Tools for Assessment and Planning of Aquaculture Sustainability

SHORT TITLE:	**TAPAS**
COORDINATOR:	**Prof. Trevor Telfer**
ORGANISATION:	**University of STIRLING, UK**
TOPIC:	**H2020- SFS-11b-2015**
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Proceedings from the Terminal TAPAS conference in Brussels

Authors:

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1 SUMMARY

On 15th January 2020, TAPAS project partners and stakeholders attended the TAPAS project closing conference at Scotland House in Brussels.

This document is Deliverable 9.7, the proceedings for the final TAPAS conference, hosted as part of the EU H2020 TAPAS (Tools for Assessment and Planning of Aquaculture Sustainability) project. The conference was held to give partners the opportunity to present the work that carried out during the project, some of the technologies that were developed, and the applications of these to European aquaculture. The Aquaculture toolbox was also explained and demonstrated.

The document includes and introduction to the conference, details of the venue and programme and summaries of the presentations that were given at the conference. It also features pictures of some of the presenting partners. The conference presentations were given by: Laurent Barille (UN), Stefano Ciavatta (PML), Trine Dale (NIVA), Lynne Falconer (UOS), Pierre Gernez (UN), Hanne Kaas (DHI), Arnaldo Marin (UM), Pauline O'Donohoe (MI), Nikos Papandroulakis (HCMR), Andreu Rico (IMDEA), Stefan Simis (PML), Trevor Telfer (UOS) and Manolis Tsapakis (HCMR). Malcolm Beveridge and Paul Tett from the TAPAS project Advisory Board gave a key note talk presentation and moderated open discussions, respectively.

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2 Introduction

2.1 Introduction to the Conference

TAPAS is a four-year EU Horizon 2020 collaborative research project, which began in March 2016. The TAPAS consortium is made up if 15 partner organisations including research institutions, SMEs and regulators from across Europe. The project aims to promote and consolidate the environmental sustainability of the European aquaculture.

Aquaculture is the fastest growing food production sector in the world. However, the EU self-sufficiency in terms of seafood is low, with nearly 70% of the seafood consumed being imported. To turn this situation, EU member states prepared national strategies for an ambitious 25% growth by 2020. The TAPAS project will provide scientific research data about aquaculture sectors in both marine and freshwater environments to sustainably support this action.

The outcomes include the development of the Aquaculture Toolbox, a web-based tool to help decrease the licensing time for new and existing developments, enhance the public image of aquaculture and to gain a better understanding of the sustainability of aquaculture in the EU.

The sustainability of aquaculture must be ensured by applying a holistic view in developments as well as in the management of existing facilities. This method is described in the aspects of the ecosystem approach to aquaculture (EAA) saying that aquaculture activities should always be within the carrying capacity of the ecosystem. The Toolbox includes modelling and monitoring tools to investigate carrying capacity categories of freshwater and marine aquaculture in terms of recent regulation, policies, and indicators of sustainability while remaining focused on the most relevant problems of the aquaculture industry.

On 15th January 2020, project partners and stakeholders attended the TAPAS project closing conference at Scotland House in Brussels. Here, the Aquaculture Toolbox was explained and demonstrated, and partners presented the work they had completed using the tools identified in the toolbox.

2.2 Venue, participants

The final TAPAS conference was held at Scotland House in Brussels, Belgium. The final conference was held for stakeholders and partners. At the conference, partners were able to present the work they had completed during the TAPAS project.

A total of 39 participants attended the final conference. The participant list consisted of partners and stakeholders from research institutions, academia, SMEs, and aquaculture industry.

2.3 Program

The opening session set TAPAS in the context of wider European Aquaculture. This session was followed by a session all about the Toolbox, including a demonstration and an opportunity for attendees to try it out. In the afternoon session partners exhibited the results of their studies

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and technological and model development. The session wrapped up in the late afternoon with a presentation about the future implementation of the TAPAS project and a discussion.

3 Aquaculture Toolbox

3.1 Theory and reasoning behind the Aquaculture Toolbox

Trevor Telfer of the University of Stirling opened the conference with a welcome and introduction to the TAPAS project, providing context of aquaculture in Europe and some of the licensing and regulations in Scotland and Norway. The presentation went on to explain how current fragmented approaches to licensing create additional challenges for the future of enhancing the environmental sustainability of aquaculture, and how the aims and objectives of the TAPAS project will help contribute to the sustainable growth of the European aquaculture sector. In a brief breakdown of work packages, participants were also introduced to the case studies and models used across Europe during the project.

Consultant, Malcolm Beveridge explained the need for aquaculture production to increase as part of blue growth, in order to help meet the planet's increasing demand for protein and nutrition. His presentation also stressed the need for this growth to be managed so that it can be done sustainably. Some of the key areas highlighted by Malcolm were alternative sources for aquafeeds, implementing of the UN code of conduct for responsible fisheries and adoption of new model technologies, such as cellular aquaculture.

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Per capita fish supplies have doubled over the past half century. Much of this can be ascribed to the recent, rapid expansion of aquaculture, which now accounts for half of all fish and shellfish consumed. Aquaculture has the potential not only to address supply-demand gaps but also many of the Sustainable Development Goals, including those on poverty, hunger, health, work, climate and the aquatic environment.

This presentation focuses on aquaculture and food and nutrition security. However, it also highlights that for aquaculture to fully realize its potential to meet the SDGs there must be a shift away from the current prevailing narrative of the sector's role in fish supplies.

The various sectors that comprise the Blue Economy have different associated costs and benefits. Countries must consult widely and adopt a strategic multi-sector approach in order to determine the role of the aquaculture sector within the Blue Economy. In some countries sectoral expansion may be limited because essential resources, such as space, are to be preferentially allocated to other sectors. Elsewhere, growth of aquaculture SMEs may be prioritised over that of multinationals in order to generate greater local economic impact. In yet other parts of the world growth of aquaculture may be guided to improving resilience to climate change or helping provide food-based solutions to poverty and hunger.

With nearly 90% of wild fish stocks fully or overfished, it is widely believed that future growth in supplies must come from aquaculture. However, new, disruptive 'clean fish' technologies are also under rapid development. Three-D printing of fish produces contaminant free products that require little land or water, no fishmeal or fish oil, pose no welfare issues and produce little in the way of greenhouse gases.

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Pauline O'Donohoe from The Marine Institute in Ireland presented policy recommendations and the future of EU policy for aquaculture, based on bottlenecks that already exist in the application process.

Following three phases of consultation with industry, regulators and relevant stakeholders the bottlenecks facing the development and advancement of the European Aquaculture industry were identified through Work Package 2 of the TAPAS project.

These bottlenecks included:

- The time taken to determine a licence decision.
- Poor communication with, within and between decision makers.
- Negative perception of the industry.
- Lack of political will to support or expand the aquaculture industry.
- Costs involved in applying for a licence vary significantly across jurisdictions.
- National and EU - legislation and regulatory frameworks are complex, both on an EU and a national level.
- The number of licences varies between jurisdictions in terms of licences, permits, registrations, and other authorisations, which can be a significantly high number when totalled.
- The Term and Ownership of licence was found to be too short which makes planning, investing and operating a business difficult.
- Amending / Renewing licence - In many jurisdictions it is equivalent to a new application.
- Policy - The need to implement national policies fully was highlighted.
- Application Complexities - the number of licences required to operate is considered excessive. Simplification of the administrative process is needed.
- Incomplete Applications - incomplete applications and request for further information and surveys during the process leads to time delays and increases the duration of the process.
- Decision making - the process is complex, with Multiple agencies/Multi-level governance involved.

During consultation recommendations were drawn up to help alleviate these bottlenecks. As follows:

- Develop a modern electronic licensing system focused on the provision of:
    - Formal timelines with real-time tracking.
    - Accessible guidance and procedural information for all users.

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    - Enhanced communication.
    - Flexibility to support new and emerging technologies.
- Provide clear guidance for quantifying impact and balancing risk, with accessible and understandable tools to assist in quantification and risk assessment.
- Develop and improve tools and environmental models, making them accessible to industry and planners, to assist with site identification, site optimisation and carrying capacity assessment.
- Carry out real time, inexpensive, risk focused monitoring to assess the environmental impacts and monitor for potential impacts.
- Level the playing field for costs of applying for, and fees applied to, aquaculture licences, particularly regarding environmental impact statement preparation.
- Streamline aquaculture legislation by condensing the number of licences required to operate (and synchronising validity periods); incorporating operational flexibility into the legal framework and appropriate licence terms to support industry investment and planning, facilitating research using trial licence models.
- Harmonise the implementation of EU regulations by reducing the variation in implementation including harmonising of procedure and requirements for EIS and EIA incorporating reference to the benefits and costs of aquaculture within regulation.
- Encourage the implementation of the National Plans and the amended EIA Directive across jurisdictions to help simplify processes and administration.
- Designate strategic national aquaculture zones as part of spatial plans where risk assessments, capacity and impact studies are carried out on an 'area' approach in advance of issuing licences, balancing considerations of economic growth and environmental protection with cumulative impacts of development.
- Develop local scale, producer lead, communication platforms to facilitate dispute resolution between resource users, enhancing cooperation and developing a forum to represent local producers on a broader regional scale to input into local planning.
- Develop public communication platforms to make monitoring information publically available, providing context, and to provide explanatory information about aquaculture to the media and general public.

The Aquaculture Toolbox now contains relevant licensing and policy tools for applicants and regulators to aid in the licensing process taking into considerations these recommendations.

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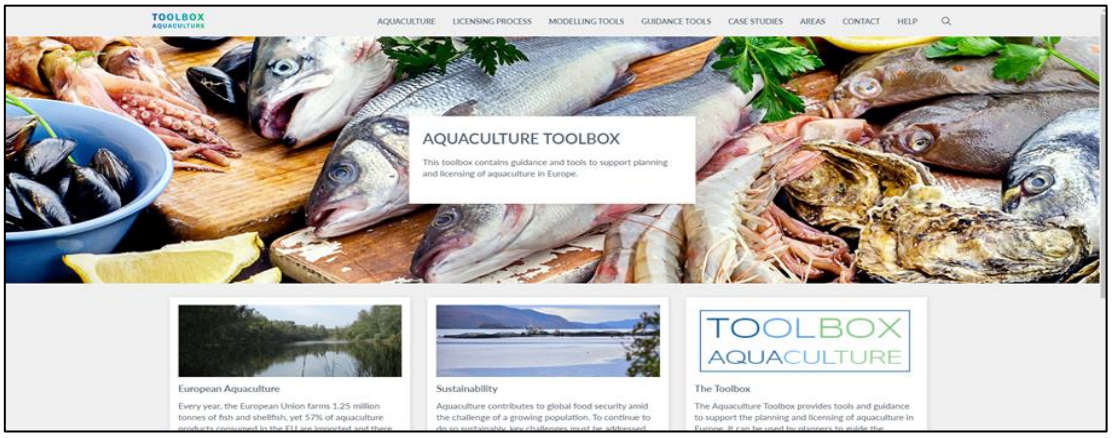
3.2 The Aquaculture Toolbox

Hanne Kaas from DHI AS in Denmark, introduced the reasoning behind the Aquaculture Toolbox. The toolbox is a major dissemination platform for TAPAS tools which will communicate the needs for licensing of European aquaculture now and in the future, give guidance on best practice in regulation and performance, provide one-stop access to model and guidance tools to support aquaculture planning and management, support the application by examples of use of model and guidance tools and support the "conversation" between all stakeholders. She demonstrated how stakeholder engagement throughout the TAPAS project has helped guide the content for the toolbox, with the most frequently demanded tools being models and those used for spatial planning.

A Toolbox walk-through and demonstration was carried out by Lynne Falconer of the University of Stirling.



3.3 Application of models to shellfish production

Laurent Barille of the University of Nante, France presented information about how models can be applied to shellfish production to map and model growth potential. GIS tools can be used for site selection taking into consideration the current potential and climate-robustness of offshore areas in order to map industry relevant indicators such as days until market weight, conflicts in use of space, food availability and bathymetry. There is increasing demand and limitations for

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available space for shellfish cultivation, the models can be used to determine if offshore sites are suitable for bivalve production.

A range of models for shellfish production have been developed and applied as part of the Tools for Assessment and Planning of Aquaculture Sustainability (TAPAS) project (Falconer et al. 2016). They operate at both near-field (defined as the farm to regional water body scale) and far-field (national water body to global scale) levels, for the planning and management of sustainable aquaculture. All relevant models for European shellfish production integrate a spatial dimension and combine organismal energy budget and ecosystem modelling, earth observation and Geographic Information System (GIS). Their spatial resolutions vary from 20 m, for Sentinel 2 observations of the tidal variability over oyster-farming areas (Gernez et al. 2017), to 12 km, for pan-European approaches (Palmer et al. 2019a). Earth observation combined with Dynamic Energy Budget (DEB) models were used to map industry relevant indicators (Palmer et al. 2020). As the increase in and expansion of aquaculture and other human activities in the nearshore coastal environment has resulted in limited available space, extending shellfish production further offshore was considered for France, the UK, and Norway (Palmer et al. 2019b). Offshore shellfish production should be considered as a potential use via the implementation of the 2014 Marine Spatial Planning (MSP) EU directive. Site selection to ensure the feasibility and sustainability of aquaculture investments and activities was identified as a crucial step (Barillé et al. 2020, Falconer et al. 2019). Large-scale zoning has been demonstrated to highlight broad areas of interest, which can be targeted for more detailed or high-resolution investigation for farm-scale siting (Palmer et al. 2019 b). GIS-based Spatial Multi Criteria Evaluation (SMCE) showed that large areas are suitable for offshore shellfish aquaculture despite other existing uses of the offshore coastal area. SMCE tools should be transferred to stakeholders, and particularly to shellfish growers and representatives, to help them participate and self-advocate in the ongoing MSP debate and implementation.

3.4 Satellite data and use in European aquaculture monitoring

Sites that are deemed suitable for aquaculture and where aquaculture is already taking place can be monitored using satellite observation. Stefan Simis (Plymouth Marine Lab, UK) and Stefano Ciavatta (Plymouth Marine Lab, UK) introduced the conference to the use of satellite data in European aquaculture monitoring. There are challenges associated with using satellite monitoring for aquatic environments because of the resolution required to resolve water colour from land/cloud and atmosphere. Medium (300m) and high (10-100m) resolution satellite images can be used to identify harmful algal blooms and provide early warning for fish farming and aquaculture to help prevent losses. Satellite images can also be used to identify cages and aquaculture farm structures and in conjunction with models in order to produce 3D products for aquaculture site selection, monitoring and forecasting.

This presentation covered the major challenges and opportunities associated with satellite observation in the near-coastal inland and inshore aquaculture domains. The advantages of high resolution (land) sensors and medium resolution (ocean colour) sensors were discussed. An overview of water quality remote sensing products (optical-biogeochemical water type zones, chlorophyll-a, turbidity and harmful algal bloom occurrence) is provided, as well as examples of data assimilation between remote sensing and biogeochemical modelling to reach

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3D assessment capabilities. The presentation focusses on the use of optical satellite data for water quality retrieval, with additional examples of mapping aquaculture practises using radar (fish cages), and marine pollution (floating debris and vegetation).

3.5 Does aquaculture provide ecosystem services?

Trine Dale from NIVA, Norway, presented the ecosystem services provided by aquaculture in Europe. For extensive shellfish aquaculture these include coastal protection, nutrient removal, improving water clarity, and providing habitat and food. Her talk explained that the ecosystem services provided depend on the type of aquaculture and the characteristics of the ecosystem where it is located. Sustainability of Aquaculture and the ecosystem services it provides can be improved by minimizing the negative tradeoffs. This can be achieved by good site selection, species diversification and improving farm management and operating practices.

3.6 Effective use of models for chemical regulation

Manolis Tsapakis (HCMR, Greece) discussed how Marine Antifoulant Models can be used to predict the behaviour of antifoulants and aquaculture emissions in the water column and sediment. These models have shown concentrations for both to be higher in the summer months. This is thought to be because there is an increase in antifoulant use in the summer. When compared to data from a Greek case study, the results of the model were validated.

