Vlaams Instituut voor de Zee
Flanders Marine Institute

BOOK OF ABSTRACTS

VLIZ Marine Science Day 2019

13 MARCH 2019 | BREDENE, BELGIUM

VLIZ Special Publication #83

Book of Abstracts

VLIZ Marine Science Day

MEC Staf Versluys, Bredene
13 March 2019

VLIZ special publication #83

This publication should be quoted as follows:

Jan Mees and Jan Seys (Eds). 2019. Book of abstracts – VLIZ Marine Science Day. Bredene, Belgium, 13 March 2019. VLIZ Special Publication 83. Vlaams Instituut voor de Zee – Flanders Marine Institute (VLIZ): Oostende, Belgium. 165 + xi p.

Vlaams Instituut voor de Zee (VLIZ) – Flanders Marine Institute
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Photo cover: VLIZ

ISSN 1377-0950

PREFACE

This is the 'Book of Abstracts' of the 19th edition of the VLIZ Marine Science Day, a one-day event that was organised on 13 March 2019 in the MEC Staf Versluys in Bredene.

This annual event has become more and more successful over the years. With over 400 participants and more than 100 scientific contributions, it is fair to say that it is the place to be for Flemish marine researchers and for the end-users of their research. It is an important networking opportunity, where scientists can meet and interact with their peers, learn from each other, build their personal professional network and establish links for collaborative and interdisciplinary research.

Marine scientists from all Flemish universities and scientific institutes – and representing all marine science disciplines – have contributed to this volume. The book thus illustrates the diversity, quality and relevance of the marine sciences in Flanders (and Belgium): it provides a beautiful and comprehensive snapshot of the state-of-the-art of marine scientific research in Flanders.

Pre-doc and post-doc scientists present their research in an exciting way and communicate their fascinating science – and its importance to society – to the wider public. We thus hope to demonstrate the excellence of Flemish marine science and to increase its national and international visibility.

The volume of research that is presented here holds a great promise for the future. It shows that marine science is a very lively discipline in Flanders, and that a new generation stands ready to address the grand challenges and opportunities that our seas and oceans represent.

For the third year in a row, the Brilliant Marine Research Ideas are awarded, an initiative sponsored through the philanthropy scheme of VLIZ. We are proud to announce that last year's winners present their results here at the VLIZ Marine Science Day.

I want to congratulate all participants with their contributions, and I invite them all to become members of VLIZ and to actively participate in our events and activities in the future.

Bredene, 13 March 2019

Prof. Dr Jan Mees

General Director VLIZ

TABLE OF CONTENTS

INFORMATIVE POSTERS

COMPETITION POSTERS

Keynote Presentations

Why marine science?

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In this talk I will give an overview of my marine science career. Where I came from, what I have done, and why I made the choices I did. I will use this overview to give students some tips for how to be a successful marine scientists based on my experience.

The UN Decade of Ocean Science for Sustainable Development (2021-2030)

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The United Nations Decade of Ocean Science for Sustainable Development, 2021-2030 is a unique ten-year, global cooperative program to expand scientific partnerships to support effective science, ocean management, and sustainable development. The speakers and an open floor to the science community will explore how to collaborate with the UN, international bodies, governments, science community and private sector through the Decade. National and international experts will be invited to engage to share their science priorities and identify opportunities to become involved in the implementation planning process. Existing scientific networks can catalyze opportunities for new and expanded collaboration, and will be a foundation of planning for the Decade. The Decade will consist of top down and bottom up science initiatives to map the ocean floor and processes, bolster ocean observation systems in all basins, develop a data and information portal, establish an integrated multi-hazard warning system, advance ocean component in earth-system observation, research and production, and strengthen capacities, ocean literacy and technology cooperation. The Implementation Plan will seek to achieve additional specific results, driven by the mission needs of society and science, and produce lasting benefits.

Award Presentations

Using multiple geophysical methods for the assessment of submarine groundwater discharge in the Western Belgian coastal area

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Submarine groundwater discharge (SGD) is a mix of fresh groundwater discharging from the land and recharging seawater. SGD has the potential of influencing shallow coastal environments, since it constitutes a gateway for nutrients and pollutants in marine ecosystems. In Belgium, the shoreline is delineated by a semi-continuous dune belt, which varies in thickness. Freshwater recharges in the dunes during rainfall, leading to the development of a freshwater lens. Part of it flows towards the North Sea as submarine fresh groundwater discharge (SFGD). Although the existence of SFGD in the western part of the coast is known for decades, it has never been thoroughly characterized and quantified. *De Westhoek* nature reserve was chosen as a study site given its wide dune belt and low anthropogenic influence.

To delineate SGD, a combination of several geophysical methods are used for characterizing the salt / freshwater interface. Electromagnetic (EM) and electrical resistivity tomography (ERT) methods were chosen for their sensitivity to salinity variations. EM mapping was done on the beach at low tide with the CMD-MiniExplorer and the DUALEM-421s. Both devices have multiple investigation depth ranges up to 4m. Land ERT (Abem Terrameter LS) was performed on the beach and in the dunes. Finally, marine ERT (IRIS Instruments Syscal Pro Deep Marine) profiles were collected at sea during high tide with logistical support from the Flanders Marine Institute (VLIZ).

The combination of techniques provides a lateral and vertical distribution of salinity from the dune to the sea. 1 km from the French-Belgian border, we identify a large discharge zone located approximately at the low water line. This discharge zone can be followed laterally; it shifts seaward towards the French-Belgian border where it is located below the low water line. Our study is the first successful combination of EM, land and marine ERT to detect freshwater discharge in the intertidal and near-shore zone. Further field campaigns are planned to identify other areas of SFGD along the coast and to characterize SGD further (geochemistry, quantity…).

Keywords: Submarine groundwater discharge; Geophysics; ERT; EM

Counteracting anthropogenic CO2 emissions by microbial stimulation of silicate weathering

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On the COP21UN climate change summit, all governments have agreed to limit global warming within a 2°C increase with respect to preindustrial conditions. To achieve this target, large-scale deployment of so-called negative emissions technologies (NETs) - the active capture and removal of CO2 from the atmosphere - will be needed. One of several NET approaches that is gaining increasing attention is Enhanced Silicate Weathering (ESW). ESW makes use of the natural weathering reaction, whereby carbonate and silicate dissolution consume atmospheric CO2. The chemical weathering of olivine is influenced by a number of parameters, of which the temperature and pH are the most important. One important recent finding is that pore water conditions in coastal sediments can be far more acidic than previously thought. In so-called electro-active sediments, long filamentous microbes called “cable bacteria” perform long-distance electron transport, a metabolism which induces strong acidification (down to pH ~ 5) of the top few centimeters of the sediment, which greatly stimulates the dissolution of acid-sensitive minerals such as carbonates and iron sulfides, and is also expected to strongly increase the dissolution rate of olivine. Recently, it has been argued that electro-active sediments may be globally common in the coastal zone and therefore, these acidic marine sediments could be a target location for coastal ESW. However, until now, the impact of pH changes induced by cable bacteria on the enhanced weathering of olivine has not been investigated.

Here we present the results of a small-scale laboratory incubation experiment. Natural coastal sediment was collected in Rattekaai (The Netherlands) and enriched with 0, 5, 10 and 20 % of olivine (dry wt percent). We have followed the development and activity of the cable bacteria over 2 months using microsensor profiling of pH, H2S and O2, as well as the evolution of pore water profiles of nutrients (PO43-, NH4+ and dSi), trace metals (e.g. Ni) and alkalinity. Cable bacteria activity was comparable between treatments, while phosphate and ammonium profiles showed no difference between treatments. In contrast, dSi and alkalinity concentrations were higher in the treatments with higher olivine enrichments. These results suggest that olivine dissolution is indeed stimulated in electro-active sediments. Given the widespread distribution of cable bacteria in natural sediments, microbial stimulation of silicate weathering could provide a viable option for ESW.Text

Keywords: Cable bacteria; Net Emission Technologies; Silicate weathering

Graafgedrag bij de Europese paling (*Anguilla anguilla*)

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In dit onderzoek hebben we het graafgedrag van de Europese paling onderzocht in het glasaal- en elver eelstadium, de levensstadia bij het arriveren in de Europese wateren. Het is al langer bekend dat het voor Anguillidae zeer belangrijk is om over een schuilplek te beschikken, maar of de Europese paling zich al dan niet ingraaft bleef tot op de dag van vandaag ongekend. Ondanks dat in eerder onderzoek beweerd werd dat Anguilliformes, buiten hun langwerpig en cilindrisch lichaam, geen morfologische adaptaties hebben om zich in te graven, groef de Europese paling zich toch zeer efficiënt in. Ingraven gebeurde door krachtig met de kop heen en weer te bewegen in een horizontaal vlak, in combinatie met undulaties van het volledige lichaam. Net zoals vele andere gravende vissen is de Europese paling dus een 'head-first burrower'.

Palingen verkozen een fijne korrel boven een grovere korrel, met uitzondering van de kleine individuen die grof grind prefereerden. Dit kan gerelateerd zijn aan hun lichaamsgrootte, aangezien deze individuen in staat zijn om gemakkelijk tussen de interstitiële ruimtes van de grovere grindstenen te manoeuvreren. Daartegenover werd vastgesteld dat ingraven het snelst plaatsvindt in een bodem van fijn grind, gevolgd door zand en tenslotte grof grind. Verassend genoeg werd wel vastgesteld dat de palingen in 70% van de gevallen zand boven fijn grind verkozen, ondanks dat het ingraven sneller verloopt bij deze laatste. Een mogelijke verklaring is dat zand een betere reflectie is van hun natuurlijk habitat of dat zand beter geschikt is om langdurige tunnels te maken. Wanneer de palingen de keuze kregen tussen een bodemsubstraat en materiaal om zich tussen te verschuilen, werd in de meerderheid van de gevallen nog steeds graafgedrag geobserveerd. In de meeste gevallen werd eerst schuilgedrag geobserveerd, gevolgd door graafgedrag. Dit suggereert dat de Europese paling, zeker in de meest juveniele stadia, een spontane graver is. Verder onderzoek is nodig om het graafgedrag in latere levensstadia in kaart te brengen.

Sewage-derived resort runoff threatens coral reefs? A pilot isotopic assessment of nitrogen at Pulau Redang, Malaysia

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In the Anthropocene coral reefs are threatened by a host of global and local stressors. In the past two decades, development of island tourism at Pulau Redang, Peninsular Malaysia, has increased the annual number of visitors by an order of magnitude, from 22,725 visitors in 1995 to 184,043 visitors in 2017 (Data Source: Department of Marine Parks Terengganu, 2017). Sewage-derived nutrient enrichment has emerged as a potential ecosystem scale threat to coral reefs around this island[1]. Here, the spatial extent of sewage-derived nutrient sources across Redang is assessed using stable isotopic techniques to measure δ15N in competitive macroalgae (Lobophora spp.), corallivorous gastropods (Drupella spp.), and branching corals (Acropora spp.), representing nutrient uptake over multiple temporal scales[2]. Combining δ15N with conventional benthic reef monitoring data, we then test the relationship between δ15N and coral reef community composition with a multivariate approach on all 55 benthic cover types, and a univariate approach on community structure indices and major benthic group coverage. We show that Acropora has the best potential as a bioindicator of pollution at Redang. Significantly higher enrichment of Acropora δ15N was identified in the tourist hub on the east coast (3.85 ‰ ± 0.18 SE), where septic tanks and eutrophic waste-water outflows are potential nutrient sources, compared to pristine reefs on the uninhabited northern and western sides (3.02 ‰ ± 0.04 SE). Regional Acropora δ15N was significantly correlated to regional variance of cover type richness, Shannon diversity index, and Simpson dominance index; coexistence of coral-dominated reefs alongside degraded zoanthid barrens was only found in the tourist hub region. In Terengganu there is a need for better cooperation between state and marine park authorities to ensure that tourism-derived nutrient enrichment does not cause reef degradation. Determining the ecological impact caused by nutrient enrichment is an important first step in the long-term sustainable development of tourism on the now-booming Terengganu islands.

Keywords: Marine parks; Resilience; Tourism development; Diversity; Water Quality

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Changing culture: Factors influencing sea turtle egg consumption in Redang Island, Malaysia

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Sea turtles in Malaysia have faced serious population declines due to multiple anthropogenic stressors; one of the key stressors being the direct consumption of their eggs. On Redang Island, a primary nesting site for green turtles (*Chelonia mydas*) in Malaysia, turtle eggs have been consumed for centuries. In the past, the local community was dependent on the eggs for their livelihood through a licensed collection system. Owing to the precipitous decline in sea turtles, the main nesting beaches were protected as sanctuaries in 2004, prohibiting egg collection from these beaches. Between 1996 to 2014, a local awareness program was initiated for grade 5 school students (age 11 years) educating them on sea turtle conservation. At the end of the program the children pledged to stop consuming turtle eggs. Our study investigated the prevalence, influencing factors and impact of the awareness program on egg consumption. Respondent perceptions towards egg consumption and conservation were also explored. Data were collected through interviews in 73 households in the Redang village. Based on the respondents' perceptions, our findings suggest that the consumption of turtle eggs has decreased since the initiation of protection measures. Using logistic regression, we found that older people and past egg collectors were more likely to consume turtle eggs. Attending the awareness program resulted in a significant decrease in egg consumption in the younger age groups. Turtle egg consumption in Redang is predominantly influenced by cultural factors linked to age and taste preferences rather than economic factors. The perceptions towards the conservation of sea turtles were positive, primarily due to the locals recognising that turtle populations would go extinct without protection. Moreover, a rapid growth in the local tourism sector has served as an economic alternative to egg harvesting. The respondents recognised the importance of sea turtles for tourism, showing that species values are changing. We recommend future efforts to focus on restarting tailored awareness programs, targeted at all age groups and locals employed in the tourism sector.

Keywords: Sea turtles; Human-nature interactions; Sea turtle eggs; Cultural services; Conservation; Education; Awareness; Interview; Social-ecological system

Electron shuttling and elemental cycling in the seafloor

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The seafloor (or marine sediment) is an invaluable part for the cycles of chemical elements (carbon, nitrogen, sulphur) through planet earth. For example, more than half of the reactive nitrogen (e.g. ammonium) is converted to unreactive N2-gas in the sediment. The seafloor is also an efficient reactor that recycles 90% of the sulphur and carbon it receives, back to the water column. The settling of organic carbon, which is a reduced compound (i.e. rich in negatively charged electrons), starts a complex series of redox-reactions (oxidation of organic carbon coupled to the reduction of, e.g., oxygen). The transformations that occur when chemical species pass through the upper 10 – 100 cm of the seafloor (also called 'early diagenesis'), determines which elements and what fractions are either stored in the deep mantle or are recycled back to the ocean and atmosphere. Redox transformations are strongly affected by the presence or absence of micro- and macro-organisms. Biological activity by small critters or certain types of micro-organisms can have a large effect on geochemical cycling within the seafloor. During my PhD project, I investigated the impact of two types of ecosystem engineers on the biogeochemical cycling of carbon, iron, sulphur and associated trace elements in the seafloor: Long filamentous micro-organisms (cable bacteria) and large macro-fauna (bioturbators). Both ecosystem engineers stimulate the recycling of carbon, sulphur and iron. Cable bacteria do this by acidifying the top few centimetres of the sediment, and bioturbators by enhancing the transport of solid particles and dissolved substances in the sediment.

A field study in the coastal North Sea showed that the acidic environment generated by cable bacteria in the upper 5 cm of the sediment promotes the dissolution of acid sensitive minerals like FeS and CaCO3. The dissolution of these minerals releases iron and related trace metals (manganese, cobalt, arsenic) in the pore water. A fraction of these elements re-precipitates at the oxygen-rich sediment-water interface. However, under fluctuating oxygen concentrations (from fully oxygenated to oxygen depleted), cable bacteria actually amplify the seasonal cycle of arsenic release from the sediment, as revealed by a study in Lake Grevelingen. Animals that inhabit the seafloor stimulate the transport of solid particles by their burrowing activity (bio-mixing) and enhance the exchange of dissolved species between the pore water of the sediment and the overlying water column by the flushing of their burrows (bio-irrigation). A field study in the Blakeney salt marsh (Norwich, UK) showed how bioturbation actually limits the burial of organic carbon and reduced iron-sulphide and diagenetic modelling reveals that the geochemical effects are already noticeable at very low bioturbation activity. Implementing these results in a long-term model, showed that the evolution of burrowing could have induced a low-oxygen atmosphere in the past and might have triggered global warming by increasing atmospheric CO2 during the Cambrian explosion (when multicellular life developed in the ocean, ~500 million years ago). Finally, field data following a human-induced sediment mixing event (which is essentially equivalent to human bioturbation) from the Belgian Coastal Zone suggests that bottom trawl fishing and dredging also limits organic carbon burial, and provides a clear illustration of how human activity can inadvertently change the coastal carbon cycle.

Keywords: Electron shuttling; Elemental cycling

Pre-Doc Presentations

Unraveling fatty acid bioconversion in harpacticoid copepods facing a changing environment

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As climate change is a global challenge that affects everyone, everywhere, reducing its impacts is a key action point of the UN Sustainable Development Goals (SDG 13: *take urgent action to combat climate change and its impacts*). Shifts in oceanographic conditions such as temperature and pCO_2 are affecting the physiological performance and productivity of organisms in coastal food webs and thereby threatening the overall functioning of the coastal ecosystem. A better understanding of the physiological response and adaptive capacity of coastal marine organisms is critical to assess their fate and to conserve coastal ecosystems in a rapidly changing ocean (SDG 14: *conserve and sustainably use the oceans, seas and marine resources*).

Harpacticoid copepods are a dominant component of estuarine benthic meiofauna, efficient grazers on diatoms, and a major food source for juvenile fish. They are known to contain high levels of polyunsaturated fatty acids (PUFAs), which are essential dietary constituents for fish and humans as the latter can't produce these omega-3 and omega-6 fatty acids themselves. Harpacticoid copepods on the other hand are able to bioconvert PUFAs that originate from primary producers. This capacity might be an essential strategy for harpacticoid copepods to respond quickly to environmental changes, since climate change reduces the amount of PUFAs within primary producers, and thus, their availability for higher tropic levels.

Our research aims to uncover the genetic pathways of PUFA bioconversion in harpacticoid copepods and how these mechanisms respond following a combination of a reduced PUFA diet and realistic future warming. Our species of interest is *Platychelipus littoralis*, a harpacticoid copepod occurring abundantly in the Westerscheldt estuary. We generated RNA-Seq data and fatty acid profiles from *P. littoralis* subjected to different diet and temperature treatments. Even when fed a PUFA-deficient diet (i.e. the chlorophyte *Dunaliella tertiolecta*), *P. littoralis* always maintains sufficient PUFA levels compared with a control treatment. By means of a *de novo* transcriptome assembly and subsequent annotation and differential gene expression analysis, we are able to link the fatty acid profiles to potential PUFA bioconversion-related genes.

Keywords: Transcriptomics; Global change; Harpacticoid copepods; Fatty acid metabolism

An ecosystem model of the Oosterschelde estuary

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The Oosterschelde is located in the south-western part of the Netherlands, in a region known as the Delta area. It was the former mouth of the Scheldt river, however, decades of high human control and influence ended up transforming it in from an estuary into a tidal bay. Yet, its ecosystem remains highly valuable due to the mussel culture activities taking place in the subtidal areas and its designation as a NATURA-2000 conservation site.

The present study developed a 1-D transport-biogeochemical model, which divided the basin into 99 compartments along the longitudinal axis, reproducing the main processes of the pelagic and benthic environments with special emphasis on the phytoplankton-nutrients-bivalve dynamics. The model was calibrated for the period 1996-2005 showing a good fit to data of Chla, DIN and PON. Dynamics in the western zone of the basin was found to be highly influenced by import from the North Sea in terms of primary production, but with the highest local pelagic primary production occurring in the eastern zone. Possible competition for nutrient uptake was detected between the pelagic and benthic primary producers in all zones of the Oosterschelde. The North Sea also influenced nutrient regeneration via the input of substrate, which is remineralised mainly in the western zone, leaving the central and eastern zone mostly dependent on benthic mineralization and transport processes from the western zone to supply their demand. Bivalve filter feeders were shown to exert a high grazing pressure on the phytoplankton. On the regional scale, mussels had more impact, but oysters were equally or even more relevant on the scale of a reef. The biomass of the bivalve species experienced a downward trend during the last four years of simulation, which could be an indication of increasing competition for food.

Keywords: Oosterschelde; Mussels; Oysters; Ecosystem modelling

Adaptation and acclimation in a rapidly changing marine environment: A case study of the brown seaweed *Dictyota dichotoma* in Europe

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Global climate change is affecting marine species and assemblages worldwide. While a tremendous effort has already been done to assess the impact of changing environmental conditions on marine life, there are some important knowledge gaps that hamper our ability to accurately predict the persistence of marine species under global climate change. Most importantly, little is still known about the occurrence of intraspecific variation in fitness-related traits, which may allow populations from the same species to withstand different levels of stress. Relying on tolerance estimates from a single population may therefore lead to incorrect assessments of species responses to climate change, especially in the context of thermal tolerance limits, since it will underestimate the vulnerability of central populations to warming and/or overestimate the sensitivity of warm-edge populations.

To address this issue, we are evaluating the thermal response of growth rate and photosynthesis for different populations of the brown seaweed *Dictyota dichotoma*. In order to define the vulnerability of these different *D. Dichotoma* populations to global warming, we are constructing thermal performance curves for each trait, which allows us to identify the optimum temperature for growth and photosynthesis as well as the thermal limits for performance and tolerance in each population.

Keywords: Climate change, Intraspecific variation, *Dictyota dichotoma*

What moves European sea bass?

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The poor state of the data-deficient European seabass (*Dicentrarchus labrax*) in the southern North Sea calls for an informed fisheries management to protect the intertwined ecological and socio-economic stakes at risk. The highly mobile seabass is known to move from shallow, inshore feeding grounds in summer to deeper waters offshore in search of warmer temperatures in winter for spawning. Knowledge on these spatiotemporal changes in movement behaviour and distribution is critically limited for seabass in the southern North Sea.

The cutting-edge technology of the acoustic data storage tag (ADST) enables the observation of fish movements in the wild. The transmitted acoustic signal of ADSTs can be detected by receiving hydrophones, whenever the tagged fish roams within its detection range. Tag recovery allows to access the data-storage part and reconstruct individual depth and temperature records stored on the tag itself. From 2018 to 2020, 100 sea bass, caught by hand-line fishing in the Belgian Part of the North Sea, will be tagged with ADSTs (so far 40 have been tagged).

This PhD project aims to better understand seabass spatial dynamics in Belgian waters and the southern North Sea. Therefore, habitat use and seasonal migrations will be investigated and related to patterns in sea bass exploitation. As a final objective, the observed spatiotemporal dynamics will be translated into fisheries management recommendations. Here, the first results from sea bass detections on the LifeWatch acoustic receiver network will be discussed.

