Data Insight through the Value of Eco-marine-robotics (DIVE)

Prepared by:

Chair: Simona Aracri
simona.aracri@cnr.it
CNR-INM

Vice-Chair: António M. Pascoal
antonio@isr.tecnico.ulisboa.pt
IST-ISR

Vice-Chair: Pramod Maurya
maurya@nio.org
NIO

Vice-Chair: Decio Crisol Donha
decdonha@usp.br
University of São Paulo

Vice-Chair: Dana Yoerger
dyoerger@whoi.edu
WHOI

Summary/Abstract (max. 250 words)

New observational robotic platforms significantly enhance ocean observations and have the potential to fill the crucial data gaps near shore, off-shore and in the deep sea, as they are capable of reaching some of the most remote areas of the planet. However, these platforms are missing fundamental elements that are limiting their wide-spread adoption by marine scientists: cost, ease of operation, data validation, overall standardisation and interoperability.

The primary outcome of an observational oceanographic mission are data and physical samples, but data policies applied in ocean sciences are not fully adopted in marine robotics, possibly compromising the quality of the data and limiting its broad use. This is because of the lack of data standards in marine robotics research.

DIVE aims at advancing best practices used in the marine sciences data management and at ensuring their implementation by the marine robotics community. These practices will include categories such as mission planning strategies, operational procedures, sensor configurations, data formats and post processing standards. Within these categories, there will be instances of calibration and logging requirements, as well as data treatment and processing protocols, and finally dataset publication guidelines.

Marine robot capabilities and the needs of oceanographic observations are continuously evolving; this co-evolution poses a considerable challenge when establishing comprehensive data and observational standards.

Ultimately, inspired by successful programmes such as Argo, DIVE will explore existing standards that can be harmonised and established within internationally recognised bodies such as ISO (International Organization for Standardization) or IEEE (Institute of Electrical and Electronics Engineers).

Scientific Background and Rationale (max 1250 words)

Background: scientific observations and marine robots

It is crucial to better understand ocean processes and their dynamics. In order to do so, we need new oceanographic observations in unexplored areas of the planet.

The temporal and spatial resolution of oceanographic data can increase by using new marine technology, which is routinely created in marine robotics labs, prototyped, and published. Few exceptions are scaled and commercialised - gliders[1]; argo[2] floats , which continue to evolve, see BGC argo and Deep argo, and then also Wave Glider[3], Saildrone[4], ASV Global[5].

Emerging technology is capable of pushing the boundaries of ocean observations, because it is capable of reaching the most remote areas of the planet and the harshest, while removing people from harm's way (Aracri et al. 2020) and decreasing the carbon footprint of ocean observations (NZNOC - Net Zero Oceanographic Capability,).

Focussing on the marine robotics data challenge will have major impacts on the robotic community by:

➔ pivoting the robotic design (hardware and software) around a specific task: ocean data collection
➔ rendering each deployment repeatable to build consistent time series
➔ enabling the reproduction and simulation of in situ missions in coupled digital twins of the ocean and of the platform
➔ planning data expeditions to facilitate the subsequent dataset dissemination
➔ accelerating the technological uptake into the Global Ocean Observing System and the Blue Economy

In validation and calibration, physical samples are also important, in this respect ROVs[6] (Remotely Operated Vehicle) and HOVs (Human-Occupied Vehicles)[7] and AUVs (Autonomous Underwater Vehicle) are now being used, contributing to sound datasets. The need to harmonise robotic data has been recognised also by programmes such as the Ocean Observatories Initiative in the US[8].

Currently marine technology development is often driven by offshore industry demands (Hastie et al. 2018, Sayed at al. 2018). However, in light of the climate crisis and the ocean decade (Guan et al. 2023, Visbeck 2018), a marine robotics task force focused on collecting unprecedented data is now needed more than ever to accelerate the marine robotics absorption into the global observing system.

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[1] https://cordis.europa.eu/project/id/284321
[2] https://argo.ucsd.edu/outreach/publications/bibliography/
[3] https://robots.ieee.org/robots/waveglider/
[4] https://www.pmel.noaa.gov/ocs/saildrone
[5] https://www.l3harris.com/all-capabilities/asview-control-system
[6] https://en.wikipedia.org/wiki/Remotely_operated_underwater_vehicle
[7] https://oceanexplorer.noaa.gov/technology/subs/hovs/hovs.html
[8] https://oceanobservatories.org/

A new robotic development paradigm dedicated to ocean observations would also unblock past data that, for the moment, cannot be used by the wider scientific community. This is because the standards to process and share these data are unavailable or too time consuming.

The valorisation of marine robotics data lies in few fundamental steps in marine technology development: sensor integration software, logging methods, geolocalisation (which encompasses sensor integration and platform telemetry logging), data formatting, and metadata supply. All these steps are indispensable to make the output data findable and interpretable by the marine scientists and beyond. In brief, these requirements make a dataset FAIR (Findable, Accessible, Interoperable, Reusable).