This presentation gave a general overview on the use of veterinary medicines and other potentially toxic substances (heavy metals, antifoulant, disinfectants) in European aquaculture, and described the modelling tools available for assessing their environmental fate and ecological risks. Moreover, the models developed and tested in the three TAPAS case-studies were described. First, there was a general introduction to the hydrodynamic model developed by PML to assess the risks of emamectin benzoate and diflubenzuron in salmon cages located in Norwegian fjords. It is based on the Finite Volume Community Ocean Model (FVCOM) and calculates surface water and sediment concentrations over large areas, enabling impact assessments for several farms at the same time. Second, there was a general introduction to the Spanish case study, where the MAMPEC model was applied to calculate exposure of Cu leaching from antifouling paints in water and sediments from sea-bream and sea-bass farms. Moreover, several monitoring campaigns were used to assess the capacity of biofilms to act as indicators of farm pollution. Finally, the Greek case-study was presented. Similarly, to the Spanish one, the main objective of Greek case study was to validate the MAMPEC model for the chemical regulation of antifouling agents. The model was validated against in-situ data of Cu in the water column and sediment from an Allocated Zone for Aquaculture (AZA) in the Vourlias

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Bay. The study shows that that during summer the predicted concentrations of total copper are higher than during winter for the water column and sediment due to the lower flow velocity. Thus, flow velocity is an important factor to reduce antifoulant wastes and their dispersion in the environment both in the water column and sediment. According to the results of this study, the model reproduces reasonably well the observed mean values and gradients for the dissolved copper for each season separately and for the copper in sediment. Thus, the model outputs could contribute to chemical risk assessment based on established threshold limits for water and sediment.

3.7 Real-time monitoring and data collection for Aquaculture

Marnix Laanen (Water Insight, Netherlands) and Nikos Papandroulakis (HCMR, Greece) presented examples of real-time monitoring and data collection technologies for aquaculture operators that were developed within the TAPAS project. These in situ tools can assist daily operations and long term modelling and reporting. Aquaculture Specific Profiler (ASP) are used for vertical profiles of the water from the surface to the bottom of the fish farm. It can provide data about the physical, ecological and chemical water quality with user configurable payload. Meanwhile Autonomous Underwater Vehicles can monitor the integrity of cage material by performing regular inspections of the cage material condition and transmitting alarms if problems (such as tears in the net) are detected.

An optical sensor based observation system with solar panels and 3G connection, called a WISPstation, can be used for ecological water quality measurements by recording radiance and irradiance. It performs continuous and autonomous high-quality spectrometer measurements for water quality which can be used by aquaculture farms and regulatory bodies to assist in decision making.

At the end of the TAPAS project, it has been concluded that the development of an effective AUV for aquaculture netting inspection is achievable and it has the potential to facilitate off-shore aquaculture installations. High-frequency automated water quality monitoring with the WISPstations can provide real time information to aquaculture farms and regulatory bodies to assist with decision making. And finally, today's technology advances can be effectively applied to the Aquaculture Industry, to enhance production and decrease operational costs.

4 Implementing TAPAS recommendations and tools

The implementation of TAPAS recommendations and tools was covered by Trevor Telfer (University of Stirling). The TAPAS project has several outcomes for exploitation including recommendations and guidance for changes to aquaculture policy in Europe; individual tools, models and methods for collecting data and information about aquaculture sites and the Toolbox for European aquaculture, which provides decision support for both producers and regulators. By utilizing these tools and recommendations, national level strategy and policies can be changed and/or developed, contributing to new or existing legislation and license processes,

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administrative procedures can be simplified, and European aquaculture can benefit from growth through the coordination of spatial planning.

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6 Final conference agenda

TAPAS	**Tools for Assessment and Planning of Aquaculture Sustainability : TAPAS (Grant No. 678396)** **FS-11B-2015. Consolidating the environmental sustainability of European aquaculture**

FINAL TAPAS PROJECT CONFERENCE

Scotland House, Rond-point Robert Schuman 6, 1040 Bruxelles, Belgium

Wednesday 15 January 2020

Approximate time	*Title*	*Presenters*
09.00	Arrive and registration	
09.30	Welcome and introduction to the project	Trevor Telfer (University of Stirling, UK)
10.00	Food production and blue growth – the needs	Malcolm Beveridge (Consultant)
10.30	Bottlenecks, policy recommendations and informing EU policy	Pauline O'Donohoe (Marine Institute, Ireland)
11.00	Coffee break	
Aquaculture Toolbox		
11.30	Theory and reasoning behind the Aquaculture Toolbox	Hanne Kaas (DHI AS, Denmark)
12.00	The Aquaculture Toolbox	Lynne Falconer (University of Stirling, UK)
12.30	Lunch – informal demonstration of the toolbox	
13.30	Application of models to shellfish production	Laurent Barille (University of Nante, France)
13.50	Satellite data and use in European aquaculture monitoring	Stefan Simis (Plymouth Marine Lab, UK) Stefano Ciavatta (Plymouth Marine Lab, UK)
14.10	Does aquaculture provide ecosystem services?	Trine Dale (NIVA, Norway)
14.30	Effective use of models for chemical regulation?	Andreu Rico (IMDEA, Spain) Arnaldo Marin (University of Murcia, Spain) Manolis Tsapakis (HCMR, Greece)
14.50	Real-time monitoring and data collection for aquaculture	Marnix Laanen (Water Insight, Netherlands) Nikos Papandroulakis (HCMR, Greece)
15.10	Coffee - networking	
Tie up session and discussion		
15.40	Implementing TAPAS recommendations and tools	Trevor Telfer (University of Stirling)
16.10	Discussion forum	Paul Tett – (SAMS, UK) moderator
17.00	Close	Trevor Telfer (University of Stirling, UK)

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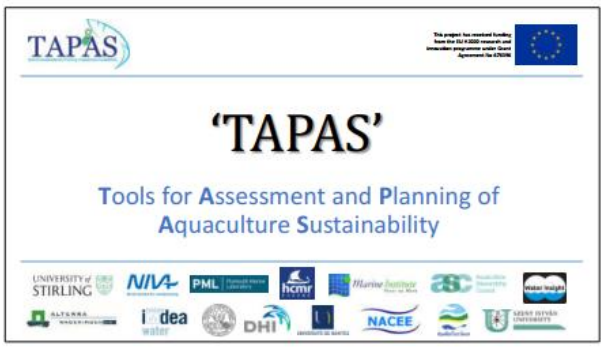
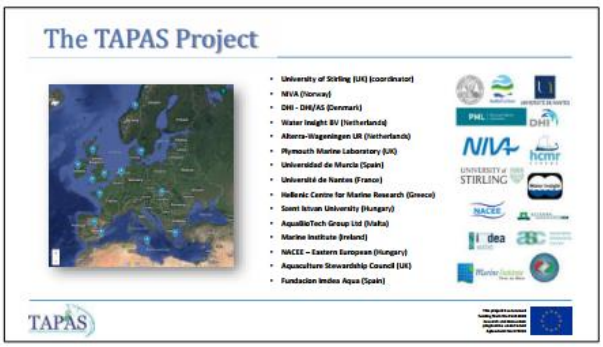
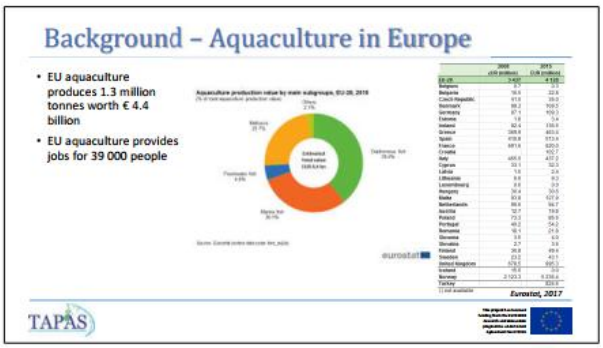
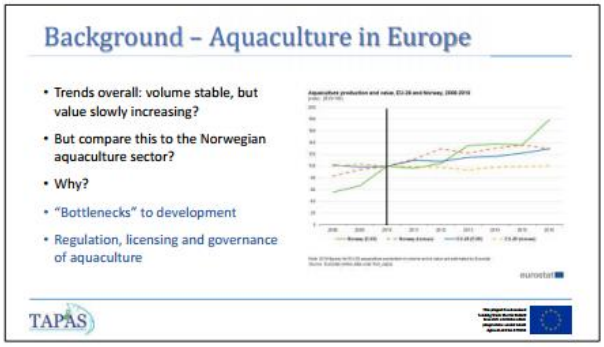
7 Presentations

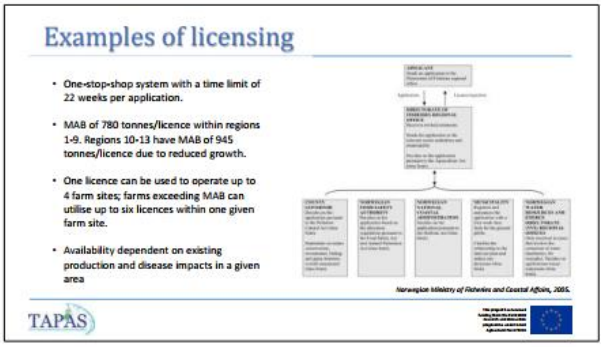
7.1 TAPAS Introduction











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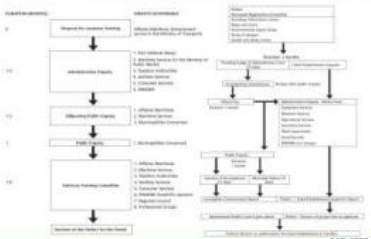
Examples licensing

- Five authorities have to be independently contacted as part of the application procedure.
- Processing time takes approx. 112 weeks.
- Rent is paid to the Crown Estate for a seabed lease.
- Currently under review

Gordon, 2018

Examples of licensing

- Mainly shellfish. Fish key for expansion
- Different concessions (private or state owned land/sea area)
- Large number of consultees at each stage
- Only one new licence granted in last 25 years



FAO, 2009

Examples of licensing

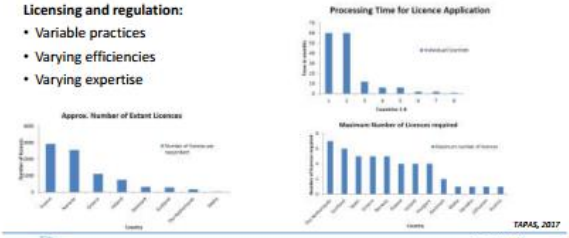
- Large number of organisations involved
- Different regulatory and social economic factors taken into account
- Different ministry responsible for each factor, e.g. often 5 or more permits required

FAO, 2009

Bottlenecks in licensing and regualtion?

Licensing and regulation:

- Variable practices
- Varying efficiencies
- Varying expertise



TAPAS, 2017

The Challenges for Aquaculture?

- Fragmented approaches to aquaculture licensing and regulation, together with limited availability of suitable areas, are a major barrier to future development and expansion of the aquaculture sector.
- There is a need to support member states to establish more efficient regulatory frameworks and to reduce cost and time of licensing aquaculture farms.
- There is a need to ensure there are appropriate tools, models and approaches available to predict and monitor environmental impacts and also quantity ecosystem services provided by aquaculture.
- There is a need to strengthen environmental sustainability of aquaculture and enhance its image.

Aims and objectives - TAPAS

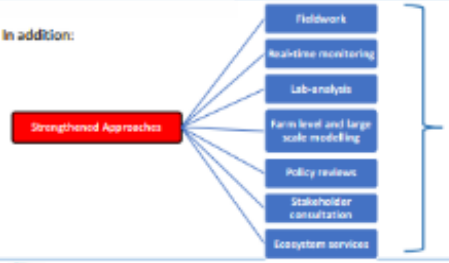
- Identify sustainability requirements and licensing approaches, and identify **bottlenecks** hampering cost-efficient licensing and regulatory practices.
- Identify the gap between the availability of and needs for models, modelling and decision frameworks, and critically analyse and refine existing tools and technologies, developing new approaches if needed.
- Assess the environmental services provided by European aquaculture
- Strengthen management practices and develop an **Aquaculture Sustainability Toolbox** for timely and cost-efficient environmental assessment and regulation

What does the TAPAS offer?

- Improved regulatory frameworks for adoption by Member states
- Improved tools for quantification of environmental services
- Improved spatial planning linked to carrying capacity and sustainability indicators
- Improved, more efficient tools for licensing and aquaculture development
- Improved, more efficient tools for monitoring and prediction of environmental impacts
- Significantly enhanced real time in-situ monitoring linked to early warning and sustainability

The TAPAS Project

In addition:



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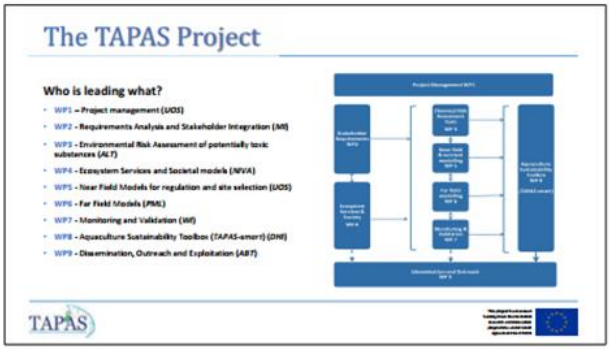

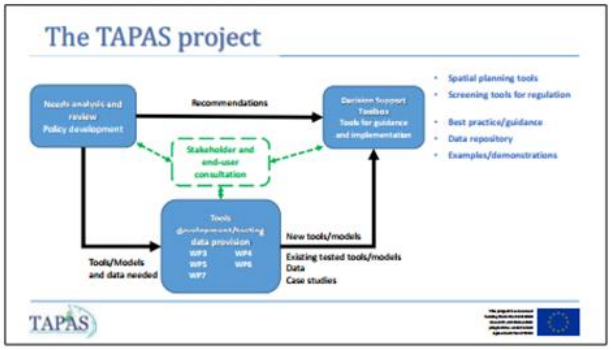

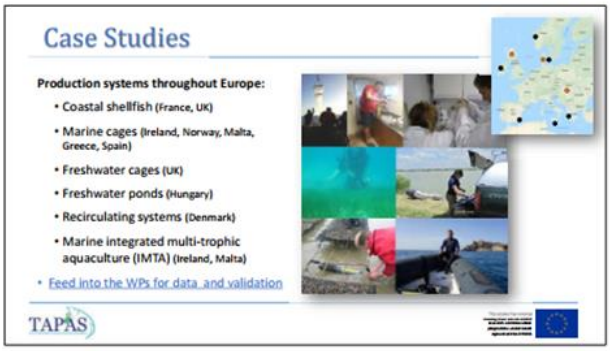

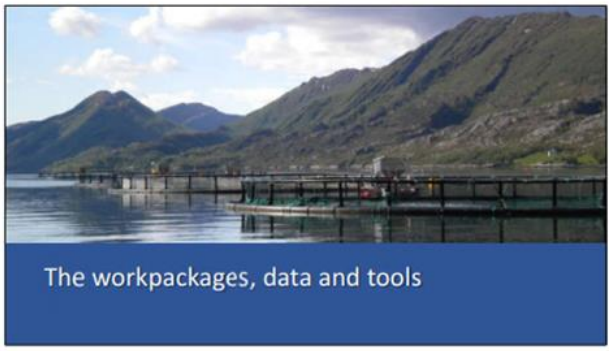

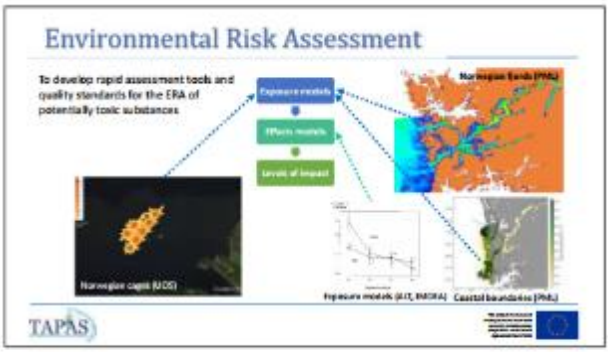

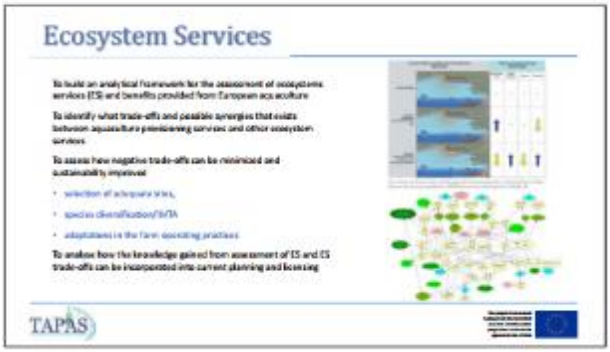

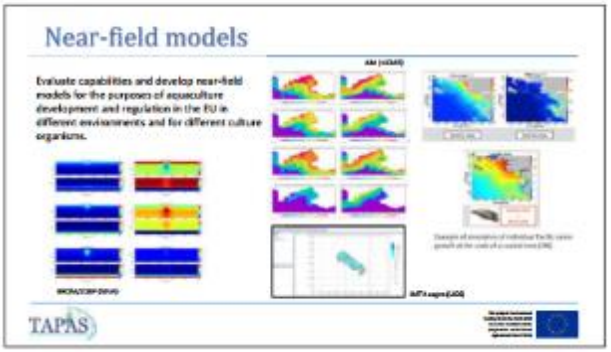

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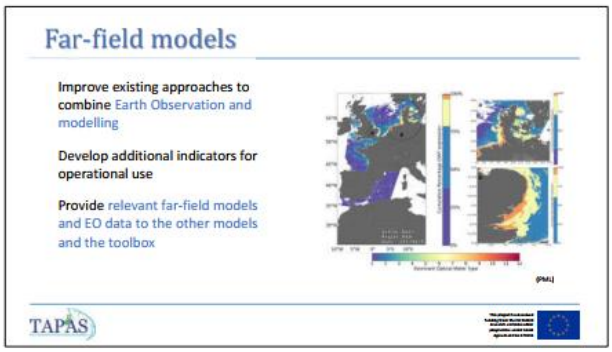