Keywords: *Dicentrarchus* labrax; European sea bass; Movement ecology; Electronic tagging; Acoustic telemetry

Ocean health in Belgium: Living near the coast is associated with better health

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Positive effects of natural environments such as green space and blue space on human health and wellbeing received considerably more attention in the last decade. Benefits from the coast and marine ecosystems mainly arise through 4 mechanisms, i.e. stress reduction, elevated physical activity, healthier social interactions and better environmental quality. However, evidence linking residential proximity to the coast with human health and wellbeing is scarce. Therefore, we investigated whether Belgian citizens living closer to the coast report better health.
Data from the Belgian Health Interview Survey (n = 60,939 representative for the Belgian population, taken in 1997, 2001, 2004, 2008 and 2013) were used to investigate whether proximity to the coast is associated with the health of Belgian citizens. Human health and wellbeing were quantified by three metrics, i.e. overall subjective health, psychological stress (GHQ-12 score), and vitality (SF-36 score). In a linear regression model analysis, we tested whether people residing in proximity of the sea feel better in general, i.e. obtained a better evaluation for one of these metrics. Proximity to the coast was calculated as fastest driving distances between the domicile address and the Belgian coast. These driving distances were divided in eight categories, i.e. >250 km, 200-250 km, 150-200 km, 100-150 km, 50-100 km, 20-50 km, 5-20 km and 0-5 km from the coast. The outcomes of our analyses are normalized based on potential confounding factors, such as for example, the age of the respondent, having a chronic disease, having a paid job, income, smoking status, physical activity, the appreciation of social interactions, the amount of blue space and green space in the area and the air quality in the area (PM_{10} and NO_2 concentrations).

Proximity to the coast is associated with higher scores for subjective health, vitality and psychological stress. Most strikingly, people living at 0-5 km from the coast report 3.7 % better subjective health than people living elsewhere ($p = 0.011$). Besides this local effect, large scale trends were observed in the psychological stress and vitality. For example, a pronounced gradual increase in vitality occurred towards the coast ($p \leq 0.002$). This increase in vitality was most substantial for people living at 20-50 km from the coast, which were 12.3 % more vital than people living in the hinterland. Our results indicate that these changes in health and wellbeing associated with distance to the coast are in the same order of magnitude as the relations of for example smoking behavior or income with health.

Next to the important role of the sea, also the appreciation of social interactions and having a chronic disease correspond with large changes in health and wellbeing, as hypothesized prior to this study. Health was always less strongly related with the environment (amount of blue space and green space, air quality) than with personal variables (e.g. physical activity).

Our study provides the first evidence of a positive association between proximity to the coast and the physical and mental human health and wellbeing in Belgium. Potential mechanisms were explored, and remain a matter for further research.

Acknowledgments
We would like to thank the providers of the data, i.e. Scientific Institute of Public health, OD Public health and surveillance (2015). Health Interview Survey 2013 [Data file and code book]. Obtainable under condition from the WIV-ISP Web site: https://his.wiv-isp.be/SitePages/Acces_microdata.aspx

Keywords: Blue space; Coast; Health; Well-being

Impact assessment of offshore dredging activities and wind farms on sediment dynamics using a coupled ocean-wave-sediment transport model

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Intensification of offshore human activities, i.e. aggregate extraction and wind farms operation, in the Belgian Coastal Zone (BCZ) leaves an imprint on biodiversity and biogeochemical cycles via changes in sediment dynamics. This impact requires a quantitative assessment in order to develop indicators for management policies. The FaCE-IT project (Functional biodiversity in a Changing sedimentary Environment: Implications for biogeochemistry and food webs in a managerial setting) funded by the Belgian Science Policy Office (BelSPo) was created to assess the local impact of an individual wind farm and upscale it over the BCZ using numerical modelling.
The coupled Ocean-Wave-Sediment transport (COAWST) modelling system (Warner, 2010) was implemented for the BCZ on the fine resolution grid (i.e. 1 km2), which is connected with the coarse resolution grid (5 km2) set for the English Channel and the Southern Bight of the North Sea in two-way nesting. The sediment model was initialized with several classes for both cohesive and non-cohesive sediments provided by the Flanders Marine Institute (VLIZ). The full validation using VLIZ in-situ data and satellite products from Copernicus Marine Environment Monitoring Service was conducted with a specific target to solve various processes important for sediment dynamics, such as freshwater plume dynamics and patterns of residual currents, as well as a system response to different meteorological events.

Scenarios have been designed to represent aggregate extraction and the turbid wake issued from wind farm flow perturbation and epifaunal activity in terms of sediment source, sinks and redistribution. Preliminary results showing the influence of those local perturbations on seafloor integrity and suspended particulate matter are presented at the regional scale of the BCZ.

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Keywords: Ocean modelling; Belgian coastal zone; Offshore wind farms; Sediment transport

Supporting SDGs through genetic research in sustainable shrimp fisheries management

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Our research focusses on one of the core topics of the UN Sustainable Development Goal 14 (Life Below Water) and one of the main sectors of the blue economy: the **sustainability of fisheries**. As a case-study, we focus on the exploitation of the Atlantic seabob shrimp *Xiphopenaeus kroyeri* in the Guianan Ecoregion (Guyana, Suriname, French Guiana) in South America, where this species constitutes the most important shrimp resource for both artisanal and industrial fisheries. Concerns about the sustainability of the fishery in the Guianan Ecoregion, especially in Suriname, have led to a joint strategy taken by the artisanal and industrial fishery, NGOs, academic researchers and the government. This strategy towards a sustainable exploitation of the species is unique for a developing country, and resulted in awarding the fishery with the MSC label for sustainable practices, being the first tropical shrimp fishery worldwide obtaining this label. However, to achieve a real ecosystem approach to fisheries (EAF), important questions on the genetics of the species, more specifically on its phylogeny and population structure in the Guianan Ecoregion, still remain unanswered.

The obtained genetic data to support fisheries management has been applied in a two-pronged approach: first, analysis of several genetic markers revealed the presence of an additional, undescribed species of the seabob shrimp. This second species differs notably in its ecology, since it only inhabits the inshore zone, essentially in the area where artisanal fishermen operate. Furthermore, its densities seem to be much lower than the described seabob shrimp, which could have serious implications for its sustainable exploitation and conservation. Next to that, the stock structure of the shrimp is analysed using microsatellite markers, which were newly developed using Next Generation Sequencing (NGS). The first results indicate a genetic differentiation between different stocks in the Guianan Ecoregion, new information which has to be taken into account in fisheries management.

The extensive sampling campaign was thanks to a very close cooperation with the fisheries industry. As such, this **industry-ecology linking** is an important component of the success of the scientific research behind the MSC certification, and can act as a blueprint for supporting the SDGs. We focus on Suriname and Guyana, which are both regarded as **Small Island Developing States** (SIDS), a group of small developing countries (not necessarily islands) which are a prime focus of the SDGs. Because of their small size and small population, SIDS experience a proportionally far greater benefit from the sustainable exploitation of marine resources than larger countries. Next to SDG 14, there are several links with the other SDGs: SDG2 (Food Security), SDG8 (Employment and Growth) and SDG12 (Responsible Consumption and Production).

This case study clearly illustrates the application of scientific insights to sustainable development and thus will contribute positively to the achievement of the SDGs. Furthermore, this model of MSC linking of industry-ecology does not only apply for developing countries but can also be brought into practice in developed countries and thus also in the Belgian part of the North Sea.

Keywords: Tropical shrimp fisheries; Genetic research; Sustainable Development Goals; MSC label

The sustainability conundrum of fishmeal substitution by plant ingredients in shrimp feeds

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Aquaculture is central in meeting expanding global demands for shrimp consumption. Consequently, increasing feed production is the main responsible for overall environmental impact. Significant amounts of fishmeal are included in shrimp diets, causing dependency on finite marine resources. Driven by economic incentives, terrestrial plant ingredients are widely viewed as sustainable alternatives.

We modelled the incremental fishmeal substitution by plant ingredients in shrimp feed and assessed effects on marine and terrestrial resources, such as fish, land, freshwater, nitrogen and phosphorus. We find that complete substitution of 20-30% fishmeal totals led to increasing demand for freshwater (+63%), land (+81%) and phosphorus (+83%), while other substitution rates lead to proportionally lower impacts. These findings suggest added pressures on essential agricultural resources, socio-economic and the environment, as a trade-off to pressures on finite marine resources. The importance of utilizing by-products and novel ingredients such as microbial biomass, algae and insect meals in mitigating the use of marine and terrestrial resources is discussed.

Keywords: Aquaculture; Shrimp feed; Aquafeed; Fishmeal; Plant ingredients; Marine resources; Terrestrial resources; Feed transition; Food system; Food security

Using Geofish to estimate potential catch loss for the fishery sector

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For several decades, the fishing industry is under pressure due to high fuel costs and catch limitations (declining stocks), but also the available fishing grounds are increasingly regulated by numerous (European) directives. Besides that, - fishers also operate in territorial waters which are regulated by several national jurisdictions. In addition, a more intensive use of marine space and new stakeholders lead to a greater competition between the fishing industry and other maritime sectors. All of this makes it difficult to keep a clear overview of the actual space for fisheries. Therefore, we created the information platform "Geofish" (www.geofish.be), which presents available geographic information in multiple layers in an online consultable system. The Belgian fishing fleet, wherefore it is developed in first instance, operates in a wide region (from Irish Sea to the Greater North Sea), facing a lot of spatial competition. For example, around 285000 km² of Belgian fishing grounds are currently designated as marine protected area (MPA), under various legislation (mainly Natura 2000). At the moment, most of these areas are still accessible for fishing activities but certain restrictions (closure, technical net adaptions…) are ready for implementation. This is visualized with the Geofish tool, with indication of the potential fishery restrictions. Besides, MPAs, the construction of wind farms is also substantially reducing the areal extent of the fishing grounds (+- 14400 km²), already causing loss of fishery grounds. By including fisheries landings data (weight and value of commercial fish) in the tool, we can also estimate possible financial loss of fishery closures. Such information is essential to support the sector in the changing maritime landscape and increased competition for space.

Keywords: Marine spatial planning; Geographic tool; Fisheries

The Belgian coast: where does the sand go?

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The Belgian coastal area is historically prone to flooding due to storms. This 65km long sandy coast is characterised by dunes and concrete sea dikes. In order to protect the coastal settlements and the hinterland from flooding, sea dikes were built in the past. From the 1970's onward, sand nourishments are the preferred way to protect the coast.

The coastal area from the dunes to 1.5km offshore is surveyed to monitor the coastal topography and bathymetry. These data are analysed, also taking into account dredging and nourishment works.

Over the whole Belgian coast, on average, there is a net increase in volume over time. However, there are large spatial differences. Areas with large accretion exist both west and directly east of Zeebrugge harbour and on the Broersbank near Koksijde. In contrast, structural erosion is found near Knokke and between De Haan and Wenduine. In these erosive areas, frequent re-nourishment is required to maintain the coast. Furthermore, it is found that the dunes and dry beach are mostly accretive. The intertidal beach is also mostly accretive; however, a large erosional area exists east of Zeebrugge. The shoreface and seabed are mostly erosive with only a few accretive areas.

When correcting for nourishments the accretive trend reduces drastically, yet remains positive. Since very few shoreface nourishments are present, the trends of the shoreface and seabed hardly change.

The analysis concludes that there is a small net component of cross-shore sediment transport from the shoreface towards the dunes. Yet, several erosion hotspots need continuous attention. Additionally, nourished volumes from beach nourishments remain in the zone above low water. Further research is needed to determine the accuracy of the surveys and the exact rates of erosion or accretion.

Keywords: Belgian coast; Beach volumes; Nourishments

Below the sea – below the radar? The United Nations' Sustainable Development Goals (SDGs) as an opportunity for raising awareness of the ocean?

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People all over the world depend and rely on the ocean. The ocean and seas provide fundamental ecosystem services for mankind supporting the livelihood of people worldwide. [1] In 2015, the UN General Assembly (UNGA) adopted the document 'Transforming our world: the 2030 Agenda for Sustainable Development' including a list of 17 Sustainable Development Goals (SDGs) and 169 accompanying targets. The agenda is a universal call to action which recognizes the need for sustainable management of natural resources for social and economic development and includes a goal on the conservation and the sustainable use of the oceans, seas and marine resources (SDG 14 – 'Life Below Water'). [2] Several studies on the interrelation of the different SDGs indicate that SDG 14 interacts with all other SDGs and associated targets and plays a central role in achieving the 2030 Agenda [2]. However, in spite of the recognition of the importance of the marine environment to advance sustainable development and its relevance across the whole scope of the agenda, the awareness of the ocean and the ocean literacy is still poor and there is a need for enhanced capacity building and awareness raising [3].

In this context, the aim of the present study is to gain insight on possibilities to raise awareness of the importance of the ocean in society and politics. For this, an online survey was launched in January 2019 targeting the Alumni of the Master's Programme 'Oceans & Lakes' investigating the perception of different aspects regarding the Sustainable Development Goals. This includes the perception of the relative importance of different goals, the interrelation of SDG 14 with other SDGs, and how and at which level the SDGs can be operationalized. Furthermore, the survey tries to give an insight into the influence of education on the perception of SDGs. The online survey is combined with the output of a workshop with an interdisciplinary group of experts from the EU funded Horizon 2020 project SOPHIE (Seas, Oceans & Public Health in Europe) (www.sophie2020.eu). The workshop, conducted at the end of January 2019, aims to develop concrete actions to raise awareness of the ocean using Citizen Science. A focus is placed on the interrelation of the ocean with other developing areas, like human health (SDG 3 – 'Good Health and Well-Being') or 'Zero Hunger' (SDG 1) to increase the impact of possible actions.

The expected results of this research will give insight into the perception of people with a marine education with regards to the SDGs and SDG 14's relative importance and will propose concrete actions that could be taken to promote ocean literacy and improve the awareness of the ocean in the society and politics. The research is timely in regard to the starting planning phase for the United Nations Decade of Ocean Science for Sustainable Development (2021 – 2030).

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Keywords: Sustainable Development Goals (SDGs); Interdisciplinary; Perception; Ocean Literacy; Citizen Science; Ocean and Human Health; SOPHIE; Survey; Expert Workshop; Ocean Decade

Dune behaviour along the Belgian coast

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The behaviour of the dunes along the 67 km Belgian coast has been investigated based on a data set of annual surveys dating back to as early as 1979. Depending on the amount of wind-blown sediment input and dune erosion, dune volume changes over time. Worldwide, dune volume is an important factor for coastal safety which provide protection for the hinterland against storms. Dune volume changes along the Belgian coast are generally between -50 and +50 m^3/m. Between each survey there is considerably longshore variability in dune volume change. Furthermore, large differences in dune volume change are found between each year. Dune volume change along the Belgian coast mainly show a positive linear trend in time (dune growth). It is found that half of the coastal sections with dune growth have correlation coefficients larger than 0.9. This indicates that a large part of the dune volume data is well represented using a linear model in time. Variations in wind-blown sediment input to the dunes from survey to survey, along the Belgian coast were calculated based on a modified Bagnold model for the period 2000-2017. The wind regime consists of a fairly balanced mix of moderate (85% of winds are below 8 m/s) onshore, offshore and shore-parallel winds. Wind speeds between 8-10 m/s take the largest portion of the total sediment transport. The mean direction of potential transport over all years is 260 ± 14° to the North, indicating that the direction is fairly constant. For some years, potential transport is up to 3 times larger than other years. However, no significant relation is found between dune behaviour and potential sediment transport on yearly to decadal timescale. Due to transport limiting factors, wind forcing alone is not sufficient to explain the year-to-year variability in dune growth rates. Furthermore, dune erosion by storm events is in the same order of magnitude as dune growth by wind-blown processes. A strong negative correlation exists between dune erosion and maximum water level at the central part of the Belgian coastline, indicating high erosional sensitivity during storms.

Keywords: Aeolian sediment transport; Dune development; Belgian Coast; Decadal timescales; Water level

Effects of seismic sound on the movement and behaviour of wild Atlantic Cod (*Gadus morhua*) in the BPNS

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In the search for offshore resources like oil and gas, exploration of the seabed is performed by seismic vessels. These vessels are equipped with air guns emitting a loud blasting sound towards the sea bottom. Due to its characteristics of low frequency and high power, these seismic sounds travels far and yield high resolution information on the bottom structure but that also makes it a potential tread to marine aquatic life. The hearing range of most fish falls within the low frequency range (100-500 Hz) and the effects seismic surveys might have on their behaviour and physiology are unclear. In 2016 a Joint Industry Program (JIP) was initiated to investigate the potential impacts of seismic sound on Atlantic Cod (*Gadus morhua*). As part of this project we investigated the effects of a seismic survey on the movement and behaviour of wild cod resident in the Belgian Part of the North Sea (BPNS). In the summer of 2018 we tagged a total of 56 fish with acoustic transmitters to track their movement, depth usage and acceleration (average displacement along 3 axes) while a seismic survey took place. The survey was operational for three full days and had a closest approach of approximately 2km from the study site (Belwind offshore Windpark). Here, we will present the first results showing the movement and behaviour of individual wild cod and how this changes over time and under the influence of seismic sound.

Keywords: Seismic sound; Telemetry; Atlantic cod; Animal behavior; BPNS

Cryptic diversity and limited connectivity in two commercially important octopus species

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Due to the increasing global market demand for cephalopods many traditional octopus fisheries in the Indian Ocean have expanded very fast in the past decades while shifting their focus from local and inland markets to international export. Just as in other regions worldwide, landings of these octopus fisheries are decreasing and concern over sustainability is raised. While octopus farming might be an option for the future, to date, octopus production relies completely on wild fisheries, with many communities having few alternatives to marine resource extraction. To maintain the sustainability of these socio-economic important fisheries, management actions must be taken, such as the establishment of Marine Protected Areas (MPAs). Connectivity among populations through larval dispersal is a crucial factor, which should be taken into account when designing MPA networks, since it influences population genetic structure, as well as the ability to persist and recover from stressors, like overfishing. In order to obtain baseline data for management plans, the present study investigated (1) diversity of Octopodidae in the Western Indian Ocean (WIO) and (2) connectivity and genetic structure among populations of two commercially important species: *Octopus cyanea* and *O. vulgaris*.

Arm tips of 275 octopus individuals were collected on landing sites and markets, at 15 different sites in Madagascar, Tanzania and Kenya. DNA was extracted and a fragment of the mitochondrial cytochrome C oxidase subunit 1 (COI) gene was amplified and sequenced. In addition, 41 COI sequences of *O. vulgaris* from South Africa, Brazil, Amsterdam Island, Tristan da Cunha, Senegal and Galicia were retrieved from online databases to be included in this study.

DNA barcoding revealed the presence of five different species in our collected tissue samples from the WIO, with first records for *Octopus oliveri* and *Callistoctopus luteus* in this part of the Indian Ocean. For *O. cyanea* (n = 229, 563 bp), 22 haplotypes were found, forming a single haplogroup, with one dominant haplotype present at all sites. Analysis of molecular variance (AMOVA) revealed a shallow but significant genetic population structure among all sites (φ_{ST} = 0.025, p = 0.02), with significant differentiation among: (1) Kanamai (Kenya), (2) southern Kenya, Tanzania, North and West Madagascar, (3) Southwest Madagascar and (4) East Madagascar (φ_{CT} = 0.035, p = 0.017). For *O. vulgaris* (n = 71, 482 bp), 15 haplotypes were identified, forming three haplogroups. A significant genetic population structure was found among all sites (φ_{ST} = 0.82, p ≤ 0.01). Based on pairwise φ_{ST}-values and hierarchical AMOVAs, populations of *O. vulgaris* could be grouped as follows: (1) Brazil, (2) Madagascar and (3) all other sites. A significant increase in genetic distance with increasing geographic distance was found (Z = 232443,81 r = 0.36, p = 0.039). These results indicate that for *O. cyanea* four regions should be considered as separate management units in the WIO. The very divergent haplogroups in *O. vulgaris* from Brazil and Madagascar might be evolving towards speciation and therefore should be considered as separate species in FAO statistics.

Keywords: Marine Protected Area; population genetics; Gene flow; Mitochondrial DNA; COI

Let's talk about stress: Can we measure the stress of a flatfish?

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Marine fish reside in a stressful environment. Wind farms, fishing activities, cruise ships, dredging but also rising seawater temperature, changing salinity and others can cause a disruption of the environment and increase the stress of the fish. This stress evokes a hormonal stress response regulated by the hypothalamus - pituitary gland - interrenal axis (HPI axis). The outcome of the activation of the HPI-axis is the production of cortisol which on its turn can help the fish to adapt to the change and cope with stress. When certain stressors remain for a longer period of time, fish experience chronical stress. This can cause harmful effects on the health and growth of fish. Despite its importance, only recently a method was pinpointed to investigate the chronical stress level of fish by evaluation of the glucocorticoid profile in the scales (Aerts et al., 2015). However, this method was only tested in aquaculture species and never in wild caught fish. Hence, the main aim of the study was to investigate the glucocorticoid profile in wild caught common dab (*Limanda limanda*). If glucocorticoids, and more specifically cortisol, are stored in the scales, this can offer a good biomarker to measure chronical stress in common dab and can even help to assess the effect of anthropogenic activities at sea.

In total 111 fish were caught and the glucocorticoid profile of the scales was analyzed of all fish. Scales of 75 fish were analyzed immediately after catch. The other 36 fish were kept in artificial environments for 4 (18 fish) or 6 (18 fish) months after which the glucocorticoid profile was analyzed.

Scales of fish that were analyzed immediately after catch contained on average 0.004 ± 0.006 µg cortisol per kg scales. Scales of fish that were kept under artificial circumstances contained more cortisol (0.066 ± 0.066 µg/kg). This demonstrates that common dab is able to store cortisol in their scales and that this analysis can be used as a biomarker for chronical stress.

Furthermore, it also indicates that wild-caught fish kept in artificial environments endure chronic stress which has to be kept in mind when performing long-term experimental studies.

Keywords: Cortisol; Biomerker; Stress; Flatfish; Common dab

Ecophysiology and survival of the Blue mussel (*Mytilus edulis*) as offshore wind farm fouling and aquaculture key species, is adversely affected by a changing marine climate

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For decades, a combination of global changes and local anthropogenic stressors have put a strain on the marine environment. The International Panel for Climate Change (IPCC) predicts a global rise in ocean temperature of 3°C and a drop in oceanic pH of 0.3 by the end of this century, according to its 'business-as-usual' climate scenario. In addition to these global changes, human activities can affect the marine ecosystem locally. In the Belgian Part of the North Sea (BPNS), the area used for or allocated to the construction of offshore wind farms (OWFs) is increasing and with it, large quantities of potentially non-indigenous fouling fauna can now settle on these artificial hard substrates.

The Blue mussel (*Mytilus edulis*) is both a key species in these fouling fauna communities and the prime candidate for extensive aquaculture projects planned inside the OWF concession areas. The presence of this species undoubtedly affects the local food web structure and the biogeochemistry of the surrounding environment. Partly on account of its shell biofilm, the habitation and cultivation of Blue mussels could also aggravate the local emission of nitrous oxide (N_2O), a potent greenhouse gas (Heisterkamp et al. 2013).

A total of 900 Blue mussels were equally and randomly distributed across four different environmental treatments. These manipulated climate conditions were designed as a fully crossed experiment with varying sea water temperature and pH: CTRL (control setting with ambient 20°C and current pH), PH (acidified setting with 20°C and pH lowered by 0.3), TEMP (ocean warming scenario with 23°C and current pH) and CC (climate change scenario with combination of 23°C and pH lowered by 0.3). For six weeks, several ecophysiological parameters were monitored or tested and the differential effects of the climatic conditions were analysed. Proportional survival and mussel growth in three dimensions were monitored closely during the 42 days of incubation. Weekly experiments were set up to gain insight into the respiration, as a proxy for metabolic rate, as well as the nutrient exchange and the production of N_2O. Additionally, the potential changes in microbial composition and oxygen microprofile of the shell biofilm were characterised weekly. Considering the aquacultural value of this species, changes in mussel tissue quality were also assessed.

This presentation reports on the combined effects of these climate conditions on the survival and growth of the Blue mussel, as well as on the oxygen consumption by both the mussel itself and the associated shell biofilm. All manipulated treatments had a lower proportional survival compared to the current climate control setting, with the lowest survival rate in the climate change scenario (66.67%). Sea water temperature and pH had opposite effects on mussel growth, where the stimulating effect of an increased temperature was trumped by the adverse effect of a lowered pH when combined in the climate change treatment. The environmental manipulations had an amplifying synergistic effect on the metabolic rate, with the highest respiration rates in the climate change setting, and affected the oxygen consumption, thickness and patchiness of the associated shell biofilm.