For instance, long and continuous time series ([Bryden et al. 2019](#)) monitoring the evolution of deep water masses are rare; such tasks can be achieved only via Eulerian monitoring, measuring the desired magnitudes in the same location over a certain period (e.g., moorings and fixed observatories) or via Lagrangian instruments such as argo floats or through gliders, although these last two are normally limited by the operational depth — max 1500 m for spray gliders ([Sherman et al. 2001](#)), max 6000 m for deep SOLO ([Roemmich et al. 2019](#)) and deep APEX argo floats. Alternatively, to measure the entire water column it is necessary to embark on oceanographic expeditions and perform hydrographic transects, typically with a CTD (Conductivity Temperature Depth) probe mounted on a Niskin rosette winched to the ship. The latter solution obviously provides excellent data, but sparse in time and at a high environmental, economical and human time costs. The rapidly emerging marine technology can be directed towards continuous deep sea monitoring for instance. With the progressive miniaturisation of marine robotics and the advent of new materials ([Aracri et al. 2021](#)), a community made of marine scientists and ocean roboticists can come together to create scalable solutions to minimise the impact, enhance continuity and increase the spatio-temporal resolution of deep ocean observations. Time series like RAPID[9] and OSNAP[10] are currently also not real-time. Real-time and near real-time monitoring would support timely and appropriate societal/policy decisions. Case in point, we know what the overturning circulation did two years ago, but not right now. Novel robotic platforms can provide real-time data.

Moreover, few fully operational robots enable marine monitoring in extreme environments such as the poles. This is the case of AUTOSUB[11], [PROTEUS](#) (Portable RObotic TEchnology for Unmanned Surveys) and [SWAMP](#) (Shallow Water Autonomous Multipurpose Platform), which took part in data campaigns in the Svalbard Archipelago (Arctic) and in Ross Sea (Antarctic). Extreme environments have an impact not only on the design of the robots and on the sampling strategies, but also on the logistics of the expedition itself, which is an important challenge for polar missions. Having a set data policy, encompassing probes calibration, sensor integration, sampling method and data dissemination also seeps into the layout of an in-situ expedition. Minding the data valorisation of oceanographic expeditions centred around marine robots focuses the

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[9] https://rapid.ac.uk/
[10] https://www.o-snap.org/
[11] https://noc.ac.uk/facilities/marine-autonomous-robotic-systems/autosubs

expedition preparation, which must also include the creation of an appropriate logging software, discussions around the data format and nomenclature ([Aracri et al. 2022](#)), future use and dissemination of the data, and so on. Robotic data, e.g. battery performance, geolocalisation, movements of the platform, constitute a key part of the environmental dataset, as they allow for a more aware data interpretation and for the repeatability of the deployment.

All the aforementioned elements render each data point gathered from marine robots in similar conditions extremely valuable. In such remote and pristine environments, the employment of robots not only minimises the impact of the observations, but also it reduces drastically the danger that personnel are usually exposed to.

These two examples, deep ocean datasets and polar exploration, are both strictly linked to the underpinning task of monitoring the evolution of the anthropogenic impact on the world ocean and they call for a multidisciplinary focus on the data policy of marine robotics.

Ultimately, rendering the coupled scientific and robotic dataset available for the wider scientific community and beyond serves multiple purposes: valuing unique data, making the deployment repeatable and consistent with previous campaigns, creating a hub of information capable to feed, for instance, the rapid growth of Digital Twins of the Ocean and supporting the development of machine learning tools to improve the weather and forecast systems.

Challenges

The major challenges for the DIVE WG (Working Group) will be to create data standards encompassing the key features of both disciplines, oceanography and robotics.

To create a standard DIVE will have to work through, and overcome several hurdles. Namely,

- create a structured interdisciplinary community to foster interdisciplinary exchange about the valorisation of a novel generation of environmental data coming from emerging marine technologies.
- depict a marine robotics panorama, including all the related rising disciplines, such as marine soft robots[12,13].
- thoroughly map the oceanographic variables onto the robotic measurements, i.e. select those variables, proper of the observational platform that identify univocally the collected environmental dataset.
- set deployment and logging protocols .

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[12] Workshop: Aquatic Soft Robots at Robosoft 2019
https://sites.google.com/view/aquaticsoftrobots/home?authuser=1
Simona Aracri, Markus P. Nemitz, Pablo Valdivia y Alvarado, Giuseppe Suaria
[13] Workshop: Ocean Soft Robots: Exploration and Data Challenge at RoboSoft 2023
https://softroboticsconference.org/workshop-info/
Simona Aracri, Ditzia Susana Garcia Morales, Zurong Zhang, Jan Peters, Francesco Giorgio-Serchi, Prof Annika Raatz, Corrado Motta, Roberta Ferretti, Francesca De Pascalis, Massimo Caccia.