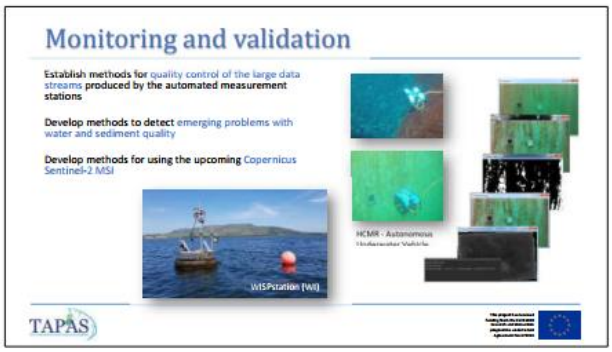

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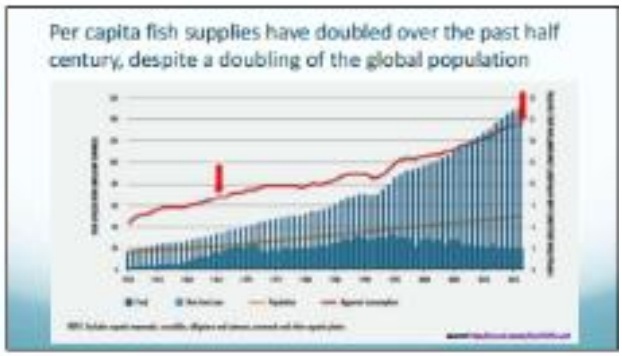
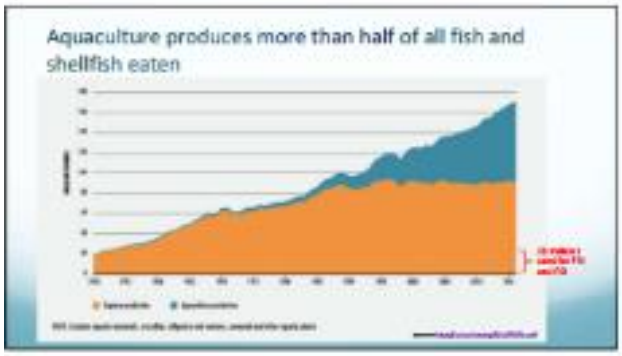
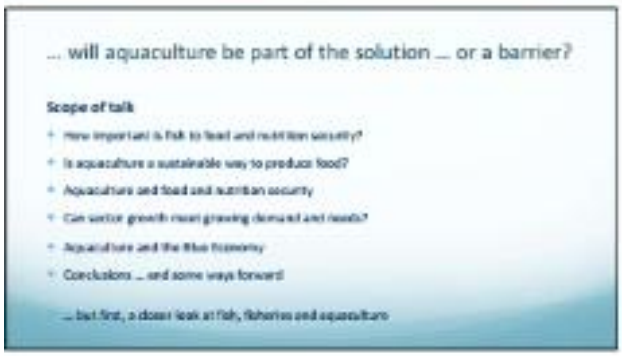
7.2 Aquatic Food Production and the Blue Economy







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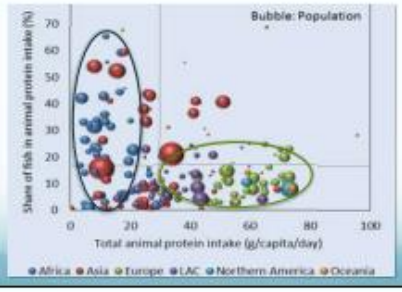
Nutrient dense fish '.. a special role in nutrition and health'*

* ICN2 Second International Conference on Nutrition
better nutrition better lives

Fish is especially important in the diets of poor consumers



... and can be especially important during the first 1000 days

The contribution (%) of different food groups and breast milk to the intake of energy and nutrients in toddlers, Samfya District, Zambia

	Energy	Protein	Fat	Carbohydrates	Calcium	Iron	Vitamin A
Toddlers (n=99; age: 14-20 months)							
Fish	6	39	6	0	35	16	14
Meat and dairy	1	5	2	0	2	3	2
Cereals	23	17	7	32	5	8	2
Roots and tubers	13	3	1	22	12	23	3
Vegetables and fruits	3	3	0	4	0	10	17
Legumes and nuts	5	7	11	1	2	6	1
Other foods*	5	3	5	6	3	5	1
Breast milk	47	23	67	34	41	7	61

modified from Langyintuo et al. (2014)

Is aquaculture a sustainable way to produce food?

Inputs of energy, capital and labour used to convert resources into food, inevitably producing wastes

Fish are highly efficient convertors of feed into flesh

Environmental impacts are determined by species, system and management

... between species groups

.. within species groups

Aquaculture, food and nutrition security

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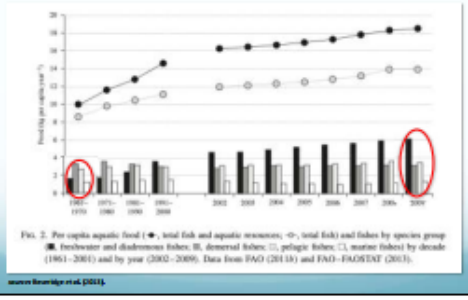
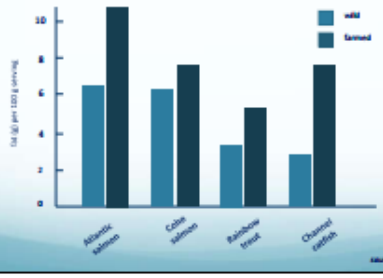
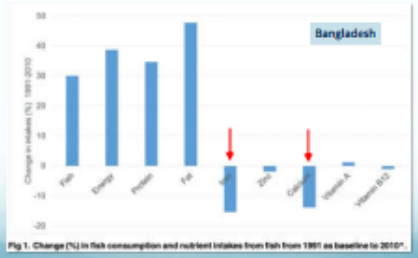
Aquaculture is changing the types of fish we eat



Farmed fish is fattier than wild counterparts

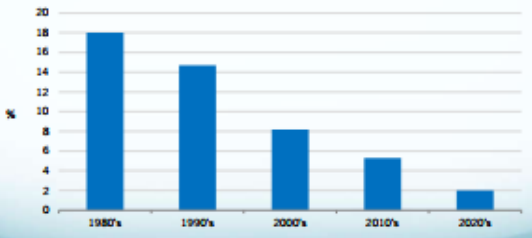


Eating more farmed fish may increase energy, protein and fat intake … but reduce micro-nutrient intake

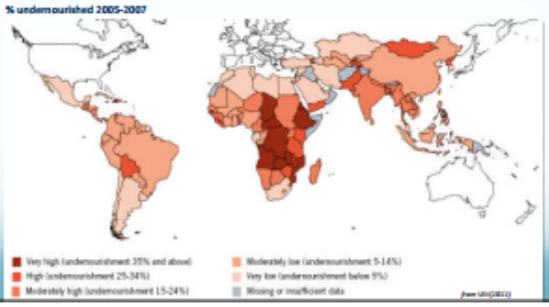


Will aquaculture be able to meet future demand?

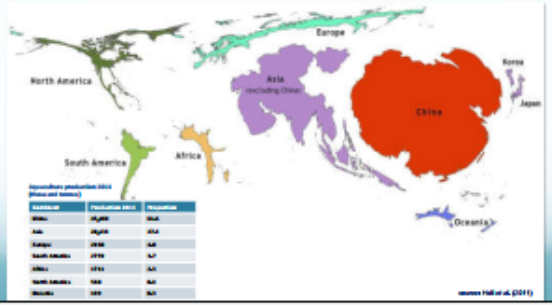
Aquaculture growth is slowing …



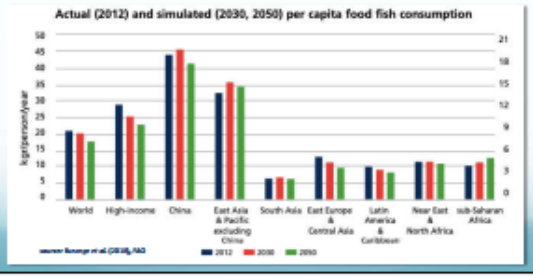
Poverty and hunger are greatest in Africa and South Asia



The world according to aquaculture …but where's Africa?



Fish consumption looks OK … provided you're not poor and live in the right part of the world



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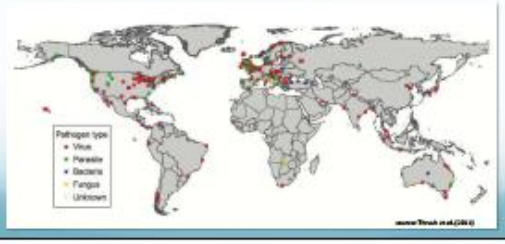
Disease shocks could affect aquaculture growth

Incidence of emerging aquatic animal diseases, 2002-2010



Climate change will have geopolitical and economic repercussions, with consequences for food security

- '.. population growth is likely to put pressure on fish markets, leading to higher prices ..'
- '.. higher prices may decrease per capita food fish consumption at world level ..'

although

- '.. higher prices should stimulate increases in productivity and efficiency ..'

aquaculture and the blue economy

The EU Blue Economy is diverse … but growing slowly

- Coastal tourism; fishing; mineral, oil & gas extraction; ports, warehousing & water projects; shipbuilding & repair; maritime transport
- Gross operating profit €74.3 billion, 2% higher than in 2009
- Mainly UK, Spain, Germany, France and Italy
- 2% of employment is in the Blue Economy
- Five sectors targeted
  - Aquaculture
  - Coastal tourism
  - Marine biotechnology
  - Ocean energy
  - Seabed mining

Aquaculture's role in EU Blue Economy is small and constrained …

- 1.5 million t; equivalent to 20% EU fish production
- Employs 85 k people, 20% women

Key issues

- lack of maritime space
- competitiveness in global markets
- licensing and administration
- impacts on the environment, incl. wild fish
- lack of capital

… contributing to a €25 billion European seafood trade deficit

… the Blue Economy is about more than just aquaculture

Ireland anticipates limited sectoral and seeks synergies with other sectors

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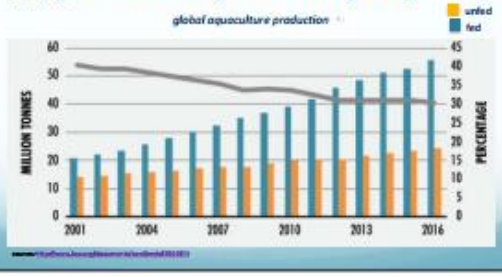
Norway aims to facilitate development and uptake of new technologies to address key challenges

New technology development licenses and green licenses

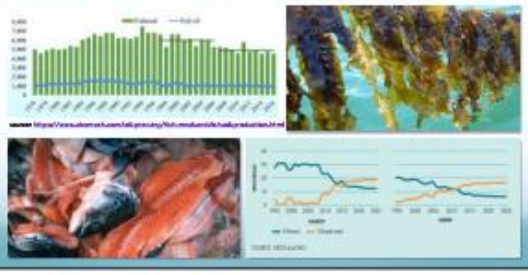
- offshore systems and semi-closed and closed systems
  - Territorial issues - space
  - Sea lice and welfare
  - Wastes, esp. chemical wastes
  - Escapes

Conclusions – and ways forward

Aquaculture production may be able to fill the demand-supply gap … but sector growth needs guiding



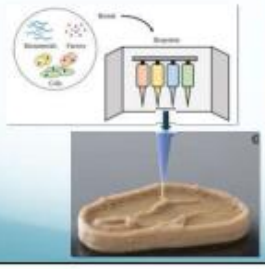
Fishmeal and fish oil supplies are declining … aquafeeds must come from alternative sources



Countries must use incentives to secure the economic, social and environmental outcomes they want

Implementing the UN Code of Conduct for Responsible Fisheries with respect to aquaculture helps ensure sustainability

e.g. BlueNalu … mission: global leader in cellular aquaculture



- Consistency of product supply
- Fewer external shocks (disease, climate, etc.)
- No blood vessels, no bones …
- No mercury, no parasites or microplastics …
- No animal welfare issues

Thank you

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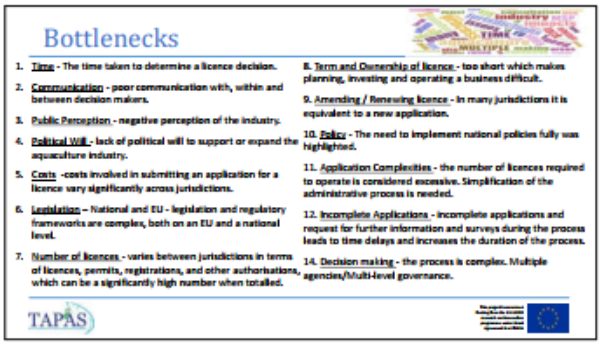
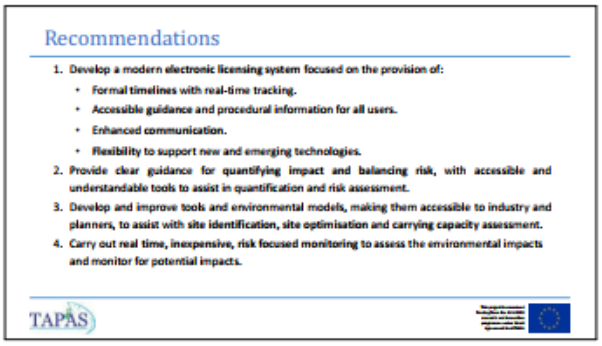
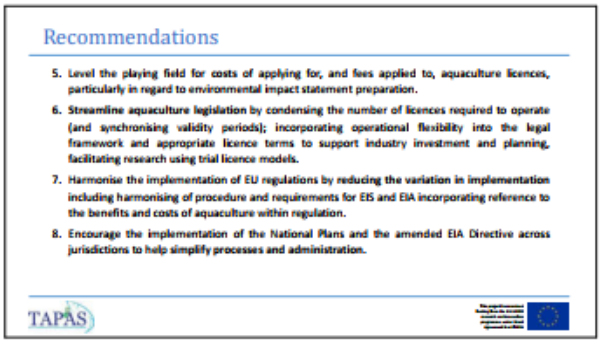
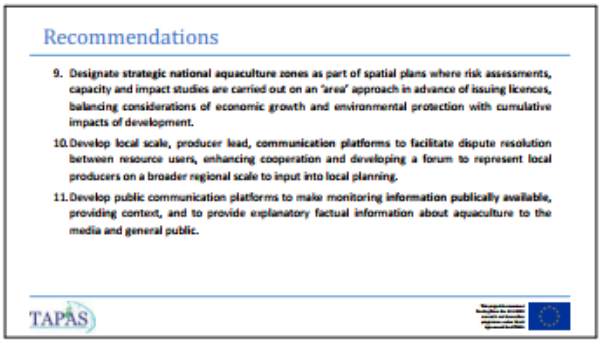
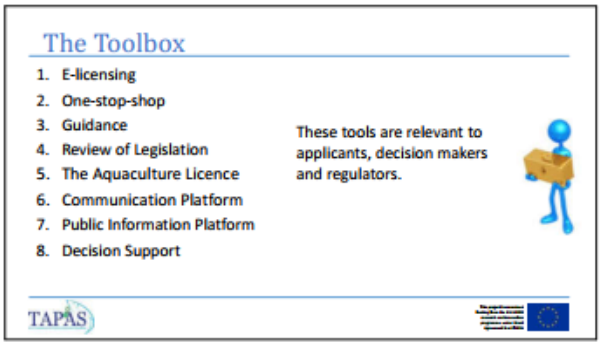
7.3 Bottlenecks, Policy Recommendations and Informing EU Policy

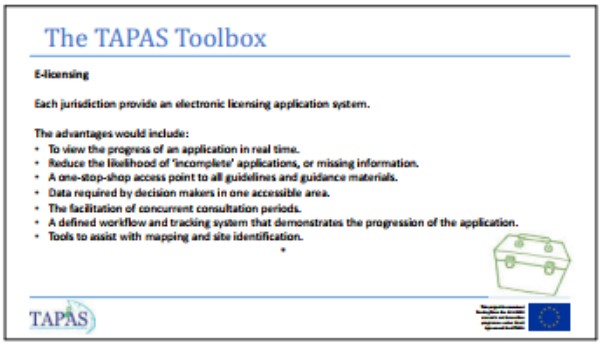












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The TAPAS Toolbox

One-Stop-Shop

To assist with the coordination between the applicant and decision-making authorities, as well as between decision-support agencies.

