Joint European Research Infrastructure network for Coastal Observatories

Terms of reference of the Forum for Coastal Technologies (FCT)

D#1.3

Grant Agreement n° 262584
Project Acronym: JERICO

Project Title: Towards a Joint European Research Infrastructure network for Coastal Observatories

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Version and Date: Version 1.2, 4 Oct. 2012

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1. Document description

REFERENCES

Annex 1 to the Contract: Description of Work (DoW) version 22 Feb. 2011

Document information	
Document Name	Terms of Reference of the Forum for Coastal Technologies
Document ID	D1.3
Revision	version 1.2
Revision Date	4 oct 2012
Authors	Ingrid Puillat, Ph. Monbet, Y. Aoustin, G. Nolan
Security	

History			
Revision	**Date**	**Modification**	**Author**
v1.0	30 may 2012		Puillat
V1.1 and V1.2	30 Sept- 4 Oct. 2012	English corrections	Monbet, Puillat

Diffusion list				
Consortium beneficiaries	X			
Third parties	X			
Associated Partners	X			

2. Executive Summary

This report presents the JERICO Forum for Coastal Technologies (FCT).

In Europe there is a high level of research in public and academic institutes, but this research doesn't always lead to instruments that are able to be used in an operational way. To give momentum, one must create (or make understandable) the value of the technology to the instrument user.
Companies need visibility to invest in the oceanographic market (which is a niche market). Looking outside the traditional technical and scientific environment, many technologies could be suitable to develop new sensors. On the other hand, many instrument users don't have a sound knowledge of the available market.
In the above context, JERICO organises a 'Forum for Coastal Technologies (FCT)'.

This forum aims to facilitate informal exchanges on scientific and technical topics/issues related to the coastal environment monitoring. In particular the FCT should :

- provide a strong interface between SMEs, industry, stakeholders and science & technology, e.g. by joint developments and technology transfer,
- provide a market intelligence tool, indicator of the tendencies/growth in the JERICO related market for instruments and services,
- seed an Euro-Act, based on the model and in close collaboration with the US-Alliance for Coastal Technologies (ACT) organisation,
- provide an unbiased third party test-bed for sensors and measuring systems,
- analyse the market, forecasting scientific and societal needs for new coastal observations,
- identify upcoming standards for quality assessment and for reducing equipment and maintenance costs, by exchanging ideas about best practices,
- sustain joint research and development initiatives on sensors and platforms.

As a first step to set up this forum, the FCT "Terms of Reference" has been prepared. This latter describes the expected activities such as workshops and experiments organization. This is documented in section 1. A dedicated webpage is available at http://www.jerico-fp7.eu./coastal-technologies.

The expected main outcome of the FCT is to get industry and sensor users working together in a win-win situation. To initiate this, online surveys have been carried out with Surveymonkey®. The first FCT survey has been dedicated and completed by the JERICO's partners. The aims were to determine the FCT's perimeter and boundaries. The results of this first survey are given in annex 1.

To date, a second survey is still in progress. Basically, this survey is dedicated to companies (major groups and SMEs) that either develop, use or supply sensors, instrumentation and platforms to monitor coastal oceanographic parameters and processes.

The aims of this second questionnaire are to :

- assess the industry knowledge about the oceanographic community needs.
- evaluate how the sensor user community is aware of the last R&D developments and commercial offers .

3. FCT Terms of Reference

Objectives:

The main objectives for the FCT are:

- Provide a forum for the marine sensor user community and sensor industry to regularly exchange information about user requirements and technological developments,

- Promote greater interaction between the scientific requirements and related market for marine sensors and equipment, including better feedback from users to developers on improved design for ease of use,

- Organize workshops where the industry get an idea of research and monitoring requirements and where developers of new instruments can keep the community up to date,

- Foster Small and Medium Enterprise (SME) attendance at the key JERICO workshops and summer schools,

- Carry out performance demonstrations, comparisons and evaluations of key sensing technologies in close cooperation with the Alliance for Coastal Technologies, (see www.act-us.info for more information)

Methodology/roadmap

On one hand, FCT should facilitate user's feedback through activities that involve hands on demonstrations, where possible. On the other hand, there is a need to establish what companies currently produce and deliver, what they are planning to develop, and what are both scientist's needs and operational services (may differ from science and research). To fill these gaps, the FCT intends to carry out several kinds of activities:

- Online surveys to highlight needs and identify gaps

- Workshops to initiate and facilitate interactions between industry and sensors users

- Dedicated Web pages set up, including JERICO yellow pages, documents and information on FCT

- On line surveys

The FCT first action is the completion of several online surveys. The first questionnaire is intended to survey sensor users about 'what they measure the most frequently, what are their needs and what are the gaps with the commercially available products on the market. This helps to focus the FCT activities on selected parameters and sensors. A second questionnaire is mainly dedicated to sensing instrumentation providers/manufacturers.

- FCT Workshops

The FCT plans to organize 2 workshops that should gather private companies and sensor's users. Companies not involved in oceanography, might be also invited by the FCT if these companies bring a unique advantage to our community (eg. ICT and telecom companies).

- The first JERICO FCT Workshop: Brest (France) 10th October 2012, along with the SEATECHWEEK 2012 event.

This 1-day workshop is focused on oxygen and nutrients measurements: calibration procedures, deployments, maintenance, and robustness. Beside this first FCT workshop, a metrology experiment dedicated to the measurements of temperature, dissolved oxygen and salinity, is organized in IFREMER facilities. This experiment is dedicated to calibrate sensors and to compare calibration results.

-Second JERICO FCT Workshop: second half of 2013. To date, the content is to be defined depending of the first workshop feedback and conclusions.

- Web pages and Yellow pages

The FCT web pages should contain the description of the FCT activities, and documents made available for the user community. For instance, it can publish results after inter-calibration experiments, procedures for calibration and trials. This web site can include public reports, databases for sensors and platforms. It would also help to better identify the sensors market.

The FCT needs to develop the "yellow pages" concept pioneered in ESONET NOE Project (FP6 Network of Excellence: www.esonet-emso.org); where the user's community can get a full overview of all relevant sensor products available. This should be done by:

- asking the companies to provide summary information on their products.. The collected information should in particular concern range, precision, accuracy, maintenance and calibration issues. Sensors could be sorted into 3 main groups: physical, chemical and biological. These groups could then be subdivided with several parameters: e.g. nutrients, Temperature and salinity, chlorophyll, turbidity, etc.

- providing some users feedback through indicators (see US-ACT)

An online forum could also be initiated via social networks such as Viadeo or LinkedIn.

These activities should ultimately contribute to establish recommended standards along with other JERICO WPs to define the JERICO label.

This firs survey and its results are reported in annex 1.

4. Conclusions

The bases of the JERICO FCT are now set-up. This forum is ready to welcome active participants. The first FCT event is the workshop that is held at the Sea Tech Week 2012 in October 2012. Registrations for this event already showed the interest from both industry and the scientific community. In parallel, the first metrology experiment is also organised. The outcomes from both the workshop and the experiment should be published on the FCT website.

The FCT should use this promising start to foster its future activities, build and reinforce its consortium to ultimately enhance collaboration between industry and the scientific.

Annex 1 – First FCT survey

Acknowledgements:

Ifremer thanks Pole Mer Bretagne and Philippe Monbet for his contribution to the FCT activities.

FORUM FOR COASTAL TECHNOLOGIES

FCT

First survey analysis – JERICO FCT

February 2012 v 1.0

1. OBJECTIVE

The fundamental goal of this survey was to determine the boundary of the Forum for Coastal Technologies (FCT). The purpose was to identify common 'sensors' interests within the JERICO community and answer the question : what are, for you, the main interesting chemical/physical/biological sensors and most importantly what are the sensors you use the most?

2. SURVEY COMPOSITION

From December 14th 2011 to February 9th, JERICO conducted a web-based survey to help to define the boundary of the FCT. This work has been carried out by the FCT team using 'surveymonkey.com' as the web-based survey tool. The survey contained a total of 41 questions divided into 5 sections:

- General information
- Sensors for chemical / biogeochemical measurements
- Sensors for physical measurements
- Sensors for biological measurements
- View on the forum for coastal technologies (FCT)

3. SURVEY SYNTHESIS

This survey carried out amongst the JERICO community, allowed to highlight the main topics that the Forum for Coastal Technologies (FCT) could deal with. Here are the main tendencies that emerged the survey.

Firstly, the survey is relatively representative from the JERICO community as there were 22 surveys filled by 17 different institutions (CNR, Italy filled the survey 5 times). For this community, research and monitoring in coastal waters appears to be the main focus. Sensors are then mainly deployed on buoys, vessels and fixed platforms. Transferring data from these sensors is usually done by GSM. The different parameters [and related technologies] that are measured are:

- dissolved oxygen [optical] and inorganic dissolved nutrients (nitrate /nitrite, phosphate, silicate and ammonium) [UV for nitrate and wet chemistry for all]
- temperature and salinity (usually available through classic CTD measurements)
- chlorophyll (fluorescence)

Most of the sensors used by the JERICO partners originates from commercial products. But the survey shows that there are some 'in-house' developments and designs. This is probably to tackle issues such as calibration which was the 'common' top issue cited for both chemical, physical and biological sensors measurements. Some other important issues cited were: maintenance, reliability and bio-fouling. About this latter, more than half of the JERICO partners are (or recently were) involved in the use of development of novel anti fouling technologies. Despite a relatively large range of solution, copper based solutions seem to be the most cited.

