

Challenges for sustainable monitoring and evaluation of the EU Marine Strategy Framework Directive in the Atlantic offshore waters: the iFADO project

F. Campuzano (1), M. García (1), T. Dabrowski (2), S. Groom (3), M. Ruiz-Villarreal (4), V. Brotas (5), M. Kaufmann (6), S. Hartman (7), P. Oliveira (8), A. Martins (9), M. Juliano (10), F. Vieira (11), M. Lux (12), C. Barreda (13), X. Rebour (14), A.P. Simão (15) and R. Neves (1)

- (1) MARETEC- Instituto Superior Técnico - Universidade de Lisboa. Avenida Rovisco Pais, 1049-001 Lisboa, Portugal. campuzanofj.maretec@tecnico.ulisboa.pt.
- (2) Marine Institute. Rinville, H91 R673, Oranmore, Galway, Ireland.
- (3) Plymouth Marine Laboratory. Prospect Place, PL1 3DH, Plymouth, United Kingdom.
- (4) Instituto Español de Oceanografía. Centro Oceanográfico da Coruña, 15001, A Coruña, Spain.
- (5) Faculdade de Ciências da Universidade de Lisboa. Campo Grande, 1749-016. Lisboa, Portugal.
- (6) Universidade da Madeira. Colégio dos Jesuítas, Rua dos Ferreiros, 9000-082, Funchal, Portugal.
- (7) Natural Environment Research Council. National Oceanography Centre, Waterfront Campus, European Way, Swindon, United Kingdom.
- (8) Instituto Português do Mar e da Atmosfera, I.P. (IPMA). Av. Alfredo Magalhães Ramalho, 1495-165 Lisboa, Portugal.
- (9) Departamento de Oceanografia e Pescas. Universidade dos Açores, Rua Professor Doutora Frederico Machado, 9901-862, Horta, Açores, Portugal.
- (10) Universidade dos Açores, Lda. Edifícios da Marina, Apartado 64, 9760-412, Praia da Vitória, Ilha da Terceira, Açores, Portugal.
- (11) Fundo Regional para a Ciência e a Tecnologia. Rua do Mercado 21, Ponta Delgada, 9500-326, São Miguel, Açores, Portugal.
- (12) Noveltis. 153 Rue du Lac, 31670, Labège, France.
- (13) Plataforma Oceánica De Canarias. Carretera de Taliarte, s/n, Telde, Gran Canaria, Spain.
- (14) Pole Mer Bretagne Atlantique. Rue Jim Sévellec 40, CS 83809 – 29238, Brest Cedex 3, France.
- (15) Direção Geral de Recursos Naturais, Segurança e Serviços Marítimos. Av. Brasília, 1449-030, Lisboa, Portugal.

Abstract: The European Atlantic Area in situ characterization/monitoring is challenging due to the high costs involved (24% of total EU waters for 12% of total population). The implementation of the EU Marine Strategy Framework Directive (MSFD) is complex if the objective is to extend periodic monitoring programs to offshore waters. Remote sensing and modelling have been recognised by the Copernicus Marine Service as suitable methodologies to characterise the global ocean both for nowcast and forecast. iFADO (Innovation in the Framework of the Atlantic Deep Ocean, 2017-2021) is an Interreg Atlantic Area project which main objective is to integrate technologies, including remote sensing, numerical modelling and in situ monitoring, to ease management decisions from MSFD competent authorities. The iFADO project builds on the most recent technologies for data gathering and processing, suited for providing sustainable services to blue economy agents by fostering the regional quadruple helix cooperation (public sector, university/research centres, enterprise and citizens).

Key words: remote sensing, numerical modelling, traditional monitoring, novel monitoring methodologies, MSFD, deep ocean

1. INTRODUCTION

The iFADO project (Innovation in the Framework of the Atlantic Deep Ocean) is a European project funded from ERDF funds of the INTERREG Atlantic Area Programme that will develop its activities during the period November 2018-2021. The project aims to create marine services at

regional and subregional scale using the EU Atlantic Waters as case study. By filling current technical gaps, the iFADO project will use the European Marine Strategy Framework Directive (MSFD, 2008/56/EC), including the recent MSFD Commission Decision (EU 2017/848), and its implementation to demonstrate the application of innovative products. The project will combine

traditional monitoring with cost-effective, state-of-the-art technologies: remote sensing, numerical modelling and emerging observation platforms such as gliders and new sensors equipped in oceanic buoys.

1.1. Overall objective

The Atlantic Action Plan aims to revitalize the Marine and Maritime Economy, recommending closer collaboration among member states such as to set up sustainable strategies for natural resources exploitation while promoting innovation and regional strategies that secure and enhance the marine and coastal environments. The European Atlantic Region (EAR) has the largest potential for “blue growth” due to, among others, its size, maritime tradition, and vast deep-sea areas available for exploitation. The Copernicus Marine Environment Monitoring Service (CMEMS) set up tools to monitor and forecast marine systems at the oceanic scale, foreseeing the subsequent development of innovative services by regional/local actors, oriented to the development of solutions at regional/local scales able to support authorities and investors. This project aims to downscale CMEMS products and to combine the conventional monitoring programmes with ocean buoys, satellite data and emerging technologies such as gliders, to develop tailor-made and innovative products. The latter will:

- 1) assist the MSFD competent authorities;
- 2) provide services at regional/local scales necessary to enhance the blue economy development;
- 3) contribute to the challenges posed by climate change;
- 4) provide tools for the optimisation of observing strategies for better forecasting; and
- 5) capitalise on individual partner initiatives and historical data based on an EAR perspective.