The important tasks are to:

- Provide the Aquaculture Licence application forms.
- Act as the sole responsible agency to coordinate all the actors in the regulatory process.
- Centralise all elements of the application and coordinate the decision-making process.
- Facilitate communication with the applicant, liaising on their behalf with other agencies/actors.
- Provide appropriate guidance to the applicants, to ensure the completeness of the submission.
- Ensure formal timelines are adhered to.
- Process application fees.

The TAPAS Toolbox

Guidance

Provisions that should be available to the prospective applicant should include:

- Detail of the steps involved in application process.
- Detail of the consents required, expected timelines, expected costings, the regulatory agencies involved, and contact information for assistance through the process.
- Detail of the decision-making process; the steps, milestones and expected timelines.
- Provision of all documents centrally available in a single online portal.
- Direct stakeholders to information such as:
  - Information on relevant regulation and legislation.
  - Regulatory assistance/guidance information and requirements.
  - Information on funding.
  - Information on careers and training opportunities.
  - Information on strategic projects and investments.
  - Industry reports and production statistics.
  - Contact details for aquaculture groups.

The TAPAS Toolbox

Review of Legislation

Member States should:

- Carry out a review of their aquaculture consenting process, with the aim to identify the changes needed that will:
  - Ensure consenting decisions happen in a timely manner.
  - Create clarity and transparency in the consenting process.
  - Ensure it takes on board best practice and experience from other jurisdictions.
- Ensure the review provides clear, specific and actionable recommendations to allow for rational, streamlined, transparent, efficient legislative framework and licensing system.
- Produce a specific and timed implementation plan for the recommendations from the review.

The TAPAS Toolbox

The Aquaculture Licence

The aquaculture licence should:

- Define the activity and methodology that is permitted.
- Define the location within which the activity is permitted.
- Define the period for which an aquaculture activity can be conducted.
- Define the review, amendment and ownership processes regarding the licence.
- Define the parameters within which an activity is permitted, and the necessary monitoring to ensure compliance.
- Detail production quantities.
- Define terms and conditions of activities.
- Detail fees relating to holding the licence.

The TAPAS Toolbox

Communication Platform - Conflict avoidance and resolution methods

An effective forum for communication at a local level, within and between producers, and with other resource users, should be facilitated and supported to allow for the development and progression of common management plans.

Providing a forum for communication between producers:

- Allows for effective resource planning and problem solving.
- Enhances local development in a structured way.
- Allows better management between users and better utilisation of shared space.
- Allows better exchange information on fish health and management practices between producers for better environmental management.
- Facilitates communication between aquaculture producers and other resource users locally.

The TAPAS Toolbox

Conflict avoidance and resolution methods (cont.)

- Provides for collective representation of the sector in broader scale planning and development.
- Provides an effective channel for financing and funding, assisting local industry and services.
- Facilitates a bottom-up and top-down communication with regulators, where the forum can act as an intermediary.
- Facilitates representation of aquaculture producers on an area and regional level.
- Allows for the effective dissemination of technology and information within local producers, from the research and the regulatory bodies.
- Informs the sectors on general issues.
- Provides engagement with other interested parties to discuss/encourage in integration of associated activities, e.g. fisheries & fishing, tourism, leisure users, etc.

The TAPAS Toolbox

Public Information Platforms

As a minimum provision, an effective public information platform should provide:

- Clear, correct and reliable information and reference materials.
- Better the understanding of the processes of aquaculture and its contributes to food security and ecosystem services.
- Inform regarding the methods involved in aquaculture.
- Inform regarding the environmental footprint of the industry.
- Provide information on food safety, nutritional benefits, responsible sourcing and environmental effects.
- Address current questions or concerns regarding issues relating to the sector, providing the latest scientific thinking.
- Act as a focal point for stakeholders.
- Exchange information on fish health.
- Inform regarding organic production and origins of the food produced in the sector.
- Encourage and facilitate public aquaculture engagement.
- Provide guidance to industry on approaches to being open to public engagement.

The TAPAS Toolbox

Decision Support

The Regulator is the primary arbitrator when it comes deciding on the consent to allow the operation of an aquaculture facility.

To reduce administrative burden and improve decision-making capacity, jurisdictions should review their decision-making processes to:

- Have clearly defined timelines, laid out in the process, for reaching decisions.
- Enhance efficiency in facilitating timely decision making.
- Clearly define the actors involved in the decision making process, and their roles.
- Have a clearly defined frameworks detailing the processes and individual steps.
- Deliver a transparent approach.
- Ensure direct access to in-house technical expertise to facilitate informed scientific judgement.
- Integrate changes to alleviate the bottlenecks using best practice and technical expertise from other systems.
- Ensure decision making bodies are adequately resourced.
- Facilitate knowledge exchange with regulators, researchers and stakeholders.

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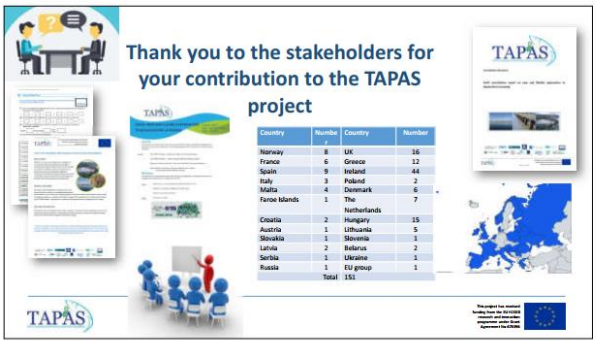
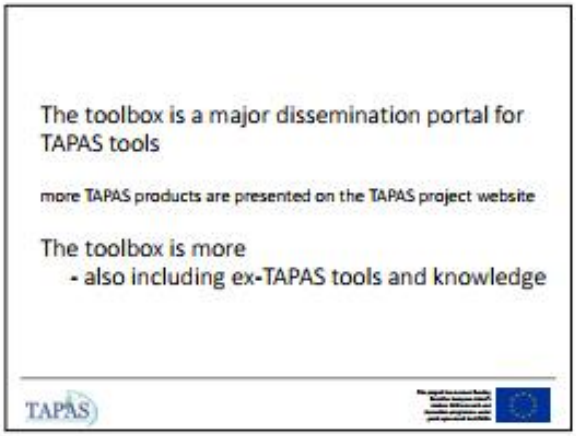
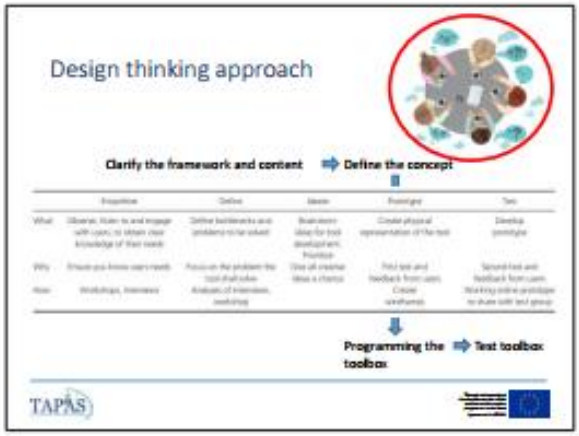


7.4 The Sustainability Toolbox





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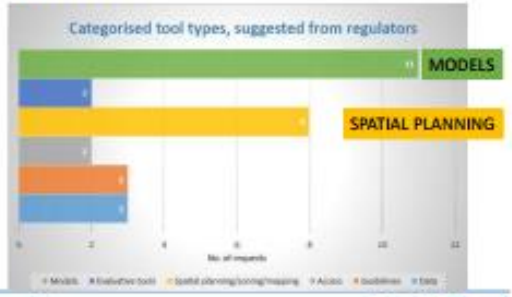
Framework, requirements, content

- Gather information about **existing tools** (ex-TAPAS tools)
- Gather information about **tools developed by TAPAS**
- Several consultations with different stakeholders to clarify
  - **Bottlenecks** for development of European aquaculture
  - **Requirements** for licensing
  - **Tools** asked for by regulators and industry

Tools asked for



Guidelines for development

- Make it web-based to allow access from a wide audience
  - Industry, Regulators, Public
- Focus on being intuitive and easy to use.
- Focus on licensing process - interactive tools (models) – guidance tool – examples by case studies

Toolbox home page

This is version 1!

- By using a content management approach (CMS) we are supporting easy updating/addition
  - more information and tools may easily included in the future
  - and the Toolbox can be adapted to specific owners [countries] / stakeholders

Our Umbraco

The process developing a website

Consultations on the way with partners and stakeholders

The licensing process is the core skeleton

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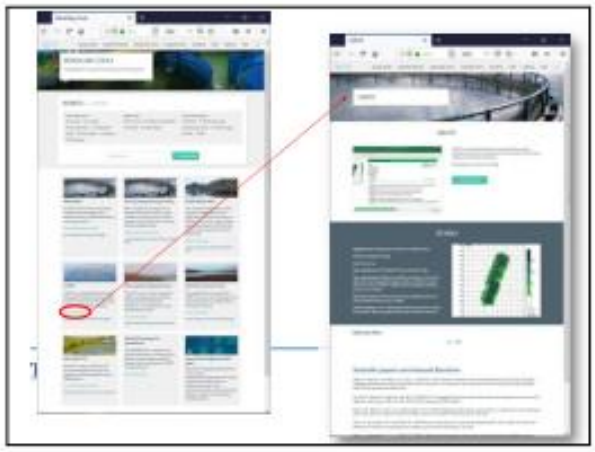
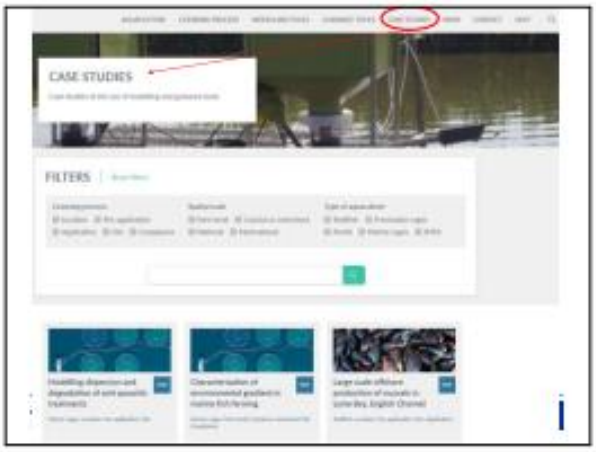
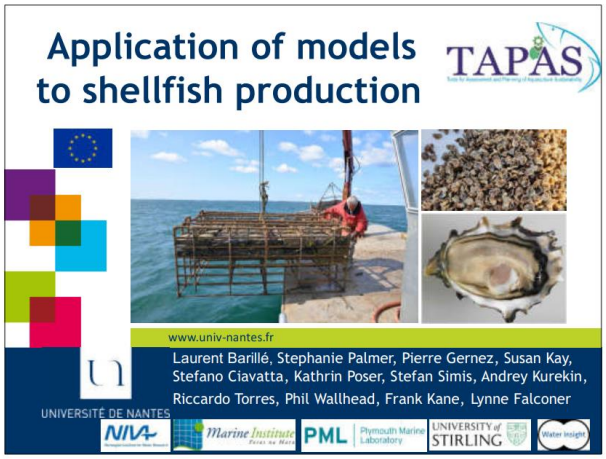
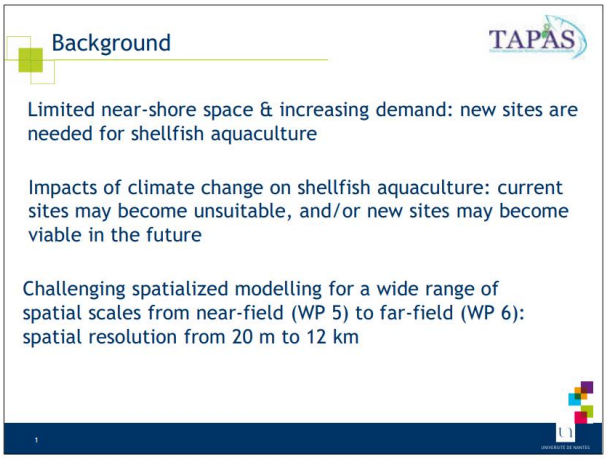




7.5 Application of models to shellfish production





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Tools for Assessment and Planning of Aquaculture Sustainability

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DELIVERABLE: 5.1

Critical Evaluation and Suggestion of Models

Combination of:

- deterministic individual growth models (bioenergetic model)
- remote-sensing time-series
- ecosystem model output
- Geographical Information System (GIS)

Falconer *et al.* 2016

SCOPE FOR GROWTH model

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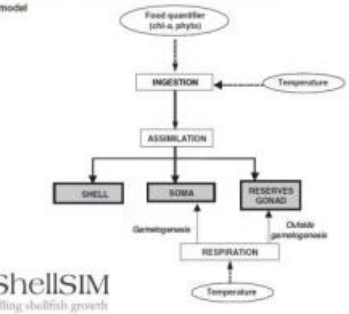
SFG model



ShellSIM modelling shellfish growth

PML Plymouth Marine Laboratory

DYNAMIC ENERGY BUDGET model

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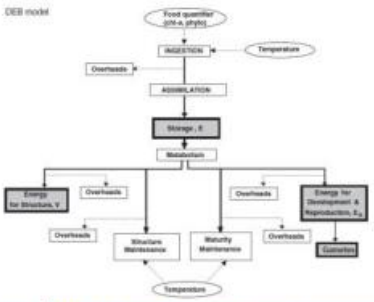
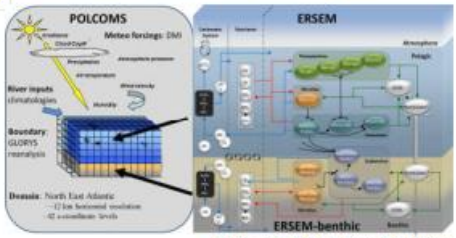


Add-my-Pet DEB codes & parameters

Ecosystem model: POLCOMS - ERSEM

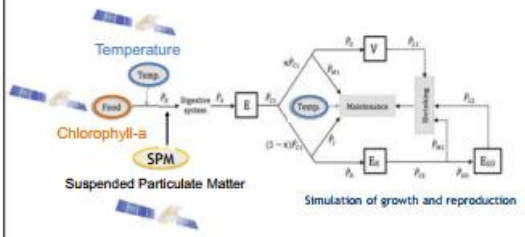


European Regional Seas Ecosystem model (ERSEM)

PML Plymouth Marine Laboratory

Ciavatta S. *et al.* 2018 *JGR Ocean*

Bioenergetic modeling & Earth-Observations



TAPAS main bivalve species

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Blue mussel
Mytilus edulis

Pacific oyster
Crassostrea gigas

TAPAS's Objectives

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- Model & map growth potential
- GIS tools for site selection
- Consider current potential and climate-robustness of offshore areas in European seas
- Develop & map industry-relevant indicators

Nearshore potential for shellfish aquaculture

Coupling Earth Observation data with ecophysiological model

MERIS full resolution (300 m) & Pacific oyster DEB model

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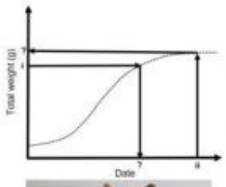
Case-study South Brittany

Production # 6000 tons of *Crassostrea gigas*

Bivalve culture in bottom cages

DEB output into industry indicators



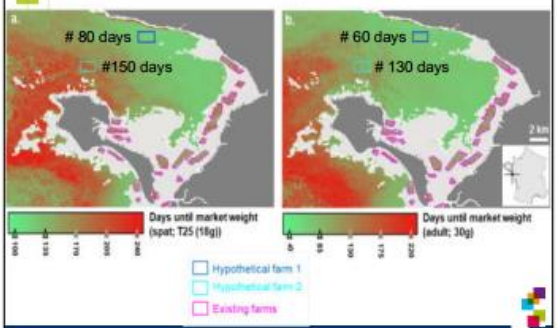
Spat pre-growing : time for T6 to reach 14 g, corresponding to T20-T25 spat

