Procedures of sensors deployment methodology on physical supports/platforms

Deliverable D2.2
of the COMMON SENSE project

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COMMON SENSE

MARINE SENSORS - MARINE MONITORING

Acronym: COMMON SENSE
Title: COST-EFFECTIVE SENSORS, INTEROPERABLE WITH INTERNATIONAL EXISTING OCEAN OBSERVING SYSTEMS, TO MEET EU POLICIES REQUIREMENTS

Grant agreement n° 614155

Deliverable 2.2

Procedures of sensors deployment methodology on physical supports/platforms

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Authors:	Alberto Ribotti[1], Fabio Antognarelli[1], Andrea Satta[1], Maurizio Avella[1], Roberto Avolio[1], Gennaro Gentile[1], John Barton[2], Mireno Borghini[1], Aleksandar Dimitrov[3], Declan Dunne[4], Anita Grozdanov[3], Yassine Lassoued[4], Perica Paunovic[3], Federica Pessini[1], Katrin Schroeder[1], Paolo Magni[1] [1] CNR, [2] Tyndall, [3] FTM-UCIM, [4] UCC
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EXECUTIVE SUMMARY

The aim of task 2.3 is to define specific platform characteristics and identify deployment difficulties in order to determine the adequacy of sensors within specific platforms. In order to obtain the necessary information, two online questionnaires were realized. One questionnaire was created for sensor developers and one for those partners that will test the sensors at sea.

The seven developers in COMMON SENSE have provided information on seven sensors: two for underwater noise – CEFAS and IOPAN; two for microplastics – IDRONAUT and LEITAT; one for an innovative piro and piezo resistive polymeric temperature and pressure – CSIC; one for heavy metal – CSIC; one for eutrophication sensor – DCU. Outside the scope of the questionnaire, FTM has proposed three sensors of which two for oil spill and one for heavy metals, realized in the framework of a previous EU project but that can be improved and tested with several platforms.

This information is anyway incomplete because in most cases for the novel sensors which will be developed over the course of COMMON SENSE, the sensors cannot be clearly designed yet as the project only started a few months ago - and, consequently, technical characteristics cannot actually be perfectly defined. This produces some lag in the acquired information that will be solved in the near future.

In the other questionnaire, partners-testers have provided information on eleven platforms. Outside the questionnaire, IOPAN has described two more platforms, one of which is a motorboat not previously listed in the DoW, and they have informed us that the oceanographic buoy in Gdansk Bay is not actually available. This is valid also for platforms from other partners where there were only preliminary contacts like for example for Aqualog and OBSEA Underwater observatory.

In the following months, new information will be provided and questionnaires information updated. Then important characteristics have to be considered such as maintenance, energy autonomy, data transfer/storage and dimension of the sensors that are actually missing.

Further updates of this report are therefore necessary in order to individuate the most suitable platforms to test each kind of sensor and then used at the end of 2014 when WP9 (Testing activities) will start.

Objectives and rationale

The objective of deliverable 2.2 is the definition of the characteristics and procedures of sensors deployment methodology on physical supports/platforms, possible needs and characteristics of the available platform.

This is preparatory for the activities in other WPs and tasks:

- for task 2.2 (New generation technologies), that will provide cost-effective sensors for large scale production through Deliverable 2.1 [month 10];
- for task 2.5 (Monitoring strategy) where sensitivity and stress tests of new sensors will be designed in order to establish confidence limits under different situations and certify the performance of the new instruments [Deliverable 2.5 at month 16].
- for WP9 (Field testing) starting at month 12 (October 2014) when the deployment of new sensors will be drawn and then realized;

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1 INTRODUCTION

1.1 Background

The Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for Community action in the field of water policy, begins with the statement "*Water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such*". Indeed, water is one of our most precious and valuable resources. Therefore of utmost importance is that we learn how to adequately use, protect, and preserve water resources. However, the water is a limited and vulnerable resource. The use of water affects the quality of this resource itself as well as the quality of the environment in a broader sense. Water pollution has been a problem that has accompanied human development and the greatest human achievements. New strategies and new radical approaches are needed to improve the management of water bodies, in terms of increasing the quality and efficient use of freshwater, reducing the undesirable effects of land use and human activities on water quality, and working with local government to identify options and new technologies to assess the chemical and ecological status of water bodies and to develop best practice.

A number of organic and inorganic contaminants, such as petroleum hydrocarbons, other persistent organic pollutants, mercury and heavy metals are considered as priority pollutants in water bodies. New and efficient methods are needed for monitoring the implementation of various EU agreements and national programmes on reduction of water contamination. Relatively recent advancements in the field of the sensing technologies have brought new trends in the environmental field. The progress in micro-electronics and micro-fabrication technologies has allowed a miniaturization of sensors and devices, opening a series of new and exciting possibilities for pollutants monitoring. Moreover, robotics and advanced ICT-based technology (in particular, the extensive use of remote sensing and telemetry) can dramatically improve the detection and prediction of risk/crisis situations related to water pollution, providing new tools for the global management of water resources.

The COMMON SENSE project aims to support 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 that will contribute to our understanding of how the marine environment functions.

The core project research will focus on increasing the availability of standardised data on: eutrophication; concentrations of heavy metals; microplastic fraction within marine litter; underwater noise; and other parameters such as temperature and pressure. This will be facilitated through the development of a sensor web platform, called the *Common Sensor Web platform*.

This proposal will first provide a general understanding and integrated basis for sensors cost effective development (WP1 and WP2). In WP2 the aim is:

- to obtain a comprehensive understanding and an up-to-date state of the art of existing sensors;
- to provide a working basis on "new generation" technologies in order to develop cost-effective sensors suitable for large-scale production;
- to identify requirements for compatibility with standard requirements as the MSFD, the INSPIRE directive, the GMES/COPERNICUS and GOOS/GEOSS.

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In Task 2.3 (Physical supports/Platforms. Availability and adequacy. Characteristics and difficulties) the aim, in the first 8 months of the project, is to define specific platform characteristics and identify deployment difficulties in order to determine adequacy of sensors within specific platforms. This is a first approach as in most cases new sensors are not yet developed and, consequently, technical characteristics are not perfectly known. This is valid also for the approach to the elaboration of the procedures of deployment methodology, how to avoid/minimize conflicts with daily professional activities (compatibility issues), calendars and availability, sensor operability, optimization, transmission of data specificities, stakeholders involved (including cooperation issues) and all the possible information that will be useful in the other WPs, specifically for task 2.5 and WP9. This information is necessary for each platform provided within the project (e.g. research vessels, nautical platforms, oil platforms, buoys, submerged moorings, smartbuoys).

1.2 Organisation of this report

This report provides information on the characteristics of several platforms that will be accessible for the deployment and testing of the five kinds of sensors. These are the four listed as WPs from 5 to 8, so for eutrophication, microplastics, heavy metals, underwater noise, plus additional new sensors for innovative piro and piezo resistive polymeric temperature and pressure, nanosensors for autonomous pH and pCO_2 measurements.

In order to acquire all necessary information, two different questionnaires have been realized and filled by partners: one questionnaire for sensor developers and a second for testers, i.e. those partners that will check sensors in situ. The two questionnaires have been defined and realized by CNR and UCC.

These two questionnaires will be provided and then described through tables and graphs.

Information on further sensors and platforms have been also provided by some partners through short descriptions but outside questionnaires.

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2 LITERATURE REVIEW/STATE OF THE ART

As stated in Section 1.1 the core project research will focus on increasing the availability of standardised data on: microplastic fraction within marine litter; eutrophication; concentrations of heavy metals; underwater noise. Furthermore the work also addresses additional new sensors for innovative piro and piezo resistive polymeric temperature and pressure and nanosensors for autonomous pH and pCO_2 measurements.

Below is a short introduction on the scientific themes behind the main four sensors in development with its bibliography. For further details on each of these sensors, see D2.1.

2.1 Microplastics fraction

Microplastics are small plastic particles and have become a paramount issue especially in the marine environment. Not unequivocally defined, some marine researchers [Bro08] define microplastics as all plastic particles smaller than 1 mm pertaining to their microscopic size range while others [Moo01; Moo08] define them as smaller than 5 mm recognizing the common use of 333 µm mesh Neuston nets for field sampling. The abundance and global distribution of microplastics in the oceans has steadily increased over the last few decades with rising plastic consumption worldwide [Bar02]. Then experiments sampling wastewater from domestic washing machines demonstrated that a large proportion of microplastic fibers found in the marine environment may be derived from sewage as a consequence of washing of clothes. As the human population grows and people use more synthetic textiles, contamination of habitats and animals by microplastics is likely to increase [Bro08].

Microplastics are not as conspicuous as larger plastic items, but particles of this size are available to a much broader range of species and have been shown to be ingested by deposit-feeding lugworms (*Arenicola marina*) and filter-feeding mussels (*Mytilus edulis)* ; see [Tho04], [Wri13]) to name just two examples. Ingestion of microplastics by species at the base of the food web causes concern as little is known about its effects [Moo01]. It remains unknown if microplastics may be transferred across trophic levels.

Furthermore, plastic particles may highly concentrate and transport synthetic organic compounds (e.g. persistent organic pollutants, POPs) commonly present in the environment and ambient sea water on their surface through adsorption [Mat01]. Evidences [Der02; Teu09] suggest microplastics to be a potential portal for entering food webs. Of further concern, additives added to plastics during manufacture may leach out upon ingestion, potentially causing serious harm to the organism. Endocrine disruption by plastic additives may affect the reproductive health of humans and wildlife alike [Teu09].

At current levels, microplastics are unlikely to be an important global geochemical reservoir for POPs such as PCBs, dioxins, and DDT in open oceans. It is not clear, however, if microplastics play a larger role as chemical reservoirs on smaller scales. A reservoir function is conceivable in densely populated and polluted areas, such as bights of mega-cities, areas of intensive agriculture and effluents flumes.

Oil based polymers ('plastics') are virtually non-biodegradable. However, renewable natural polymers are now in development which can be used for the production of biodegradable materials similar to that of oil-based polymers. Their properties in the environment, however, require detailed scrutiny before their wide use is propagated.

Microplastics are both abundant and widespread within the marine environment, found in their highest concentrations along coastlines and within mid-ocean gyres. Ingestion of microplastics has been demonstrated in a range of marine organisms, a process which may facilitate the transfer of chemical additives or hydrophobic waterborne pollutants to biota [Col11; And11; Zar11]. Harrison

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[Har12] tried to separate synthetic microplastics (5-mm fragments) from sediments, while with COMMON SENSE we will try to measure microplastics floating in the water.

2.2 Eutrophication

Eutrophication is referred to as an increase in the rate of supply of organic matter to an ecosystem [Nix95]. Eutrophication includes a number of processes whose rate changes following an increase in nutrient inflow to a coastal ecosystem. The increase in nutrient inflow may be either natural or anthropogenic, the latter being related to land clearing, production and applications of fertilizer, discharge of human waste, animal production, and combustion of fossil fuels [Nix95].

In recent decades, increased anthropogenic inputs of nitrogen and phosphorus have led to severe eutrophication problems in many coastal areas worldwide, inducing higher phytoplankton primary production [Clo01]. On the other hand, eutrophication and increased turbidity of the water can severely reduce light availability in the water column, affecting benthic communities and causing a shift from macrophyte-dominated environments to phytoplankton-dominated ones [Gle07; Via10]. This can lead to significant changes both in the structure and function of the affected ecosystems. The process of eutrophication also increases the frequency and intensity of phytoplankton growth which can generate anoxic conditions. These modifications may have far-reaching consequences, such as fish-kills, interdiction of shellfish aquaculture, loss or degradation of sea grass beds and smothering of benthic organisms, with significant economic and social costs [Bri03]. Moreover, one of the effects of eutrophication is the development and persistence of harmful algal blooms (HABs), caused both by toxic and nuisance algae. In parallel, a trend of cell size reduction in phytoplankton composition has been signalled in a wide range of aquatic environments in the last decades, suggesting that it can be one of the phytoplankton's responses to global climate change [Pad12].