- outline the FAIR data dissemination process for marine robotics data through the established data portals (SeaDataNet, Copernicus, ECMWF).

<u>Working group Motivation</u>

The state of the coupled data policies for emerging water-based technologies is too immature for it to be fit to a structured grant proposal, such as Horizon Europe or NSF. For this reason a strong international consortium is necessary to create a space where a community of experts can liaise and collaborate.

Terms of Reference (max. 250 words)

<u>Goal 1: Establish a Community</u>
Decio Crisol Donha and Simona Aracri

DIVE will create a website and an online forum ([Discord](#) or [Slack](#)). The discussions on such platforms will revolve around questions like: how the data policy impacts the design/architecture/operability of an ocean robot? How does it impact mission planning? What data protocols can and should be implemented in marine robotics for new platforms to be absorbed in oceanographic missions?

<u>Goal 2: Pilot Campaigns and Dataset Dissemination</u>
Simona Aracri and Dana Yoerger

The outcome of the initial discussion in Goal 1 will be the backbone of Goal 2. DIVE will identify a pilot deployment, which will implement the actions identified during the initial community discussion. Before an expedition, the preparation of the robots needs to effectively embed the autonomy, dexterity and resilience necessary to survey a target site. For instance, logging frequency, transmission rates, logistic and environmental constraints are all crucial elements for the groundwork on the robot and even more important to ensure a timely data dissemination and data valorisation.

<u>Goal 3: Guidelines and Best Practices</u>
Antonio Pascoal and Pramod Maurya

Ultimately, the concrete output of the WG will be to develop a set of guidelines, protocols and procedures to use as standards / best practices by officially recognised bodies such as IEEE or ISO. Standards in data policy ensure repeatability and traceability of a deployment and its data, hence actually bridging the gap between prototyped technology and commercialised platforms, which can be readily adopted in oceanography.

Working plan (logical sequence of steps to fulfil terms of reference, with timeline. Max. 1000 words)

<u>Towards goal 1:</u>
DIVE will set the community discussion on the impact of data policy on the robotic architecture, on the field missions of novel observational platforms and on the oceanographic-robotics gap as far as data protocols are concerned. Shifting through the established data policy in oceanography that need to be embedded in marine robotics will enable a critical analysis of past and future coupled datasets (robotic and environmental),

from field campaigns involving emerging marine technology and will allow the working group to extract the elements that hindered the dissemination and the validation of the environmental and robotic data. With robotic data we refer to those variables that facilitate the repeatability of a given deployment.

Towards goal 2:

The outcome of the forum and WG discussion will allow us to revise the robot architecture within at least one field mission, planned within one of our active projects. From such a pilot campaign, DIVE will compile a report and disseminate the resulting coupled dataset. During this phase DIVE's community discussion will continue and will build on the data campaign experience. A first dataset publication limited to the manoeuvrability of a marine vehicle is reported in Ferretti et al. 2023.

Towards goal 3:

DIVE's work and forum discussions towards the creation of a common standard will also build on the work led by CNR-INM in the past year (Aracri et al. 2022), which automatises the creation of a FAIR coupled dataset, fit for publication in the most widespread data repositories (SeaDatanet[14], Copernicus[15], Ocean Sites[16]) with the aid of an open source software[17], developed to support marine scientists and roboticists in the process. To accelerate the technological uptake in marine sciences (e.g. EOOS Technology Forum[18]) DIVE will liaise with official standard bodies such as ISO and IEEE to lay the foundation for an official data policy capable of enabling the consistent deployment of diverse platforms, in order to create valuable inter-platform data series and unprecedented data, ontologically unique in unexplored areas of the ocean.

Timeline

The first year will be dedicated to build a community to discuss the current data protocols, ubiquitous in oceanography, and their adoption into the marine robotic domain. For this reason DIVE will create a website to share the progress of the group and an online forum to host the discussion. These two tools will catalyse a proactive community around DIVE. The first WG meeting, at Ocean Sciences Meeting (OSM), in New Orleans, February 2024, which will happen in hybrid form to enhance inclusivity and minimise environmental and economical impact. During the first WG meeting we will discuss the appropriate locations for future meetings. Relevant conferences might be EGU 2025, Vienna and OCEANS 2026 (Asia) or alternatively Breaking the Surface[19] and the Marine Robotic School at CSIR NIO in Goa. In 2025 and 2026 DIVE will contribute to the conference with a scientific contribution such as conference paper/talk/poster. In addition to the WG's members hybrid meeting (virtual and in person), we will organise a

