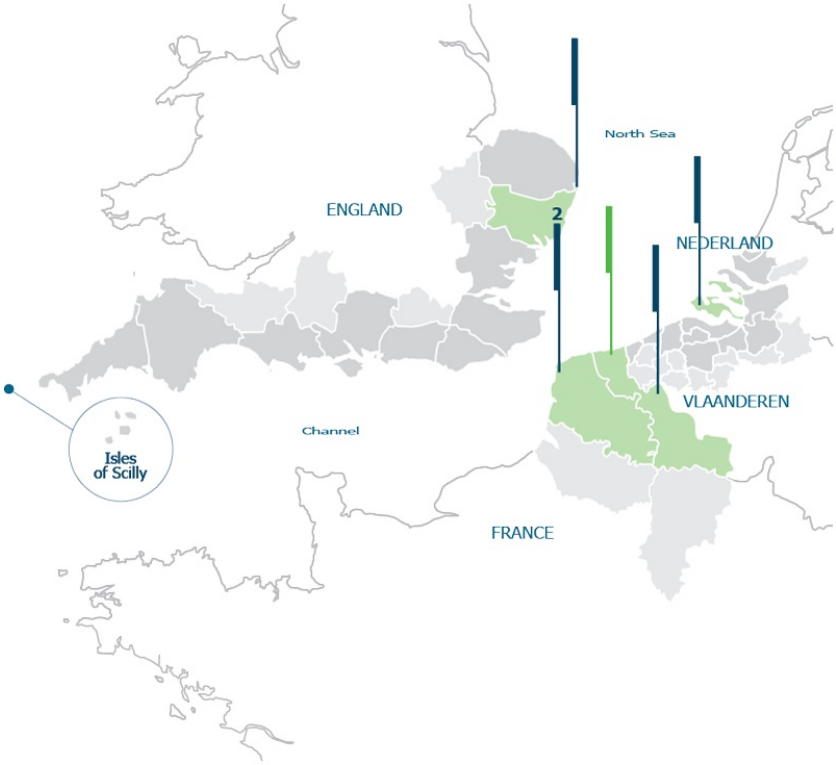
DYMAPHY

Development of a DYnamic observation system for the assessment of MArine water quality, based on PHYtoplankton analysis

■ Project summary



DYMAPHY aims to improve the assessment of the quality of marine waters in the 2 Seas area, through the study of microalgae (phytoplankton) and related environmental parameters at high resolution by employing a combination of traditional and new approaches, which could then be used by other regions. Partners, all specialists of marine environments or public authorities, decided to focus on phytoplankton as it represents the basis of all food chains in the sea, guaranteeing and sustaining the productivity of living resources and giving significant information on the environmental status of marine waters, and indications of short-term and long-term changes in water quality. To detect and react to these changes, partners will develop better-standardised procedures and greater automation in data analysis which can then be integrated into routing monitoring applications. Partners will first compare and calibrate existing tools for monitoring and analysing phytoplankton and environmental parameters. They will then log the monitored signals in a common database and then carry out sampling campaigns in the English Channel, North Sea and Estuaries of the 2 Seas area, to test their common procedures.

■ Activities

What was the project trying to achieve?

The DYMAPHY project aimed at contributing to a better assessment of marine water quality

within the “2 Seas” Region, by considering the study of environmental variables and micro-algae (phytoplankton) dynamics. Indeed, phytoplankton concentration and composition reflect the environmental status and water quality, sustain aquatic marine resources, and may be responsible for harmful events (toxicity, bioaccumulation) with consequences in socio-economic issues (shell fish fisheries and aquaculture, tourism, etc.) and human health. In order to detect and react on short term events as well as long term changes in phytoplankton communities, which reflect the state and quality of marine waters, there is a need for a fast, cost effective, innovative, robust, reproducible and standardized monitoring procedure that could be applied at high frequencies if necessary. The main objective was to develop, within a cross-border effective work, better-standardised procedures for monitoring phytoplankton as well as promoting greater automation in data analysis. The project aimed at setting up the basis for an easier integration of innovative methodologies which could be applied in vivo and in situ in routine monitoring applications by monitoring agencies and academic institutes, through an easier understanding and access to procedures and tools by environmental managers, stakeholders, local and regional authorities. Furthermore, the DYMAPHY project wanted to promote discussion on the recommendations and results of their application in monitoring common activities, in common publications, in communications at international conferences, in national and regional workshops, as well as actively participating in education, training and outreach activities.