Chlorophyll-a (chl-a) and phytoplankton, together with nutrient concentrations, are major variables proposed by the European Environmental Agency [Ær01] as indicators of water quality and trophic status. Bricker [Bri03] proposes trophic classes and chl-a thresholds to rank the eutrophication status of estuaries and coastal areas, and to address management options. It includes quantitative and semi-quantitative components, and uses field data, models and expert knowledge to provide Pressure-State-Response (PSR) indicators. Comparison of anthropogenic nutrient loading with natural background concentrations is also a valuable tool for pressure assessment in the context of Descriptor 5 of the MSFD, this being aimed at minimising human-induced eutrophication. In addition to the measurement of variables such as transparency, nutrients and chl-a and the establishment of nutrient-based classification systems, other factors may determine the ultimate level and type of expression of eutrophic symptoms within a system including tidal exchange, freshwater inflow, hydrodynamics and saprobity [Clo01; Tag12]. Long-term investigations and comparisons at the eco-region level will be crucial for understanding whether the observed dynamics are mainly locally determined or whether they could be partially driven by global changes.

The marine regions and sub-regions considered by COMMON SENSE are all affected to varying extent by eutrophication problems [Oja11]. The Baltic Sea is characterised by a low water exchange rate, making it sensitive to eutrophication. The increased turbidity and change in algae composition can change foraging and habitats of fish and fish-larvae, as well as mating patterns hence disturbing the distribution and productivity of fish. In the Baltic Sea, from the 1960s to present time, improvements in chemical contaminants have resulted in improvements in the health of top predators, but eutrophication and hypoxia are still widespread. In the North Sea, nutrient discharges causing eutrophication and hypoxia have declined in the last 25 years but problem areas exist seasonally within larger river plumes, particularly in eastern waters. Eutrophication can alter phytoplankton

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species composition and cause seasonal hypoxia particularly within bottom waters in strongly stratified areas. Pelagic animals more tolerant to low dissolved oxygen, such as jellyfish, may become more prevalent. Benthic community composition will be shaped either by direct mortality or by increasing the vulnerability to predation of less tolerant taxa. Direct and indirect effects often act synergistically, causing shifts in habitat use and modifying trophic cascades with complex results [Tag12]. In the Mediterranean Sea marked differences occur among different subregions. In the Western Mediterranean, land-based pollution may result in the enrichment of the marine environment both in nutrients and in organic matter. The former can cause eutrophication in the water column, while the latter reduces the depth of the redox potential discontinuity in sediments. On the contrary, Eastern Mediterranean waters are characteristically oligotrophic [Azo86].

2.3 Heavy metals (or Contaminants, descriptor 8 of MSFD)

The most important classes of chemical contaminants recognized by EU, GESAMP and United Nations are biocides, metals, poly-aromatic hydrocarbons, plastics, polychlorinated biphenyls and polybrominated diphenylethers. There are several dangers associated with the release of chemical contaminants in aquatic ecosystems, and there are various sources of pollutants directly linked with human activities such as industry, sewage, agricultural wastes, etc. Furthermore there are a number of ways that chemical contaminants can be released to the environment (e.g. release during production or from industrial effluents, direct applications, disposal, transport) and a wide variety of uses in products. In addition, chemical levels of many substances, such as some brominated flame retardants and perfluorinated chemicals, have increased in the marine food chain and are expected to continue to increase. Among chemical substances discarded into the sea, Persistent Toxic Substances are especially worrying because of their persistence and their toxic effect on plant and animal life if concentrations exceed certain thresholds. Biological contamination is less studied, often related to aquatic farms or wastewater outlets, and can be linked to increasing infectious diseases in cetaceans. In a broad sense, it can be referred to as a contamination which “is caused when an input from human activities increases the concentration of a substance in seawater, sediments, or organisms above the natural background levels for that area and for the organisms” [Cla97].
Heavy metals are members of a loosely defined subset of elements that exhibit metallic properties. It mainly includes the transition metals, some metalloids, lanthanides, and actinides. Many different definitions have been proposed but no consensus of exact definition exists due to a lack of a "coherent scientific basis" [Duf02]. Motivations for controlling heavy metal concentrations in gas streams are because they pose a danger for health or for the environment. Some are carcinogenic or toxic, affecting, among others, the central nervous system (manganese, mercury, lead, arsenic), the kidneys or liver (mercury, lead, cadmium, copper) or skin, bones, or teeth (nickel, cadmium, copper, chromium) [Zev01]. Heavy metal pollution can arise from many sources but most commonly arises from the purification of metals. Unlike organic pollutants, heavy metals do not decay and thus pose a different kind of challenge for remediation. Plants, mushrooms, or microrganisms are occasionally successfully used to remove some heavy metals such as mercury. Plants which exhibit hyper accumulation can be used to remove heavy metals from soils by concentrating them in their bio matter. Some treatment of mining tailings has occurred where the vegetation is then incinerated to recover the heavy metals.
Anthropogenic metals are mainly carried with air masses from Northern and Central Europe. As a result, metal concentrations in Mediterranean surface waters are higher than in the open ocean, and those of the inflowing North Atlantic Ocean [Hei14]. The marine regions and sub-regions considered by COMMON SENSE are all affected to varying extent by contamination problems [Oja11]. Over the past 50 years there have been substantial inputs of chemical substances into the Baltic Sea via direct

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discharges from land-based sources (e.g. industrial and municipal wastes), river runoff or draining, atmospheric deposition from local and more distant sources, or due to shipping. As a result, the Baltic Sea ecosystem has become contaminated with numerous substances, including many persistent organochlorines (e.g. DDT, PCB, dioxins) and heavy metals. Meanwhile, the amount of many hazardous substances discharged into the Baltic Sea has been reduced, mainly due to the effective implementation of environmental legislation (e.g. Helsinki Convention), their substitution by harmless or less hazardous substances, and technological developments. On the other hand, new contaminants (such as pharmaceuticals, agrochemicals and PCB replacements) are being released and can be assumed to have a potential effect on biota. The residence time of chemical pollutants is high because of the persistence of many contaminants, the specific hydrographical conditions (salinity and oxygen gradients) in the Baltic Sea as well as remobilization processes ([Dip08] and references therein). In the North Sea, the major sources of chemical contaminants are direct-discharges (e.g. sewage outfalls, storm water, oil and gas drilling) and run-off from industrialized, urbanized and agriculture areas which contaminates adjacent coastal habitats [Mak95]. In the North Sea, adverse effects of chemicals present within sediments have been documented on organisms, particularly along shipping routes. Chemical and biological pollutants are often associated with SPM which occurs at higher concentrations in southern vs. northern waters and in coastal areas that are routinely dredged. Among chemical substances discarded into Mediterranean coastal waters, Persistent Toxic Substances (PTSs) are especially worrying because of their persistence and their toxic effect on animal and plant life if concentrations exceed certain thresholds. The flows of industrial heavy metals, such as mercury, increased by 300 % between 1950 and 1990, and this trend has only recently been reversed [BPl05]. Spain, France, Italy and Greece are the main contributors to the heavy metal loads in the Mediterranean Sea [Ben11, Mzo11]. In the Western Mediterranean, the Tyrrhenian and Adriatic Seas are believed to be the most impacted regions [UWM98, Dan03], but high pollutant-load hot spots are quite widely spread along the Mediterranean Sea [Oja11].
Several sensors have been realized in the recent years to check the presence of specific or general heavy metals like PVC membrane electrodes [Zam13a; Zam13b; Ha12], amorphous nitrogenated carbon thin film electrodes [Sec12] or inkjet printed surfaces enhanced Raman spectroscopy (SERS) substrate [Esh12], just mentioning the most recent published on scientific papers.

2.4 Underwater noise

Unlike light, which dissipates quickly underwater, sound can also travel farther and up to five times faster underwater, allowing animals to communicate over great distances.
On the web [1], it is well described the man made noise (as byproduct its offshore activities) in the water and its differences with environmental noise (usually generated by aquatic animals for imaging, navigation and communication or by natural sources such as breaking of waves or rain).
When sound is generated underwater, it will have a relatively high level near the source. The level of sound will be attenuated as the sound propagates away from the source, and at some distance it will decay to the level of the background noise in the ocean.
On land, a wide range of measurements have been taken of the noise levels from all categories of man-made noise. Generally however, there is a lack of the equivalent information for underwater noise, although as a result of environmental pressures some measurements are now being made of noise from activities related to petrochemical exploration and exploitation. There are three main reasons for this:

1. the lack, to date, of any clear need for taking measurements except for military applications;

[1] http://www.underwaternoise.org.uk

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2. the difficulty and expense of taking underwater measurements;
3. the lack of any well established criteria by which any measurements taken could be judged.

The information on man-made underwater noise may be divided into 5 categories:

1. Shipping noise
2. Pile driving and construction noise
3. Sonar and related research equipment
4. Underwater explosives and blasting
5. Offshore oil exploration and production

On underwaternoise.org.uk ,it is possible to find quite recent publications on the theme divided per kind of man made source of underwater noise, especially on the effects on cetaceans.

2.5 pH sensors

pH sensors are widely used in chemical and biological applications such as environmental monitoring (water quality), blood pH measurements and laboratory pH measurements amongst others. The earliest method of pH measurement was by means of chemical indicators, e.g. litmus paper that changes its color in accordance to a solution's pH. For example, when litmus is added to a basic solution it turns blue, while when added to an acidic solution the resultant color is red. Since many chemical processes are based on pH, almost all water samples have their pH tested at some point. The most common systems for pH sensing are based upon either amperometric or potentiometric devices. The most popular potentiometric approach utilizes a glass electrode because of its high selectivity for hydrogen ions in a solution, reliability and straight forward operation. Ion selective membranes, ion selective field effect transistors, two terminal microsensors, fibre optic and fluorescent sensor, metal oxide and conductometric pH-sensing devices have also been developed [Ko07]. However, these types of devices can often suffer from instability or drift and, therefore, require constant re-calibration.

Polymers are also used in various sensors for pH measurement [Ko07]. Namely, by introduction of functional groups, polymers can be designed to selectively swell and shrink, resulting in changing mass and elasticity, as a function of analyte concentration. The ion-exchange properties of conducting polymers are of special interest for potentiometric- sensor development [Ko07]. Conducting polymers are ideally suited for sensor applications because they not only exhibit high conductivity and electroactivity but they could also be used as a general matrix and can be further modified with other compounds in order to change selectivity. Compared to conductive polymers, nonconductive polymers usually have a high selective response and a high impedance, which is important for eliminating interference by other electroactive species.

3 METHODOLOGY

As described in Section 1.1, the aim of task 2.3 is to define specific platform characteristics and identify deployment difficulties in order to determine adequacy of sensors within specific platforms. We must keep in mind that in most cases new sensors cannot be clearly defined or developed yet and, consequently, technical characteristics cannot be perfectly defined. This introduces some lag in the acquired information that will be solved in the next months. Anyway the easiest way to obtain all necessary information to answer the task is through online questionnaires but they must be short enough not to bore the interviewee and exhaustive in their content. Therefore, one questionnaire was created for sensor developers and one for those partners that will test the sensors at sea.

Sometimes sensors developers and testers are the same partner in COMMON SENSE. An example is given by some i.e. UCC and SubCTech straddling the line as integrators, or CSIC.