Reference

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Keywords: Climate change; Ocean acidification; Offshore wind farm; Blue mussel (*Mytilus edulis*); Ecophysiology; Aquaculture; Nitrous oxide (N2O); Microbial biofilm

Fatty acid profiling of copepods to meet SDG 2, 13 and 14: Comparing temperature responses in a tropical and temperate estuary

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Climate change is a focal point in the UN sustainable development goals (SDG 13: *take urgent action to combat climate change and its impacts*). Predicted temperature changes will have a disproportionally higher impact on coastal ecosystems, such as estuaries. In these estuaries, benthic harpacticoid copepods (Crustacea, Copepoda) play a pivotal role at the base of the food web as they are the main consumers of primary producers such as diatoms and serve as a food source for higher trophic levels like fish. Their high levels of fatty acids (e.g. omega-3, omega-6), are essential for the maintenance of physiological functions in many organisms in this food web, including humans. In view of their role in the marine food web, balanced fatty acid profiles in these copepods are indicators for a healthy and stable ecosystem and any change in these profiles is expected to cascade through the food web and to have implications on the use of marine resources as a food source for humans (SDG 14: *conserve and sustainably use the oceans, seas and marine resources*).

In this study, responses to increased temperatures were studied and compared between two benthic copepods: *Platychelipus littoralis*, from the Westerschelde estuary and *Canthocamptus sp.* from the Guayas estuary in Ecuador. With increased temperatures, the fatty acid profile of these copepods will change in order to adapt to the environment. These changes in fatty acid profile are expected to be more pronounced in tropical species which are naturally less subjected to daily and seasonal temperature variability, in contrast, temperate species are expected to be able to adapt better in changing environments.

In controlled lab experiments, the copepod species were subjected to different elevated temperature treatments. We found that with increased temperatures, concentrations of essential fatty acids such as EPA and DHA (omega-3) tend to decrease. Although this decrease is less pronounced than expected, it can induce unfavorable effects on the higher trophic levels, which need these primary consumers for the majority of their fatty acid uptake.

Also humans rely on marine resources for the uptake of certain essential fatty acids that cannot be obtained through other food sources. In Ecuador, coastal communities largely depend on marine resources for their daily nutrition. When the essential fatty acid content in marine organisms is decreasing due to climate change, this can result in malnutrition in these vulnerable communities (SDG 2: *end hunger, achieve food security and improved nutrition and promote sustainable agriculture)*.

Keywords: Climate change; Copepods; Lipids; Westerschelde; Guayas

Mangroves, charcoal production and mercury pollution in Matang Mangrove Forest Reserve, Malaysia

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Estuary mangroves can act as an important sink for heavy metals via sediments and plant tissues. Among the heavy metals, mercury (Hg) is one of the most hazardous, due to its high toxicity, mobility and long persistence in the environment (Pirrone *et al*., 2010). Globally, the problem of Hg emission is of great concern for human health due to the increase of anthropogenic activities. In this work, we studied the Hg distribution in Matang Mangrove Forest Reserve (MMFR) in Malaysia to assess whether charcoal production and increasing human activities in the vicinity can raise the Hg pollution and consequently risk to the environment and humans. Limitations such as no regular monitoring on metal concentration and very few scientific studies on Hg at MMFR, makes the present study highly relevant.

The main objectives are to evaluate Hg pollution level in different mangrove plant tissues and surface sediments and investigate if there is any concentration gradient from plausible point sources to the river mouth. To achieve this result, we sampled leaves (in four stages – young, mature, senescent and decomposing), bark and roots of the dominant species *Rhizophora apiculata* (Blume) for up- and midstream sampling sites and of *Rhizophora mucronata* (Lamk.) for two downstream locations; sediments from both the river bank and the inside of the forest; gastropods of the species *Cassidula aurisfelis* (Bruguiere) and cockles of the species *Anadara granosa* (Lamk.). Sample preparation was done by freeze-drying and grinding the samples to fine powder with mortar and pestle.

The concentration of Hg in each sample was detected using a mercury analyzer MA3000 (Nippon Instruments Corporation, Japan). Among the plant tissues, leaves showed relevant Hg concentration, ranging from (12.9±3.8) µg/Kg to (30.3±6.4) µg/Kg for mature leaves and from (31.3±3.9) µg/Kg to (42.6±7.4) µg/Kg for senescent and decomposing leaves, from which we might suggest a major influence of atmospheric deposition instead of water flow on the input of Hg. Geo-accumulation index calculated from the sediment data shows that all sites can be considered as unpolluted, indicating limited impact on Hg pollution from the human activities upstream, resulting also in safe consumption for cockles cultured in the estuary (being the measured Hg values below the permissible limit of 500 µg/Kg according to EC regulation no. 466/2001).

Perhaps future scientific investigation like detailed analysis of the smoke composition from the charcoal factories and analysis on other heavy metals in the mangroves might be able to provide more insights on the environmental impact(s) of charcoal production in the nearby area.

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Keywords: Sediment; Biota; Health risk; Rhizophora

Evaluation of the anti-*Vibrio* activity of essential oils and their components

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Vibrio harveyi is a major pathogen of marine fish and shrimp, which causes significant losses in the aquaculture industry worldwide. Essential oils and their components are concentrated hydrophobic liquid containing volatile aroma compounds from plants.

Since the past a few decades, they have been widely used for bactericidal or fungicidal, which not only in the pharmaceutical industry but also in the agricultural industry, especially in aquaculture. Furthermore, a variety of essential oils and their components have been claimed they are quorum sensing inhibitors, which can interfere with the virulent quorum sensing signal in bacteria. However, knowledge on the impact of essential oils and their components on the volatile antimicrobial activity and quorum sensing inhibition in V. harveyi is lacking.

In the present study, we evaluated the vapour-phase-mediated antimicrobial activity (VMAA), different concentration of antimicrobial activity and specific quorum sensing-inhibitory activity (AQSI) of 22 essential oils and 12 essential oil components, against *V. harveyi*. Results showed that the VMAA of a volatile spread symmetrically across a microtiter plate and one-quarter of the tested essential oils and their components showed growth-inhibitory VMAA at 24h. Then, six essential oils and three essential oil components inhibited 50% of the growth at 0.0001%, compared to the control. Moreover, just the four most active essential oils inhibited quorum sensing at 0.001%, with AQSI higher than 2. In conclusion, the anti-Vibrio activity of essential oils and their components both in broth cultures and via their vapour-phase. Not all the essential oils and their components are able to inhibit quorum sensing in V. harveyi. And two essential oils and one essential oil component were considered to be highly promising to control V. harveyi in aquaculture.

Keywords: Essential oil; Vibrio harveyi; Vapour-phase; Quorum sensing

Post-Doc Presentations

Marine biogenics in sea spray: A new source of pharmaceuticals and nutritionals

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Sea spray is a complex mixture of inorganic salts and marine biogenics. Marine biogenics are molecules produced by marine organisms such as algae and bacteria. In general, these molecules are known for their harmful effects (e.g. algal toxins or bacterial toxins). Yet, some of these molecules can have potential beneficial health effects and are inhaled daily by people living in coastal regions. Our research has shown that marine biogenics in sea spray aerosols interact with key molecular targets in human cells. As such, these marine biogenics could be an underexplored potential health source and important biotechnological leads for new pharmaceuticals. In our research, we observed significant effects on the mTOR pathway. Similar to a known chemical mTOR inhibitor, we observed a downregulation of genes involved in the mTOR pathway after exposure to natural sea spray aerosols. Downregulation and inhibition of the mTOR pathway have been associated with positive health effects in numerous studies. Furthermore, we observed significant regulation of genes and pathways that are closely linked with mTOR most likely caused by the effects on the mTOR pathway. These genes and pathways include the new pharmaceutical target PCSK9 and the steroid biosynthesis. In our experiments, for all genes and pathways, the effects of the natural sea spray aerosol extract and the chemical mTOR pathway were highly similar. This suggests that sea spray aerosols contain molecules similar to the chemical mTOR inhibitor, at least in terms of effects, and highlight the potential of sea spray aerosols as new harmaceutical leads. Overall, these results provide a substantial molecular evidence base that marine biogenics in sea spray can be a health source for coastal populations.

Keywords: Marine biogenics

DNA-based monitoring in the North Sea region: The future for environmental benthic monitoring?

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Human activities such as marine aggregate extraction, construction of wind turbines and dredge deposition induce habitat changes that alter both abiotic and biotic components of the seafloor ecosystem. Macrobenthos is used as an essential indicator for environmental quality, but up till now based on morphological species identification. DNA-based approaches such as metabarcoding may speed up or at least complement the characterisation of the different macrobenthos communities. However, diversity assessment by means of metabarcoding strongly depends on the chosen primers, the bioinformatic pipeline and the availability of reliable reference sequence data. Furthermore, standard routine application and comparison across areas is hampered due to differences in sampling strategies, laboratory protocols and data analyses used in different countries. To accommodate this, the EU funded Interreg NSR project GEANS (Genetic tools for Ecosystem health Assessment in the North Sea region), aims to harmonize and consolidate existing genetic tools and methods across the North Sea to improve and enhance genetic monitoring.

The objective of this study is to compare DNA-based versus traditional morphological species identification for macrobenthic communities. To that end, the set-up of a reliable genetic reference library for the Belgian part of the North Sea (BPNS) is needed. In the last 15 years, ILVO researchers have listed 334 macrobenthic species from nine phyla for the BPNS. Polychaeta, Malacostraca and Bivalvia are typically the most species rich classes and harbour 40%, 37% and 13% of all species, respectively. Ethanol preserved specimens have been morphologically identified, diagnostic characters photographed and stored as reference material for DNA-based identification. To date, the ILVO genetic reference database contains 101 vouchered macrobenthos species and 119 epibenthos and demersal fish species. Completing the reference database on a North Sea scale, i.e. collecting and sequencing the remaining species is one of the main goals within the GEANS project.

To further evaluate whether DNA-based approaches describe the macrobenthic diversity in a comparable way as the morphology-based approach, and to highlight the added value of both approaches, we applied both methodologies on field samples from the four prevailing habitat types in the BPNS, each characterized by a different level of diversity and macrobenthic species community. Three replicate Van Veen grabs were collected in each of the four habitats. One replicate per habitat was processed according to standard monitoring protocols, resulting in the morphological identification of 45 families. All replicates were further used for genetic analyses, using DNA from both the bulk samples and from the ethanol fixative of the sample. We compared the performance of four primer sets (respectively amplifying 420, 580, 510 and 350bp of the COI barcode region) in terms of macrobenthic taxon detection. Despite substantial differences in the total number of amplicon sequence variants (ASVs) generated by each primerset (2139, 22151, 14813, 15211, respectively), the number of detected families was comparable to the morphology-based analysis (64, 51, 56 or 43, respectively). However, nearly 50% of the families were not similar between both methods (27, 26, 27 or 22, respectively). This can be explained by: 1) the fact that not all replicates were morphologically identified (4 samples), leading to a underestimation compared to the DNA-based analyses (12 samples); 2)

some families detected through genetic analyses are normally not accounted for as ‘macrobenthos’ in morphological assessments, and should be omitted when comparing both methods; and 3) the genetic (COI) reference database is far from complete: combining our own generated barcode sequences with those available in the public Barcode Of Life Database (BOLD) showed that so far only 33 out of the 45 morphologically identified families have been sequenced and voucher referenced. Our results further showed substantial differences in taxonomic diversity depending on the primer set used, and on the source of DNA (bulk versus ethanol). The results contribute to a thorough evaluation of the pros and cons of DNA-based identification of macrobenthic communities in relation to human impacts.

Keywords: Impact assessment; Metabarcoding; COI; macrobenthos

A new bio-geomorphic model approach accounting for subgrid-scale heterogeneity of biogenic structures

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In hydrodynamic and morphodynamic models, the effect of biogenic structures (such as vegetation, mussel beds or oyster reefs) on flow and sediment transport is generally expressed through the hydraulic roughness. The accuracy of bio-geomorphic model predictions depends on their ability to represent the spatial complexity of these biogenic structures, which is largely limited by computational power. This requires practical model choices, such as limiting the spatial resolution (that is, the model grid size), usually assuming a uniform spatial distribution at the subgrid scale. In this communication, we show that this uniformity assumption leads to considerable overestimation of the flow resistance if the subgrid distribution of biogenic structures is spatially correlated (that is, presenting clustered patterns). We also introduce a novel model approach that solves this multiscale issue by redefining the hydraulic roughness to account for this subgrid heterogeneity.

Our approach builds on the similarity between the Chézy formula in fluid dynamics and Ohm's law in electricity. Taking the analogy further, we recalculate the coarse-scale hydraulic roughness just as the total resistance of an electronic circuit that combines resistors (equivalent to subgrid-scale biogenic structures in our analogy) connected in series (along-flow) and in parallel (across-flow). Although very simple, our approach improves considerably the flow routing in hydrodynamic models that operate at coarser scales than the scale at which biogenic structures are defined. As a result, fine-scale biogenic heterogeneity can now be accounted for at a reasonable computational cost, increasing the accuracy of large-scale bio-geomorphic model predictions.

In this communication, we illustrate the effectiveness of our subgrid approach by considering the flow deviation around expanding patches of tidal marsh vegetation. This process is a crucial mechanism for the initiation and development of channel networks in tidal marshes, which then facilitate the delivery of sediments to the vegetated platforms, hence building up elevation and increasing resilience to sea level rise. With our new subgrid approach, accounting for all these feedback mechanisms between tidal hydrodynamics, sediment transport and salt marsh vegetation dynamics is now possible, even when considering large-scale systems.

Our new subgrid method has also potential for further applications in large-scale modeling of river flood plains, estuaries and other coastal shallow waters. For instance, it would provide improved model predictions quantifying the impact of large-scale coastal wetlands (tidal marshes and mangrove forests) on the landward propagation of storm surges, giving deeper insights in essential ecosystem services provided by biogenic structures.

Keywords: Modeling; Flow; Vegetation; Bio-geomorphic; Multi-scale

Big bang or a soft whistle? Expected changes to European fisheries under the Landing Obligation

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To reduce over-exploitation and unsustainable fishing practices, European fishers are now obliged to land unwanted catch at a cost to incentivize catching the 'good ones'. Undocumented 'discarding' of quota- or size-regulated animals at sea has, at least, technically, become history. The overall aim of this policy is to catch less but utilize more, and it challenges those fishers who used to throw away large portions of their catch dead or dying to become more selective. With the implementation of this "Landing Obligation" in full swing, the big question is whether this policy change will deliver, and so contribute to a recovery of European fish stocks, or whether it will do more harm than good? This presentation summarizes the recent release of a book published by Springer about the Landing Obligation which timely bundled relevant research results including evaluations of its impacts at economical, socio-cultural, ecological and institutional levels. In 20 chapters set into five sections, this book comprehensively compiles and profiles most of the up-to-date outcomes from multi-annual Horizon 2020 DiscardLess and Minouw projects, amongst others, and also provides viewpoints from policy makers, NGOs and fishing organization representatives. In a nutshell, some of this work suggests that, if fully complied with, a reduction of discarding will eventually lead to healthier stocks in the long run, at a fraction of costs for the fishing industry. Innovative, bottom-up initiatives to develop more selective fishing gears have received a boost from the Landing Obligation, as well as established and novel techniques to assess survival of discards and identification of species based on genetic fingerprinting. However, the policy's success may hinge on its fleet-wide enforcement. The uptake of innovations by fishers and a mindset to adapt to the required changes may take a decade or more to develop, as examples from countries such as Iceland and Norway, where similar policies have been implemented, have shown.

Keywords: Discard ban; Common Fisheries Policy; Fisheries management; Sustainability

Behavioral plasticity in a benthic bivalve enhances tolerance of microalgal grazers to ocean warming and acidification

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Anthropogenic carbon dioxide emissions are rapidly changing seawater pH and carbonate chemistry with vast repercussions on marine biodiversity. Direct effects of both phenomena on species populations are well documented, but how such effects cascade through communities and affect functioning remain mostly unknown. In this presentation we demonstrate how the interaction network between porewater nutrients, primary producers, benthic grazers, predators and large bioturbators in a soft-sediment community significantly restructures in response to experimental warming and acidification.

Under unmanipulated conditions microalgal freshness was influenced by top-down control of epifaunal grazers and the omnivorous ragworm *Hediste diversicolor*, while the peppery furrow shell *Scrobicularia plana* reduced porewater nutrient availability to primary producers. Under high pCO_2 conditions (+ 3°C, - 0.4 pH units) *S. plana* did not influence porewater nutrients, promoted microalgal freshness and inhibited population biomass of *H. diversicolor*. Juvenile bivalves and the mudsnail *Hydrobia ulvae* had lower survival under high pCO_2 conditions, particularly in the absence of *S. plana*.

Using porewater hydraulic signatures we furthermore demonstrate that such change in community interactions is linked to behavioral plasticity in *S. plana*. This key species shifted feeding behavior from predominant filter feeding under ambient conditions to almost exclusive deposit feeding under high pCO_2 conditions. Deposit feeding is associated with less intake of water and thus reduces physiological disruption related to hypercapnia. This behavioral shift is also associated with enhanced interference competition from bioturbation that might explain negative effects on *H. diversicolor*, while at the same time deposit feeding is known to stimulate primary production via gardening mechanisms.

Hydrobia ulvae and juvenile bivalves both rely on freshly produced microalgae for their diet and are prey for *H. diversicolor*. Release from predation pressure and the facilitation of food resources associated with behavioral plasticity in *S. plana* therefore seems to explain the alleviated mortality of these marine calcifiers to ocean acidification and warming in the presence of *S. plana*.
In summary, this study demonstrates that in addition to direct effects on species, populations and communities, non-lethal effects that alter ecosystem interactions will determine the resilience of soft sediment communities to climate change.

Keywords: Future oceans; Ecosystem interaction network; Benthic community; Ocean acidification; Ocean warming

Meet
The Company

UXO-survey: A multisensor approach

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During the winter of 2018 ADEDE performed a UXO (unexploded ordnance) survey of part of the harbour of Horten, Norway. Horten used to be the main base of operations for the Norwegian Navy and as such was a military target during World War II.

ADEDE opted to perform the survey using four distinct techniques:
- Magnetometry;
- Sidescan sonar;
- Electromagnotemtry;
- And sub-bottom profiling.

The aim of the survey was to detect the presence of potential aerial bombs within the survey area. With this aim in mind ADEDE used the four datasets to obtain the maximum of information on the project area, and the potential UXO anomalies located therewithin.

Keywords: Magnetometry; Sidescan sonar; Electromagnotemtry; Sub-bottom profiling; UXO; Anomalies; ADEDE; Horten

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Keywords: Full-service solutions; Water; Modelling

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Keywords: Surveys

From farm to fork, from sea to spoon

Vandendriessche Sofie

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Keywords: Research; Jobs; Marine; Fisheries

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Shaping water and land. From complex offshore services for both fossil and renewable energy sectors, over large dredging and reclamation project at the edge of water and land to all possible civil and environmental works onshore. Thanks to the continuous investment in people and own equipment, in combination with the intense cooperation between the different departments, Jan De Nul Group studies and executes complex multidisciplinary projects from A to Z. A total package, time after time, and in a sustainable way.

Jan De Nul Group is expanding and looking for new colleagues. Check our vacancies at jobs.jandenul.com.

Keywords: Engineer; Dredging; Offshore; Construction

The Operational Directorate Natural Environment (Royal Belgian Institute of Natural Sciences)

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The Operational Directorate Natural Environment (OD Nature) is the largest scientific directorate of the Royal Belgian Institute of Natural Sciences (RBINS) and envisages being a “centre of excellence in fundamental and applied research of biodiversity and ecosystems in support of the protection and sustainable management of the natural environment”. To realise this vision, the OD Nature has a fourfold mission: 1) to study the biotic and abiotic components of the natural environment and the interactions of the systems that form part of it, 2) to provide scientific expertise including running a monitoring program for the North Sea and capacity building in the field of biodiversity in developing countries, 3) to manage and improve databases and major scientific instruments, and 4) to represent the Federal state in international bodies and instruments.

The OD Nature currently employs around 120 collaborators (in Brussels and Ostend) with a large and diverse expertise and strong reputations in fields that include ecology, molecular biology, nature conservation and protection, biodiversity, chemistry, hydrodynamics, modelling, databases and image processing. The institute has a long tradition of scientific research in the marine environment (with special focus on the North Sea) but its expertise is also applicable to freshwater and terrestrial environments worldwide.

The North Sea waters and sediments are both rich and diverse in life and form a sensitive ecosystem that is under heavy pressure from intense human activities (such as fishing, sand and gravel extraction, shipping, oil and gas drilling, tourism, industry, …). Therefore, it is important for scientific research to be carried out in our marine territories, not only to learn more and better understand the sea, but also to better protect it and make predictions for the near and more distant future. Most of the OD Nature research takes place at the crossroads of human activities and nature conservation, and concentrates on the following subjects: marine mammals, exotic species, jellyfish, sea birds and bats, hard substrates, underwater noise, hydrodynamic models, sediment transport models, ecological models, remote sensing, marine geology, marine chemistry and Antarctic biodiversity. OD Nature also coordinates and manages the RV Belgica and is responsible for the Belgian North Sea Aerial Survey program tracing marine pollution.

Keywords: Scientific research; Biodiversity; Nature conservation; Sustainable management; Scientific services

Vacancies @ VLIZ

Mertens Tina and Mees Jan

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The Flanders Marine Institute (VLIZ) promotes accumulation of marine knowledge and excellence in marine research in Flanders. The marine research areas are the ocean and seas, the coast and the tidal systems. The target groups for knowledge accumulation are the marine research community as well as educational institutions, the general public, policymakers and the industry (within the scope of the blue economy).

At regular intervals, Flanders Marine Institute (VLIZ) announces **new vacancies** so as to contribute to the support of coastal and marine scientific research in the **dynamic setting** of **VLIZ**. Check the available jobs at www.vliz.be/en/jobs. Or stay tuned by signing up for VLIZINE, the e-zine containing practical information on research and policy collected for and by Flemish marine scientists or keep an eye on the VLIZ Facebook page. Keep in mind that you can always submit your curriculum vitae via an open application to jobs@vliz.be.

In addition, **students** can work in a stimulating setting of coastal and marine sciences. VLIZ recruits several **student employees** each year, both for the summer months of July, August or September, and for other holidays and for days during the academic year. Student employees get the opportunity to take part in the regular VLIZ working. For more details, check www.vliz.be/en/student-opportunities. Interested students who want to work during the summer months can forward their curriculum vitae before 30 April 2019 to jobs@vliz.be, together with a letter of motivation and any preference for period, activity to be carried out or division to work for. For other periods one can freely apply.

VLIZ gladly gives guidance to students who want to write a **thesis** at VLIZ. A broad range of subjects are offered for a Bachelor and/or Master thesis. See www.vliz.be/en/student-opportunities for the list of topics.

VLIZ offers students following a training course or bachelor/master programme the possibility to perform an **internship**. The subjects can be consulted on www.vliz.be/en/student-opportunities.

Are you interested in one of the above activities? Would you like to make a specific proposal or receive more information? Then do not hesitate to contact jobs@vliz.be or come and meet us at the VLIZ booth of 'Meet the Company'.