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[14] SeaDataNet PAN-EUROPEAN INFRASTRUCTURE FOR OCEAN & MARINE DATA MANAGEMENT https://www.seadatanet.org/

[15] Copernicus Marine Data Store https://data.marine.copernicus.eu/products

[16] OceanSITES http://www.oceansites.org/

[17] https://corradomotta.github.io/FAIR-Data-in-Marine-Robotics/html/index.html

[18] https://www.eoos-ocean.eu/wp-content/uploads/2022/08/EOOS-Tech-Forum-report-2022.pdf

[19] https://bts.fer.hr/

hybrid workshop (e.g. Ocean Soft Robots workshops[20,21]) dedicated to the DIVE's community that we will create via virtual forum discussion and the website. These interconnected workshops, in addition to the DIVE virtual forum, will establish a continuous communication among disciplines with active participation of members belonging to both communities, weaving together an extended cross disciplinary network. Such an extended network will promote funding opportunities for young scientists and not only to travel to such workshops.

The exchange around robotic data policies will reverberate through robots architecture, mission planning and data dissemination. During the second year, DIVE will focus on a compelling use case, one or more members of the working group will apply the identified data policy gaps to their planned exploration, under the umbrella of other research projects. This activity will allow for the WG to apply what was learned during the first year discussion, which will continue in light of the preparation and outcome of the pilot deployment. The results and lessons learnt will feed DIVE's second meeting, also in the hybrid form, alongside a chosen conference. One of the aims of the second DIVE meeting will be to identify funding opportunities to support the activity of the group in future years. DIVE will also support young scientists via the POGO-SCOR Fellowship Program to host an early career researcher from a developing country at one of the member institutes, for them to have access to the local facilities and to accelerate their learning process in marine robotics with a particular focus to the data management impact.

During the third year DIVE will lay out a structured data policy and best practices, stemming from the work of the first two years. We will liaise with an internationally recognised standard body such IEEE SA[22] (if possible also ISO[23] or BODC[24]). The standard that we envisage aims at valorising the oceanographic observations and the robotic data gathered by emerging marine platforms.

Budgeting

An approximate distribution of expenditure would be a mean of 1500$ per member per meeting (3 meetings x 10 members x 1500$).
For instance EGU would cost approximately 1800$ if travelling from South Korea -500$ (early bird registration), 500$ (accommodation) and 650$ (flight from Seoul), 150$ (meals) -.
The same conference would cost 1200$ travelling from Italy -500$ (early bird registration), 500$ (accommodation) and 50$ (flight from Milan), 150$ (meals) -.

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[20] Workshop: Aquatic Soft Robots at Robosoft 2019
https://sites.google.com/view/aquaticsoftrobots/home?authuser=1
Simona Aracri, Markus P. Nemitz, Pablo Valdivia y Alvarado, Giuseppe Suaria
[21] Workshop: Ocean Soft Robots: Exploration and Data Challenge at RoboSoft 2023
https://softroboticsconference.org/workshop-info/
Simona Aracri, Ditzia Susana Garcia Morales, Zurong Zhang, Jan Peters, Francesco Giorgio-Serchi, Prof Annika Raatz, Corrado Motta, Roberta Ferretti, Francesca De Pascalis, Massimo Caccia.
[22] https://standards.ieee.org/
[23] https://www.iso.org/home.html
[24] https://www.bodc.ac.uk/

- ➔ D1 - DIVE website release
- ➔ D2 - Virtual Forum
- ➔ dissemination article describing the memorandum of understanding of DIVE, possible publishing magazines are [Oceanography](#) and [IEEE RAM](#).
- ➔ D3 - Pilot campaign report
- ➔ D4 - Pilot campaign FAIR coupled dataset publication
- ➔ D5 - Best Practices publication in https://www.oceanbestpractices.org/journal/
- ➔ D6 - White paper publication outlining the structure of a marine robotics data internationally recognised standard

Young Scientists Community

One of the important legacies that DIVE intends to leave is a vibrant community of scientists at all career levels interested in broadening the impact of technology in marine sciences. Special attention will be dedicated to young and early career scientists. The online forum and the hybrid format of the interconnected workshops are meant to catalyse the interest of young researchers and to enhance inclusivity. During such workshops smaller thematic tables (breaking rooms) will stimulate participation. The DIVE website will keep the recordings of the workshops, as well as reports and publications. DIVE will meet during marine conferences (robotics and Earth sciences) that encourage young scientists participation and have in place funding opportunities for young researchers and scientists coming from developing countries to travel to the same conference.

Co-funding

A strategic choice of conferences will allow the WG to benefit from the research funding of the members who would independently travel to the conference (co-funding). Such choice will widen the discussion to experts in both disciplines, in fact (young) scientists belonging to the research groups of the WG members could pertain to both the robotics and marine realm, given the nature of the choice of the consortium constituents.

