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Integrate Aquaculture:
an eco-innovative solution to foster
sustainability in the Atlantic Area

INTERREG Atlantic Area 2014-2020 Project EAPA_232/2016

WP6 - Defining a framework for IMTA development

Action 1 report: State of the opportunities for the development of the IMTA sector on the Atlantic Area

DELIVERABLE 6.1

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Target audience

AA Joint Secreatriat	X
Partnership	X
Associated partners	X
Media	
Public	X

Means of delivery

E-mail	X
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Social media	X

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Contributing partners: **All**

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CONTENTS

1 Introduction & context

The objective of the project INTEGRATE is the promotion of Integrated Multi-Trophic Aquaculture (IMTA). These systems are based on the cultivation of multiple species belonging to different trophic levels and interacting on the same site. It is also the occasion to enhance the partnership between the research sector and the industries in the innovating aquaculture sector while supporting the technology transfer to the professionals and to the education.

One phase of the project, the WorkPackage N°6, "Defining a framework for IMTA development: Action Plans for the Atlantic Area" is split into 4 actions:

- identification of barriers and levers to the application of IMTA through AA;
- stakeholder positions of IMTA in Europe;
- diagnosis of the regulations applicable to IMTA in AA;
- how to develop an action plan: from diagnosis to action.

To do so, Agrocampus Ouest, the WP leader, has established the method to drive the survey and achieve the different actions. This method has then been applied by the different partners in their own countries to obtain as much data as possible about the IMTA sector on the Atlantic Area.

2 Methods

The objective of Action.1 of this WP, is the identification of the barriers and the levers for the development of IMTA. The location of the IMTA initiatives in the Atlantic Area will be presented with a map for each country, where the different systems will be characterized and summarized. The aim was also to highlight the main difficulties encountered by the producers aiming at developing IMTA facilities. This synthesis document presents the results and an analysis of the work achieved from September 2017 to September 2018 by the different partners.

2.1 Identification of the IMTA network on the AA

In the first phase, the network of stakeholders potentially involved in the IMTA sector was identified. Through project partner's personal networks via phone calls and e-mail the different actors at strategic levels were contacted. At a national scale, our contacts were likely to provide a list of past and present IMTA projects already recorded. In fact, very poor information was available at this scale. At a regional scale, professional organizations for aquaculture and fisheries were contacted, as well as technical centers and research institutes. They had a better view of the IMTA sector and some information about IMTA initiatives. Finally, at a local scale, decentralized State services**,** educational institutions and producers provided good information about the different IMTA facilities already operational or in progress.

2.2 The different steps to the identification of barriers & levers

In a second phase, **exploratory interviews** were conducted by the project partners with producers and other relevant stakeholders identified as potentially involved in IMTA initiative. A total of 28 interviews were conducted with 20 producers, 4 natural parks, 2 administrations and 2 professional organizations. The aim was to investigate the understanding of IMTA and to obtain information about the perception of these practices, their characterization, and about the evolution of the aquaculture and IMTA sector in the AA. It was also the occasion to identify the chronological steps and key points of the administrative procedure for aquaculture and IMTA projects implementation. This first task finally allowed us to draw a map of the different facilities involved in IMTA initiatives for the partner countries in the Atlantic Area.

Interviews' guides were redacted by the WP leader and shared with all the project partners, so all the interviews conducted in all project partner's countries, would have a similar format, helping to identify the relevant data to collect during the interviews. The main benefit of these one-to-one interviews was that it encourages the interviewee to speak freely, and helped with the gathering of qualitative information.

12 IMTA systems particularly relevant as regards their history and the way they were implemented, were selected as **case studies** for further analysis. These case studies gave us a better understanding of the factors of opposition to an aquaculture project, identifying when this opposition starts, and for which reasons. Those case studies would also be the basis of a comparative analysis to identify variables or modalities that might obstruct or facilitate the implementation of IMTA facilities, and to answer questions such as "Is fish farming more difficult to implement compared to shellfish farming activities?", "is it easier to implement aquaculture systems in-land or offshore?". 37 interviews were conducted for those 12 case studies. The diversity of actors interviewed is presented in the table below. During this second part of the study, a second interviews' guide was created to run the case studies and collect more precise data relevant both for the analysis of the barriers and levers for the IMTA development in the AA, but also for the comparison of the case studies in the second phase. The results of this second objective will be presented in a second WP6 action report.

Producers	Professional organizations	Mayors	Scientists	Administrations	Residents associations	Fishermen
21	4	2	3	4	2	1

Table 1: Repartition of the case studies' interviews

The two rounds of interviews had two distinct purposes:

- the exploration of the IMTA sector through the interviews;
- a deeper analysis of the implementation of IMTA projects with the case studies.

Furthermore, the data collected during those two phases were gathered to run a global analysis of the sector and to point out the potential barriers and levers for the development of the IMTA sector in the AA. Figure 1 below resumes the different steps of the survey.

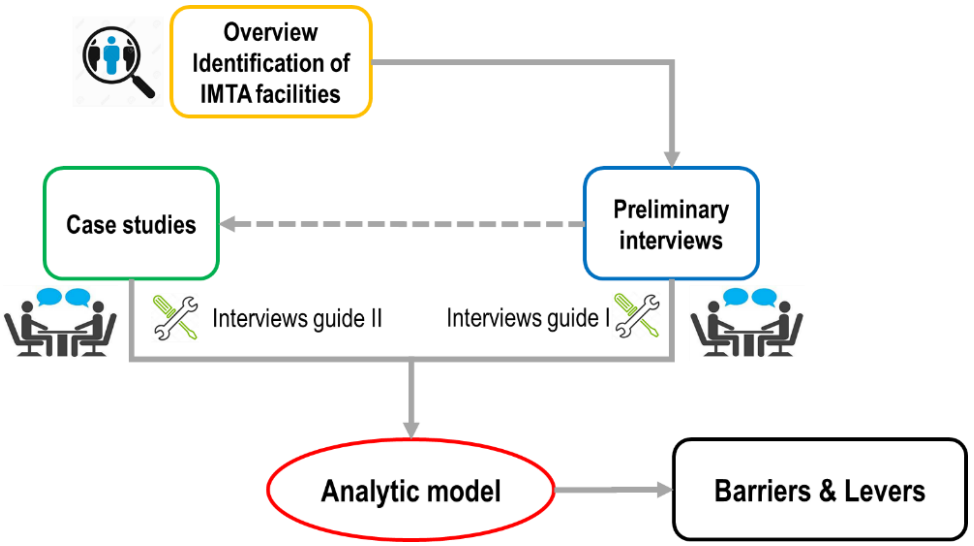

Figure 1: Schema of the different steps of the survey for
the identification of barriers and levers for the development of IMTA in the AA

2.3 Production of an analytic model for the analysis of barriers & levers

The interviews have been the subject of a structured summary to underline the main ideas and facilitate the translation into exploitable results. The information collected has been organized in a cross table with different components and indicators for the two axes of study (Appendices 1 & 2) and to get a general analysis of the IMTA sector. This method allowed us to organize the different issues encountered by the actors interviewed in order to identify the recurring ideas, to highlight the main barriers and levers of the development of IMTA in the AA (Action 1 of the WP6) and to give a comparative analysis of the case studies (Action 2 of the WP6).

The results of the two sets of interviews were analyzed and helped to understand that our first approach, based on social acceptability, was too restrictive. Social acceptance is one of the factors limiting the development of aquaculture and might explain the failure of several aquaculture implementations. However, the amount of IMTA projects remains very low and social acceptability only cannot explain this low

infatuation for IMTA practices. Another approach should thus be to re-direct the interviews toward the interest of the potential project holders for IMTA.