When it comes to the use (or not) of sensor itself, the main reason evoked that stop using sensor is the lack of confidence in the produced data. Neither the cost or the lack training was mentioned. Actually, the majority of the JERICO partners can in fact avail of training and guidance in improving data quality from their sensors in use. It also seems that a large majority of the JERICO partners possess sufficient awareness about the companies that are involved in sensing and platforms development in their home country.

The survey also asks the view of JERICO partners about the next generation of sensors. The responses were really diverse and amongst them was cited 'miniaturization, reliability, long term unmanned deployment, bottom up profiler, easy calibration, cheaper product.

Furthermore, about the view of the JERICO on the FCT, the survey shows that FCT could create a better link between the sensor users and the industry through actions like:

- regular exchange of information about user requirements/issues and technological developments
- making sure that industry is aware about the wish/requirement of users
- set up recommended standards
- performance demonstrations

The survey indicates that most of the JERICO partners would like to see SMEs and environmental agencies invited in the FCT.

The Alliance for Coastal technologies (US ACT) was mentioned several times as the initiative that the FCT should be aware of. Finally, the most favorite formats for the FCT meeting are workshop and field demo.

4. DETAILED RESULTS

4.1 FIGURES AND PARTICIPANTS

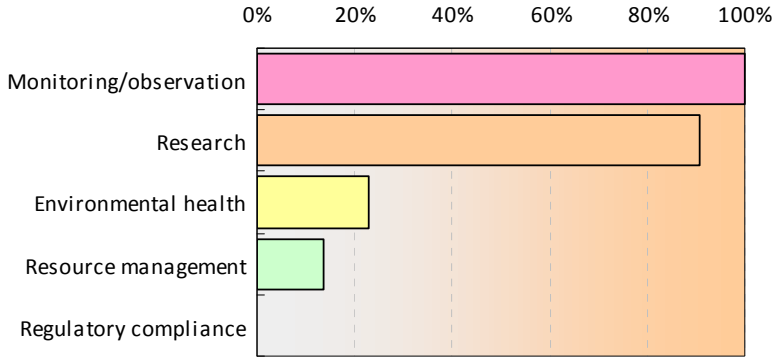
The table 1 presents who did participate to the survey

Part.	Institute / Organization	Country	Department / Lab. (If any):	Contact person	Response Date
1	OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale)	Italy	Oceanographic Calibration Centre (CTO)	Rajesh Nair	**Feb 24, 2012**
2	Cefas	UK		Naomi Greenwood/Dave Sivyer	**Feb 9, 2012**
3	Ismar-CNR	Italy	Sede di Bologna	Dr. Mariangela Ravaioli and Giovanni Bortoluzzi	**Feb 7, 2012**
4	ISMAR-CNR	Italia		Marco Faimali	**Feb 1, 2012**
5	IOI-Malta Operational Centre, University of Malta	Malta	Physical Oceanography Unit	Prof. Aldo Drago	**Jan 31, 2012**
6	CNR-ISMAR BOLOGNA	Italy			**Jan 30, 2012**
7	IOI-Malta Operational Centre, University of Malta	Malta	Physical Oceanography Unit	Prof. Aldo Drago	**Jan 28, 2012**
8	Bundesamt für Seeschifffahrt und Hydrographie (BSH)	Germany	Oceanography	Detlev Machoczek	**Jan 27, 2012**
9	National Oceanography Centre, Southampton	UK	Biogeochemistry and Ecosystems	Dr. david Hydes	**Jan 26, 2012**
10	CNR ISMAR	Italy		Mauro Bastianini	**Jan 26, 2012**
11	Norwegian Insitute for Water Research - NIVA	Norway	Oceanography and remote sensing	Dominique Durand	**Jan 25, 2012**
12	Marine Institute	Ireland		Glenn Nolan	**Jan 24, 2012**
13	Instituto Español de Oceanografía	SPAIN		Alicia Lavín	**Jan 23, 2012**
14	Institute of Hydro-Engineering of the Polish Academy of Sciences	Poland	Department of Coastal Engineering & Dynamics	Rafał Ostrowski	**Jan 23, 2012**
15	NIOZ	Netherlan d		Marck Smit	**Jan 20, 2012**
16	Helmholtz-Zentrum Geesthacht, Institute of Coastal Research	Germany		Dr. Wilhelm Petersen	**Jan 19, 2012**
17	CNR Institute for Marine Sciences	Italy	Trieste laboratory	Fabio Raicich	**Jan 19, 2012**
18	Management Unit of North Sea Mathematical Models	Belgium		Dries Van den Eynde	**Jan 17, 2012**
19	Helmholtz Zentrum Geesthacht	Germany	Institute for Coastal Research	Franciscus Colijn	**Jan 16, 2012**
20	Hellenic Centre for Marine Research	Greece	Institute of Oceanography	George Petihakis	**Jan 15, 2012**
21	CNR ISMAR	Italy		Katrin Schroeder	**Jan 13, 2012**
22	Finnish Environment Institute	Finland	Marine Research Centre/State of the Marine Environment	Seppo Kaitala	**Jan 13, 2012**
23	Ifremer	France	REM/RDT	Yannick Aoustin	**Dec 14, 2011**

4.2 GENERAL INFORMATION

Q1. For what purpose do you use/develop sensors?

Answer Options	Response Percent	Response Count
Regulatory compliance	0,0%	0
Resource management	13,0%	3
Environmental health	21,7%	5
Research	91,3%	21
Monitoring/observation	100,0%	23
Other, please specify (eg HAB, eutrophication…)		5
answered question		**23**

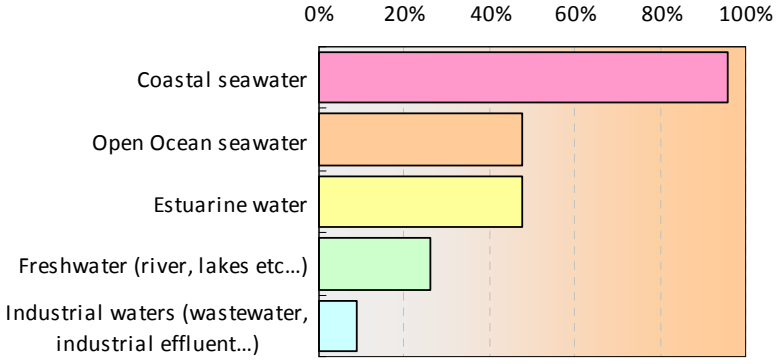


Results show that the JERICO community is mainly focused on monitoring and research activities when using sensors. In the 'other' section were also specified topics like:

- Eutrophication and anoxia monitoring, biogeochemical cycles, Long-term time series
- HAB, eutrophication, ocean acidification, CO2/CH4 leakage,
- HAB, eutrophication, pollution, environmental parameters: (S, T, nutrients, pCO2, alkalinity, chlor a, pigments, pH, algal composition, O2)
- Oceanographic research, live stock management, operational coastal oceanography, process study

Q2. In what type of 'medium' do you use/develop sensors?

Answer Options	Response Percent	Response Count
Open Ocean seawater	47,8%	11
Coastal seawater	95,7%	22
Estuarine water	47,8%	11
Freshwater (river, lakes etc…)	26,1%	6
Industrial waters (wastewater, industrial effluent…)	8,7%	2
Other, please specify		1
answered question		**23**
skipped question		**0**

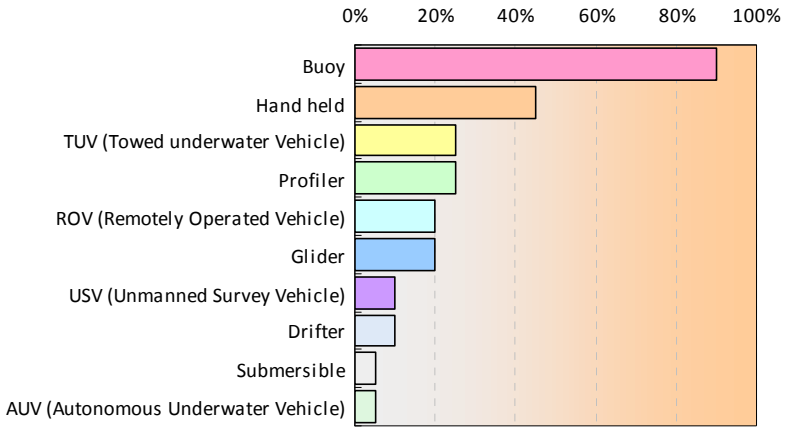


Results show that the JERICO community is mainly focused on coastal waters (including estuaries). Open ocean waters and fresh waters are also of concerned, but to a less extent. Finally, industrial waters do not seem to be the priority for JERICO community. In the 'other' section were also specified topics like:

- all types of water from green water to sewage plant exhaust

Q3. What kind of platform do you use to carry your sensors?