What were the activities implemented?

Phytoplankton data was acquired, from field surveys and culture measurements, for inter calibration and inter comparison of innovative techniques, combined with other techniques. During three inter calibration exercises which were performed in 2010 and 2011, participants compared the results obtained with different machines and techniques on micro-algal cultures. Special attention was given to the characterisation of harmful algae. Natural estuarine, coastal and offshore samples were also tested, since the growth conditions in the field differ from culture conditions and have an influence on the optical fingerprints. The second activity was dedicated to acquire greater automation in phytoplankton analysis, for the classification and discrimination of phytoplankton groups by innovative techniques. Particularly, partners considered pulse-shape recording flow cytometry, as it provides a very useful tool in this respect, offering the additional advantages of high sample through-put, suitability for field use, and making it possible to define some characteristics of microalgae such as size, shape and pigment composition. Different approaches were applied and different methodologies were tested. In parallel, software tools produced by an external consultant’s company were tested and evaluated. Finally, the application and validation of the operational procedures and tools for data analysis concerning innovative techniques were carried out, at high spatial and temporal resolution, in common monitoring cruises in the North Sea in spring 2011, the Eastern English Channel in spring 2012 and in the Dutch estuaries at the end of summer 2012. During at least one of these cruises and field work, sampling strategies and results were validated with a remote sensing model of recognition of phytoplankton functional groups. Automated measuring systems developed within the project were tested.

■ Results

What were the key results of the project?

Reports on the three cross border inter calibration exercises CAL1, CAL2 and CAL3 were released in the course of the project, based on the analysis of both culture and field marine samples by innovative techniques. A common operational protocol for using pulse-shape recording flow cytometry for phytoplankton analysis was written. On the other hand, a report and a publication gave recommendations on the application of spectral fluorometry for discriminating Haptophytes from diatoms. The combined use of spectral and modulated fluorometry was also tested in order to address phytoplankton photosynthetic parameters. The determination of phytoplankton cell biovolume and DNA content in phytoplankton cells made it possible to convert biovolume into carbon content and to estimate phytoplankton biomass. Finally, an automated system for water quality assessment was built, by coupling an autonomous sampling device with a high frequency measurement system, connected to a spectral fluorometer. A freeware and user-friendly software was developed, consisting of a “R-GUI toolbox” for analysis of flow cytometry data which contains different types of tools. In parallel, a new module for the EASYCLUS© software was released. Finally, a common data base of environmental and phytoplankton data was devised, including a specialists section for raw data from sensors and a public section on environmental and processed/validated data. Classification tools were developed for the application of spectral fluorometry: a first software tool was proposed and tested on culture and field data. Moreover, a naïve clustering method was applied to the MAREL Carnot data in order to detect characteristic clusters without any biologic knowledge. Reports on each common oceanography cruise were written after performing data analysis. Finally, the first maps of phytoplankton groups addressed at high spatial resolution in the region have been processed.

Did all partners and territories benefit from the results?

Even though not all the partners were currently applying the same techniques to study and/or monitoring phytoplankton dynamics and distribution, they benefited from the results of the project as they actively participated in the common work which led to them. About external beneficiaries: first of all, academic and research institutions and laboratories of the “2 Seas” area, the scientific community in general that participated in the exchange of skills, human resource training and capacity building which were effective all along the project. Moreover, results were disseminated and validated through our participation in international conferences, invited talks or seminars. Environment and Water agencies at regional or local level benefited from the definition of the operational procedures and recommendations for the use of innovative semi-automated techniques for monitoring phytoplankton and some of them started including these approaches in current monitoring activities and/or in high frequency recording systems. These approaches dealt to cope with European directives requirements as the Water and the Marine Strategy Framework Directives and helped supporting the development of new water quality indicators. Information about the respective average size and distribution of phytoplankton functional groups will enhance the description of primary producers in size-based fish tropic models providing information on available resources for fish and shellfish industry and professionals. Finally, the project provided the general public with a new way of presenting information on phytoplankton as responsible for goods and services but which could be harmful for human activities and/or human health. It contributed to the transferring of knowledge, acting as pedagogical support for scholar and academic activities as well as for

marine outreach institutions, contributing to the enhancement of the public concern for marine environmental issues.

What were the effects / outcomes for the territories involved?

