AMOS
Aquaculture Monitoring Observatory System

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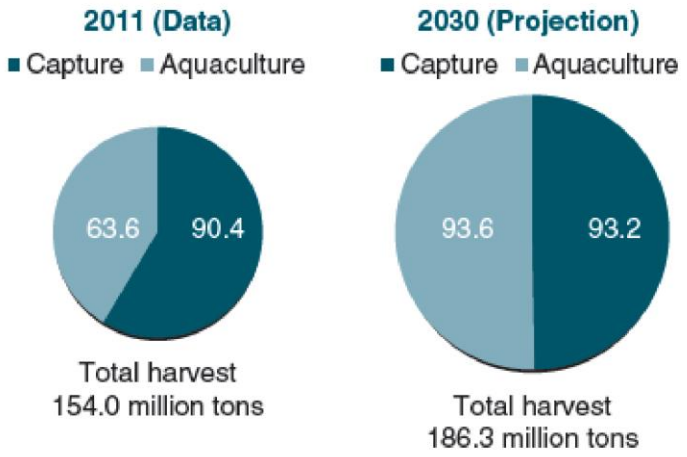
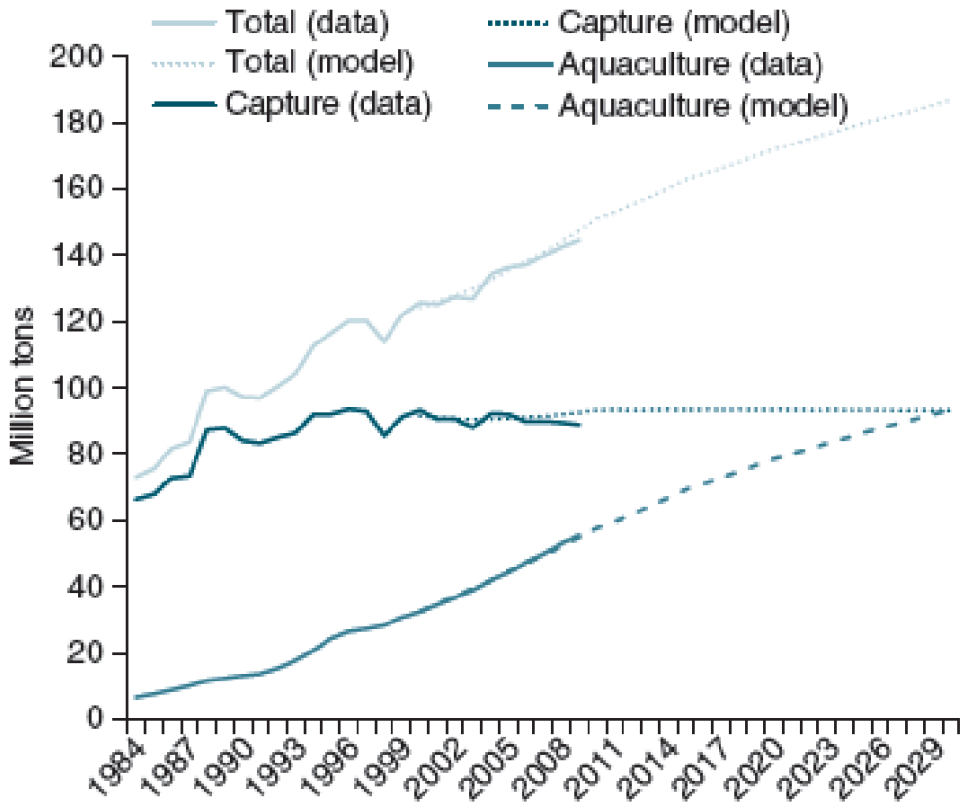
December 2020

AMOS: Introduction

- An increasing demand of food fish
- Collapsing of wild fish stocks
- Increasing price of wild stocks





Source: FAO Report, Fish to 2030

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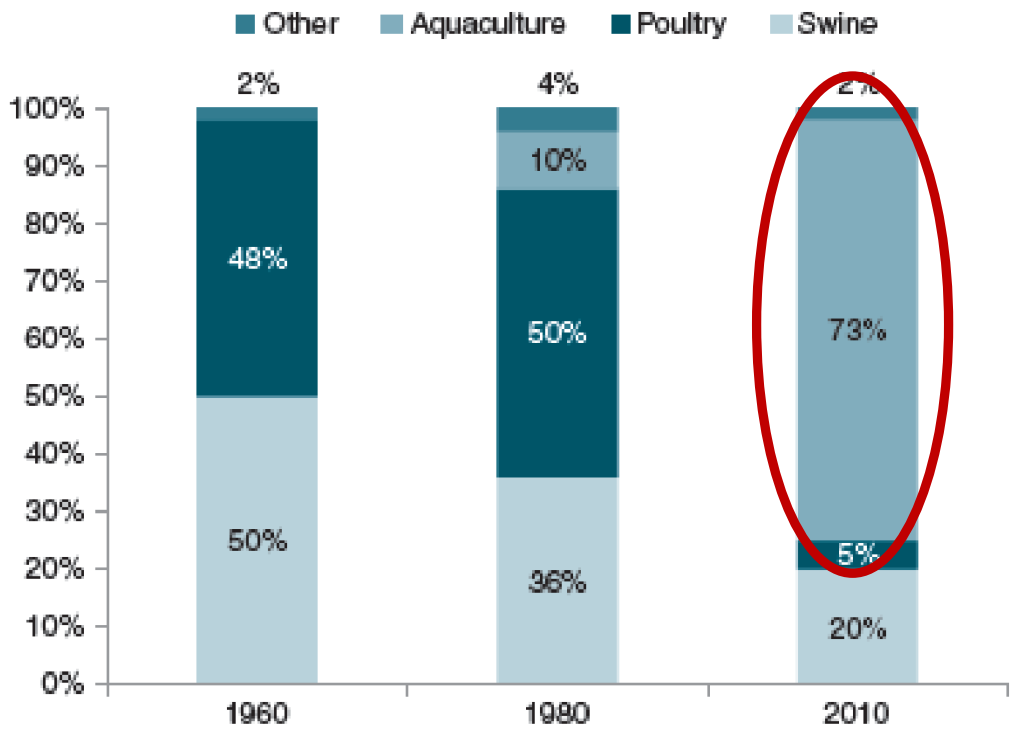
AMOS: Introduction