Thanks to the results of the exploratory interviews and the case studies, an analytic model has been set-up. This model evolved through the analysis of the results of the interviews and the collection of additional data thanks to different workshops organized for the WP4. We have thereafter relied on the final model for the analysis of the results (Figure 2). The results presented in this document are based on the outputs of this analytic model and are presented through the different indicators found as relevant according to this model. Finally, we can resume our survey to the study of two major axes:

- the interest of the producers or potential project holders for IMTA. In this part, we mainly study the assets and the downsides of IMTA perceived by those actors;
- the social acceptability and the political context, the regulations and the different interactions between the project holders and the local stakeholders.

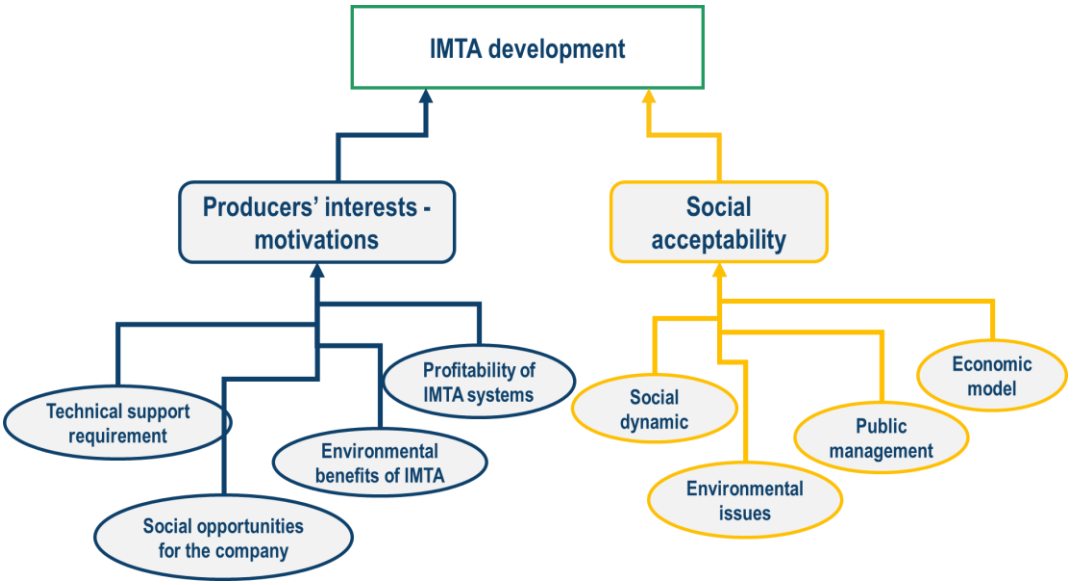

Figure 2: Schema of the analytic model build from exploratory interviews and adjusted from cases studies and workshops outputs

The main objectives of our study were to collect information regarding the development of IMTA, the assets of such practices and its downsides. Many different systems were identified offshore, inland and on the foreshore, with a diversity of species in production. One must keep in mind that each partner in the project did not have the same means to conduct these interviews, nor the same time allocated to run this survey. This issue has an impact on the data collected by the different partners, and the analysis comes out of this collective and non-homogenized work. Some limitations of the survey are discussed below.

The first problem in our method is the fact that different interviewers conducted the study in the different countries which can lead to a non-homogenization of the questions asked and answers collected. Some interviewers focused only on technical aspects or social acceptability, while others focused on the characteristics of the systems. This might have generated some biases in the analyses because of the lack of information on several indicators.

The second bias is the over representation of the producers and the low number of interviews undertaken with environmental associations, fishermen, or other local stakeholders. This is due to the location of some facilities, where no local actors had direct interactions with the production site, or with the difficulties to reach the stakeholders. However, good information has been collected regarding the arguments from the opponents to the development of aquaculture thanks to the information provided by administration in charge of the projects in France, Spain and Ireland, and key stakeholders.

2.4 Presentation of the results

Our analysis of the barriers and levers for the development of IMTA will be split into two steps. First, an analysis at the scale of each partner country through synthesis sheets is presented below in the section 3. A merged analysis at the scale of the Atlantic Area will then be presented thanks to a crossed analysis of the results of the interviews run by the partners in the section 4.

The minutes of all interview were redacted and the indicators or the main components of the different dialogs have been identified and placed into an analysis table. The section 4 will help to understand the recurring ideas revealed by the majority of the interviews as they were extrapolated from the merged analysis of the partner countries' interviews. However, specificities from different countries on certain points are also presented and clarified.

3 IMTA state in partner countries

The following information sheets present the global state of the IMTA sector in every partner country. They aim to give a first image of the IMTA systems in the different countries, and to illustrate the key barriers and levers specific to each country.

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Integrated Multi-Trophic Aquaculture in the UK

Development of IMTA in the UK is limited in 2018, and up to date has been formed of very small scale and/or experimental facilities. The uptake of IMTA has been specifically on marine sites, rather than the smaller scale freshwater installations that are present in smaller numbers. The sites that are, or have been in operation have tended to use existing species (pacific oysters, blue mussels, queen scallops etc.) as there is good practical husbandry knowledge within the industry. There is also an interest in using IMTA as a means of capacity enhancement on selected sites, by means of improving levels of bioremediation on the benthic habitat.

IMTA systems' diversity

Development of IMTA systems in Scotland has been generally focused around existing marine finfish installations, although some small trial land-based systems have been attempted. There is comparatively little practical crossover between the finfish and shellfish sectors in Scottish aquaculture, and this makes it difficult to develop potential synergies, and to encourage new IMTA development. The business model, and economic scale of the finfish industry is focused largely on refining production, and while IMTA is of interest, there has to date been no large scale, commercial, diversification into IMTA.

IMTA implementation procedure

IMTA development follows the same procedure as for other commercial marine cultivation. The key bodies involved in processing an application for a new, or adapted site, will be:

The local Council/Authority – the main planning application must be lodged with the council, who will balance it against various local and national frameworks and make the ultimate decision as to whether to approve/refuse. The council will take advice on specific matters from other partners – these include those mentioned below.

SEPA (Scottish Environment Protection Agency) will undertake modelling to determine the effects of the installation, and make a recommendation as to stocking levels. This will be more important for finfish installations.

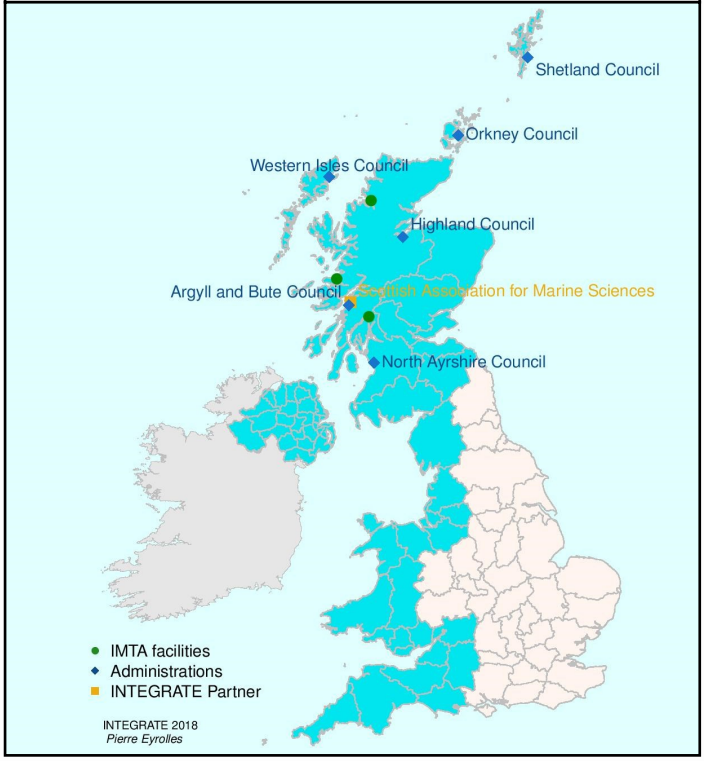
Marine Scotland – The marine agency of the Scottish Government, who will provide the site with a marine licence.

