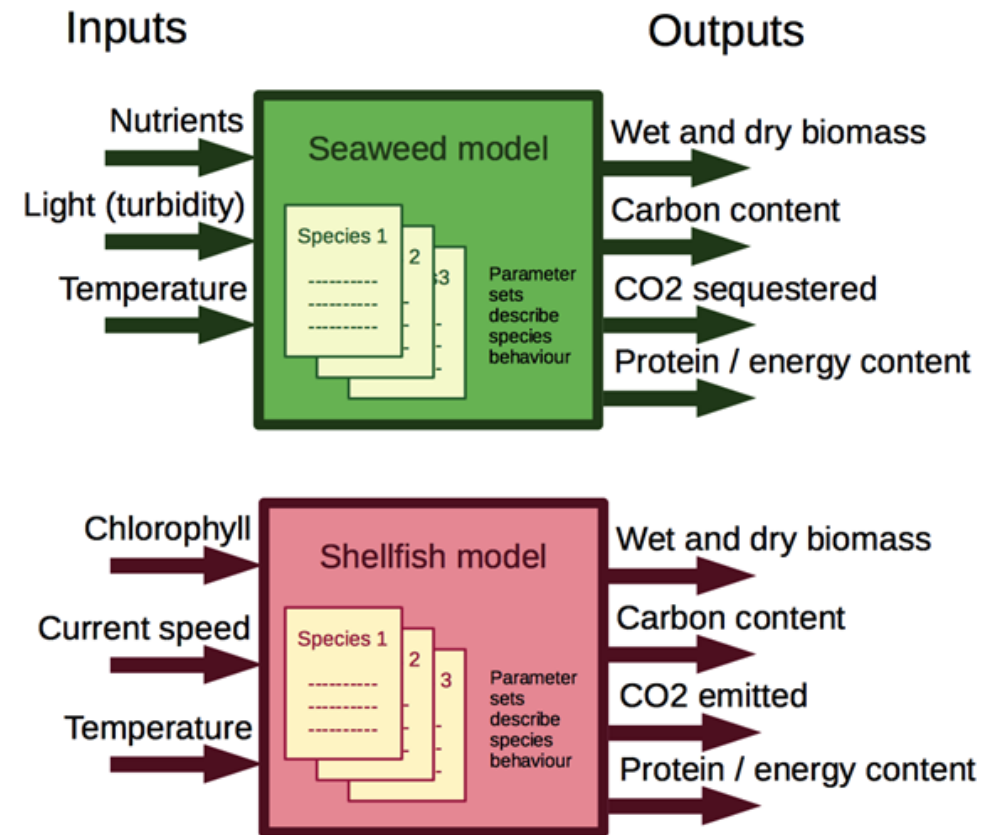
Generic seaweed and shellfish models able to represent multiple species (i.e. 1 structure, multiple parameter sets)

Highly parameterized (i.e. not modelling process detail)

Takes monthly parameters and returns productivity and associated variables per grid square

Includes nutrient (and OM?) production and uptake to allow spatial interactions to be implemented

Calculates productivity per m of rope(? – to be discussed)



Task 2: Analysis

2.2 . Farm model

- scale up to 1x1 km grid square
- account for infrastructure / landing CO₂ emissions
- Feed back to geospatial data on nutrient (+OM?) dynamics
- proposed to allow multitrophic farms but may not do this due to evaluation comments

2.3 Nutrient model

- criticized by evaluator
- as presented in tender each month the drawdown (or regeneration) of nutrients was to be propagated to adjoining grid squares to approximate 'mass balance'
- Needs to be refined – to discuss later

Task 2: Analysis

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- Needs to be refined – to discuss later

Task 2: Analysis

2.4 . Farm optimization and allocation algorithm

- Genetic algorithm to optimize farm type and placement to achieve a given set of targets (e.g. limits to area used, optimizing for CO2 drawdown while achieving a given protein output for food+feed)
- Targets derived from scenarios presented in tender call but others can be added
- Can take a 'no aquaculture' mask to represent protected areas
- Also risk maps of e.g. HABs, maximum wave height etc to balance maximum production against risk

Task 2: Analysis

2.5 . Net CO₂ emissions

- Net CO₂ uptake from seaweed up to point of landing (as per call we are not considering fate of landed products)
- Net CO₂ release from shellfish (including calcification) to point of landing
- Carbonate system response modelled (i.e. 1 mole CO₂ taken up in water does not equate to 1 mole removed from atmosphere due to buffer factor).
- Also calculate methane, N₂O emissions per farm.

