COMMON SENSE Project: A step forward to implement MSFD

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***Abstract*—*COMMON SENSE project will contribute to support the implementation of the Marine Strategy Framework Directive (MSFD) and other EU policies (e.g. Common Fisheries Policy), providing easily usable across several platforms, cost-effective, multi-functional innovative sensors to detect reliable in-situ measurements on key parameters by means of methodological standards. This project will focus, by means of a multidisciplinary and well-balanced consortium, on eutrophication, contaminants, marine litter, underwater noise and other parameters such as temperature and pressure. A Common Sensor Web Platform will be developed in order to enhance interoperation between sensor data and GEOSS. System deployments in several platforms will be carried out, in order to validate the sensors developed.*

***Keywords*—*Common Sensor Web Platform, deployment, innovative cost-effective sensors, in-situ measurements, MSFD, microplastics, nutrients, heavy metals, underwater noise, temperature, pH, pCO2.*

I. INTRODUCTION

MARINE ecosystems are integral to key environmental functions which support life on Earth, including climate regulation, prevention of erosion, and absorption of carbon dioxide. The oceans also contribute to economic activities resulting in prosperity, social well-being and quality of life. However, many marine environments, including some of those in EU marine territories, face increasing challenges, such as loss of biodiversity and habitats, pollution, and the impacts of climate change. For Europe, increasing environmental interest and awareness in both public and private sectors is a strategic objective for sustainable development and for ensuring continuity of economic activities. To achieve this, and to improve EU competitiveness, new technologies and methods for monitoring the marine environment are required. COMMON SENSE project supports the implementation of European Union marine policies such as the Marine Strategy Framework Directive (MSFD) and the Common Fisheries Policy (CFP). The project has been designed to directly respond to requests for integrated and effective data acquisition systems by developing innovative sensors for in-situ monitoring that will contribute to our understanding of how the marine environment functions.

The new generation sensors will be able to share data with existing and new observing systems and will be compatible with the Global Ocean Observing System (GOOS) and the Global Earth Observing System of Systems (GEOSS).

COMMON SENSE, which was launched in November 2013, is funded by the European Commission's Seventh Framework Programme (FP7) and is coordinated by LEITAT Technological Center in Spain. Its consortium brings together 15 partners from seven different countries, encompassing a wide range of technical expertise and know-how in the marine monitoring area.

In an overall strategy of the work plan, project work packages can be grouped into 4 key phases: (1) **R&D** including a comprehensive understanding of EU legislation, a basis for cost-effective sensor development, the Sensor web platform and integration, sensor development , ; (2) **DEMO and Field testing**; (3) **Dissemination and exploitation** and (4) **Project Management** .

The project will focus on increasing availability of standardized data on different parameters according to some of the MSFD descriptors. These sensors will be used to make different reliable in-situ measurements of key parameters relating to Good Environmental Status (GES) of marine waters by means of methodological standards.

This paper reflects project results until the moment (Month 18).

II. SENSORS

Table I shows the sensors developed under COMMON SENSE and the link with the MSFD.

TABLE I
MSFD DESCRIPTORS / INDICATORS ADDRESSED WITHIN COMMON SENSE

DESCRIPTOR	INDICATOR
1	1.6.3. Physical, hidrological and chemical conditions.
5	5.1.1. Nutrients concentration in the water column.
8	8.1. Concentration of contaminants in seawater.
10	10.1.3.Trends in the amount, distribution and, where possible, composition of microparticles (in particular micro-plastics).
11	11.2.1. Trends in the ambient noise level.

Eutrophication is one of the most widespread environmental problems of inland waters, and is their unnatural enrichment with two plant nutrients, phosphorus and nitrogen. It is the ecosystem's response to the addition of artificial or natural substances, mainly phosphates, through detergents, fertilizers, or sewage, to an aquatic system. Negative environmental effects include hypoxia, the depletion of oxygen in the water, which may cause death to aquatic animals.