Time for adults to grow to minimum market weight (30 g)

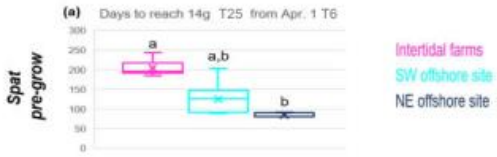
Weight obtained for the main December market

Flesh quality index (regular, *Fines*, *Spéciales*)

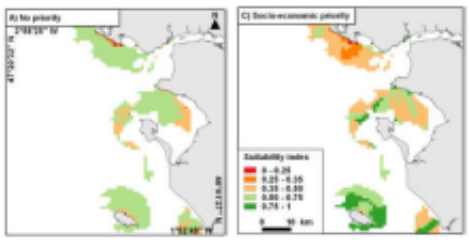
Oyster growth performance indicators



Off-shore growth potential



Considering conflicting uses



A GIS spatial multi-criteria evaluation has shown that there was space available for bivalve off-shore cultivation

GIS TAPAS expertise

Use of geographic information systems for aquaculture and recommendations for development of spatial tools

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Affordable for small companies

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Manuscript Details

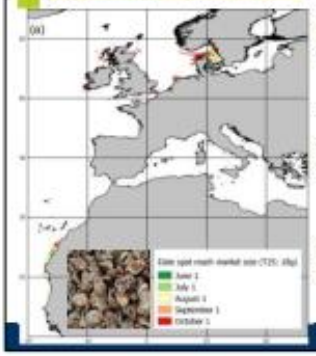
Manuscript number	AQUA_2019_1896
Title	BIOLOGICAL, SOCIO-ECONOMIC, AND ADMINISTRATIVE OPPORTUNITIES AND CHALLENGES TO MOVING AQUACULTURE OFFSHORE FOR SMALL FRENCH OYSTER-FARMING COMPANIES
Article type	Research Paper

Aquaculture

Laurent Bardik, Anthony La Bris, Philippe Goulletquer, Yoann Thomas, Philippe Gloe, Frank Rans, Lyvine Falconer, Patrice Guillobreau, Brice Trouillet, Stephanie Palmer, Pierre Gernez

Pacific oyster off-shore growth indicators

(daily time steps, spatial resolution 0.1°)



Spat pre-growing : time for T6 spat (0.5 g in April) to reach 18 g, corresponding to T25 spat

Main restrictions:

food (>1 µg Chl a L^{-1})
bathymetry (<200 m)

Hotspots: UK, the southwestern North Sea, and western Africa

Conclusions

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Significant potential for off-shore shellfish aquaculture that can be exploited by large companies (Arctic, western sahara, South England) as well as smaller ones in near-shore conditions

Added value of spatialized data: spatial variability of growth performances at all spatial scale

Earth Observation time-series can have a significant contribution for aquaculture (ESA SENTINEL 2 & 3)

Remote Sensing for Aquaculture

frontiers

Topic Editors

Deliverables in open-access repository

TAPAS

zenodo

Earth Observation and model-derived aquaculture indicators report

OpenAIRE

Exploitation of TAPAS program

TAPAS

Transfert of a Spatial Multi-Criteria Evaluation tool for bivalve off-shore aquaculture in the Région Pays de la Loire (France)

PAYS DE LA LOIRE

CONCHYLICULTURE des Pays de la Loire

Shellfish farmers representatives

Strategic coastline documents for the Marine Spatial Planning of the French Atlantic coast to be ready in 2021

Thank you for your attention

TAPAS

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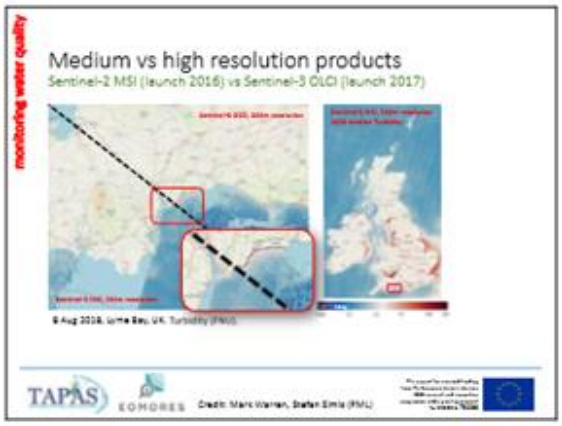
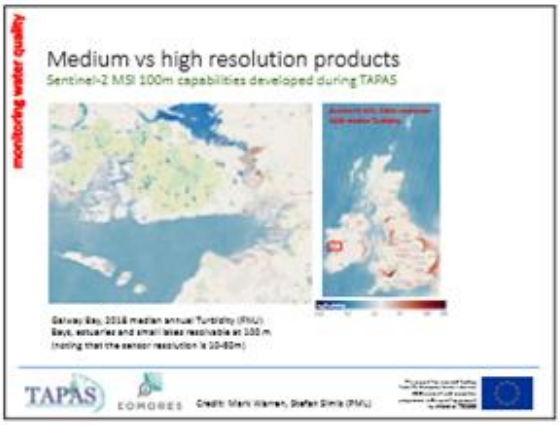
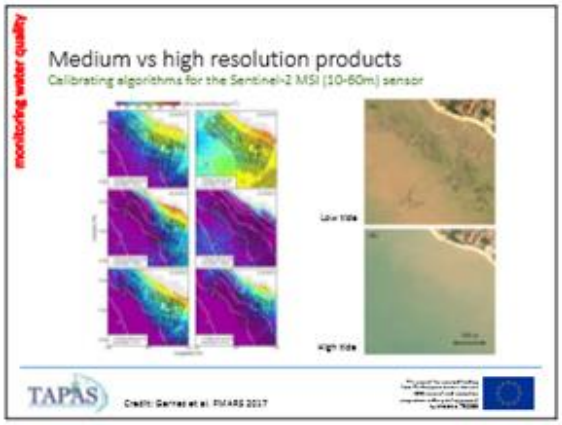
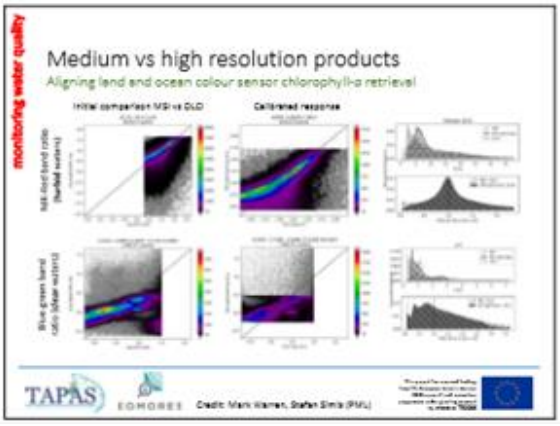
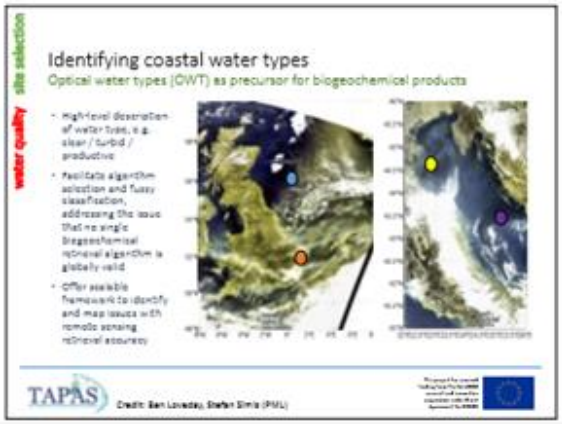
7.6 Satellite observation capabilities in European Aquaculture monitoring











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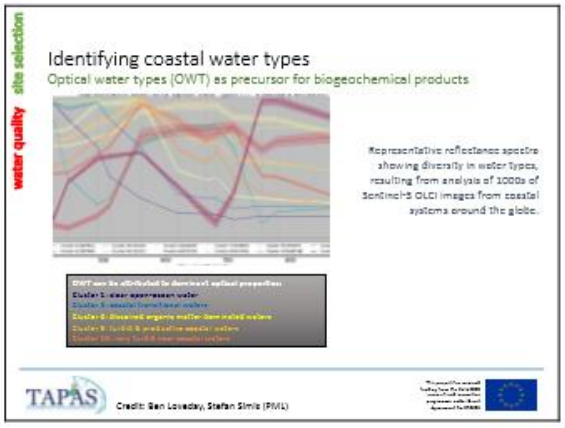

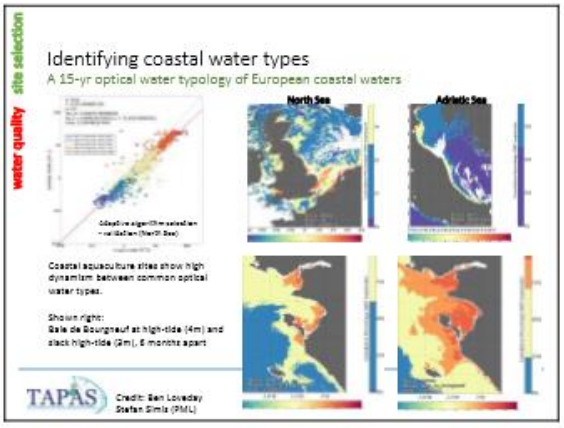

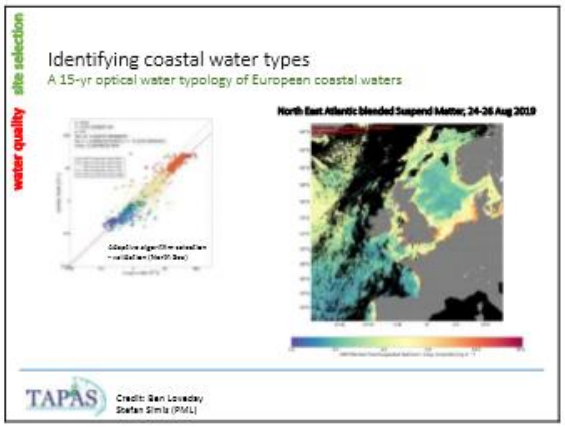

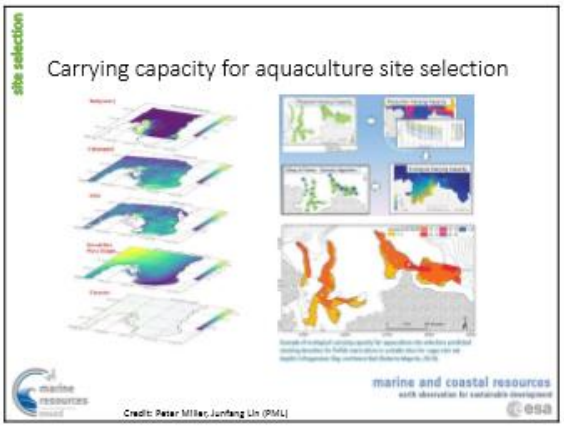

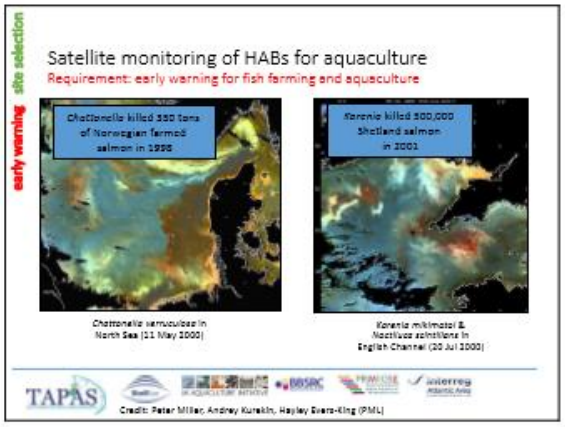

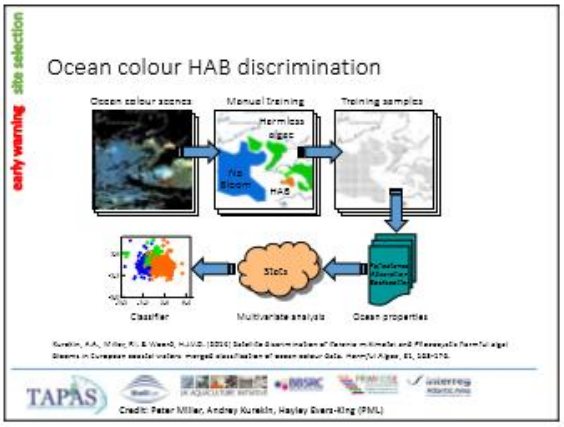

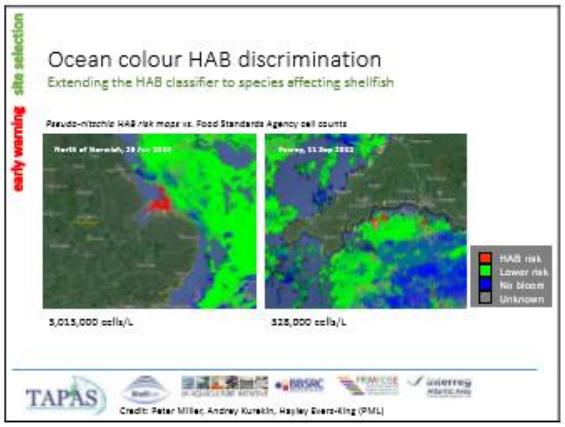

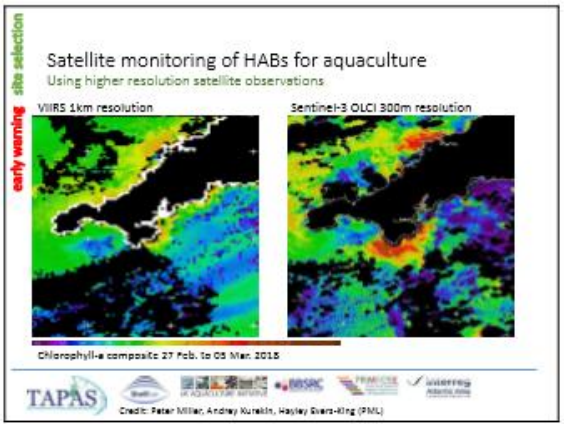

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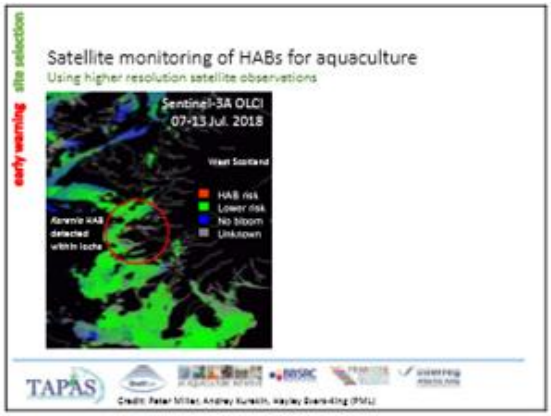