Answer Options	Response Percent	Response Count
Submersible	4,8%	1
AUV (Autonomous Underwater Vehicle)	9,5%	2
USV (Unmanned Survey Vehicle)	9,5%	2
Drifter	14,3%	3
ROV (Remotely Operated Vehicle)	19,0%	4
Glider	23,8%	5
TUV (Towed underwater Vehicle)	23,8%	5
Profiler	28,6%	6
Hand held	47,6%	10
Buoy	90,5%	19
Other, please specify		14
answered question		**21**
skipped question		**2**



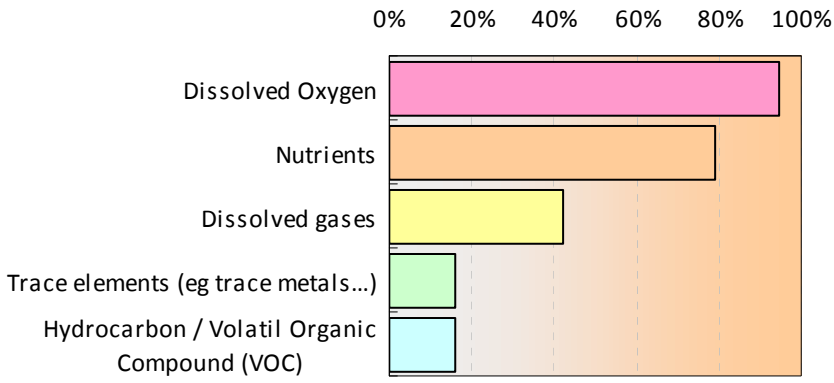
The most common answer was 'buoy' followed by 'Hand held'. About 20 % also use TUV, profiler, ROV or glider as a platform for their sensors. In the 'other' section were also specified platforms like:

- Coastal platform
- fixed platforms, lighthouse
- Commercial ships used as ships if opportunity carrying autonomous instruments
- Oceanographic Tower
- Ferries, merchant ships
- Coastal tide gauge installations with additional sensors
- Oceanographic Ship
- Measuring towers, piers, boats
- FerryBox
- Fixed platform
- Tripode, put on the bottom of the sea
- Ships of opportunity, fixed platforms in shallow coastal waters, wind turbines,
- Ship of opportunity ferries and research vessels
- Vessel (fishing boat)

4.3 SENSORS FOR CHEMICAL / BIOGEOCHEMICAL MEASUREMENTS

Q1. What kind of chemical / biogeochemical parameters do you intend to measure most often sensors?

Answer Options	Response Percent	Response Count
Nutrients	78,9%	15
Dissolved Oxygen	94,7%	18
Dissolved gases	42,1%	8
Hydrocarbon / Volatil Organic Compound (VOC)	15,8%	3
Trace elements (eg trace metals…)	15,8%	3
Other, please specify		6
answered question		**19**
skipped question		**4**

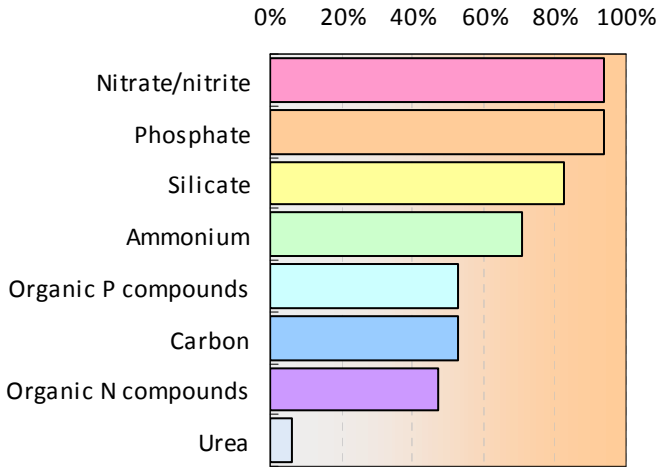


Oxygen and nutrients were the most cited parameters for this question. In the 'other' section were also specified parameters such as:

- Bio-electrochemical activity of biofilm (bacteria)
- Carbon (DIC/TA)
- Chlorophyll
- CO2 system
- Chlorophyll, temperature, conductivity
- Trace element in estuaries and in deep sea"

Q2. In terms of nutrients, which of the following are of interest for you?

Answer Options	Response Percent	Response Count
Nitrate/nitrite	94,1%	16
Phosphate	94,1%	16
Silicate	82,4%	14
Ammonium	70,6%	12
Organic P compounds	52,9%	9
Carbon	52,9%	9
Organic N compounds	47,1%	8
Urea	5,9%	1
Other, please specify		0
answered question		**17**
skipped question		**6**



Classical nutrients (Nitrate/nitrite, phosphate, silicate and ammonium) were the most cited with percentages above 60%. Organic compounds (N, P) and carbon seem also to be of interest.

Q3. Related to the above questions, what kind of technologies (primary and secondary) do you use for your sensors? (eg nitrate : Primary - wet chemistry, Secondary - ISE…)

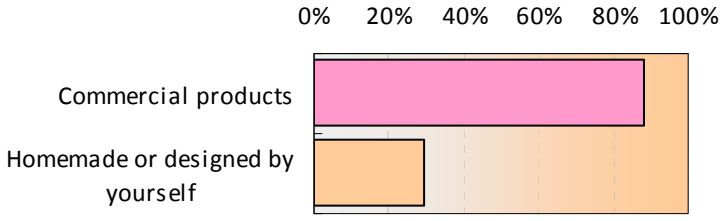
Answer	NO3	NO2	PO4	Si(OH)	NH4	Org. P	Carbon	Org. N	urea	O2	Diss. gases	HydroC/ VOC	Trace elements
1	WC	WC	WC	WC	WC	WC	WC	WC		WC	GTDs	OS	
2	WC	WC			WC					Optical method			
3													
4										Diffusion and NDIR analysis			
5													
6										Optic, polarography			
7													
8													
9	WC		WC										
10	WC/UV	WC	WC	WC	WC					Optode	Membrane system CO2		
11	WC/UV		WC	WC	WC					Optode			
12													
13													
14													
15										Optode, optic electrochemical			
16	WC	WC	WC	WC						Sensor			
17													
18	WC	WC	WC		WC					Optode	CO2 IR		
19													
20	WC	WC	WC	WC	WC	WC		WC		Photometry			
21										Sensor			
22										Sensor			
23	WC	WC	WC	WC									

NO3=nitrate, NO2=nitrite, PO4=phosphate, NH4=ammonium, Org. P=organic P, Org. N=organic N, O2= Dissolved oxygen, HydroC/VOC= Hydrocarbon / Volatile Organic Compound (VOC)
WC=Wet chemistry, UV=Ultraviolet technology, NDIR / IR=Infrared technology, GTDs=Gas Tension Devices, OS=Optical Sensors

With regards to nutrient, most measurements are based on wet chemistry. Nitrate is also measured by UV spectrophotometry. Dissolved oxygen and other gases are measured by various technologies, but optical methods seem to be well used.

Q4. Are your current chemical sensors primarily from ?

Answer Options	Response Percent	Response Count
Commercial products	88,2%	15
Homemade or designed by yourself	39,4%	5
Other, please specify		2
answered question		**17**
skipped question		**6**

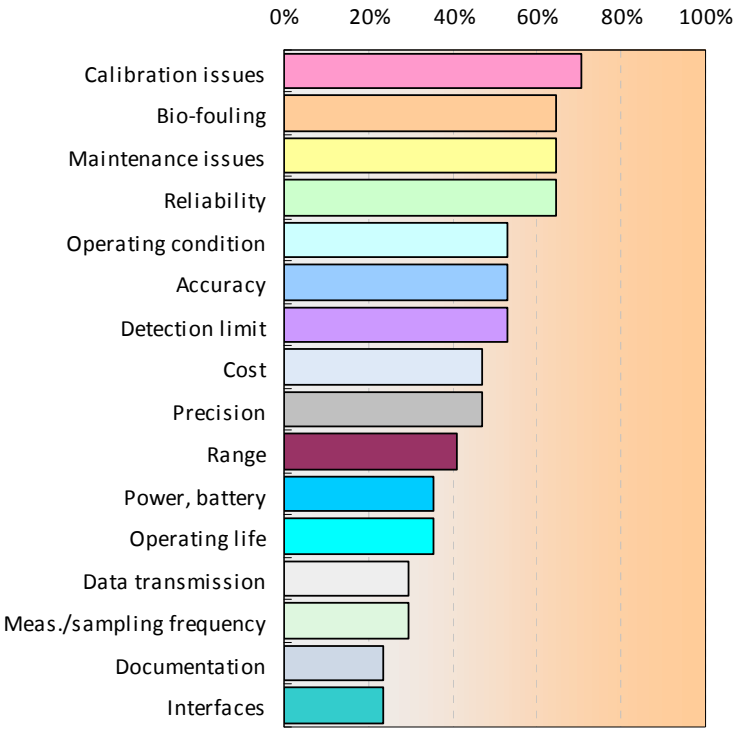


A substantial part of the chemical sensors used within the JERICO community are derived from commercial products. In the 'other' section was also specified:

- Integration of sensors into broader observing systems
- N/A

Q5. Which of the following areas are you really concerned about with regard to chemical sensors?