Developing countries participation

When choosing the location and conference for the WG annual meeting DIVE will consider events taking place in or close to developing countries (e.g. Marine Robotic School at CSIR NIO in Goa). Moreover online participation to the meetings and workshops will be open for young researchers coming from developing countries. DIVE will make sure to share publications, lectures and grey literature branching from the WG on the dedicated website.

Workshop network

In fact, alongside the WG annual meeting, DIVE will create a workshop series open to all the interested scientists with the aim of nourishing the marine technology interdisciplinary community. The workshop series will also share DIVE progresses with the wider scientific community. The workshops, discussions and resulting reports will be freely accessible on DIVE's webpage and online forum to allow interactive and inclusive discussion.

Funding applications

Over the course of DIVE's activity, especially starting from the second yearly WG meeting, the members will come together to apply for further funding to finance the enterprise of the WG. In addition to this, DIVE will seek funding through the POGO-SCOR Fellowship Program to host an early career researcher from a developing country at one of the member institutes.

Commercialisation

DIVE's mission, centred on environmental and robotic data gathered by emerging marine technology, will identify the commercial gaps that hinder the ocean robotic uptake, hence the working group will take care of disseminating its outcome also within its industrial network. The Synthesis of the Dialogues with Industry Report[25] recently published by GOOS (Global Ocean Observing System) also includes a discussion about the role of data and data access in the business development of ocean technology.
A further development of DIVE will also be to facilitate the commercialisation of those fully operational marine platforms that are needed the most and are already employed in ocean observations.

Working Group composition (as table). Divide by Full Members (10 people) and Associate Members, taking note of scientific discipline spread, geographical spread, gender balance, and participation by early-career scientists (max. 500 words)

The aim of this SCOR working group is to create an interdisciplinary focus on the integration of emerging marine technologies and ocean sciences. Hence the chosen members belong to institutes and research groups which contribute to both oceanography and robotics. DIVE members will then represent their multidisciplinary groups.
Moreover, marine robotics is a strongly male dominated environment (Lupu et al. 2022) therefore the creation of a gender balanced group is particularly challenging. DIVE will promote diversity within its upcoming community, starting by fostering an inclusive environment among young researchers during the annual meetings and workshops.

DIVE's consortium is made of 10 full members and 10 associated members, coming from Oceania, Africa, Europe, North America and South America for a total of 17 countries involved.

The composition of the working group encompasses both senior members with extensive experience in their respective fields and early career scientists.

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[25] https://goosocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=32076
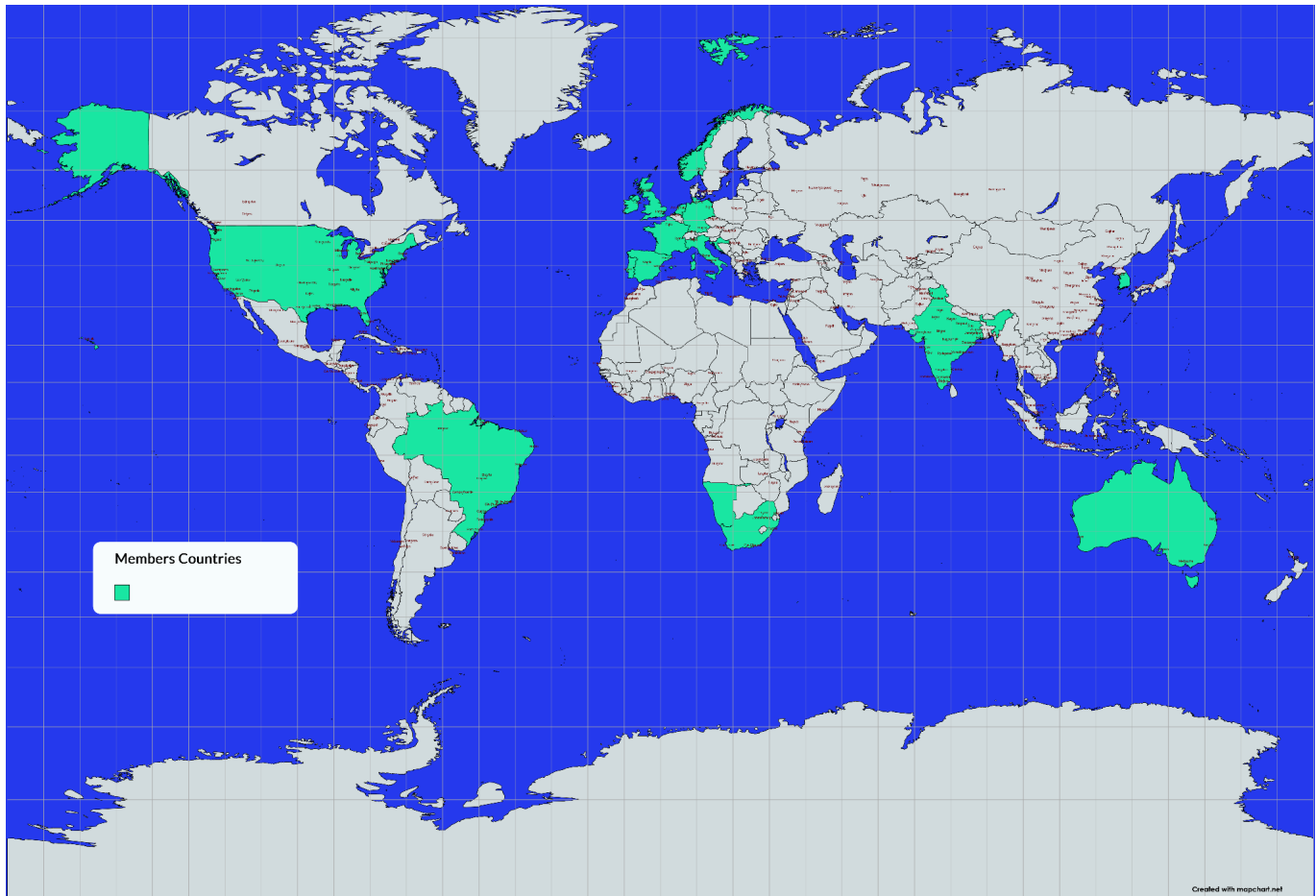
Name	Gender	Institute	Country	Expertise
1 Simona Aracri (Chair)	F	CNR-INM	Italy (Europe)	Marine Science/Robotics
2 Samuel Mafwila	M	University of Namibia (UNAM)	Namibia (Africa)	Marine Science
3 Marieke Femke de Jong	F	NIOZ Royal Netherlands Institute for Sea Research	Netherlands (Europe)	Marine Science
4 António M. Pascoal (Vice-chair)	M	IST-ISR Instituto Superior Técnico-Institute for Systems and Robotics	Portugal (Europe)	Marine Robotics
5 Johanne Vad	F	The University of Edinburgh	UK (Europe)	Marine Science

