# VLIZ RESEARCH FRAMEWORK

## JANUARY 2018

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# VLAAMS INSTITUUT VOOR DE ZEE VLIZ

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# PREAMBLE

VLIZ was established in 1999 and since then has a **multidisciplinary** character, supporting all marine research disciplines and some thousand marine scientists in Flanders.

VLIZ **supports** networks of marine **scientists**, provides access to the research vessel Simon Stevin and other research equipment and infrastructure, develops data systems and data products and manages research data at the service of Marine Research Groups. The VLIZ library is a gateway for marine scientists and the wider public to various collections of physical documents and online information, contributing to the enhancement, visibility and use of the Flemish marine scientific output. Policy relevant products and services, such as the Compendium for Coast and Sea are provided to the marine research community, policy makers and industry. VLIZ is a strong advocate of Ocean Literacy and promotes Flemish marine scientific research through exhibitions, public meetings, publications, public presentations, websites, seminars, workshops and symposia.

The above mentioned **core activities of VLIZ**, supporting marine research at Flemish universities and knowledge institutions, **continue in 2017 and beyond**. Since 2017, VLIZ has also been mandated to **initiate and perform research**, at the service of, in **collaboration** with or **complementary** to the Flemish and international Marine Research Groups. To this end, this VLIZ research framework has been developed. It describes the research themes VLIZ wants to actively pursue and transparently communicates VLIZ' research ambitions. The implementation of the research activities in concrete projects will be detailed in yearly work plans/research agendas. Research by VLIZ aims to create an added value in the Belgian marine research landscape through multidisciplinary research activities, collaborating with, complementing and strengthening other Marine Research Groups. Throughout all research activities, options for the **valorisation of data and infrastructure** will be evaluated and applied.

**Collaborations** may take various forms, depending on the needs and scale of the research activities. Examples are co-promotorship and/or supervision of MSc or PhD students, collaborative applications of research infrastructure and/or data, joint development and execution of sampling campaigns or experimental design, bringing together partners with complementary expertise and preparing joint project proposals for external financing at national and international level.

In the implementation of this research framework, there will be three possible **roles for VLIZ**. For **data** or **infrastructure driven** research activities, VLIZ can initiate, lead and perform research (preferably in collaboration with other research groups when relevant and possible). For **research activities outside the active field of Flemish Marine Research Groups**, VLIZ can initiate, lead and perform complementary research, seeking collaboration with other research groups through an Ad hoc Expert group. For **detected research needs in the field of currently active Marine Research Groups**, VLIZ will stimulate the initiation of projects lead by the respective Marine Research Groups and promote and take part in interdisciplinary collaboration when relevant and possible, offering the possibility to compose an Ad hoc Expert group. The **Scientific Board** will be notified of all Expert group meetings and initiated research projects.

Research at VLIZ is structured in **six large research themes**, most of which are sub-divided in sub-themes. All themes allow for a **multidisciplinary** approach to fundamental as well as applied research. Whereas themes I to IV have a certain focus in their content, themes V and VI have a broader scope. This does not reflect an unlimited research ambition, but allows

VLIZ to respond to new policy-driven research needs (complementary to or in collaboration with policy supporting research institutions), and to collaborate with other research groups in high-risk research or to perform fast research related to out-of-the-box ideas. Multidisciplinary **Centres of Excellence** and enabling **platforms** will support research at VLIZ as well as in Flemish Marine Research Groups.

Through this research framework, we aim to strengthen the Flemish marine research community and contribute to VLIZ' mission: to promote the **accumulation of marine knowledge and excellence in marine research** in Flanders.

# PREAMBULE

VLIZ is opgericht in 1999 en heeft sindsdien een **multidisciplinair** karakter, waarbij het alle disciplines van marien onderzoek, en op die manier een duizendtal mariene wetenschappers in Vlaanderen, ondersteunt.

VLIZ **ondersteunt** netwerken van mariene **wetenschappers**, voorziet toegang tot het onderzoeksschip Simon Stevin en andere onderzoekinfrastructuur, ontwikkelt datasystemen en dataproducten en beheert onderzoeksgegevens ten dienste van Mariene Onderzoeksgroepen. De VLIZ-bibliotheek is een toegangspoort tot verscheidene collecties van fysieke documenten en online informatie voor mariene wetenschappers en het bredere publiek. Op die manier draagt ze bij tot een verbetering, een verhoogde zichtbaarheid en een groter gebruik van Vlaamse mariene wetenschappelijke output. Beleidsrelevante producten en diensten, zoals het Compendium voor Kust en Zee, worden aangeboden aan de mariene onderzoeksgemeenschap, beleidsmakers en de industrie. VLIZ is een sterke verdediger van oceaangeletterdheid en promoot Vlaams marien wetenschappelijk onderzoek door middel van tentoonstellingen, publieke vergaderingen, publicaties, publieke presentaties, websites, seminaries, workshops en symposia.

De hierboven vermelde **kernactiviteiten** van VLIZ, ter ondersteuning van marien onderzoek aan Vlaamse universiteiten en kennisinstellingen, **duren voort** in en **na 2017**. Sinds 2017 is VLIZ ook gemandateerd om **onderzoek** te **initiëren en uit te voeren**, ten dienste van, in **samenwerking** met of **complementair** aan de Vlaamse en internationale Mariene Onderzoeksgroepen. Daartoe werd deze VLIZ-onderzoeksstrategie ontwikkeld. Ze beschrijft de onderzoeksthema's waar VLIZ actief op wil inzetten en communiceert transparant over VLIZ' onderzoeksambities. De implementatie van de onderzoeksactiviteiten in concrete projecten zal worden uitgewerkt in jaarlijkse werkplannen/onderzoeksagenda's. Onderzoek door VLIZ heeft tot doel om een toegevoegde waarde te creëren in het Belgische mariene onderzoekslandschap door multidisciplinaire onderzoeksactiviteiten. Daarbij wil VLIZ samenwerken met andere Mariene Onderzoeksgroepen, hen aanvullen en versterken. Bij alle onderzoeksactiviteiten zullen mogelijkheden voor de **valorisatie** van **data** en **infrastructuur** worden geëvalueerd en toegepast.

**Samenwerkingen** kunnen verschillende vormen aannemen, afhankelijk van de noden en de schaal van de onderzoeksactiviteiten. Voorbeelden zijn co-promotorschap en/of begeleiding van MSc of PhD studenten, samenwerkend gebruik van onderzoeksinfrastructuur en/of data, gezamenlijke ontwikkeling en uitvoering van staalnamecampagnes of het uittekenen van experimenten, het samenbrengen van partners met complementaire expertise en het voorbereiden van gezamenlijke projectvoorstellen voor externe financiering op nationaal en internationaal niveau.

Bij de implementatie van deze onderzoeksstrategie zullen er drie mogelijke **rollen** zijn **voor VLIZ**. Voor door **data** of **infrastructuur gedreven** onderzoeksactiviteiten kan VLIZ onderzoek initiëren, leiden en uitvoeren (bij voorkeur in samenwerking met andere onderzoeksgroepen wanneer relevant en mogelijk). Voor **onderzoeksactiviteiten buiten het actieve veld van Vlaamse Mariene Onderzoeksgroepen** kan VLIZ complementair onderzoek initiëren, leiden en uitvoeren, waarbij VLIZ samenwerking zoekt met andere onderzoeksgroepen via een Ad hoc Expertengroep. Voor gedetecteerde **onderzoeksnoden in het veld van momenteel actieve Mariene Onderzoeksgroepen** zal VLIZ de initiatie van projecten geleid door de respectievelijke Mariene Onderzoeksgroepen stimuleren en interdisciplinaire samenwerking promoten en daaraan deelnemen wanneer relevant en mogelijk. Daarbij biedt het de mogelijkheid aan om een Ad hoc Expertengroep samen te

stellen. De **Wetenschappelijke Kerngroep** zal op de hoogte gebracht worden van alle vergaderingen van Expertengroepen en geïnitieerde onderzoeksprojecten.

Onderzoek in het VLIZ is gestructureerd in **zes grote onderzoeksthema's**, waarvan de meeste zijn onderverdeeld in subthema's. Alle thema's laten een **multidisciplinaire** aanpak van zowel fundamenteel als toegepast onderzoek toe. Waar thema's I tot IV een zekere inhoudelijke focus hebben, hebben thema's V en VI een bredere scope. Dit geeft geen onbeperkte onderzoeksambitie weer, maar laat VLIZ toe om te antwoorden op nieuwe door beleid gedreven onderzoeksnoden (complementair of in samenwerking met beleids-ondersteunende onderzoeksinstituten), en om samen te werken met andere onderzoeks-groepen in hoog risico-onderzoek of om snel onderzoek uit te voeren gerelateerd aan out-of-the-box ideeën. Multidisciplinaire *Centres of Excellence* en **platformen** zullen het onderzoek ondersteunen, zowel aan in VLIZ als in Vlaamse Mariene Onderzoeksgroepen.

Door middel van deze onderzoeksstrategie streven we ernaar om de Vlaamse mariene onderzoeksgemeenschap te versterken en bij te dragen tot de missie van VLIZ: het versterken van de **mariene kennisopbouw en de excellentie van het marien onderzoek in Vlaanderen**.

# Introduction

# INTRODUCTION

## 1. VLIZ' NEW RESEARCH MANDATE

Since 2017 VLIZ has a new mandate, laid down in its covenant with the Flemish Government. This Covenant (open to public consultation on www.vliz.be) stipulates that VLIZ will continue to support and represent the marine scientific community in Flanders by facilitating networking, gathering and disseminating information, managing research and data infrastructure and promoting marine science at national and international levels. However, it also states that VLIZ is mandated to **initiate and perform research**, at the service of, in collaboration with or complementary to the Flemish and international Marine Research Groups.

To achieve this strategic goal, VLIZ has established a **research division**. One of its tasks is to detect challenges and opportunities for marine research in Flanders, also in collaboration with the **blue economy**. VLIZ has initiated a process to develop a research framework, within the framework and under the conditions of the present covenant, as presented to the Scientific Committee in a process note *(Procesnota VLIZ Onderzoeksagenda*, 17 March 2017).

The VLIZ research framework presented here describes the research themes VLIZ wants to actively pursue. Its goal is to transparently communicate VLIZ' research ambitions to its stakeholders, especially to the marine research community in Flanders represented by the Scientific Committee of VLIZ. While the research areas and approaches are identified, specifications about particular projects are limited to enable a broad interface with the heterogeneous scientific landscape of Flanders.

The research will be carried out in a **collaborative** way, in which each partner's contribution enhances the interactions between disciplines, reinforcing **interdisciplinarity**. The basic principles for this collaborative research are outlined in VLIZ' approved Strategic Plan 2017-2021 (Mees 2017) and include inter-/multi-/transdisciplinarity, innovation, neutrality, promoting Responsible Research and Innovation Principles, Promoting Open Science, supporting Sustainable Development Goals and Grand Societal Challenges (UN 2015, European Marine Board 2013b). As part of the implementation of each theme VLIZ will evaluate possibilities for infrastructure and data driven research, and valorising and reinforcing its current capacities.

The implementation of the VLIZ research framework will be coordinated by VLIZ' research division, which will seek active collaboration with all other VLIZ divisions and with Marine Research Groups in Flanders, but also in Belgium and abroad.