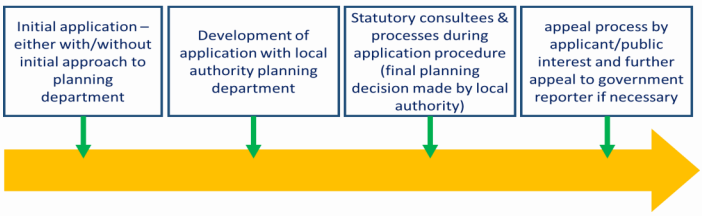
Crown Estate Scotland – the owners of the foreshore and the seabed, from whom the site must have permission, and to whom annual rental is paid.

Local stakeholders – this may include local community councils, fisheries trusts, conservation bodies and members of the public, who may comment on a proposal.

IMTA is specifically mentioned in Scottish Government policy, and is seen as favourable development. As the uptake of IMTA on farm sites has been limited in Scotland to date, it is difficult to predict how long an application will take, although the process is comparatively easy, and if there are no objections, the application will likely be in the region of several months.

Mapping of the IMTA actors on the British atlantic area





Schema of the implementation procedure of an IMTA system in the UK

Current limits of the IMTA development

The existing IMTA work that has occurred in Scotland has benefited from much interest from within the aquaculture sector, as well as from the media, academia and government. The main limit to development at present is the lack of uptake from the finfish sector. The majority of production in this field is controlled by large, multinational firms – as mentioned previously, they have been very interested and helpful in the development of IMTA, but no-one has taken up IMTA at a commercial level yet. When this occurs, we will likely get a much better idea of the 'real world' obstacles that IMTA is likely to face.

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Integrated Multi-Trophic Aquaculture in Ireland

Development of IMTA in Ireland is at its infancy in 2018, although there are many commercial aquaculture activities in close proximity to each other that could be considered as unintentional IMTA, these systems were not studied in this project. To date, most of the IMTA activities reported in Ireland have happened at research level. In this factsheet we analyze marine systems (land-based or offshore) and fresh water systems excluding aquaponics. In Ireland, two companies with commercial IMTA activities have been identified, sea-based and the other a land-based fresh water system.

IMTA systems' diversity

Two types of system have been identified in Ireland, each involving two trophic levels:

- Atlantic salmon *(Salmo salar*) farming in offshore cages, associated with macroalgae production on longlines;
- Perch (*Perca fluviatilis*) integrated with duckweed (*Lemna* spp.) production in land-based ponds and raceways.

IMTA implementation procedure

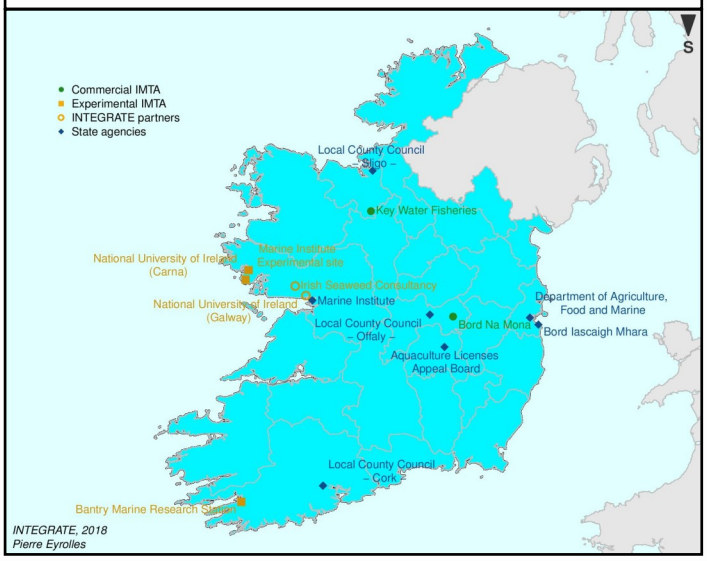
In Ireland, any aquaculture activity requires an Aquaculture License and when the proposed aquaculture activity occupies State-owned foreshore, a Foreshore License is also required. The procedure for an IMTA license is identical to that of any other aquaculture license but uses a specific 'multi-species' license application template.

Granting of aquaculture licenses is coordinated and overseen by the **Department of Agriculture Food and Marine** (DAFM). On receipt of an application it is sent to the Marine Engineering Division, the Commissioner of Irish Lights, the Sea Fisheries Protection Authority and the Marine Institute for recommendations and to ensure compliance with other site boundaries and navigational channels etc.

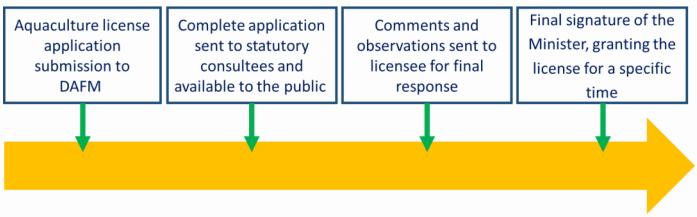
After this initial revision, the full redacted application is sent to a group of **statutory consultees** (a total of 17 state bodies and departments) for comment; they are given 6 weeks to respond. At this time, the public is informed by notices in local newspapers and on DAFM's website. Public comment on the application is invited and may be submitted (to DAFM) for up to 4 weeks from the date of publication of the notice. All the comments and observations are sent to the licensee who is given 3 weeks in which to respond.

Depending on the type of license applied for, and the proposed location, there are various additional requirements (environmental assessments/integrated pest management plans/structural plans). Full explanation of the process can be found in the DAFM's website[1]. Based on the two case studies analysed, completion of the application process took between two and three years.

Mapping of the IMTA actors on the Irish Atlantic Area



Schema of the implementation procedure of an IMTA system in Ireland



Current limits of the IMTA development

- IMTA is a relatively new concept in Ireland and relatively unknown;
- As an operational concept the details are not well described and available to the stakeholders;
- There are no clearly presented incentives to invest in this form of aquaculture.

References

[1] https://www.agriculture.gov.ie/seafood/aquaculturefore shoremanagement/formsdownloads/

Integrated Multi-Trophic Aquaculture in France

Development of IMTA in France in 2018 is based on very different types of systems, due to the specificity of the French aquaculture sector, moslty based on shellfish farming. In this factsheet, the study is limited to the marine systems (marine water), land-based or offshore. About ten companies have been identified on the atlantic area of the French coast, as well as a network of developing poly-culture systems since the 90's. Research units focused on the Mediterranean area are also working on divers aspects of IMTA, such as the performance of those systems on the environmental point of view, and the economic viability of the companies.

IMTA systems' diversity

At least 4 types of systems are mainly represented in France, with mostly two trophic levels in interaction:

- co-culture oyster - shrimps in half-closed ponds in the swamps of Charente Maritime;
- salmonids farming in offshore cages associated with algae production;
- algea culture on offshore ropes associated with mollusks farming;
- marine fish nursery with algae production.

IMTA systems in France present also a diversity in terms of production's scale, with companies producing hundreds of tons of shellfishes and small scale fishfarms with less than 10 tons of production.