Task 2: Analysis

2.6 . Impacts on fishing



- Identification of potential impacts and how to evaluate them quantitatively :
 - Spatial impact on fisheries;
 - Light and nutrient depletion on fish stock;
 - HAB proliferation on fish stock.
- Include the data in the software and implement the four scenario:
 - Assuming 1, 2 and 5 million tons (wet weight) of algae and shellfish production in the EU27;
 - Realistic distribution of cultivation in waters of EU27 Member States.
- If possible, translate quantitatively these impacts from an economic point of view (9 months extension)

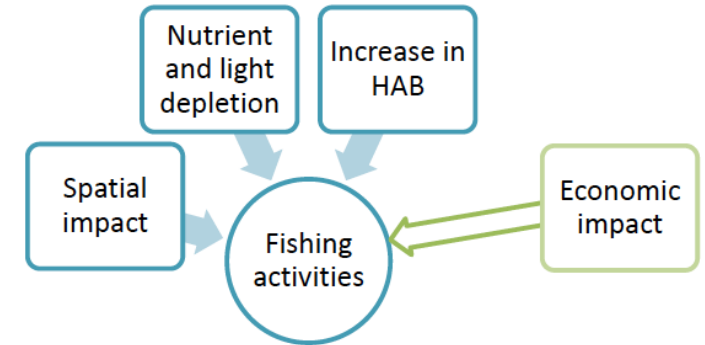


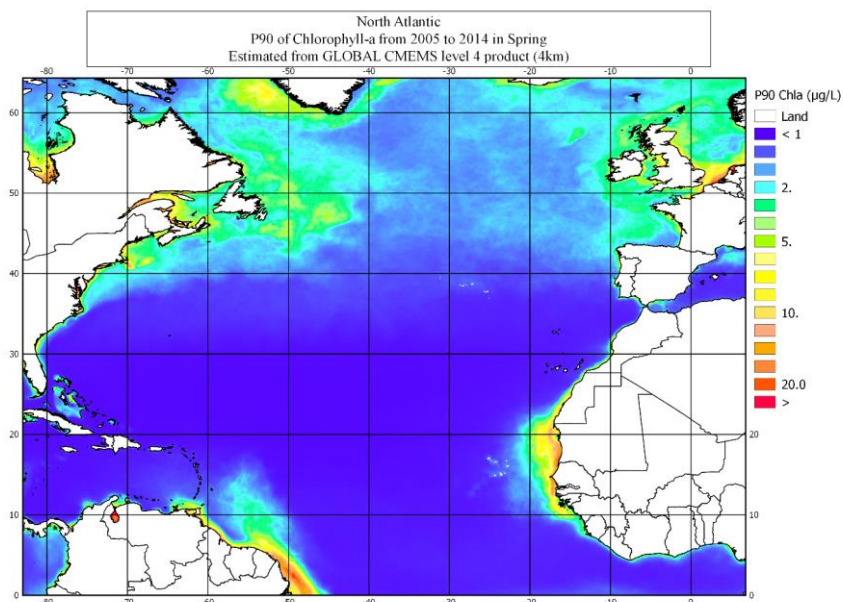
Figure 14: Potential impact on fishing (main impact studies in subtask 3.6 in blue, ideas and track in green)

Task 3 : Preparing digital maps

- The digital maps will show the results of task 2.
- They will be at least a 1km x 1km grid.
- They will be provided in digital format
- They will illustrate the potential of European seas for low-trophic level aquaculture

They will show at minima:

- **The production potential** for each species in the areas listed above. Maps will be provided for dry and wet weight in kg, kg protein, kcal, kg CO2 ... All expressed in unit/km²/year.
- **A scenario for each species to maximise production.** This will include the effect of the carrying capacity of the waters in terms of nutrients.
- **The impact on fishing** of an increase in cultivation of extractive species



As requested, the maps will be provided in format easily ingested by the **EMODnet** ingestion portal (<https://www.emodnet-ingestion.eu/about>) and respect **INSPIRE** rules. The data format provided will be in Geotiff, netCDF and png.

← Example of map provide in the “Sea Basin Checkpoint” North Atlantic project (DGMARE)



Task 4 : Prepare results for peer-reviewed journal

- technical manuscript detailing the methodology and approach taken and validating the results against observational data of aquaculture activities around European seas and independent species-specific and farm-level models of aquaculture production.
- Thereby validate predictive capability of both the carrying capacity and spatial allocation of aquaculture within our system.
- published in a broad, high profile technical journal such as PLOS ONE, which is fully open access

 **Task 5: Transition and Handover details at the end of the contract**

- Review of the documents and software → Continuous
- Organization of training courses with the Client to explain what has been done and how, and how to install, use, parameterize, and/or implement the software → 1,5 month before the end of the contract
 - Training course support, agenda and minute of meetings will be provided
- Coordination for technical support if correction of bugs are needed → until 3 months after the end of the contract
- Coordination for technical support in case of a malfunction → until one year after the end of the contract

Discussion :



Thank you for your attention