Keywords: Jobs; Vacancies; Internship; Thesis; Student employee

Demo Booths

MarineTraining.eu – Towards tomorrow's new blue challenges in Europe's Marine and Maritime education landscape

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Currently, a skills gap exists between the marine and maritime industry sector and graduated workforces from higher education and vocational training institutes. In order to bridge that gap, the Belgian node of the European Marine Biological Resource Centre - a distributed European Research Infrastructure Cluster (EMBRC-ERIC, of which Belgium is an associate partner through Ghent University, University of Hasselt, Royal Belgian institute of natural sciences and the Flanders Marine Institute) has set up a platform that brings together all available marine trainings at a European scale, and provides a series of services towards training organizers and policy makers.

This comprehensive database focusses both on higher education institutes and vocational education institutes and collects existing marine training initiatives for each country, ranging from vocational education programs, master and doctoral programmes to expert trainings and specialist courses. The platform is expanding by including non-accredited training initiatives via involvement in other European projects and networks (MATES, RIGHT, …). Services of the Marine Training Platform include advertising possibilities, practical services to trainees and training organizers (application and registration) and the support of marine dedicated e-learning initiatives.

The Marine Training Platform also promotes the use of innovative technologies. Since 2017 we have been organizing workshops about using Arduino in marine sciences. Arduino is an easy-to-use hardware and software platform with endless possibilities on reading data captured with sensors and controlling connected instruments. Via this hands-on training workshops students learn to implement this technology and get an understanding of the possibilities of the platform and the potential use in research. A next edition of this workshop is planned in spring 2019 (to be announced on marinetraining.eu).

Ultimately, the Marine Training Platform wants to enhance competitiveness and innovation capacity of the marine and maritime value chain by closing the skills gap between training offers and industry needs.

Marine Training Platform is Europe's leading website for:
- trainees in search of European Marine and Maritime training initiatives,
- trainers in search of assistance for organizing European Marine and Maritime training initiatives,
- stakeholders in search of insights into European Marine and Maritime training initiatives

For more information: www.marinetraining.eu

Keywords: Training; Education

EMBRC: a pan-European Research Infrastructure for marine biological and ecological research

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The European Marine Biological Resource Centre (EMBRC-ERIC) is a pan-European distributed Research Infrastructure. It provides and supports large-scale and high-quality marine science in Europe as part of the European Strategy Forum on Research Infrastructures (ESFRI) roadmap since 2008. The present operators include renowned marine biological stations and institutes across the European Union and associated countries. Through access to state-of-the-art national facilities, EMBRC-ERIC will provide the necessary and relevant services, facilities and technology platforms to study marine organisms and ecosystems, promoting the development of blue biotechnologies. By being part of EMBRC, Flanders remains on the front stage of the Blue Growth scenario, with fundamental and applied research and education activities in sustainable aquaculture, exploitation of living resources, blue biotechnology, ecosystem health and marine management.

The Flemish EMBRC consortium consists of 10 internationally prominent laboratories, belonging to four EMBRC operators (UGent, KU Leuven, UHasselt and VLIZ). The Royal institute for Natural sciences is an additional Belgian operator. The societally and economically relevant overarching research themes in which the Flemish consortium wants to continue to excel and strengthen its position are threefold:

- Global change ecology and evolution,
- Marine living resources and food production, and
- Ecosystem health

For more information on access our infrastructures, visit www.embrc.eu

Keywords: ESFRI; EMBRC-ERIC; Research Infrastructure

Master of Science in Marine and Lacustrine Science and Management

Oceans & Lakes

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The 2-year master programme “Master of Science in Marine and Lacustrine Science and Management” (in short: “Oceans & Lakes”) addresses students with a background in Sciences. Oceans & Lakes is an interuniversity programme organized by the Faculty of Sciences of Vrije Universiteit Brussel, Universiteit Antwerpen and Universiteit Gent. It provides students with strong fundamental and applied knowledge and prepares them for an active role in scientific research and management of marine and lacustrine systems. The programme provides insight into the diversity and complexity of life and processes in oceans, lakes and estuaries. It adopts a multidisciplinary approach integrating physical, chemical geological, ecological and societal aspects and including nature conservation and sustainable development. Oceans & Lakes is open to holders of a bachelor’s degree in biology, biochemistry and biotechnology, chemistry, geology, geography, geography and geomatics, bio-engineering or environmental sciences.

Keywords: Master programme; Oceans & Lakes

Hogere Zeevaartschool - Your maritime partner in marine science projects

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Within the context of Flemish Higher Education, the Hogere Zeevaartschool (HZS, in English Antwerp Maritime Academy) occupies a unique position. As the only university college in the country to educate our budding maritime officers (both in Nautical Sciences and in Maritime Engineering), we function between the academic world and the maritime industry and offer our expertise in these matters to both sides: shipping activities tend to impact the natural marine environment, and the contact of ships with sea water tends to have important and detrimental consequences for the ship and the equipment on board - let alone the valiant crews sailing the seven seas.

Researchwise, this provides us with plenty of opportunities to offer this expertise in a number of academic projects as well. A short overview of several of the research programmes going on at our institute demonstrates this adequately:

- the correct use and application of paint layers on ship hulls and ballast tanks
- corrosion of static steel structures in the North Sea (from shipwrecks over sheet piling in ports to windmills)
- using sensors and data analysis to detect corrosivity of marine environments
- analysis of relations between ship traffic, wind conditions, waves and erosion in intertidal ecosystems in the Scheldt estuary
- using sensors and data analysis to detect potential polluting ship emissions
- navigating with a highly performing solar vessel (2nd place at the 2018 Solar & Energy Boat Challenge in Monaco!)
- testing the performance and sustainability of antifouling paints
- hydrographic analysis of edimentation and channel formation in a newly created tidal area (Burchtse Weel, Antwerp)
- data analytics and optimisation in a nautical context
- and many more…

A full list can be found at https://www.hzs.be/en/research/scientific-research.

At the VMSD, we hope to discuss how this expertise can be an added value in your (research) project.

Keywords: Corrosion; Nautical science; Maritime science; Antifouling; Nautical data

JPI Oceans - The Joint Programming Initiative Healthy and Productive Seas and Oceans

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JPI Oceans is an intergovernmental platform that strives to increase the **impact** of national investments in **marine and maritime research and innovation**. By joining forces, JPI Oceans focuses on **long-term collaboration** between **EU Member States** and **Associated Countries and international partners**. The platform provides its member countries with a shared **voice**, **strategic agenda** and **action plan** to address complex ocean-related societal challenges that cannot be solved at national level.

JPI Oceans **adds to the value** of national research and innovation investments by aligning national priorities and implementing joint actions.

This is achieved by:
- planning and launching **joint calls** for transnational research and innovation projects
- sharing **research infrastructures** and resources
- enhancing **science-policy** cooperation with stakeholder involvement to translate science into policy
- initiating **new forms of collaboration** between projects and scientists
- **strategic community building**, disseminating and communicating research results to support their exploitation and facilitating mutual learning

In partnership with the European Commission, the BlueBio and MarTERA ERA NETS and JPI Climate, JPI Oceans initiated and set up in the last six months four new calls for research proposals with a total budget in excess of 60 million Euro:
- JPI Climate & JPI Oceans Joint Transnational Call on Next Generation Climate Science in Europe for Oceans. Deadline: 2019.06.14
- Blue Bioeconomy Cofund – Open call for pre-proposals. Deadline: 2019.03.18
- 2nd MarTERA Call on maritime and marine technologies. Deadline: 2019.03.29
- Joint call for proposals on microplastics in the marine environment. Deadline: 2019.02.28

OceanTeacher Global Academy: Delivering IOC capacity development for the ocean we need for the future we want

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The OceanTeacher Global Academy (OTGA) is a global network of Regional Training Centre's (RTCs) delivering training on ocean sciences, services and management using the OceanTeacher e-Learning Platform.

The main goal of OTGA is to promote the sharing of training resources and expertise related to ocean sciences in a coordinated way, and that serve all IOC Member States capacity development needs. It does so by promoting the establishment of RTCs that can better address the training needs of the IOC Regions, provide training in local/regional language(s) whilst focusing on locally relevant case studies. The OTGA has currently a network of 9 RTCs across the globe, using 4 languages for training, with the possibility of expansion in the future.

The OceanTeacher e-Learning Platform enables the sharing of standardised, quality training contents in a coordinated framework. It is a comprehensive web-based training platform that supports classroom training (face-to-face), blended learning and online (distance) learning.

Courses cover a range of topics related to the IOC programs, contributing to the IOC Mandate and the implementation of the IOC Capacity Development Strategy, enabling equitable participation of all IOC Member States and IOC Programs. Furthermore, OTGA contributes to the Agenda 2030 and its Sustainable Development Goals (SDGs), including SDG 4, 5, 9, 10, 13, and 14. As of 2019 onwards, OTGA will focus on developing training courses focusing on the implementation of the SDG 14, including topics such as Ocean Acidification and Ocean Carbon, Marine Spatial Planning, but also others such as Operational Oceanography, Marine Scientific Research and the United Nations Law of the Sea (UNCLOS), Guidelines on the Transfer of Marine Technology (TMT), etc., besides updating already existing training courses on topics such as Marine GIS Tools and Applications, Ocean Data Management, Research Data Management, Marine Biological Data (OBIS related), etc.

Besides the IOC Programmes and its Member States, other users of the OceanTeacher e-Learning Platform include UGent, EMODnet, VLIZ, POGO, AWI, etc…

The UNESCO/IOC Project Office for IODE obtained its certification as a Learning Services Provider (ISO 29990:2010) in 2018. The OceanTeacher Global Academy is a Project of IOC/IODE, Oostende, supported by the Flanders-UNESCO Trust Fund for Science (FUST) of the Government of Flanders, Belgium.

Keywords: Capacity Development; IOC; Training; SDGs; Ocean Sciences; Online

The Ocean Biogeographic Information System (OBIS) - Demo of its new portal

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Playing a central role in fostering data sharing of marine species observation data since 1999, the Ocean Biogeographic Information System (OBIS) has built the world's most comprehensive database on the diversity, distribution, and abundance of life in the ocean. The OBIS Network is made up of thousands of scientists and data managers employed by hundreds of institutions around the world, who ensure that scientifically researched, collated and published data adhere to FAIR (Findable, Accessible, Interoperable, Reusable) principles. With the release of the second generation of OBIS (OBIS 2.0), we now have a more solid foundation to build improved data processing/integration workflows, new data synthesis routines that add value to OBIS data, and new types of products and applications for scientific and decision-making. OBIS is now extending beyond species occurrence data, embracing ecosystem Essential Ocean Variables in support of the Global Ocean Observing System (GOOS) and the Marine Biodiversity Observation Network (MBON) in their efforts to build a sustained, globally coordinated observing system on the status and trends of marine biodiversity and habitats. The success of bringing millions of marine species observations into the public domain is a major achievement. Through FAIR access to data, OBIS provides equitable access and benefits to research, biodiversity conservation management and policy making, and also enhances international collaboration, for which OBIS is recognized by many global organizations including the United Nations General Assembly. OBIS continuous to support several international processes such as those under the UN Regular Process (World Ocean Assessment), the Convention on Biological Diversity (CBD) and the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES).

During this demonstration, we will show the new data portal and a number of services and products which are development with financial support from the Flanders Government, among others. This should also be an opportunity for the OBIS secretariat to get in touch with local scientists and other stakeholdes in understanding their needs, as well as seek opportunities for future collaboration.

Keywords: Biogeography; Data; Biodiversity; Infrastructure; Ecosystem; Open access

European Marine Board (EMB): The leading European think-tank in marine science policy

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The European Marine Board (EMB) provides a platform to develop common priorities, advice on marine research and to bridge the gap between marine science and policy. Our members are major national marine and oceanographic research performing institutes, funding agencies and national university consortia with a strong marine focus. Through our extensive pan-European scientific network, we identify emerging scientific and societal challenges and opportunities and articulate the research and capacity needs to address them. We act at the interface between science and policy, advancing marine science and providing considered advice to decision makers and research programme managers. Acting in a leadership role, we work to foster European research collaboration towards a sustainable use of the seas and ocean.

EMB has an outstanding reputation as a provider of high-quality science-policy advice. Our publications are designed for a non-technical audience, providing recommendations for future research and capacity building which can be addressed by European and national funding mechanisms. In addition, we organize open events and workshops that bring together scientists, decision makers and stakeholders to collectively address a topic of identified scientific and societal importance. Through open dialogue, our events deliver joint visions and recommendations to advance the issue at hand.

Looking ahead, the European Marine Board will continue to operate as the foremost platform for seas and ocean strategy and foresight in Europe. We have built a strong reputation through development of rigorous processes for delivering science policy advice and will adapt to the changing landscape of marine science policy. We will work with key partner networks to advance marine science and identify emerging challenges and opportunities of societal importance.

Keywords: Policy; Science; Science-policy interface

EMODnet: Your gateway to marine data in Europe

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Marine data are needed for many purposes: for acquiring a better scientific understanding of the marine environment, but increasingly also for decision making as well as supporting economic growth. Data must be of sufficient quality to meet the specific users' needs and be accessible in a timely manner. Both conditions are essential to achieving the crucial balance between making optimal use of our marine resources and protecting them.

Yet, despite being critical, this timely access to high-quality data proves challenging. Europe's marine data have traditionally been collected by a myriad of entities with the result that much of our data are scattered throughout unconnected databases and repositories. Even when data are available, they are often not compatible what makes the sharing of the information and data-aggregation impossible. Going to sea to set up new research cruises to gather data that already exist, is timely and costly.

To tackle those problems, in 2007 the European Commission through its Directorate General for Maritime Affairs and Fisheries (DG MARE) initiated the development of the European Marine Observation and Data network, EMODnet, a long-term initiative in the framework of the EU's Integrated Maritime Policy. Today EMODnet is comprised of more than 150 organisations which work together to assemble marine data and metadata and make them, together with ready-to-use data products, easily and freely accessible for a wider range of users. This "collect once and use many times" philosophy benefits all marine data users, including policy makers, scientists, private industry and the public.

Currently, EMODnet consists of seven sub-portals providing access to marine data and information from the following broad themes: bathymetry, geology, physics, chemistry, biology, seabed habitats, and human activities. Since the beginning of 2017, the EMODnet Data Ingestion Portal was launched which facilitates additional data managers to ingest their marine datasets for further processing, publishing as open data, and contributing to applications for society.

With this increase in EMODnet Open Marine Data, initiatives, such as the upcoming second edition of the OpenSeaLab Hackathon, are set up to seek new opportunities in the blue economy through the development of new applications using the marine data offered by EMODnet. The event will take place this Autumn from 4 to 6 September 2019, in Antwerp (Belgium). Registrations are free and will open in March 2019. More information can be found at www.opensealab.eu.

Keywords: Marine open data; Blue growth; Thematic lots; Hackathon

Semi-automatic identification of phytoplankton using image classification techniques

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Phytoplankton is the base of the marine food web. Its changes in abundance and species composition are indicators of the health of the marine ecosystem and has an effect on trophic levels of economic importance. In addition, harmful algal blooms may cause losses to aquaculture, fisheries, tourism and human health. Furthermore, phytoplankton has an influence on the global climate, due to its role in the carbon cycle and in the production of precursors of clouds.

Long-term phytoplankton data series are necessary to understand changes and pressures on an ecosystem; therefore, they are relevant to achieve the Sustainable Development Goals from United Nations. As traditional methodologies to obtain these type of data are labor intensive and time consuming, the Flanders Marine Institute (VLIZ), as part of the Belgian LifeWatch observatory, decided to apply image analysis for the taxonomic classification of such samples.

From 2017 onwards, VLIZ is sampling phytoplankton on 17 stations in the Belgian Part of the North Sea (BPNS). Those samples are processed with a Flow Cytometer And Microscope (FlowCAM®), resulting in a collection of pictures. Each picture captures a particle and a set of measurements associated to that particle. These produced images are then further analysed with the software VisualSpreadsheet to annotate taxonomic names to these particles.

Using VisualSpreadsheet, we have created digital libraries of the phytoplankton taxa for the BPNS. Based on those libraries, we generate filters for each taxon that allow us to run an auto-classification for the pictures of each sample. The output of the auto-classification is manually validated by an experienced operator, to correct the errors of the automatic prediction. The quality-controlled datasets generated are freely available through the LifeWatch Data Explorer (http://www.lifewatch.be/en/lifewatch-data-explorer), on the condition that the dataset is cited.

Keywords: Biodiversity; Image analysis; Phytoplankton; Belgian Part of the North Sea; FlowCAM

Mooring scientific instruments in challenging North Sea conditions – Troubled water

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Marine and coastal ecosystems should be managed in a sustainable way by 2020 with effective regulations in place, as stated by the United Nations sustainable development goals. To have an effective management in place, ecosystem functioning and dynamics should be thoroughly understood and detailed information on movement behaviour and habitat use should be available. In the framework of the Belgian contribution to LifeWatch (http://www.lifewatch.be/) a biodiversity Observatory was established in the Belgian part of the North Sea (BPNS) to provide the scientific data needed for management and conservation of species and habitats. For the Observatory, hydrophones, among other scientific instruments, are deployed in the coastal waters of the BPNS. These hydrophones detect the presence of marine mammals and tagged fish.
The hydrophones are installed at strategic locations and different installation methods are used. Mooring scientific equipment in the coastal waters of the North Sea is challenging. Strong currents, sediment transport and high waves prevail. Moreover, many different anthropogenic and natural sound sources mask the recordings the instruments. As a result, attachment methods and mooring designs should be well-considered. Where feasible, hydrophones are attached to a construction on the seabed (e.g. ship wreck, wind turbine) or at surface buoys (e.g beacons for navigation or research). At locations where no structure is available, other mooring methods are required.

At the Flanders Marine Institute, we developed a mooring frame for the installation of scientific instruments at the seabed. The mooring facilitates a convenient, cost-effective deployment with no disposal of material after recovery, minimal chance of loss of equipment and an assurance of high quality data. Moreover, the design is modulated and tested for the inclusion of other scientific instruments for oceanographic and/or biological research. Do you want to learn more about this mooring device? Visit us at the LifeWatch Demo booth!

Keywords: Scientific instruments; Bottom mooring; VLIZ tripode; Observatory

The LifeWatch Taxonomic Backbone: How can it help you with your research and how can you help to make it more complete?

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The LifeWatch Taxonomic Backbone facilitates the standardization of species data, and the integration of the many distributed databases and data systems. It – virtually - brings together different component databases and data systems, dealing with five major components: (1) taxonomy, through regional, national, European, global and thematic databases, (2) biogeography, based on databases dealing with species occurrences, (3) ecology, in the form of species-specific traits, (4) genetics and (5) literature, by linking all available information to the relevant sources and through tools that can intelligently search this literature. The development of the LifeWatch Taxonomic Backbone started in 2012 and has now entered it maintenance phase. The content of the taxonomic and biogeographic components still grows on a daily basis and efforts are being made to document traits information and to link all components with available literature.

The LifeWatch Taxonomic Backbone offers a whole range of services to the scientific community, which can support them in answering specific ecological questions that have so far not been dealt with due to the lack of accessibility, availability, standardization and linking of data. Both easy-to-use online tools and web services allow scientists e.g. to compare their own data with already collected data from the same or similar regions, to check whether any of the taxa in their database is still known under that name or to see whether any of their listed species is e.g. tagged as an endangered or alien species.

The LifeWatch Taxonomic Backbone is offering tools and functionalities which are often developed based on identified needs within the scientific community. In addition, scientists can also contribute themselves to make it more complete. Feedback on e.g. taxonomy and traits is highly appreciated and communicated with the involved experts of the different component databases. And all distribution information collected by individual scientists can become part of the biogeographic component of this backbone, e.g. by contributing occurrence data with the biogeographic component of the system.

We will demonstrate the content and functionalities of the LifeWatch Taxonomic Backbone, including e.g. the World Register of Marine Species (WoRMS), the Interim Register of Marine and Non-marine Genera (IRMNG), the European Ocean Biogeographic Information System (EurOBIS) and the many available web services related to these systems.

Keywords: LifeWatch Taxonomic Backbone

Water quality in the Belgian part of the North Sea: exploring ocean's health through online applications

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Large environmental changes, either natural or anthropogenic, generally occur over long periods of time. Physico-chemical properties of water are known to follow periodic seasonal changes, but ongoing climate changes affecting temperature, primary production and species distributions may drive ecosystem shifts over the long term. Therefore, it is crucial to monitor the environmental conditions in coastal waters consistently over a long period of time. For this purpose, the Flanders Marine Institute (VLIZ) initiated a scheme of high frequency sampling campaigns in the Belgian Part of the North Sea in 2002.

During the multi-disciplinary sampling campaigns, water column data is collected on physical, biochemical and biodiversity related aspects of the environment, including measurements of nutrients, pigments, suspended matter and turbidity. These water quality descriptors can provide supporting information for status assessments of eutrophication, pollution and changes in coastal waters; but also provide an important historic dataset with descriptors otherwise not accessible to the broad public.

Fixed versions of the datasets are published yearly (Flanders Marine Institute, 2019) whereas the most recent collections can be accessed online via the LifeWatch Data Explorer. Via this online application, it is possible to browse quality-controlled data, select on specific water quality descriptors, specify temporal and spatial windows and create exports of that data. Data and metadata are fully documented, and published under a CC-BY license, allowing use of the data under the condition of providing reference to the original source.

Flanders Marine Institute (VLIZ), Belgium (2019): LifeWatch observatory data: nutrient, pigment, suspended matter and secchi measurements in the Belgian Part of the North Sea. https://doi.org/10.14284/328

Keywords: Water quality; BCP; Online application; Open access

MarineRegions' Maritime Boundaries - A world reference for global fisheries research

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MarineRegions is a global geographic database containing (i) international marine and maritime boundaries and (ii) marine placenames.

The basis for the Maritime Boundaries dataset is the United Nations Convention on the Law of the Sea (UNCLOS), which was signed in 1982 and came into force in 1994. This convention has defined a series of maritime zones (internal waters, archipelagic waters, territorial sea, contiguous zone, exclusive economic zone and continental shelf) and establishes the degree of rights and obligations of a country in each of those areas. The Exclusive Economic Zone (EEZ) is a country's basic geo-unit for the management and scientific research of marine natural resources. Despite the strategic significance of EEZs, a standard dataset with maritime boundaries was not available at the global level until it was developed and made available by the Flanders Marine Institute (VLIZ) (Claus et. al, 2014). Currently, the MarineRegions products are being used as essential datasets in global ocean conservation initiatives such as Sea Around Us (Zeller et al., 2016), Global Fishing Watch (Kroodsma et al., 2018) and the Ocean Health Index (Halpern et al., 2012).

In this demonstration, we illustrate how users can explore, download and use the MarineRegions datasets through MarineRegions.org and by various web service applications. Moreover, we highlight how our products are essential for global fisheries research. Prof. dr. Daniel Pauly, founder of the Sea Around Us project, and Global Fishing Watch CTO Paul Woods testify how the MarineRegions products are used in their research and why they are essential for their work.

MarineRegions is accessible through MarineRegions.org and by various web service applications.

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Keywords: Maritime boundaries; Marine Regions; International research; Dataset; Fisheries

How open science helps your research, and how VLIZ can help you

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Open data science is becoming more and more a norm in scientific research. Public funding agencies on all levels require data management plans that describe how research data will be archived and shared. More and more scientific journals require that the data upon which a paper is based is accessible and that the analysis is reproducible. In the near future, the requirements for open data science will even increase.

The trend towards open science can also help you as a researcher. Your research projects will benefit from applying open science principles as they: make research data discoverable, safeguard your data now and in the future, foster collaboration, and make research more efficient as other scientists can use your data in other projects. In other words, data will become FAIR: Findable, Accessible, Interoperable, Reusable. Each step towards open science brings benefits.

The downside is that applying these principles require some extra time and effort. And this is how the Flanders Marine Institute (VLIZ) can help. We are adopting the open science principles and are supporting marine researchers with (i) managing and storing their research data and (ii) storing their publications. The Marine Data Archive (MDA) is an online repository specifically designed to archive and publish marine data files, enabling individual researchers, research groups, and project consortia to store, preserve, document, and share their data. The Open Marine Archive (OMA) repository provides permanent and free access to digital publications on marine, estuarine and coastal topics.