Answer Options	Response Percent	Response Count
Interfaces (input/output…)	23,5%	4
Documentation	23,5%	4
Measurement/sampling frequency	29,4%	5
Data transmission	29,4%	5
Operating life	35,3%	6
Power, battery	35,3%	6
Range	41,2%	7
Precision	47,1%	8
Cost	47,1%	8
Detection limit	52,9%	9
Accuracy	52,9%	9
Operating condition (pressure, corrosion etc…)	52,9%	9
Reliability	64,7%	11
Maintenance issues	64,7%	11
Bio-fouling	64,7%	11
Calibration issues (ease, time, frequency, automatic…)	70,6%	12
Other, please specify		2
answered question		**17**
skipped question		**6**

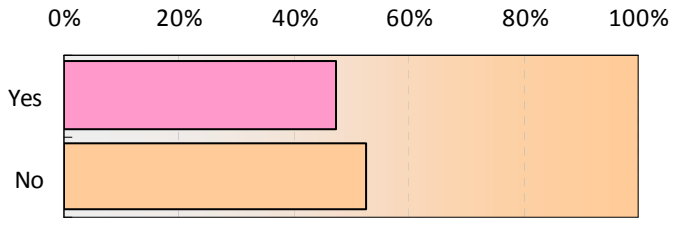


The issues that emerged from this question were calibration, bio-fouling, maintenance and reliability. Operating condition, accuracy, detection limit seem to be also important to the JERICO community. In the 'other' section was mentioned:

- All of above are of interest - reliability is the most important criterion
- Our main concern is the reliability and maintenance of the nutrient sensors

Q6. Considering bio-fouling, have you been involved in the use or development of novel anti-fouling technologies (e.g. shutters, copper based systems etc…)?

Answer Options	Response Percent	Response Count
Yes	47,4%	9
No	52,6%	10
If yes, please describe briefly		9
answered question		**19**
skipped question		**4**



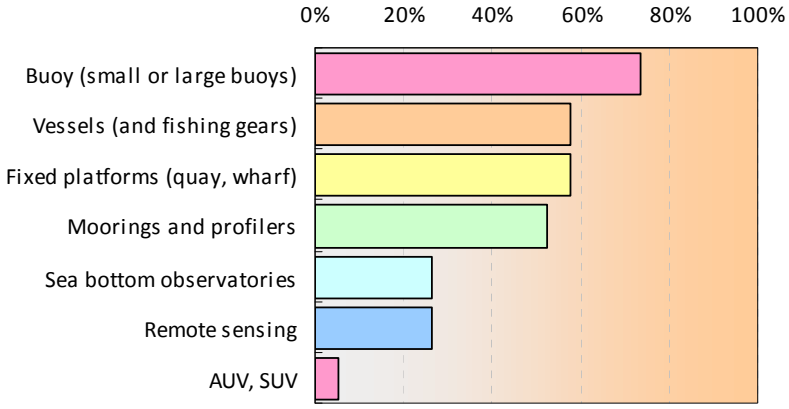
About half of the survey participants were involved in the use or development of novel anti fouling technologies. Their experiences concerned:

- Chemical and physical anti-bio-fouling methods
- Development of bio-film sensor able to optimize and modulate the antifouling chemical treatment
- Copper shutter and brush

- Copper caging and rotating brushes on sensors
- Chlorination (buoys), automatic cleaning (FerryBox), wiper
- Efficient anti bio-fouling procedure developed for the FerryBox (flushing during harbor stops with acid and base solutions has proven effective)
- Copper shutters, bromine solutions, copper rings
- Washing system for ferrybox instruments
- Local chlorination by means of electrolyse

Q6. What type of platforms do you use?

Answer Options	Response Percent	Response Count
AUV, SUV	5,3%	1
Remote sensing	26,3%	5
Sea bottom observatories	26,3%	5
Moorings and profilers	52,6%	10
Fixed platforms (quay, wharf)	57,9%	11
Vessels (and fishing gears)	57,9%	11
Buoy (small or large buoys)	73,7%	14
Other, please specify		2
answered question		**19**
skipped question		**4**

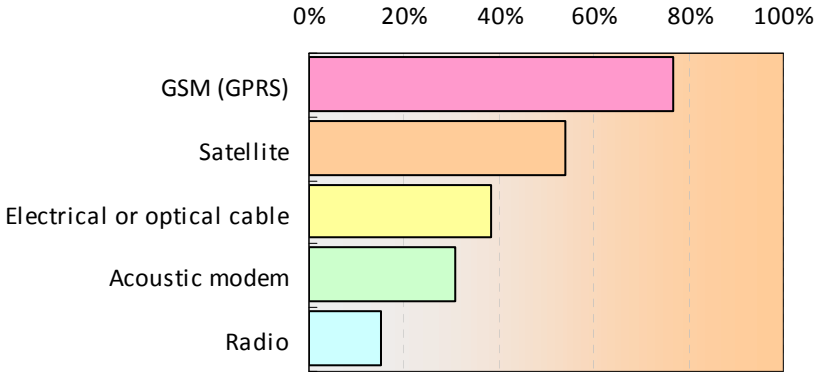


Buoys are the most used platform for chemical and biogeochemical measurements. Vessels and fixed platforms such as quay, jetty or wharf are also a common platform. In the 'other' section were specified platforms like:

- Fixed platform = offshore mast
- Gliders, scanfish, ships-of-opportunity, fixed piles (Waddensea)

Q7. When using chemical sensors, how do you transfer your data?

Answer Options	Response Percent	Response Count
GSM (GPRS)	76,9%	10
Satellite	53,8%	7
Electrical or optical cable	38,5%	5
Acoustic modem	30,8%	4
Radio	15,4%	2
Other, please specify		5
answered question		**13**
skipped question		**10**



GSM appears to be the most used technology to transfer data when using chemical sensors. However, the satellite technology seems to be also well used. In the 'other' section were specified technologies to transfer data such as:

- Data recovered when we recover the mooring
- Long range Wi-Fi systems
- N/A
- Electrical/optical cable for underwater nodes (under construction)
- Embedded data logger

Q8. What in your view comprises the next generation of chemical sensors and platforms to be developed in support of operational oceanography?

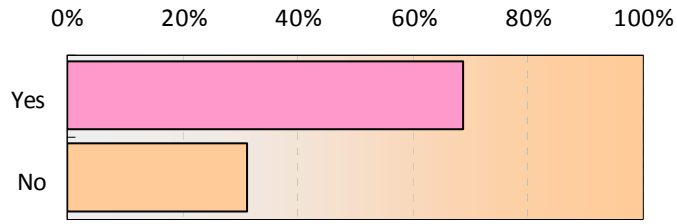
Answer Options	Response Count
	11
answered question	**11**
skipped question	**12**

The different answers about the next generation of chemical sensors are listed below:

- MEMS "lab on a chip" sensing suites, miniatuarized systems (e.g. for use on AUVs), stand-alone sensors for microbiological & ecotoxicological variables.
- Miniaturized and lower power sensors to fit onto eg. gliders
- Automatic bottom-up profilers to provide coherent, fine-scale profiling of multiple oceanographic parameters
- State-of-the-art research vessel (central, multibeam platform)
- Reliable "lab on a chip"
- Vertical profiling from merchant ships
- Optical nutrient sensors that are not susceptible to biofouling and that are suited to long-term unmanned deployment
- Acidification
- Reliable sensors/analysers for nutrients, pCO2,
- Full CO2 system including alkalinity, improved nutrient sensors, sensors for primary production measurements
- Optical sensors

Q9. Could you avail of training and guidance in improving data quality from the sensors in use?

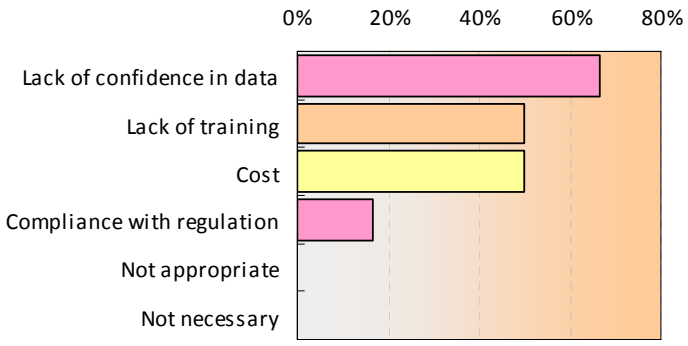
Answer Options	Response Percent	Response Count
Yes	68,8%	11
No	31,3%	5
answered question		**16**
skipped question		**7**



About 67 % of the survey's participant can benefit to training and guidance in improving data from chemical sensor measurements.

Q10. If you don't use chemical sensors, what is your main reason(s)?

Answer Options	Response Percent	Response Count
Not necessary	0,0%	0
Not appropriate	0,0%	0
Compliance with regulation	16,7%	1
Cost	50,0%	3
Lack of training	50,0%	3
Lack of confidence in data	66,7%	4
Other, please specify		4
answered question		**6**
skipped question		**17**



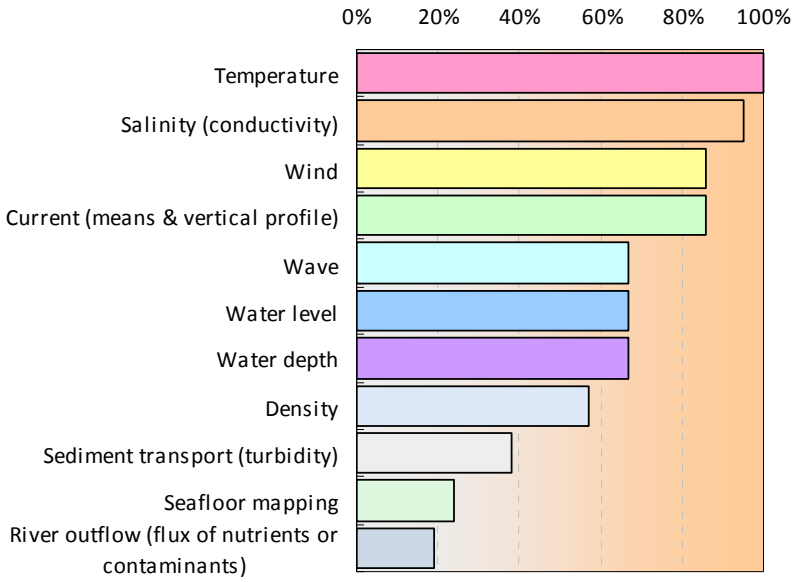
Lack of confidence in the data appears to be the main reason to not use chemical sensors. In the 'other' section were also specified reasons like:

- Reliability, not fully developed technology
- Lack of technical and scientific staff
- We concentrate on coastal hydrodynamics.
- Time to set up etc and limited stay in the water (max 2 months)

3.4 SENSORS FOR PHYSICAL MEASUREMENTS

Q1. What physical parameters do you measure using your instruments?