Here below you see a table that summarizes how each partner participates in COMMON SENSE:

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Participant number	Participant short name	Developer	Tester
1	Leitat	?	√
2	AquaTT	√	√
3	CSIC	√	√
4	CNR		√
5	DropSens	√	
6	DCU	√	
7	FTM-UCIM	√	
8	FNOB		√
9	IDRONAUT	√	√
10	IOPAN		√
11	UCC	√	?
12	SNELLOPTICS	√	
13	SubCtech	√	√
14	TELAB	√	
15	CEFAS	√	√

In the questionnaires the following information will be also necessary for the future activities of the project, possibly useful in other WPs and specifically for task 2.5 and WP9, and so they were part of the questionnaires: the approach to the elaboration of the procedures of deployment methodology, how to avoid/minimize conflicts with daily professional activities (compatibility issues), calendars and availability, sensor operability, optimization, transmission of data specificities, stakeholders involved (including cooperation issues). It was necessary to keep information to the six different sensors, primarily the first four, to be tested in the five different platforms, all listed in the table below:

Sensors for	Sensors deployment and testing activities
1. Eutrophication (nutrients) 2. Microplastics 3. Heavy metals 4. Underwater noise 5. Innovative piro and piezo resistive polymeric temperature and pressure sensors 6. Nanosensors for autonomous pH and pCO_2 measurements	The research platforms that will be used for the field testing of the innovative sensors can be grouped into: (A) Research vessels (regular cruises); (B) Oil platforms; (C) Buoys and submerged moorings; (D) Ocean racing yachts; (E) Drifting buoys, among others that will be approached.

More specifically, the research platforms for the field testing that are thought to be available (by partners indicated in brackets), as specified in the DoW of the project plus two more taken in consideration, are the following:

A. Research vessels

Research vessel URANIA (CNR)

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Research vessel OCEANIA (IOPAN)
Research vessel SARMIENTO DE GAMBOA – SdG (CSIC)

B. Oil platforms
The oil platform on the Southern Baltic (IOPAN)

C. Buoys and submerged moorings
Oceanographic buoy in Gdansk Bay (IOPAN)
Oceanographic submerged moorings in the Mediterranean (CNR)
ICM-CSIC deep moorings at the continental slope and canyons of the NW Mediterranean
Smartbuoys (CEFAS)

D. Ocean racing yachts
IMOCA Open 60 boats (FNOB)

E. Drifting buoys.
Drifting buoys (ICM-CSIC)

F. Fishing vessels
Many COMMON SENSE partners have been working with fishermen and fishing fleets for many years; several contacts will be made to different fleets in the Baltic, North and Mediterranean Seas in order to disseminate project activities and identify possible collaborations within the framework of the project (assessing sensor deployment).

G. Expendable ocean instruments, manned vessels and further available platforms

It was also requested to indicate further available platforms to be used for sensors installation and the characteristics of the possible installations.
After having identified the structure of the two questionnaires, in collaboration with several partners, each one was exported from MS Word to Google Drive format.
The URLs for the two questionnaires were:

- For Sensor Developers (grey questionnaire): http://goo.gl/hDFWtn
- For Sensor Testers (blue questionnaire): http://goo.gl/uMwNsV

Common for both were the following:
Name *
Email address*
Organisation between the following *

○ 01 - LEITAT	02 - AQUATT
○ 03 - CSIC	04 - CNR
○ 05 - DROPSENS	06 - DCU
○ 07 - FTM-UCIM	08 - FNOB
○ 09 - IDRONAUT	10 - IOPAN
○ 11 - UCC	12 - SNELLOPTICS
○ 13 - SUBCTECH	14 - TELAB
○ 15 - CEFAS	

Then the two questionnaires to be filled are visible here below:

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QUESTIONNAIRE FOR SENSOR DEVELOPERS	QUESTIONNAIRE FOR SENSOR TESTERS
**Mandatory* 1. Select sensor type * (*Mark only one oval*) ○ Eutrophication ○ Microplastics ○ Heavy metals ○ Underwater noise ○ Innovative piro and piezo resistive polymeric temperature and pressure sensors ○ Nanosensors for autonomous pH and pCO_2 measurements 2. Please describe sensor technical characteristics (depth, maintenance, power, etc.) that can be useful to understand the best platform for the installation. …………………………………………………………… 3. Installation methodology and difficulties …………………………………………………………… 4. Adequacy of Sensors: sensor operability, optimization, transmission of data specificities. …………………………………………………………… 5. Which kind of data transmission/storage is possible/necessary? …………………………………………………………… 6. Special needs? …………………………………………………………… 7. Stakeholders involved? …………………………………………………………… 8. Suggestions on platform (see above between A. and G.) …………………………………………………………… 9. What type of data will your sensor produce? Please list all parameters that your sensor will measure (e.g., temperature, salinity, etc.) and specify the data type for each of them (e.g., number, Boolean, classification, position, time, etc.) …………………………………………………………… 10. What is the frequency of measurements of your sensor * *(Mark only one oval)* ○ Every few seconds ○ Every few minutes ○ Every few hours ○ Every few days ○ Other: (*please specify*)	** Mandatory* 1. Please select platform * (*Mark only one oval*) ○ A. Research Vessel - URANIA (CNR) ○ A. Research Vessel - OCEANIA (IOPAN) ○ A. Research Vessel - SARMIENTO DE GAMBOA – SdG (CSIC) ○ A. Research Vessel - Other (please specify below) ○ B. Oil Platform - The oil platform on the Southern Baltic (IOPAN) ○ B. Oil Platform - Other (please specify below) ○ C. Buoys and Submerged Mooring - Oceanographic buoy in Gdansk Bay (IOPAN) ○ C. Buoys and Submerged Mooring - Oceanographic submerged moorings in the Mediterranean (CNR) ○ C. Buoys and Submerged Mooring - ICM-CSIC deep moorings at the continental slope and canyons of the NW Mediterranean ○ C. Buoys and Submerged Mooring - Smartbuoys (CEFAS) ○ C. Buoys and Submerged Mooring - Other (please specify below) ○ D. Ocean Racing Yacht - IMOCA Open 60 boats (FNOB) ○ D. Ocean Racing Yacht - Other (please specify below) ○ F. Fishing Vessel - (please specify below) ○ G. Expendable ocean instruments, manned vessels and further available platforms (please specify below) …………………………………………………………… 2. If your answer to the previous question is "Other" or under categories F or G, then please specify. …………………………………………………………… 3. Platform Characteristics: Which sensors can be mounted on the available platform? (*Tick all that apply*) ○ Eutrophication ○ Microplastics ○ Heavy Metals ○ Underwater Noise ○ Innovative piro and piezo resistive polymeric temperature and pressure sensors

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11.Can you be more specific (e.g., measurement every 15 to 30 min) …………………………………………………………… 12.What limitations are there on the volume of data that can be collected and transmitted by the core logging system (size of data packages, frequency of transmissions)? …………………………………………………………… 13.How do you think the sensor data will be transferred to the data centre? (e.g., real time, at the end of the cruise) and using what technology (satellite, internet, etc.)? …………………………………………………………… 14.Does your sensor data need to be processed after acquisition? If so, what are the final parameters (data) that will be stored in the COMMON SENSE central database? …………………………………………………………… 15. What are the requirements in terms of delivering and managing your sensor data? (*Tick all that apply*) ○ Deliver sensor information and observations on the web ○ Allow users to subscribe to sensor alerts and notifications ○ Allow advanced users to remotely plan sensor tasks (e.g., schedule measurements, etc.) ○ Allow sensors to be discovered through a search interface ○ ……………………………………………………………	○ Nanosensors for autonomous pH and pCO_2 measurements 4. Platform Characteristics: How many sensors of each type can be mounted at the same time on each platform? …………………………………………………………… 5. Platform Characteristics: Frequency of platform maintenance? …………………………………………………………… 6. Please describe compatibility issues …………………………………………………………… 7. Please describe calendars and platform availability …………………………………………………………… 8. Special needs? …………………………………………………………… 9. Stakeholders involved? …………………………………………………………… 10. Additional question for Category F: Available fishermen vessels? …………………………………………………………… 11. Additional question for Category F: Frequency of installation …………………………………………………………… 12. Additional question for Category F: Area of work …………………………………………………………… 13. Additional question for Category F: Advantages and disadvantages ……………………………………………………………

4 RESULTS AND DISCUSSION

The two questionnaires have been compiled by 7 developers and 11 testers. Here we will present the answers and the statistics.

All the answers have been summarized in two tables that are in Annex 2 of this report.

4.1 Sensors developers

About the Questionnaire for Sensor Developers in the following table and figure the seven answering partners are shown.

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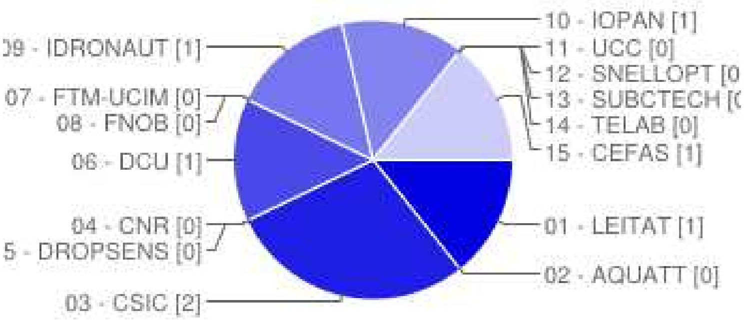


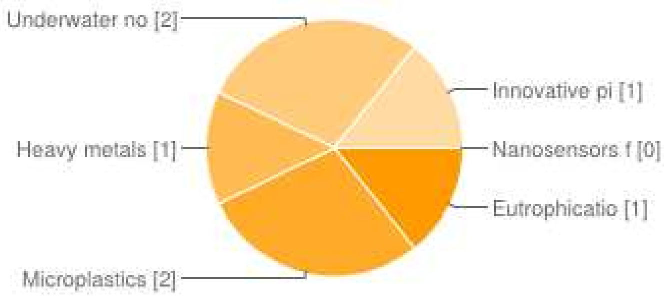
Organisation	Number of answers
01 - LEITAT	1
02 - AQUATT	0
03 - CSIC	2
04 - CNR	0
05 - DROPSENS	0
06 - DCU	1
07 - FTM-UCIM	0
08 - FNOB	0
09 - IDRONAUT	1
10 - IOPAN	1
11 - UCC	0
12 - SNELLOPTICS	0
13 - SUBCTECH	0
14 - TELAB	0
15 - CEFAS	1

In the figure above the name of the partner with its number in the project and the number of questionnaires compiled in square brackets are visible.
Again in the table on the right.
So CSIC, partner number 3, has for example compiled two questionnaires.

Here below the name of the compiler is shown:

Name	Organisation	Email
Mike Challis	CEFAS	mike.challiss@cefas.co.uk
Fabio Confalonieri	IDRONAUT	confalonieri@idronaut.it
Concepció Rovira	CSIC	cun@icmab.es
Zygmunt Klusek	IOPAN	klusek@iopan.gda.pl
Jose Saez	LEITAT	jasaez@leitat.org
Martí Gich	CSIC	mgich@icmab.es
John Cleary	DCU	john.cleary@dcu.ie

In the following figure the sensor type with the number of questionnaires compiled on it. This data is tabulated in the table on the right.



Sensor	Number of choice	Developer
Eutrophication	1	John Cleary
Microplastics	2	Fabio Confalonieri Jose Saez
Heavy metals	1	Martí Gich
Underwater noise	2	Mike Challis Zygmunt Klusek
Innovative piro and piezo resistive polymeric temperature	1	Concepció Rovira

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and pressure sensor		
Nanosensors for autonomous pH and pCO_2 measurements	0	none

So Underwater noise and Microplastics have two questionnaires compiled each while no one for Nanosensors for autonomous pH and pCO_2 measurements.