All researchers are encouraged to use these services to archive and publish their data, and to share their scientific publications to foster collaboration within the Marine Science Community.

Keywords: Open science; Open access; FAIR data principles; Repository

ScheldeMonitor: The online data and information hub for the Scheldt Estuary

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The Sea Scheldt, its tidal tributaries (Durme, Rupel with the Zenne, Dijle, Grote Nete and Kleine Nete), the Western Scheldt and its mouth have a unique tidal ecosystem that provides many services, including a significant impact on the economy, society and nature. It has been, and still is, the subject in numerous fundamental and applied scientific studies.

In the framework of the cross-border Flemish-Dutch long-term vision of the Scheldt Estuary, a knowledge and information portal was set up for research and monitoring in the Scheldt (http://www.scheldemonitor.org). Yearly, there is a large update of Scheldt related data in the dataportal and every five years, a large evaluation of the quality of the Scheldt is executed by a consortium. The first five-year-period (T2009) handles data over the period 2005-2009, and in 2018 the second evaluation (2010-2015) of the Scheldt was completed (T2015). This data, as well as literature and reports supporting the several types of ongoing research in the Scheldt, is available through this online platform.

To gain insight in the dynamics of the Scheldt area through time, a series of historical maps were added. An application makes it possible to visualize and compare a current map with a historical map of choice. Currently 128 maps are accessible dating from the 16th till the 20th century.

In general, ScheldeMonitor offers information (expertise, literature, projects, etc.), data (datasets, measurements, etc.) and data products (maps, graphs, indicators, etc.) and can be accessed at http://www.scheldemonitor.org

Keywords: Scheldt; Dataportal; Waterquality; Morphodynamics; Physico-chemistry; Ecology; Diversity; Tidal ecosystems; Estuary

Compendium for Coast and Sea 2018, a key guide for the marine expert

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On December 7 2018 the Compendium secretariat of VLIZ launched the newest edition of the Compendium for Coast and Sea. The Compendium for Coast and Sea 2018 is the third edition in this series of multifunctional guides for the marine expert. As in previous editions, the Compendium aims to encompass the dispersive information from the Flemish-Belgian marine sciences in a scientific and neutral way. For this latest edition all publications were thoroughly revised and new products were developed. In doing so a lot of attention was paid to improving the recognisability of the Compendium and the user experience.

The Compendium for Coast and Sea 2018 is composed of the following elements:
- Indicator Report Marine Research and Innovation 2018: Trends and figures on marine research and marine innovation in Flanders and Belgium (NL/EN: digital + print);
- Knowledge Guide Coast and Sea 2018: Information portal on the use of the coast and sea in Flanders and Belgium (NL: digital + print; EN: digital);
- Expert Guide Marine Research 2018: Portfolio of marine research in Flanders and Belgium (NL: digital; EN: digital + print);
- Catalogue Marine Research Infrastructure 2018: Overview of the available infrastructure for marine research in Flanders and Belgium (NL/EN: digital);
- Marine Policy - Policy instruments and legislation 2018: Overview of the most pertinent international, European, federal and Flemish marine policy context (NL/EN: digital);
- A communication product (envelope) with handy sheets that quickly guide the marine expert through the Compendium for Coast and Sea 2018 (NL/EN: print).

Following the Open Access policy, all Compendium publications can be freely consulted and downloaded via the Compendium website and via the integrated marine information system (IMIS) of VLIZ. Also visit our website for handy search modules that assist you with a more targeted search.

If you want to learn more about the Compendium for Coast and Sea 2018 and experience it first hand, come visit our demonstration booth.

Keywords: Compendium for Coast and Sea; Knowledge broker; Scientifically based; BNS + Coastal zone and Scheldt estuary

VLIZ-philanthropy: The sea as a good cause

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The Flanders Marine Institute (VLIZ), recognized as a charitable organization, uses donations, bequests and other financial contributions in a targeted manner to support philanthropic projects and to award grants in order to increase scientific knowledge about the sea and promote social awareness of the major importance of the seas and ocean. The projects and grants need to fit under the following themes 1) Measuring is knowing, citizens can help, 2) The sea is a source of inspiration and innovation and 3) The ocean has no limits.

Currently three philanthropy projects are running:

- **SeaWatch-B**, a beach observation network that aims to generate reliable long-term data on our North Sea beaches using volunteering citizen-scientists. The generated data are relevant to study environmental changes of our sea and beaches, such as plastic pollution, climate change, etc. Donations are used to a.o. purchase sampling equipment.

- **WoRMS editors**. The World Register of Marine Species (WoRMS) is an authoritative reference list of all life in the ocean. It aims to capture the names of all species described and is continuously updated by a group of taxonomic experts (the editors). Gifts are used to fill gaps in coverage, participate in international workshops, expand the content of taxonomic databases, etc.

- **Protect marine life in Chile**. The extremely productive coastal ecosystems of Chile are recently subject to a variety of economic developments affecting the traditional way of living. Therefore, a diversity of local initiatives has been set up in the region to protect these fragile marine ecosystems. Donations are used to buy equipment in order to monitor the marine biodiversity as well as to develop educational programs for local people and schools.

You can also put forward your project idea! An initiative needs to contribute to the scientific knowledge about coastal and marine areas anywhere in the world. Each project needs to carry a neutral and objective message. Projects can be inspired by mere curiosity or wonder. In any event, projects should contribute to more sustainable ocean management in the short or long term by generating new scientific knowledge and measuring data. It is furthermore recommended that the projects involve not only professional scientists but also children, youngsters and other layers of society in the acquisition and collection of knowledge (citizen science, ocean literacy). The project needs to be supported by at least one VLIZ staff member, who will act as mentor of the project. Each project proposal is then presented to the VLIZ Scientific Committee, which in turn presents the project for approval to the VLIZ Board of Directors.

On top of that VLIZ philanthropy awards on a yearly basis the BMRI grant: 'Brilliant Marine Research Ideas', a call intended to inspire and enable PhD students (less than 6 years of research experience at pre-doc level) affiliated to a Flemish University or Flemish University College to execute a brilliant idea during their PhD within the frame of their research. This grant has a maximum fund of EUR 5.000 per person.

Also you can support ‘the sea as a good cause’! Your membership fees, donations and bequests will be used worldwide in a targeted manner to increase scientific knowledge about the sea and to promote social awareness of the major importance of the seas and ocean.

- A gift to VLIZ-philanthropy: www.vliz.be/make-gift
- Become a VLIZ member: www.vliz.be/en/membership
- Buy a sweater, t-shirt or tote-bag from our Sea&Science collection. The profit goes to coastal, marine and ocean research worldwide: www.vliz.be/en/VLIZ-shop

Feel free to contact filantropie@vliz.be for more information.

Keywords: VLIZ philanthropy; SeaWatch-B; WoRMS editors; Chile; Brilliant Marine Research Idea; Membership; Donation; Shop

Informative Posters

Let's jump in the plastics pool: How to detect unnoticed small plastic particles in our North Sea?

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There is growing awareness about possible adverse environmental effects and human health risks created by microplastics in the marine environment. Although there is now a considerable body of literature on the presence of larger microplastic particles (> 50 µm), there is - due to limitations in sampling and detection method - little information on the quantities and types of small microplastic particles (< 50 µm) present in marine environments. Here, we developed a simple, high-speed, and low-cost digestion and staining method to detect and visualize microplastics in seawater samples. First, seawater containing several types of artificial microplastics was filtered and a subsequent on-filter digestion protocol was applied, using chemical agents that do not visually modify the tested polymers. Subsequently, the microplastics on the filters were stained using Nile Red as fluorescent dye (according to Maes et al. 2017). This dye adsorbed to the plastic particles present on the filter, making them fluorescent when exposed to green, blue or ultraviolet light, allowing detection and visualization of the microplastics using a fluorescence microscope. A cross-validation of this detection method was performed by analyzing the irradiated plastic particles with a scanning electron microscope coupled to an Energy-Dispersive X-ray Spectroscopy (EDS) and with micro Fourier transform infrared (µFTIR) spectroscopy. The developed method will be applied to analyze small microplastic particles in North Sea water samples in a fast, reliable, and cost-efficient way. This may contribute to a robust, operational monitoring method of microplastics to inform and guide policy makers.

Reference

- Maes T, Jessop R, Wellner N, Haupt K, Mayes AG (2017) A rapid-screening approach to detect and quantify microplastics based on fluorescent tagging with Nile Red. Sci Rep 7:44501. doi: 10.1038/srep44501.

Keywords: Microplastics; Visualization; Detection; Fluorescent microscopy; Scanning electron microscopy; µFTIR

Bridging the gap between skills demand and supply in the maritime and marine sectors: MATES Project

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Are the marine and maritime sectors ready to fill the skills needs of their workforce?

MATES* is a Maritime Alliance for fostering the European Blue Economy through a Marine Technology Skilling Strategy (https://www.projectmates.eu). This project is part of the New Skills Agenda of the European Commission aimed at reducing the mismatch between the skills people are taught and the skills required to meet the needs of fast-changing labour markets. MATES' objective is to develop a skills strategy that addresses the main drivers of change to the maritime industry with particular interest in shipbuilding and offshore renewable energy. The workforce at both sectors requires new capacities to succeed in an increasingly digital, green and knowledge driven economy. Increasing the attractiveness of the sectors through a robust dissemination and outreach plan besides ensuring future adoption of the strategy is also foreseen. The skills strategy will be enriched and validated by experts and priorities will be identified in order to setup and test 11 pilot case studies on digital skills, green skills, mobility, innovation management, curricula development and ocean literacy. Additionally, Ocean Literacy initiatives will be carried out with an appropriate industrial perspective in order to refresh the image of the maritime industry addressing the youngsters and current workforce. The MATES consortium brings together a multidisciplinary partnership with the experience and expertise of 17 partners from eight European countries, coordinated by the Centro Tecnológico del Mar (CETMAR) Foundation of Spain. Ghent University, through the Marine Training Platform (www.marinetraining.eu) actively participates with expertise in the analysis of education and training needs as well as in the dissemination of events and training offers gathered by the project.

Keywords: Skills-needs; Shipbuilding; Offshore renewable energy; Blue-economy

RIGHT skills for the RIGHT people: The RIGHT Project

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The North Sea Region (NSR) boasts six of the top eight countries in Europe for innovation and is a great place to live and work. However, the region's stability and long-term prosperity depends on its ability to strengthen knowledge transfer and business support across the borders.

What can be done to stimulate sustainable economic growth in the region?

RIGHT* is an Interreg project which approach is to connect smart specialisation strategies in the NSR to human capital and skills (especially in small to medium enterprises). Through collaborations, the project will define existing and potential regional growth sectors and sub-sectors (blue and energy). In addition, skills gaps will be identified to unlock innovation capacity by testing new models to overcome skills barriers. RIGHT aims to build methodology, develop knowledge and to provide a model for long-term solutions and transferability by designing and testing tailored educational and training programmes targeting the skills gaps. The successful results will be capitalised by the partner regions to generate long-term impact in the context of rapidly changing skills demands. RIGHT Project brings together a multidisciplinary partnership of 7 regional partners. Ghent University will actively participate in the collection and dissemination of vocational trainings, educational programmes as well as in the design and testing of pilot case studies, through the Marine Training Platform (www.marinetraining.eu).

*RIGHT is a project co-funded by the North Sea Region Programme 2014 – 2020, European Regional Development Found (ERDF)

Keywords: Skills-gaps; Blue & energy; VET; North Sea Region; Innovation

The Coastal Portal – A one stop shop for spatial data of the Belgian North Sea and coast

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Nowadays there are geo- and data portals on the web for all kinds of themes with a Belgian focus. This overwhelming variety of portals makes it difficult for potential users looking for maps to find their way. In order to guide interested persons through the multitude of applications and sources, there is a need for a central referral portal. This need is met by the Coastal Portal, which can be seen as the successor of the Coastal Atlas (Province of West Flanders). The Coastal Portal aims to provide user-friendly and thematic access to information and data products on user functions and monitoring activities in the Belgian part of the North Sea and the coastal zone, including beaches, dunes and polders. To this end, both in-house and a selection of external interactive data products and maps (WMS and others) are visualised in the form of GIS layers with the aim of referring the user to the original portal in question for more information. This way, the aim is to give more visibility to the original portals or data suppliers.

In addition to interactive maps, much attention is also paid to the layout of pre-prepared static maps in function of the needs of the professional user. The portal will be systematically updated and expanded, both in terms of relevant information products and functionalities, and tries as much as possible to respond to the needs of the professional user.

The integrated character of this portal contributes to the European efforts towards a sustainable integrated maritime policy and coastal zone management. Furthermore, the Coastal Portal provides a close connection with the Compendium for Coast and Sea, which aims at combining disperse information and data from Flemish and Belgian marine and maritime research.

Keywords: Spatial data; GIS; Belgian part of the North Sea; Belgian coast; Monitoring; User functions; Marine life; Environment

Working together to resolve environmental effects of wind energy

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WREN (**W**orking Together to **R**esolve **En**vironmental Effects of Wind Energy) was established by the International Energy Agency Wind Committee in October 2012 to address environmental issues associated with commercial development of land based and offshore wind energy projects. The primary objective of WREN is to facilitate international collaboration and advance global understanding of potential environmental effects of wind energy. To support this effort, *Tethys* was expanded to serve as a collaborative outreach and engagement space, and to disseminate knowledge and information. *Tethys* has collected over 2,400 documents related to the environmental effects of wind energy (land-based and offshore). All documents are available in a table format via the *Tethys* Knowledge Base, which can be easily filtered to find documents relevant to specific searches such as document type, technology type, or environmental effect. Any documents related to a spatial location have been geotagged and made available on the *Tethys* Map Viewer. Most WREN information and content is publicly accessible. WREN also hosts quarterly webinars on the environmental concerns that are of importance to the land-based and offshore wind energy industries, as a means to effectively disseminate new information and research efforts to a large international audience of stakeholders.

Keywords: Wind energy; Knowledge base; Environmental effects

WECANet: An open pan-European Network for Marine Renewable Energy with a focus on wave energy – European COST Action CA17105

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Growing energy demand has increased interest in marine renewable energy resources, i.a. wave energy which is harvested through Wave Energy Converter (WEC) Arrays.

However, the wave energy industry is currently at a **significant juncture in its development**, facing a number of challenges which require that research re-focusses onto a holistic **techno-economic perspective**, where economics consider the full life-cycle costs of the technology. It also requires development of WECs suitable for **niche markets**, because in Europe there are inequalities regarding wave energy resources, wave energy companies, national programmes and investments. As a result, in Europe there are **leading** and **non-leading** countries in wave energy technology. The sector also needs to increase confidence of potential investors by **reducing (non-)technological risks.** This can be achieved through an **interdisciplinary approach** by involving engineers, economists, environmental scientists, legislation, governmental bodies

and policy experts. Consequently, the wave energy sector needs to receive the **necessary attention** compared to other more advanced and commercial ocean energy technologies (e.g. offshore wind).

The formation of the **first open pan-European Network** on an interdisciplinary approach will contribute to large-scale **WEC A**rray deployment by dealing with the current bottlenecks. The **WECANet** EU COST Action, presented in this paper, aims at a collaborative and inclusive approach, as it provides a strong networking platform that also creates the space for dialogue between all stakeholders in wave energy. An important characteristic of the Action is that participation is open to all parties interested and active in the development of wave energy. Previous activities organised by WECANet core group members have resulted in a number of joint European projects and scientific publications ([1]-[3]). WECANet's main target is the equal research, training, networking, collaboration and funding opportunities for all researchers and professionals, regardless of age, gender and country in order to obtain understanding in the main challenges governing the development of the wave energy sector.

In Belgium, WECANet is coordinated by the Coastal Engineering Research Group of Ghent University (UGent-CERG, http://awww.ugent.be) and is actively supported by activities of the Flanders Marine Institute (VLIZ, http://www.vliz.be), the Marine@UGent cluster and the Provincial Development Agency West-Flanders (POM). UGent-CERG has a large experience in the fields of coastal and offshore engineering and marine renewable energy, and performs integrated research using physical and numerical modelling and field measurement campaigns. The main infrastructure and know-how include prototype field measurements, wave flumes and wave basins for physical scale modelling, and numerical tools. The specialized staff members of the research group are involved in national and international projects on coastal defense, ocean energy conversion and offshore structures. UGent-CERG has established experimental facilities, and currently the new Coastal & Ocean wave Basin (COB, web link: http://COB.ugent.be) is being constructed. These facilities enable physical modelling for research purposes, for the government and for the industry. VLIZ promotes accumulation of marine knowledge and excellence in marine research in Flanders, targeting the marine research community as well as educational institutions, the general public, policymakers and the industry (within the scope of the blue economy). VLIZ is also participating in the Management Committee of WECANet. Marine@UGent GOBlue (www.marineatugent.be/) is an initiative of the UGent Marine Sciences Centre of Excellence which promotes and facilitates interdisciplinary cooperation for Blue Growth activities. POM is responsible for the implementation of the social economic policy of the Province of West Flanders and is supporting developments in the blue energy field, promoting the development of ocean energy technology by the academic sector and private companies. Factory of the Future "Blue Energy" (www.fabriekenvoordetoekomst.be) is the action plan of POM, which also has introduced TUA West, an agency that acts as a liaison between partners from various industries and civil society, supporting the triple helix model of establishing links between companies, knowledge institutions and governments.

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Acknowledgements
WECANet is funded through the HORIZON2020 Framework Programme by COST (European Cooperation in Science and Technology, www.cost.eu), a funding agency for research and innovation networks.

Keyword: WECANet

ASSEMBLE-Plus: Offering access to marine research infrastructures

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ASSEMBLE Plus is a project is to stimulate European fundamental and applied research excellence in marine biology and ecology, thereby improving our knowledge and technology-base for the European bioeconomy, policy shaping and education. The project brings together 32 marine stations and institutes with modern research infrastructures and track-records of unique service provision, from 14 European and two associated countries, under the leadership of the European Marine Biological Resource Centre (EMBRC). For the Belgian node of EMBRC, VLIZ is a partner to the project, with Ghent University as a linked third party.

The sum of the actions envisaged in ASSEMBLE Plus, including Access, Networking and Research will ultimately increase the number of users of marine biological stations and shape novel strategic development perspectives of the partners, to be based on effective integration and efficient complementarities, resulting in a key contribution to their long-term sustainability.

One of the actions to complete this goal is to offer free-of-charge transnational access (TA) to research infrastructures towards the research community. Over the lifetime of the project, 7 calls will be launched to provide access to a total of 32 marine stations in 16 countries. The stations provide access to a high diversity of marine environments; from the high Arctic and Antarctic to the tropics and the mid-Atlantic ridge. Within mainland Europe, access is provided to the Mediterranean, the Atlantic and the Baltic Sea. Habitats comprise estuaries, mega-tidal seas, cold-water coral reefs, brackish seas and sea ice communities, near-shore deep sea, and volcanic seeps.

The TA-providing stations have modern research laboratories and a wide array of specialized research facilities to support internal and external users. Several of these also have technological backup of nearby university institutions. Facilities include sampling and field access, biochemical and biological analysis, maintenance and culture of organisms, microscopy, molecular biology and bioinformatics. Biological resources encompass culture collections and bio-specimen banks.

More information about the project and the specific timing for these transnational access calls can be found at http://www.assembleplus.eu/

Keywords: EMBRC-ERIC; Research-Infrastructure; H2020

A true tropical experience: TROPIMUNDO Erasmus Mundus Masters Course in Tropical Biodiversity and Ecosystems

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TROPIMUNDO is an Erasmus Mundus Masters Course in Tropical Biodiversity and Ecosystems funded by the European Commission's excellence programme Erasmus Mundus. It is the first MSc program (2 yrs, 120 ECTS) that integrates the knowledge and skills related to four adjacent interlinked tropical ecosystems under threat (tropical rainforests and woodlands, wetlands, - both terrestrial and coastal such as mangrove forests, seagrass beds and coral reefs). Study of these ecosystems is crucial to understand, protect and manage tropical biodiversity in an era characterised by an international biodiversity crisis with imminent risks of extinction of species due to global warming and anthropogenic impacts such as habitat destruction and changes in land use.

TROPIMUNDO is unique in incorporating a 2nd semester (with theoretical courses and a significant field course) in the tropics in Guadeloupe, France (Université des Antilles – UdA), Cameroon (Université de Dschang – Udsch), Madagascar (University of Antananarivo – UNIVANTA), Sri Lanka (University of Ruhuna – RUH), Malaysia (Universiti Malaysia Terengganu – UMT) or Hong Kong (University of Hong Kong – HKU). These institutions cover specialisations in Caribbean insular ecosystems, Central African terrestrial ecosystems, Malagasy forest ecosystems, Sri Lankan terrestrial and aquatic ecosystems, Malaysian mangrove ecosystems and other South-East Asian terrestrial and coastal ecosystems, covering a wide choice of skills and qualifications in tropical biodiversity and ecosystems.

Furthermore, TROPIMUNDO brings together European expert higher education institutes, with long-standing worldwide expertise in tropical rainforests and woodlands and in coastal ecosystems in Belgium (Université Libre de Bruxelles – ULB, Vrije Universiteit Brussel – VUB), France (Sorbonne Université, Muséum National d'Histoire Naturelle – MNHN and Université de Guyane – UdG) and Italy (Università degli Studi di Firenze – UNIFI). They integrate world class scientific education and research expertise on the aforementioned tropical ecosystems and experience in designing and teaching in international MSc programs. The 1st semester primarily aims at teaching basic courses in Europe, whereas the 3rd semester focuses on specialised courses at one of the European partners. The 4th and final semester is dedicated to the thesis. Graduates obtain multiple degrees or a joint degree, a joint Europass Diploma Supplement, a Europass Mobility and a Europass Language Passport. TROPIMUNDO's learning outcomes stretch far beyond academic knowledge and insight, but also aim at demonstrating enhanced capabilities in effective analysis and communication, independence, creativity and assertiveness, critical judgement, and ethical and social understanding.

During the two years of the Master program TROPIMUNDO students can concentrate on botany, zoology and integrative ecosystem approaches in institutions worldwide. Multiple specialisations are included, such as the evolution of tropical flora and vegetation; faunistic assemblages; informatics tools to treat and manage biodiversity data and databases (biogeographical, genetic, geographical information systems) including the management and conservation of historic collections such as herbarium sheets; the study of diversity, dynamics and evolution of tropical and subtropical ecosystems (with a focus on four related systems, namely tropical rainforests and woodlands, mangrove forests, seagrass beds and coral reefs, including the interactions between flora, fauna, man and the environment within and between each of these adjacent ecosystems);conservation and restoration ecology of natural habitats and their biodiversity including competences in sustainable management and governance of biodiversity, and finally, in tropical ethnobotany, exploitation and valorisation of the functions, goods and services of natural habitats and their resources, and conservation of traditional ecological knowledge.

TROPIMUNDO maximises the inclusion of European languages by offering a content and language integrated learning program (English or English + French), and it is delivered in a society that is French, English, Dutch, Italian, Malagasy, Sinhala, Tamil, Bahasa Malaysia or Cantonese-speaking, which is valorised using buddy programs and Tandem Learning. This aims at improving the students' language capabilities for which facilities are provided by all partners.

TROPIMUNDO management is handled by a multi-level and shared responsibility involving 5 decision bodies (Steering, Selection, Jury, Internal Evaluation and External Evaluation), and 1 main execution structure (Coordination Office), all operating with equal commitment by the partners. A series of Associated Partners, including scientific institutes, governmental and non-governmental organisations responsible for conservation or management of tropical ecosystems and their biodiversity, and public authorities, agreed to advertise the program, to provide or to communicate existing placements, jobs, internships or thesis perspectives and scholarships, and to assist in evaluating the program. This links TROPIMUNDO to the real and professional world.