- Increased production of farmed fish
- Lower cost
- More efficiently
- Need of real-time access in environmental parameters



Source: Shepherd 2012

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AMOS: Aquaculture Monitoring Observatory System

Aquaculture monitoring (status based on stakeholders)

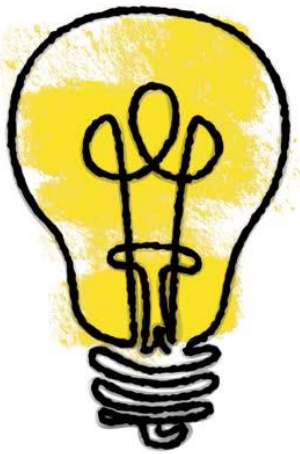
- So far a number of commercial products are available
- With controversial results and accuracy
- Different designs- No homogeneity
- No data traceability
- No data access
- Limited data products

Main objective:

Developing a cost – effective observatory system, tailored to the needs of Aquacultures with remote access, real-time data and forecast capabilities.

AMOS: Strategy

- Analysis of the current status
- Detailed specifications of produced system
- Design of the new system architecture
- Implementation, laboratory testing and validation
- Pilot application in real field conditions
- Extensive application in areas of interest



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AMOS: Development procedure following EC technology development "guidelines"

The Technology Readiness Level (TRL) scale was originally defined by NASA in the 1990's as a means for measuring or indicating the maturity of a given technology. The TRL spans over nine levels as follows:

- TRL 1 – Basic principles observed
- TRL 2 – Technology concept formulated
- TRL 3 – Experimental proof of concept
- TRL 4 – Technology validated in lab
- TRL 5 – Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – System prototype demonstration in operational environment
- TRL 8 – System complete and qualified
- TRL 9 – Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

Development reports submitted = TRL 3-4

Integration reports submitted =TRL 5

Testing reports submitted =TRL 6 - 8

Demonstrations reports submitted = TRL 7-9

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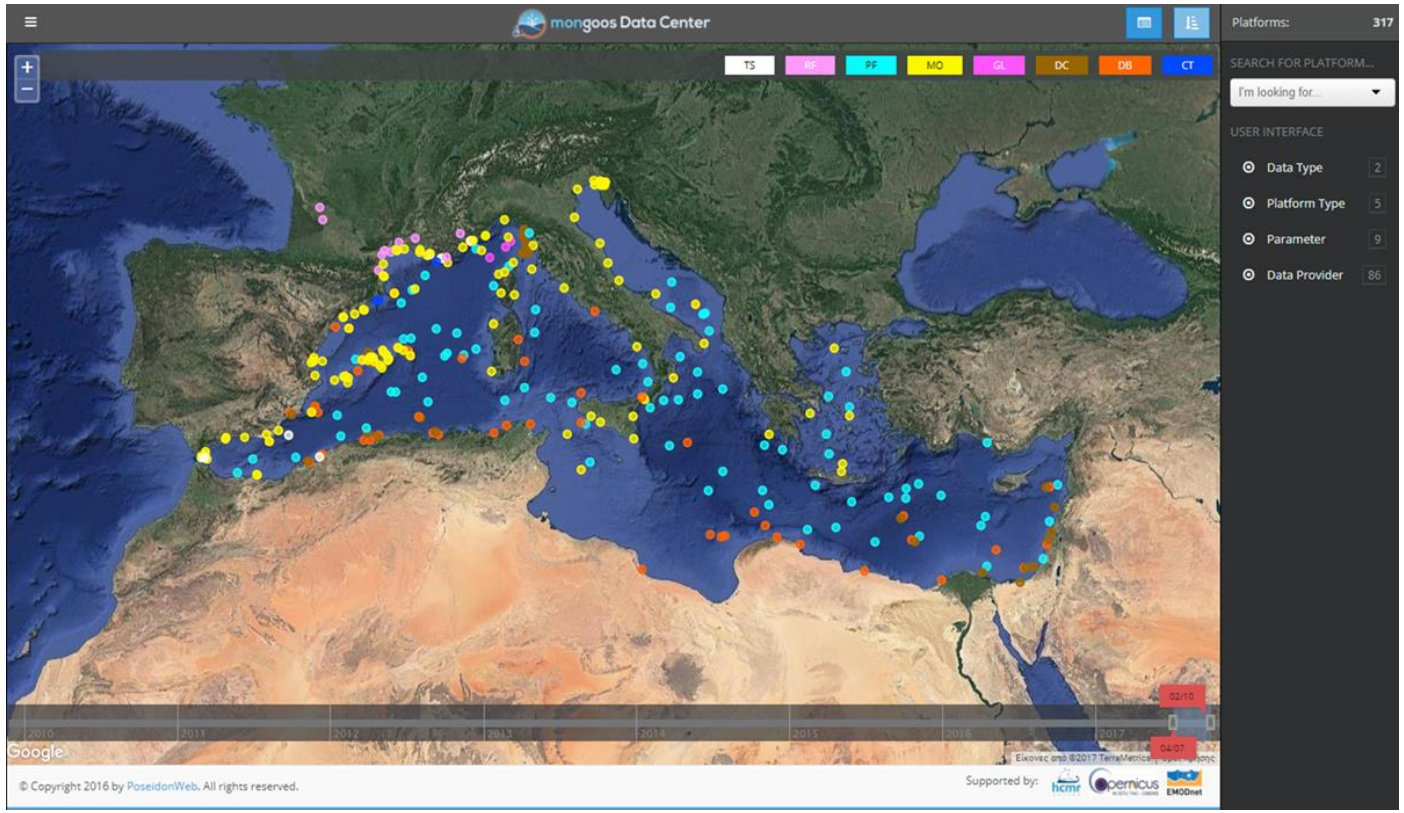
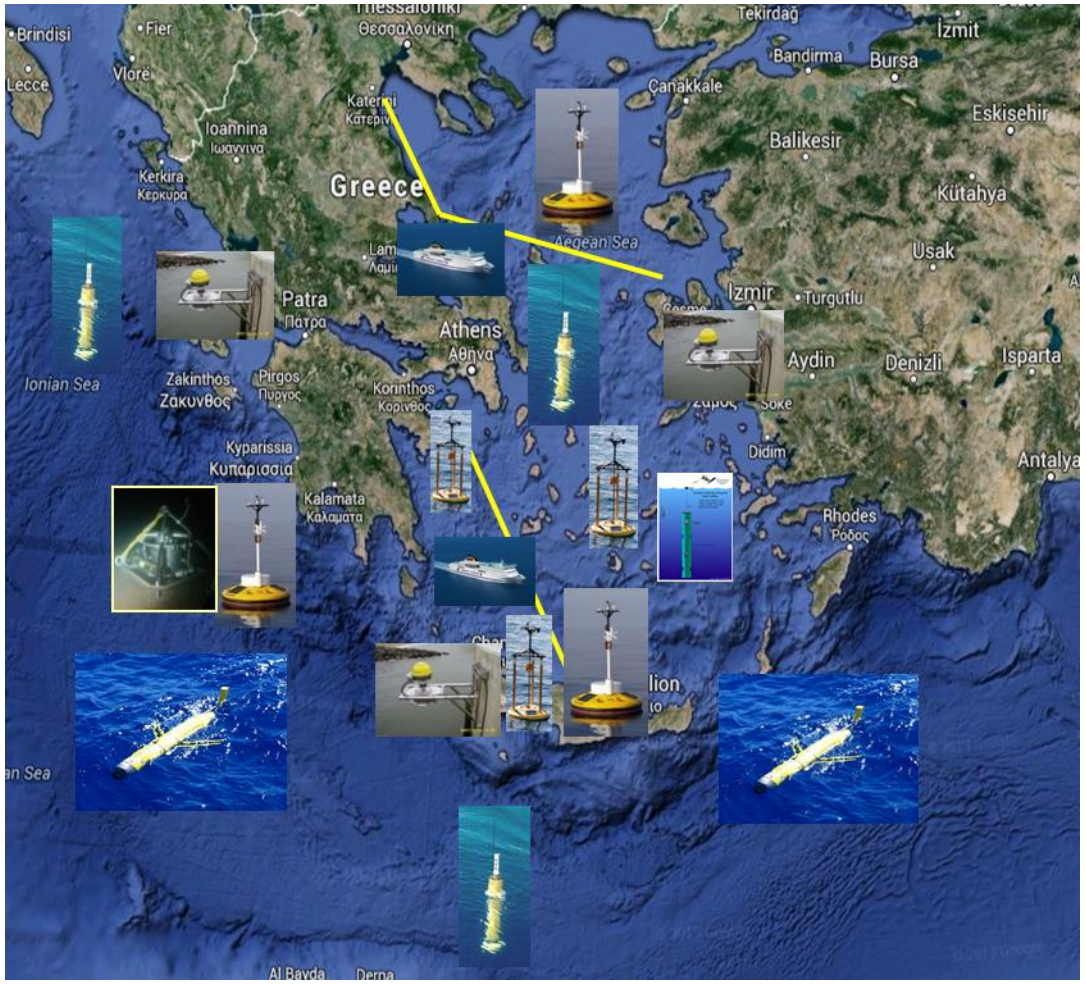
AMOS: Operational scientific monitoring technologies