The project results represent a step forward in the exploration of indicators for addressing estuarine, coastal and marine water quality and state, in the frame of European Directives as the WFD and the MSFD, and their application within national and regional policies to cope with the European Directives objectives. Moreover, it was included and labialized within the AQUIMER competitiveness cluster which focuses on reconciliation of the depletion of seafood resources and the increase in food demand with the imperatives of sustainable development and a healthy marine ecosystem. The approach consisting in considering the whole size-range of phytoplankton in current monitoring practices, as well as the application of higher temporal and spatial resolution than usual, will certainly give rise to a more accurate understanding of changes in water quality and environmental functioning, will also help the elaboration of indicators of these changes and will allow the work on modeling and predicting of these changes. The development of real-time information and early warning procedures will also be possible thanks to the operational procedures and recommendations, analytical tools and examples of results of monitoring in different estuarine, coastal and marine ecosystems of the “2 Seas”, submitted to different continental inputs and human pressure. DYPHYMA results will contribute to the current implementation of these approaches in the region, benefiting from the existing structures available. It will help to enhancing the awareness of stakeholders, professionals and the general public on the importance of addressing phytoplankton as a major provider of goods and services for human well-being, as it represent a major support of living resources and a major actor from climate change through its productivity; a major indicator of changes in water quality in response to climate changes and local human pressure through it changes in composition, biomass and productivity.

■ Distinctiveness

What was the real added-value of doing this cross-border project?

Marine ecosystems do not stop at country borders: marine systems are defined by their environmental properties and are inter-connected to each other, especially in the case of the “2 Seas” region whose maritime area results from the connection between the E. Channel and the North Sea. The real added-value of performing a cross-border work on testing, inter comparing and inter calibrating new technologies to improve the monitoring of marine systems is the possibility of benefiting from the experience and know-how gathered when facing similar challenges on similar systems which are inter connected.

Have any synergies been developed with other projects or networks?

Synergies were developed with other projects, especially when carrying out international joint field work on semi-automated techniques for monitoring phytoplankton (North Sea cruise of May 2011 resulting from collaboration between DYMAPHY and PROTOOL FP7 projects). A synergy was also developed with the “2 Seas” projects MEMO for communication purposes (joint organisation of the World Ocean Day IFREMER LER/BL–ULCO-UL1–CNRS common outreach activities in 2013, focusing on monitoring of both phytoplankton and invasive zooplankton

species), and ISECA (invitation to attend and participate as a speaker in the final ISECA meeting). Some DYMAPHY partners were also invited to attend and to present the DYMAPHY project to the FP7 JERICO meeting in Villefranche sur Mer in November 2013 and actively participated in the preparation, writing and submission of the application for a JERICO-Next H2020 network integrating innovative biological sensors. Moreover, synergies were developed with the “PegaSeas” Channel capitalisation project between France and the United Kingdom and its aim is to promote the efficient governance of the Channel Ecosystem. Finally, the project was labellised within the AQUIMER competitiveness cluster which aims to reconciling the depletion of seafood resources and the increase in food demand with the imperatives of sustainable development.

What are the key messages , key lessons learned you would like to share?

One message and lesson learned is that it seems important to establish a partnership as strong as possible, making it sure all partners benefit from each other’s different skills and know-how, sharing previous and current experience and planning and performing as much common work as possible, including common actions, reporting and publications. It is also of the outmost importance to share responsibilities to achieve a good management of the project, as well as to share the realisation and dissemination of communication products and participate in outreach and specialised events in all the countries involved (and beyond). One need not underestimate the complexity and difficulties of the financial follow up and reporting of the project, which can generate some tensions amongst partners and which can indirectly lead to importants delays in the writing and submitting of reports (as it was the case, especially for the final and closure reports). Finally, the use of English as a working language should be favoured and strengthened because it makes possible a high level of collaboration which otherwise would have been much difficult (and expensive) to achieve and which could lead to miscomprehension amongst partners.

Project Information

Title	Development of a DYnamic observation system for the assessment of MArine water quality, based on PHYtoplankton analysis
Total project budget	€ 2 460 974
ERDF	€ 1 230 487
Priority & objective	Priority 2 b. Develop activities to prevent and cope with natural, technological and human risks and to guarantee the quality of the environment
Timeframe	2008-07-01 - 2013-12-31
Lead partner	Université du Littoral Côte d'Opale
Project Coordinator	Helène PIHEN(.pihen@univ-littoral.fr)