Answer Options	Response Percent	Response Count
River outflow (flux of nutrients or contaminants)	19,0%	4
Seafloor mapping	23,8%	5
Sediment transport (turbidity)	38,1%	8
Density	57,1%	12
Water depth	66,7%	14
Water level	66,7%	14
Wave	66,7%	14
Current (means & vertical profile)	85,7%	18
Wind	85,7%	18
Salinity (conductivity)	95,2%	20
Temperature	100,0%	21
Other, please specify		2
answered question		**21**
skipped question		**2**



Temperature and salinity were the most cited by the JERICO community with regards to physical parameters. Wind and current were also largely cited for this question. In the 'other' section were also specified parameters like:

- bioelectroactivity of biofilm
- Air temperature

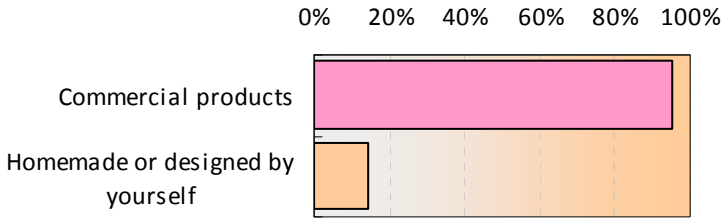
Q2. Related to the above questions, what kind of sensor technologies (Primary, secondary) do you use? (eg depth: Primary-sounder, secondary-lidar...)?

Part.	Temp.	Current	Wave	Water level	Depth	Density	Turbidity	Seafloor mapping	Flux of material	Conductivity
1	DC bridge with SPRT, CTD	ADCP, mechanical currentmeters	Wave buoys	Pressure sensors	pressure sensor	CTD	laboratory turbidimeter, commercial turbidity sensors		ADCP, acoustic velocity profilers, mechanical current meters	laboratory salinometer, CTD
2		ADCP	buoy or ACDP	pressure	pressure recorder	optical sensor	turbidity probe	sounder		electric probe
3	TS Seabird									TS, Seabird
4	platinum T (PT100) probes			float tide gauge						
5										
6	CTD	ADCP	ADCP	RADAR, Pressure gauge, Tidal gauge, acoustic		CTD				CTD
7										
8	T	ADCP	ADCP		pressure sensor					Cell
9										
10	CTD	ADCP		pressure sensor	pressure sensor					CTD
11	FSI, USA	HF radar	X band and HF radar; wave buoys	acoustic	echosounder		Turner/Endress and hauser, germany		stationary FerryBox	FSI, USA; sec. lab calibration
12										
13										
14		ADCP, GPS-controlled drifters, electromagnetic current meters	Wave buoys, ADCP, string electric wave gauges	Pressure gauges, surveying rods	single-beam echo-sounder		Laser-Doppler Partcle Size Analyser	multi-beam echo-sounder		
15	T	Doppler	accelerometer	radar	pressure, digi quarz		Optics			inductive cell
16	Seabird Microcat, SB16 and SB911	RDI ADCPs and Aanderaa RDCP (occasional)	Datawell waverider and Oceanor Wavescan	OTT Hdrometry Nimbus and Radar gauges	SIMRAD sounders on ship/boat	Seabird Microcat, SB16 and SB911		SIMRAD sounders		Seabird Microcat, SB16 and SB911
17	CTD	ADCP and at-depth measurement			pressure sensor	CTD	optical sensor		passive sampler, water samples	CTD
18	T					T & C				X
19										
20	CTD	ADCP	wave rider	tide gauge	water pressure	CTD				CTD
21	CTD SeaBird SBE37 SI	Aanderaa DCS-3900R Doppler Current Sensor	RDI Sentinel ADCP sensor	RDI Sentinel ADCP sensor	CTD SeaBird SBE37 SI	CTD SeaBird SBE37 SI	D&A OBS-3 sensor			CTD SeaBird SBE37 SI
22	T, data logger	ADCP	ADCP, buoy		pressure sensor					Cell
23										

TS= Thermosalinograph, T= thermistor, ADCP= Acoustic Doppler Current Profiler

Q3. Are your current physical sensors primarily from :

Are your current physical sensors primarily?		
Answer Options	**Response Percent**	**Response Count**
Commercial products	95,2%	20
Homemade or designed by yourself	14,3%	3
Other, please specify		1
answered question		**21**
skipped question		**2**

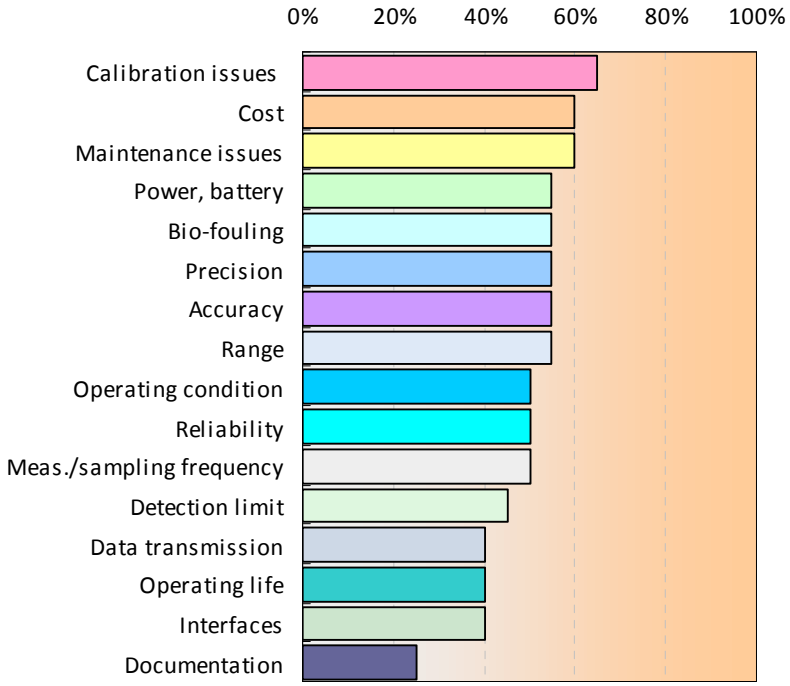


Most of the sensors for physical measurements come from commercial products. In the 'other' section was specified:

- "mainly commercial" some are fitted for special purposes"

Q4. Which of the following areas concern you about physical sensors?

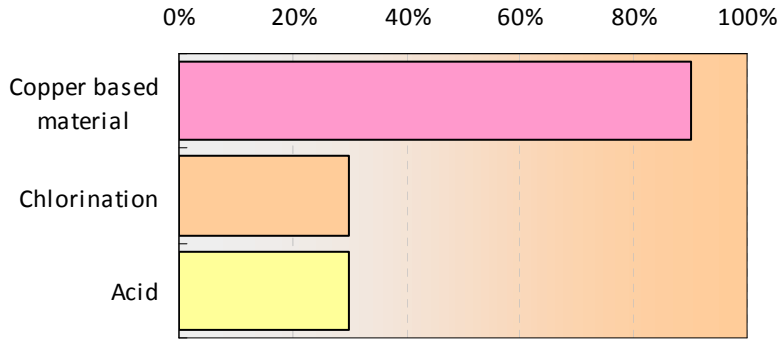
Answer Options	**Response Percent**	**Response Count**
Documentation	25,0%	5
Interfaces (input/output…)	40,0%	8
Operating life	40,0%	8
Data transmission	40,0%	8
Detection limit	45,0%	9
Measurement/sampling frequency	50,0%	10
Reliability	50,0%	10
Operating condition (pressure, corrosion etc…)	50,0%	10
Range	55,0%	11
Accuracy	55,0%	11
Precision	55,0%	11
Bio-fouling	55,0%	11
Power, battery	55,0%	11
Maintenance issues	60,0%	12
Cost	60,0%	12
Calibration issues (ease, time, frequency, automatic…)	65,0%	13
Other, please specify		0
answered question		**20**
skipped question		**3**



Calibration issues remains the most cited area of concern about physical sensors. Cost and maintenance issues are also important.

Q5. Considering bio-fouling, how do you protect your sensors?