The VLIZ research framework does not describe all the research that directly results from or corresponds to the core tasks of each VLIZ division. In this sense, **not all research that will be performed by VLIZ** is covered by this research framework and each division will be able to initiate or perform research – in consultation with the research division - related to its core functions. Examples of this are (non-exhaustive): ocean literacy in the Communication division, data management systems in the Data centre division, bibliometrics in the Library division, infrastructure operations in the Research Infrastructure division, policy implications in the Policy information division. These types of research may be performed autonomously within the respective division or in collaboration with the research division.
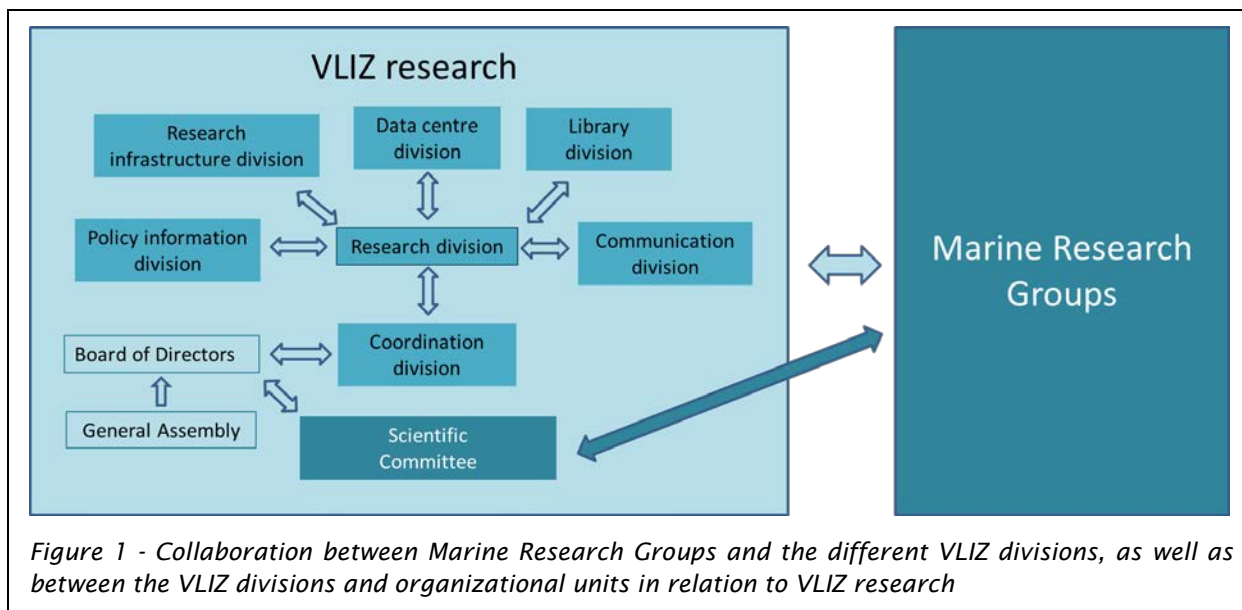
*Figure 1 - Collaboration between Marine Research Groups and the different VLIZ divisions, as well as between the VLIZ divisions and organizational units in relation to VLIZ research*

The research at VLIZ will be serviced by **multidisciplinary Centres of Excellence** and enabled through **cross-cutting supporting Platforms.** These structures differ from the organizational and administrative VLIZ divisions (Research Infrastructure, Data Centre, Policy Information, Communication, Library, Research and Coordination).

**Centres of Excellence** are or will be (further) developed to become **world-level knowledge and infrastructure hubs**, with the involvement of multiple VLIZ divisions. Such Centres create visibility for VLIZ, Flanders and its marine research community in the international marine research context and are assets in collaborative research. They will be instrumental in various research themes and will also generate research through continuous improvement of their services and technologies.

**Platforms** will consist of versatile supporting technologies, skills, infrastructure and/or methodologies that form **transversal research enabling tools**, again with the involvement of multiple VLIZ divisions.

These Centres and Platforms will also be deployed to continue and improve the VLIZ legacy of supporting marine research at all Flemish universities and institutes.
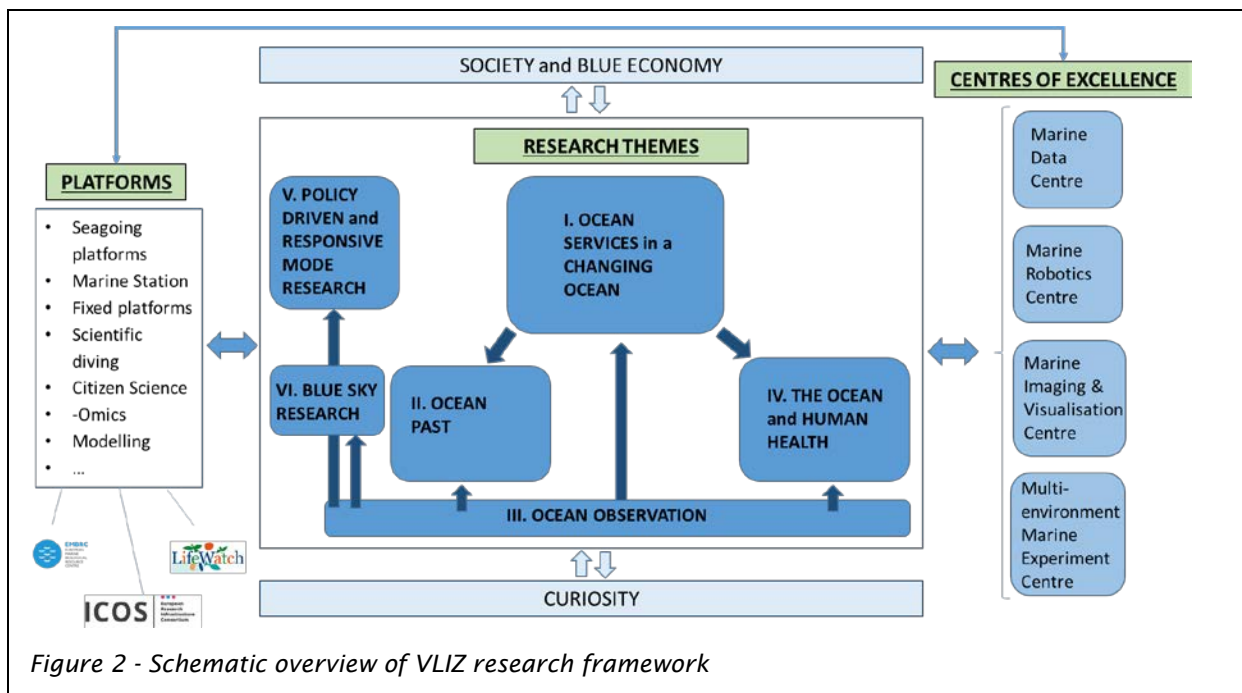
*Figure 2 - Schematic overview of VLIZ research framework*

The description of Centres and Platforms does not imply that other activities at VLIZ divisions for enabling and supporting research are in any way less important or relevant. Indeed, e.g. supplying scientific literature through the VLIZ library, providing administrative and organisational support in research projects, disseminating research results via the media or detecting policy-driven research needs and acting as a knowledge broker on the science-policy-industry interface will be essential for implementing the new research mandate at VLIZ. An outline for the organisational and practical development and implementation of these Centres and Platforms will be worked out in the initial phase of implementation of the research framework. Their (further) development will be driven by the activities performed under each research theme.

The following Centres of Excellence will establish or strengthen the international position of VLIZ as institute and Flanders as a leading region in marine research:

▪ The **Marine Data Centre**, led by the VLIZ Data Centre division, is well established and internationally renowned. It will be key in boosting data driven research. Through its data systems and infrastructures, the further valorisation of the growing amount of marine data will be pursued using the latest data analysis techniques and data mining technologies. The use of data for research by VLIZ will be recognised.

The Marine Data Centre operates according to a policy based on the IOC data policy and builds on a close relationship of trust with Belgian marine scientists. In this relationship, the Data Centre will continue to provide assistance, technologies and tools to scientists and policy makers to support marine data management.

▪ In the **Marine Robotics Centre**, which will be led and operated by the VLIZ Infrastructure division in cooperation with the Research division. Remotely Operated Vehicles, Autonomous Underwater Vehicles, Unmanned Surface Vehicles, Animal borne platforms and other types of robots will be operated, developed and/or innovated, including biosensors and other innovative measuring devices. These robots will be deployed to collect large amounts of data and access otherwise difficult to sample regions with highly precise localization. In 2017, investments will be made to expand

this Centre - with its presently available Remotely Operated Vehicle 'Genesis' – with other marine robotics and associated equipment, workspace, development and testing facilities.

- The **Marine Imaging and Visualisation Centre** will be led and operated by the VLIZ Research division in cooperation with the Infrastructure and Data Centre divisions. It will coordinate advanced image generation and image processing. With equipment and technologies such as (fluorescence) microscopes, video plankton recorder, FlowCam, ZooSCAN, scanning electron microscope with energy dispersive X-ray spectroscopy, flow cytometer, remote sensing, sediment profile imaging, multi-beam sonar or multi-transducer sub-bottom echo sounder, robot- or diver-operated underwater camera's, images are or will be generated to investigate diverse aspects of the marine environment. Smart processing technologies will optimize data-acquisition from various samples and environments and create meaningful and reliable research data and data products.

  The Imaging and Visualisation Centre can start with the current state of the art VLIZ instrumentation, the applications of which will be further developed. The planned developments for imaging, visualisation and image processing within the framework of LifeWatch and EMBRC, the European Marine Biological Resource Centre, (Research Infrastructures within the framework of the EU European Strategy Forum on Research Infrastructures - ESFRI) will also contribute to this Centre. The Centre will be expanded, funds permitting, in the coming years.

- The **Multi-Environment Marine Experiment Centre** will offer specific environmental conditions in the lab for various types of experimental testing (e.g. microcosm studies). It will allow to test hypotheses or concepts, mechanisms and interactions in small scale simulated coastal, open sea or deep sea environments and in exo-ocean conditions, without the need for immediate in situ observations. This Centre will be developed in the Marine Station. It has not been designed or initiated yet. A master plan for its design and organisation (funds permitting) will be developed by 2020.

The platforms described below will deliver the technologies and infrastructure enabling VLIZ and other Marine Research Groups to perform innovative, internationally recognized, state of the art marine research. VLIZ does not have the ambition to advance the state of the science in all these platforms. Collaboration with experts in universities and knowledge institutions will be sought when e.g. advanced omics technologies or specific complex models need to be used. Important parts of multiple platforms contribute to one or more of the three ESFRI research infrastructures VLIZ participates in: the European Marine Biological Resource Centre (EMBRC), the Integrated Carbon Observation System (ICOS) and LifeWatch.

- Seagoing platforms such as the Research Vessel Simon Stevin, the RIB Zeekat and ships of opportunity. The RV Simon Stevin is a state of the art seagoing platform with a wealth of marine observation equipment. Seagoing platforms are fully functional and coordinated by the Infrastructure division.

- The Marine Station (Marine Station Ostend, MSO) offers and will offer laboratory and experimental facilities, meso- and microcosms, exposure tanks, analytical capacity, technical workshops for mechanical and electronical maintenance and R&D. A coordinator for the MSO is working at the Infrastructure division. The MSO is fully in operation and a masterplan for its extension during the next years is in preparation.

- Fixed platforms including a potential future Blue Accelerator Marine Platform, buoys and cabled networks offer delayed-mode and real-time monitoring of multiple biological and abiotic environmental variables through an array of sensors. A

coordinator for the fixed platforms will be hosted by the Infrastructure division. Many fixed platforms are currently active and running, the potential future Blue Accelerator Platform will be developed (funds permitting) in the next years in collaboration with involved project partners.

- A Scientific diving platform allows flexible and advanced operations at sea. This platform includes a trained team of scientific divers, equipment, protocols, training and networking. Its coordinator is working at the Infrastructure division. This platform will be further developed from the current scientific diving team at VLIZ.

- The Citizen Science platform will imply active contributions of the wider public to VLIZ-research activities. The Communication division, already very active in citizen science, will host a coordinator for this platform.

- The Omics platform will enable molecular understanding of diversity, structure and function of marine organisms, populations and communities. It will combine basic laboratory infrastructure for molecular biology with computing capacity, software and bioinformatics expertise. For applications such as high throughput sequencing, VLIZ will make use of existing infrastructure and expertise in other institutions through collaborations. A coordinator for this platform will be hosted by the Research division. This platform will be further developed from the LifeWatch eDNA-infrastructure from 2018 onwards.

- The Modelling platform will develop, apply, and optimize different types of mathematical models to elucidate and quantify connections between the ocean, its inhabitants, its services, humans and the drivers of change. This platform will be a hub combining mathematical modelling knowledge with the required software and computing facilities for model applications. The coordinator for this platform will be hosted by the Research division. The modelling platform will be developed as from 2018 and the activities in this modelling platform will be complementary to marine modelling in other research groups. Where appropriate, VLIZ will collaborate with Marine Research Groups for the application or integration of specific types of models.