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AMOS: Adoption of scientific Be

FixO3
FIXED-POINT OPEN OCEAN OBSERVATORIES

Handbook of best practices

This handbook collects the "best practices" in all phases of the system covering the entire infrastructural chain of data acquisition. It includes recommendations on how to produce high quality data aiming towards common methodologies and protocols within the FixO3 network.

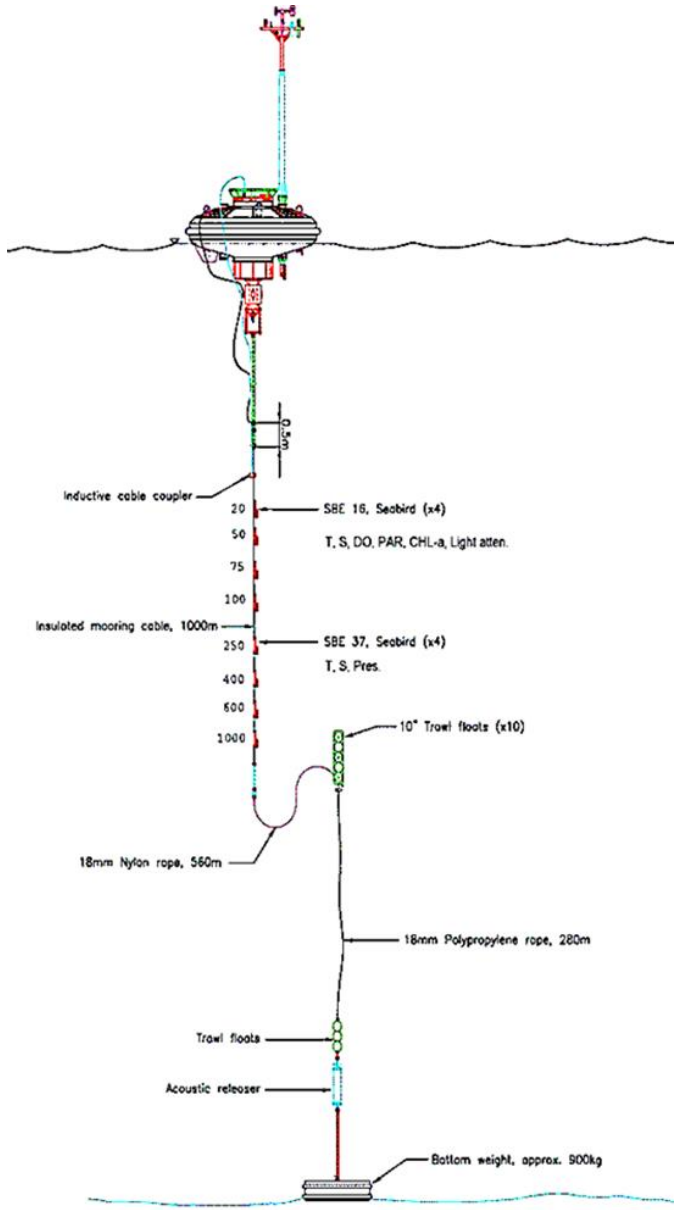
A work led by:
L. Coppola, M. Ntoumas, R. Bozzano, M. Bensi, S. Hartman, M. Charcos Llorens, J. Craig

Contributors:
JF. Rolin, G. Giovanetti, D. Cano, J. Karstensen, A. Cianca, D. Toma, C. Stasch, S. Pensieri, V. Cardin, A. Tengberg, G. Petihakis, L. Cristini

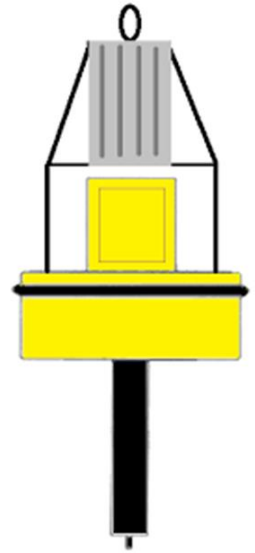
June 2016

This work has received funding from the European Union Seventh Framework Programme under grant agreement n. 312463, FixO3.