Summarising the answers, two developers propose sensors for underwater noise. One of them can be only used near the surface (0-5 m) and can be deployed in quiet moorings. It offers the possibility to receive in real time only short packets of data or a summary of them and the rest can be downloaded at the end of the cruise. Data type produced, which must be processed, describes sound pressure over time (voltage vs time). The frequency is up to 192 kHz.
The other one can be installed on a hydroacoustic buoy deployed at depths down to 100 m and has an autonomy of up to 1 month. It can be put at sea only with a ship crane but it's not so easy to recover it with rough sea states (wind over 4 Beaufort). Data is stored in the SD memories but it's possible also to install a WIFI channel and download all the data at the end of the cruise. Data types are acoustic pressure time series (frequency depends on the hydrophones installed, usually they sample at 30kHz in each of the four channels) and they must be processed.

Then two developers describe sensors for microplastics. One of them designed a sampling system based on Niskin bottles associated with the microplastics analyser. It can be deployed down to a max of 100 m. The sampling system is completed with pressure, conductivity, salinity, temperature, pH, O2, CHL-a and turbidity sensors. The system doesn't need any particular platform for installation. The data acquired can be stored by the water sampling system in the internal memory or transmitted. The other sensor includes a 10 channel optical transducer, an electronic control board and a sampling system based on Niskin bottles. Installation methodology still needs to be defined but some potential difficulties are foreseen because, in some cases, optical transducers could be installed directly on platforms or vessels shells, avoiding the need for a specific sampling system. Spectral imaging and FT-NIR require significant processing capabilities. Due to this fact and to the sensor complexity, a dedicated control board will be developed. Then required memory and data formatting can be included in this board. The suggested platforms are research vessels, buoys, underwater moorings and ocean racing yachts. The data produced is surface microplastic concentrations in mg/litre. The frequency of measurement is up to 192 kHz. Summary data can be transferred in real time while the raw data can be collected at the end of the "cruise" or transmitted on a programmed duty cycle. They have both to be processed after acquisition.

The proposed innovative piro and piezo resistive polymeric temperature and pressure sensors do not need any maintenance since they will be inside a small container and the material is stable for years. Periodically, it must be calibrated to assure that the entire device, including the sensing material, is properly working.
Measurements are directly performed by immersion into the water. It can be installed in any platform. Data can be stored in USB memory or transmitted by telemetry. The output of one raw data consists of two/four columns of ASCII data containing values of time/data and resistance/temperature (if the calibration of R(T) will be included in the device processing before acquisition). The measurements can be continuous or planned for a specific period of time. The transfer to the data centre could be made in real time by satellite or internet or at the end of the cruise. Data, after calibration, doesn't need to be processed.

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The measurements of heavy metals will be performed on surface waters that have to be delivered to the measuring setup after filtering. The needed volume is very small (well below 1 ml). The power consumption of potentiostat and pumps for microfluidic is estimated to be below 1-2 W. The sensors do not need maintenance since are single use and an array of them will be available for different measurements. The fluidic system might need maintenance against fouling.
Data can be stored in USB memory or transmitted by internet after measurement.
This sensor needs several containers: A) two liquid reservoirs with two types of buffer solutions (typically below 1 L each) for conditioning the sample at the pH needed for the analysis of the different heavy metals; B) eventually, three containers with standard solutions of different concentrations for each the heavy metals under study, of typically 20 ml each, if the standard addition method is used (i.e. 3X5=15 containers of 20 ml); C) an additional container to collect the residual liquids containing heavy metals. It can be installed on research vessels (as they have a wet laboratory). About the data produced (the frequency of acquisition is about 20 minutes), the output of one raw measurement consists of two columns of ASCII data containing values of Current Intensity and Voltage. The temperature of the measured liquid and the measurement date should also be included in the file (less than 20 kb altogether). In case of using the standard addition method, each measurement would additionally generate three more of these files. Data can be transferred in real time via internet or at the end of the cruise when they must be processed.

The last sensor described is that for eutrophication to be used in surface waters (0-3 m depth). The targeted maintenance interval is 1 month – implying that the storage capacity of reagent, calibration and waste storage containers will be sufficient for this period. The maintenance-free interval can vary depending on sampling frequency. Sensors operate using battery power, which may need to be supplemented by energy harvesting, e.g. using solar panels on buoys. The target for battery lifetime without energy harvesting is around 1 month. Data can be stored by flash memory chips or removable memory (e.g. SD cards). Data storage is required on the platform regardless of deployment scenario to provide data redundancy; e.g. in the event of communications failure. Possible means of data transmission include satellite, GSM, Wifi/Wimax, short range transmission such as ZigBee, BlueTooth, or via directional antennae in function of the deployment location. The data transmission mode is determined by the deployment location and the local transmission coverage Possible platforms for deployment of the sensors include research vessels, buoys, underwater moorings, ocean racing yachts, fishing vessels or other vessels of opportunity. Selection of the most appropriate platforms requires further information on the platforms characteristics as well as relevant features of the sensors and platform which must be determined yet. The primary output data is nutrient concentrations. The raw data is transmitted in the form of a series of light intensity readings. Each measurement also includes a temperature reading and a date stamp. Data storage capacity is determined by the selected mode of storage – e.g. 16 Gb for SD card, megabyte range for flash memory chips. Due to the small size of data generated for each individual measurement, this is not expected to represent a significant limitation.
Data logging can be used if sensors are to be deployed in scenarios where none of the possible transmission modes are available. Raw data is transmitted in the form of a series of light intensity readings and need to be initially converted to absorption values, and then to concentration values.
The final data to be stored and displayed is in the form of nutrient concentrations.
Raw data also provides additional information on sensor performance and allows cross-referencing with data stored on board the sensor (e.g. allowing reliability of transmitted data to be validated).
The data management system should also allow for additional features such as:

- event detection;

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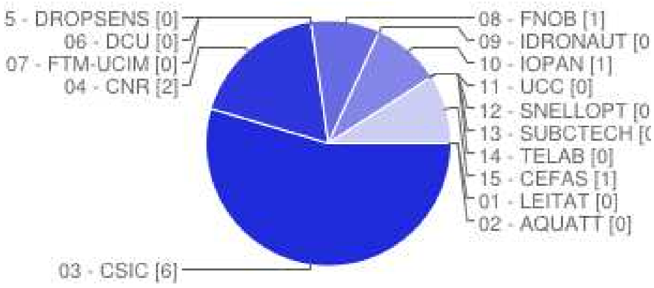
- event classification (identification of false positives/negatives);
- data smoothing (for display purposes).

Outside the questionnaire, FTM in Skopje sent a report describing three sensors, two for oil spill and one for heavy metals, developed in the framework of the EU project HydroNet[2]. For this reason they are not included in the list of compilers for Developers. FTM will also develop a nanosensor for pH and pCO_2 measurements that will be available during project time.
Their descriptions can be found in Annex 1 of this report with the platforms used to test some of them.

4.2 Sensor testers

About the Questionnaire for Sensor Testers in the below table and figure the eleven answering partners are shown.



Organisation	Number of answers
01 - LEITAT	0
02 - AQUATT	0
03 - CSIC	6
04 - CNR	2
05 - DROPSENS	0
06 - DCU	0
07 - FTM-UCIM	0
08 - FNOB	1
09 - IDRONAUT	0
10 - IOPAN	1
11 - UCC	0
12 - SNELLOPTICS	0
13 - SUBCTECH	0
14 - TELAB	0
15 - CEFAS	1

In the figure above the name of the partner with its number in the project and the number of questionnaires compiled in square brackets are visible.
This data is tabulated on the right.
So CSIC, partner number 3, has for example compiled six questionnaires.

Here below the name of the compiler is shown:

Name	Organisation	Email
Mike Challis	CEFAS	mike.challiss@cefas.co.uk
Katrin Schroeder	CNR	katrin.schroeder@ismar.cnr.it
Javier Villalonga	FNOB	jvilallonga@fnob.org
Jordi Salat	CSIC	salat@icm.csic.es
Marcin Wichorowski	IOPAN	wichor@iopan.pl

In the figure below the platform selected with the number of questionnaires compiled on it and again in the following table.

[2] http://cordis.europa.eu/result/report/rcn/46112_en.html

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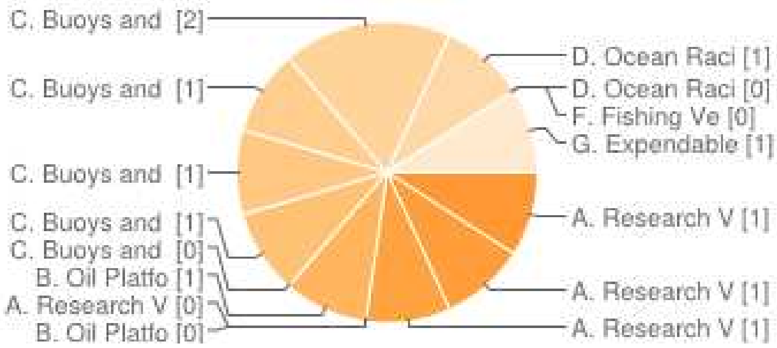

In the previous paragraph three developers proposed the Research Vessels from each possible partner to test their sensors. CNR gave the availability of its RV Urania for all sensors whose number is obviously strongly dependent on their size and characteristics, as they should be mounted on the frame of the CTD/rosette system or downflow of the on-board seawater pump. The sensor for microplastics is proposed to be tested on nets but it must have autonomous power. The maintenance of sensors is daily when on board. The availability in terms of time for RV Urania is in 2014, if not modified, a 15-days long cruise available in November/early December 2014. The cruise calendar for 2015 will be known in December 2014/January 2015 after the request in July 2014, and approximately two cruises, 15-days long each will be available.

On the RV SARMIENTO DE GAMBOA – SdG of CSIC the following sensors can be tested:

Platform	**Number of choice**	**Tester**
A. Research Vessel - URANIA (CNR)	1	Katrin Schroeder
A. Research Vessel - OCEANIA (IOPAN)	1	Marcin Wichorowski
A. Research Vessel - SARMIENTO DE GAMBOA – SdG (CSIC)	1	Jordi Salat
B. Oil Platform on the Southern Baltic (IOPAN)	0	none
B. Oil Platform - Other	1	Jordi Salat
C. Buoys and Submerged Mooring - Oceanographic buoy in Gdansk Bay (IOPAN)	0	none
C. Buoys and Submerged Mooring - Oceanographic submerged moorings in the Mediterranean (CNR)	1	Katrin Schroeder
C. Buoys and Submerged Mooring - Deep moorings at the continental slope and canyons of the NW Med (ICM-CSIC)	1	Jordi Salat
C. Buoys and Submerged Mooring - Smartbuoys (CEFAS)	1	Mike Challiss
C. Buoys and Submerged Mooring - Other	2	Jordi Salat
D. Ocean Racing Yacht - IMOCA Open 60 boats (FNOB)	1	Javier Vilallonga
F. Fishing Vessels	0	none
G. Expendable ocean instruments, manned vessels and further available platforms	1	Jordi Salat

Eutrophication, Microplastics, Heavy Metals, Underwater Noise, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO_2

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measurements. Then all kind of sensors can be tested but actually it is not possible to know if all can be tested at the same time as the calendars of cruises is not yet available.

The RV OCEANIA of IOPAN is available to test the sensors for Microplastics, Heavy Metals, Underwater Noise, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO_2 measurements. In the questionnaire it was not specified how many sensors of each type can be used at the same time. Once mounted the maintenance can be daily. The power supply is 230V (cable line - 1 wire + shield; cable line - 7 wires + shield). The calendar is available at http://www.iopan.pl/oceania.html. About the oceanographic buoy in Gdansk Bay, it was not included in any questionnaire because, due to recent mechanical failures, at the moment it is not available for testing but it will be inserted in the list of platforms possibly in the future.

CSIC suggests the use of the oil platform Casablanca (western Mediterranean) but despite preliminary contacts, it is not available yet. The sensors, that could be mounted, are of Eutrophication, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO_2 measurements.

CEFAS for Smartbuoys specifies that Gliders or USVs are more likely to be used for trials to reduce the likelihood of background noise and on it only one sensor can be mounted for Underwater Noise.