These Platforms and Centres of Excellence are or will be highly connected and integrated, and contribute to Flanders, EU and global Research Infrastructure networks (e.g. ESFRI, UNESCO IOC IODE NODCs or National Oceanographic Data Centres in the framework of the International Oceanographic Data and Information Exchange of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization).

# 2. PROCESS, STRUCTURE AND IMPLEMENTATION OF THE VLIZ RESEARCH FRAMEWORK

## 2.1 PROCESS OF THE VLIZ RESEARCH FRAMEWORK

The present version of the VLIZ research framework follows the framework and trajectory as described in the **Process Note** (*Procesnota VLIZ Onderzoeksagenda*); which was discussed at and adopted by the **Scientific Committee** in March 2017. The main elements of this Process Note are incorporated in this chapter, updated where necessary.

**In relation to its research mandates, the institute (VLIZ) follows the Strategic Goal (SG1) cf. the Covenant:**

*SG1: "To initiate, support, foster and perform innovative and multidisciplinary marine research and this at the service of, in collaboration with or complementary to the Flemish and international Marine Research Groups"*

This strategic goal is translated to operational goal 2:

*OG2: "VLIZ detects challenges and opportunities for the marine research in Flanders, including in collaboration with the business community. VLIZ' research division develops research agendas and strives for the execution (incl. prospection, projects, collaborations, financing) of the identified priorities. Doing so, VLIZ takes into account those parts of (international, national or regional) strategies, agendas and policy goals subscribed by the Flemish government (amongst which Flemish support to specific actions of the Intergovernmental Oceanographic Commission and the Joint Programming Initiative "Healthy and productive seas and oceans" (JPI-Oceans)) that are most relevant for the own research community. Research initiatives are evaluated and advised by the Scientific Committee – possibly by thematic expert groups installed through this Committee."*

**The following conditions are taken into account with this:**

- *"The Institute itself will not take up research topics for which Marine Research Groups (MRGs) identified in the Compendium for Coast and Sea have expressed an active research interest in their contacts with the Institute thereabout;*

- *The Institute will notify her Scientific Committee about her possible initiatives beforehand (**to avoid competition with existing MRGs**);*

- *The Institute will preferably perform collaborative research in which the own contribution promotes the interactions between disciplines (**strengthening interdisciplinarity**);*

- *The Institute will also focus on research that valorises the **research infrastructure** (**including the databases**)*

- *While performing research, the Institute will evaluate if and how the newly developed expertise can best be embedded in the Flemish marine research landscape (or economically valorized) and thereby also take into account the reinforcement of MRGs outside the Institution (**reinforcement of the Flemish marine research landscape**).*

**Concrete references to the research mandate are also made in OG3, OG4 and OG6:**

*OG3: "VLIZ' Research infrastructure division… offers technical and operational expertise for the use of all infrastructure **and initiates infrastructure driven research projects**"*

*OG4: "The VLIZ data centre… collects data (including via multidisciplinary measuring and sampling campaigns with the use of innovative techniques, **the use of biosensors in permanent measuring networks), develops innovative data treatment, data analysis and data mining techniques and a performant infrastructure for multidisciplinary 'big data' calculations**. Flemish research groups are involved in the realization and the use of the infrastructure, also by initiating projects, organizing data science workshops and helping to generate data publications."*

*OG6: "The Policy information division… init**iates, promotes and supports the implementation of multidisciplinary research that directly relates to the identified knowledge gaps for the needs of marine policy,** in close collaboration with the knowledge partners in the Flemish marine research landscape."*

The above mentioned goals and conditions form the corner stones of VLIZ' research mandate and research framework.

In the development of a general research framework, VLIZ supports on the key elements in the following strategic and administrative documents:

- Vision, Mission and administrative documents of the institute and general principles as laid down in the VLIZ Good Governance Charter (VLIZ 2012);
- The European Charter for Research (2005/251/EG)
- The principles on 'Responsible Research and Innovation' (RRI) as used by the EC in her approach to sustainability in research and innovation (EU 2012, EC C(2016)8265).

These documents give guidance in developing an ethical and societal framework when performing research.

The above mentioned elements lead to the identification of some criteria as conditions or transversal principles. These are pillars for the VLIZ research framework and basic criteria for project work and collaborations:

CRITERIA COVENANT

- Avoids competition
- Inter-/multi-/trans- disciplinarity
- Collaborative
- Innovative
- Proactive
- Valorises data and infrastructure
- Valorises and strengthens knowledge building
- Measurable (research) output

Aditionally the principles below are included and unanimously accepted in European and global strategic policy documents. Moreover, they are universally applicable (independent of research domain or topic) and therefore are added as transversal criteria:

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**TRANSVERSAL CRITERIA – EU AND GLOBAL STRATEGIC POLICY DOCUMENTS**

- Valorises Promotes Responsible Research and Innovation principles – RRI; (EU 2012)
- Valorises Promotes Open Science (Open Data - Open Access); (EU 2012, VRWI 2016)
- Valorises Recognizes the societal value and economic potential applications of research (EU 2012)
- Valorises Supports the implementation of the UN Agenda for Sustainable Development (SDG) and the Grand Societal Challenges, (Rome Declaration, UN Agenda 21, Navigating The Future IV)
- Valorises Underlines the importance of Capacity and Knowledge building throughout the research trajectory, promotes 'Science Sharing' and 'Science diplomacy' (UN Agenda 21, Rome Declaration, NF IV)
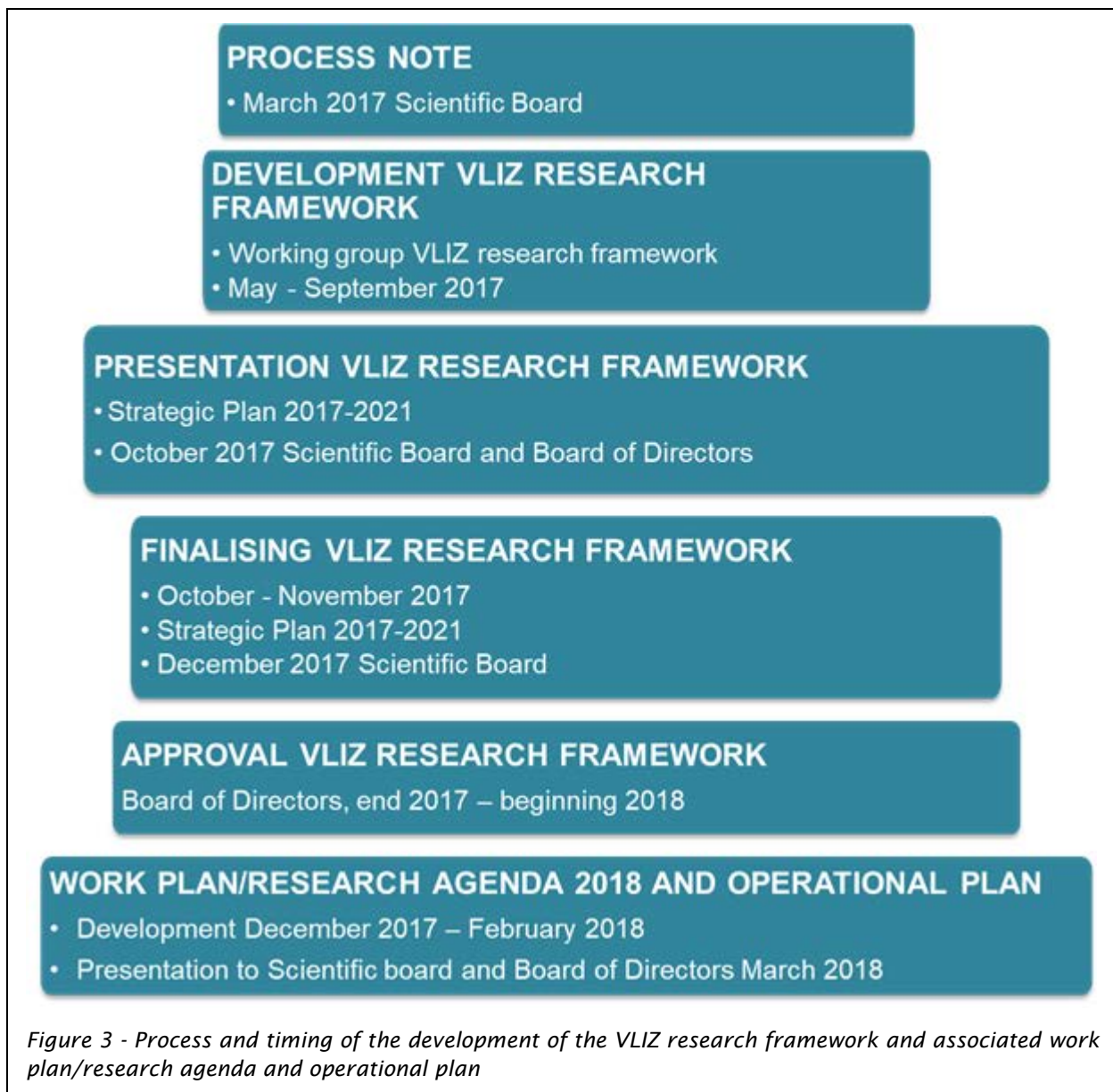
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The present version of the VLIZ research framework is based on internal discussions within VLIZ and consultations with the Marine Research Groups via the Scientific Committee, to which a first draft was presented in October 2017. The document will be presented to the Scientific Committee in December 2017. This will give another opportunity for all Marine Research Groups in Flanders to provide comments through their institutes' representatives in the VLIZ Scientific Committee.

Based on the research framework, yearly work plans/research agendas will be developed. These will be presented to the Scientific Committee for advice and to the Board of Directors for approval or adjustment at operational or strategic level where necessary, in the last quarter of each year. The sub-themes with indicative timing 2018 will be developed in further detail to form the first Work Plan to be presented in the first quarter of 2018.

An **Operational Plan** will cover the **management** of the VLIZ research framework, based on a governance structure describing the roles of the Scientific Committee, the International Strategic Advisory Committee (to be established in 2018), the Board of Directors and the VLIZ divisions. The Operational Plan will be presented together with the work plan 2018. The research framework and yearly work plans/research agendas will be subject to a **plan-do-check-act** cycle. It is important to note that, although main research lines are set out for the longer term, the VLIZ research framework is subject to change within the framework of this governance structure.

The research framework and yearly work plans/research agendas will be evaluated yearly by the Scientific Board, based on an annual report. In 2021 the research framework and research agendas will be evaluated by the Department of Economy, Science and Innovation (including a self-evaluation, an international panel and a stakeholder survey).

This final draft of the VLIZ research framework, will be presented to the VLIZ Scientific Committee in December 2017. The finalized VLIZ research framework will subsequently be presented to the Board of Directors for formal approval and adoption late 2017 to early 2018.

*Figure 3 - Process and timing of the development of the VLIZ research framework and associated work plan/research agenda and operational plan*

## 2.2 STRUCTURE OF THE VLIZ RESEARCH FRAMEWORK

**Research themes I through VI** (see 3. Research Themes) with numbered sub-themes describe the areas of research VLIZ aims to develop and pursue during the coming years. For each sub-theme, a strategic goal and one or more research activities (indicated by small letters a, b, c etc.) are listed. The links of sub-themes to the Centres and Platforms and their importance for the Blue Economy are described as well as the expected outcome of these research activities. Each research activity will start with a preparation and pre-evaluation phase. Initiation of the actual activity will depend on the outcome of this pre-evaluation, considering factors such as the internal criteria and prerequisites for projects at VLIZ in line with its mandate, available funding, possibilities for collaboration, available human and technical resources.

## 2.3 IMPLEMENTATION OF THE VLIZ RESEARCH FRAMEWORK

An autonomous **International Strategic Advisory Committee (ISAC)** will be responsible for guidance and follow-up of the VLIZ research framework. It will consist of at least three independent and external members, supplemented by the chairman of the Scientific Board, the Research Director and the General Director. The **ISAC's operation** will be described in **Terms of Reference**, which will be approved by the Scientific Board. The ISAC will report annually on the evaluation of the work plan for year X and will make strategic and operational recommendations for the work plan for year X+1.