6 Jinwhan Kim	M	KAIST	South Korea (Asia)	Marine Robotics
7 Pramod Maurya (Vice-chair)	M	NIO National Institute of Oceanography	India (Asia)	Marine Robotics
8 Dana Yoerger (Vice-chair)	M	WHOI Woods Hole Oceanographic Institution	USA (North America)	Marine Science/Robotics
9 Decio Crisol Donha (Vice-chair)	M	University of São Paulo	Brazil (South America)	Marine Robotics
10 Beatrice Tomasi	F	NORCE	Norway (Europe)	Marine Robotics

Associate Member (no more than 10)

1 Elena Ceballos	F	University of Sevilla, ETSIE WHOI Woods Hole Oceanographic Institution	Spain and USA (Europe and North America)	Marine Science
2 Emma Heslop	F	IOC - UNESCO	France (Europe)	Marine Science
3 Stefan Williams	M	University of Sydney	Australia (Oceania)	Marine Robotics
4 Tommy Bornman	M	Nelson Mandela University	South Africa (Africa)	Marine Science
5 Alejandra Sanchez-Franks	F	NOC	UK (Europe)	Marine Science
6 Koena Mukherjee	F	National Institute of Technology Silchar	India (Asia)	Marine Robotics

7 Fausto Ferreira	M	University of Zagreb	Croatia (Europe)	Marine Robotics
8 Martin Visbeck	M	GEOMAR Helmholtz Center for Ocean Research Kiel and Kiel University	Germany (Europe)	Marine Science
9 Christoph Waldmann	M	MARUM	Germany (Europe)	Marine Robotics
10 Fiona Grant	F	Marine Institute	Ireland (Europe)	Marine Policy

Stakeholders

IOC - UNESCO	associate member Hemma Heslop - Acting Director of the Global Ocean Observing System
IEEE	associate member Christoph Waldmann - chair of the Standing Committee on Standards of the IEEE Oceanic Engineering Society
ISO	associate member Christoph Waldmann - German representative for TC 8/SC 13
WDC (World Data Center)	http://wdc.org.ua/en

Working Group contributions (max. 500 words)

Detail for each Full Member (max. 2 sentences per member) why she/he is being proposed as a Full Member of the Working Group, what is her/his unique contribution?

Simona Aracri - permanent researcher at the Italian National Research Council - Institute of Marine Engineering - is the coordinator of DIVE, and the co-chair of Goal 1 and Goal 2. As a sea going scientist and physical oceanographer she has extensive experience in oceanographic observations and a postdoc in offshore robotics.