Reference

www.tropimundo.eu

Keywords: Master program

Competition Posters

Food resources and microbiome composition of the Lake Tanganyika sardines: A novel approach to investigate structure of overexploited *L. miodon* and *S. tanganicae* stocks.

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Lake Tanganyika (LT) is an ancient lake in the Great African Rift System, surrounded by the Central African countries Burundi, DR Congo, Tanzania and Zambia. *Limnothrissa miodon* and *Stolothrissa tanganicae* are two pelagic clupeid (sardine) species that are endemic to this lake (Coulter, 1991). They are very important for the local communities surrounding Lake Tanganyika since they comprise around 65% of the fish catches (De Keyzer et al., 2019). Over the last decades, fish stocks in the lake have been declining mainly due to overfishing and global warming (Nkotagu, 2008). To establish sustainable fisheries management, a good understanding of the ecology and population structure of these sardine species is needed. Knowing the precise food source of the sardines is important to analyse their role in the pelagic food web and study their ecological importance (Pikitch et al., 2004). Genetic studies on *S. tanganicae* and *L. miodon* did not show population structuring, suggesting some migration of these fish over the length of the lake (Hauser et al., 1998; De Keyzer et al., 2019). Here, we analyse the prey item and the gut microbiome composition of *L. miodon* and *S. tanganicae*. Until now, studies on the diet composition of the sardine species were mainly done visually. This technique is very time consuming, requires taxonomic specialists and is sensitive to degradation of food items (Jakubavičiute et al., 2017). In this study, we used metabarcoding to analyse stomach and gut content. Metabarcoding is a very effective way of detecting and identifying even small traces of DNA within a sample (Jakubavičiute et al., 2017). Our samples of *S. tanganicae* and *L. miodon* originate from five locations: Uvira (DR Congo) and Bujumbura (Burundi) in the North, Kalemie (DR Congo) in the centre, Mpulungu (Zambia) and Sumbu (Zambia) in the South. They were sampled during both wet (April, all locations) and dry (September, only Uvira) season. In this way, a comparison between different species, locations and seasons can be made. Findings from this study will give detailed information about the prey item and microbiome composition of sardines in LT. For the gut microbiome, we expect a difference over the north-south axis, since different bacteria phyla dominate in these basins (De Wever *et al*., 2005). A difference between seasons is not expected, because the microbiome of an individual is rather stable. For stomach content, we expect variation between species, since previous reports and differences in life cycles suggest different feeding habits. Furthermore, we expect a difference in diet composition between seasons due to a variation in abundance of certain prey species during the wet and the dry season. Since the composition of the plankton varies between the North and South, we also expect a variation in diet between locations.

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Keywords: High-throughput sequencing; Metabarcoding; Central Africa; Freshwater; Gut microbiome; Diet analysis; Fish; Clupeids

Planktonic community of southern Chile lakes: Phytoplankton, zooplankton and bacteria

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In this study we focused on evaluating the planktonic eukaryote and bacterial community structure in less studied south Chilean lakes (51-53°S) during the austral summer month of January (2016). At the present scenario of climate change, the climate-related environmental factors together with the spatial location of the lakes structuring these communities were studied. The study was carried out using Illumina based high-throughput sequencing (MiSeq) of hypervariable regions V1-V3 and V4 of 16S and 18S ribosomal RNA (rRNA), respectively, to access the community structure and distribution pattern of bacteria and eukaryotes in 27 littoral samples from southern Chile lakes. The samples were selected based on their position on the latitudinal scale, and to a span of wide environmental gradients across 27 lakes.

Sequenced data of these samples revealed the dominance of green and golden microalgae along with dinoflagellates phytoplanktonic communities, Arthropoda-Crustacea (Calanoid copepod and Ostracoda species *Notodromas monacha*) zooplanktonic communities, and Bacteroidetes, Actinobacteria, Cyanobacteria, Proteobacteria and Verrucomicrobia bacterial communities, which correlated with previous microscopy and denaturing gradient gel electrophoresis (DGGE) -based observations. Variation partition analysis revealed that the littoral planktonic communities are influenced by both environmental and spatial factors, among which temperature, electric conductance (salinity) and turbidity are of major importance. These three groups of environmental variables have previously been shown to change drastically in glacial settings.

Together, these results have obvious importance in the assessment of biodiversity changes in changing climatic conditions and calls for a continuous assessment of the unique though an understudied region of southern Chile.

Keywords: Phytoplankton; Zooplankton; Bacterial community; High-throughput sequencing; Quantitative ecology; Southern Chile lakes

Extension of the validation cases of a numerical model of the flow within the scour protection around monopile foundations

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Currently, monopiles are the most used support structure for offshore based wind energy production units. As any structure embedded into the seabed, scour holes appear due the hydrodynamic action of waves and currents leading to a loss of stability. In order to counter the effect, the hydrodynamic conditions into the soil, scour protections are placed around the monopile. Nevertheless, the hydrodynamic conditions can also lead to the failure of the scour protection as stated in [1]. [2] concludes that a numerical model of the scour protection and the hydrodynamic conditions can predict the shear stresses within the scour protection. In [1], it is shown the lack of a model able to simulate the combined action of waves and currents and a full depth numerical flume for modeling the behavior of water around monopiles and within their respective scour protection made of rip-rap material is proposed. The latter numerical flume will be referred in this abstract as “the model”. In [1], the model has been validated and compared to the experimental and numerical results presented in [2]. This validation has been done for current conditions only.

The model is developed using the OpenFOAM toolbox [3]. Wave generation/absorption as well as currents generation is performed using the module IHFOAM [4]. In the latter module, the incompressible Volume Averaged Reynolds Averaged Naviers Stokes - VARANS - equations are solved in a finite volume discretization. In order to deal with the multiphase (air, water) nature of the problem, the Volume of Fluid - VOF - method is employed, which allows using the same set of equations to solve the momentum balance in both phases, thus, speeding up the calculations. The scour protection is considered as a porous medium as performed in [2].

The current research provides an extension of the validation cases presented in [1] by further comparing the results of the numerical wave flume with the experimental results for different scour protection thicknesses (one, two and four protection layer thicknesses) in current conditions as presented in [2].

The comparison shows the robustness of the numerical model which is in good agreement with the experimental results for one, two and four layer thicknesses. In conclusion, the developed numerical current flume captures the horseshoe vortices penetrating the scour protection.

Further research will focus on the sensibility analysis of the model to different parameters of the grid (cell size in the free surface, around the pile and the scour protection) and the porous medium approach (A, B, C coefficients in the Forchheimer equation).

Acknowledgement
The first author would like, to acknowledge his FWO (Research Foundation-Flanders, project number 3G052716) PhD. funding.

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Keywords: Numerical modeling; Numerical validation; OpenFoam; IHFOAM; VARANS; Scour protection; Monopiles foundations; Wind energy

Assessment of the ecological implications when installing an SRA between Belgium and the Netherlands: An oceanographic pilot study

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In February 2004, the International Maritime Organisation (IMO) adopted by consensus the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM). The BWM requires all ships to implement a ballast water management plan by 2024. In order to anticipate on - and react to - this future situation, several governments around the world have started analyses to determine the viability of a so-called Same Risk Area (SRA). In this SRA, it is not necessary to treat the ballast water and it can be loaded and unloaded anywhere within the SRA. Ministries within the Netherlands and Belgium have taken the initiative to analyse the viability of an SRA for certain parts of their territory. The aim of this work was to investigate the possible ecological implications when such a Same Risk Area was to be installed containing the ports of Antwerp, Zeebrugge, Vlissingen and Rotterdam. The ecological impact was assessed by looking at the available biological data (biological study) in combination with hydrodynamic simulations (oceanographic study) of the sea current circulation patterns for the year 2011 in the studied region. This work presents the results of the oceanographic study.

The hydrodynamic simulation revealed that connectivity varies greatly with season and behaviour. The modelling part of the study only demonstrated a potential direct, strong and natural connection in the area of the river mouth of the Scheldt containing the ports of Vlissingen and Zeebrugge, but not the port of Antwerp. Antwerp, the only non-marine harbour, potentially showed a low unilateral connection with the other ports during the year 2011, species would be able to move from Antwerp to the other ports, but not the other way around. This oceanographic study suggest that water ballast exchange may at least increase the spreading of species or may create new connections at the scale of the studied area. The main uncertainties of this study are the absence of inter-annual variability assessment and the simplified behaviour of species in the model. Results from the oceanographic and biological studies seem to re-enforce each other.

Keywords: Ballast water management convention; Oceanographic study; Invasive species; Hydrodynamic model; Individual based model

The effect of emerging pollutants in the North Sea on fish growth: An *in silico-in vitro* approach

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Environmental risk assessment is of extreme importance to assure a safe, balanced and sustainable use of chemicals, while playing a key role in environmental regulation. However, it currently relies on ethically controversial, expensive and time-costly methods and experiments (e.g. animal testing). Moreover, quantification of chemical toxicity is commonly based on external concentrations in water, soil or air, even though it is the internal concentration in the organism that gives raise to the biological effect. Recently, a combination of *in vitro* and *in silico* has been put forward as a viable alternative to the conventional *in vivo* testing. In this study, we have applied this concept to emerging pollutants detected in the North Sea, particularly pharmaceuticals and pesticides. We assessed the effect of these chemicals on growth impairment in fish through *in silico* methods, using predicted internal concentrations of these chemicals, based on environmental concentrations. In particular, we exposed gill cells of rainbow trout (*Oncorhynchus mykiss*), RTgill-W1 cell line, to the predicted internal concentrations of each chemical and then used the *in vitro* cell growth to predict *in vivo* growth. It is our believe that the adopted methodology allows the tackling of the previously described issues related to chemical risk assessment and encourages a shift of the current paradigm.

Keywords: In vitro; In silico; RTgill-W1; Growth impairment; Pharmaceuticals; Pesticides; North Sea

Do you like the taste of algae?

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To maintain current consumption trends, the world must produce up to 50-70% more food by 2050. One promising solution to meet this increasing demand, is to consume algae or products derived from algal biomass. There are, however, some issues to be dealt with first: harvesting wild algae is mostly an unsustainable practice and the import of Asian algae often does not meet EU safety standards. Food producers, therefore, need a reliable, sustainable and predictable supply of high-quality algal biomass. Another very important issue, is that consumers want products that are tasty and safe to eat.

Within the ValgOrize project, we will therefore investigate how environmental conditions affect the production and composition of micro- as well as macroalgae and how this affects consumer acceptance.

*Funded by the European Union, Interreg 2 Seas Mers Zeeën project: Valgorize “Valorisation of algae for a better taste”.

Keywords: Algae; Biomass; Aquaculture

Revealing the trophic ecology of black corals through stable isotope analysis

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Antipatharians, also known as black corals, are colonial organisms that show a high heterogeneity in their colony morphology and polyp sizes. This morphological diversity likely sustains varied adaptations and various trophic strategies, such as variation in feeding behavior and diet composition. In some areas, black coral colonies are so dense that they dominate the community, forming black coral beds where different species co-occur. Although studies on the trophic ecology of black corals are few, they are considered to feed on zooplankton and a research, currently in progress, demonstrates that diverse species present different trophic niches, supporting the hypothesis that black corals differ in their trophic diversity. Here we are aiming to identify their diet and thus the potential diverse feeding strategies of black corals. For this purpose, we will study the stable isotopic composition of carbon, nitrogen and sulfur of black corals living in shallow waters of the northern limit of the Great Reef of Toliara, Madagascar. Tissues of black corals and three potential food sources (*i.e.* plankton, suspended particulate organic matter and benthic particulate organic matter) were sampled. Samples were collected at two sites, within the same bed, during the dry and wet seasons, in order to assess spatio-temporal variations. Further, plankton was sampled at bottom and sea surface, at night and day and categorized according to six size classes. Data generated will be analyzed using Bayesian modeling tools in R (SIAR, Stable Isotope Mixing Model and tRophicPosition) to determine the proportional contribution of food sources in the coral's diet and their trophic position. Results will reveal a new perspective on the feeding ecology of black corals, filling the numerous gaps on their trophic ecology, a knowledge that may explain how these species coexist in the same environment and that is needed to develop future conservation policies.

Keywords: Black corals; Isotope ecology; Diet; Trophic diversity

Analysis of corrosion rates on wreckage steel: A model exercise in the North Sea

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The bottom of our North Sea is studded with ship- and other historic wrecks ranging from 18th century till present times. 228 identified have been identified and 62 are still anonymous. Not surprisingly most date from the first and Second World War. These wrecks tell a story and it is important that these memories are protected. In 2013, Belgium ratified the UNESCO Convention on the Protection of Underwater Cultural Heritage and at present twelve wrecks are protected in Belgian waters. All wrecks of more than 100 years old obtain this special status automatically. However, protecting wrecks should also entail conservation for future generations. Without protection, corrosion wins and these wrecks, together with their story, will disappear. A key element enabling the selection of most appropriate preservation method is the knowledge of the actual corrosion rate.

The most appropriate model able of predict corrosion rates over a period of more than 100 years is the multiphase model of Melchers (2008). It is completely empirical and makes a distinction between the aerobic and the anaerobic phase of the corrosion process. For immersion times, the model is complex and involves a combination of aerobic and anaerobic (microbiological) corrosion processes; however, after a set and calculable time point t_s (15 years for the North Sea), the corrosion loss becomes a linear function of time:

Total corrosion loss = $c_s + (t-t_0)*r_s$

with c_s = intercept of the linear anaerobic corrosion function on the corrosion loss axis, t = time (in years), t_0 = the time period between sinking and coating failure (in years), and r_s = the apparent anaerobic corrosion rate; c_s and r_s can be inferred from actual corrosion measurements.

The Melchers model was adopted to long term North Sea conditions by changing 2 parameters being the average seawater temperature and the dissolved inorganic nitrogen (DIN) concentration. An average seawater temperature of 12.5°C was calculated based on data obtained from the Flemish Marine Institute. The anaerobic corrosion rate (r_s) is 0.053mm/year at 12.5°C without taking into account the influence of the N concentration. Melchers (2013) also provides a correction factor Rp based on the Dissolved Inorganic Nitrogen (DIN) in the sea water (set between 0.3mgN/L (OSPAR, 2017) and 1.4mgN/L (Janssen, 1993).

Rp = ratio between corrosion loss with and without the influence of microbiological activity as a function of dissolved inorganic nitrogen (DIN).

In order to subsequently validate the North Sea adaptation of the Melchers model, thickness measurements were performed on four wrecks in the Belgian part of the North Sea: the cargo ships Garden City (sunk in 1969) and Birkenfels (1966), the German WW I submarine U11 (1914) and the French destoyer Bourrasque (1941). The wrecks were chosen based on the ease of access (at 30 meters below the sea surface), and on the availability of the original construction plate thickness (data which are either lost or hidden in enclosed military archives).

Underwater plate thickness measurements were performed using a Cygnus M2-Dive with the S2C single Crystal Probe.

A preliminary analysis shows that the Melcher's anaerobic corrosion rate of 0.054mm/year (12.5°C) is overrated. A more realistic North Sea value is most probably somewhere in the neighborhood of 0.025mm/year. Moreover, MIC appears not to be involved, which corresponds with XRD and DNA analysis on historic submerged steel artefacts.

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Keywords: Corrosion rate; Historic wrecks; Multi-phase long term model; MIC; Anaerobic corrosion

Subsurface modeling and geo-archaeological mapping of the Zeebrugge area

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In the framework of the Complex Project Kustvisie (formerly known as 'Vlaamse Baaien') a pilot study is currently performed focusing on the accessibility of the harbour of Zeebrugge. The latter requires sound knowledge of the local geology. Old studies suggest the presence of a large buried palaeovalley and sandstone layers, which may cause stability and/or structural problems. At the same time, the large amount of fossil bones found offshore Zeebrugge indicates an archaeological 'hotspot'. The aim of the present study therefore is twofold: (1) obtain a detailed model of the subsurface, and (2) map the palaeolandscape evolution and archaeological potential of the area.

In a first phase a dense network of very high frequency acoustic (seismic) subbottom measurements was carried out (winter 2016–2017). Due to the widespread presence of shallow gas in the area the acoustic data only provided limited information. During a second phase, a series of cone penetration tests (CPT) and cores of up to 30 m deep were taken in the summer of 2018 (in total 26 CPTs, 9 continuous cores, 9 discontinuous cores). The continuous cores were photographed and described in detail, and sampled for a wide range of environmental analyses (a.o. pollen, diatoms, shells, C14, OSL). The discontinuous cores were sampled every 0.5 or 1 m for lithological and geotechnical analysis.

The newly obtained seismic, CPT and core data were integrated with (often very old) existing data, both offshore and onshore. This resulted in a (preliminary) 3D layer model of the wider Zeebrugge area, focusing not only on the Quaternary deposits but also on the Paleogene layers. In addition, a 3D voxel model was made with a voxel size of 50x50x0.5m. Where possible the voxels also contain geotechnical information (in addition to the lithology). Environmental analysis is currently still under way; the palaeolandscape and geoarchaeological maps will likely be available in the summer/fall of 2019.

Keywords: Subsurface model; Voxel model; Palaeolandscape; Zeebrugge

Should we trust the names of fish sold to us? An in-depth analysis of adulteration throughout the Belgian fisheries industry

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As the fisheries industry continues to aggrandise and consumers press to receive reliable and accurate product information, more rigid regulation of labelling and control mechanisms of food products throughout the fisheries industry are needed. The removal of certain deterministic traits such as fins or the head causes a major problem for accurate identification of species in fish products. In addition, fish in prepared meals or fish soup are impossible to identify using traditional methods. DNA barcoding forms a solution for these processed food products and has already shown to be successful at revealing adulteration of several fishes. This method involves amplifying and sequencing a small biomarker fragment of DNA from the samples and comparing the sequence to a reference database with sequences of known species. These databases, however, are prone to mistakes due to a lack of curators and additionally the species names used in this database are not always compendious. In this study, a reference database with COI (Cytochrome oxidase 1) and Cytb (Cytochrome b) mitochondrial genes was created to serve as a reliable platform for barcode sequences of European seafood species. This database contains voucher specimens collected across various European seas (and rivers) which are photographed and morphologically identified to species level by taxonomic experts. This ensures sequences are linked to the correct species. Thus far the database contains 81 COI sequences and 77 Cytb sequences from 24 fishes spanning 11 families, which are regularly consumed in Europe or frequently used as adulterants. Phylogenetic trees and the distribution of intra- and interspecific P-distances show these genes' strengths as barcoding sequences. COI displays a clear barcoding gap and indicates that using a threshold of 2 to 5.2% divergence will give a 100% correct species identification. Cytb displays some overlap between species, but still indicates that a threshold of 4.5 to 4.6% divergence will give an error rate of 0,18% which is well within a 95% confidence interval. Most adulteration studies have focused on the end point of the food chain. Our approach is to assess more precisely where and how adulteration takes place along the whole food chain. For this, we will thoroughly map out all steps in the fish processing chain. Once we have a clear overview of the different steps we will sample a selected number of fishes at various points along the supply chain. *Gadus morhua* and *Solea solea* are consistently among the most preferred fishes for consumption by Belgian consumers and are consistently among the most landed fish. Both fishes are also expensive, making them prone to adulteration. In addition, there is a substantial amount of imported fish in Belgium, especially of round fish, which are suspects to be adulterants of cod. The application of DNA barcoding will unveil the prevalence of fishery product adulteration in the Belgian market and the factors influencing adulteration (such as times transferred, type of supplier, distance from ocean, price or processing type) of fish products in the Belgian market.

Keywords: Seafood; Adulteration; Fraud; Authentication; Traceability; DNA barcoding; COI; Cytb; Reference database; Fish; Cod; Sole; Fisheries industry

Genetic diversity of the mud crab *Scylla serrata* in Indonesian coasts

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The mud crab Scylla serrata is an important commodity in commercial fisheries in the Indo-West Pacific and especially in Indonesia. Increasing exploitation rates and mangrove degradation are threatening S. serrata in Indonesian coasts. Therefore, genetic diversity of S. serrata populations in relation to this decrease of mangrove area will be investigated at three sample sites in the western, central and eastern region of Indonesia. Tissue samples (pleopods) of S. serrata individuals from three sampling sites were collected and preservation in 99 % ethanol. Analysis will be performed through DNA extraction and PCR in order to amplifify and sequence a fragment of the mitochondrial DNA cytochrome oxidase subunit I (COI) gene. Data analysis will be performed by making a sequence alignment with the program MEGA7 and DNA barcoding. Further analysis will estimate the genetic diversity of these three S. serrata populations and determine if they are genetically different. The preliminary results include that a successful PCR protocol was established for the amplification of COI with species-specific primers.

Keywords: Genetic diversity; Mangroves; Indonesia; Polymerase chain reaction; *Scylla serrata*

Drone technology in support of suspended sediment mapping, test case at the Prins Hendrik dike in Texel (NL)

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A pilot test case at the Prins Hendrikzanddijk project in Texel, the Netherlands, was organized end October 2018 to demonstrate drone technology for water quality monitoring. A new dune area seaward of the existing dike is created, which takes over the coastal protection function of the existing dike and combines it with nature development, public services and recreational appeal. For the demo an octocopter drone platform, Altura Zenith ATX8, was used with a multispectral camera, MicaSense RedEdge M, underneath. During drone flights, a base station shows real-time information on the location of the drone, a projected true-colour image captured by the camera and the position of neighbouring boats through Automatic Identification System (AIS). Thanks to this information it is easy to adapt flight missions according to the situation. The drone data were processed with dedicated software into Total Suspended Solids (TSS) maps. This independently from in-situ observations. Water samples, collected simultaneously with drone flights were used for the validation of the derived products.

Keywords: Drone technology; Optical sensor; Water quality

ScaldisCoast: An unstructured next generation integrated model for the Belgian Coastal Zone

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Historically, coastal modelling tools often relied on finite difference and finite volume based numerical methods on structured grids, e.g. Delft3D, XBeach, SWAN, etc. From a numerical point of view, these methods are robust, reliable and relatively fast. However, they lack the flexibility of applying locally high resolution in the area of interest, or to model complex geometries in an efficient way. In general, building the grid is time consuming and once a schematization is build, any adaptation of the grid requires serious effort, which makes it more difficult to implement complex shaped scenario analyses.

The last decades more advanced numerical schemes find their way into the world of environmental modelling in general and hydrodynamic modelling in particular. These schemes allow for unstructured triangular and quadrilateral based schematizations. TELEMAC-MASCARET is such an open source finite element based model suit. In the present study, we use the TELEMAC2D module to develop an unstructured hydrodynamic coastal model for the Belgian Coast and Western Scheldt, referred as the ScaldisCoast (ScaldisKust) model.

For the construction of the grid an advanced grid generator, GMSH, developed by the Université Catholic de Louvain-La-Neuve has been used (Geuzaine & Remacle, 2009). GMSH allows for automatic refinement near complex geometrical structures like ports and breakwaters, but also based on the bathymetry gradients, leading to higher resolution near steep slopes of the bottom. It also allows for an efficient accurate representation of sand banks and gullies. The resulting grid consists of a broad range of element sizes going from kilometres offshore to a few meters nearshore. GMSH automatically optimizes the grid for orthogonality and aspect ratios. For complex shaped scenarios, GMSH is capable of automatically adapting the model to the new local geometry or bathymetry.

On the same model domain and grid, a TOMAWAC model for wave propagation is developed. Recently the two models have been coupled. However, since the wave model and the hydrodynamic model require different grid properties, it is under investigation if the models can be coupled without sharing identical grids, allow for more efficient computing.