The yearly Work plans will be coordinated and managed by the VLIZ Research division in collaboration and consultation with heads of division and project leaders in the other VLIZ divisions (see Figure 4).
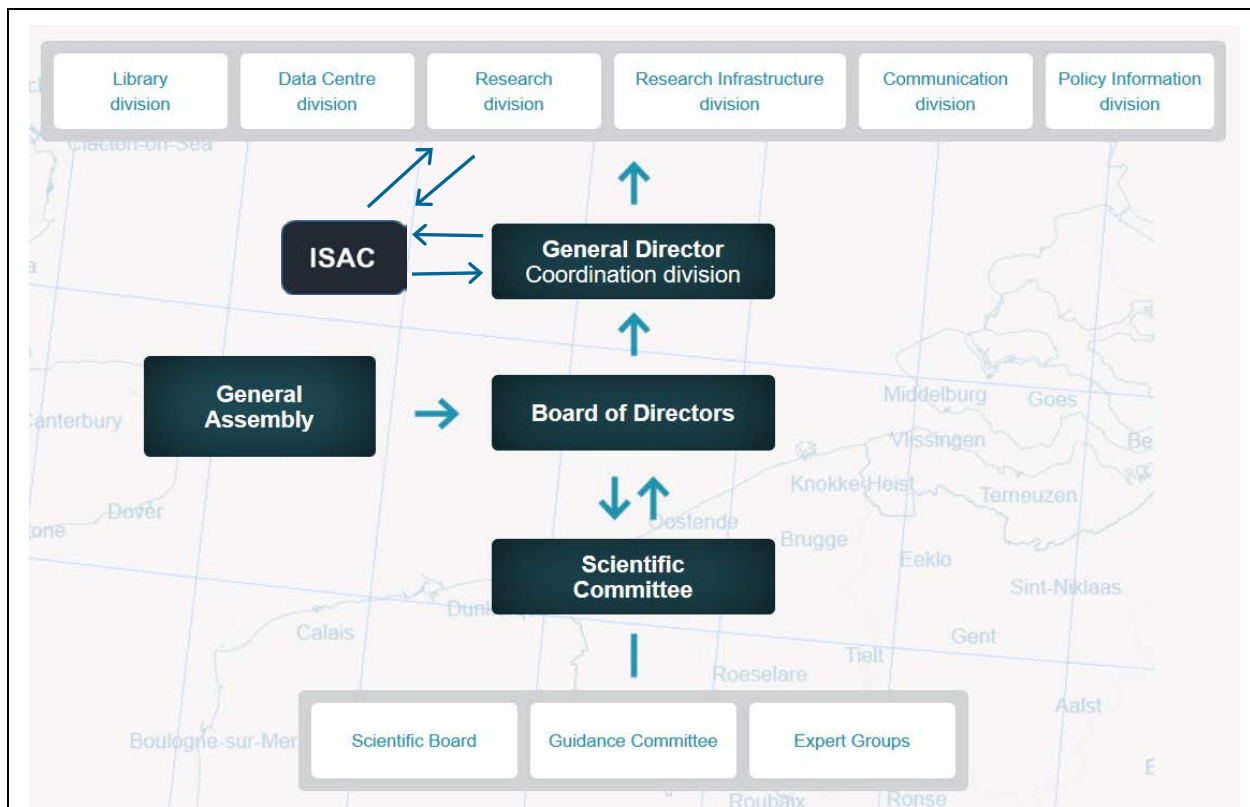


*Figure 4 - VLIZ organisation chart with position of the International Strategic Advisory Committee (ISAC)*

The activities for managing the VLIZ research agendas consist of:

- Project Management: running and approved projects
- Prospection and fundraising
- Portfolio management
- New collaboration requests (steering groups, advisory and consultation bodies)

Project management, prospection and fundraising and portfolio management are geared to the annual work plan/research agenda. The implementation of the work plan/research agenda is supervised and followed up by monthly meetings of the VLIZ Direction Committee. For decisions on the initiation of new projects, VLIZ established a Portfolio Committee (PFC).

This Committee convenes monthly and consists of the Direction Committee, programme managers from the Data Centre division, science managers, senior scientists and senior scientific collaborators from the Research division. The PFC uses three go/no go criteria, and a list of semi-quantitatively scored criteria for research projects, which are listed in table 1.

| A. CONDITIONAL CRITERIA (GO/NO GO) | | | | | |
|---|---|---|---|---|---|
| | Yes | No | Explanation | Objective measurement | |
| **1. VLIZ mandate** | proceed | NO-GO | In line with the Covenant and annexes | VLIZ Covenant 2017-2021 | |
| **2. Scientific integrity, 'VLIZ DNA'** | proceed | NO-GO | Not in conflict with the values and principles of VLIZ | VLIZ Good Governance Charter; RRI-principles; *Code of Ethics for Scientific Research in Belgium* (2009); *European Code of Conduct for Research Integrity* (2017). | |
| **3. Not in competition** | proceed | NO-GO | Competition with research/ expertise in MOGs | Consultation of the *Compendium for Coast and Sea* | |

| B. CRITERIA FOR VLIZ RESEARCH INITIATIVES AND COLLABORATION WITH THIRD PARTIES Strong = ++ Weak = - - Not applicable = na | | | | | |
|---|---|---|---|---|---|
| | - - | - | + | ++ | Explanation |
| Collaborative | | | | | Stimulates participation, is inclusive where possible |
| VLIZ research framework | | | | | Consultation of VLIZ research framework |
| Innovative, original | | | | | No replication of existing initiatives |
| Valorizes data(systems) | | | | | Consultation of Data centre division |
| Valorizes research infrastructure | | | | | Consultation of Infrastructure division |
| Inter/multi/trans-disciplinarity | | | | | Involves expertise and knowledge from other research domains or -disciplines |
| Open Science | | | | | Consultation of Library division |
| Proactive | | | | | Takes into account future development and opportunities, … |
| VLIZ intellectual 'legacy', | | | | | Contributes to institutional expertise and knowledge building within VLIZ |
| Measurable output of knowledge | | | | | (A1)-Publications, (web)application, others |
| Deliverables | | | | | Are the deliverable products and services readily identifiable? |
| Societal valorization | | | | | Consultation of Policy information division including economic valorization |
| Timing and planning | | | | | Is the planning and timing of the project feasible and is there sufficient expertise present (+) or is there need for external consultation (-)? |
| Available resources | | | | | Are there sufficient resources (+) or has the project to be topped-up with additional resources (-)? |
| External resources | | | | | Does the project contribute significant external resources? |
| SDG14 and others | | | | | Tangible contribution to the UN Sustainable Development Goal 14 'Life Below Water'? |
| Exit strategy | | | | | Are there elements incorporated that guarantee the medium- or long-term perpetuation of project-deliverables? |
| Capacity building, transfer of knowledge, Science Sharing | | | | | Generates opportunities for internships, thesis projects, education, exchange of students |
| Excellence of partners | | | | | Can the project partner(s) demonstrate excellence in their specific research field, e.g. by means of recent publications or international collaborations? |
| Added value of VLIZ research | | | | | Does research by VLIZ create an added value in the proposed project? If not, VLIZ may be involved in a facilitating role. |

*Table 1 – Criteria for the evaluation of the initiation of new research projects*

New collaboration requests in project context bring opportunities (access to new resources, expertise, long term bonds…), which can strengthen the goals of the research framework or lead to faster achievement of these goals. These requests will be evaluated by the VLIZ Portfolio Committee.

In the implementation of the VLIZ research framework, there are three possible **roles for VLIZ**:

1. For **data** or **infrastructure driven** research activities, VLIZ can **initiate, lead** and **perform** research (preferably in collaboration with other research groups when relevant and possible).

2. For research activities related to topics where no other Marine Research Group in Flanders, as defined in the Compendium for Coast & Sea, is actively involved in, VLIZ will **initiate, lead and perform complementary research**, seeking collaboration with other research groups.

3. For detected research needs in the field of currently active Marine Research Groups, VLIZ will **stimulate the initiation of projects** led by the respective Marine Research Groups and promote and take part in interdisciplinary collaboration when relevant and possible.

For each of these three roles VLIZ will evaluate and implement the possibilities for collaboration with Marine Research Groups in Flanders in an objective and inclusive way. This will happen as follows:

- For **data** or **infrastructure driven** research activities, VLIZ will evaluate which research groups will be considered for collaboration on the research topic. As part of this evaluation, VLIZ will **consult the list of Marine Research Groups from the Compendium for Coast and Sea**, managed and **annually updated** by VLIZ Policy information division. VLIZ **informs the Scientifc Board** on started research projects and collaborations involved.

- For research activities related to **topics** in which **no other Marine Research Group in Flanders** (based on the annually updated list of the Compendium for Coast and Sea) is actively involved, VLIZ will evaluate which of these and other research groups will be considered for collaboration on the research topic based on related expertise. The selected research groups will be presented to the Scientific Board to establish an **Ad hoc Expert group** with limited duration as part of the VLIZ Scientific Committee. This Expert group will convene once to discuss collaborations related to the research activity. The Scientific Board is informed about the Expert group meeting.

- For detected **research needs** in the **field of active Marine Research Groups**, VLIZ will evaluate which other research groups can be considered for collaboration on the research topic based on related expertise. As part of this evaluation, VLIZ will consult the annually updated list of Marine Research Groups from the Compendium for Coast and Sea. VLIZ presents these research groups to the leading Marine Research Group as **a suggestion for collaboration** and offers the possibility to compose an **Ad hoc Expert Group** with limited duration (as part of its Scientific Committee, through its Scientific Board) to discuss collaborations related to this research activity. The Scientific Board is informed about the meeting of the Ad hoc Expert Group, if this is established.

Research collaborations can take various forms, e.g. supervision and co-promotorship of MSc or PhD students, joint project proposals for external financing at national and international level, collaborative applications of research infrastructure, expertise and/or data, joint sampling or experimental design with complementary efforts.

It should be noted that VLIZ is at present not allowed to, and does not want to, apply for funding from FWO as main supervisor for research projects. VLIZ can only be involved as partner (co-supervisor) in such a project and as such can collaborate with Marine Research Groups to increase chances for funding of fundamental marine research. VLIZ is currently also not mandated to act as a funding agency and as such VLIZ will not launch competitive calls for projects to be funded.

In its **data policy**, VLIZ is an advocate of free data exchange. Data need to be made available as much as possible for scientific research both on a national and on an international level. VLIZ considers the management and disclosure of data as one of its core tasks. For example, data acquired during VLIZ monitoring operations within the scope of LifeWatch are always made publicly available. Metadata that illustrate the existence of a data set are always disclosed publicly, unless VLIZ has been explicitly requested not to do so. In many cases there are arguments for giving only limited access to data, or no access at all. VLIZ then implements a customised data policy in consultation with the data owner. VLIZ will monitor the disclosure of data in accordance with this policy, also when the context in which the data policy was developed has changed. For instance, partners often request a moratorium period within the scope of specific projects until the data or the results of the project have been published. VLIZ will strive to make data resulting from its own research activities freely accessible when possible. Also for VLIZ research, data accessibility may be restricted until the results of a project have been published. Customised data policies will be agreed with partners when collaborative research activities are initiated.

# 3. RESEARCH THEMES

The VLIZ research framework is structured around six main themes. A general aspect in all research is that VLIZ wants to perform **high-level hypothesis-driven research** with **global scientific and societal relevance,** but with attention for **local challenges** and **opportunities**, especially regarding **relevance** for European and Flemish marine and maritime **policy** issues and the **blue economy**. This research will be based on **observations, measurements** and *in- and ex situ* **experiments** in the Southern Bight of the **North Sea** with a focus on the Belgian Part of the North Sea. The Multi-Environment Marine Experiment Centre will allow **laboratory experiments** in controlled environments representative for other geographic regions. VLIZ wants to perform fundamental as well as applied research, complementing rather than competing with other Marine Research Groups.

Each theme is described in the following chapters. An introduction with a schematic overview of the main research areas is given below.