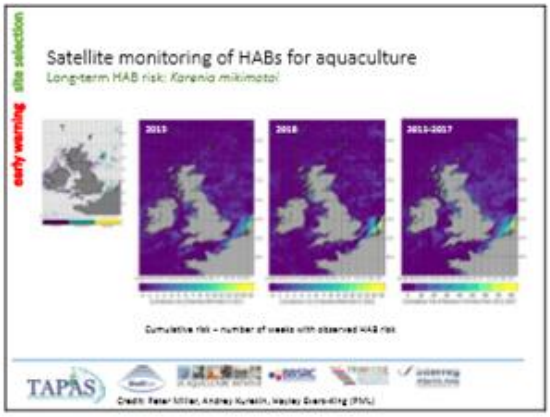

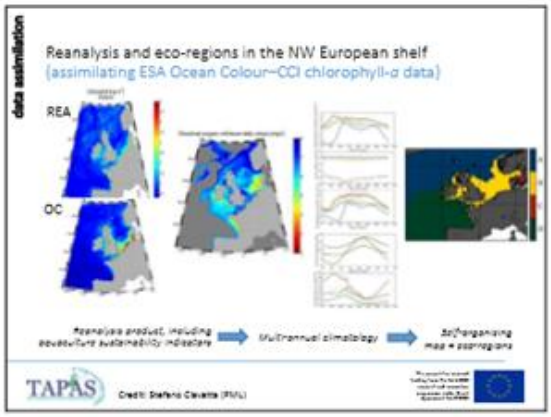

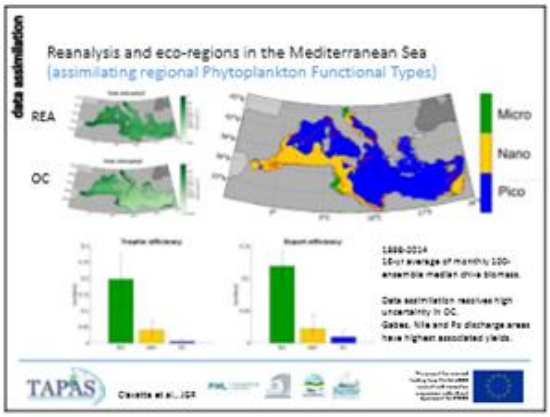

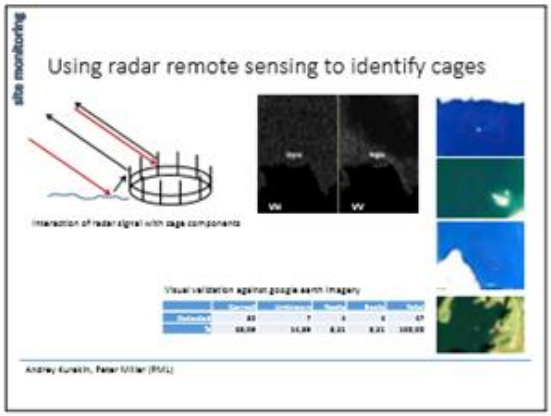

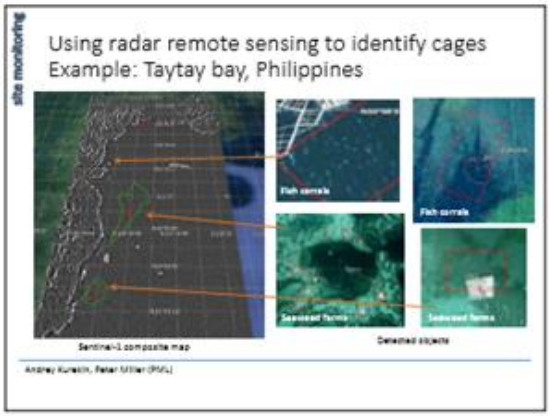

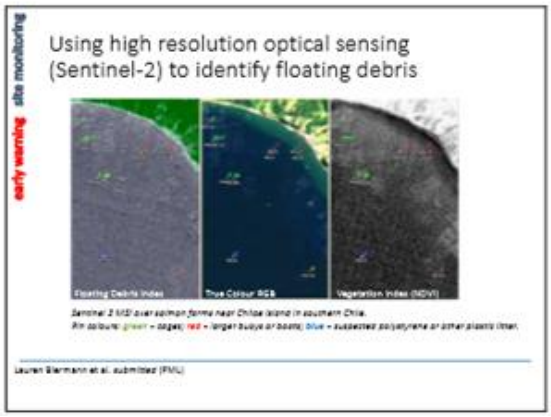

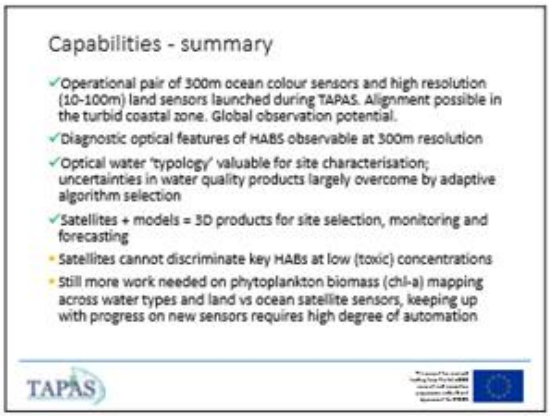

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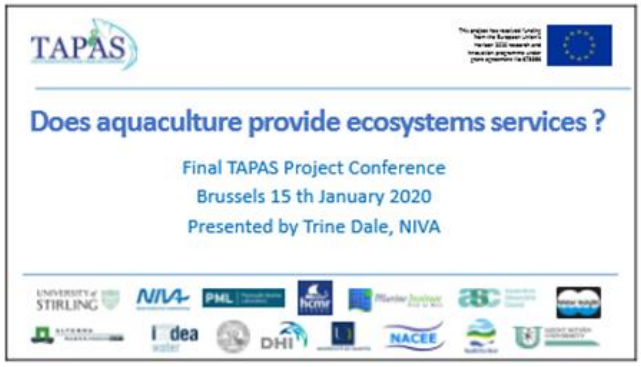
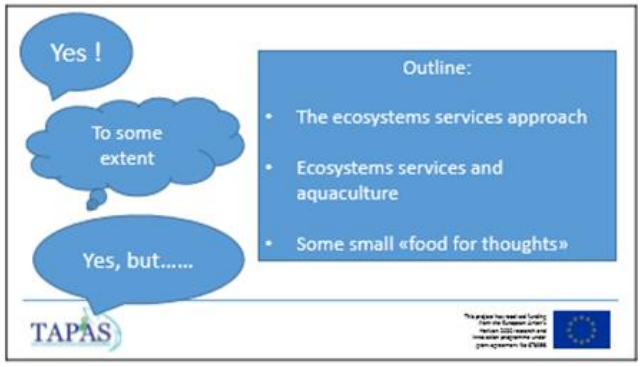
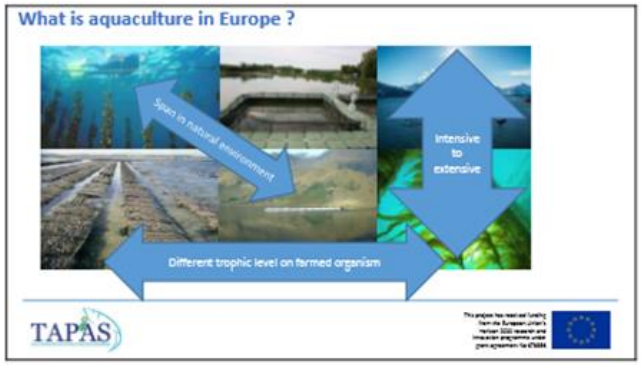
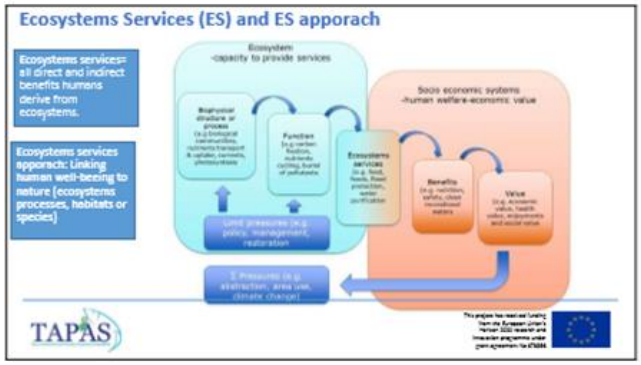
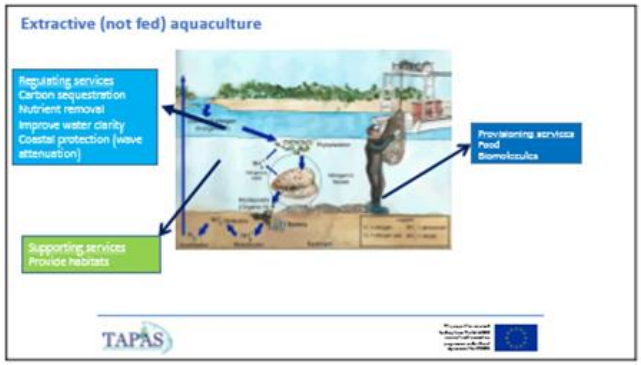
7.7 Does aquaculture provide ecosystem services?

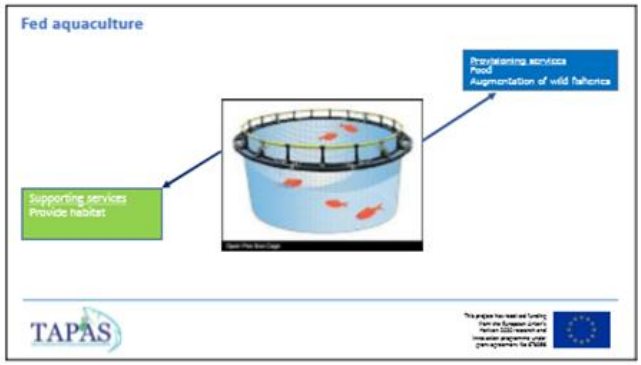












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Foof of thought. What about cultural ecosystems services ? Are there any provided by aquaculture ?

Fruitfarming in Hardangerfjorden is central to cultural heritage, important for tourism

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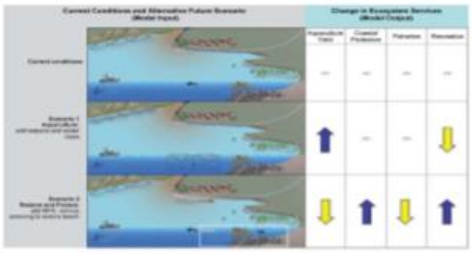
Yes, but....

Ecosystems services trade-offs



Source: Silvestri, S., Kershaw, F. (eds.), 2010. Framing the flow: innovative Approaches to Understand, Protect and Va
Ecosystem Services across Linked Habitats, UNEP World Conservation Monitoring Centre, Cambridge, UK

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Summing up

- Yes, aquaculture provide ecosystems services
- To what extent and what type of services is depending on range of factors both related to the type of auqaculture and the charactereistic of the ecosystem where aquaculture is located
- Investigate further how negative trade-offs can be minimized and sustainability improved through management and planning approaches (e.g. selection of adequate sites, species diversification and IMTA) and through adaptations in the farm operating practices

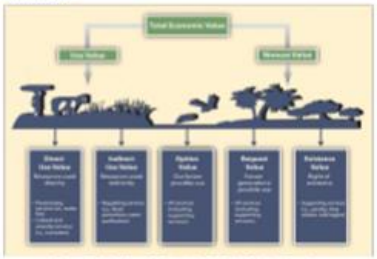
TAPAS

TAPAS

Thanks

Ecosystems services valuation

There is a range of different methods and approaches economists use to perform ecosystems services valuation



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Overall objectives of WP 4

1. To assess the combined environmental and social impacts of aquaculture, and identify management tools that could provide incentives to reduce negative impacts of aquaculture (Task 4.4) (D.4.5)-Submitted
2. To build an analytical framework for the assessment of ecosystems services (ES) and benefits provided from European aquaculture based on the general concept of Ecosystems services cascades. (Task 4.1)(D4.2)-Submitted
3. To identify what trade-offs and possible synergies that exists between aquaculture provisioning services and other ecosystem services and to be able to quantify these. (Task 4.2 & 4.3)(D.4.3)-Submitted
4. To assess how negative trade-offs can be minimized and sustainability improved through management and planning approaches (e.g. selection of adequate sites, species diversification and IMTA) and through adaptations in the farm operating practices . (Task 4.3)(D.4.4)-Submitted
5. To analyse how the knowledge gained from assessment of ES and ES trade-offs can be incorporated into current planning and licensing (Task 4.5)(D.4.6) pending

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Task 4.5 Ecosystem Services approach as a practical DSS tool (NIVA, MI, ABT)

Objective:

To understand the potential and limitations of incorporating an ES approach into regulatory frameworks – particularly planning and licensing processes.

Approach:

Exploratory exercise to analyse the potential use of an ES approach to assessing sustainability and how such an approach can be integrated into current planning and licensing practices

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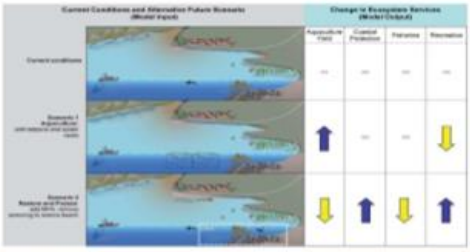
Ecosystems services trade-offs and synergies



Source: Silvestri, S., Kershaw, F. (eds.), 2010. Framing the flow: innovative Approaches to Understand, Protect and Value
Ecosystem Services across Linked Habitats, UNEP World Conservation Monitoring Centre, Cambridge, UK

TAPAS

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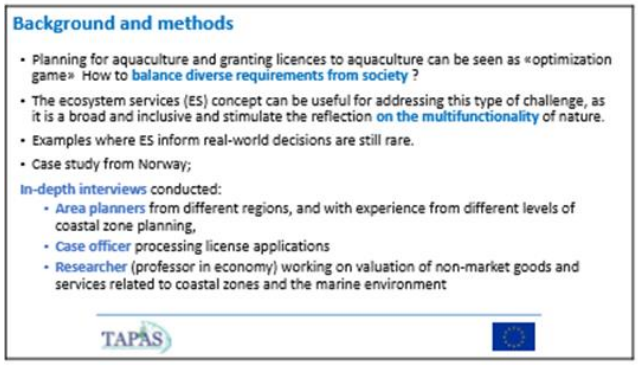
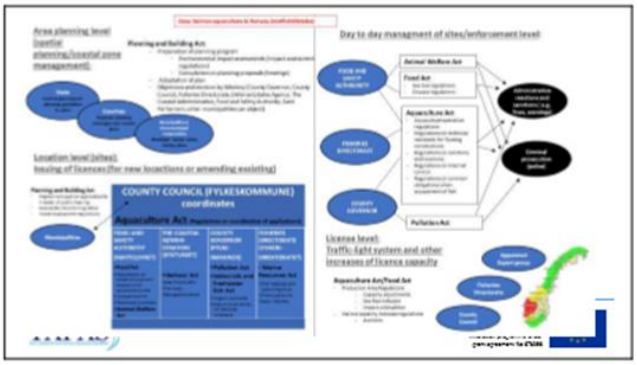
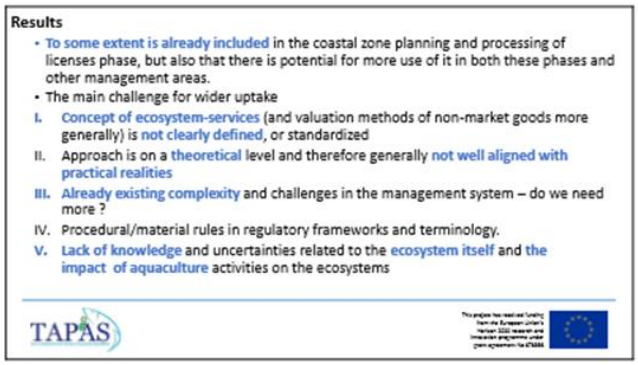
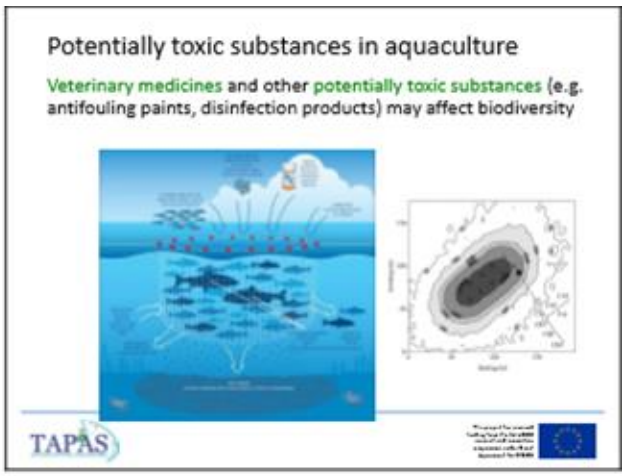






7.8 Effective use of models for chemical regulation



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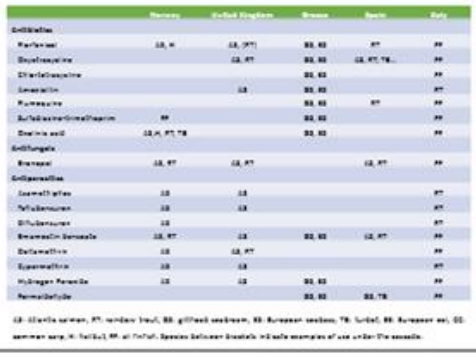
VMPs used in European aquaculture...