Answer Options	Response Percent	Response Count
Copper based material	90,0%	9
Chlorination	30,0%	3
Acid	30,0%	3
Other, please describe briefly		7
answered question		**10**
skipped question		**13**

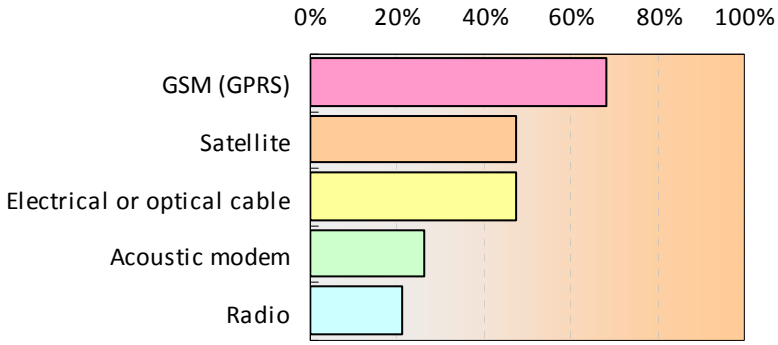


Clearly copper based material is the most common method to prevent bio-fouling. Other methods cited were:

- Wipers and TBT-based anti-foulant devices
- Copper shutters and tape
- no protection - the sensor is dedicated to monitoring on-line the bio-film development
- Regular manual cleaning on ships
- Factory-designed protection - e.g. painting
- No specific protection, periodic manual cleaning
- During FerryBox operations automatic cleaning procedure is used preventing bio-fouling; sensors on piles need up to weekly maintenance by technicians; Scanfish only short periods of operation
- Automatic washing

Q6. When using physical sensors, how do you transfer your data?

Answer Options	Response Percent	Response Count
GSM (GPRS)	68,4%	13
Satellite	47,4%	9
Electrical or optical cable	47,4%	9
Acoustic modem	26,3%	5
Radio	21,1%	4
Other, please specify		3
answered question		**19**
skipped question		**4**

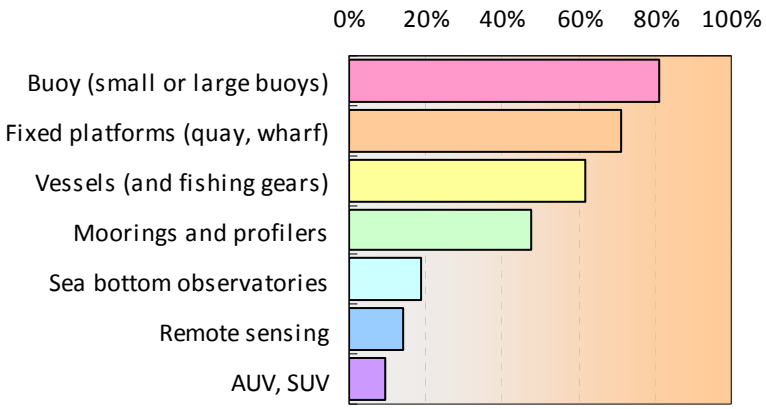


The survey shows that GSM is the most common used technology to transfer data from the sensors. In the 'other' section were specified technologies like:

- Long range WiFi
- Acoustic modem transfer imminently
- in coastal water GSM is the main carrier (low cost)

Q7. What type of platforms do you use?

Answer Options	Response Percent	Response Count
AUV, SUV	9,5%	2
Remote sensing	14,3%	3
Sea bottom observatories	19,0%	4
Moorings and profilers	47,6%	10
Vessels (and fishing gears)	61,9%	13
Fixed platforms (quay, wharf)	71,4%	15
Buoy (small or large buoys)	81,0%	17
Other, please specify		2
answered question		**21**
skipped question		**2**



As for chemical sensors, the most common platforms are buoy, fixed platform and vessels. In the 'other' section were also cited platforms such as:

- Fixed platform = quay; offshore mast
- Ships-of-opportunity, gliders, piles (shallow waters)

Q8. What, in your view comprises the next generations of physical sensors and platforms to be developed in support of coastal oceanography?

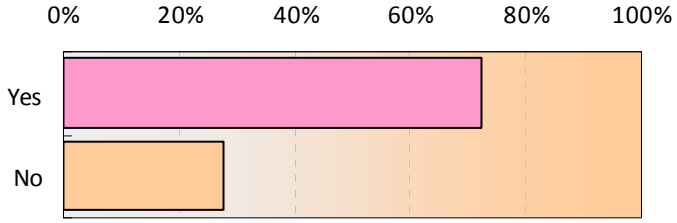
Answer Options	Response Count
	8
answered question	**8**
skipped question	**14**

The different answers about the next generation of physical sensors are listed below:

- Micro-sensors, sensor packages for AUVs, new/innovative anti-fouling technologies/techniques
- Automatic bottom-up profilers to provide coherent, fine-scale profiling of multiple oceanographic parameters
- State-of-the-art research vessel (central, multibeam platform)
- Sensors that can withstand bio-fouling and retain precision and accuracy over extended periods
- Sensors nets, gliders
- No idea
- Most physical parameters can be measured well by the existing set of sensors; smaller and cheaper sensors would be welcome
- Sensors with higher precision
- Density, low cost sensors to use within network or on vessel of opportunity

Q9. Could you avail of training and guidance in improving data quality from the sensors in use ?

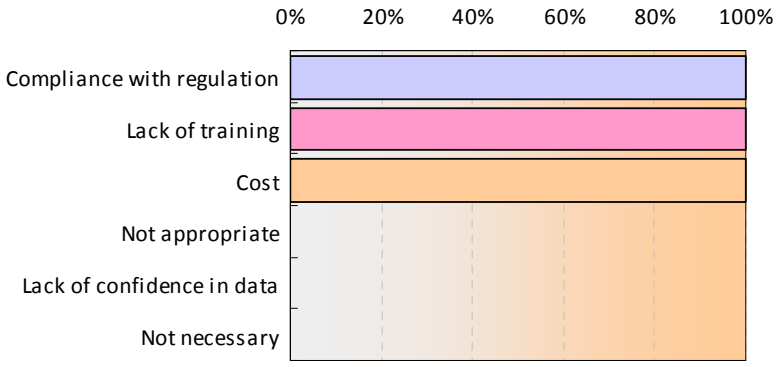
Answer Options	Response Percent	Response Count
Yes	73,7%	14
No	26,3%	5
answered question		19
skipped question		4



More than 70 % of the survey's participant can benefit to training and guidance in improving data from physical sensor measurements.

Q10. If you don't use physical sensors, what is your main reason(s)?

Answer Options	Response Percent	Response Count
Not necessary	0,0%	0
Lack of confidence in data	0,0%	0
Not appropriate	0,0%	0
Cost	100,0%	1
Lack of training	100,0%	1
Compliance with regulation	100,0%	1
Other, please specify		0
answered question		1
skipped question		22

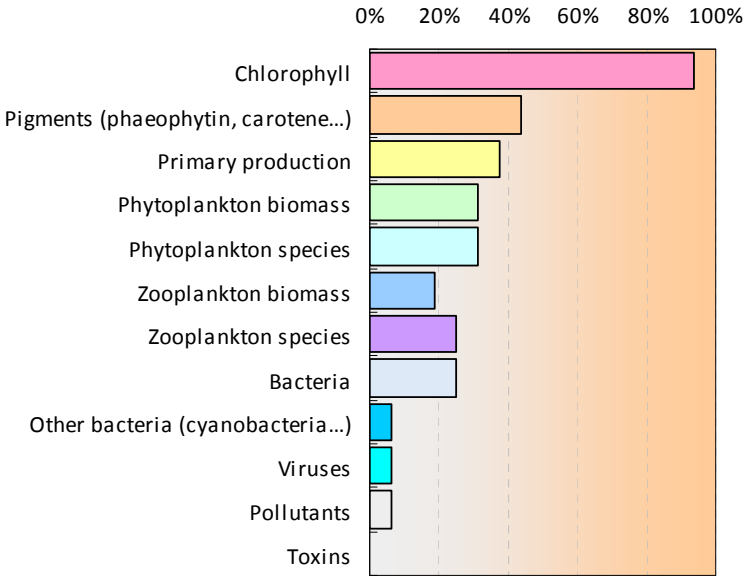


No responses were recorded for this question

4.5 SENSORS FOR BIOLOGICAL MEASUREMENTS

Q1. What biological parameters do you intend to measure most often with your sensors?

Answer Options	Response Percent	Response Count
Chlorophyll	93,8%	15
Pigments (phaeophytin, carotene…)	43,8%	7
Primary production	37,5%	6
Phytoplankton biomass	31,3%	5
Phytoplankton species	31,3%	5
Zooplankton biomass	18,8%	3
Zooplankton species	25,0%	4
Bacteria	25,0%	4
Other bacteria (cyanobacteria…)	6,3%	1
Viruses	6,3%	1
Pollutants	6,3%	1
Toxins	0,0%	0
Other, please specify		0
answered question		16
skipped question		7



Chlorophyll is clearly the most measured biological parameter within the JERICO community in front of pigments and primary production.