AMOS: Design of the new system architecture



- System build up (housing, power, processing unit, etc)
- Sensors specifications and integration
- Communication (bidirectional RT)
- Data storage and transmission
- Adjustability for deployments



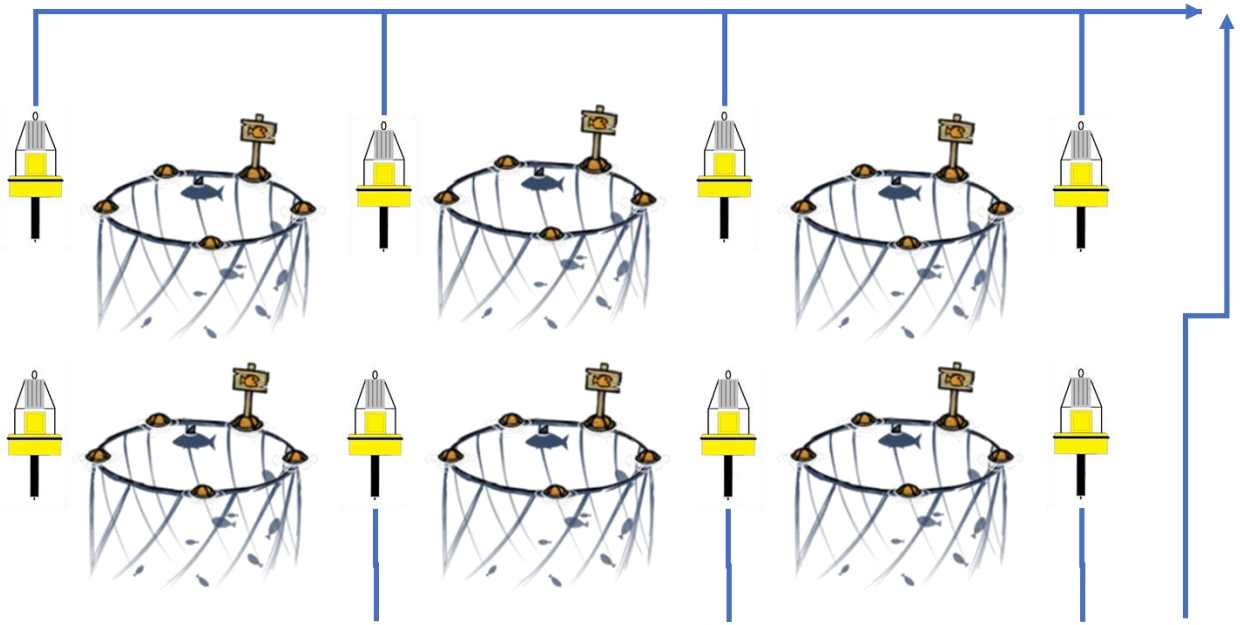
AMOS: New technologies to allow extended use

Advantages of modern IoT systems:

- Multiple modular channels of communication for hardware
- Low cost, modular sensor hardware with standardized interfaces
- Large community developing open source software and firmware

Advantages of modern Cloud infrastructures:

- High level of scalability
- High level of availability
- Modular architecture design
- Lower cost of maintenance



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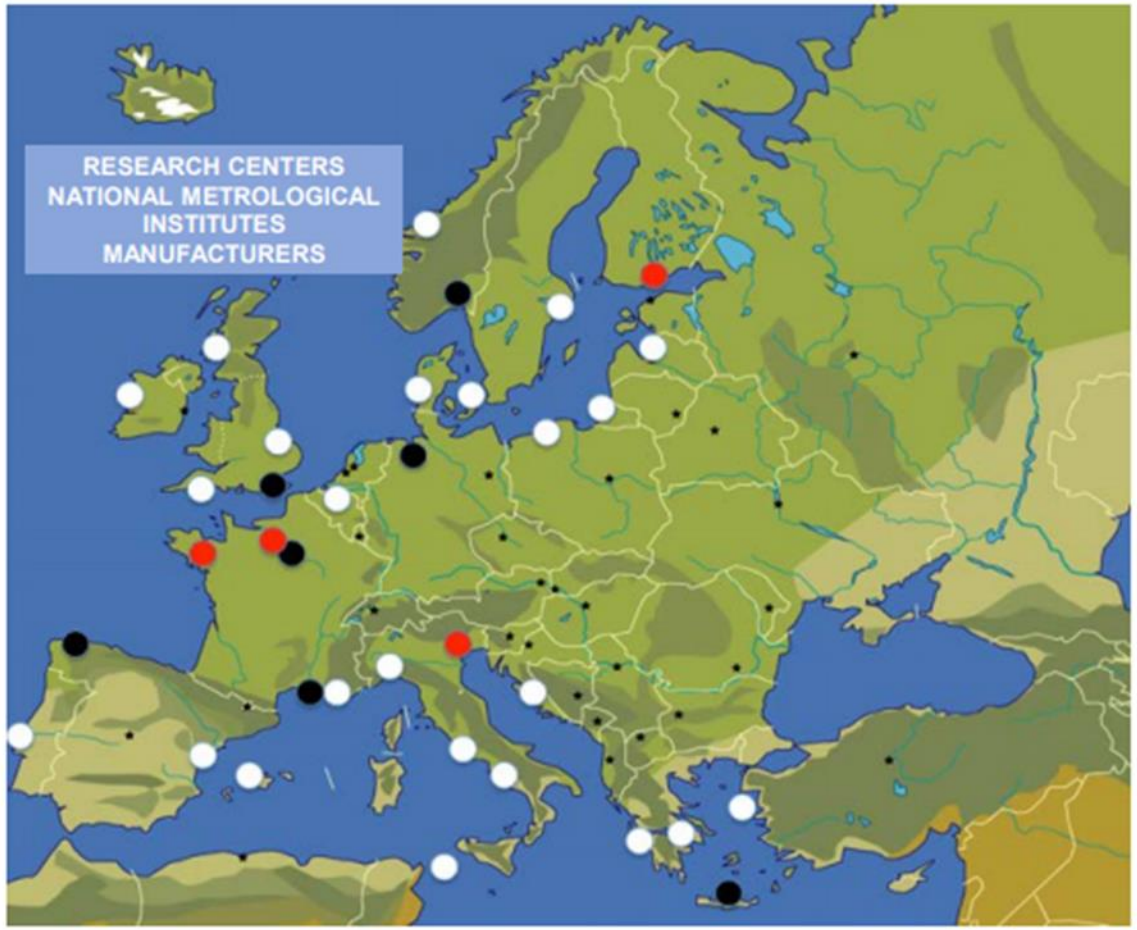
AMOS validation/calibration experiments