On the three CNR underwater moorings in the Mediterranean, all sensors can be mounted but their number at the same time strongly depends on their dimension and weight. The length of the moorings is about 250 m (not extendable), with a bottom at about 450 m depth; so any suitable depth can be chosen. There are three mooring lines available (two in the Sicily Strait and one in the Corsica Channel). There are other instruments on the mooring lines, whose position cannot change. Due to strong currents, tested sensors should not be too heavy and big. Each mooring is planned to be recovered and redeployed every six months, during an oceanographic cruise and usually in spring and autumn.

CSIC’s deep moorings at the continental slope and canyons of the NW Mediterranean can be used for the installation of Heavy Metals, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO_2 measurements. Several sensors can be mounted at the same time if they provide enough power in batteries.
Moorings maintenance is once a year or lower. Moorings must be adapted to sensors and batteries (acoustic releases, weight, wire, buoyancy, etc.).

Then CSIC suggests the Aqualog undulating mooring even if at this moment it is not ready for use. On this platform, several sensors could be installed like Eutrophication, Heavy Metals, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO_2 measurements, with a monthly maintenance.
CSIC also proposes the OBSEA Underwater observatory (for which preliminary contacts have been made). For this platform the sensors that can be installed are the same as for Aqualog but here the advantage is that this is an autonomous platform wire connected to a laboratory.

FNOB offers the Ocean Racing Yacht - IMOCA Open with 60 boats to install sensors for the study of Microplastics. As they are racing boats, the installation depends on the sensors size and needs.

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CSIC finally offers expendable ocean instruments, manned vessels and further available platforms as drifting buoys for sensors of Eutrophication, Microplastics, Heavy Metals, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO_2 measurements. All sensors can be installed if they provide enough battery power.

4.3 Further available platforms for testing

Outside the questionnaire, several partners sent their propositions on available platforms through short reports described here below.
IOPAN sent the description of two further possible platforms to be used to test sensors: an oil platform in the Baltic Sea and a motorboat in the Gulf of Gdańsk.

The oil platform named Baltic Beta “B3”.is located in the Southern Baltic Sea at Lat. 55° 28.9’ N and Lon. 018° 11.0’ E (see Figure below.)
The system has the capacity for providing power and data channels for the following additional sensors:

- microplastics;
- heavy metals;
- underwater noise;
- piro and piezo resistive polymeric temperature and pressure sensors.

IOPAN maintains the above-water set of radiometers and meteo sensors (Ramses radiometers TRiOS GmbH, Pyranometr CMP6, Pyrgometr CGR3, camera AirLive) and the data integrator mounted in the vicinity of heli deck. The data and power cable connects the integrator with the main PC located in one of the platform’s labs. The system is controlled remotely and data is transmitted via a dedicated leased internet link over GSM.
Frequency of platform maintenance is ~2 months, subject of 1 month notice. Transport is provided by vessel or helicopter.
As the current agreement with the platform owner, LOTOS PETROBALTIC S.A., allows for above-water sensors, the in-water deployment of sensors is conditioned by necessary amendment with clarified and met industrial safety standards.

The position of the Baltic Beta “B3”.buoy in the Baltic Sea

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The motorboat, owned by IOPAN, is named SONDA2 and is located in the Gulf of Gdańsk. Its dimensions are 10.5 m x 3.5m x 1.2m with a draft of 1.0 m and a displacement of 4.7 T.
Its power and speed are respectively of 232 kW and 25 kts with the capacity of 8 persons on board. Its use is limited for weather conditions of wind up to 6B and sea up to 4B and for works limited up to 20 Nm from the shore with an endurance up to 200 Nm.
It is possible to install the same further sensors as on the oil platform Baltic Beta “B3”, with more those for:

- eutrophication;
- nanosensors for autonomous pH and pCO_2 measurements.

The research capacity of the motorboat are a desk area, a working deck, a A-frame up to 250 kg, an electric winch with 150 m steel cable, 230 V and a navigation gear.
The motorboat is available in from February/March to October/November on a very short notice request. Possible area of operation can be the Gulf of Gdańsk, coastal areas, port waters, river outlet that makes possible to test the sensors in a wide range of conditions (clean/heavily polluted, fresh/saline waters).

4.4 Stakeholders involved (including cooperation issues)

Within the activities of WP1, a questionnaire has been prepared by the CNR which is addressed to the observational systems functioning in operational or pre-operational mode in the European seas. It aims to gather all the information on the technical characteristics (location, type of sensors installed, maintenance, etc.) and the acquired data (size, time of acquisition and transmission, type of use, etc.) of the system to be described.

The stakeholder involvement and cooperation is being sought through the submission of this questionnaire to the public administrations, national and local bodies, environmental agencies, fishers, etc. The questionnaire is already produced in English and Italian and is expected to be translated in other languages (e.g. Spanish, Polish). For instance, in Italy respondents included the Italian Agency for Environmental Research and several local environmental agencies which provide valuable information regarding available instrumentation and platforms used for the sea monitoring. This will be detailed and integrated with respondents from other countries within WP1 activities.

All stakeholders as such identified will be contacted in order to close a coordinated agenda for the field testing phase for each of the platforms relevant to WP9 activities. This will also enable better cooperation between key sectors by ensuring effective management and transfer of this new knowledge and technology, resulting in efficient uptake of results by stakeholders and end-users as part of WP10 activities.

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5 CONCLUSIONS

Partners have provided information on eleven platforms by the filled questionnaires plus two more from IOPAN (motorboat and a buoy) outside the questionnaire for testers. Not all the platforms are still available and for some of them there are only preliminary contacts (ex. for Aqualog, OBSEA Underwater observatory, or Oceanographic buoy in Gdansk Bay by IOPAN that is not currently available).

The seven developers have provided information on sensors (two for underwater noise – CEFAS and IOPAN; two for microplastic – IDRONAUT and LEITAT; one for an innovative piro and piezo resistive polymeric temperature and pressure – CSIC; one for heavy metal – CSIC; one for eutrophication sensor – DCU).

Once the characteristics of the platforms and the sensors have been analysed we try to associate them for subsequent testing.

The eutrophication sensor, proposed by DCU, will be designed for deployment in surface waters (0-3 meters depth) and it can be installed on research vessels (as Urania - CNR, Oceania - IOPAN, Sarmiento de Gamboa – CSIC), on buoys and submerged moorings in Gdansk Bay (IOPAN), in the Mediterranean (CNR) and on ocean racing yachts, fishing vessel or other VOS. Selection of the most appropriate platforms will require further information on their characteristics, as well as relevant features of the sensors which are not yet clearly known.

Microplastic sensor proposed by IDRONAUT is a sampling system based on Niskin bottles, associated with the micro-plastics analyser. There is no preference on the platform for the installation, however due to the weight when the Niskin bottles are full of water, a small winch should be available. Due to this the choice should be on research vessels and on the ocean racing yachts (FNOB). LEITAT, for its microplastic sensor constituted by a system based on Niskin bottles with specific interfaces to couple with the sensor, can be installed on any research vessel as the previous one and furthermore on buoys and submerged moorings that accept this type of sensor (like CNR moorings) and on ocean racing yachts (FNOB).

The heavy metal sensor can be hosted by research vessels with a wet laboratory (probably all available) but no information is provided at the moment on the method.

In order to measure underwater noise in the first 5 meters of water CEFAS proposed a sensor that can be deployed using a low noise method e.g. quiet surface moorings, or platforms moving at maximum 4 knots. So they suggested smartbuoy systems (like gliders or other USVs) and drifters. The other underwater noise sensor, proposed by IOPAN, deploying at depths up 100 meters, is suggested to be installed on research vessels Urania (CNR) and Oceania (IOPAN).

Then the innovative piro and piezo resistive polymeric temperature and pressure sensors presented by CSIC can be installed on any platform but only ocean racing yachts (FNOB) are not available to test them.

Finally about the five sensors proposed by FTM, the best platform should be a similar system as that described as the catamaran (see Annex 1), at least for those for oil-spill and microplastics. Other similar solutions can be found like on buoys or vessels provided with winches (research vessels or ocean racing yachts (FNOB). This will be decided during the next meetings.

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While reading these conclusions we must keep in mind that not all the information on sensor characteristics are yet available as the project started just six months ago and details may be subject to change.
Some important characteristics have to be considered such as maintenance, energy autonomy, data transfer/storage and dimension of the sensors that sometimes are actually missing.

In the following table the above information on the corresponding sensor/platform are summarized:

SENSORSAvailable PLATFORMS available	Eutrophication (DCU)	Microplastics (IDRONAUT)	Microplastics (LEITAT)	Heavy metals (CSIC)	Heavy metals (FTM)	Underwater noise (CEFAS)	Underwater noise (IOPAN)	Innovative piro and piezo resistive polymeric temperature and pressure sensors (CSIC)	Oil spill sensors (FTM)
RV URANIA (CNR)	X	X	X	X	?		X	X	?
RV SARMIENTO DE GAMBOA (CSIC)	X	X	X	X	?			X	?
RV OCEANIA (IOPAN)	X	X	X	X	?		X	X	?
Motorboat (IOPAN)	?	?	?	?	?	?	?	?	?
Oil Platform (CSIC)					?			X	?
Oil Platform in Gdansk Bay (IOPAN)	?	?	?	?	?	?	?	?	?
B&SM – Smartbuoys (CEFAS)					?	X			?
B&SM – Oceanografic Submerged Moorings in the Mediterranean (CNR)	X		X		?			X	?
B&SM – ICM – CSIC deep moorings at the continental slope and canyons of the NW Mediterranenan					?			X	?
B&SM – Aqualog (NOT READY)					?			X	?
B&SM – OBSEA Underwater observatory (PRELIMINARY CONTACTS)					?			X	?
Ocean Racing Yacht – IMOCA Open 60 boats (FNOB)	X	X	X		?				?
Expendable ocean instruments, manned vessel and further available platform – Drifting Buoys (ICM-CSIC)	X				?	X		X	?

Table 1- information on the corresponding sensor/platform. RV stands for Research Vessel and B&SM for Buoys and Submerged Moorings.

Further updates of this report are therefore necessary in order to individuate the most suitable platforms to test each kind of sensor. This also includes the involvement of stakeholders whose activity is realized in strict collaboration with WP1.

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7 ACRONYMS

RV	Research Vessel
B&SM	Buoys and Submerged Moorings

APPENDICES/ANNEXES

Annex 1 - FTM report on three developed sensors (two for oil spill and one for heavy metals)
Annex 2 - Questionnaire for Sensor Developers
Annex 3 - Questionnaire for Sensor Testers

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ANNEX 1

FTM REPORT ON THREE DEVELOPED SENSORS (TWO FOR OIL SPILL AND ONE FOR HEAVY METALS)

<u>Review on Procedures of sensor deployment methodology on physical supports/Platforms</u>

Generally, most of the known and already established platforms for the monitoring of the water bodies are composed of the following objects and systems:

- floating and sensorised robots;
- buoys;
- a wireless infrastructure to guarantee a robust communication among the different system components;
- ambient Intelligence core managing all the system operations;
- a Control Station from where a remote operator can supervise and decide the system operations;
- a Docking Station where the robots are recharged and maintained.

Usually, the sensors are embedded into fixed stations (like buoys in fig. A1) and mobile robots, able to be navigated in a network configuration in diverse water scenarios, from coastal sea waters to some distance from the land, as well as in creeks and rivers, and in natural and artificial lakes and lagoons.