In order to monitor Eutrophication, optical sensors have been designed. Nitrate, Nitrite, Phosphate and Ammonia are addressed. The tasks developed until now are as follows: (1) Identification, optimisation and validation of colorimetric chemistries for nutrient analytes; phosphate, nitrate and nitrite. (2) Development of in-house system to evaluate the LED's and Photodiodes (PD's). (3) Identification and optimisation of LEDs and PDs for implementation into the deployable system. (4) Increased resolution with which the sensor signal can be read increasing the sensitivity of the system.

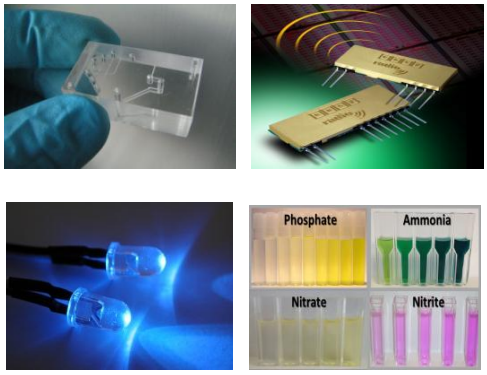

Fig. 1. Component of Nutrients sensor system

The first prototype of the sensing system has been developed. The system includes: (1) sampling system, (2) reagents, (3) optical sensor (LED & Photo detector) and waste tank. A novel bench top system was developed in-house to further validate the chemistries and to systematically evaluate each individual component to ensure that optimal operating conditions are achieved for each component prior to integration into the deployable system. Deployment in a marine environment is scheduled after 2015 summer season.

Microplastics are used to describe, commonly, plastic particles < 5 mm in diameter, which includes particles as small as 10 nanometre. Nowadays microplastics quantification is an off-line process, done in a laboratory, known as the naked eye technique. Plastics are discarded and enter the ocean as a result of many different land- and sea-based activities, but there are no reliable estimates of the quantities involved, at a regional or global scale. Microplastics have been found inside the bodies of a wide variety of marine organisms including invertebrates, fish, birds and mammals. Very small (nano-size) microplastics have been shown to cross cell membranes, under laboratory conditions, causing tissue damage. Ingested microplastics can affect the physiology of the host organism and potentially compromise its fitness.

COMMON SENSE will provide an innovative microplastics sensor, able to measure in-situ microplastics in sea water by means of a sampling system that introduces the sample to the multispectral and hyperspectral sensors. The image is then preprocessed andto determine microplastics concentration using spectroscopy technology.

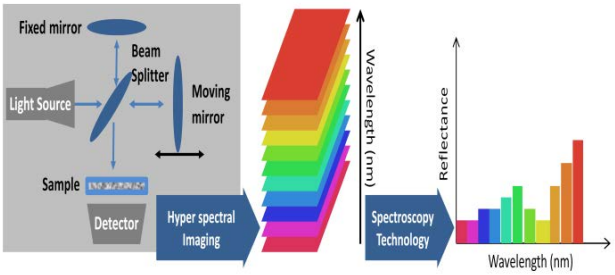

Fig. 2. Microplastics sensor design

Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed. Heavy metals are dangerous because they tend to bioaccumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted.

COMMON SENSE will provide a sensor module for automatic detection of low concentrations of heavy metals in seawater. In the current stage of the project, the determination of heavy metals such as Pb, Cd, Zn, Hg & Ni was evaluated and optimized. As a result of the work, a laboratory scale electrochemical cell setup has been developed and used for optimisation purposes of heavy metal analysis procedure.

A precompetitive screen printed electrode based sensor for the detection of Heavy metals was developed.

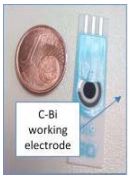

Fig. 3. Printed electrode

Heavy metal sensors will share the sensing system explained under nutrients sensors.

Underwater noise has the potential to affect marine life in various ways and in some cases over relatively large areas and time scales. It is difficult to assess to what degree the introduction of manmade noise affects the overall quality status as there is little data to allow us to quantify noise levels across the whole OSPAR area. However, most of the intensities of anthropogenic sounds exceed by several order of magnitude the ambient sounds in the marine environment that occur naturally, such as sounds that are induced by rain, wind and waves. Underwater noise can have a range of impacts on marine life such as injury, permanent or temporary hearing loss, behavioral responses and masking of biological relevant signals.