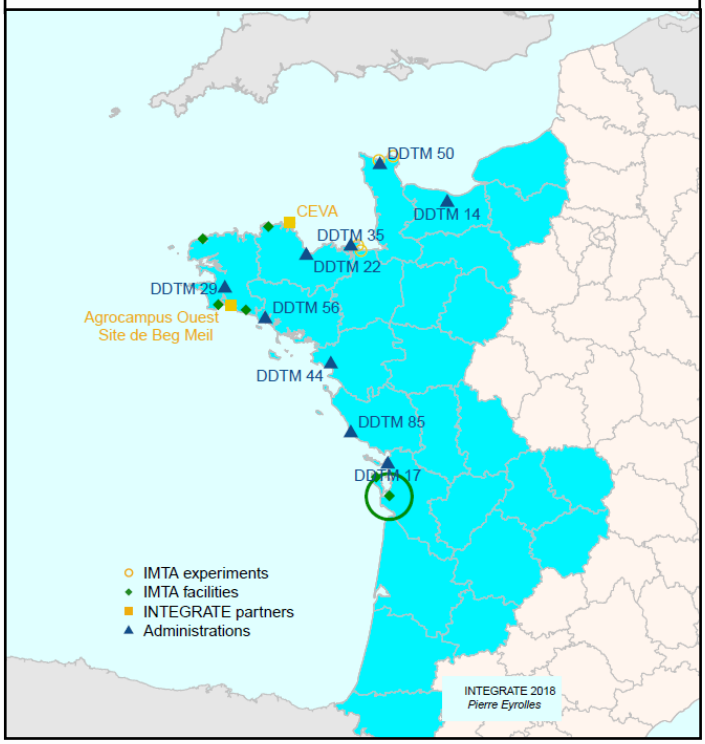
IMTA implementation procedure

The approach is exactly the same as the one for the conventionnal aquaculture. The local administration is in charge of the inquiry of the file and remains the prefered intermediary of the project promoters. Fishermen, sea farmers and their representatives are thereafter consulted during a committee. Finally, the Prefect of the department signs the treaty authorising the implementation of the facility.

This procedure can last between 4 and 24 months, but it might be much longer when it is a creation of a concession in IMTA. Those new practices must be controlled and the regulations has to evolve so the files can be treated fast enough.

Schema of the implementation procedure of an IMTA system in France

Mapping of the IMTA actors on the French Atlantic Area



Current limits of the IMTA development

- Spatial competition with other coastal or offshore activities (Marine cultures, yachting, etc.) ;
- Few feedbacks regarding the potential and the performance of those systems ;
- Multi-skill needed to master the different compartments (fish / mollusk / algae).

Moreover, even if several research projects arise in the IMTA sector and gather research structures and companies, the amount of initiatives remains very limited. The number of producers looking for diversification and adopting the IMTA model is still very low. The sector needs to find development levers in terms of technic, economic viability and regulations or social aspects.

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Integrated Multi-Trophic Aquaculture in Portugal

Development of IMTA in Portugal is limited in 2018. About four SMEs, one research Institution and two Universities have been identified on the Atlantic Area of the Portuguese coast. Research units focused on different aspects of IMTA, such as the performance of the systems considering the environment (biomitigation and ecosystem services), the technical aspects of the production and their economic viability. For this project, the study is limited to the marine systems (marine water), land-based or offshore.

IMTA systems' diversity

Most IMTA in Portugal is land based taking advantage of the existing pond aquaculture. Offshore IMTA is at its infancy with some trials with filter feeders (oysters; mussels) and macroalgae.

At least 2 systems were detected (joint or separate cultures) involving, in general, interaction of three trophic levels:

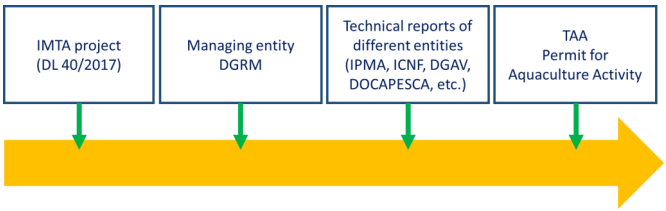
- co-culture of oyster with either meagre or seabream;
- co-culture of macroalgae, oyster, meagre, breams and mullets;
- separated cultures of sea bass, sea urchins and macroalgae;
- separated macroalgae culture associated with sea bass and sea bream pond farming;
- separated halophytes associated with aquaculture effluents.

The scale of production is in general small with a diversity of end products from the immediate selling of the products to the production of species for biomolecules.

IMTA implementation procedure

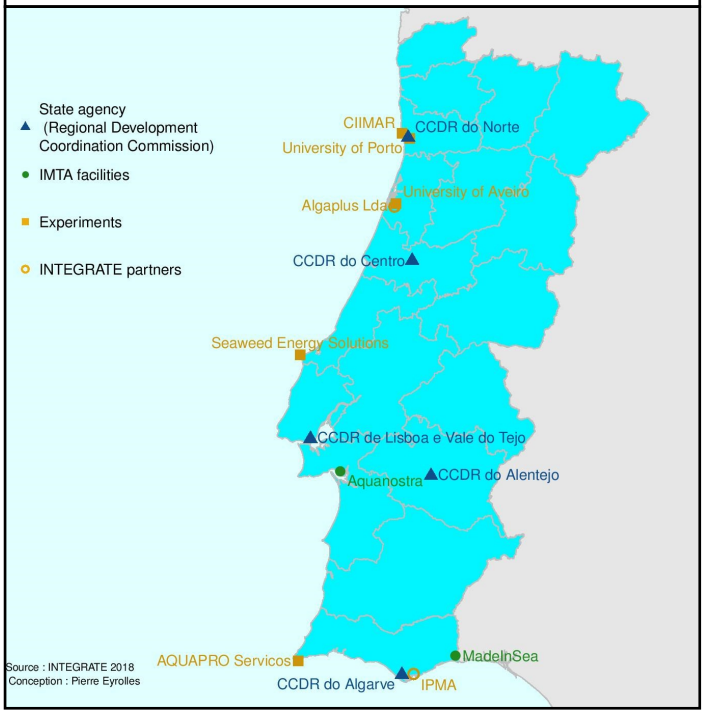
For valid aquaculture permits there is no restriction to start an IMTA in Portugal. New projects follow the licencing procedure of Law Decree DL40/2017, regardless of being IMTA or conventional aquaculture. The managing entity is Direção Geral dos Recursos Naturais (DGRM) that will ask for technical reports from other government entities: Environment (APA), Harbours (Docapesca), Aquaculture (IPMA), Marine Safety (AMN), Food Safety (DGAV), Nature Conservation (ICNF). These are binding reports and therefore their agreement is of upmost importance. Only after the general agreement DGRM will grant the Permit for Aquaculture Activity (TAA). The challenge lies in the project design in view of the different concerns that each entity evaluates.

The process of obtaining a TAA can last between 1 and 3 months, depending on the technical report timely deliberation. IMTA practices must be regulated so the permits can be granted fast enough.



Schema of the implementation procedure of an IMTA system in Portugal

Mapping of the IMTA actors on the Portugese atlantic area



Current limits of the IMTA development

In general, IMTA, as it is developed in Portugal, has very good acceptance by the public and the engaged producers are proud with quality of the product and happy with the results. Since the main system is pond aquaculture there seems to be space to grow. The amount of initiatives is limited but the number of producers looking for diversification and adopting the IMTA model is increasing. Since the production scale will be relatively low, producers are more interested to invest in products that will sell at higher prices in market niches. The sector still needs to find development levers in terms of economic viability.