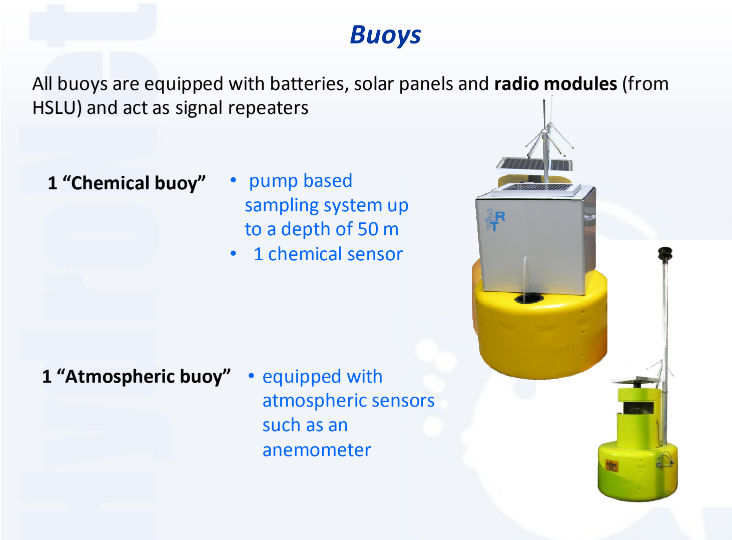

Fig. A1. Buoys as a sensor station

The robots are able to be navigated in the sea waters. The fixed buoys cooperate with the mobile robots, running as a node of the network to facilitate the communication and localization among the robots, to supply energy to the robots when required, and to monitor a wide range of parameters by means of the micro-fabricated sensors developed and used in the project.

The robots and sensors are a part of an Ambient Intelligence (AmI) platform, which integrates not only sensors and tools for monitoring the environment and robot tasks execution, but also communications backhaul systems, databases technologies, knowledge discovery in databases (KDD) processes for extracting and increasing knowledge on water bodies' management. Following the

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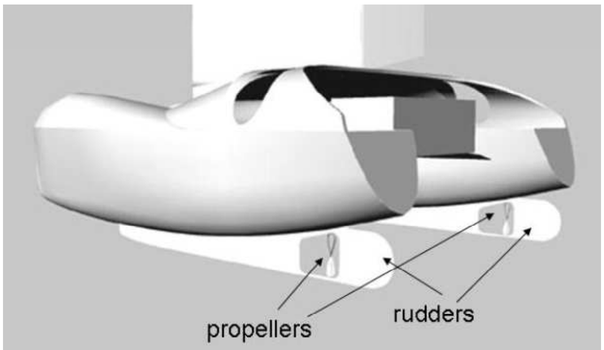
computation on stored data, feedback is sent back to human actors (supervisors, decision makers, industrial people, etc.) and/or artificial actuators, in order to perform actions.

EU project HydroNet has developed and tested a new technological platform for improving the mercury monitoring of coastal water bodies. For this reason two kinds of robots were under development: one for coastal waters (with hybrid electric-sail propulsion, fully equipped) and the second one for rivers and lagoons with low depth water (hydrosliding robot with an aeronautical propeller outside of the water to avoid the robot from getting stuck in seaweed or sand banks).

Robots for coastal waters

The coastal water robot is a carbon-fiber catamaran with length of 1991 mm and width of 1164 mm, shown on Figure A2.

The robot has a sampling system (a probe lowered by a winch) to sample waters up to 50 meters of depth. To increase the endurance, they use a hybrid locomotion approach: electric propulsion using two propellers and a sail to be used to spare energy when the robot moves downwind. The robot had to move in an area with an order of magnitude of 30 km^2 and had to be able to performe missions of 10-12 hrs.
The main components constituting the robot are listed below:



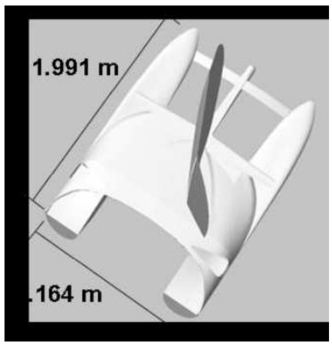


Fig. A2. Images of the robot with characteristic dimensions

a) Supervisor: it is the main processor managing all the robot operations. Furthermore, through a radio module, it is able to communicate with the Ambient Intelligence core to receive command and to send information;

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b) Obstacle Avoidance Module: it is an electronic board receiving the data from the range sensors and running obstacle avoidance algorithms. The range sensors present on the robot to avoid static and dynamic obstacles are:
- a laser scanner, to avoid obstacles above the water surface;
- a sonar, to avoid obstacles under the water surface.

c) Localization System: it is composed of different sensors (a compass, a GPS, a velocity sensor) to estimate robot speed and position;
d) Sampling System + Sampling Control: the sampling system is constituted by a probe lowered by a winch. The collected water is then routed to the appropriate sensors to detect the compound of interest;
e) Four slots for chemical sensors;
f) PMU (Power Management Unit) + Battery Pack: they manage the robot energy. The use of solar panels to harvest energy will be also investigated;
g) Two propellers + Rudder: they represent the robot locomotion system;
h) Anemometer, Sail Actuator and Sail Driver Electronics: on the base of the measured wind, the robot can control the boom to use the sail for the navigation and, consequently, to save electric energy.
Advantages of the Hydro Net platform were:
- “Sensor” motion capability;
- High flexibility, self-organizing and dynamic reconfiguration capability of the system;
- High scalability of the platform;
- High configurability and scalability of the AmI software platform.

The sampling system of the robots can consists of five samplers (200 ml each) that allow collection of five water samples at different depths (-10m,-20m,-30m,-40m,-50m). The samplers were arranged around a physical sensor probe. The system is driven by a winch on the deck of the robot that allows it to be lowered and to rise it at different depths. A side view of the sampling system used in the Hydro Net project is presented in Figure A3.

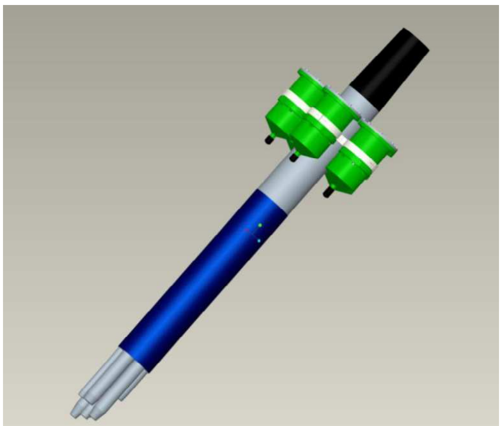
Fig. A3. Sampling system

The sampler was divided into two parts:
- the lower parts, that is the wet volume in which the water is collected, and
- the upper part, where the mechanical and electrical components are located.

The particularity of the sampler was that the water sampler is not contaminated during the sampling: in fact, the wet volume was completely made of TEFLON™.

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Once collected, the water is transferred to the sensors by means of a fluidic system: for this purpose, a special device has been designed that allows connection of the sampling system to the fluidic system and thus to the sensors.
The hooking between the Sampling system and the Fluidic system was achieved by means of a special component called a “spider” shown in Fig. A4. The spider was fixed to the robot deck: when the probe is lifted by the winch, the spider takes and orientates it so that the connection between the syringes and fluidic system inlets is obtained automatically. When the approaching maneuver is finished, the samplers flush the water that, through the red pipes which are a part of the fluidic system, reaches the sensors.

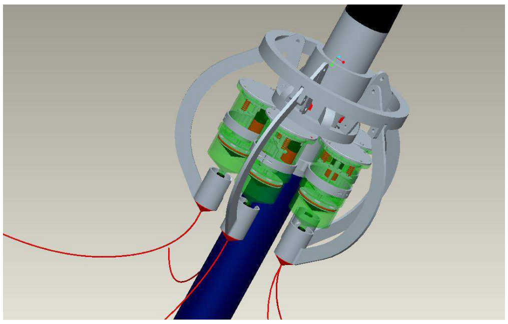

Fig. A4. The spider connection between the Sampling System and the Fluidic System

Integration of Sensor for Total Tetroleum Hydrocarbons into the Platform

The sensors for oil pollution control were developed including two different types of optical sensors integrated into the HydroNet platform. An oil slick detector “CRAB” was based on remote sensing technology, which enables continuous monitoring of the water surface (Fig. A5 and Fig. A6).

Fig. A5. LUMEX oil-slick sensor (located on the bow of the robot)

The original optical scheme and data processing method reduce significantly any influence of waves and ripples and solar background illumination and allow detection of very thin oil films on water surface with a thickness less than 0.5 µm. This sensor was an “Yes-No” real-time indicator of the presence of oil films on the water surface.
Another sensor that was developed had to measure the concentration of petroleum hydrocarbons dissolved in water. The “AE-2 mini” sensor was based on a highly sensitive luminescent analysis. High

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selectivity was achieved by using original membrane extraction technology. Combination of low detection limit and high selectivity enables the monitoring of dissolved petroleum hydrocarbons

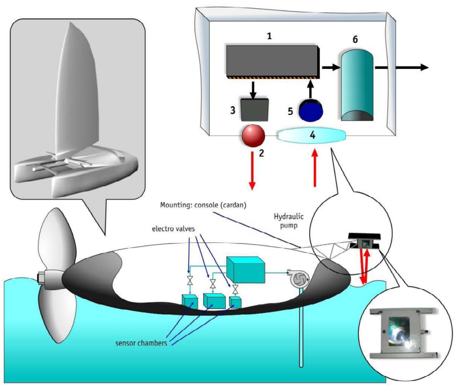

Fig. A6. General block diagram of the CRAB sensor

starting with background values. The main goal of the project was adopting such technology to a floating system with strict requirements of size and power consumption by creation of a new miniaturized extraction module and optical sensor. Target specification of the "AE-2 mini" on-line oil in water sensor are specified in Table A1.

Table A1. Target specification of the "AE-2 min" online oil in water sensor

Parameter	**Specification**
Range	0.05 – 10 mg/l
Measurements per hour	2
Water consumption per 1 point	500 - 1000 ml
Hexane consumption per 1 point	1.0 ml
Sampling time	2 – 4 min
Operational time	20 – 40 days
Calibration	every 30-40 days
Communication ports:	RS485, RS232, current loop 4-20 mA
Ambient temperature	0 to +50 OC
Power supply	dc 12 V
Power consumption, aver./ max	2 / 10 W
Dimensions of sensor	170 x 170 x 210 mm
Weight, total	5 kg

Integration of Sensor for Heavy Metals into the Platform

Electrochemistry is an inherently sensitive method that is capable of detecting a variety of inorganic and organic species at the ppb level. Electrochemistry is particularly advantageous for detecting dissolved metal species, such as Hg(II), Cd(II) and Cr(VI). Electrochemistry has been widely used for determining these and other metals in different aquatic environments. Due to the fact that the detection is carried out at the electrode surface, miniaturization of the electrochemical sensors is straightforward. Moreover, decreasing the size of these sensors enhances the mass transport of the detected species making the measurement faster.

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The sensor for the heavy metals was designed to be part of a flow system as is shown in Figure A7. The heart of the sensors was a solid electrode that was modified by a specific layer to introduce selectivity towards the specific analyte, e.g. Cd2+. The solution should flow across the electrochemical cell while a potential will be applied to the electrode and reduce and accumulate the metals on the electrode surface. This would be followed by a fast stripping pulse, which will oxidize the metals and allows their quantitative determination.