Q2. Related to the above questions, what kind of technologies (primary and secondary) do you use for your biological sensors ? (eg Chlorophyll : primary - fluorescence, secondary - remote sensing…)

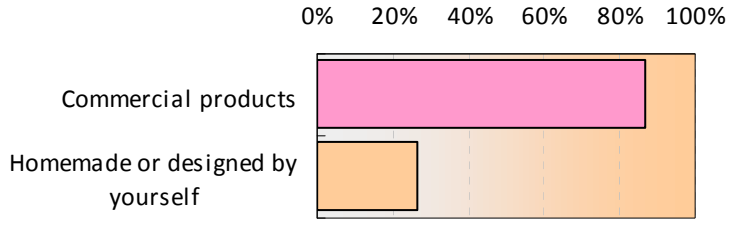
Chlorophyll	Pigments	Primary production	Phytoplankton biomass	Phyto. species	Zoo. biomass	Zooplankton species	Bacteria	Other bacteria	Viruses	Pollutants	Toxins	Other
FLUO	absorbance, FLUO											
primary and secondary Turner design SCUFA FLUO sensor		primary										
							secondary					
	FLUO, RS		RS		RS	RS						
FLUO												
FLUO												
Wetlabs FLUO												
FLUO, RS												
FLUO, Remote Sensing	FLUO	oxygen	from chlorophyll-a	cell counting								
FLUO;	AOA BBE Moldaenke; HPLC lab	O2, RS (irradiance under water)	FLUO, lab measurement of chlor-a	flowcytometry; discrete samples by microscope	CPR	CPR; instrument developed at AWI (MOKI)						molecular probes to detect dominant algal species
FLUO, RS - in situ sampling		in situ sampling	in situ sampling	in situ sampling	in situ sampling	in situ sampling	in situ sampling	in situ sampling				
FLUO Wetlabs	FLUO, Trios											
Optical sensors		optical & wet chemistry		flowcam								

FLUO=fluorescence or fluorometer, RS=Remote Sensing

Different technologies were mentioned. Fluorescence and remote sensing were the most cited ones.

Q3. Are your current biological sensors primarily?

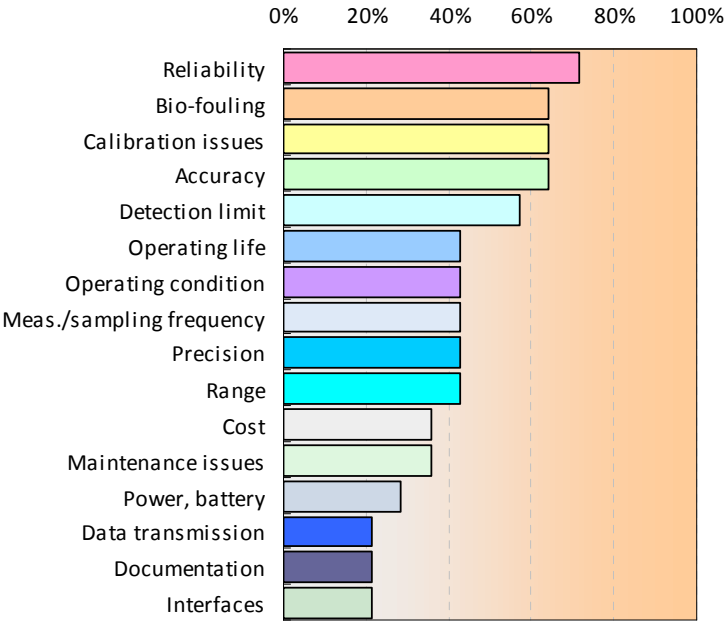
Answer Options	Response Percent	Response Count
Commercial products	87,5%	14
Homemade or designed by yourself	25,0%	4
Other, please specify		0
answered question		16
skipped question		7



Most of the sensors for biological measurements come from commercial products.

Q4. Which of the following areas really concern you with regard to biological sensors?

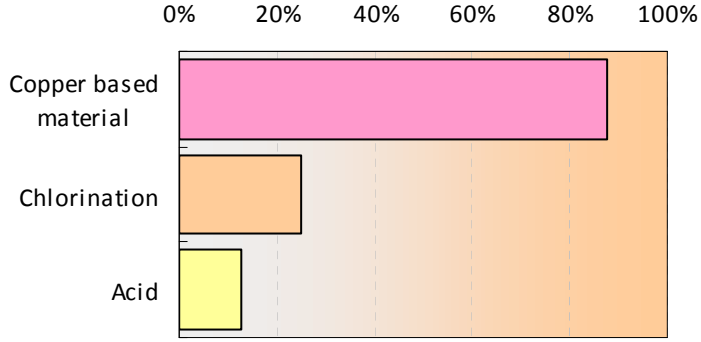
Answer Options	Response Percent	Response Count
Interfaces (input/output…)	21,4%	3
Documentation	21,4%	3
Data transmission	21,4%	3
Power, battery	28,6%	4
Maintenance issues	35,7%	5
Cost	35,7%	5
Range	42,9%	6
Precision	42,9%	6
Measurement/sampling frequency	42,9%	6
Operating condition (pressure, corrosion etc…)	42,9%	6
Operating life	42,9%	6
Detection limit	57,1%	8
Accuracy	64,3%	9
Calibration issues (ease, time, frequency, automatic…)	64,3%	9
Bio-fouling	64,3%	9
Reliability	71,4%	10
Other, please specify		0
answered question		14
skipped question		9



Reliability seems sot be the most area of concern regarding biological concern, closely followed by biofouling, calibration issues and accuracy.

Q5. Considering bio-fouling, how do you protect your sensors?

Answer Options	Response Percent	Response Count
Copper based material	87,5%	7
Chlorination	25,0%	2
Acid	12,5%	1
If yes, please describe briefly		7
answered question		8
skipped question		15

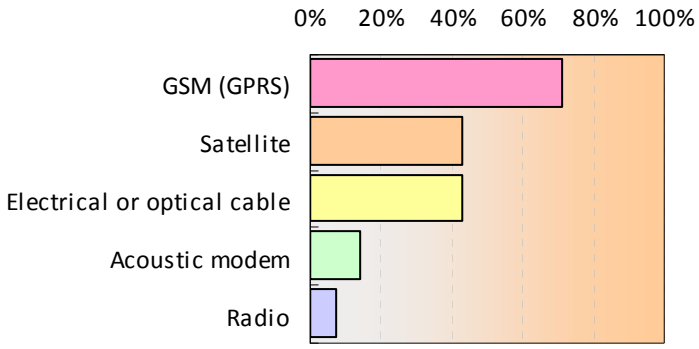


Copper based materials are the most cited method to prevent bio-fouling. Other methods mentioned were:

- wipers
- no protection
- brushes
- Frequent cleaning by technicians
- Only a system for the FerryBox has been succesfully used against bio-fouling
- copper shutters
- Automated washing

Q6. When using biological sensors, how do you transfer your data?

Answer Options	Response Percent	Response Count
GSM (GPRS)	71,4%	10
Satellite	42,9%	6
Electrical or optical cable	42,9%	6
Acoustic modem	14,3%	2
Radio	7,1%	1
Other, please specify		3
Answered question		**14**
skipped question		**9**

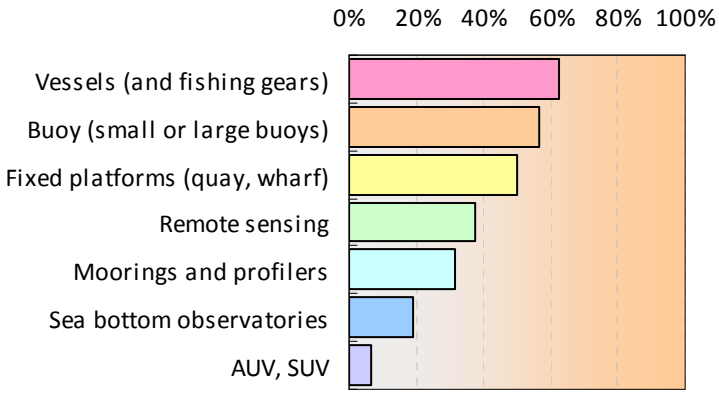


The survey again shows that GSM is the most common used technology to transfer data from the sensors. In the 'other' section were specified technologies like:

- long range wifi
- many data can only be derived from measurements in the lab
- data logger

Q7. What type of platforms do you use for your biological sensors?

Answer Options	Response Percent	Response Count
AUV, SUV	6,3%	1
Sea bottom observatories	18,8%	3
Remote sensing	31,3%	5
Moorings and profilers	37,5%	6
Fixed platforms (quay, wharf)	50,0%	8
Buoy (small or large buoys)	56,3%	9
Vessels (and fishing gears)	62,5%	10
Other, please specify		1
answered question		**16**
skipped question		**7**



As for the other sensors, the most common platforms are vessels, buoys and fixed platforms. In the 'other' section were also cited platforms such as:

- ships-of-opportunity, piles, underwater nodes at Helgoland

Q8. What in your view comprise the next generation of biological sensors and platforms to be developed in support of coastal oceanography? (please briefly describe)

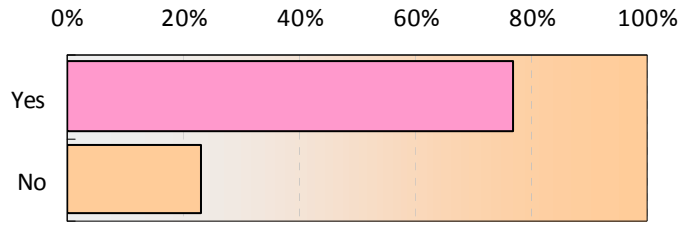
Answer Options	Response Count
	10
answered question	**10**
skipped question	**13**

The different answers to this question are listed below:

- Micro-sensors, sensors for AUVs, acoustic, cytometric & imaging technologies (including combinations)
- Sensors which give more information regarding species composition
- State-of-the-art research vessel (central, multibeam platform)
- Cytometry
- Sensors that can operate reliably and unmanned for periods > 1 month
- Better chlorophyll determination, algal species, detection of HAB, better biomass determination
- Development of sensors to measure process related parameters, to improve ways to measure zooplankton, bacteria and phytoplankton automatically
- Higher precision sensors that can be calibrated easily
- Solid standard for calibration
- Genomic sensors

Q8. Could you avail of training and guidance in improving data quality from the sensors in use?