Perform calibration experiments and laboratory validation for the products developed in AMOS.

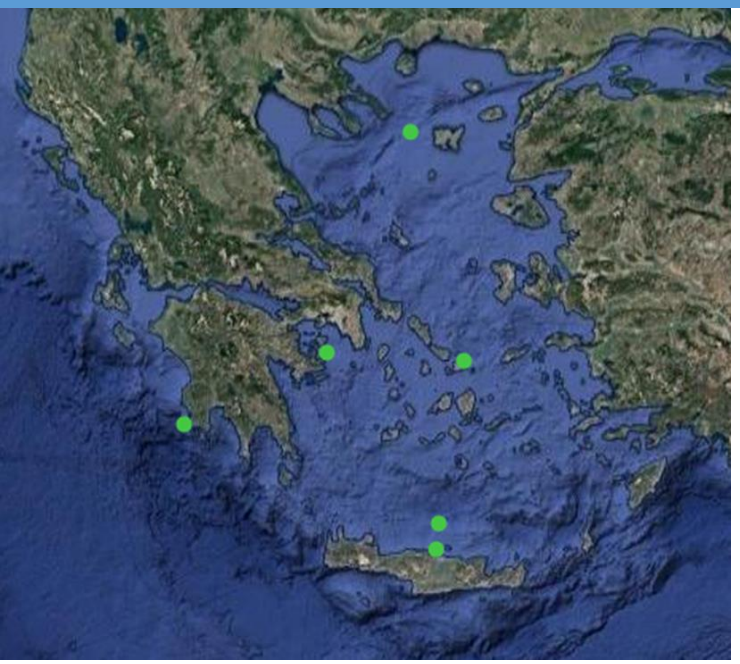
- The general challenges and further developmental needs for the detailed characterization in terms of accuracy and reliability of the project products will be investigated and documented.

1. Definitions of Test Parameters
   - Accuracy
   - Bias
   - Precision
   - Reliability
   - Range
2. Experimental approach/methodology
   - Reference material/equipment
3. Laboratory tests
   - Description
   - Results

- Fully documented procedure
- Direct link with data quality



AMOS demonstrations



POSEIDON SYSTEM

The POSEIDON system, an integrated observing infrastructure at the Eastern Mediterranean as contribution to the European Ocean Observing System

- **Several obs and technology nodes**
- **The observing system, which is composed by a network of moored buoys, two underwater gliders, a ferrybox system, a cabled observatory, a fleet of Argo floats, an HF radar system and a repeated cruises based ecosystem monitoring program**

iMBBC
ΙΘΑΒΒΥΚ

Pilot aquaculture farm

- **A pilot aquaculture net pen cage farm since 2000**
- **16 rectangular cages 6×6 m and 4 circular cages of 12-m diameter**
- **Five cultured species**

AMOS demonstrations

Platform	Field of application	User type	User name	Country	Project	TNA name	Year
SB, PCL	pH sensor	RI/ Industry	Univ. de Las Palmas de Gran Canaria/ sensorLab	Spain	JERICO (EU FP7)	MEDACID	2013-2014
E1-M3A (R/V visits)	winch for small boats	RI	HCMR	Greece	PERSEUS (EU FP7)	N/A	2013-2015
PCL	O_2, Fluorescence, Turbidity	RI	HCMR, CNR	Italy	JERICO (EU FP7)	TOFU	2013-2016
SB							15-2016
E1-M							017
Argo profi							
HCB							017
PB, E1-M							017
PB							
HCM Aqua facili							
PB							018
AB, E1-M							
HCB E1-M							
PFB							
PFB	pH, pCO2 sensors	RI	NIVA	Norway	Jerico Next (EU FP7)	Carbonas	2017-
PCO	Magnetometer	RI	INGV	Italy	N/A	N/A	2018-
HCB, PCL	Phytoplankton fluorescence	RI	MIO, FMI	France, Finland	Jerico Next (EU FP7)	FluorMed-1	2018-
HCB	Passive filtering system for microplastics	RI	Univ. of Aveiro	Portugal	Jerico Next (EU FP7)	Microplastox	2018-

Technology demonstration and scientific analysis

TRL8:The final product in its final configuration is successfully demonstrated through test and analysis for its intended operational environment and platform.

TRL9: The final product is successfully operated in an actual mission.

ELSEVIER

Journal of Marine Systems
Volume 162, October 2016, Pages 37-46

Seasonal pH variability in the Saronikos Gulf: A year-study using a new photometric pH sensor

Melchor González-Dávila [a], J. Magdalena Santana-Casiano [a], George Petihakis [b], Manolis Ntoumas [b], Miguel Suárez de Tangil [c], Evangelia Krasakopoulou [b, d]

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https://doi.org/10.1016/j.jmarsys.2016.03.007

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Open Access Article

Methods and Best Practice to Intercompare Dissolved Oxygen Sensors and Fluorometers/Turbidimeters for Oceanographic Applications

by Sara Pensieri [1,*], Roberto Bozzano [1], M. Elisabetta Schiano [2], Manolis Ntoumas [3], Emmanouil Potiris [3], Constantin Frangoulis [3], Dimitrios Podaras [3] and George Petihakis [3]

[1] National Research Council of Italy, Institute of Intelligent Systems for Automation, Genoa 16149, Italy
[2] National Research Council of Italy, Institute of Marine Science, Genoa, 16149, Italy
[3] Hellenic Centre for Marine Research, Institute of Oceanography, Heraklion Crete, 71003, Greece
* Author to whom correspondence should be addressed.