Integrated Multi-Trophic Aquaculture in Spain

Development of IMTA in Spain is very limited. It is remarkable that there are only two aquaculture facilities that have implemented IMTA. However, some companies and research organizations have started up different pilot trials to develop this type of aquaculture activity. This document outlines the most relevant pilot trials in the Atlantic Arc in Spain.

IMTA systems' diversity

Most of the aquaculture facilities located within the Atlantic Arc in Spain are land based or raft culture in the case of the Galician mussel

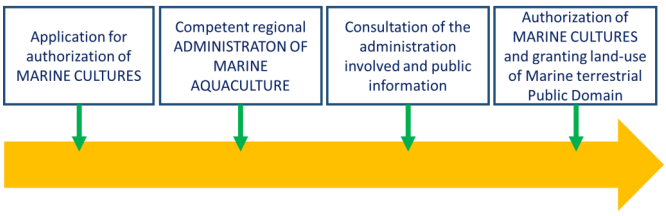
Specifically, the two facilities which currently have an IMTA system on going are both located in Andalucía, South of Spain. The interactions among species are described below:

- semi-intensive Co-culture fish, mainly seabream (*Sparus aurata*) and seabass (*Dicentrarchus labrax*) + mollusc (oyster + clams);
- semi-extensive co-culture fish seabream (*Sparus aurata*) and seabass (*Dicentrarchus labrax*) + extensive crustaceans and omnivorous fish.

IMTA implementation procedure

There is no a regulatory framework in Spain which describes the implementation of these type of systems. To implement an IMTA, the developer must request for an authorisation of the potential species that will be cultured. Each Autonomous region has its own regulation.

This procedure can last between 1.5 and 35 months, depending on the region.



Schema of the implementation procedure of an IMTA system in Spain

Mapping of the IMTA actors on the Spanish Atlantic Area

Current limits of the IMTA development

The regulatory framework of the aquaculture activities is complex and different in each region:

- spatial competition with other coastal or offshore aquaculture activities;
- special environmental protection areas: (Red Natura 2000, Natural Parks, etc.) within or near the facilities;
- lack of clear definition/requirements of an IMTA activity at a national level;
- limited information about technical, economic and environmental viability of IMTA at an industrial level.

There are a few companies which carry out IMTA cultures at an industrial level. However, most of the Autonomous regions are starting to see this type of aquaculture as an alternative sustainable model to the conventional aquaculture.

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4 Barriers & levers for the development of IMTA in the AA

The results of the interviews of the partner countries have been analyzed through the analytic model and according to two main axes: IMTA perception and interests for producers, and the social acceptability.

4.1 IMTA perception and interests for producers

In this first section we introduce an analysis of the different reasons that might encourage the producers to develop an IMTA system, but also the concerns these practices arise from their point of view.

Regarding the results, it appears consistent and more clear to classify the answers according to our indicators to four grand themes: environmental benefits of IMTA, profitability of IMTA systems, technical support requirement, and social acceptance of innovative practices. Barriers and levers for the development of the IMTA sector are presented below for each one of these previous thematic.

4.1.1 Environmental benefits of IMTA

A large number of respondents agreed that bioremediation in IMTA systems is a good lever for IMTA development, and might be considered as a reasonable motivation to implement those practices for the producers. Consumers' environmental concerns can influence the global consumption of seafood (Whitmarsh and Palmieri, 2011), and this element is another argument in favor to the development of sustainable aquaculture practices such as IMTA. IMTA environmental benefits might also improve the image of aquaculture and increase the chance of success in the implementation of new aquaculture sites as it is perceived as an improvement of the practices (Barrington et al., 2010). This process might encourage the producers to commit themselves in the IMTA sector.

Impact of aquaculture and IMTA on wild stocks has not been mentioned by any of the producers during the interviews. It has only been evoked during a workshop about technical best practices of IMTA in France. The use of local species and the monitoring of potential spread in the environment must be taken into account and considered as best practices to implement for IMTA.

4.1.2 Profitability of IMTA systems

At the moment, the major barrier to the development of IMTA is that economic sustainability of these systems is not ensured despite several studies presenting comparison between traditional aquaculture and IMTA systems' profitability (Carras, 2017; Whitmarsh et al., 2006). Further economic studies should be carried out to establish the economic sustainability of the different IMTA systems. The results of the interviews show that concerns about profitability of IMTA involve several aspects: the cost of the labor force cost associated with technical aspects, the time required to develop and commercialize a second crop, and finding the markets for them. Furthermore, the risk on the investment has also been mentioned.

It has to be mentioned that some IMTA systems including mussel and seaweed ropes remain very difficult to implement for fish producers. Equipment required for seaweed or shellfish production is completely different from fish net-cages and represents a huge investment for a less profitable species compared to salmon for example (Hughes and Black, 2016).

As long as the profitability of the IMTA model systems are not demonstrated, or that the effort needed to obtain financial gain is too high, IMTA systems will not be adopted by the producers, which is also part of the answer to enhance the development of IMTA. IMTA systems can enable the producer to largely increase the revenue per surface unit, growing multiple species on the same area. Two examples of IMTA in France with the co-culture of oysters and shrimps, and in Portugal with IMTA trials in traditional earthen ponds illustrate this idea.

The notion of diversification is important for most of the producers and is the second lever on the economic point. Producers are seeking for their company to thrive long-term, and to shelter from a potential mortality crisis, especially for oyster or mussel producers. IMTA is presented as an answer to this quest of diversification (Hussenot, 2004; Kleitou et al., 2018), but for most of the studied systems, co-production is insignificant in terms of revenues, and IMTA practices are an insignificant part of the resilience of the companies. Diversification through IMTA systems should be encouraged.

Finally, the production of new species might also be seen as an opportunity to target new markets, in addition to the fact that IMTA products might be commercialized under specific quality standards. The question of the means of valorization of IMTA products has to be answered as several producers encounter difficulties to transform seaweeds and many trials of algae production have been abandoned because of too low prices of non-transformed algae.

4.1.3 Technical support requirement

The complexity of IMTA, the fact of simultaneously producing multiple cultures is actually perceived as a barrier by the majority of the actors. This point has also been established with a survey on aquaculturists' perception of IMTA (Kinney, 2017). Environmental constraints, and the interaction with wild populations on offshore sites are also raising concerns, and several producers do not even consider establishing an offshore IMTA system for these reasons. On the contrary, some researchers consider offshore aquaculture (to be understood as very far from the coast) as the best way to develop aquaculture in order to prevent social acceptability issues or incompatibilities with other marine activities (Buck et al., 2018).

There is also a demand from the producers for the results of research studies in IMTA regarding species interactions or densities to implement. One lever to this challenge might be the use of technical support from technical institutes, or companies' cooperation, but this last solution is not possible in every country as only one company is allowed to exploit a concession in France and Portugal.

Finally, the situation in France is particular, the rope systems for shellfish farming represent a very small part of the production, and offshore fish farming barely exists. It might be interesting to develop other systems more suitable to the French particularity (foreshore farming, very little fish farming).

4.1.4 Social opportunities for the company

The first lever identified on this point comes from the current strong connection of IMTA facilities to research programs. Producers might find opportunities to establish scientific collaboration and to have direct access to research results, but also to acquire new skills for their employees and get an innovative advantage. The social lever is here seen as professional fulfilment for aquaculture employees.

The second lever identified related to social aspects during the interviews was the improvement of the image of the companies (Thomas, 2010). This information is related to the notion of profitability and marketing issues, but also to the environmental benefits IMTA practices might generate.

On the contrary, if IMTA can generate environmental benefits on which companies can communicate, one must pay attention to what message shall be conveyed. While the majority of consumers are not aware of even general aquaculture practices, communicating on the fact that IMTA shellfishes were grown thanks to fish wastes might create concern. One barrier to the development of IMTA might be the social acceptance of these aquaculture innovative practices.