1.2. Common Challenge

The European Atlantic Area is specific for its extent and especially for having a narrow continental shelf and extensive deep areas. Hence, the influence of large-scale ocean circulation/dynamics extends almost up to the shore-line. Furthermore, its great surface area hinders detailed in situ characterization/monitoring due to its extremely high costs involved (24% of total EU waters for 12% of total population). The implementation of the MSFD is therefore, very challenging, particularly if the objective is to extend periodic monitoring programs to off-shore waters. Remote sensing and modelling have been recognised by the CMEMS as suitable methodologies to characterise the global ocean both for nowcast and forecast. The iFADO project aims to demonstrate that similar strategies are valid at the regional scale and that downscaling

is the most suitable mechanism to generate the required solutions and that new technologies are able to provide data in higher quantity, with wider spatial coverage and for remote marine areas. Institutions in charge of the implementation of the MSFD experience great difficulty in monitoring extensive areas. At the same time, it is those institutions that have more potential to both acquire/access in situ/historical local data necessary for validation. For these reasons, they have been included as Associated Partners, becoming the first generation of users of the system and important disseminators near marine economic actors.

1.3. Project Consortium

The iFADO partnership, involving 20 partners, will foster the regional quadruple helix cooperation including public sector, university/research centres, enterprise and end-users to ensure that the designed products meet the market needs and are sustainable after the project lifetime.

Table. 1. List of project partners, acronym and country. The partner role is indicated within brackets: Leader (L), Full (F) or Associated (A) partner.

Partner	Acronym	Country
Instituto Superior Técnico (F, L)	IST	Portugal
Foras na Mara - Marine Institute (F)	MI	Ireland
Plymouth Marine Laboratory (F)	PML	UK
Direção Geral de Recursos Naturais, Segurança e Serviços Marítimos (A)	DGRM	Portugal
Instituto Español de Oceanografía (F)	IEO	Spain
Faculdade Ciências da Universidade de Lisboa (F)	FCUL	Portugal
Universidade da Madeira (F)	UMa	Portugal
Natural Environment Research Council (F)	NERC	UK
Instituto Português do Mar e da Atmosfera (F)	IPMA	Portugal
Fundo Regional para a Ciência e a Tecnologia dos Açores	FCRT	Portugal
Direção Regional dos Assuntos do Mar (A)	DRAM	Portugal
NOVELTIS (F)	NOVELTIS	France
Secretaria Regional do Ambiente e dos Recursos Naturais (A)	DROTA	Portugal
Mercator Océan (A)	MERCATOR	France
Plataforma Oceánica de Canarias (F)	PLOCAN	France
Ministerio de Agricultura, Alimentación y Medio Ambiente (A)	MAGRAMA	Spain
Pole Mer Bretagne Atlantique (F)	PMBA	PMBA
Agence Française pour la Biodiversité (A)	AFB	France
Department of Housing Planning Community and Local Government (A)	DHPCLG	Ireland
Department of Environment Food and Rural Affairs (A)	DEFRA	UK

2. WORK PACKAGES

The project work is organised in eight work packages. Some brief comments are given for each work package (excluding the Administration WP1).

WP2 Communication: most of the project activities will be disseminated through the project webpage (<http://www.ifado.eu/>), and social media (twitter: [@AAiFADO](#), Facebook: [@AAiFADO](#); LinkedIn: [iFADO](#); vimeo: [iFADO](#)). The project will also target the sailing for pleasure community in order to be able to raise awareness related to the MSFD and to collect data in the offshore waters.

WP3 capitalisation: will allow to companies to evaluate their products within the iFADO consortium capacities (cruises and platforms). The project will ease the process by a common simplified memorandum of understanding (MoU) for collaborating with the consortium.

The project:

- will evaluate the capacities for enhancing and improving the traditional monitoring surveys focusing in the offshore areas (WP4);
- explore the cost-effectiveness of novel technologies and sensors for completing the monitoring in the Atlantic waters (WP5);
- evaluate satellite products in order to provide assistance for the MSFD descriptors such as marine litter (D10) and Biodiversity (D1);
- will explore numerical models capacities to calculate indicators and complete the areas where traditional observations and remote sensing do not reach;
- will integrate information from all the different sources to provide indicators that integrate the different data sources easing the link between science and policy making and providing state-of-the-art products to the responsible authorities.

3. COLLABORATION OPPORTUNITIES

The iFADO project is looking for companies that are interested in testing their developments in open waters conditions (i.e. cruises or the consortium platforms) and that will benefit from the visibility that the project will provide them to the monitoring institutions and policy-making organisations. This visibility will be reinforced through the project webpage and social media.

The project is open for other institutions/projects that are currently performing monitoring activities in the Atlantic waters in order to provide visibility to their activities and to share methodologies for indicators calculation.

The project is looking for collaboration with citizens in order to obtain more effective ways to collect data

in offshore waters by promoting the use of existing mobile apps for ocean data collection with special focus in the sailing for pleasure community. Citizens will also be approached by ocean literacy events in the five participant countries.

4. CONCLUSIONS

The achievement of Good Environmental Status (GES) defined in the MSFD depends strongly on the capacity of monitoring and interpreting the data obtained by several methodologies including remote sensing, *in situ* sampling and numerical modelling. Novel technologies are providing new opportunities for monitoring the vast extensions of the European Atlantic waters both in term of cost-effectiveness and emergence of new sensors.

The combination of all these elements along with the involvement of industry are the elements considered crucial for a successful implementation of the MSFD and the main motivation for the iFADO project.

Acknowledgements

This research is a contribution for the iFADO project funded from ERDF funds of the INTERREG Atlantic Area Programme under contract EAPA_165/2016.

REFERENCES

Commission of the European Communities. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy. *Marine Strategy Framework Directive*.