Academic Editor: Russell Binions

Sensors **2016**, *16*(5), 702; https://doi.org/10.3390/s16050702

Received: 1 March 2016 / Revised: 23 April 2016 / Accepted: 6 May 2016 / Published: 17 May 2016

(This article belongs to the Special Issue Sensors for Environmental Monitoring 2016)

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JERICO-NEXT TNA: CarbonAS pH dataset March-June 2018

Date	2018-03-18
Temporal extent	2018-03-18 -2018-06-18
Author(s)	King Andrew[1], Ntoumas Manolis[2]
Affiliation(s)	1 : Norwegian Institute for Water Research 2 : Hellenic Centre for Marine Research
DOI	10.17882/62413
Publisher	SEANOE

AMOS scientific payload/ sensors

Parameter	Data frequency	Sensor availability
Temperature	Real time	Commercial available (COTS)
Salinity	Real time	COTS
Fluorescence	Real time	COTS
Dissolved oxygen	Real time	COTS
Colored dissolved organic matter (CDOM)	Real time	COTS
pH/ ppCo2	Real time	Limited
Turbidity	Real time	COTS
Sea currents	Real time	COTS
Meteo	Real time	COTS
Waves	Real time	Limited
Image systems	Real time	Limited
Passive samplers/chemical parameters e.g toxic microalgae	Analysis required	Limited

- Physical parameters
- Biochemical parameters
- Meteo and waves
- Image analysis systems
- Camera payloads
- Acoustics payloads

1) Data set related to EU policy /directives
2) RT data flow for the industry

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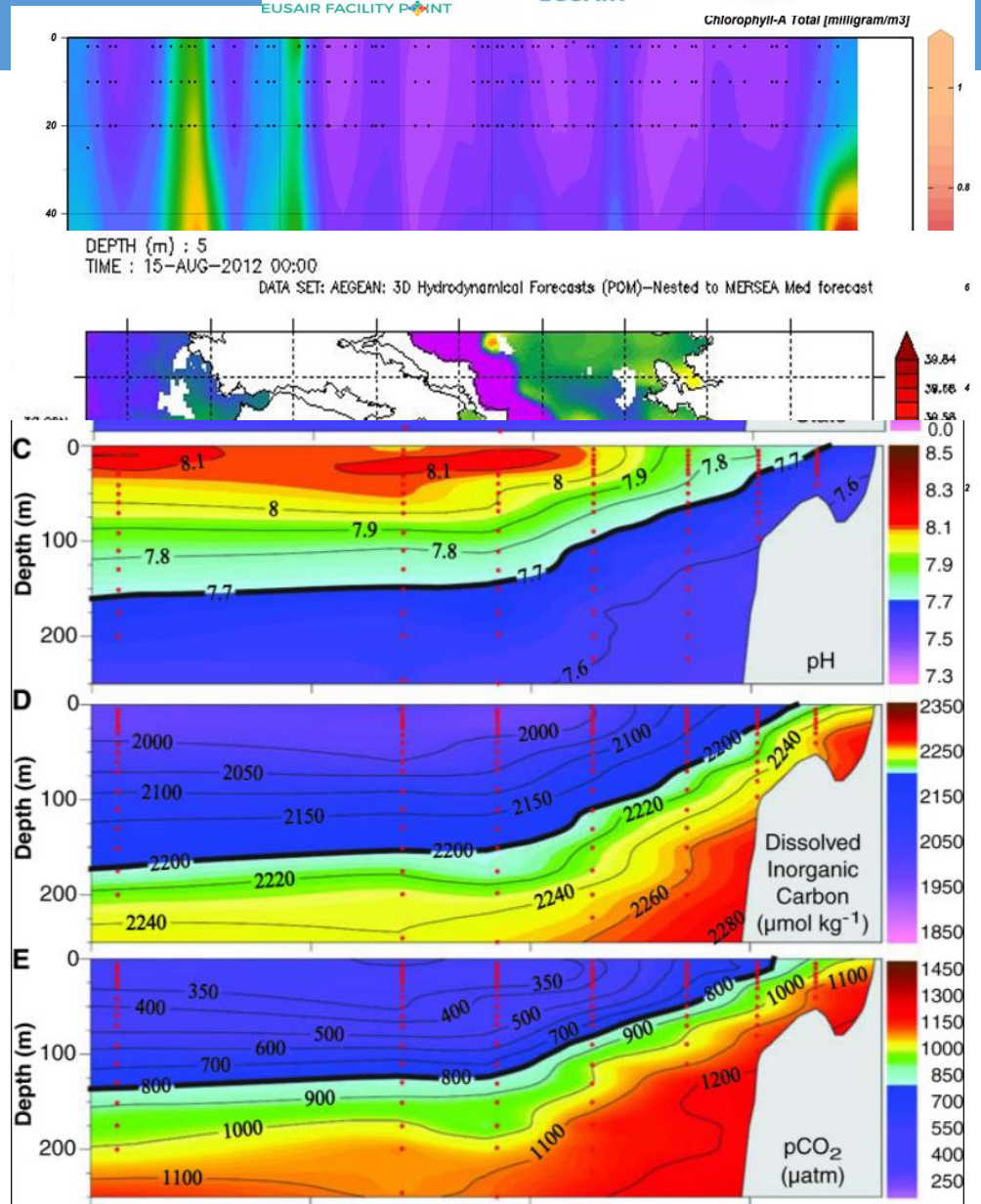
AMOS Data products and outcomes

- RT data flow
- Assimilation/ modelling products
- AI-based data analysis and event detection algorithms

Decision support system

Public authorities, policy makers, EU directives….