4.2 Social acceptability

Our initial hypothesis was that new IMTA systems encountered social acceptability issues during the implementation process and that it was the main factor affecting the development of aquaculture and thus IMTA. This idea drove us to set up a precise definition of social acceptability. Our definition is based on the one of Fortin, Fournis and Beaudry (2013) which enables the integration of the different scales of a territory for the analysis as they present social acceptability as: "a political evaluation process of a project producing interaction between a plurality of actors involved at different scales, and from which are progressively built institutional arrangements and rules, acknowledged as legitimate since relevant to the vision of the territory and to the model of development favoured by the actors in question". The major idea being that acceptance of a project is only possible thanks to the acceptance at three levels: micro-social, meso-political and macro-economic.

Macro-economic aspects are in relation to the development policies at an international scale. Social acceptance at a macro-economic level is the acceptance of the (economic) model of development of a technology in a territory.

The meso-political acceptance is in relation with the acceptance of the governance and the way the projects are decided at a national and local scale.

The micro-social level deals with the different perceptions of a community and the process of coordination, support or opposition, toward this project. At this level, we have mainly focused on the interactions between stakeholders and on the causes of potential protests, coalitions or cooperation.

Poor data were collected during the survey regarding the two first levels, but texts from national and regional scales have been studied, followed-up by a local focus to confirm their consistency. The study of regulations and governance tools allowed us to include the meso-political level in the analysis. The results are presented through four main themes:

- social dynamic gathering the social acceptability of aquaculture and of the means to implement the projects;
- environmental issues focusing on the impacts of aquaculture perceived by local stakeholders but also on the way project holders solve it;
- public management dealing with governance and regulation aspects;
- economic model making the relation between the aquaculture project and the expectations of the local stakeholders.

4.2.1 Social dynamic

Aquaculture can suffer from a bad image, especially for fish farming. This first barrier to the development of IMTA systems is aggravated by a lack of communication and participatory process for the implementation of new aquaculture sites. Oppositions might also be heightened because of a concentration of aquaculture activities in the same area. These elements were the major barriers identified by the different actors interviewed during the survey. One must pay attention to the fact that several stakeholders, mainly environmental stakeholders, residents and sailing clubs, can also feel underrepresented during the procedure of implementation. This feeling has been highlighted in social acceptability studies in France (Paul, 2016).

Consulting processes cannot guarantee the acceptability of the project, even when it is done upstream of the instruction of the file, but it can give more visibility, transparency and enables trust between project holders and local residents. Those consulting processes are considered as the major lever to facilitate the implementation of new aquaculture sites (Batellier, 2016; Kaiser and Stead, 2002; Prno, 2013), but they might extend the length of the process, already very long for the project holders. Moreover, companies might

fear a strong opposition during these participatory processes that might cancel the project, and also they feel reluctant to reveal their innovative project. In any case, it belongs to the project holder to set-up a participatory process to present the project to the public and rise its chances of acceptation with the possibility that the discussion will lead to major changes to the core of the project; or to not communicate on the project with the risk that opposition arise and delay or cancel the project.

Another lever might be to communicate the aquaculture practices and the ecosystem services associated with aquaculture and IMTA. Visits of production sites organized by the producers themselves are known to help each stakeholder to better understand others' constraints and motivations.

4.2.2 Environmental issues

The main barrier highlighted by the different actors regarding the environmental issues is the environmental impacts of aquaculture themselves. There remains a lot of opposition to aquaculture project based on environmental arguments, especially with open-sea aquaculture projects.

However, several producers and technical institutes highlight a potential reduction of those impacts with the IMTA practices, even if the environmental benefits are debated for open-sea systems (Navarrete-Mier et al., 2010). Some of these arguments (eutrophication, invasive species spread), can be refuted by the simple application of good practices (bioremediation, cultivation of local species), whereas other aspects such as the benthic deterioration remains as concerns that current IMTA practices cannot solve. There are however research efforts on the use of detritus feeders such as sea-cucumber or polychaeta to help minimize this issue.The concept of IMTA has already convinced several local stakeholders and facilitated the implementation of aquaculture sites in France and Ireland. It appears as a good lever to enhance the implementation of aquaculture, resolving parts of its environmental impacts.

A second major barrier is the way project holders manage those impacts according to the regulations. Regarding this second point, the modalities of the environmental assessments for aquaculture or IMTA projects are not relevant to the expectations of the local stakeholders, nor the project holders in France. The lack of transparency and homogeneity for those environmental assessments, and the lack of precise frame for their realization do not help the project holders to guarantee their good will, or the stakeholders to trust them.

One lever to face this problem might be to better define when to realize those studies and what must be included, while specifying the production volume limits. It would enable the different actors to have points of reference and to agree on a common consent.

4.2.3 Public management

The will to develop aquaculture at the European and national levels is clearly established (European Commission, 2010, 2017). However, this wish is not easily applied at a smaller scale, firstly because the local representatives are subject to social pressure that prevents them from supporting those projects, and secondly because in certain territories, the aquaculture sector is already developed and generally disliked. These first barriers must be put in regards to the spatial planning issues of the marine activities. Certain projects lead to protests from fishermen or pleasure boaters because of a competition for space. This second point embodies the second barrier identified by the different stakeholders interviewed.

Another barrier is the difficulty to obtain licenses for the exploitation of multiple species on the same site. It relies on the accumulation of the different regulations specific to each species. Those regulations might not be compatible in terms of spatial constraints and may prevent the establishment of the project as it happened in France. Better marine space management tools are required to solve this problem.

The last barrier underlined by the majority of the project holders is the time period necessary to obtain authorization of production (Hughes et al., 2016). Some companies have waited four years for their authorization to produce shellfishes or seaweeds, even while there is a favorable context for their authorization.

In France, one of the actors proposed to establish an institution or a committee gathering representatives of the different marine activities (economic actors but also residents, environmental associations and sailing clubs) in order to manage the spatial planning issues. This committee would interfere before the administrative procedure and the licensing. The projects would be presented to the different actors *via* this committee and would lead to a negotiation upstream the administrative procedure. This process might fasten the licensing preventing late opposition and litigation to the court.

4.2.4 Company model

Big companies or structures associated with salmon farms producing high volumes can encounter heighted opposition and an increased demand for environmental assessment. Moreover, in certain regions, the population is *de facto* averse to aquaculture development because of the high concentration of farms implemented on the territory.

One must also keep in mind that several companies have underlined the fact that their activity would create many jobs for the region. But this argument has been contested by opponents arguing that those jobs were already undertaken within the company, and it was only a reorganization.

Finally, the last point is the profitability of the project. If the economical sustainability is not recognized, the project can be challenged by local stakeholders, which is particularly difficult for the companies willing to establish an experimental or innovating project to give proofs of the sustainability of a new production model.

These three points studied in this section focus on the company model and can be questioned by the opponents to the project. There is no real lever or answer to this issue. The integration of a company and its activity only depends on the territory on which it is implanted. The project holder must then be sure he clearly identifies the expectations and the particularities of the local stakeholders.

5 Perspectives

This document presents a merged analysis of the data collected in the different countries, and it leads to a global discussion of the main issues encountered over the Atlantic Area. Specific regulations or specific procedure for IMTA implementation are not discussed in this study, but it will be the subject of another study planned by the project. Though, these results underline several points that might be interesting for the development of the IMTA sector in each partner countries.