Regulatory risk assessment for VMPs

ERA guidance under VICH and EMA:

- Phase I (trigger 1 µg/L), Phase II (PEC/PNEC)
- General scenarios and models for registration of VMPs at country level

The Scottish case:

- Risk evaluation on a farm-by-farm case

Active ingredient	Environment	Environmental Quality Standards
Teflubenzuron (in-feed)	Marine waters	Annual average: 6 ng/L MAC: 30 ng/L
	Marine sediments	MAC: 2 µg/kg dw outside AZE MAC: 10 mg/kg dw inside AZE

Allowable zone of effect (AZE) of 25 m from edge of cages

TAPAS

Models for the ERA of VMPs...

- Simple algorithms (Metcalfe et al. 2009) valid for Phase I ERA

Major production systems	In-feed medication	Bath treatments
Rainbow trout (tanks/raceways), inland	WASP7	Chloramine-T
Carps (ponds), inland	VDC ERA-AQUA	ERA-AQUA
Salmon (cages or net pens), Atlantic	AutoDEPOMOD	BATH-AUTO PYCEZE Dichlorvos DIVAST
Gilthead seabream (cages or net pens), Mediterranean	MERAMOD	
European seabass (cages or net pens), Mediterranean	MERAMOD	

- Very few cases of model validation
- Models based on exposure (simplistic effect assessment)
- Only suited for farm-scale evaluations

TAPAS

ERA models in TAPAS

- Literature review

- Model development and validation

	Northern Europe	Mediterranean
Production system	Cages in Hardangerfjord, Norway	Cages in the coast of Mundia (Spain) and Vourlas bay (Greece)
Species	Atlantic salmon	Seabass, seabream
Type of chemicals and mode of application	Bath or in-feed medication against sea-lice	Antifouling paints to prevent biofilm and algae growth in net pens
Chemicals	Emamectin benzoate, Diflubenzuron	Copper

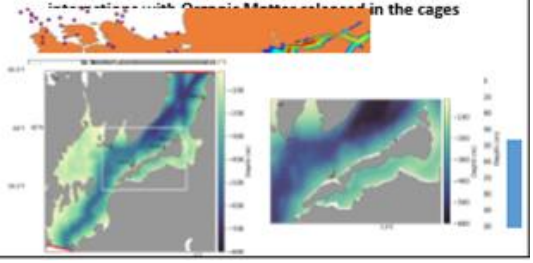
TAPAS

Risk assessment of sea-lice treatments in salmon aquaculture in Norway

Ricardo Torres, Muchamad Al Azhar, Trine Dale, Paul van den Brink

TAPAS

1. **Evaluate impact of sea-lice treatments Emamectin benzoate and Diflubenzuron used in fish farm cages aquaculture.**
   1. **Develop fit-for-purpose Hydrodynamic model of site (3D, baroclinic, nested within ROMS 800m)**
   2. **Develop fate modelling tools for therepeutants with [illegible] in the cages**



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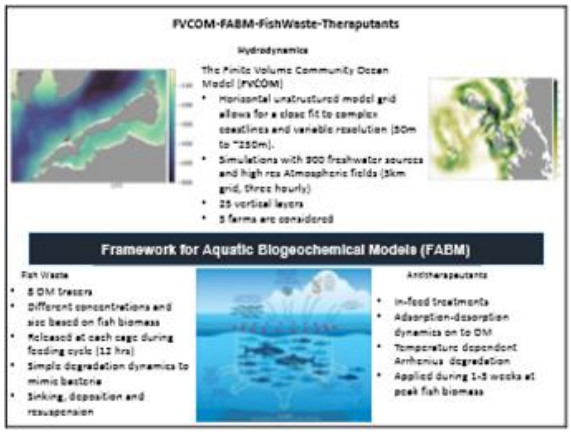

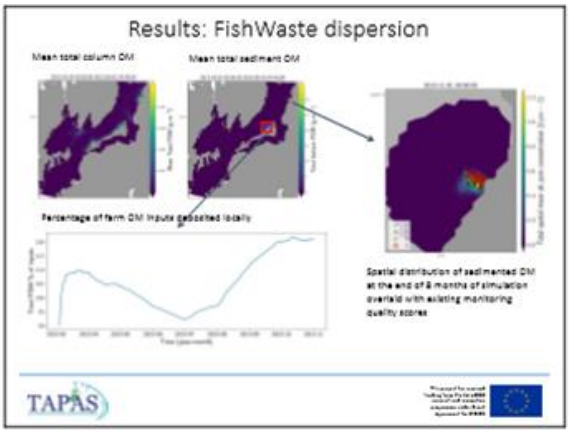

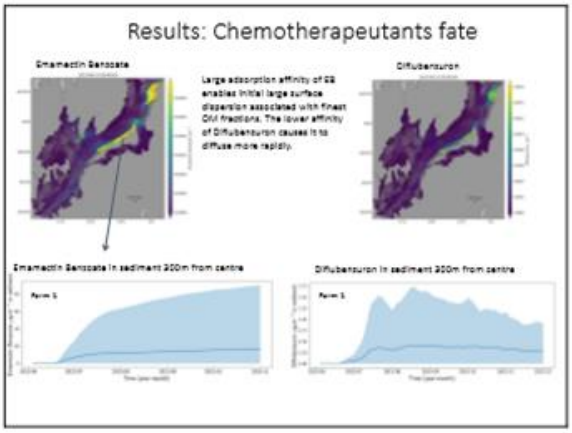

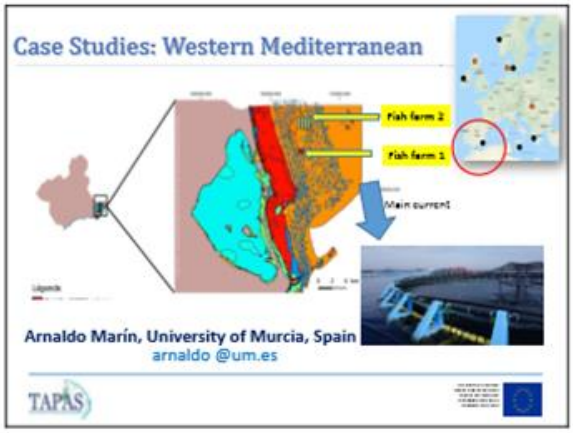

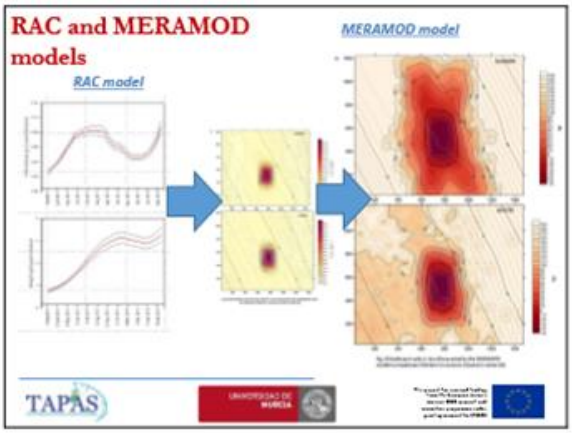

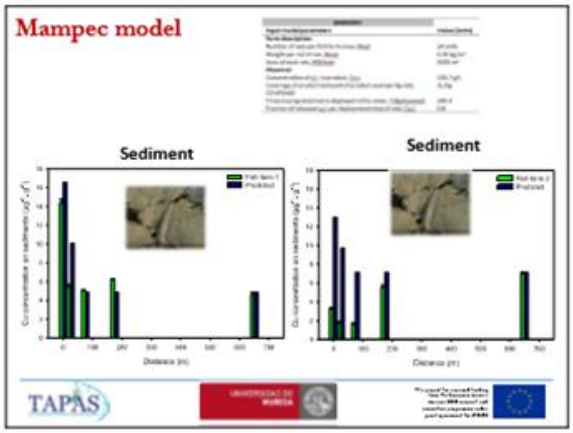

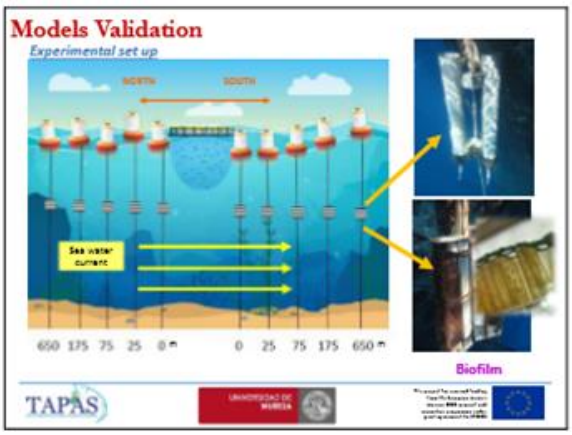

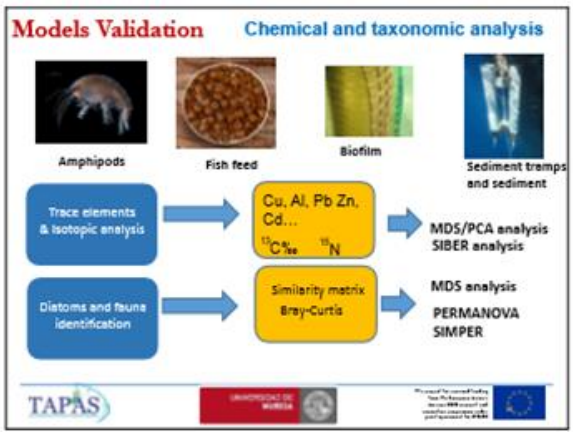

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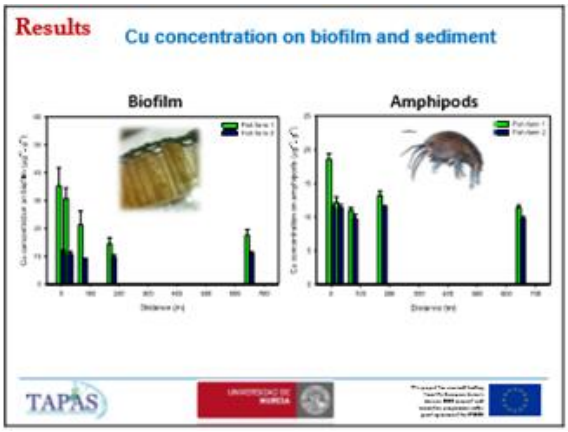

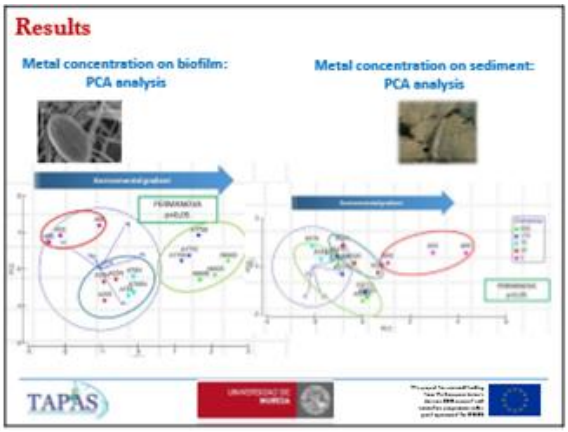

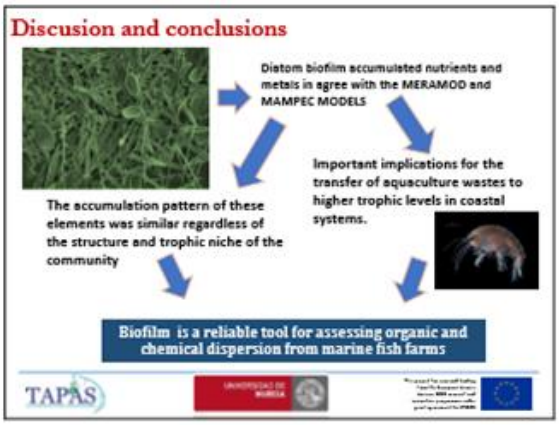

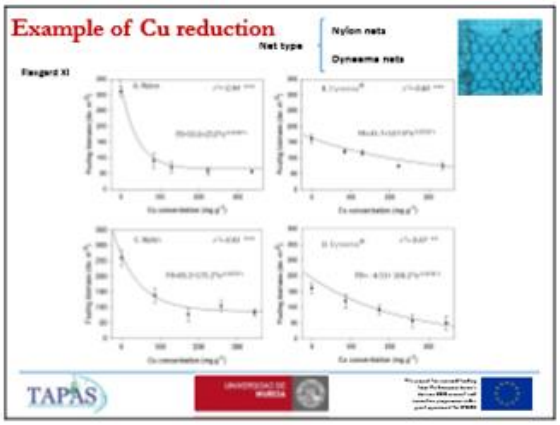

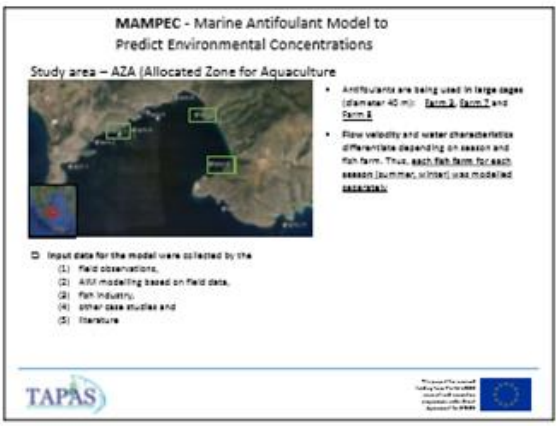

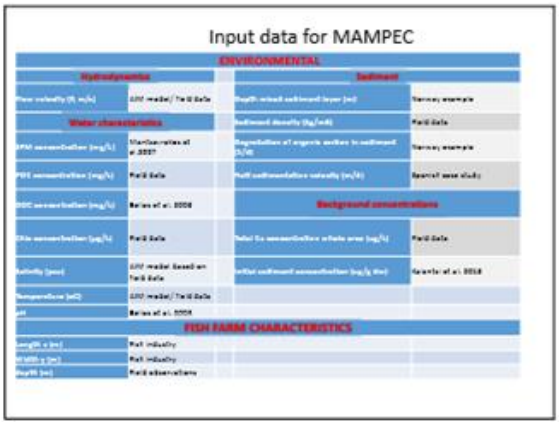

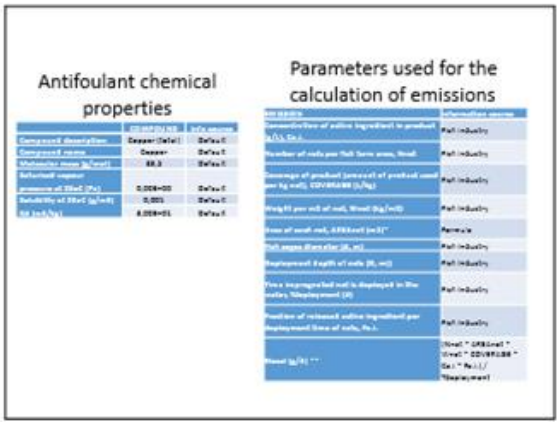

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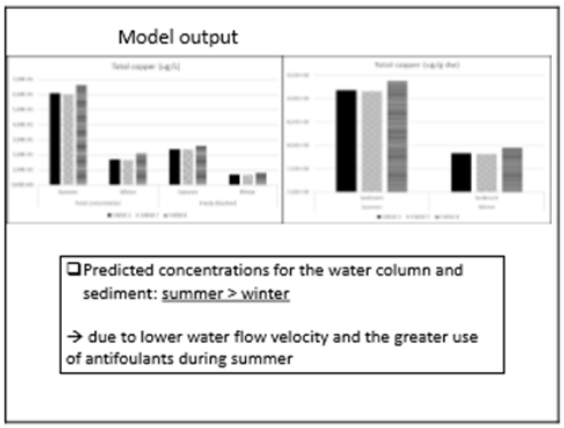