Finally, the TELEMAC2D – TOMAWAC models are coupled to the sediment transport model SISYPHE in order to model sediment transport and bottom evolution along the Belgian Coast. Since the TELEMAC-MASCARET model suit is open source, this allows us to implement new transport models, e.g. those derived by the CREST research program, into the software.

Keywords: Coastal Modelling; Unstructured grids; Belgian Coast

Effect of climate change on the microbiome of the blue mussel

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Marine environments are being threatened by global change. Increased atmospheric CO_2 concentrations lead to global warming on the one hand, and on the other hand to a decrease in ocean pH. Moreover, marine coastal areas are increasingly used for the production of marine renewable energy, mainly by installing offshore wind farms. As such, artificial hard substrates are being introduced in areas that are otherwise characterized by sandy sediments. These artificial hard substrates are being colonized by a fouling fauna: for instance, the bivalve *Mytilus edulis*. They can serve as a predictable and resource-rich surface for microbial communities and are to be considered as biogeochemical hotspots in the aquatic environment producing considerable amounts of N_2O, and in this way affecting the N-cycle. N_2O is considered a highly potent greenhouse gas, and thus also contributing significantly to global warming. In the PERSUADE project (BELSPO) 16S rRNA gene sequencing will be conducted to detect and identify these N_2O producing sources in biofilms associated with the shell of the mussel. The microbiome and some functional genes will be screened between the current natural situation and acidified and warmer conditions, and a combination of both. In this way, we can try to predict if climate change has an influence on the bacterial composition of biofilms and if this change in composition may have an effect on the N-cycle. Preliminary results show that the microbial communities present in the microbiomes of the mussels, and the denitrification rates, differ between the control and all climate change treatments. These results indicate that climate change may influence the N-cycle and may have an impact on the production of an important greenhouse gas. The new hard substrates created by offshore wind farms in the North Sea may thus influence communities and nutrient cycles more than previous expected.

Keywords: Offshore wind farm; Microbiome; Climate change; N-cycle

Seabed impacts after mechanical disturbance by beam and pulse trawls in two North Sea experiments

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Flatfish live in, at or near the seabed. Commercial bottom trawl fisheries that target these fish species require close contact with the sediment to increase their encounter and to avoid their escape from the trawl. Close seabed contact is insufficient in itself to result in high flatfish catches. The flatfish-directed trawlers further stimulate flatfish by tickling the flatfish using tickler chains (beam trawls) or by using electricity (pulse trawls). The catch stimuli are distinctly different and so we hypothesized that the expected mechanical impacts and abrasion of beam trawls is distinctly different from pulse trawls. Two Before-After Control-Impact (BACI) experiments were conducted in sandy sediments to compare the mechanical disturbance to the seabed for both gears. The results showed, indeed, that beam trawls penetrated deeper into the sediment than pulse trawls (4.1 cm vs 1.8 cm). The penetration was estimated as a combination of the resuspended sediment and the depth of the disturbed sediment layer assessed from Sediment Profile Imagery (SPI). Sediment resuspension was similar for both gears, as it was primarily caused by hydrodynamic drag of towing the trawl net through the water rather than the different catch stimuli. We assigned the difference in penetration entirely to the gear elements that are in close contact with the seabed, i.e. the tickler chains and the electrodes. The increased penetration depth of beam trawls further caused other differences in seabed impacts. The sediment grain sizes were reworked into deeper layers (up to 4 cm depth) by beam trawls than by pulse trawls (~1 cm). The bathymetrical profile was consequently flattened to a greater extent, trawl tracks were deepened more (beam trawls: 1.5 cm vs pulse trawls: 0.7 cm) and the oxygenated layer, reflecting benthic life, was disturbed deeper and did not recover with the duration of the experiments (~48 h). We conclude that these experiments have quantified the more profound mechanical effects of commercially deployed beam and pulse trawls in a coastal and in an offshore fishing ground. The implication of these findings suggest a decreased seabed effect of pulse trawling as opposed to beam trawling, but its interpretation requires caution when extrapolated to fleet level. Extrapolation requires that the variation in sediment and gear characteristics are compared to the sediment and gear types used in our experiment, and that this variation is accounted for when assessing seabed impacts at ecosystem (or fleet) level.

Keywords: Beam trawl; Biogeochemistry; Habitat impacts; Particle size distribution; Penetration depth; Pulse trawl; Seafloor integrity; Sediment resuspension

North Sea Wrecks – a future decision support tool for blue growth activities

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Throughout history, all kinds of military operations played out on, near or above the North Sea. As a result, the North Sea is littered with remnant wrecks and munitions from naval and air battles, munition dumps, minefields, aerial bomb ditching, training maneuvers, and shipping accidents. The presence of toxicants, such as the chemical constituents of explosives and hazardous cargo such as bunker fuel, left inside these deteriorating objects may endanger both the environment and citizens working on or living near the sea. With the growing number of economic activities in various parts of the North Sea, interactions with wrecks and munitions are expected to increase. During operations at sea, like dredging, cable laying or pile-driving etc., there may be a risk of encountering munitions or inadvertently damaging shipwreck compartments that hold hazardous cargo through direct and indirect contact (e.g. vibrations). This can also affect the heritage value of certain shipwrecks. Yet, despite these hazards and the transnational nature of the blue growth activities in the North Sea, there is currently no universal strategy or approach to assess and mitigate the risks posed by wrecks and (associated) munitions. To date, only fragmented risk mitigation actions exist at the national level.

The North Sea Wrecks project, which is being funded under priority 3 of the Interreg North Sea Region program, intends to develop and provide new tools to marine spatial planners, response organizations, economic actors and other stakeholders to assess and propose solutions for risks related to wrecks and munitions in the North Sea. Nine partners from five North Sea bordering countries - assisted by an advisory board of public authorities for maritime safety and planning, scientists and private companies dealing with wrecks and UXO (UneXploded Ordnance) - have committed to (1) investigate and describe nationally fragmented data sources on wrecks, cargo and munitions, (2) develop a comprehensive risk assessment methodology for wrecks and munitions in the North Sea, based on VRAKA – a probabilistic risk assessment method for potentially polluting wrecks in the Baltic (Landquist et al., 2016) – , and (3) deliver recommendations to policy makers and Blue Growth entrepreneurs as a first stepping stone towards improved transnational collaboration. The project will combine archival research with in situ hazard and exposure assessments, toxicological studies, and (GIS-based) ecosystem impact assessments. A travelling exhibition will present results of the project and will contribute to the sensibilisation campaign.

Keywords: Wrecks; Munitions; Pollution; Risk assessment

Hydrodynamic modelling of wave-structure interaction processes using OpenFOAM

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Numerical tools such as boundary element methods based on linear potential flow theory are frequently used for simulating floating structures: wave energy converters or dredging and offshore installation vessels for example. At this moment, non-linear viscous models such as the open source computational fluid dynamics (CFD) toolbox OpenFOAM are very popular amongst academic researchers. During the last years, the marine industry is showing an increasing interest in using CFD models for designing structures or optimising installation processes.

The PhD work of Brecht Devolder [1] is an academic example of recent developments in OpenFOAM for the marine, offshore and coastal engineering sectors. Fundamental research and thorough modelling resulted in (i) more accurate results by developing and implementing enhanced turbulence models for two-phase free surface flows [2,3] and (ii) accelerated simulations by developing a novel coupling algorithm between the motion of a floating structure and the flow field around it [4]. This coupled model is applied, for the first time ever, to simulate an array of nine individual heaving point absorber wave energy converters subjected to regular waves [5].

Currently, a research project is running between KU Leuven (campus Bruges) and the DEME group, and focusses on CFD simulations of realistic floating structures using OpenFOAM. Further developments are related to the use of overset meshes, multiple degrees of freedom motions, mooring lines and combined wave-current simulations. All the developments presented need thorough verification and validation and are required to open up the possibility to perform CFD simulations of any coastal and offshore structure with reasonable calculation times or to optimise their design and efficiency.

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Acknowledgement
Brecht Devolder is postdoctoral researcher at the department of civil engineering at KU Leuven, campus Bruges. His two years research project is a collaboration between KU Leuven and DEME and is funded by the agency Flanders Innovation & Entrepreneurship (VLAIO) and DEME.

Keywords: Numerical modelling; CFD; OpenFOAM; Floating structures

Cultivating extremophilic microalgae *Galdieria sulphuraria* on urine for production of high-value pigment C-phycocyanin

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Urine contributes as a mere 1% of the total volume that an average household discharges as wastewater. However, urine contributes up to 80% of the nitrogen and 55% of the phosphorus in domestic wastewater. Offering an economical incentive to separate and reuse urine from urban sewage may significantly reduce loading of nutrients into wastewater treatment plants and subsequent surface waters.

As part of the New Energy and Resources from Urban Sanitation (NEREUS) project, this research intends to study a new pathway to reuse urine for the production of a high-value compound. Thermoacidophilic microalgae Galdieria sulphuraria was chosen for its production of C-phycocyanin, a versatile pigment of high value with thermostable properties, in addition to its affinity for extreme culture conditions. This research-in-progress will study under which conditions G. sulphuraria is able to grow on urine derived medium and whether an interesting amount of C-phycocyanin can be produced.

Keywords: Biotechnology; Microalgae; Wastewater; Nutrients; Circular economy; Extremophile; Urine; NEREUS; C-phycocyanin; *Galdieria sulphuraria*

Investigate monthly morphological parameters and meteo-marine forcing factors on a multibarred beach

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Many sandy beaches around the world bear intertidal bars. These sand bars are a series of parallel troughs and crests on the intertidal part of the beach. The amplitudes, heights, and number of the bars vary greatly between different settings, and their morphodynamics are not fully understood yet. However, these bars may represent a first defense against the erosion of the beach, and their complete understanding is therefore crucial in coastal management. The aim of this study is to identify the key parameters in the determination of the monthly morphodynamics of a multibarred beach.

RTK GPS profiles taken along five cross-shore lines at Groenendijk (Koksijde, Belgium) were analyzed to extract the most relevant parameters to study the monthly changes and the evolution of the intertidal bars. The profile points were first tested to determine the best preprocessing method: reprojection of the points onto a fixed profile axis and interpolation techniques were evaluated.

Several morphological parameters describing intertidal bars and beach morphology, such as sand volume, bar position, and distance between bars, were calculated using the profile points. Their ranges of monthly change were then used to determine which ones were significant to describe the bar behaviour. Further statistical analysis was then applied to investigate these parameters. Meteo-marine forcings, such as wave and current parameters, were evaluated between studies.
Results indicate that sand volume is not an appropriate parameter, at least for this study site and at this time scale: its monthly evolution is lower than the mean measurement error. Also, the number of bars can't be reliably determined due to differences in length between all profiles. However, other parameters such as distance between crests, or bar asymmetry, display significant changes from month to month.

The determination of monthly evolution at Groenendijk beach is part of a BELSPO-funded project named Remote Sensing data for investigating the morphodynamics of the Belgian multi-barred macro-tidal beach (RS4MoDy). It combines camera drone surveys and historical airborne LiDAR and orthophotos to assess the morphodynamics of the zone from short-term to long-term. The final goal of this project is to produce a conceptual model of barred beach morphodynamics at many different time scales, from event to yearly evolution.

Keywords: Barred macrotidal beach morphodynamics; RTK GPS beach profiles; Storm event; Dune-beach system

Risk assessment of microplastics in the ocean

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The presence of microplastics in the marine environment has been an issue of concern for over a decade now, but their environmental risk in the ocean have, to date, not been addressed and quantified. The environmental risk assessment of microplastics presented here quantifies, based on a regulatory framework for assessing environmental risks of pollutants (i.e. REACH), safe concentrations for the marine pelagic and marine benthic compartment. Above these safe concentrations adverse biological effects are likely to occur. At most locations, the *in situ*concentrations in the upper pelagic compartment remain below the safe concentration (6650 particles m-3). However, local exceedances of this threshold are already taking place in sites that are heavily polluted with buoyant microplastics. In addition to the pelagic phase, also inshore, harbour and beach sediments are of concern. As human populations continue to grow, and if our dependence on plastic does not change under a business as usual approach, we may expect a steady and substantial increase in microplastic concentrations in both the pelagic and benthic marine environment. Adverse effects of microplastics are to be expected on highly polluted beaches and in coastal ecosystems as of the second half of this century if plastics emissions are not reduced.

Infographic: http://www.vliz.be/imisdocs/publications/319070.pdf

Keywords: Microplastics; Ecological effect; Ambient concentrations; Simulations

Genetic variation of the mud crab *Scylla serrata* in relation to heavy metals pollution in Indonesia

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The Mud Crab *Scylla serrata* is the most important commodity of commercial fisheries in Southeast Asia and the South Pacific. Its market price is high compared to the other commodities, due to its good meat quality and impressive size. Its high abundance and easy cultivation method make *S. serrata* trade one of the busiest markets with increasing exploitation rate from 26,628 tons in 2008 to 33,910 tons in 2012. *Scylla spp*. are widely distributed in the mangroves of Indonesian. Unfortunately, the areas are suffering from the thriving coastal development, such as aquaculture, industrial and tourism activities. One major threat is heavy metals pollution as the result of poor wastewater treatment and management. At a cellular level, the exposure of mutagenic pollutants to *S. serrata* tissue might lead to chromosomal aberrations and gene mutations. The varied alteration due to the different degree of heavy metal pollution might lead to a noticeable physiological and morphological alteration that will interfere with the *S. serrata* fisheries. These genetic interferences lead to genetic diversity alteration by changing *S. serrata* population size and age structure.

The objectives of this study are (1) to determine the genetic variation and heavy metal concentration of S. serrata and (2) to define the correlation between those two parameters in different Indonesian mangrove ecosystems. Five sample sites were chosen to represent different degrees of heavy metals pollution. Thirty individuals and 100 grams of sediment samples were collected from each location. Pereopod tissues were preserved in 96 % of ethanol for molecular analysis. As for heavy metals analysis, the cheliped tissues and sediment samples will be dried in the oven (50 °C) for 4 days. Genetic variation will be analyzed by Polymerase Chain Reaction (PCR) using the mitochondrial DNA cytochrome oxidase subunit I (COI) as the marker. Genetic variation indices will be determined using the software Arlequin. Heavy metals concentration analysis will be carried out using Sector Field Inductively Coupled Plasma Mass Spectrometer (ICP-MS). The degree of contamination will be calculated using a biota-sediment bioaccumulation factor (BSAF) and metal pollution index (MPI). Correlation between genetic variation and heavy metals concentration will be determined by performing a Spearman's rank correlation test. The degree of genetic variation and its correlation with pollution in the different locations is expected to answer a question of decreasing size of wild catch crab in a highly polluted area. If this is happened to be the case, it is an urgent call for developing a better wastewater treatment and management plant in the affected locations.

Keywords: *Scylla* serrata; mtCO1; Heavy metals

Understanding the biodiversity and evolutionary history of the amphipod genus *Eusirus* in the Southern Ocean

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The diversity of the Antarctic marine fauna has been shaped by various evolutionary processes (dispersals, diversifications, extinctions), which were greatly influenced by the geological and climatic history of the region. Some Antarctic lineages are descendants of Gondwanan ancestors and arose by vicariance during the progressive breakup of Gondwana, which ultimately led to the complete geographical isolation of the Antarctic continent. The Plio-Pleistocene glacial cycles have been inferred to act as a “diversity pump” on the Antarctic continental shelf. Allopatric speciation of less dispersive organisms could have resulted from the isolation of populations in ice-free refugia during the glacial advances. These glacial cycles were often suggested to have influenced the diversification of numerous complexes of closely related and morphologically very similar Antarctic species. The continuous discovery of such (pseudo-) cryptic species in the Southern Ocean suggests that its biodiversity is currently greatly underestimated. Such species complexes have been found in the amphipod genus *Eusirus*. In a preliminary phylogeny (COI and 28S) of the whole genus, some Antarctic nominal *Eusirus* species are composed of genetically distant clades, suggesting putative new species. In this study, we will sequence complete mitochondrial genomes, using a combination of skim sequencing and long-range PCRs of different *Eusirus* species, to which sequence data from nuclear (28S, ITS2) will be added. By greatly increasing character sampling as well as taxon sampling (including Antarctic and non-Antarctic species) compared to preliminary studies, we intend to reconstruct a robust phylogeny of the genus. Based on this DNA dataset and the phylogeny, we aim to (1) provide a better estimate of the actual diversity within the genus, using various DNA-based species delimitation methods (GMYC, PTP, 4 theta rule and ABDG) and; (2) provide a better understanding of their evolutionary history: where does the Antarctic clade come from? Did *Eusirus* species disperse in and/or out of the Antarctic shelf at any time of their evolutionary history? Were there periods of increased diversification during their evolution on the shelf and how do these relate to the geological/glacial history of the region?

Keywords: Evolutionary history; Biodiversity; Southern Ocean; Amphipoda; Eusirus

Rapid ecosystem services assessment & conceptualization of conservation effectiveness in Pendjari Biosphere Reserve, Benin

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Despite increasing public awareness and inclusion into both academic and policy spheres, natural ecosystems and the services they provide are under intense and widespread pressure. Humans have dramatically altered ecosystems worldwide, hindering the ability of these systems to deliver provisioning, regulating, supporting and cultural services. The Millennium Ecosystem Assessment (2005) found that over 60% of ecosystems are either degraded or transformed, resulting in substantial economic growth for some and the exacerbation of poverty for others. While all humans depend on the four of ecosystem services for their livelihood and well-being, it is understood that rural people living in developing areas have a greater reliance on natural resources and are therefore more susceptible to negative impacts associated with transformation and degradation. In 2015, the United Nations released a set of 17 Sustainable Development Goals which aim to alleviate poverty and safeguard human well-being for the world's poorest while protect the environment and the essential services it delivers.

The Pendjari Biosphere Reserve (PBR) lies in extreme north-western Benin, was designated as a UNESCO Man and the biosphere reserve in 1986. The Biosphere Reserve and is of great ecological, scientific and cultural importance but is not immune to the global trend of ecosystem degradation and transformation; 37. 4% of the population lives below the poverty line but those living near the national park are among the poorest in the country. The economy is agrarian-based, mainly sustenance-based, and the growing population (2.8%/year) drives the conversion of grassland into agricultural fields. Understanding the threats and temporal trends of ecosystem services in the PBR is essential for the sustainable management of natural resources.

This study examines the threats to and temporal trends of ecosystem services in the Pendjari National Park through use of the Nominal Group Technique (NGT). Additional objectives of this study include an assessment of changes following a recent management shift (2017) and an assessment of the utility of the NGT as a tool in conservation. The NGT is a focus group variation that consists of individual brainstorming following by group discussion and ranking, yielding both qualitative and quantitative results. Each group exercise thus consisted of three parts: identification of threats, trends and changes to management following the privatization of the park. Results were coded according to the "drivers, pressures, states, impacts and responses" (DPSIR) cause-effect chain framework developed by the European Environment Agency (EEA) to describe complex interactions between society and the environment.

Keywords: Natural resource management nominal group technique; Ecosystem services; Nominal group technique; DPSIR

Differential effects of resource diversity on taxis to food, population growth, and interspecific interactions of cryptic marine nematode species

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Resource partitioning has been central for understanding the dynamic changes of species composition and coexistence in biological communities. Based on the principle of competitive exclusion, species occupying the same ecological niche cannot coexist for a long time due to strong interspecific competition for resources. The approach to reduce competition is to diversify niches, for instance, through resource partitioning. This may seem unlikely for cryptic species, i.e., morphologically (nearly) identical but genetically different species, but previous investigations have shown that these closely-related species differ in ecological characteristics and may exhibit differential food preferences. However, the importance of resource diversity in facilitating coexistence of cryptic species remains poorly understood, particularly in marine ecosystems. Nematodes are one of the most abundant and species-rich taxa in marine environments and may play significant roles in ecosystem processes such as benthic mineralization and organic matter decomposition. They can perceive many attractive and repellent chemical cues in the environment, among others emanating from their food, which can be important in their foraging, reproduction and survival strategies. Litoditis marina is a bacterivore nematode species complex associated with macro-algae, with four cryptic lineages (Pm I-IV) that are often found to co-occur in the field. Here, we investigate food preference in the four cryptic species (Pm I-IV) of L. marina using taxis (i.e. a directed movement)-to-food assays, and explore population growth in monospecific and interspecific treatments (using qPCR) under different levels of resource (bacteria) diversity.

Keywords: Cryptic species; Coexistence; Resource partitioning; Resource diversity; Nematodes

mtDNA enrichment from preserved samples for meta-genomic skimming

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Genetic assays become increasingly common in biodiversity monitoring programs. An often used tool is metabarcoding of multi-species samples. The core of this concept is to amplify (using polymerase chain reaction: PCR) and to sequence a short piece of the genome. A common issue with this approach is that the primers do not perform equally well in different phylogenetic groups, making it difficult to quantify the relative abundance of species in bulk. Sequencing all available DNA in a sample without prior PCR would circumvent this problem, but such high-throughput sequencing can still be expensive. A cost-effective middle-way is to enrich mitochondrial DNA (mtDNA) using differential centrifugation and to sequence meta-mitogenomes. Successful mtDNA enrichment has been demonstrated on fresh samples, but access to such material is often difficult in marine sciences, where samples are collected on research vessels, often in remote corners of the world. We therefore tested a protocol that starts from frozen samples and samples preserved in EtOH and DESS. Our results show that freezing does not substantially impede mtDNA enrichment, making meta-mitogenomics an attractive method for marine biodiversity assessment.

Keywords: Biodiversity; Monitoring; Genetics; Molecular ecology; Barcoding

Long-term health monitoring and survival rates of skates (*Rajidae*) caught as bycatch

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One of the main aims of the INTERREG – 2 Seas project "SUMARiS" (Sustainable Management of rays and skates) is to quantify vitality, injury and survival rates of four different skate species (thornback ray - Raja clavata, spotted ray - Raja montagui, undulate ray - Raja undulata and blonde ray - Raja brachyura) discarded by English Channel and North Sea active and passive gear fisheries. During seatrips on-board of Belgian commercial beam-and ottertrawlers, skates were randomly selected from the catch and evaluated for vitality, reflex responsiveness and extent of injury using the Reflex Action Mortality Predictor (RAMP) method. A selection of these sampled rays was monitored ex situ for a 3-week period. During this period, survival and health parameters were monitored, such as weight development, spiracle opening rate per minute, burying behaviour, etc. The results of the first trip with an ottertrawl showed an immediate at vessel mortality of 5.7% (n= 209) and a delayed mortality of 50% (n=8) after the 3 week monitoring period. The skates that died during the 3-week period, showed an average weight loss of 8 %, while the skates that survived gained an average weight of 6%. Looking at the results from the first beam trawl trip, a delayed mortality of 40% (n=20) was observed. From the total of the 8 deceased rays, 4 rays belonged to vitality class C (= "poor"), and 4 to vitality class B (= "good/fair"). A weight loss of 4.8% (n=12) was observed for the surviving skates, while the control skates had a weight gain of 4.8% (n=5). During the 3 week monitoring period, the spiracle movement rate was on average 25.42 per minute and showed no difference between the vitality classes. The control skates had an average spiracle opening rate of 31.4 per minute. The immediate and delayed mortality percentages which have been calculated are in line with previous research which showed that immediate mortality was generally lower than the delayed mortality (Schram & Molenaar, 2018). The spiracle opening rate of the control rays is in accordance with the mean of 30 openings per minute reported by Hughes (1959), while test rays seem to have a slightly lower rate (~25/min). Our study also shows that a sufficiently long monitoring period is necessary to allow the delayed mortality to asymptote. Further analysis of the data will show the effects of different environmental, technical and biological factors on both types of mortality using modelling in R statistical software. The outcomes of this thesis will deliver important insights for (inter)national decision makers and fishery managers on whether an exemption on the landing obligation should be granted for these skate species.