## I. OCEAN SERVICES IN A CHANGING OCEAN

### THIS THEME COVERS

- Data gathering for **improved understanding of marine ecosystems**
- Modelling to **quantitatively relate ocean life** to **ocean services** and **drivers of change**
- **Experimental research**
- Refinement of models for **global change** impact research
- Applied ecosystem research for the **blue economy**

### THIS THEME CONNECTS TO OR SUPPORTS THE FOLLOWING (SCIENCE) POLICY INITIATIVES

- Joint Programming Initiative on Healthy and Productive Seas and Oceans: action on Ecosystem services and multi-stressor impact
- EU Marine Strategy objectives as an environmental pillar to the Integrated Maritime Policy (European Parliament and Council 2008, European Commission 2007)
- Flanders Innovation Policy; EU Blue Growth Strategy and Smart Specialisation strategy (European Commission 2014)
- Priorities and recommendations for 'understanding marine ecosystems and their societal benefits' in Navigating the Future IV (European Marine Board 2013b, European Commission 2012).
- Rome Declaration (EurOCEAN conference 2014)

## II. OCEAN PAST

### THIS THEME COVERS

- **Continental shelf prehistoric research** to elucidate the **palaeolandscape** of the North Sea.
- **Archaeological research** on marine and maritime **heritage**
- **Historical research** based on maritime written and iconographic sources and/or related to the human history of Flemish seafarers, harbours or the North Sea region

- Objectives of the Oceans Past Initiative, the legacy of the History of Marine Animal Populations (Census of Marine Life)
- The urgent call for multi-disciplinary research in seas and ocean to address societal challenges (e.g. JPI Oceans, Navigating the Future IV)
- Convention on the protection of the underwater cultural heritage and its context and related national and regional legislation (UNESCO 2001)
- Maritime spatial planning framework directive (European Parliament and Council 2014)
- Law on the protection of the marine environment and the organisation of marine spatial planning in the marine areas under Belgian jurisdiction (Belgian government and parliament 1999)
- Law on the protection of cultural heritage underwater (Belgian government 2014)

## III. OCEAN OBSERVATION

**R**ESEARCH TO IMPROVE AND/OR DEVELOP

- An *in* situ **marine sensor** network
- **Remote sensing** for marine ecosystems, with a focus on satellite observations
- Near-shore bottom and sub-bottom **acoustic** observations
- **Molecular** detection and identification
- **Visual** observations
- Marine **robotics technologies**

**T**HIS RESEARCH CONTRIBUTES TO THE FOLLOWING INTERNATIONAL SCIENTIFIC INITIATIVES

1) European Ocean Observing System (EOOS)
2) UNESCO's Global Ocean Observing System (GOOS)
- Partnership on the Global Observation of the Oceans (POGO)

## IV. THE OCEAN AND HUMAN HEALTH

**R**ESEARCH ON

- **Modelling** of human health in relation to the ocean and coastal environments, the Blue Gym hypothesis and associated socio-economic factors
- Exposure to **marine aerosols** containing bioactive components
- Harmful algal blooms

**T**HIS THEME CONNECTS TO OR SUPPORTS THE FOLLOWING (SCIENCE) POLICY INITIATIVES

- The UN Sustainable Development Goals (SDGs, especially SDG 3 and SDG 14)
- UNESCO IOC and SCOR (Scientific Committee on Oceanic Research) Harmful Algae Programme (GlobalHAB)
- Linking Oceans and Human Health: A strategic research priority for Europe (European Marine Board 2013a)
- EU Marine Strategy Framework Directive (European Parliament and Council 2008)

## V.   POLICY-DRIVEN AND RESPONSIVE MODE RESEARCH

- Research on **emerging topics**, also if they are not directly linked to one of the four previously described research themes.
- **Regional and local** priorities such as Flemish support to developments and innovation in the Blue Economy
- **International policy priorities**, **research initiatives** and **agendas**, such as joint research and development programmes
- **Bright and dazzling research ideas** related to the ocean

## VI.   BLUE SKY RESEARCH

- Collaborative **high-risk**, blue sky research related to the ocean

# Ocean Services
# in a Changing Ocean

# I. OCEAN SERVICES IN A CHANGING OCEAN

The ocean and its ecosystems provide many **societal benefits**, ranging from carbon cycling, primary production and oxygen production over seafood production, energy supply, climate regulation, mineral and biological resources to leisure and recreation at attractive coastal environments (European Marine Board 2013b). Most of these services depend on marine life, internal interactions between populations and interactions of marine biota with abiotic ocean variables. The effect of human-induced **climate change** on the ocean as well as the role the ocean can play in regulating the global climate is an international research priority, identified as the ocean-climate nexus (Schulz et al. 2015). Climate change results in multiple stressors such as coastal erosion, temperature and salinity changes, altered nutrient loads and eutrophication, ocean acidification or coastal hypoxia, acting together with **other human factors** such as marine contaminants, fishery or sand exploitation on specific components of the ocean, driving changes in the ecosystem and its services.

VLIZ will follow an **ecosystem based approach** for improving the understanding of and quantifying (1) how ocean services depend on marine ecosystem functioning and (2) which drivers impact this functioning and related services in a quantitative manner. VLIZ has the position to take a <u>long-term perspective</u>[1] in this, <u>systematically</u> gathering baseline abiotic and biotic data and assessing trends and drivers on a larger time scale. <u>VLIZ infrastructure</u> offers opportunities to create a comprehensive and integrated dataset on biotic and abiotic variables. The LifeWatch and ICOS research infrastructures already provide many critical data. Methodological research in the Imaging and Visualisation Centre will result in more useful information from the use of e.g. the FlowCAM, ZooSCAN, flow cytometer (see also III.4). Open <u>Data from EMODNET, OBIS and other data systems</u> are and will be further disclosed by the Marine Data Centre, and these will be used by the research division to investigate historic relationships between biodiversity, drivers of change and ocean services and to compare past with current situations. Generated data will be channelled to these systems when relevant through the Marine Data Centre.

## I.1. DATA GATHERING FOR IMPROVED UNDERSTANDING OF MARINE ECOSYSTEMS

<u>GOAL</u>

To create **comprehensive, continuously updating datasets** of sufficient quality to understand the functioning of the marine ecosystems and change-driving factors in the long term and to install a biobank with species of the Belgian Part of the North Sea represented in different ways: genetic samples, images, traits…

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[1] Underlined text marks the asset of VLIZ, the unique position VLIZ can take in the context of a research theme or the novel aspects of research performed by VLIZ

a. **Data archaeology** for structurally composing meaningful datasets of past and current marine life and abiotic factors in the Belgian Part of the North Sea, enabling to reconstruct historical communities and their functioning.

b. Regular sampling and/or measurements and analysis of

- Biological components

  - Viruses, bacteria, archaea
  - Phyto- and zooplankton communities
  - Gelatinous plankton
  - (Epi)benthic communities
  - eDNA and other marine biodiversity proxies
  - Other benthic and pelagic ecosystem components, also in collaboration with experts in the Flemish Marine Research Groups

- Abiotic components

  - Classic CTD-type measurements
  - pH, Nutrients, dissolved inorganic and organic carbon, dissolved gases
  - Selected physical parameters (e.g. currents, hydro/meteo)
  - Bottom profiles: oxygen penetration, sediment type etc.
  - Major contaminants in different compartments (e.g. microplastics)

  This **regular data gathering** activity will be performed at different levels:

  - Monthly at several North Sea stations selected on the basis of different current regimes and seafloor properties.
  - At the Blue Accelerator platform: more frequent sampling and measurement of selected aspects.
  - Selected ship wrecks as artificial hard substrates/biodiversity 'hotspots': seasonally.

c. Citizen Science activities to gather data on easily measurable biological and abiotic variables or observations on a continuous basis, e.g. on the beach and groynes. Starting from current activities, this will be further developed based on the type of data that are useful for the ecosystem modelling (see I.2).

d. Document the occurrence and traits of all species from the **Belgian Part of the North Sea**, creating **reference biodiversity datasets**, including a DNA biobank and an image bank of scanning electron microscopy images. This will be used to compare future states of the North Sea, enabling to detect long-term trends. Data will be compared with the Belgian Register of Marine Species (BeRMS) and added when relevant. In combination with historical species records (see a.) it will allow to evaluate biodiversity shifts.

## PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION

- Monthly cruises for the LifeWatch observatory already yield very valuable data on various biological components in the Belgian Part of the North Sea. VLIZ will evaluate which extra information can be obtained from these sampling campaigns.

- Historical data on Flanders' sea fisheries: collecting, digitizing and integrating the structurally collected but fragmented commercial data and scientific survey data (species composition, relative abundance, species and stock parameters...) from

1900s; and collecting and integrating fragmented data and information to quantitatively reconstruct the sea fisheries since the late middle ages.

- Reconstructing historical time series on key marine species (e.g. brown shrimp Crangon crangon, North Sea herring Clupea harengus, European plaice Pleuronectes platessa, sole Solea solea, Atlantic cod Gadus morhua).

- Environmental and biotic data is collected and integrated to document 'lost' fishing metiers and evaluate e.g. the exceptional Downs herring catch in 1942-44.

- Catch and effort data from recreational near-shore tow-net fishing (on foot) in the last decade have been collected, through a voluntary scheme of self-reporting by recreational fishermen. Both target species (brown shrimp, flatfish) and bycatch is reported.

- Catch and effort data from recreational fishermen fishing from small-scale vessels (both towed gear, passive gillnets and hooks), following a voluntary scheme of self-reporting, since 2017.

## CENTRES AND PLATFORMS INVOLVED

- Marine Data Centre
- Marine Imaging and Visualisation Centre
- Marine Robotics Centre
- Omics, Citizen Science, Seagoing platforms, Fixed platforms, Modelling, MSO

## COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

## IMPORTANCE FOR BLUE ECONOMY

- Understanding the marine ecosystem is key in order to predict and manage impacts of blue economy activities
- Increase understanding to better design blue economy activities e.g. for building with nature
- Creating a sound knowledge base for bioprospecting

## EXPECTED OUTPUT

- Open datasets of different biotic and abiotic properties, interlinked by sampling time and location as a basis for building and improving ecosystem models

- Publications on (1) method development for monitoring microbial abundance, diversity and functions; (2) first descriptions of microbial diversity, abundance and functions in the BPNS and correlations with other trophic levels; (3) occurrence and spatiotemporal patterns of microplastics in different strata of the BPNS; (4) description of complete Belgian marine eukaryotic biodiversity and associated bio- and image banks (5) historical analysis of communities in the BPNS including extinctions, non-native species, invasions, climate species

# I.2. MODELLING FOR IMPROVED UNDERSTANDING OF MARINE ECOSYSTEMS

<u>GOAL</u>

To improve the understanding of marine ecosystems by building and validating **models** that **quantitatively relate ocean life** to **ocean services** and **drivers of change,** such as climate change, fishing, habitat changes...

<u>ACTIVITIES</u>

a. Combining <u>existing and compiled long-term datasets (see I.1)</u> with **data mining techniques** and models to discover **drivers of long-term trends or disruptive historic events** that can be related to **ecosystem functioning**. This will start with a prospective phase identifying such trends and events. Research to Ocean Past (see II) will also detect this type of trends and events. Large marine datasets will be made available to allow for **Big Data projects** to provide new insights in the marine environment as well as to advance Big Data processing technologies such as machine learning and artificial intelligence.

b. With the <u>data gathered in I.1</u>, build and/or validate **ecosystem models** that describe (from gene to community level, coupling benthic and pelagic compartments and taking into account biodiversity)
   - Energy transfer and biomass production
   - Carbon cycling
   - Nutrient cycling
   - Oxygen production and consumption

c. Model socio-economic impact of these ocean services, to evaluate and quantify the benefits of these services for society and the blue economy. This includes assessing the contribution of various ecosystem components to these benefits and modelling the socio-economic consequences of drivers of ecosystem change.

d. Evaluate multiple stressors as drivers of change in these models and their relative impacts: current regimes, sedimentation rates, ocean acidification, temperature changes, extreme weather events, marine contaminants, changed fishing regimes...