Industry related users, stakeholders…



AMOS Data products and outcomes

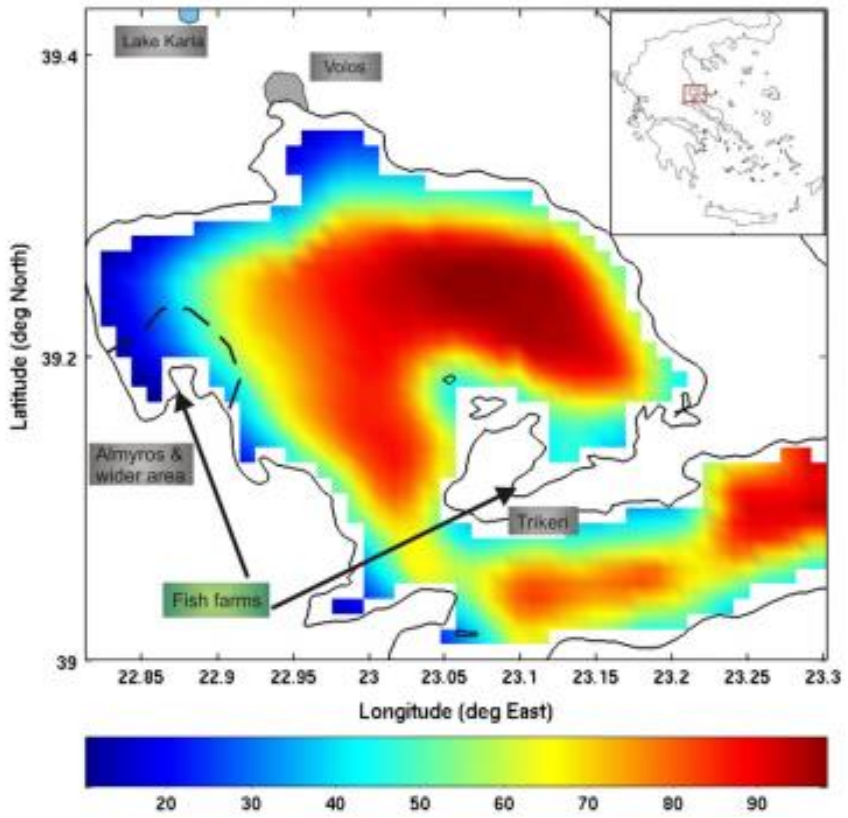


Fig. 1. Bathymetric map of Pagasitikos gulf (m), fish farm locations and model domain.

Journal of Marine Systems 94 (2012) S65–S77

Contents lists available at SciVerse ScienceDirect

Journal of Marine Systems

journal homepage: www.elsevier.com/locate/jmarsys

Application of a complex ecosystem model to evaluate effects of finfish culture in Pagasitikos Gulf, Greece

G. Petihakis [a,*], K. Tsiaras [a], G. Triantafyllou [a], G. Korres [a], T.M. Tsagaraki [a,b], M. Tsapakis [a], P. Vavillis [a], A. Pollani [a], C. Frangoulis [a]

Plankton response to nutrient enrichment is maximized at intermediate distances from fish farms

Ecological Modelling 222 (2011) 2512–2523

Contents lists available at ScienceDirect

Ecological Modelling

journal homepage: www.elsevier.com/locate/ecolmodel

Open in Acrobat

Beyond the cage: Ecosystem modelling for impact evaluation in aquaculture

Tatiana M. Tsagaraki [a,b,*], George Petihakis [a], Kostas Tsiaras [c,2], George Triantafyllou [c], Manolis Tsapakis [a], Gerasimos Korres [c], George Kakagiannis [d,3], Constantin Frangoulis [a], Ioannis Karakassis [b,1]

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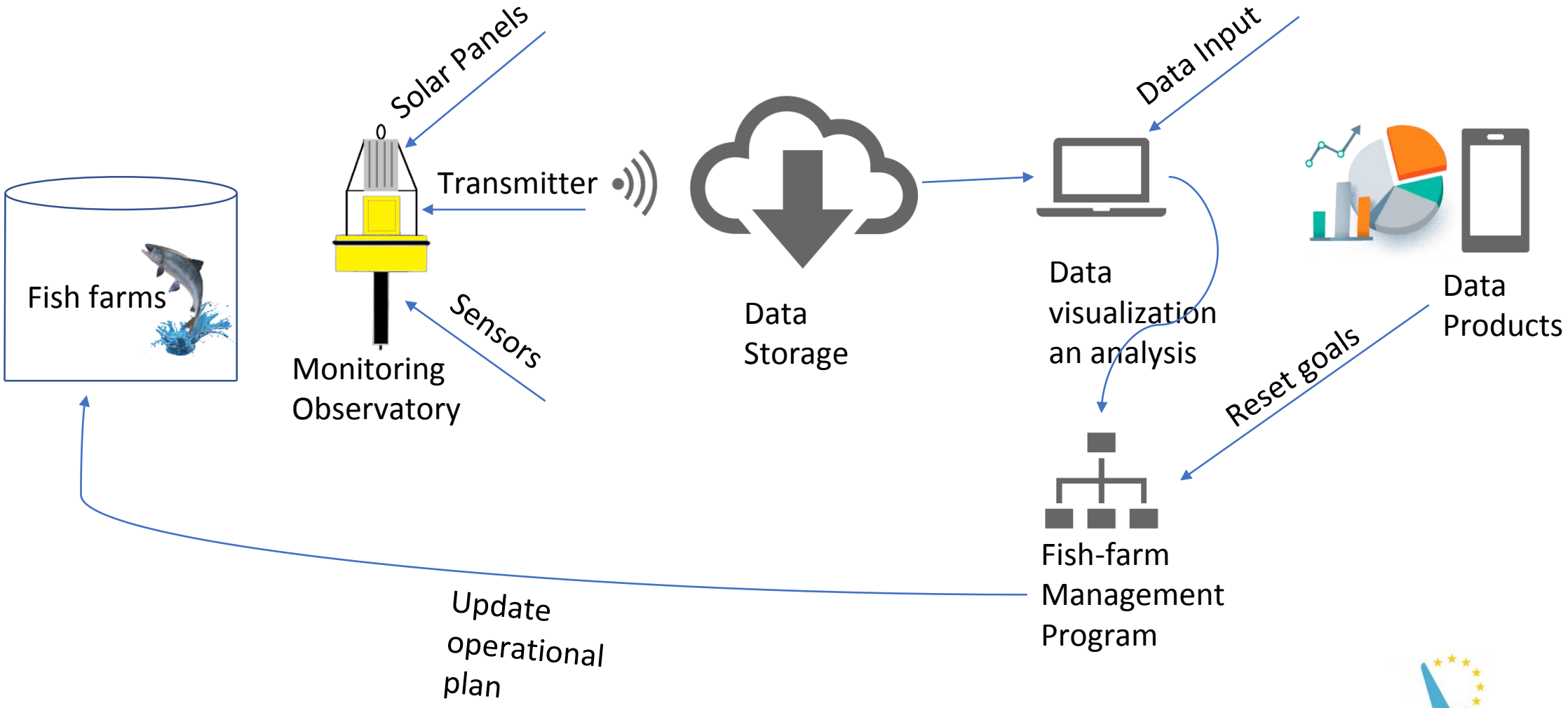
[b] Marine Ecology Laboratory, Biology Department, University of Crete, Vasilika Vouton, 71049, Heraklion, Greece
[c] Institute of Oceanography, Hellenic Centre for Marine Research, 46.7 Km Athens-Sounio Ave, Mavro Lithari, P.O. Box 712, 19013, Anavissos, Attika, Greece
[d] Department of Marine Sciences, Aegean University, 81100, Mytilene, Lesvos, Greece