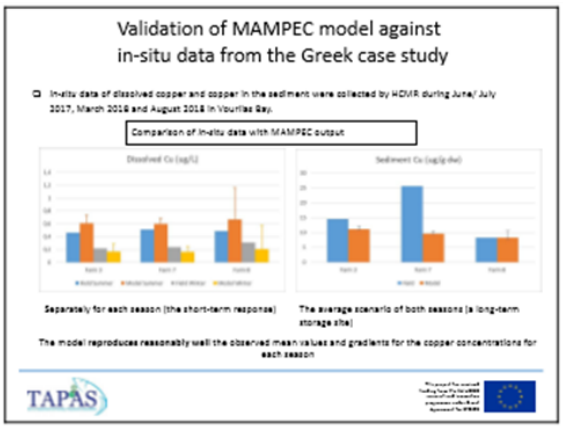

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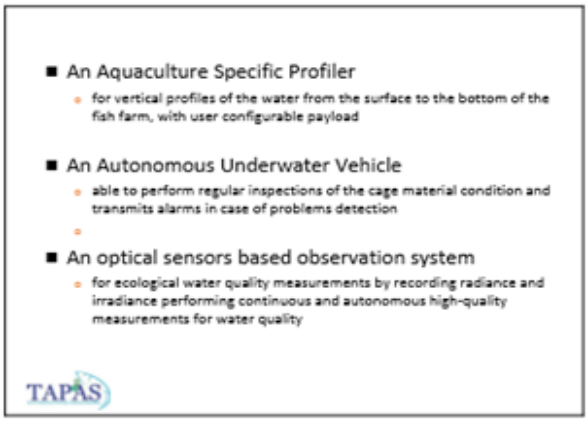
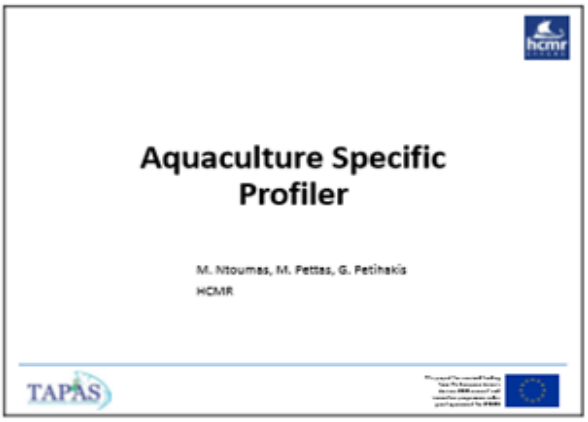
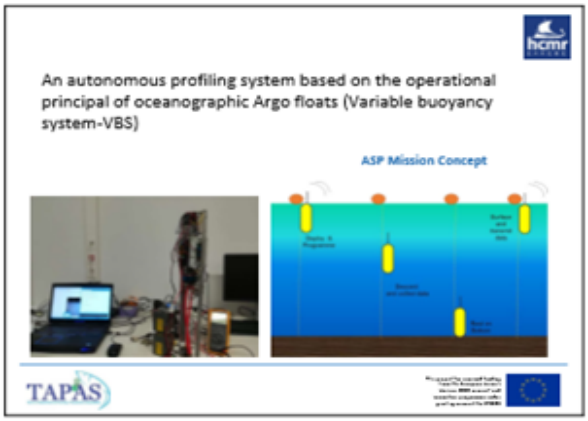
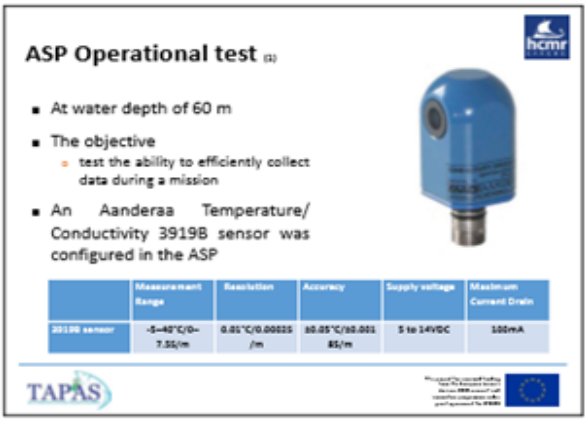
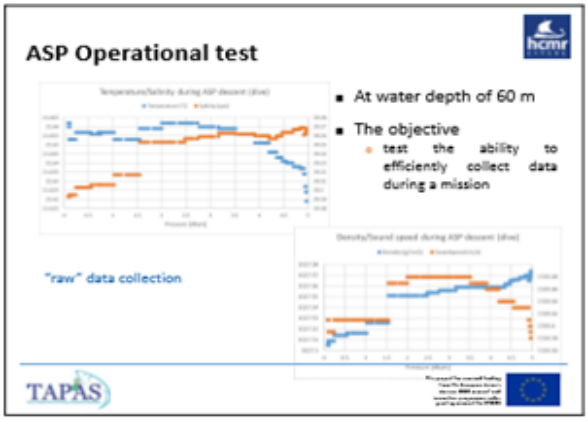
7.9 New in situ observation technology

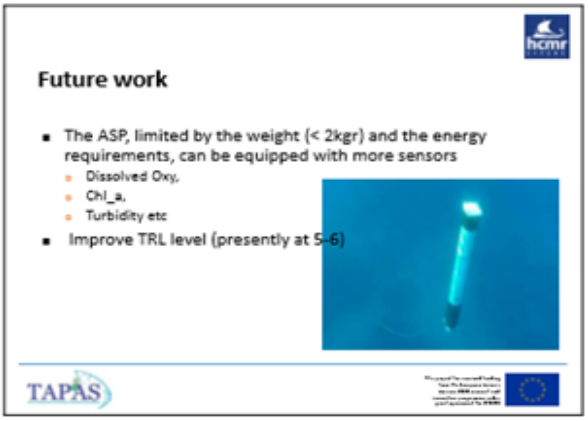












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An AUTONOMOUS UNDERWATER VEHICLE for AUTOMATED INSPECTION of AQUACULTURE NET PEN CAGES

V. Chalkiadakis, G. Livanos, K. Moirogiorgou, M. Zervakis, N. Papandroulakis
HCMR

The problem

- Negative Consequences by fish-cage structural failures in aquaculture installations
  - fish escapes
  - decreased growth performance

Today's Practice

- Inspection by specialized professional divers
  - costly
  - less frequent
  - more difficult in off-shore installations
- Inspection using ROV
  - on-site personnel required

TAPAS AUV approach

- Use of Autonomous Underwater Vehicles (AUV) for automatic inspection and reporting
  - lower operational cost
  - frequent inspections
  - early problem detection

*An effective solution **particularly** for off-shore aquaculture*

Solution Overview

- AUV* equipped with
  - Lite On-board Navigation System based on computer vision
  - Docking Station for wireless battery charging and video uploading
  - Off-line automatic Net Inspection s/w

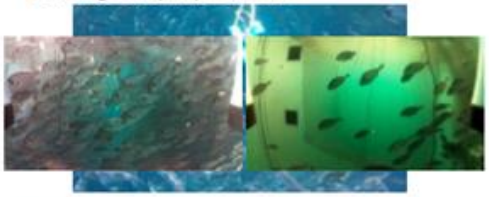
(*)
- Based on BlueRobotics / BlueROV2
- Open source electronics and ROV navigation s/w
- Inertia and Positioning Sensors

Net inspection

- Based on image processing of video-frames annotated with time and AUV position
- Net hole identification concept
  - Regular Texture image analysis
    - Template matching techniques
      - comparison of a source image with a template image
    - Edge Detection techniques
  - Retrieve damage location using annotation
  - Generate Alarms and Reports
- Hardware development for online analysis (CMBR project)

Field trials

- Test and trials conducted under different conditions
  - Stocking density may be an issue



Future work

- Improve Autonomous Navigation
- Use the system as "platform" for additional tools (e.g. fish size measurement)
- Reduce the size of the vehicle, making it feasible to equip each net cage with one
- Improve TRL level (presently at 5-6)

Autonomous above water radiometer system WISPstation

M.L. Laanen & S.W.M. Peters
Water Insight

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

Water quality monitoring

The problem: Aquaculture industry and regulation need to know water quality parameters (CHL-a, sediments & transparency) for:

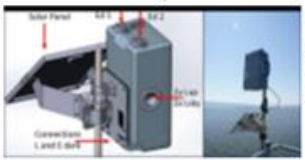
- Environmental reporting (ongoing and licensing)
- Farm yield modelling
- Event monitoring / forecasting and decision taking

Current practice: lab samples

- Labour intensive
- Expensive

Within TAPAS, the WISPstation was developed

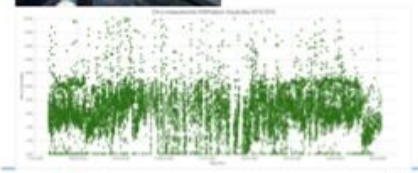
WISPstation Specifications



Based on proven technological solutions
- √ Turn key installation
- √ High spectral resolution
- √ Solar powered autonomous measurements
- √ Data communication over 3G/4G
- √ Parameters:
  - Chlorophyll-a
  - Suspended matter
  - Transparency
  - CDOM
  - Phycocyanin
  - Water quality indicators
- √ Data directly available over internet API
- √ No motors / robots: little maintenance
- √ Installable on poles or buoys
- √ Low sensitivity to spectrometer drift
- √ Remotely configurable over 3G/4G
- √ Adjustable measurement frequency
- √ Quick repair / replacement options
- √ Buy or limited lease/hire options

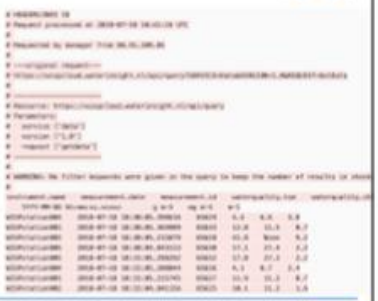
WISPstation field tests Crete & Hungary

Status: active, some 20,000 measurements collected for TAPAS

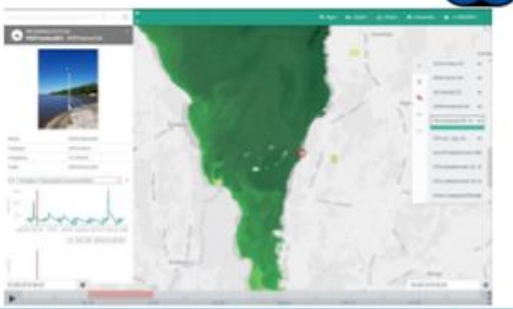


WISPstation output

WISPcloud backend:
- Storage
- Quality Control
- Algorithms
- Output API

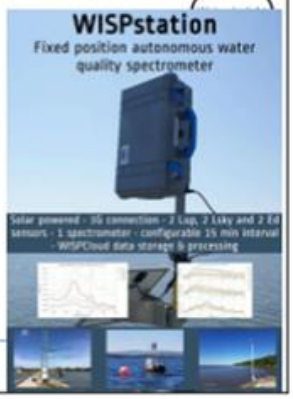


WISPstation output 2



WISPstation solution

- Realtime information
- Autonomous operation (very limited maintenance after installation)
- Comparable accuracy to laboratory analysis
- Configurable API output
- … but also other output possible
- WISPstation data can also improve atmospheric correction of EO data



Conclusions

- The development of an effective AUV
  - is achievable
  - facilitates off-shore aquaculture installations
- High-frequency automated water quality monitoring with the WISPstation provide real time information to aquaculture farms and regulatory bodies to assist in decision making
- Today's technology advances can be effectively applied to the Aquaculture Industry, to enhance production and decrease operational costs

[end message]

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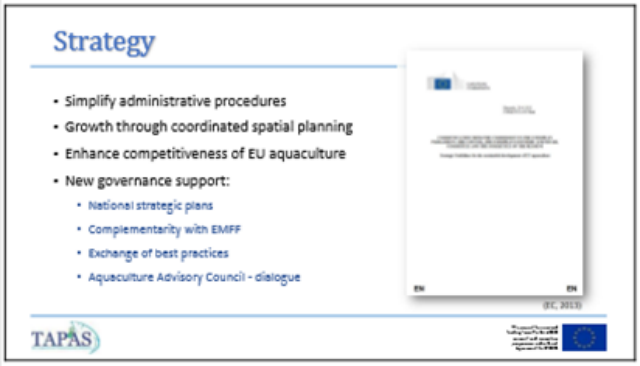
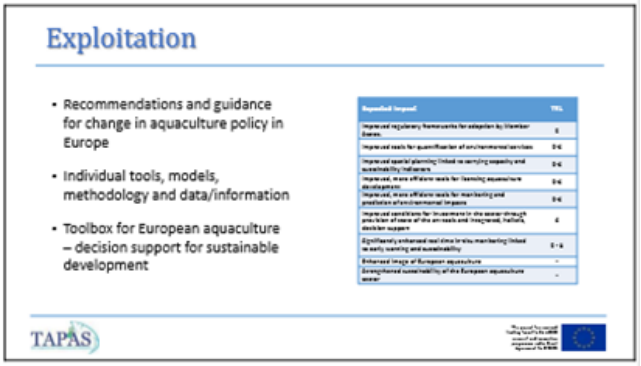
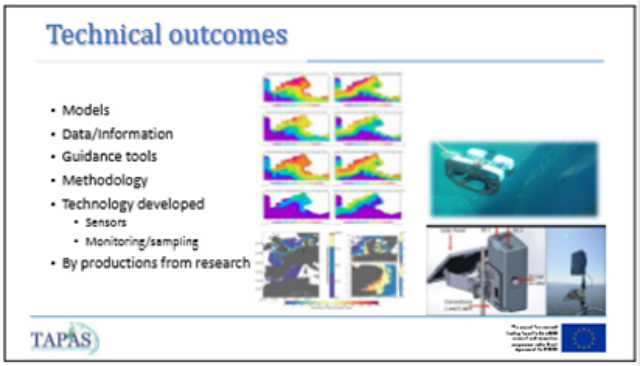
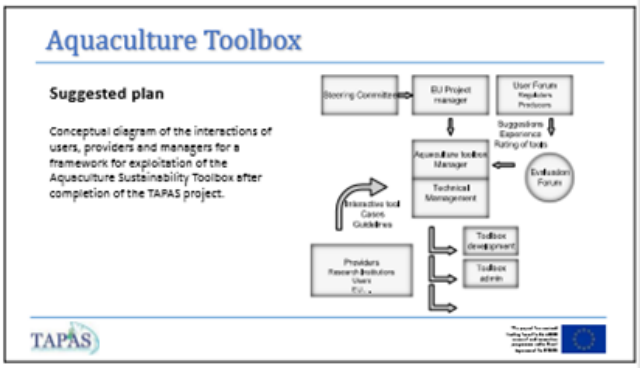
7.10 Implementing TAPAS recommendations and tools









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Markets and end-users

The exploitable results of the TAPAS project are relevant to:

- Authorities for aquaculture licensing and regulation
  - Guidance, Aquaculture Toolbox
- Aquaculture producers
  - Guidance, data & information, modelling tools,
- The public
  - Information on governance, compliance
- The consultants, scientific and research community
  - Methods, tools and data

TAPAS

Implementation – How?

EU policy driving but implementation at national level

National stakeholder meetings:

- Guidance in developing regulation/licensing for aquaculture
- Guidance to simplify administrative burden – One stop shop
- Tools for management of sustainable aquaculture
- On line licensing
- Reliable information for public.

Peter Langyel - Hungary

TAPAS

National level implementation?

- Based on "Updated strategic guidelines for sustainable development of EU aquaculture"
- Use a staged approach to putting into practice?

- How can TAPAS help?

National level strategies/policies developed

Existing or new legislation?

Licensing process

Decision support

TAPAS

National level implementation?

- Economic benefits of aquaculture
- Social benefits of aquaculture
- Social license for aquaculture
- "Political will" to develop aquaculture
- Involvement of stakeholders
  - Regulators, NGOs, producers, others?
- Review existing national plan

TAPAS – policy recommendations, information WPs and guidelines – inform the debate

National level strategies/policies developed

Existing or new legislation?

Licensing process

Decision support

TAPAS

National level implementation?

- Will legislation need to be changed?
- What standards should be achieved?
  - Environmental standards
  - Welfare
  - Product Environment Footprint (PEF)
  - Etc.....
- Consider certification and 'Beyond compliance'

TAPAS – policy recommendations and guidelines

TAPAS – data, results, methodology - provide detail

National level strategies/policies developed

Existing or new legislation?

Licensing process

Decision support

TAPAS

National level implementation?

- Involvement of all stakeholders
  - Regulators, NGOs, producers, conflicting users, others?
- Licensing authority?
  - Who is responsible?
- What aquaculture system and size?
  - Ponds, Cages, RAS etc?
- Implications of change?
  - Economic?
  - Environmental?
  - Trade-offs needed?

TAPAS – Aquaculture Sustainability Toolbox

TAPAS – monitoring provision and technology outcomes for data provision

National level strategies/policies developed

Existing or new legislation?

Licensing process

Decision support

TAPAS

National level implementation?

- Simplified licencing procedures (one-stop shop?)
- Decision support for:
  - Site selection and suitability for aquaculture
  - Application of environmental standards
  - Monitoring and Compliance

- TAPAS – Aquaculture Sustainability Toolbox

National level strategies/policies developed

Existing or new legislation?

Licensing process

Decision support

TAPAS

TAPAS

Tools for Assessment and Planning of Aquaculture Sustainability

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