<u>PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION</u>

- Multi-model inference to quantify the relative importance of abiotic factors in the population dynamics of marine zooplankton
- Modelling of drivers behind the exceptional herring catch in 1942-44

<u>CENTRES AND PLATFORMS INVOLVED</u>

- Marine Data Centre
- Modelling platform

<u>COLLABORATION WITH MARINE RESEARCH GROUPS</u>

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of data and expertise

- Understanding the marine ecosystem is key in order to predict and manage impacts of blue economy activities
- Increase understanding to better design blue economy activities e.g. for building with nature
- Evaluating socio-economic impact of different scenarios/options in blue economy activities

## EXPECTED OUTPUT

- Different types of models relating ocean life to ocean services, which can test hypotheses such as 'CO2 turnover in the BPNS is mainly regulated by benthic bacteria', described in publications
  - Focus on lower trophic levels: bacteria – phytoplankton – zooplankton – detritus – nutrients
  - Benthic-pelagic coupling
- Socio-economic value of main ocean services quantified and published

# I.3. EXPERIMENTAL RESEARCH TO UNDERSTAND MECHANISMS AND REFINE ECOSYSTEM MODELS

## GOAL

To improve our understanding of the **impacts of key drivers of change** on the ocean ecosystem

## ACTIVITIES

**Laboratory experiments** measuring certain **effects** of one or multiple stressors/drivers **on key species, populations or communities**. These drivers of change and the key species/populations/communities will be selected based on literature and knowledge created from I.1 and I.2. Depending on the species concerned, this can be done with micro- or mesocosm setups or in experimental aquaria/tanks. Hypotheses on aspects of ecosystem functioning in various marine environments will be tested under appropriate experimental conditions.

## CENTRES AND PLATFORMS INVOLVED

- Marine Imaging and Visualisation Centre
- Marine Data Centre
- Multi-environment Marine Experiment Centre
- Omics, Modelling, Marine Station, fixed platforms

## COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

Understanding the effects of blue economy impacts as drivers of change

**EXPECTED OUTPUT (REFLECTED IN PUBLICATIONS)**

- Mechanistic understanding of key drivers of change in the ocean
- Refinement and/or improvement and validation of models generated in I.2
- Relation of drivers of change to ocean services through mechanistic modelling

# I.4. APPLY REFINED MODELS FOR UNDERSTANDING THE EFFECTS OF AND IMPACTS ON GLOBAL CHANGE

**GOAL**

To improve our understanding of how **global change** will affect the ocean ecosystem in the **near and distant future** (European Marine Board 2017)**.**

**ACTIVITIES**

Use models developed in I.2 and I.3 in combination with predictions and measurement data of global change parameters such as temperature, pH, pCO2, greenhouse gas concentrations, e.g. as measured by ICOS.

**CENTRES AND PLATFORMS INVOLVED**

- Marine Data Centre
- Modelling platform

**COLLABORATION WITH MARINE RESEARCH GROUPS**

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of data and expertise

**IMPORTANCE FOR BLUE ECONOMY**

Implications of global change effects on the marine ecosystem are important for the blue economy (e.g. changes in primary production, nutrient concentrations, seafloor stability…)

**EXPECTED OUTPUT (REFLECTED IN PUBLICATIONS)**

Predictions of the impact of global change on different ocean services in the BPNS, which can be extended to the North Sea and beyond

# I.5. APPLIED ECOSYSTEM RESEARCH FOR THE BLUE ECONOMY

**GOAL**

To improve our **physical and ecological understanding** of **constructions** related to new economic activities **in the sea** and building with nature

a. Perform **experiments** in <u>laboratory settings, mesocosms</u> or dedicated test facilities (e.g. Greenbridge Coastal and Ocean Basin, potential future <u>blue accelerator platform</u> and other large infrastructures in Flanders and the neighbouring countries) to **understand fundamental mechanisms** and test hypotheses that are at the basis of conceptual **constructions for building with nature**. These will be linked to <u>marine ecosystem models developed in I.2 and I.3</u> and will enable optimal design for science based field trials in a later stage. E.g. simulate and model wave and sedimentation impact on biogenic reefs with different building 'blocks'

b. **Predict** and validate **community changes** due to alterations in current velocity and direction **upon** the **construction** of islands, new sand banks or tidal pools based on <u>models developed in I.2 and I.3</u>

c. Evaluate **socio-economic impacts** of **building with nature**: taking into account the benefits of coastal protection and the positive and negative consequences for tourism and economy

### CENTRES AND PLATFORMS INVOLVED

- Marine Data Centre
- Marine Imaging and Visualisation Centre
- Modelling platform
- Marine Station Ostend

### COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

### IMPORTANCE FOR BLUE ECONOMY

Better design for constructions built with nature

### EXPECTED OUTPUT

Publications and applicable knowledge on concepts and techniques for building with nature

# II. OCEAN PAST

In recent years there has been a major shift in the level of interest and coordination amongst a specialized community of researchers dedicated to **Continental Shelf Prehistoric Research**. This new integrated research field linking the analysis of climate change, sea-level change, environmental conditions, and the prehistoric archaeology of people who lived on and migrated across the continental shelf, land now submerged beneath the sea (Flemming et al. 2014). **Marine and maritime archaeology** covers pleistocene as well as more recent eras. Research on submerged landscapes and underwater cultural heritage will improve marine policy application, e.g. related to the obligations under UNESCO and will inform stakeholders in Marine Spatial Planning. VLIZ has the human capacity and has or will invest in advanced infrastructure such as a multi-transducer echosounder and an autonomous underwater vehicle to invest in marine and maritime (pre)historic research.

Ocean past offers an excellent opportunity for **interdisciplinary research** between exact sciences and social sciences and humanities. Ocean past also refers to historical ecology, reconstructing past communities for assessing trends and drivers of change. The latter aspect is covered under theme I.

## II.1. PALAEOLANDSCAPES

### GOAL

To reconstruct the **(pre)historic submerged landscapes** of the BPNS and adjoining southern North Sea, which will allow us to better understand the current situation and possible future (coastline) changes

### ACTIVITIES

Map the **shallow geology** of the BPNS with advanced geophysical and geological techniques (SES-quattro, vibrocores…) and reconstruct (pre)historic landscapes and communities based on pollen, **fossils**, sedimentary DNA and other traces of past life

### PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION

- Modelling the shallow geology and mapping the palaeolandscape evolution of the Zeebrugge nearshore area
- Mapping the prehistoric landscapes and assessing past communities based on fossils found near het Scheur
- Collaboration with Bradford University for investigating the catastrophic outflow of a large ice-marginal lake into the southern North Sea and its relation to the offshore palaeovalleys on the Belgian Continental Shelf and the drowning of Doggerland

### CENTRES AND PLATFORMS INVOLVED

- Marine Robotics Centre
- Marine Data Centre
- Marine Imaging and Visualisation Centre (processing of acoustic 'images')
- Omics, Marine Station, Seagoing platforms

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling design with complementary efforts

IMPORTANCE FOR BLUE ECONOMY

- Properties of sub-surface seafloor layers may affect the sea floor stability and suitability for blue economy projects
- Knowing the palaeohistory of sites where blue economy activities are developed can create opportunities for outreach (cf. Rotterdam harbor extension)

EXPECTED OUTPUT

Publications on the palaeolandscape of the coastal zone of the BPNS, including methodological papers describing applications of the newest methodologies (mapping, dating) and papers on the palaeoecology of former communities (based on fossil findings)

# II.2. OCEANS AND HUMAN HISTORY: MARINE AND MARITIME ARCHAEOLOGY AND UNDERWATER CULTURAL HERITAGE

GOAL

To improve our understanding of **past human life** based on **objects** or **structures** found in, at or under the **sea**.

ACTIVITIES

a. Map and investigate the remnants of **past human structures** such as settlements, towns, buildings or defence structures with <u>**3D visualization of the subsurface**</u> and further archaeological research

b. Archaeologically investigate the interesting parts of the **palaeolandscape**s identified in B1 for traces of (pre)historic **human life**

c. Research **archaeological objects** and **underwater heritage**: identification, justification for protection as maritime heritage, techniques for effective protection and management

PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION

- Mapping and investigating the remnants of 14th century Oostende
- Mapping and investigating the Roman castellum Brittenburg near Katwijk as a start of investigating Roman defence structures along the Dutch-Belgian coastline
- Research archaeological remains (wrecks) from the first World War

CENTRES AND PLATFORMS INVOLVED

- Marine Robotics Centre
- Marine Data Centre
- Marine Imaging and Visualisation Centre
- Seagoing platforms, Scientific Divers

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling design with complementary efforts

### IMPORTANCE FOR BLUE ECONOMY

There is a need and there are national and international obligations to deal with maritime heritage when starting new economic developments. VLIZ research acts as an example on how this is done (e.g. Zeebrugge project) while minimizing the risk of strong delays due to unexpected findings.

### EXPECTED OUTPUT

- Publications on the position and historic meaning of past human structures and prehistoric human life
- Methodological publications on selecting underwater objects as maritime heritage
- Improved knowledge and publications on the protection of marine and maritime heritage

# II.3. OCEANS AND HUMAN HISTORY: MARITIME HISTORICAL RESEARCH

### GOAL

To improve our understanding of **past maritime human activities** in the North Sea region or involving Flemish seafarers and harbours, and use related **documents or objects** for advancing historic research.

### ACTIVITIES

Investigate written and other sources and set up multidisciplinary collaborations for different types of historic research, related to trade, daily life, maritime techniques, sociology, language…

### PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION

Investigate subsets of the Prize Papers stored at The National Archives in Kew (England) to start collaborative historic research, related to Flanders in the 18th century

### CENTRES AND PLATFORMS INVOLVED

- Marine Data Centre
- Citizen Science

### COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of data and expertise

## IMPORTANCE FOR BLUE ECONOMY

- Possibilities for outreach linking historic activities to present-day blue economy

## EXPECTED OUTPUT

- Publications on new historic insights
- Network of research collaboration with historic research groups

# III. OCEAN OBSERVATION

VLIZ wants to contribute to an **integrated ocean observing system** to further our understanding of the complex marine environment and **to supply scientific data** allowing the analyses and feeding the models to investigate ocean services (see I). VLIZ will <u>valorise its advanced infrastructure</u> to obtain reliable and high quality <u>ocean data</u>, which will be managed and disclosed to other scientists and to actors in the blue economy by the Marine Data Centre. A goal of advancing ocean observation is to gather as many of the needed research data as possible by **online in situ** or **remote measurements**, reducing the need for actual sampling campaigns.

## III.1 IN SITU MARINE SENSOR NETWORK

<u>GOAL</u>

To create a **network of sensors** in the water column and the sediment that create the necessary input for running the ecosystem models from sub-themes I.2 and I.3 (this sub-theme is closely related to sub-theme I.1)

<u>ACTIVITIES</u>

    a. Map the **existing sensors**, identify **gaps** in sensor types or data that could be obtained by in situ sensors
- Chemical sensors: pH, nutrients, contaminants, methane…
- Physical sensors: temperature, current, wind, salinity, sound…
- Biotic sensors: molecular probes, microbial biosensors for contaminants, physiological response sensors

    b. Optimize **sensor deployment** and **data streams** to allow optimal use of different outputs in the same ecosystem models

    c. Create and use **new sensors** for a smart network

<u>PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION</u>

Many sensors have been obtained and taken into use in the framework of the LifeWatch ESFRI and optimisation of their output is on-going.

<u>CENTRES AND PLATFORMS INVOLVED</u>

- Marine Robotics Centre
- Marine Data Centre
- Fixed platforms, Seagoing platforms

<u>COLLABORATION WITH MARINE RESEARCH GROUPS</u>

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

- Understanding the marine ecosystem based on fast and in situ measurements in order to predict and manage impacts of blue economy activities
- Capacity building on the use of marine sensors, applicable at local sites of blue economy activities
- Potential collaborations and spin-offs for developing novel in situ sensors

### EXPECTED OUTPUT

- Optimized sensor network measuring the most important drivers of marine ecosystem functions
- Publications on novel applications of biosensors related to marine ecosystem functioning

# III.2. REMOTE SENSING FOR MARINE ECOSYSTEMS

### GOAL

To maximize the **use** of **marine remote sensing data** obtained by **satellite observations** in ecosystem models and minimize the need for in situ sampling.

