IMPAQT – AN INTELLEGIENT MANAGEMENT SYSTEM FOR INTEGRATED MULTI-TROPHIC AQUACULTURE- A CASE STUDY: CAMLI PILOT SITE

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Introduction

As aquaculture evolving through industrial scales by exploiting advance technology, a world wide interest in both land-based and nearshore aquaculture systems for combining as an integrated systems comprising fed aquaculture species (e.g. finfish), inorganic extractive aquaculture species (e.g. seaweeds) and organic extractive species (e.g. suspension- and deposit-feeders) has become more concrete (Chopin et al, 2008; Bird et al., 2009; Silva et al. 2012). Integrated Multi-Trophic Aquaculture (IMTA) describes the arrangement whereby species are co-cultured for mutual benefit. IMTA allows the by-products, including waste, from one aquatic species to be the input (fertilizer, food, *etc.*) for another (STFC, 2013). Currently, such systems have also been perceived as the most prominent progress towards the sustainable of aquaculture, by considering on its potential economic, societal and environmental benefits without any substantial contradictions since it is based on the principle of exploiting waste nutrients from higher trophic-level species for producing lower trophic-level species as added commercial value within a single production system (Troel *et al, 2009*). Such an integrated system not only mitigates considerably emission of production related wastes and thus reduces the nutrient load in the water (FAO,2018), but also increase capability for managerial efficiency in terms of cost reduction and improved product quality

The IMPAQT project is an ambitious challenge to design and demonstrate an IMTA system supported by and Intelligent Management System (IMS). The project's demonstration has been planned to be carried out at six different pilot sites around Europe and one in China, all which has their production and product properties comprising different trophic species such as seaweeds, mussels, scallops, lobster and fish.

The pilot in Camli (Cesme, Turkey) has been installed within the boundaries of the offshore production sites of a commercial enterprise at industrial scale which mainly produces seabream, seabass and meagre. The pilot has been designed to carry out an integrated aquaculture production for seabass, blue mussel and sea lettuce. The development of such an offshore IMTA system requires the identification and analysis of environmental, economic and operational costs and benefits in order to be able to compare to a traditional monoculturing offshore system with a similar scale . The comparative results of such investigations will enable to assess the actual feasibility for anIMTA system for the future development of offshore aquaculture.

Figure 2. The IMPAQT Camlı Pilot Site, Cesme Bay, Aegean Sea, Turkey: Mussel Rafts, Macroalgae ines and fish cages: The yellow bouys are equipped with sensor systems, powered by sloar panels.

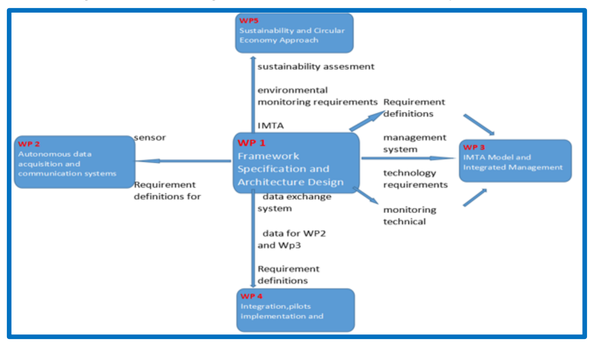

Figure 1. The work design of the Ptoject IMPAQT.

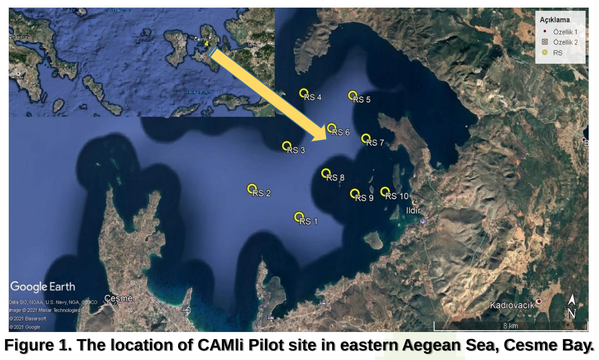

Figure 1. The location of CAMli Pilot site in eastern Aegean Sea, Cesme Bay.

IMPAQT Project: Çamlı Pilot in Cesme-Turkey.

The IMPAQT project (https://impaqtproject.eu/) has an overall objective for developing and validating in-situ a multi-purpose (inland, coastal and offshore productions), multi-sensing (heterogeneous sensors and new/emerging technologies) and multi-functional (advanced monitoring, modelling, data analytics and decision making) management platform for sustainable IMTA production. Its ambition is to drive a paradigm shift in the European Industry by paving the way to both a more environmentally friendly and more efficient/higher yielding European Aquaculture Industry.

IMPAQT's approach, as designed in 5 Work Packages (Figure 1) is to synchronize 4 main target objectives:

i) To design and implement new/emerging efficient and cost-effective technologies in monitoring and management systems for IMTA production,

ii) To validate the IMPAQT systems and IMTA model in-situ and the fish/seafood product in laboratory,

iii) To demonstrate an optimal sustainable IMTA development in a holistic perspective based on ecosystem services and circular economy principles, and

iv) To promote an effective transfer of knowledge derived by IMPAQT activities to the EU aquaculture stakeholders.