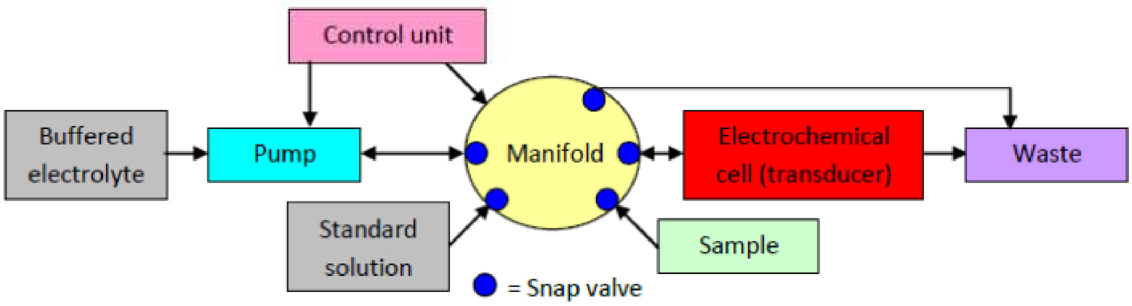

Fig. A7. Schematics of the electrochemical sensors

The specifications of the sensors have been determined in the course of the project and are tabulated in Table A2. The operation range of the sensors will be:
Mercury 1-500 ng/l
Cadmium 5-4000 ng/l
Chrome 0.3-10 mg/l

Table A2. Specifications of the electrochemical sensors for heavy metals

	Cr (VI) (electrochemical)	Cd (II) (electrochemical)	Hg (II) (electrochemical)
Power consumption (W)	<5	<5	<5
Power supply (V)	12	12	12
Weight (kg)	<3	<3	<3
Sampling water (l)	10 ml	10 ml	10 ml
Measurement time	30 min	30 min	30 min
Sensor maintenance	1 week	1 week	1 week
Detection limit	1 ug/l	50 ng/l	10 ng/l
Accuracy	± 20 %	± 20 %	± 20 %
Volume	<4 l	<4 l	<4 l
Waste production (for measurement)	10-50 ml	10-50 ml	10-50 ml
Calibration period (Manual)	every day	every day	every day
Output signal	RS232/CAN bus	RS232/CAN bus	RS232/CAN bus

The characteristics of the nanosensor for pH and pCO_2 measurements follows.

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CHARACTERISTICS of Nanosensor for pH and pCO_2 measurements

Sensor component: Graphene (or MWCNT)/PANI = 1 : 2

PERFORMANCE

- Measurement Range 2-12 pH
- Initial Accuracy 0.01 (estimated) 1
- Typical Stability 0.005/month (estimated) 1
- Calibration spectrophotometric determination of pH referenced to certified TRIS buffer

ELECTRICAL CHARACTERISTICS

Internal Memory	2 GB	
Internal Batteries	10.5 v 19.8 Ah	
Power:	6 - 18 VDC	External supply supersedes
20 mA	operating internal battery if external	
10 mA	Standby voltage is higher	

PHYSICAL CHARACTERISTICS

Weight	4.1 kg in air
	0.1 kg in water
Maximum Depth	70 meters
Temperature Range	0 to 50 deg C
Salinity Range	20 to 40 PSU (external reference)

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COMMON SENSE

MARINE SENSORS - MARINE MONITORING

ANNEX 2

QUESTIONNAIRE FOR SENSOR DEVELOPERS

The COMMON SENSE project has received funding from the European Union's Seventh Framework Program (Ocean 2013-2) under the grant agreement no 614155.

Timestamp	Your name	Your email	Your Organisation	Select sensor type	Please describe sensor technical characteristics (depth, maintenance, power, etc.) that can be useful to understand the best platform for the installation.	Installation methodology and difficulties	Adequacy of Sensors: sensor operability, optimization, transmission of data specificities.	Special needs?	Stakeholders involved?	Suggestions on platform (see above between A. and G.)	What type of data will your sensor produce?	What is the frequency of measurements of your sensor	Can you be more specific (e.g., measurement every 15 to 30 min)	What limitations are there on the volume of data that can be collected and transmitted by the core logging system (size of data packages, frequency of transmissions)?	How do you think the sensor data will be transferred to the data centre? (e.g., real time, at the end of the cruise) and using what technology (satellite, internet, etc.)?	Do your sensor data need to be processed after acquisition? If so, what are the final parameters (data) that will be stored in the COMMON SENSE central database?	What are the requirements in terms of delivering and managing your sensor data?
2/21/2014 1.48.43	Mike Challiss	mike.challiss@cefas.co.uk	15 - CEFAS	Underwater noise	Depth 0-5m Maintenance - unknown at present, likely to be dictated by power consumption, which is also unknown at this stage	To be deployed / installed using a low noise method e.g. quiet moorings, movement through the water limited to 4knots (maximum) Periodic biofouling	Short packets of data or summary data are all that can be sensibly transmitted. Most initial data analysis will need to be done within the unit allowing this summary to be provided to the central logger for transmission. This communication platform needs to have an intelligent interface, in the event connection is lost it allows the data packets to recommnece from where the link is dropped rather than restarting from the beginning. All appropriate raw data will be saved to hard drive locally for shore based download and anaysis, the summary data being used to index the events of interest		Cefas Dropsense (central collection of data and transmission) ICM-CSIC (drifting buoys, Lagrange)	C. Smartbuoy systems (via gliders or other USVs) E. Drifting Buoys - maybe	Voltage vs time describing sound pressure over time, eg WAV file	up to 192kHz		See above	Summary data in real time, raw data at the end of the "cruise" or deployment on a programmed duty cycle	Yes. Raw sound files and processed sound files, sound pressure and frequency over time	
2/27/2014 23.21.47	Fabio Confalonieri	confalonieri@idronaut.it	09 - IDRONAUT	Microplastics	Sampling system based on niskin bottles, associated with the micro-plastics analyser. Details of the system has not been discussed with the LEITAT and SNELLOPTICS partners. Preliminary information from the project foresees that the sampling system can be deployed downto max 100m. The system power will be 12VDC about 500mA when running, negligible when in stand-by between measurements. The sampling system will be completed with traditional sensor to measure: pressure, conductivity, Salinity, temperature, pH, O2, CHL-a and turbidity. There is no preference on the Platform for the installation, however due to the weight when the niskin bottles are full of water the best is to have a small winch.	The water sampler can be deployed using a rope, coax. cable or multiconductor cable. The difficoulty is the weight when the niskin bottles are full of water.	The Water sampling system can store acquired data and bottle status in the internal memory or transmitt them by means of rs232/rs485 or telemetry interface.				The parameters will be: Pressure, temperature, conductivity, salinity, pH, Dissolved Oxygen, Turbidity and Chlorophyll-a, and data and time of acquisition. All parameter are numbers.	Every few seconds		Not jet defined	Not jet defined	No, data will be in Engineering format.	Deliver sensor information and observations on the web, Allow advanced users to remotely plan sensor tasks (e.g., schedule measurements, etc.)
2/28/2014 3.06.24	Concepció Rovira	cun@icmab.es	03 - CSIC	Innovative piro and piezo resistive polymeric temperature and pressure sensors	The sensor, concerning the material, can be installed in any platform. It is too early to determine the best platform since we should develop with other partners the sensor device. The sensors do not need maintenance since will be inside a small container and the material is stable for years. Only time by time it will be necessary to realize again the calibration in order to be sure that the entire device in which the sensing material is included is properly working. The measurements will be performed directly by immersion on water. The power needed for the measurement is very low: (1-5 micro W, R(RT) = 10-20 kOhms for a sensing área of aprox. 2x3 mm2 with a resolution about 0.001 degrees).	It will depend on the device prepared. It is difficult to be more specific at this stage, but in general it will be as any thermometer with resistance change as output.	Data can be stored in USB memory or transmitted by telemetry.	Fabrication appropriate holders with containers for the temperature sensors.	Depending on the zone where field tests are performed, the local Environmental Authorities, ships of opportunity, environmental agencies, NGO...	In any platform	The output of one raw measurement consists of two/four columns of ASCII data containing values of time/data and resistance/temperature (if the calibration of R(T) will be included in the device processing before acquisition).	Can be continuous or programmed for a specific period of time		No loimitations	It could be made in real time via satellite or internet or at the end of the cruise	No, if the calibration of R(T) will be included in the acquisition package.The raw data is the resistance vs time (the intensity - around 10-50 A - should be stable in time).	Deliver sensor information and observations on the web, Allow users to subscribe to sensor alerts and notifications

2/28/2014 5.12.57	Zygmunt Klusek	klusek@iopan.gda.pl	10 - IOPAN	Underwater noise	Autonomic Hydroacoustic Buoy, deploying depth up 100 m, four hydrophones, sampling frequency 30 kHz in each channel, autonomy up to 1 month, storage 2 micro-SD 64 GB weight ~160 kg, Looking up echosounder - 119 kHz, compass and inclinometer	From ship crane, no difficulties with deploying, problems with fishing out of the buoy when sea state > 4 B	Possible WI-Fi channel, data usually stored on SD cards	ship crane with the suspension arm > 6 m, lifting capacity >5000 N	(Ecology organisations, universities, meteo observations, marine mammal hearing groups)	URANIA (CNR), OCEANIA	Acoustic pressure time series, in frequency range from 5/100 Hz (depending on the hydrophone type - used Reson TC 4032/4033) up to 12 kHz. Bubble entrainment depth when using looking up echosounder Buoy orientation in space	4*30 kSamples/sec	every 1-3 sec	Size of data packages - depending on the time serise usually in one second package noise, also echo profile and position in space (compass+inclinometer)	At the end of the cruise, WI-Fi channel possible	Data must be processed. Final parameters are: Noise spectrum level, statistics of momentary values acoustic pressure of the noise. Indicators for MSFD Descriptor 11.1 and 11.2	Allow advanced users to remotely plan sensor tasks (e.g., schedule measurements, etc.)
2/28/2014 8.24.32	Jose Saez	jasaez@leitat.org	01 - LEITAT	Microplastics	The sensor will include a 10 channel optical transducer, an electronic control board and a sampling system (depending on platform characteristics). The optical transducer will be composed by: - N ligh beams at different wavelenghts - 5 channels for spectral imaging sensor (color measurement) - 5 channels for optical absorption sensor (near infrared fourier transform) The electronic board will include a processor, memory and interfaces for: - Signal acquisition - Control of light sources and sensors - Communication ports. - Energy and power management The sampling system will be based in Niskin bottles with specific interfaces to couple with the sensor system.	Installation methodology still need to be defined but some potential difficulties are foreseen: - in some cases, optical transducers could be installed directly on platforms or vessels shells, avoiding the need for sampling system. Would be possible to drill shells to install optical lenses? - If it is not possible to modify shells to install optical lenses, the sampling system will be used. In this case, automated operation is needed so the sampling system must be able to take water samples by submerging niskin bottles. Would be possible to install such a system?	Spectarl imaging and FT-NIR require important processing capabilities. Due to this fact and to sensor complexity, a dedicated control board will be developed. Then, required memory and data formatting can be included in this board. An interface with the sensor hub must be defined to allow integration with the resto of the sensors. Then, data could be sent to the sensor platform for data transmission.	As a dedicated electronic board will be developed, system integration should be easily achieved by an agreement on: data format, transmission rates, communication protocols.... Integration in floating platforms will present additional difficulties due to the reasons mentioned before.	Sensor developer: Snelloptics Electronic board developer: Leitat Sampling system developer: Idronaut Definition of testing methodology and integration requirements: Leitat, snelloptics, Idronaut, CSIC, FNOB, UCC	A, C and D.	Main information: Surface Microplastic concentration in (mg/litre). Additional discrete sensors are included in the sampling system: turbidity, florescence, CTD, ph, DO2. Other measurements: location, date and time are also needed but not included in the sensor by itself.	Every few minutes	30	No special limitations are foreseen in this topic.	Both options will be possible. It will depend on how the maritime experts request data (real time, historical....). Real time data could be transferred only if required technology is incorporated in the platform.	Sensor data will be processed in the dedicated electronic board. Additional processing might be needed to joing sensor data with other inputs like: GPS coordinates, water temperature, data and time...	Deliver sensor information and observations on the web, Allow advanced users to remotely plan sensor tasks (e.g., schedule measurements, etc.) , Allow sensors to be discovered through a search interface
2/28/2014 8.41.30	Martí Gich	mgich@icmab.es	03 - CSIC	Heavy metals	The measurements will be performed on surface waters that have to be delivered to the measuring setup after filtering. The needed volume is very small (well below 1 ml). The consumption of the potentiostat and pumps for microfluidic is estimated to be below 1-2 W. The sensors do not need maintenance since are single use and an array of them will be available for the different measurements. The fluidic system might need maintenance against fouling.	It will depend on the measuring strategy which could be static (needing the participation of an operator) or fully automated, depending on the degree of automation achieved. It is difficult to be more specific at this stage.	Data can be stored in USB memory or transmitted by internet after measurement but we don't know by which means.	Several containers will be needed: A- Two liquid reservoirs with two types of buffer solutions (typically below 1 L each) for conditioning the sample at the pH needed for the analysis of the different heavy metals. B- Eventually three containers with standard solutions of different concentrations for each the heavy metals under study, of typically 20 mL each if the standard addition method is used (i.e. 3X5=15 containers of 20 ml). C-An additional container to collect the residual liquids containing heavy metals.	Depending on the zone where field tests are performed, the local Environmental Authorities as well as volunteeers and NGOs or environmental agencies	A) Research Vessel URANIA (since it has a wet laboratory) because in the case that low level of automation is achieved allows making the measurements in following a static approach (with the participation of an operator). Sarmiento de Gamboa and maybe OCEANIA could also host the plattform.	The output of one raw measurement consists of two columns of ASCII data containing values of Current Intensity and Voltage. The temperature of the measured liquid and the measurement date should also be included in the file (less than 20 kB altogether). In the case of using the standard addition method each measurement would additionally generate three more of these files.	Every few minutes	20 min	No limitations	It could be made in real time via internet (see above) or at the end of the cruise.	Yes, the raw data is an intensity vs voltage and a final processing (of eventually several of these datasets if standard addition method is used) will be needed before obtaining the heavy metal concentrations in water.	Deliver sensor information and observations on the web