### ACTIVITIES

a. **Optimize** the **application** of open data from various **satellite sensors** observing the Belgian Part of the North Sea for ecosystem models.

b. **Validate** ecosystem **characteristics** derived from satellite sensors based on in situ measurements of e.g. primary production, chlorophyll concentration, suspended solids, HABs

c. **Improve** and **develop** remote sensing **methods** and technology for use in **shallow coastal waters** and e.g. for detecting major taxa of phytoplankton

### PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION

- Collaboration with prof. Heidi Dierssen (Coastal Ocean Laboratory for Optics and Remote Sensing, University of Connecticut, USA) for a sabbatical at VLIZ contributing to remote sensing science.
- VLIZ contributes to the STEREO project HYPERMAQ on hyperspectral high-resolution remote sensing

### CENTRES AND PLATFORMS INVOLVED

- Marine Robotics Centre
- Marine Data Centre
- Marine Imaging and Visualisation Centre
- Modelling, Fixed platforms, Seagoing platforms

### COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

- Knowledge on how to use remote sensing data to evaluate ecosystem impact of blue economy activities
- Use of remote sensing data to optimize location and/or timing of blue economy activities (e.g. aquaculture related to primary production, construction of coastal defence structures related to suspended solids flow and concentrations)

**EXPECTED OUTPUT**

- Remote sensing data readily available for use in marine ecosystem models
- Improved quality of remote sensing data through further development and refinement in combination with ground truthing through classical techniques, documented in publications

# III.3   NEAR-SHORE BOTTOM AND SUB-BOTTOM ACOUSTIC OBSERVATIONS

**GOAL**

To **improve acoustic techniques** for (**sub-)bottom observations** in near-shore sediments, also in sediments rich in natural gas (methane) and for **observing** this **natural gas** in sediment and water

**ACTIVITIES**

- Converted waves detection, e.g. with ocean bottom cable for characterizing sub-bottom layers containing natural gas
- Acoustic refraction measurements with large offset range for characterizing sub-bottom layers containing natural gas
- Application of acoustic techniques to detect water column gas and measure and characterize gas concentrations below the seafloor
- Apply and further develop emerging transforming and innovative technologies related to acoustic and non-acoustic bottom and sub-bottom observations

**PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION**

- Literature review for an up-to-date overview of possible techniques for bottom and sub-bottom observations in sediments containing natural gas.
- Test the application of an ocean bottom cable for sub-bottom observations in the sluice dock
- Using the multi-transducer sub-bottom echosounder with various settings for analysing the natural gas in sediments near Zeebrugge

**CENTRES AND PLATFORMS INVOLVED**

- Marine Robotics Centre
- Marine Data Centre
- Marine Imaging and Visualisation Centre
- Seagoing platforms, modelling, scientific divers

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

### IMPORTANCE FOR BLUE ECONOMY

- Knowledge of sub-bottom properties in near-shore zone crucial for the development of new activities
- Gas may have impact on cohesion and sediment properties

### EXPECTED OUTPUT

- Technique for identifying sub-bottom properties in near-shore gas rich zones, documented in publications
- Information on the amount of methane gas in the (shallow sediments of the) southern North Sea, documented in methodological and descriptive publications

# III.4. VISUAL OBSERVATIONS

### GOAL

To **improve visual observation** techniques and image processing methods in order to obtain information for running and validating ecosystem models (see I.1, I.2 and I.4).

### ACTIVITIES

a. Enhance and further standardise the methodology of using various **visual observation equipment** (FlowCAM, ZooSCAN, Video Plankton Recorder…)

b. Develop and improve **image processing technologies and methodologies**, for images obtained with advanced imaging equipment as well as with standard cameras or scanners, e.g. in citizen science projects.

c. Apply and further develop emerging **transforming and innovative technologies** related to optical and acoustical observations, e.g. related to underwater cameras (3D photogrammetry, sector-scanning sonars…)

### PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION

- Operating procedures for visual observation equipment have been developed in the framework of the LifeWatch and EMBRC ESFRIs.
- A methodology has been developed for classification into major groups of zooplankton images of samples analysed with the ZooSCAN.

### CENTRES AND PLATFORMS INVOLVED

- Marine Imaging and Visualisation Centre
- Marine Data Centre
- Modelling

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

**IMPORTANCE FOR BLUE ECONOMY**

- Maximising the information that can be obtained from fast and (semi-)automated visual measurements and analyses for a better understanding of the marine ecosystem in order to predict and manage impacts of blue economy activities
- High-resolution (semi-)automated inspection of offshore structures and other protruding objects (e.g. cables, pipelines, munition…)
- Potential collaborations - and in a later phase spin-offs - for developing novel visual observation technologies

**EXPECTED OUTPUT**

- The Marine Imaging and Visualisation Centre is consolidated as a leading Centre for the generation and processing of visual images
- Improved visual observation and image processing technologies, documented in publications

# III.5. TRANSFORMING AND INNOVATIVE TECHNOLOGIES IN MARINE ROBOTICS

**GOAL**

To **improve marine robotics** enabling novel ways of ocean observation

**ACTIVITIES**

To **apply and develop** emerging, transforming and **innovative technology** to enhance marine robotics. This will be driven by research questions and may comprise research in the field of miniaturization, automation, navigation, autonomous capacity, compatibility with sensors etc.

**CENTRES AND PLATFORMS INVOLVED**

Marine Robotics Centre

**COLLABORATION WITH MARINE RESEARCH GROUPS**

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure and expertise

- New technologies may be useful to solve blue economy questions, knowledge transfer to the blue economy
- Opportunities for commercialization of new technologies
- Support for the implementation of Industry 4.0 in the Blue Economy

**EXPECTED OUTPUT**

- The Marine Robotics Centre is consolidated as a leading Centre for application of and innovation in marine robotics
- New technologies, documented in publications, will enable more efficient and effective use of marine robotics

# IV

# The Ocean and Human Health

# IV. THE OCEAN AND HUMAN HEALTH

The marine environment contributes significantly to human health through the provision and quality of the air that we breathe, the food we eat, the water we drink and in offering health-enhancing economic and recreational opportunities. However, many of our perceptions of the relationships between the marine environment and human health are still relatively unexplored (European Marine Board 2013a).

This theme will be closely related to the ecosystem approach as outlined in theme I. It is necessary to understand all interactions in order to assess and predict the **ocean services** that have **a human health relevance**. VLIZ wants to improve our understanding of the **potential public health benefits** from marine and coastal ecosystems and evaluate the applicability and elucidate the reasons behind the **Blue Gym** hypothesis (White et al. 2016). A first sub-theme will focus on **epidemiological research** of coastal communities and the **socio-economic factors** linking the marine environment with human health and well-being. As for ocean services, VLIZ wants to take a <u>long-term perspective</u> in this theme, allowing for the investigation of slower trends. An <u>interdisciplinary consortium</u> will be formed to engage in this research field, which to our knowledge is <u>currently not investigated in Flanders</u>. Research will also expand on fundamental aspects of some factors, such as **marine aerosols** and **harmful algal blooms**, and on their relationship with human health.

## IV.1. EPIDEMIOLOGICAL MODELLING AND THE BLUE GYM HYPOTHESIS

<u>GOAL</u>

To evaluate the **impact** of the **marine ecosystem** on the **health** and **well-being** of communities living or spending their holidays in coastal cities and municipalities and if a positive impact is indicated, to evaluate **socio-economic, psychological and physiological factors** (social interactions, more exercise, less stress, seafood consumption) contributing to this effect.

<u>ACTIVITIES</u>

a. Perform **epidemiological studies** on cohorts of different **subpopulations** (based on age, gender, socio-economic background, location, occupation) in the **Belgian coastal region** and comparable reference locations, evaluating their **physiological** and **psychological health** in relation to their contact with and appreciation of the marine environment

b. **Sociological, psychological** and **physiological/medical research** to answer the question **why people benefit** from the proximity of the **sea**, including evaluation of the **economic impact** of these reasons in relation to coastal tourism

c. **Compare** these aspects in **different coastal communities** and **environments** in the framework of an international project.

- Marine Data Centre
- Citizen Science
- Modelling

COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of data and expertise
- Joint sampling or experimental design with complementary efforts

IMPORTANCE FOR BLUE ECONOMY

- Gaining insight in human health impacts of the marine ecosystem may indicate how this can be influenced (or not) by blue economy
- Economic projects can take into account the impact on human health and well-being in the design phase
- Improving key aspects of coastal life may boost tourism-based economy

EXPECTED OUTPUT (DOCUMENTED IN PUBLICATIONS)

- Epidemiological knowledge on the impact of the ocean on human health in coastal communities, useful for e.g. integrated coastal zone management
- Economic valuation of living/staying in a coastal environment
- Knowledge on the reasons of human health benefits from ocean proximity

# IV.2. MARINE AEROSOL EXPOSURE

GOAL

To evaluate the impacts of marine aerosols on human health

ACTIVITIES

a. Determine concentrations of **bioactive components** (toxins, polyphenolics) in marine aerosols by sampling and advanced chemical analysis

b. Measure and model **exposure** of **coastal populations** to these aerosols based on surveys, empirical relations between biogenic concentrations in seawater and in aerosols and aeorosol monitoring. **Model potential negative/positive effects** based on literature.

c. **Evaluate effects** at **molecular and/or cellular level** for different concentrations of observed substances

PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION

Start of aerosol monitoring and experimental aerosol generation with in situ samples by a job student

- Marine Data Centre
- Marine Robotics Centre
- Omics, Citizen Science, modelling, marine station, fixed platforms

## COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

## IMPORTANCE FOR BLUE ECONOMY

A positive effect of marine aerosols on human health would be an asset for coastal tourism and demography.

## EXPECTED OUTPUT (DOCUMENTED IN PUBLICATIONS)

- Characterization of chemical compounds in marine aerosols with relevance to human health
- Exposure of coastal population to these substances: empirical results
- Applicability of water toxin concentrations to derive aerosol concentrations and modelling of coastal exposure at different geographical locations
- Relating exposure to potential effects based on experimental results and laboratory tests

# IV.3. HARMFUL ALGAL BLOOMS

## GOAL

To **understand** the **factors leading** to **harmful algal blooms** (HABs), to develop and improve **monitoring techniques** for detecting harmful algal blooms and to **model** the **occurrence** and **impact** of harmful algal blooms.

## ACTIVITIES

a. **Method development** for harmful algae **detection** with image analysis (FlowCam), cyst analysis (vibrocore), molecular information (omics) and chemical toxin analysis.

b. **Micro- and mesocosm** research to determine the importance of critical **environmental variables** (temperature, current, light, turbulence, competition, grazing) for HAB formation

c. Use **ecosystem models** from sub-themes I.2 and I.4 to model **future risks** of HABs in the BPNS and human health risks from toxins via the marine food web or through aerosol exposure.

d. Evaluate these risks through **dedicated laboratory experiments**

## PROJECTS AND INITIATIVES ON-GOING OR IN PREPARATION

Participation in IOC UNESCO IPHAB

## Centres and Platforms Involved

- Marine Data Centre
- Marine Robotics Centre
- Marine Imaging and Visualisation Centre
- Omics, modelling, marine station, fixed platforms, seagoing platforms

## Collaboration with Marine Research Groups

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

## Importance for Blue Economy

- Improved understanding of HABs is important for profitability of aquaculture and fisheries
- Modelling the possible impact of blue economy projects (changes in currents, nutrient loads, sedimentation…) on HAB formation

## Expected Output (Cocumented in Publications)

- Standard methods for harmful algae detection
- Models for predicting HAB risks (longer term)

# Policy driven and Responsive Mode Research

# V. POLICY DRIVEN AND RESPONSIVE MODE RESEARCH

VLIZ wants to be able to have the opportunity to perform research on **emerging topics** through **regional, national or international policy developments** and respond to international research agendas or bright and dazzling research ideas. As in the other themes, the focus will be on <u>infrastructure driven and data driven collaborative research</u>. Research in this framework should lead to novel scientific insight and meet peer-review standards. Results will contribute to an **expanded scientific knowledge base**, also supporting the broader economic development. Policy driven VLIZ research will be complementary to project-specific (contract) research performed by dedicated consultants or other institutions.

## V.1. LOCAL AND REGIONAL FLEMISH POLICY PRIORITIES

### GOAL

To support Flemish policy priorities related to the Belgian Part of the North Sea by expanding the broad scientific knowledge base.

### ACTIVITIES

Perform scientific research in the context of policy priorities such as Flemish support to developments and innovation in the Blue Economy or coastal protection.