António M. Pascoal - associate professor of IST, senior researcher at ISR - is the co-chair of Goal 3. He has coordinated and participated in a large number of international projects that have led to the design, development, and field-testing of single and multiple autonomous marine vehicles and systems in cooperation with partners in India, USA, Korea, and Europe

Pramod Maurya - principal scientist at CSIR – National Institute of Oceanography, Dona Paula, Goa - is the co-chair of Goal 3. His research encompasses marine Robotics, coral reef monitoring and the interconnection between science and technology.

Decio Crisol Donha - head of the mechanical engineering department at the Polytechnic School of USP - he is co-chair of Goal 1. Decio specialises in naval and oceanic engineering and control/automation of vehicular systems. Their expertise.

Dana Yoerger - senior scientist at the Woods Hole Oceanographic Institution and a researcher in marine robotics - he is the co-chair of Goal 2. His research applies automation principles to remotely operated and independent underwater vehicles, enhancing their capability, enabling them to explore ocean depths, and making them easier to use.

Samuel Mafwila - director of Sam Nujoma Marine and Coastal Resources Research Centre (SANUMARC), University of Namibia, Henties Bay, Namibia - he is a marine scientist specialised in physical and biological oceanography. He will contribute to DIVE with his more than 20 years working experience in both the public and private sectors, in fisheries and international projects.

Marieke Femke de Jong - senior scientist at the Royal Netherlands Institute for Sea Research, Texel, Netherlands. She is a physical oceanographer, PI in the Overturning of the Subpolar North Atlantic Project (OSNAP), with DIVE she is bringing her multi year experience in in-situ data and data processing and insights in the role of ocean circulation in climate.

Johanne Vad - postdoctoral research associate, School of Geosciences, University of Edinburgh - she will provide her expertise about marine habitats, in particular sponge grounds, anthropogenic impact in the marine ecosystem. Her knowledge will be important to design a meaningful robotic deployment and subsequent data interpretation.

Jinwhan Kim - professor, Department of Mechanical Engineering (co-affiliated with Graduate School of Ocean Systems Engineering and Robotics Program), KAIST, Korea - His expertise in marine robotics, vehicle guidance and navigation will facilitate DIVE to adapt the robot control to a particular data mission.

Beatrice Tomasi - senior scientist at the Norwegian Research Center, Bergen, Norway. Information scientist and technologist, PI of the MarTERA UNderwater robotics with multi-moDal communIcation and Network-Aided positioning system (UNDINA) project. Her knowledge of underwater robotics, underwater communications and positioning systems will contribute to the appropriate data transmission and localisation during marine robotic deployment.

Relationship to other international programs and SCOR Working groups (max. 500 words)

DIVE will interface with the SCOR Working Group 164 CoNCENSUS[26]: Advancing standardisation of COastal and Nearshore demersal fish visual CENSUS techniques. DIVE's coordination, in fact, already collaborates with CoNCENSUS's associate member, Laura Ghigliotti. The common intent of standardising oceanographic data coming from emerging marine robotic platforms and visual underwater data overlaps not only in the data policy realm, but also in the instrument integration with the observational platform and the field mission planning.

Members of DIVE - A. Pascoal and P. Maurya- participated in the SCOR Working Group 118 - New Technologies for Observing Marine Life[27] which aimed at making marine scientists aware of novel methods (that included the use of marine robots) to dramatically improve the techniques available for ocean and marine life observation. The new proposed group, DIVE, goes one step further, because it wants to address important issues related to the methodologies used for proper data acquisition including strategies for ocean data acquisition at the proper spatial and temporal scales, data interpretation and classification and standards for data dissemination.

Key References (max. 500 words)

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[26]https://scor-int.org/group/concensus-advancing-standardisation-of-coastal-and-nearshore-demersal-fish-visual-census-techniques/
[27]https://scor-int.org/group/118/

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ANTONIO PASCOAL

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9th May 2023

Application for SCOR Working Group: Data Insight through the Value of Eco-marine-robotics (DIVE)

To Whom it May Concern,

I am writing to support the Working Group proposal DIVE.

This proposal aims at promoting and introducing best data practices in the marine sciences to the marine robotics community in order to value and disseminate data gathered by emerging robotic platforms. The focus of DIVE – marine robotic data – reverberates through mission planning strategies, operational procedures, sensor configurations, data formats, post processing standards, e.g. calibration and logging requirements, data treatment and processing protocols, and dataset publication guidelines. The group will also address educational and training needs.

DIVE proposal addresses crucial aspects of the technological uptake in the ocean sciences realm, therefore I am glad to endorse DIVE submission.