5.1 Technical aspects

Technical issues have been pointed as barriers for the development of IMTA, especially for offshore systems, even if this type of aquaculture is sometimes seen as the future of the sector because of the too heavy constraints due to the interactions of the different marine activities along the coasts. The competition for the marine space is more and more difficult in certain countries, and the development of aquaculture is not always considered as a priority compared to tourism or fisheries activities. Besides, relevant IMTA systems, matching with the specificities of a territory such as the shellfish farming on the foreshore in France, remains to be developed. The improvement of existing practicies is also a point to examinate. Overall, the economic sustainability of such systems must be guaranteed to grab producers' interests.

5.2 Profitability

The economical sustainability of IMTA systems remains to be established, but several studies have shown positive results (Carras, 2017; Neori et al., 2004; Whitmarsh et al., 2006). It appears that IMTA production might not be economically interesting compared to very efficient salmon monoculture systems for now, but with the evolution of the market and a better valorisation of the environmental sustainable practices, producers might be interested in the implementation of IMTA systems.

The economic sustainability of IMTA might be guaranteed by the implementation of new regulations or by the implementation of the polluter-pays principle. Seaweed and shellfish farmers might be likely to be funded by fish farmers or other CO_2 emitters thanks to the extraction of CO_2, phosphorus and nitrogen their activities guarantee. Such a system might enhance the profitability of IMTA systems and contribute to its development.

5.3 IMTA dissemination and communication

The demonstration of the environmental benefits is another crucial point for the development of the IMTA sector. It would enable the implementation of the previous economical levers through regulation tools, but could also improve the image of aquaculture with the implementation of sustainable practices. In France and Ireland, the argument of the bioremediation of IMTA systems facilitated the implementation of two systems. The Action 2 report will present these examples as case studies.

IMTA sector tends to expand through small scale commercial and experimental facilities. These sites are good communication tools. An example of the implementation of an IMTA site in the AA demonstrates that public visits on site lead to a moderation of the opposition to aquaculture. This communication aspect could lead to a better understanding of the IMTA practicies, and to a better acceptance of aquaculture in general. This point is in relation with the fact that public needs information not only on the products, but also on the profession.

The results of the different surveys undertaken during the project INTEGRATE revealed that the intrinsic qualities of a project do not to prevent opposition and protests from the local stakeholders. However, environmental benefits associated to IMTA practices can be relevant arguments for residents and administration for the licensing. Finally, participatory tools are essential to improve the probability of

acceptance of a project. The lack of representativness of NGOs and residents has been highlighted during different workshops and should be considered.

5.4 Regulation tools to be updated

The last point of this analysis is that there are no specific regulations against IMTA practices. Any project holder is free to apply for multiple species production. But in fact, it is a long process to obtain the authorization to cultivate a new species on an existing site (long delays). Moreover, to find a suitable location where to cultivate every species involves several texts regulations, and constrains with the production of certain species to a nearby location.

Moreover, the specific regulations can be very different from a country to another. In Portugal, a company can cultivate multiple species on the same site, but one site cannot be exploited by different companies. Furthermore, in the aquaculture sector, very few companies have the required skills to properly grow seaweeds, shellfishes and fish together. This specificity of the regulation is the same in France, while in the UK, different companies can work side by side, holding separate licenses.

6 Conclusion

This survey leads to the identification of barriers and levers for the development of IMTA on the Atlantic Area. Different points have been highlighted during the interviews conducted with various stakeholders on the Atlantic Area. Environmental, social, technical, economic, but also regulation levers can be targeted to enhance the development of the IMTA sector.

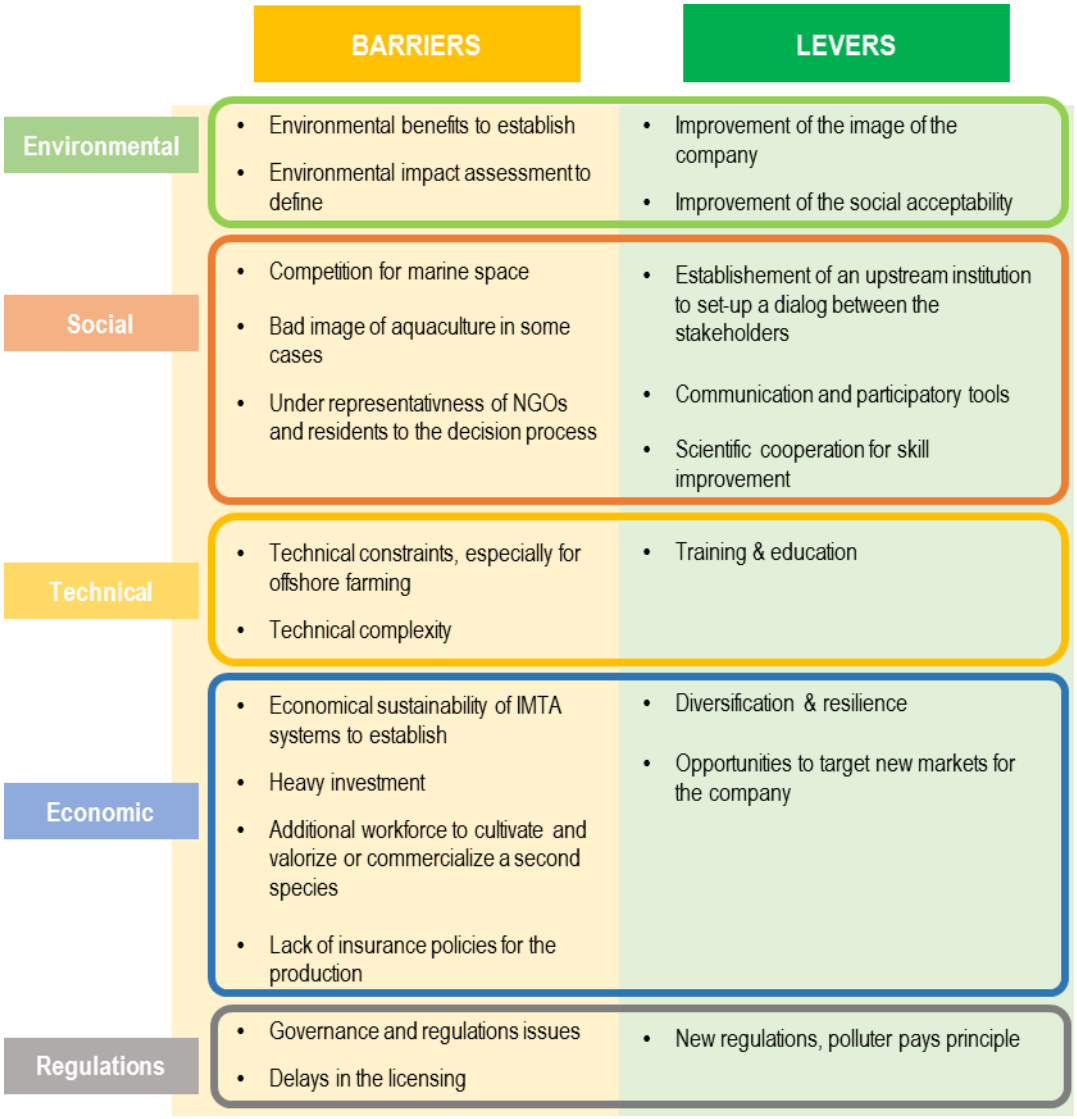

Figure 3: Summary of the barriers and levers identified by producers and stakeholders for the development of the IMTA sector on the Atlantic Area

Following the above analysis, the next action of the WP6 of the project INTEGRATE is the design of an action plan and its recommendations for the development of the IMTA in the Atlantic Area. Meeting administrators, presenting these levers and discussing the tools available to achieve this objective of boosting the IMTA sector are the next steps of INTEGRATE.