AMOS system operation



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AMOS Consortium

Marine Research Institutes

- specialized in ocean and aquaculture sciences and monitoring

Universities

- specialized in developing marine technology components and modules

Public Sector authorities

- policy oriented dissemination of the results

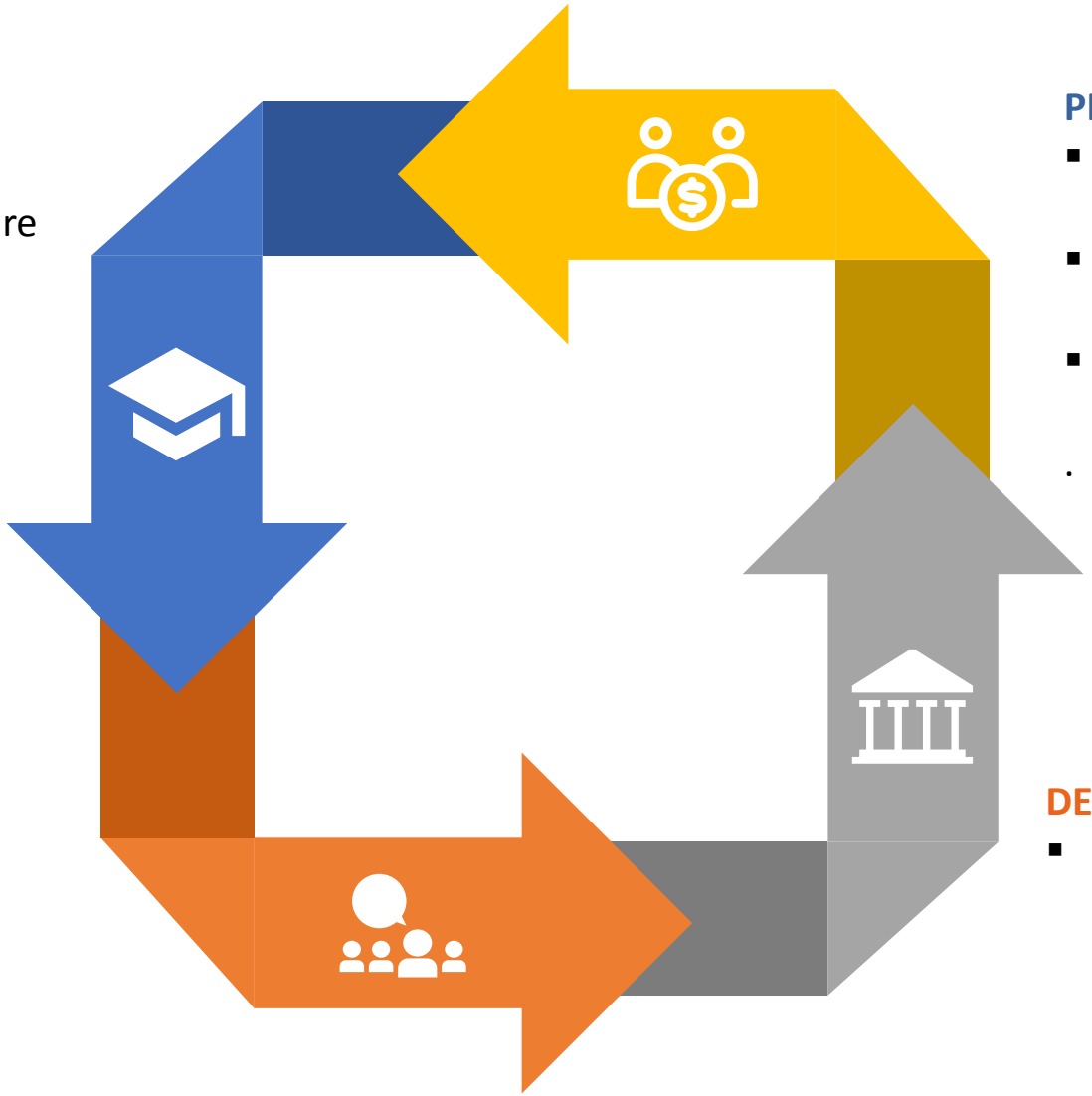
Private Sector

- specialized in developing marine technology components and modules
- industry oriented dissemination of the results

AMOS: a co-creation approach

ACADEMIC RESEARCH

- **Marine Research Institutes**: specialized in ocean and aquaculture sciences and monitoring
- **Universities** specialized in developing marine technology components and modules



PRIVATE SECTOR

- specialized in developing **marine technology** components and modules
- industry oriented dissemination of the results
- co-creation approach for a targeted solution for a sustainable aquaculture

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SOCIETY

- Citizen and general public involvement through communication and dissemination of results

DECISION MAKERS

- Involvement of local, national and regional authorities and policy makers

AMOS and relative EU projects

2020-2024: JERICO S3 -Joint European Research Infrastructure of Coastal Observatories: Science, Service, Sustainability (EC H2020)

2020-2024: NAUTILOS - New Approach to Underwater Technologies for Innovative, Low-cost Ocean observation (EC H2020)

MINKE. Metrology for Integrated marine maNagement and Knowledge-transfer nEtwork 2021-2025: (EC H2020)

2017-2020: Regional Cooperation for the transnational ecosystem sustainable development


Thank you