Çamlı Pilot Site (Figure 2) is located in the Çeşme Bay along the eastern coast of Aegean Sea in Turkey (Figure 3). The pilot has been designed as a trio-torphic system comprising macroalgae lines, mussel rafts, and fish cages at unit commercial production unit (Figure 4). Three bouys (Figure 5) equipped with a set of sensors (Figure 6) around the system enabling continuous measurement of a set of envrionmental variables such as temperature, salinity, DO, Chl a, turbidity, etc.) provides observational data via wireles connection tools developed (Figure 7). There are also surface and under water cameras and wheather station providing data via same connection tools. All data are transfered first to a dedicated server and then to the cloud account as a data storage and retrieval platform. The data on the farming operations such as feeding, mortality, grading, stoking density, disease treatment, etc. are been entered by user so that;

- monitoring growth and feed consumption for the optimization of stocking, feeding and harvesting,
- monitoring and preventing health related problems
- monitoring environmental footprint, and.
- monitoring welfare of cultured organisms.

can be performed more efficiently by using the integrated systems (Figure 8) and thus, the ability to control the state of production and to predict iteratively harvestable products over a calender schedule can be more realible and feasible.

Figure 4. Trio-trophic system components in Camli Pilot Site. The mussels stockedin bags under the raft (upper pictures), the macro algal lines (lower right picture), and the fish in cages .

Conclusive Remarks

In order to achieve tthe project's goals, the IMPAQT project with its a multidisciplinary and interactive teams, has been challenging to develop tools, protocols and technologies, in pilots (Figure 9). The easy accessibility and user friendliness (Figure 8) together with innovative data processing and communicating techniques have also been prioritized as well as precision and accuracy of the data analytics to be exploited. Considering that the CAMLi Pilot is the only one as commercial enterprise with industrial scale, the results to be obtained at the site is particularly precious not only for the finalization of the project but also for the possible improvements in the near future.

Figure 5. The Bouy equipped with sensors and data traansfer tools.

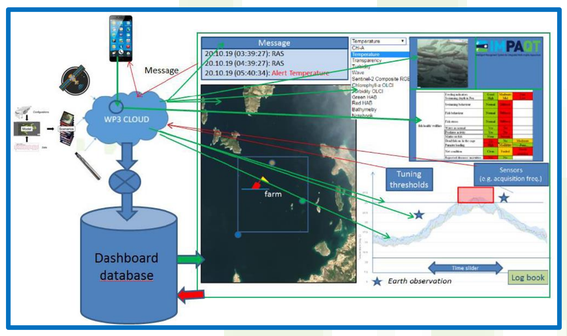

Figure 8. The accesibility and the user freindliness of the integrated systems being developed in the project IMPAQT .

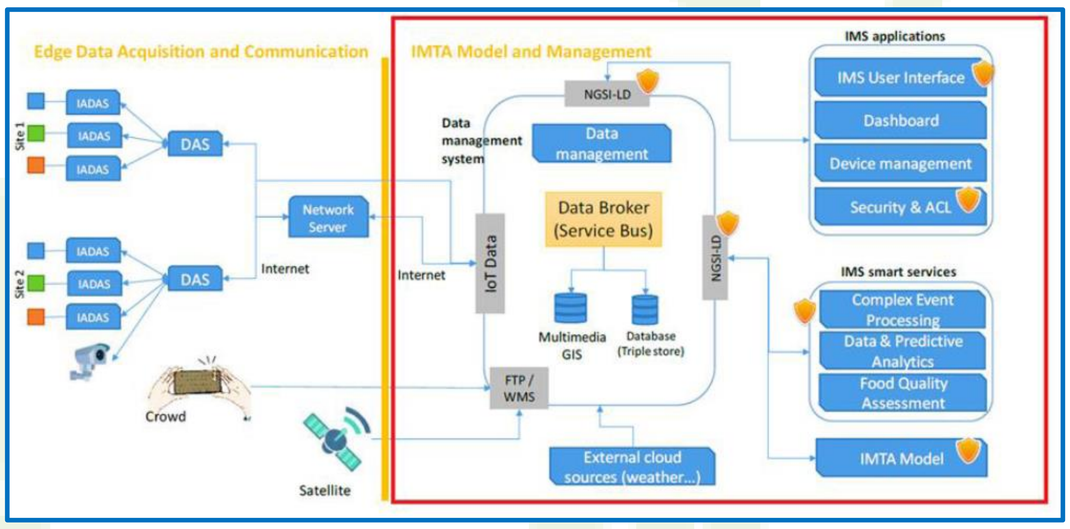

Figure 9. The Architecture view with potential tools, protocols and technologies which have been developing in the IMPAQt project

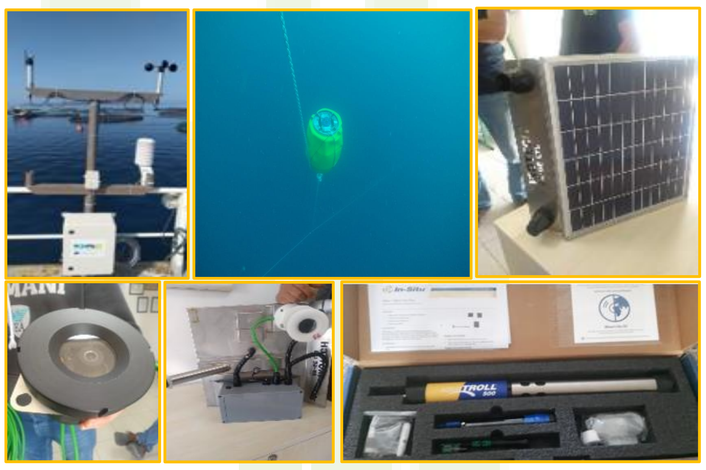

Figure 6 The sensors and observational tools used in the Camli Pilot within the frame of the Ptoject IMPAQT.

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