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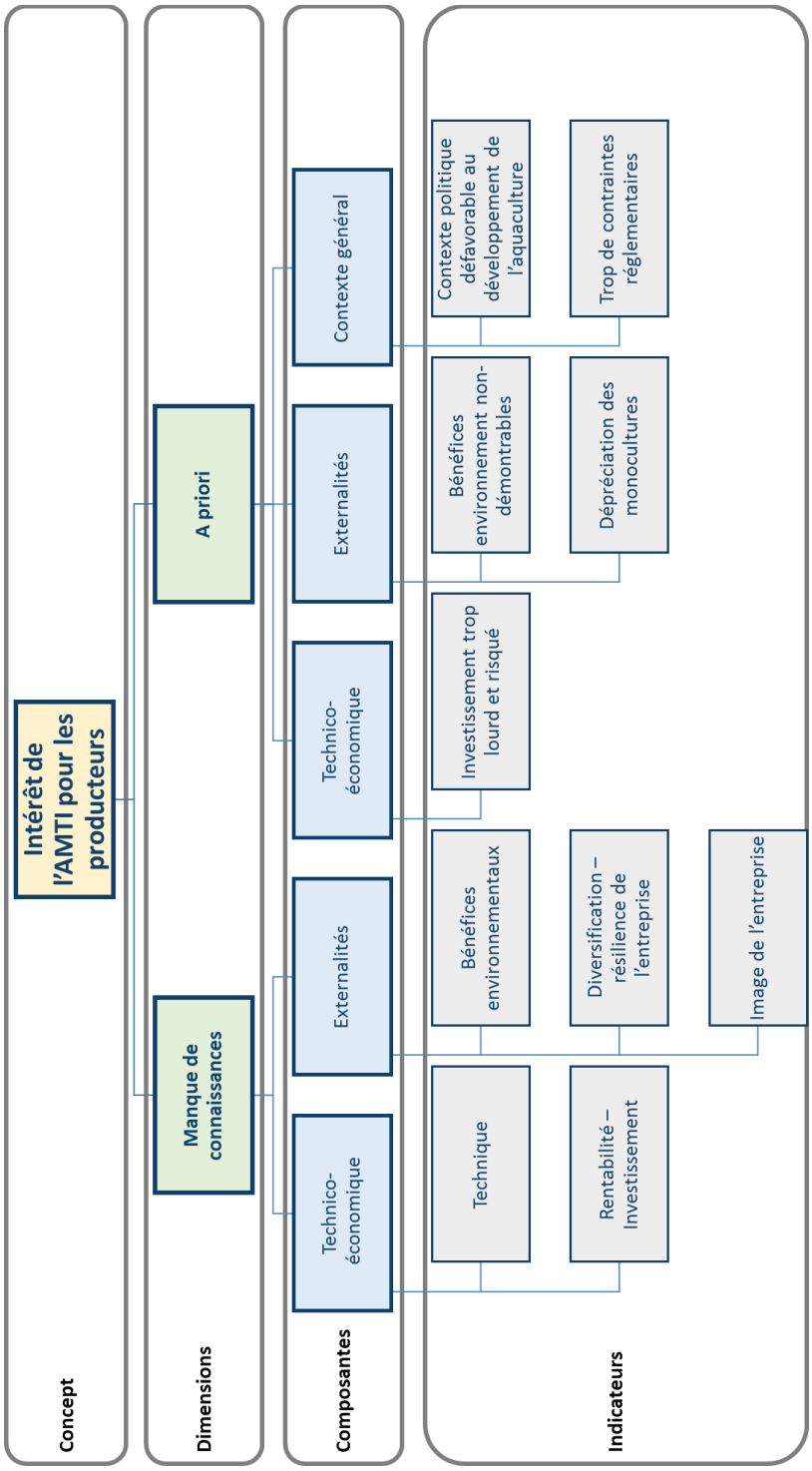
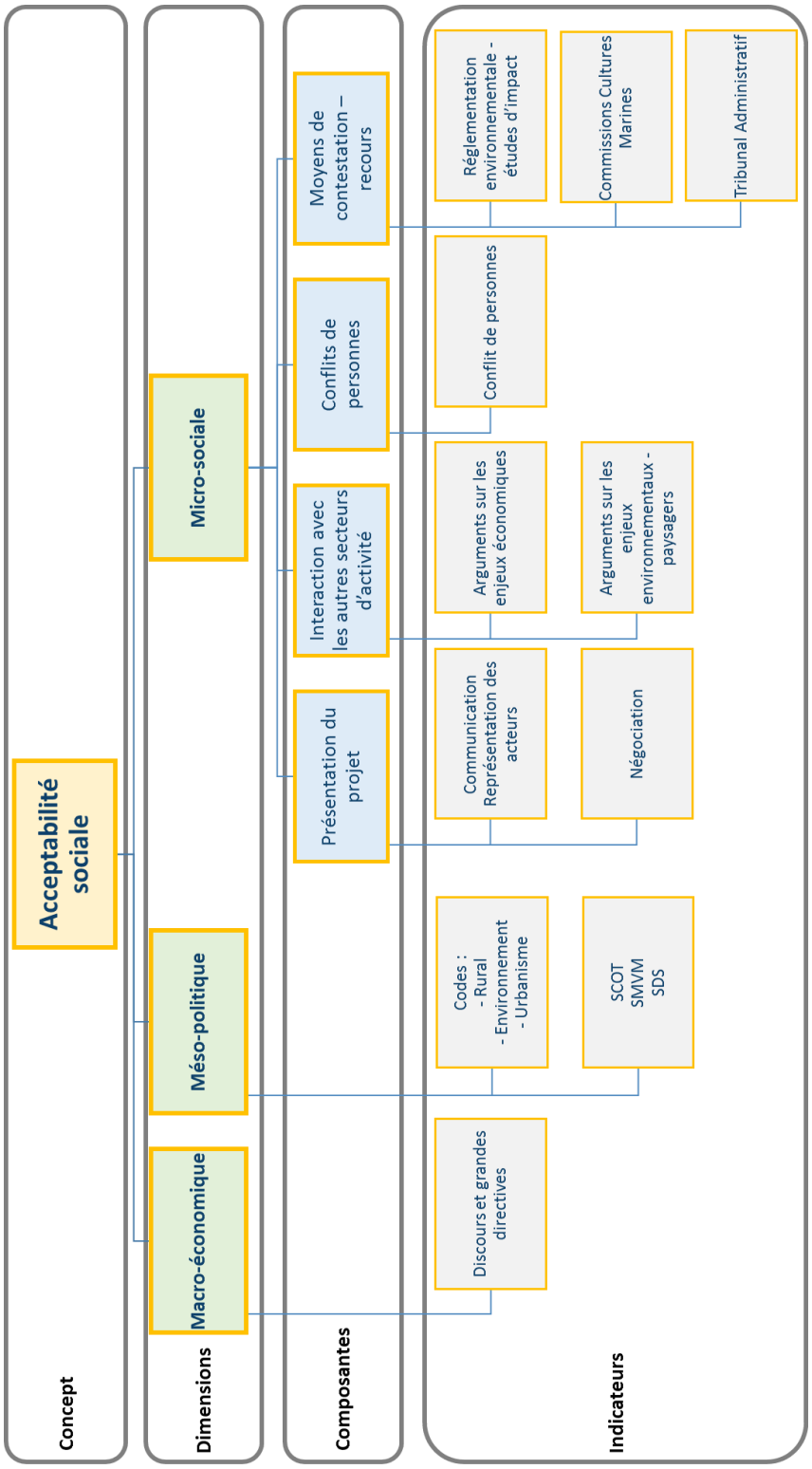
8 Appendices

8.1 Appendix 1



8.2 Appendix 2



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