2/28/2014 8.53.55	John Cleary	john.cleary@dcu.ie	06 - DCU	Eutrophication	Sensors will be designed for deployment in surface waters (0-3 m depth) Targeted maintenance interval is 1 month – implying that the storage capacity of reagent, calibrant and waste storage containers will be sufficient for this period. The maintenance-free interval will vary depending on sampling frequency. Sensors will operate using battery power, which may need to be supplemented by energy harvesting e.g. using solar panels on buoys. The target for battery lifetime without energy harvesting will be 1 month also.	Installation method will vary depending on the platform to be used and the deployment scenario (depth, sea conditions, accessibility etc.) Technical advice and support on mountings etc. will be required from partners with more expertise/experience in carrying out marine sensor deployments.	Analytical specifications of the sensors are yet to be determined. Sensors will be designed for deployment in surface waters (0-3 m depth). Applicable temperature range of the sensors will need to be assessed. Data storage can be implemented using Flash memory chips or removable memory (e.g. SD cards). Data storage will be required on the platform regardless of deployment scenario to provide data redundancy e.g. in the event of communications failure. Possible means of data transmission include satellite, GSM, Wifi/Wimax, short range transmission such as ZigBee, BlueTooth, or via directional antennae. The deployment location and coverage will determine the choice of data transmission mode.	Additional needs may be identified as the project progresses.	Relevant environmental agencies (depending on deployment location) NGOs Vessels of opportunity	Possible platforms for deployment of the sensors will include: A. Research vessels - Research vessel URANIA (CNR) - Research vessel OCEANIA (IOPAN) - Research vessel SARMIENTO DE GAMBOA – SdG (CSIC) C. Buoys and submerged moorings - Oceanographic buoy in Gdansk Bay (IOPAN) - Oceanographic submerged moorings in the Mediterranean (CNR) D. Ocean racing yachts F. Fishing vessels Other vessels of opportunity Selection of the most appropriate platforms will require further information on the characteristics of the various platforms, as well as relevant features of the sensors and platform which are yet to be determined.	The primary output will be nutrient concentrations. The raw data will be transmitted in the form of a series of light intensity readings. Each measurement will also include a temperature reading and date stamp.	Hourly		Data storage capacity will be determined by the selected mode of storage – e.g. 16GB for SD card, megabyte range for flash memory chips. Due to the small size of data generated for each individual measurement, this is not expected to represent a significant limitation. Data transmission capacity will vary depending on the mode of transmission – e.g. SMS is limited to 160 7-bit characters, Sat. Comm. may charge by transmission duration and/or data size.	Possible means of data transmission include satellite, GSM, Wifi/Wimax, short range transmission such as ZigBee, BlueTooth, or via directional antennae. The deployment location and coverage will determine the choice of data transmission mode. Data logging will be utilised if sensors are to be deployed in scenarios where none of the possible transmission modes are available.	Raw data in the form of light intensity readings will be acquired and transmitted. The raw data will need to be converted initially to absorption values, and ultimately to concentration values. The final data to be stored and displayed will be in the form of nutrient concentrations. Raw data should also be stored as it provides additional information on sensor performance and allows cross-referencing with data stored on board the sensor (e.g. allowing reliability of transmitted data to be validated). The data management system should also allow for additional features such as: • Event detection • Event classification (identification of false positives/negatives) • Data smoothing (for display purposes)	Deliver sensor information and observations on the web, Allow users to subscribe to sensor alerts and notifications, Allow advanced users to remotely plan sensor tasks (e.g., schedule measurements, etc.) , Allow sensors to be discovered through a search interface

COMMON SENSE

MARINE SENSORS - MARINE MONITORING

ANNEX 3

QUESTIONNAIRE FOR SENSOR TESTERS

The COMMON SENSE project has received funding from the European Union's Seventh Framework Program (Ocean 2013-2) under the grant agreement no 614155.

Timestamp	Your name	Your email	Your Organisation	Please select platform	If your answer to the previous question is "Other" or under categories F or G, then please specify.	Platform Characteristics: Which sensors can be mounted on the available platform?	Platform Characteristics: How many sensors of each type can be mounted at the same time on each platform?	Platform Characteristics: Frequency of platform maintenance?	Please describe compatibility issues	Please describe calendars and platform availability	Special needs?	Stakeholders involved?	Additional question for Category F: Available fishermen vessels?	Additional question for Category F: Frequency of installation	Additional question for Category F: Area of work	Additional question for Category F: Advantages and disadvantages
2/21/2014 1.42.43	Mike Challiss	mike.challiss@cefas.co.uk	15 - CEFAS	C. Buoys and Submerged Mooring - Smartbuoys (CEFAS)	Glider or USV is more likley to be used for trials to reduce the likleihood of background noise	Underwater Noise	1off	N/A deployed for fixed duration then recovered	Size may be a constraint for prototype units	Made available to suit noise programme	N/A	Cefas IOPAN	N/A	N/A	N/A	N/A
2/25/2014 2.11.03	Katrin Schroeder	katrin.schroeder@ismar.cnr.it	04 - CNR	C. Buoys and Submerged Mooring - Oceanographic submerged moorings in the Mediterranean (CNR)		Eutrophication, Microplastics, Heavy Metals, Underwater Noise, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO2 measurements	the number of sensors to be mounted at the same time strongly depends on the dimension and wieght of these sensors. The length of the mooring is about 250 m, from the bottom at about 450 m depth, so any suitable depth can be chosen. There are three mooring lines of this type available	the platform will be recovered and redeployed every six months, approximately	there are other instruments on the mooring lines, which position should not change. Due to strong currents, not to heavy and big sensors can be installed. The length of the mooring line cannot be extended.	the platforms are accessed every 6 months with an oceanographic vessel. The calendar of each year of the ship time will be known in December of the year before (for deployments in 2015, we will need to wait until December 2014 to know the exact dates), but usually we access the platforms in spring and in autumn.						
2/28/2014 5.34.29	JAVIER VILALLONGA	jvilallonga@fnob.org	08 - FNOB	D. Ocean Racing Yacht - IMOCA Open 60 boats (FNOB)		Microplastics	Regarding it´s a racing boat , will depend on the size and instalation needs of sensors	Racing Boat with maintenance crew		Imposible to confirm at the present moment						
3/4/2014 5.59.49	Katrin Schroeder	katrin.schroeder@ismar.cnr.it	04 - CNR	A. Research Vessel - URANIA (CNR)		Eutrophication, Microplastics, Heavy Metals, Underwater Noise, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO2 measurements	The number of sensors is strongly dependent on their size, to be mounted on the frame of the CTD/rosette system. One can be mounted on nets (ex. for microplastics)	daily, while on board	The issues depend on the size and the charachtersitics of the sensors. They can be mounted on the frame of CTD/rosette system, or downflow of the on-board seawater pump. If on nets, ex. for microplastics, the sensor must has autonomous power.	In 2014, if not modified, a 15-days long cruise will be available in November/December 2014. The cruise calendar for 2015 will be known in December 2014, and approximately 2 cruises, 15-days long will be available.		None. Sensor developers can be embarked if requested.				
3/4/2014 10.01.41	Jordi Salat	salat@icm.csic.es	03 - CSIC	A. Research Vessel - SARMIENTO DE GAMBOA – SdG (CSIC)		Eutrophication, Microplastics, Heavy Metals, Underwater Noise, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO2 measurements	Oceanographic Research Vessel. All kind of sensors can be tested	none	none	not yet	none	none				
3/4/2014 10.07.47	Jordi Salat	salat@icm.csic.es	03 - CSIC	B. Oil Platform - Other (please specify below)	Casablanca (W. Mediterranean) Preliminary contacts. Still not available	Eutrophication, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO2 measurements	Still not agreed	Still not agreed	Under research	Still not agreed	Under research	Oil company (Repsol) Marine authorities				

3/4/2014 10.13.18	Jordi Salat	salat@icm.csic.es	03 - CSIC	C. Buoys and Submerged Mooring - ICM-CSIC deep moorings at the continental slope and canyons of the NW Mediterranean		Heavy Metals, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO2 measurements	several sensors provided enough power in batteries (see maintenance)	Fixed. Once a year or lower	Not known	Not yet	Mooring has to be adapted to sensors and batteries (accoustic releases, weight, wire, buoyancy, etc)	none				
3/4/2014 10.16.48	Jordi Salat	salat@icm.csic.es	03 - CSIC	C. Buoys and Submerged Mooring - Other (please specify below)	Aqualog (undulating mooring). Still not ready for use	Eutrophication, Heavy Metals, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO2 measurements	Under research	Relocatable. Around once a month.	Still not known	Not yet	Under research	none				
3/4/2014 10.26.28	Jordi Salat	salat@icm.csic.es	03 - CSIC	G. Expendable ocean instruments, manned vessels and further available platforms (please specify below)	It should be: E. Drifting buoys (ICM-CSIC) but for any reason the E option is missing in the window above	Eutrophication, Microplastics, Heavy Metals, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO2 measurements	Several sensors provided enough battery power	None. Expendable platforms	??	Not yet	To be studied according to sensors' charactreritics	Ships of opportunity. E.g. Marine Rescue agencies Fishing vessels Yacht clubs etc				
3/4/2014 10.30.41	Jordi Salat	salat@icm.csic.es	03 - CSIC	C. Buoys and Submerged Mooring - Other (please specify below)	OBSEA Underwater observatory (preliminary contacts)	Eutrophication, Microplastics, Heavy Metals, Underwater Noise, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO2 measurements	Autonomous platform wire connected to a laboratory	Still not known	Still not known	Still not known	Still not known	UPC (Politechnical University of Catalonia)				
3/12/2014 5.25.35	Marcin Wichorowski	wichor@iopan.pl	10 - IOPAN	A. Research Vessel - OCEANIA (IOPAN)		Microplastics, Heavy Metals, Underwater Noise, Innovative piro and piezo resistive polymeric temperature and pressure sensors, Nanosensors for autonomous pH and pCO2 measurements	not defined, depend on mounting/cabling of sensors	Research Vessel, available all the time	Power supply 230V, cable line (1 wire + shield), cable line (7 wires + shield)	available at http://www.iopan.pl/oceania.html						