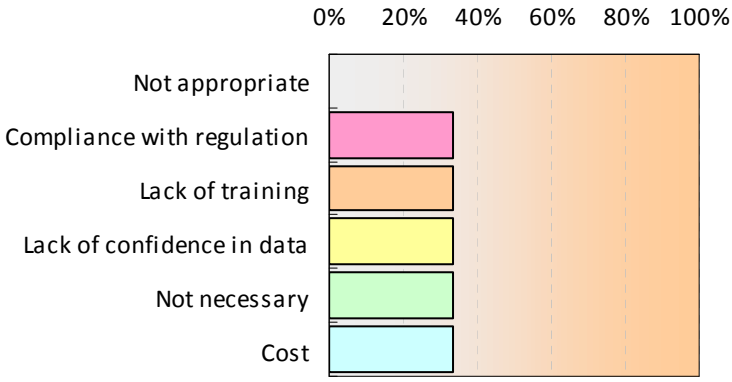
Answer Options	Response Percent	Response Count
Yes	78,6%	11
No	21,4%	3
answered question		**14**
skipped question		**9**



Almost 80 % of the survey's participant can benefit to training and guidance in improving data from biological sensor measurements.

Q9. If you don't use biological sensors, what is your main reason(s)?

Answer Options	Response Percent	Response Count
Cost	33,3%	1
Not necessary	33,3%	1
Lack of confidence in data	33,3%	1
Lack of training	33,3%	1
Compliance with regulation	33,3%	1
Not appropriate	0,0%	0
Other, please specify		1
answered question		**3**
skipped question		**20**



Responses were split between all the options. In the 'other' section were specified:

- We concentrate on coastal hydrodynamics.

4.6 VIEW ON THE FORUM FOR COASTAL TECHNOLOGIES (FCT)

Q1. How can we use the FCT to create a better link between the sensor user community and sensor industries? (please briefly describe)

Answer Options	Response Count
	13
answered question	**13**
skipped question	**10**

About half of the participants answered this question and their responses were:

- The FCT could act as a "clearing house" for information exchange and airing of issues between users and industry and vice-versa. It can also be useful as a medium for seeding new ideas/techniques/technologies both ways. It could also provide an operating framework for testing and non-judgemental evaluations of technologies
- Bring the sensor user community and sensor industries together regularly to exchange information about user requirements and technological developments
- Sensor users can share their technical/practical problems (e.g. bio-fouling problems) with sensor producers
- promoting greater interaction between the scientific requirements and related market
- Set up recommended standards
- Increasing awareness of user needs. Better feed back from users to makers on improved design for ease of use.
- Organize workshops where the industry get an idea of requirements for research and monitoring and where developers of new instruments can update the community on new developments. Create a Linked In group for the FCT to promote interaction. Foster SME attendance at some of the key JERICO workshops and summer schools.
- Transferring the information on requirements and necessity from users to the industry
- Performance demonstrations and comparisons, close cooperation with ACT-US
- Workshops, product demonstrations, web-based forum for open discussion
- Inform the sensor industry about our wishes; ask the sensor user community what the need; bring both together,
- Provide the users the opportunity to express their demands to the manufacturers
- Share information and data between the 2 communities, demo and evaluation missions

Q2. Are there other initiatives that we should be aware of/link to? (please briefly describe)

Answer Options	Response Count
	6
answered question	**6**
skipped question	**17**

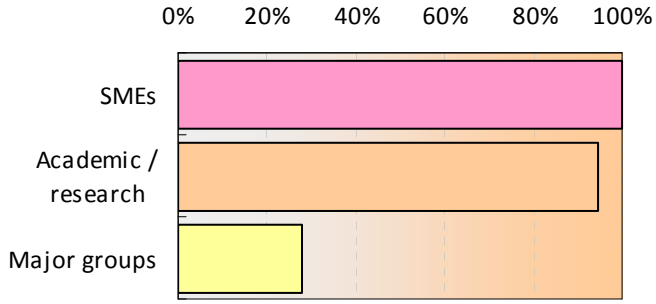
Answers were:

- Alliance for Coastal Technologies (ACT)
- Investigate if there are other initiatives dealing with this subject, if yes, try to benefit from their experience
- Following the ACt model for system assessment. Provision of testing tanks.
- US ACT led by Mario Tamburri.
- The UE Call on sensors and the groups involved on it.

- EU projects; ACT contacts; be aware that sensor technology may take place outside the normal marine sensor technology industry

Q3. Who in your opinion should be invited to participate in the FCT?

Answer Options	Response Percent	Response Count
Major groups	27,8%	5
Academic / research	94,4%	17
SMEs	100,0%	18
Other, please specify		5
answered question		**18**
skipped question		**5**

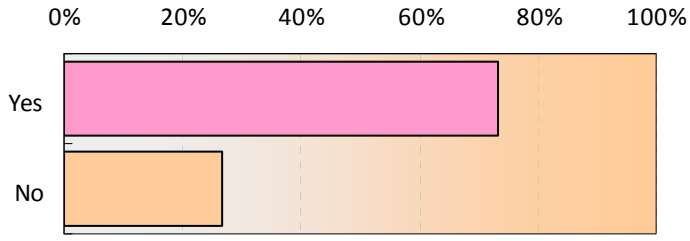


To this question, SMEs and Academic/research are reached almost 100 %. Major groups was not often cited
In the 'other' section were specified organisms like:

- Environmental agencies
- EC officials in the water technology area
- Monitoring Agencies
- as a first start of the FCT bringing together academic and SME might be sufficient to get a first view on needs and wishes;
- managers (public or private), shipping companies

Q4. As a JERICO partner, have you sufficient awareness of the companies that are involved in the development of marine sensors and platforms in your home country?

Answer Options	Response Percent	Response Count
Yes	75,0%	12
No	25,0%	4
Please briefly describe (if yes how and if no why)		13
answered question		**16**
skipped question		**7**



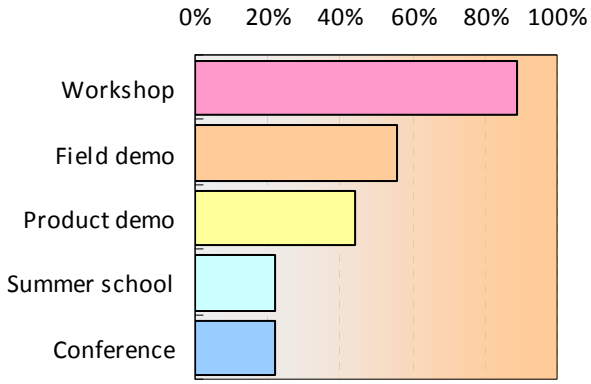
The JERICO partners seem to be sufficiently aware of the companies that develop marine sensors and platforms in their respective countries. This awareness is promoted through:

- Direct contact, Internet, publicity, newsletters, visits by representatives of companies, dialogue and exchange of information with colleagues
- Oceanology International and direct contact with companies
- The products of other italian companies as the "Resinex", "Floatex", "Ageotech" and "Gralltech"
- My interest has been directed so far to a very special niche in the industry (bio-film monitoring)
- Not aware of companies developing marine sensors in Malta
- Visit of exhibitions e. g. OI London, journals e. g. Sea Technology
- Probably could be improved
- Few sensors are developed and commercialized in Ireland for marine activities so could use more insight into European companies that have/are developing new sensors to meet my needs
- Some information for the companies involved in develop sensors
- with contacts with colleagues, exhibitions, scientific papers
- In the framework of national and international projects and workshops

- I would need input from a few other persons to cover the field but I think this maybe a simple thing to solve. The number of companies probably is not much larger than 10 (?).(Germany)
- Dealers as Luode Consulting Oy and Navarc Oy

Q5. What format should the FCT meetings take?

Answer Options	Response Percent	Response Count
Conference	22,2%	4
Summer school	22,2%	4
Product demo	44,4%	8
Field demo	55,6%	10
Workshop	88,9%	16
Other, please specify		4
answered question		**18**
skipped question		**5**



The most favorite format for the FCT meeting is workshops. Field and product demo are also often cited. Some other propositions consist of:

- All of above have their role - but key is getting user feed back to the makers which best done through activities that involve hands on time
- With interaction between users and companies.
- What can companies deliver, what are the planning to develop, which needs have scientists and operational services (may differ from science and research)
- "invite companies not involved in oceanography could be valuable
- 2 field demos for 1 or 2 parameters or 1 (2) technologies"

Q5. If you have any suggestions about the FCT and/or wishes/actions you would like the FCT to carry out, please include them below:

Answer Options	Response Count
	2
answered question	**2**
skipped question	**21**

Two suggestions were expressed:

- FCT should get a first full overview of all relevant sensor products available by asking the companies to show their portfolio; this maybe done through inspection of their respective websites; the information should also collect measuring ranges, precision, accuracy, maintenance and calibration issues of these sensors; sensors should be grouped like in this questionnaire into physical, chemical biological and subdivided in groups, e.g. nutrients, Sand T, chlorophyll, turbidity, etc.
- Web site, public reports, data bases for sensors and platforms