### INITIATIVES ON-GOING OR IN PREPARATION

- Investigations of different aspects related to the First World War munition dump site 'Paardenmarkt':
    - Munition burial depth with the <u>multifrequency echosounder</u>
    - Features and behaviour of gas in the sediment in relation to its effect on corrosion of the munition and stability of the sediment (see also C3)
    - Microbial communities in and near the dump site
- Modelling the shallow geology of the Zeebrugge nearshore area

### CENTRES AND PLATFORMS INVOLVED

All Centres and platforms potentially involved

### COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

### IMPORTANCE FOR BLUE ECONOMY

A sound scientific knowledge base is indispensable for sustainable development of the blue economy

- New scientific insights, documented in publications
- Scientific and public support for policy driven projects, also related to the blue economy

# V.2. INTERNATIONAL POLICY PRIORITIES AND AGENDAS

## GOAL

To scientifically support international Flemish engagements and contribute to the implementation of international science policy.

## ACTIVITIES

a. Perform collaborative research facilitated by bilateral agreements in the context of marine research, joint research and development programmes such as BONUS+, support to certain actions of the International Oceanographic Commission (IOC) of UNESCO or the European Joint Programming Initiative Healthy Oceans (JPI Oceans).

b. Perform collaborative research on topics identified by international research agendas such as the European Marine Board's upcoming position paper 'Navigating the Future V' or international research initiatives such as the International Quiet Ocean Experiment (Tyack et al. 2015).

## INITIATIVES ON-GOING OR IN PREPARATION

- Contact with *Institut des Sciences de la Mer* in Rimouski, Quebec to initiate a research exchange visit in the framework of the bilateral agreement between Quebec and Flanders
- Expression of interest to the JPI Oceans action 'Munitions in the sea' related to the First World War dump site 'Paardenmarkt'
- Valorising the opportunities offered by the donation of RV Mtafiti to the Kenya Marine and Fisheries Research Institute, e.g. in the framework of the Second International Indian Ocean Expedition (IIOE-2) organised by UNESCO-IOC and SCOR
- Exploring collaborative research alliance in the Northeast Atlantic with the Royal Netherlands Institute for Sea Research (NIOZ), the Alfred Wegener Institute in Germany (AWI) and the Danish University DTUAqua to jointly tackle international marine research and policy priorities related to the North Sea, at the appropriate scale.

## CENTRES AND PLATFORMS INVOLVED

All Centres and platforms potentially involved

## COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

New scientific insights from international collaborations may be useful for increasing the knowledge base supporting sustainable blue economic development

## EXPECTED OUTPUT

- New scientific insights, documented in publications
- Visibility of Flanders as important player in the marine research field
- Flanders contribution to the implementation of UN SDG14 'Life Below Water'
- Marine Science Diplomacy

# V.3.  BRIGHT AND DAZZLING RESEARCH IDEAS

## GOAL

To work out brilliant research ideas into actual research projects. VLIZ wants to seize quick opportunities for short and fast research based on out-of-the box thinking or intuitive thoughts and to test concepts or findings resulting from serendipity.

## ACTIVITIES

Perform innovative research (e.g. collaborative projects, proof-of-principle experiments, novel model applications) based on brilliant research ideas related to emerging topics or local opportunities

## CENTRES AND PLATFORMS INVOLVED

All Centres and platforms potentially involved

## COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

## IMPORTANCE FOR BLUE ECONOMY

New scientific insights may be useful for increasing the knowledge base supporting sustainable blue economic development
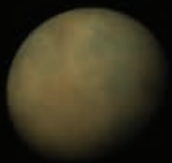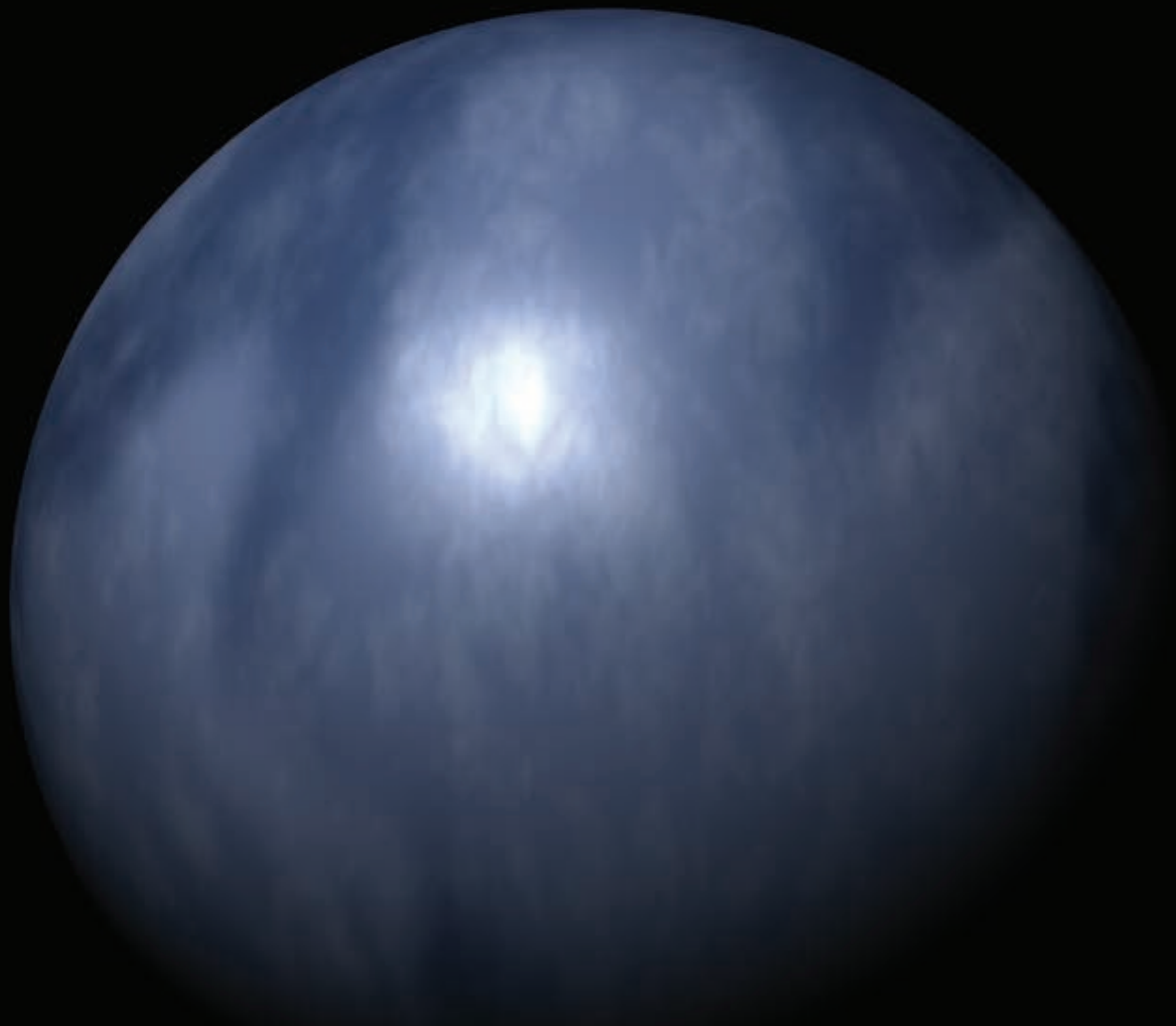
## EXPECTED OUTPUT

New scientific insights, documented in publications

# VI

# Blue Sky Research

# VI. BLUE SKY RESEARCH

This theme allows VLIZ to engage in <u>collaborations on high-risk, blue sky research</u> related to the ocean, such as on exo-oceans or the origin of life, which otherwise would be difficult to get started. VLIZ wants to be involved in the activities to be developed by a possible future joint working group on exo-oceans between the European Space Sciences Committee and the European Marine Board. This theme includes explorative research for discovering new signals or trends, e.g. by non-targeted data mining and applying big data technology on newly available datasets or opportunistic measurements with certain research infrastructure.

## GOAL

To gain new insights and knowledge on ocean-related questions and to detect new signals or trends in the ocean system.

## ACTIVITIES

a. Experimental research to test hypotheses on the origin and evolution of life and energy in deep-sea or exo-planet conditions
⇨ Preparation/pre-evaluation: not before Q3 2020

b. Explorative research on marine topics, also in collaboration with other Marine Research Groups
⇨ No priority or timing, will be considered whenever opportunities arise;

## CENTRES AND PLATFORMS INVOLVED

- Marine Robotics Centre
- Marine Data Centre
- Multi-environment Marine Experiment Centre
- Marine Imaging and Visualisation Centre
- All platforms can potentially be involved

## COLLABORATION WITH MARINE RESEARCH GROUPS

- Supervision and co-promotorship of MSc or PhD students
- Joint project proposals for external financing at national and international level
- Collaborative applications of research infrastructure, data and expertise
- Joint sampling or experimental design with complementary efforts

## EXPECTED OUTPUT

New insights and improved knowledge

# REFERENCES

- Belgian government and parliament. 1999. Wet van 20 januari 1999 ter bescherming van het mariene milieu en ter organisatie van de mariene ruimtelijke planning in de zeegebieden onder de rechtsbevoegdheid van België.

- EurOCEAN conference. 2014. Rome Declaration, Setting a vision for seas and ocean science. Rome, Italy.

- European Commission (2007) An integrated maritime policy for the European Union. *Commission Communication,* 575.

- --- (2012) Blue Growth opportunities for marine and maritime sustainable growth. *Commission Communication,* 494.

- --- (2014) Innovation in the blue economy: realising the potential of our seas and oceans for jobs and growth. *Commission Communication,* 254.

- European Marine Board. 2013a. *Linking Oceans and Human Health: A Strategic Research Priority for Europe.* Ostend, Belgium: European Marine Board.

- ---. 2013b. *Navigating the Future IV.* Ostend, Belgium: European Marine Board.

- ---. 2017. *The ticking time bomb of climate change: why human actions in the next 10 years can profoundly influence the next 10,000.*: European Marine Board.

- European Parliament and Council (2008) Directive 2008/56/EC: establishing a framework for community action in the field of marine environmental policy.

- ---. 2014. Directive 2014/89/EU: establishing a framework for maritime spatial planning.

- Flemming, N. C., M. N. Çağatay, F. L. Chiocci, N. Galanidou, H. Jöns, G. Lericolais, T. Missiaen, F. Moore, A. Rosentau, D. Sakellariou, B. Skar, A. Stevenson & H. Weerts. 2014. *Land Beneath the Waves: Submerged landscapes and sea level change. A joint geoscience-humanities strategy for European Continental Shelf Prehistoric Research.* Ostend, Belgium: European Marine Board.

- Mees, J. 2017. Strategisch Plan 2017-2021, Vlaams Instituut voor de Zee. Oostende, Belgium: VLIZ.

- Mees, J., H. Pirlet, A. K. Lescrauwaet, T. Verleye, R. Pirlet, C. Janssen & G. Verreet. 2015. Marine Research. In *Compendium for Coast and Sea 2015: An integrated knowledge document about the socio-economic, environmental and institutional aspects of the coast and sea in Flanders and Belgium,* ed. J. Mees, 8-51. Ostend, Belgium.

- Schulz, M., H. Goose, E. Hofmann, P.-Y. Le Traon, S. Lozier, B. Salihoglu & I. Sousa Pinto. 2015. The Ocean Climate Nexus Consensus Statement: the critical role of ocean science in responding to climate change. European Marine Board and Consortium for Ocean Leadership.

- Tyack, P., G. Frisk, I. Boyd, E. Urban & S. Seeyave. 2015. International Quiet Ocean Experiment Science Plan. Scientific Committee on Oceanic Research of the International Council for Science and Partnership for Observation of the Global Oceans.

- UN. 2015. *United Nations Resolution A/RES/70/1 of 25 September 2015.*

- UNESCO. 2001. Convention on the protection of the underwater cultural heritage and its context.

- White, M., S. Pahl, B. Wheeler, L. Fleming & M. Depledge (2016) The 'Blue Gym': What can blue space do for you and what can you do for blue space? *Journal of the Marine Biological Association of the United Kingdom,* 96**,** 5-12.