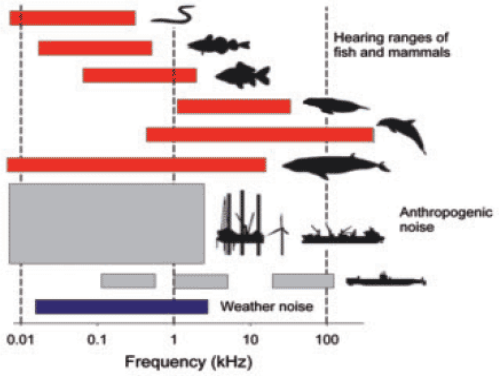

Fig. 4. Main sound's frequency

COMMON SENSE will provide a compact bespoke acoustic sensor, able to acquire and record underwater noise. The acoustic sensor platform has the flexibility to increase the sampling frequency to cover the latest recommendations about noise monitoring (20KHz). It includes pre-processing algorithms, noise sources classification and it can act as a data logger.

Transversal sensors are mainly sensors required in most measurements processes in order to be used as a reference for comparison or, for instance, to localize where the sensor is. Transversal sensors usually have a high manufacturing cost, and there are not multicomponent systems.

COMMON SENSE is developing innovative sensors to measure temperature, pH, or pCO_2. Figure 5 shows the newly developed temperature, pressure, humidity and strain sensor (left), produced using full organic low cost materials. This sensor provides extreme sensitivity, high stability and can be easily integrated into other measuring devices. On the right, NC sensor for pH is showed.

Fig. 5. Transversal sensors

Furthermore, the common sensor platform integrates GPS and RTC commercial chips for the location and timing of measures.

III. COMMON WEB PLATFORM

In order to share information generated by the sensors with existing or new observation systems, a common web platform is designed to be the link between the sensing system and the observation systems.

This platform uses open and standard protocols, in order to maximize the compatibility with existing services. This platform implements OGC SWE (Sensor Web Enablement), an open protocol, used to share data among all the supply chain.

As main services of SWE, the Common Sensor Web Platform, implements:

- SOS, Sensor Observation System

  It's the core service for delivering observations. It will provide access to sensor observations. This will also be used by the sensors to submit their observations.

- SIR, Sensor Instance Registry

  This service facilitates the sensor discovery, in order to couple it with a Sensor Observable Registry (SOR)

- SES, Sensor Event Service.

  Provides to users the capability to subscribe to sensor events.

Furthermore, a DBMS, Data Base Management System, is implemented in order to store data in a centralized element.

IV. DEPLOYMENT PLATFORMS

The whole system, sensors, sampling systems and communications will be deployed in different platforms, in order to validate and compare the results. The aim of the field testing activities is to validate the behavior of the different sensors in different measuring conditions (static platforms and/or dynamic platforms), and to validate the sensors in different environments (temperature, salinity, wind…) and different seas (Baltic, Mediterranean and North seas).

A set of different platforms are available to deploy and validate the sensors: Research vessels; Oil platform; Buoys and submerged moorings; Ocean racing yacht (IMOCA Open 60) and drifting buoys.

First deployments will start during the summer season and will continue thoughout the following year 2016.

V. CONCLUSIONS

Cost-effectiveness of the new sensors developed by the project will enable to save millions of Euros at European scale. The new applied technology will make possible in-situ sample collection, reducing the cost and resources required derived from data collection. Real time information will be provided; thanks to the pre-processor inserted within sensors able to interpret the signal measured by the sensors and send the information directly to the communication platform.

Integration of specific innovative sensors into modular systems which can be easily adapted to different monitoring requirements and deployment platforms.

Common Sensor Web Platform which will provide a more sophisticated view of the environment by implementing Open Geospatial Consortium Sensor Web Enablement standards and optimizing data acquisition, indexing, access and interoperability.

Deployment and testing of multifunctional sensor packages using floating devices, buoys, platforms and ships, under different sea conditions in key locations.

Effective Knowledge and Technology Transfer ensuring maximum value and benefit from the COMMON SENSE project.

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