Yours sincerely,

Rajesh Nair
Co-chair, Technology Plan Working Group
European Global Ocean Observing System (EuroGOOS)

Date of Signature: 09/05/2023
E:mail rnair@ogs.it

8th May 2023

Application for SCOR Working Group: Data Insight through the Value of Eco-marine-robotics (DIVE)

To Whom it May Concern,

I am writing to support the Working Group proposal DIVE. The DIVE proposal seeks to promote and introduce the best data practices in the field of marine sciences to the marine robotics community, in an effort to value and spread data gathered by new robotic platforms. This focus will affect mission planning strategies, operational procedures, sensor configurations, data formats, post processing standards (such as calibration and logging requirements), data treatment and processing protocols, and dataset publication guidelines, as well as any educational and training needs. Due to its important implications for technological uptake in the ocean sciences, I am pleased to endorse the DIVE submission.

Yours sincerely,

Dr Sandy Thomalla

Research Group Leader
Ocean Systems and Climate
Southern Ocean Carbon-Climate Observatory
CSIR, Holistic Climate Change, Smart Places
Tel: +27 (0)21 658 2764

Board members: Prof. T. Majozi (Chairperson), Ms P. Baleni, Dr A. Childs, Dr R. Masango, Mr S. Masie, Ms T. Mokhabuki, Dr V. Mthethwa, Mr J. Netshitenzhe, Dr C. Render, Mr C. Shariff, Dr T. Dlamini (CEO)

www.csir.co.za

11th May 2023

Application for SCOR Working Group: Data Insight through the Value of Eco-marine-robotics (DIVE)

To Whom it May Concern,

I am writing to support the Working Group proposal DIVE.

This working group wants to facilitate in-depth knowledge sharing between marine scientists, robotics developers, and data scientists. The group's reach extends beyond its own members, to include expert networks and the wider community. DIVE will keep marine scientists and roboticists informed of new marine observation platforms, as well as provide a platform for discussing the political and technical intricacies that may arise, to finally deliver coupled environmental and robotic dataset following the FAIR principles.

Yours sincerely,
Dr. Christoph Waldmann
Chair of the IEEE OES Standing Committee on Standards

Date of Signature: 11/05/2023
Email waldmann@uni-bremen.de

![EuroGOOS — European Global Ocean Observing System logo]

EuroGOOS AISBL

Rue Vautier 29

1000 Brussels

Belgium   **12 May 2023**

Application for SCOR Working Group: Data Insight through the Value of Eco-marine-robotics (DIVE)

To Whom it May Concern,

I am highly supporting the Working Group proposal DIVE. This working group intends to facilitate in-depth knowledge sharing between marine scientists, robotics developers, and data scientists. The group's reach extends beyond its own members, to include expert networks and the wider community. DIVE WG will keep marine scientists and roboticists informed of new marine observation platforms, as well as provide a platform for discussing the political and technical intricacies that may arise, to finally deliver coupled environmental and robotic datasets following the FAIR principles.

Yours sincerely,

Inga Lips
Secretary General

Email: inga.lips@eurogoos.eu

IEEE Oceanic Engineering Society
445 Hoes Lane
Piscataway, NJ 08854
Tel: +1 352-872-5544

9 May 2023

Application for SCOR Working Group: Data Insight through the Value of Eco-marine-robotics (DIVE)

To Whom it May Concern,

I am writing to support the Working Group proposal DIVE. This working group wants to facilitate in-depth knowledge sharing between marine scientists, robotics developers, and data scientists. The group's reach extends beyond its own members, to include expert networks and the wider community. DIVE will keep marine scientists and roboticists informed of new marine observation platforms, as well as provide a platform for discussing the political and technical intricacies that may arise, to finally deliver coupled environmental and robotic datasets following the FAIR principles.

Best regards,

Christopher Whitt
IEEE Oceanic Engineering Society President
(president@ieeeoes.org)
Date of Signature: 10/05/2023

Rome 12th May 2023

Application for SCOR Working Group: Data Insight through the Value of Eco-marine-robotics (DIVE)

To Whom it May Concern,

This is a letter of support for the proposal of the DIVE Working Group.

The development of new marine robotic platforms for ocean observations has significantly improved monitoring in near-shore, off-shore, and deep-sea areas. These robots have different levels of performance, but their progressive use by the marine scientific community is slowed by the lack of agreement on issues such as data validation and standardization. Data acquisition in oceanographic missions is a key element in marine science and technology research, but marine robotics developers, vendors, and operators are not fully aware of the scope of current data policies. This compromises the technological uptake of marine robotics. To address this issue, DIVE aims to advance and standardise best practices among marine scientists and ensure their endorsement by the marine robotics community. Such data practices involve, among others, robotics mission planning, operational procedures, sensor configurations, data formats, and post-processing protocols.

For the fundamental contribution that the working group intends to offer to the marine community I am glad to support DIVE.

Yours sincerely

Juan José Dañobeitia
EMSO ERIC Director General

Date of Signature: 12/05/2023
Email: juanjo.danobeitia@emso-eu.org