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Keywords: Landing obligation; Discard mortality; Survival; Elasmobranches; Bycatch

Investigating the genetic diversity and connectivity of giant mangrove crab *Scylla serrata* (Forskal, 1775) inhabiting mangrove swamps in Indonesia

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The giant mangrove crab *Scylla serrata* (Forskal, 1775), which is closely associated with mangrove forest, is one of the highly valued fishery commodities in Indonesia and is abundantly present throughout this region. However, the increasing human population and demands lead to unsustainable exploration and unsuitable management of mangrove forest, which is the primary habitat for *S. serrata*. The degradation of mangrove swamp might lead to declining crab populations and even threaten its existence. The relatively long pelagic larval duration (PLD) enables the planktonic larval stage of *S. serrata* to disperse as far as 1500 km, depending on the current. Thus, the currents and tides are crucial in determining the recruitment of larvae into an adult population. Knowledge of these patterns of connectivity is useful for fisheries management.
In order to analyze the genetic diversity and connectivity of giant mangrove crabs, a fragment of the mitochondrial cytochrome oxidase subunit I gene (COI) will be used. Another approach to achieve a better resolution of the genetic structure of *S. serrata* is using both mitochondrial and microsatellite DNA markers. In addition, the connectivity of giant mangrove crab between the population in Indonesia and East Africa might be worth to investigate.

Sampling in the main islands of Indonesia was done from September to October 2018 and photo of every individual captured as a reference. As the preliminary step of the molecular genetic investigation, DNA extraction and amplification performed and amplicon intensity checked with gel electrophoresis. DNA sequencing will be carried out in the near future.

Keywords: *Scylla serrata*; Pelagic larval dispersal; COI; Microsatellite; Connectivity

Environmental DNA, an emerging tool to predict the potentiality of nature inspired designs and oyster reef restoration: A Coastbusters case study for oyster reefs construction in the Belgian part of the North Sea

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Ecological engineering uses natural processes and materials to resolve environmental challenges by restoring ecosystems and creating opportunities for nature. Ecosystem functions fulfilled by such nature inspired designs are next to coastal defence and shoreline stabilization, also provision of breeding and nursery habitats. Challenges at hand for the creation or restoration of native oyster reefs are understanding the natural oyster spat availability and hence, its colonisation capacity and the presence of *Bonamia ostrea* oyster disease in Belgian waters. Within the Coastbusters project, which is used as a case study, the use of artificial oyster reefs as an innovative bio-stabilization method is being investigated for application in the Belgian part of North Sea (BPNS).

Previous studies revealed that *Ostrea edulis* (Linnaeus 1758), commonly known as European flat oyster, is the only indigenous oyster in BPNS. However, only modelling data (from Royal Belgian Institute for Natural Sciences) is present on the spatio-temporal spat availability of oyster spat in Belgium. Therefore, the present study will analyse historical water samples from 2000-2010 for environmental oyster mtDNA (eDNA) which will allow us to produce a BPNS eDNA presence map that relates to spat density and the presence of native oyster individuals. To validate the viability of artificial oyster reefs, also the presence of the *Bonamia ostrea* oyster disease (SSU rDNA) in eDNA of the historical water samples will be researched. Preparatory lab experiments on detection sensitivity, primer selectivity and lifetime of eDNA in seawater will support the protocol for oyster mtDNA and *Bonamia* SSU rDNA detection in seawater samples.

Therefore, this innovative eDNA approach will be the cornerstone of oyster reef restoration feasibility and will directly contribute to the Coastbusters development projects.

Keywords: eDNA; Bivalve reefs; Coastbusters; *Ostrea edulis*; *Bonamia ostraea*; Ecosystem services; Coastal resilience

What are the boundary conditions to implement nature-inspired coastal defence solutions? A Coastbusters blueprint comparison between Europe and Bay of Bengal

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Ecological engineering uses biobuilders, natural processes and materials to resolve environmental challenges by restoring ecosystems and creating opportunities for nature. Incorporating nature in engineering design results in resilience and adaptability. New ecosystem services are created benefiting coastal defence, shoreline stabilization, biodiversity and provision of breeding and nursery habitats, but also potential food supply or recreational activities. The ongoing industrial research Coastbusters project aims to unravel the required boundary conditions necessary to facilitate reef building to bio-stabilize natural accretion of sand and reinforce the foreshore against coastal erosion.

The specific hydrodynamic, biological and chemical features of such biogenic reef system and the surrounding area should be identified correctly. Hence, adequate site of interest can be selected to deploy structures inducing biogenic reefs. For this study, two broad coastal regions are selected as potential application field: temperate Europe and tropical Bay of Bengal. A comparative study between them will generate a set of boundary parameters and basic design conditions necessary to evaluate potentials of the concept at any coastline worldwide. Several case-study sites will be selected on the basis of their typifying conditions and need for erosion protection. The results will take into account the site-specific boundary conditions, but also the reef biobuilder species-specific habitat constraints.

The outcomes of the project work will provide the scientific communities with a set of measurable tools to predict locations where artificial biogenic reef could be of use as alternative nature based coastal protection scheme. Moreover, a blueprint will be rolled out to reach out to policy makers to choose a more sustainable source of marine ecosystem services as part of local coastal zone management in developed and developing countries.

Keywords: Coastbusters; Ecological engineering; Nature Inspired Design; Coastal erosion; Blueprint; Biogenic reef; Europe; Bay of Bengal

Genetics for conservation and fisheries: Population structure and connectivity of *Octopus mimus* along the Peruvian coast

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The Peruvian marine ecosystem is considered as one of the most productive in the world. Therefore, it is important for fisheries locally and globally. *Octopus mimus* is one of the main benthic resources in artisanal fisheries along the Peruvian coast, being important for local and international markets. The species *O. mimus* is distributed along the Southeast Pacific Ocean from northern Peru to central Chile. However, regarding recent studies, the distribution of this species is not yet fully known. *Octopus mimus* has been related to *O. hubbsorum*from Mexico, probably being the same species, and some individuals in Ecuador were genetically identified as *O. mimus*. Therefore, there could be only one population along the east Pacific coast or different metapopulations.

The biological traits of *O. mimus*, such as pelagic and benthic life stage, makes it a good model for connectivity research. One of the aims of a Marine Protected Area (MPA) is to preserve the demographic connectivity and *O. mimus* is considered for conservation in three MPAs in Peru. The connectivity processes influence the genetic structure, persistence and maintenance of genetic diversity. Due to this, it is important to ensure the connectivity of *O. mimus* populations. To achieve this aim, we will analysis the population structure using the mitochondrial cytochrome C oxidase subunit 1 (COI) gene and microsatellites as markers.

Arm tips of 168 Individuals of *O. mimus* were collected from fishermen at seven sites along the Peruvian coast. DNA was extracted using the salting-out method and PCR was done using universal COI primers (HCO2198 and LCO1490). The DNA sequences will be analysed in order to determinate whether there is gene flow among *O. mimus* populations and to provide basic information to assess octopus fishery and improve the management of MPAs in Peru.

Keywords: COI; Marine Protected Areas; Gene flow; Genetic structure

Data archeology in the framework of a long-term Kenya Belgium Cooperation

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The "Kenya-Belgium Cooperation in Marine Sciences" or KBP was initially launched in 1985 as collaboration between the Free University of Brussels (VUB) and the Kenya Marine and Fisheries Research Institute (KMFRI) under the supervision of the late Prof. Dr. Philip Polk. In 2012, this long lasting collaboration resulted in a formal "Memorandum of Understanding" (MoU) between the Flanders Marine Institute (VLIZ) and the Kenya Marine and Fisheries Research Institute (KMFRI). This MoU aims to promote further partnership in the field of marine sciences between Belgium and Kenya (in a coordinated way). One of the activities within this MoU is the recovery of data resulting from marine research in Kenya.

The Kenya-Belgium data collection currently includes about 111,800 biotic observations on benthos, algae, fish, zooplankton, phytoplankton, birds and mangroves which cover more than 400 unique locations that were sampled between 1873 and 1999. The dataset provides a better insight into the different types of research conducted between 1985 and 1996 in framework of the "Kenya-Belgium Cooperation in Marine Sciences (KBP)" and can facilitate further coastal biodiversity research in Kenya.

The Kenya-Belgium data collection is online available through the LifeWatch portal (http://www.lifewatch.be/en/marine-data-archeology) and can be assessed through the Integrated Marine Information System hosted at VLIZ.

http://www.vliz.be/en/imis?module=dataset&dasid=5821

Keywords: Data archeology; Kenya; Marine; Historical datasets; Biodiversity

Analysis of genetic stock structure and connectivity of the sea snail *Thaisella chocolata* (Duclos, 1832) along the Peruvian coast for sustainable fisheries management

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Thaisella chocolata (or 'caracol negro' in Peru, 'caracol locate' in Chili) is considered in Peru as a species of commercial importance. For the period January/February 2018, *T. chocolata* represented 32.5 % of the total invertebrate landing at the harbour of Callao (Lima). Despite this, not much is known about the state of its populations. The analysis of the genetic connectivity among those can be a first step to manage the stock efficiently. In this study the mitochondrial DNA COI and perhaps microsatellites will be applied on populations from four sampling locations along the Peruvian coast. *Thaisella chocolata* is a mollusc of the family of the Muricidae, living on rocky substrate along the Peruvian and the Chilean coast. The species has a long pelagic larval phase and the Humboldt current could facilitate long-distance dispersal. Nevertheless, there are different possible threats to the Peruvian populations, such as fisheries, El Niño southern oscillation and pollution. These impacts can reduce the effective population size and genetic diversity. Therefore, even with a good theoretical connectivity the population could be endangered.

Keywords: Thaisella chocolate; Muricidae; Peru; Population genetics; Fisheries management

Feeding behaviour of seven important fouling species: The key to their success?

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Offshore wind farms in the Southern part of the North Sea add artificial hard substrate to areas previously characterized by the presence of naturally soft bottoms only. These hard substrates are rapidly colonized along the depth gradient by fouling organisms. Some fouling species are found at the entire depth range along the wind turbines, while some of the species are restricted to limited parts of the pile. Most of the fouling species are suspension feeders, taking advantage of a variety of different food sources from the water column. The aim of the present study is to examine the intra-specific feeding behaviour of seven fouling species that are found at different depths on an offshore wind turbine. The investigated species included the blue mussel *Mytilus edulis*, the anemone species *Diadumene cincta* and *Metridium dianthus*, the crabs *Pisidia longicornis* and *Necora puber*, the amphipod *Jassa herdmani* and the brittle star *Ophiothrix fragilis*. Six sampling locations along the depth gradient and around the wind turbine were selected: the intertidal, the *Mytilus edulis* zone (~ 5 m depth), the *Jassa herdmani* zone (8-9 m depth), the *Metridim dianthus* zone (15-25 m depth), the erosion protection layer (EPL) and the soft substrate near the pile. At least three individuals belonging to the seven abovementioned species were collected where possible. From each of the species, the carbon and nitrogen stable isotopes were analysed. Using the stable isotope data, the trophic niches of each species at the different sampling locations were estimated. The position and overlaps of the trophic niches provided information with regards to the feeding preferences of each species at every location. The results indicated that some species (*Necora puber* and *Diadumene cincta*) exploit the same food source, independent of their sampling location. However, most of the investigated species shift food sources according to the depth at which they occur. Such trophic plasticity can be at the basis of their success as fouling organisms, as it allows them to take benefit of a wide range of food items. This study suggests that there is a difference in the resource exploitation by the same species occurring at different depths of the offshore wind turbines. Such variability emphasizes the importance of understanding the complexity of a species' feeding behaviour.

Keywords: Specialist feeders; Generalist feeders; Fouling fauna; Offshore wind farms

Global patterns of seaweeds species diversity

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Knowledge of global patterns of species richness is fundamental for contemporary studies in ecology, evolution and conservation. Surprisingly, recent studies on global patterns of species diversity were primarily conducted across heterotroph taxa (e.g. foraminifera, fishes, mammals, corals; Tittensor et al. 2010), but did not consider the major oceanic and coastal primary producers, namely phytoplankton (e.g. cyanobacteria, diatoms, dinoflagellates, green algae, coccolithophore) and seaweeds (brown, green and red macroalgae). The biodiversity in some of these autotroph groups far surpasses most of the macro-heterotroph taxa and adding these data could possibly alter the current picture of global patterns of marine species richness. Nevertheless, we are lacking such data for marine primary producers including seaweeds. Kerswell (2006) and Keith et al. (2014) provided a genus-level richness global distribution for the seaweeds. Genus richness, however, does not necessarily reflect species richness as recently shown in a prominent group of brown seaweed (Dictyotales; Steen et al. in prep.).

In this year VLIZ Marine Science Day we would present the preliminary results of our project, started in January 2019. In this project, we will specifically aim at examining global patterns of species richness across the three seaweed clades (Chlorophyta, Rhodophyta, Phaeophyceae) through the assemblages of a dataset of geographical distribution of the marine seaweeds based on online databases (e.g. OBIS, GBIF) and available seaweed checklists for specific regions (Polynesia, Caribbean, Macaronesia). Global spatial distribution maps of species richness will be derived from this dataset for all seaweeds, and for separated clades (e.g. phylum, family, order) to define specific richness distribution patterns. Then, we will assess the extent to which environmental conditions can predict species richness in seaweeds, following Keith et al. (2014) methodology.

Keywords: Seaweed; Modeling; Distribution Maps; Distribution Patterns

Deep history: Revealing the palaeolandscape of the southern North Sea

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During the Late Quaternary, the southern North Sea (SNS) was subject to major palaeogeographical changes due to the alternation of several glacial–interglacial cycles. During glacial stages, sea level dropped up to a hundred meters during the glacial lowstand. This together with the expansion and decay of continental-scale ice sheets induced significant modifications in the landscape and drainage systems of NW Europe at local and continental scale. The existence of large proglacial lakes has even been suggested Emerged landscapes were subsequently drowned during warm interglacial stages, when sea level gradually rose and transformed river mouths into deltas and/or estuaries fringed by large headlands and shallow embayments.

Until now, palaeolandscape research in the SNS mainly focused within national boundaries and specific (local) areas (e.g. Dogger Bank) or time periods (e.g. Holocene). Recently the first steps were taken towards an international, wide-scale palaeogeographical and geoarchaeological study of the central and southern parts of SNS located between East Anglia and the Netherlands (Brown Bank, Axial Channel and adjoining areas). This study focuses on the entire Late Quaternary period. This area contained large rivers and lakes during Pleistocene glacial stages and remained partially emerged during thousands of years during early interglacial stages. The southern North Sea, especially the Brown Bank area, is rich in Late Pleistocene fossil fauna. Moreover, a small but significant number of Mesolithic artefacts and human remains have been recovered from the study area, attesting to prehistoric human activity.

In April 2018, a first geophysical campaign was performed in the Brown Bank area on board of the RV Belgica by an international team composed of scientists from VLIZ, UGent and Bradford University (UK). High resolution sparker, parametric echosounder (PES) and multibeam data were acquired simultaneously, resulting in a continuous acoustic image, ranging from the seafloor down to c. 100 m below the seafloor (bsf). The sparker data allowed to image the deeper structures (≥ 10 m bsf) such as buried palaeovalleys, estuaries, deltas, etc. The PES data allowed to image the shallow sub-bottom (≤ 10 m bsf) in unprecedented detail (dm resolution). This data has revealed flooding surfaces and several meter-scale enigmatic buried dune-like features. Based on the seismic data, a small number of shallow vibrocores (3–4 m) were collected in July 2018 on board RV Pelagia by TNO and Deltares. The cores are currently being sampled for age dating and other analyses (e.g. OSL, C14, sedimentary DNA, etc.). Based on the results of this study, a series of surveys will be performed in the study area in 2019, during which we plan to collect complementary geophysical and sedimentary/archaeological data. This study aims to better understand the palaeogeographic evolution of the SNS and provides insights on human occupation of this area during marine lowstands.

Keywords: Palaeolandscape; Geoarchaeology; North Sea

The Scheur: A unique prehistoric fossil graveyard off the Belgian coast

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Over the past few decades Dutch fishermen have dredged up large amounts of unique prehistoric palaeontological material at the Scheur, a navigation channel northeast of the harbour of Zeebrugge. Especially the large number of walrus bones from the last ice age (116,000-12,000 years ago) is striking. The excellent state of the bones and the find of both males, females and young animals indicate that a large colony must have lived here, possibly the most southern walrus colony in the world. In the same area also a number of vertebrae from ancient whales were dredged up, dating from the Middle Eocene (roughly 43 million years ago). Remains of these primitive marine mammals are very rare in NW Europe (only three known sites in the North Sea). The unusual size of the vertebrae (width c. 30 cm) could suggest a hitherto undiscovered species of the family Protocetidae.

Two targeted surveys in 2017 and 2018 produced additional finds of Late Pleistocene land mammals, related to interglacial fauna (wild horse, aurochs, red deer, roe deer, rhinoceros, boar and hippo) as well as glacial fauna (brown bear; wild horse; red deer). All the bone material is most likely preserved *in situ*, derived from layers exposed at the seafloor. Due to maintenance dredging of the navigation channel 10 to 12 m of sediments were removed, thereby exposing older Late Pleistocene and even Paleogene strata. Determination and dating of the fossils are currently ongoing, including the screening for ancient DNA. Radiocarbon analysis of the walrus bone is ambiguous (the method only goes up to 40,000 years), and palaeogeographic reconstructions suggest that the bone material predates the last ice age. Further planned research of the site includes the acquisition of shallow sediment cores and dating based on shell residue and other indicators for climate (e.g. pollen, diatoms, dinoflagellates). Combined with acoustic subbottom data this should allow to reconstruct the evolution of the palaeolandscape at the site.

Keywords: Scheur; Fossil bones; Palaeolandscape

Severe effects of neonicotinoid insecticides on *Nitocra spinipes* under different exposure conditions

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Neonicotinoids have been constantly replacing formerly used insecticide groups (e.g. organophosphates, pyrethroids, etc.) in the past few decades. Their physical-chemical properties including lower log K_{OW} and higher water solubility make them readily absorbed by plants and act quickly at low doses. On the other hand, these properties make them susceptible for runoff and subsequent transfer into the aquatic environment. They have been detected in surface waters in the ng L^{-1} to low µg L^{-1} range, and finally in marine waters at concentrations ranging from 0.5 to 10 ng L^{-1}.

In this work, we assessed potential acute and chronic effects of four neonicotinoids (clothianidin CLO, imidacloprid IMI, thiacloprid TCL and thiamethoxam TME) on the brackish copepod *Nitocra spinipes*. Neonicotinoid exposure was performed under three different scenarios. First in a 96h acute lethal toxicity test according to ISO 14669. Second in a recovery experiment based on 96h exposure to two different neonicotinoids (CLO and TCL) followed by transfer to fresh medium and continuous observation to explore the recovery potential of exposed copepods. Finally, we performed a 7-day larval development test with TCL according to ISO 18220.

In the acute tests we found **immobilization to be a more sensitive endpoint than death**, showing EC_{50} (96h, immobilization) values ranging from 0.81 µg L^{-1} (CLO) to 430 µg L^{-1} (TME). Our recovery experiment showed that 69 % of the organisms exposed to 100 mg L^{-1} TCL were able to recover mobility after 24h, while those exposed to 100 mg L^{-1} of CLO remained immobilized.

The larval development test with TCL showed a **clear delay in development** of *N. spinipes* nauplii and the EC_{50} (7d) was calculated at 10.3 µg L^{-1}, while the NOEC (7d) was 1.23 µg L^{-1}.

N. spinipes showed **considerable sensitivity when exposed to neonicotinoid insecticides both in short- and long-term exposure** for adults and nauplii, respectively. Immobilization was a clearly more sensitive endpoint as compared to death in acute testing and locomotion is crucial for copepod survival in terms of feeding behaviour and predator avoidance. Regarding the recovery potential, there seems to be no general agreement for different neonicotinoids. Developmental effects of TCL on copepod nauplii suggested further testing of other neonicotinoids and particularly CLO (lowest acute EC_{50}) under chronic exposure conditions.

Keywords: Neonicotinoid insecticides; Marine copepods; Immobilization; (Ir)reversible effects

A video system as a multi-tool to monitor the Belgian coast

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A large variety of natural processes is acting at the coasts over wide ranges of spatial and temporal scales. Their consequences are multiple and some of them can be catastrophic, given the high degree of development of human activities. Erosion is an important consequence of these natural coastal processes, originating from meteo-marine forcings such as waves, tide, and winds. Coastal erosion is expected to intensify due to sea-level rise, storminess and increase of human pressures. Therefore, it is crucial to monitor the coast in order to undertake actions for protecting it as well as to get further insights about the natural processes driving beach morphological changes. A video monitoring system equipped with six cameras looking in different directions, is installed on a 44m high building in Mariakerke near Ostend. It is in operation at the site since June 2014. The Argus system takes semi-hourly a snapshot image, and a single image frame of the first of 10-minute image recorded, for each camera. They are automatically saved during day light hours and operate through all weather conditions. The video system has been used to assess storm impacts on the intertidal beach. Another purpose of the system is to locate and to track aeolian features, as well as to monitor surface moisture content on the beach for a large coverage in time and space. Video imagery coupled with meteo-marine forcings is a powerful multi-tool to get a comprehensive view of the processes and morphology occurring at the coast and to support decision making for sustainable coastal management.

Keywords: Beach morphology; Shoreline; Storm; Wind; Sediment transport

Benthic community structure and responses to global warming in the Prince Gustav Channel, Antarctica

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The debate concerning climate change has been a central subject matter since the early '90s, and its consequences are strictly related to the sustainable development goals. Variation in environmental parameters are of crucial importance in particular for the 13th – Climate Action - and 14th – Life below water – goals, since it deeply impacts both human and animal life. Climate is rapidly mutating, and anthropogenic influence to such development is unquestionably significant. Evidences of climate change are distinctly visible in a variety of environmental networks, with marine ecosystems being the most affected. Environmental factors as temperature and pH are critical elements in determining species habitats and dynamics, hence it is not surprising that many organisms are facing profound modification of their life cycle events in response to climate change. Polar species represent an extremely sensitive group of organisms as they live in a very pristine ecosystem, and their survival is severely threatened by climate change. The Antarctic continent has always been studied in order to better understand the relation between human-induced climate changes and ice melting, and in this context the Antarctic peninsula represents the most impacted region on earth. It is indeed experiencing rates of atmosphere warming greater than the global mean and the -9 °C isotherm has moved southwards, determining a loss of 28 000 km2 of ice shelves since 1960. Disintegration of ice shelves and glacier retreat events are closely associated to variation in community structures at different trophic levels of the Antarctic food web.

The study of community response to climate changes is of particular interest when investigating the possible trophic cascade, hence alterations of diverse organisms and their dynamics in relation to the environment they inhabit. Benthic fauna is especially useful to investigate how indirect and direct anthropogenic influence is able to affect and re-shape the ecological dynamics of species considerably distant from humans. Climate change has a negative effect on benthic interactions, although some organisms may actually be capable of adapting to specific altered conditions, therefore a growing interest is rising towards these fascinating communities, and particularly with respect to the phylum of Nematoda. Nematodes are unquestionably the most abundant metazoans populating the seafloor sediments and it is largely verified that they are good bio-indicators of environmental conditions in several diverse ecosystems, from shallow to deep waters, and from undisturbed to scoured sediments. For these reasons, the following study will focus on nematodes abundance and biodiversity.

The samples will be used to investigate three distinct research hypotheses. First of all, major changes in sediment conditions and community assemblages of associated meiofauna will be studied to assess the influence of different ice condition in historical and present times. Indeed, glacier impact, hydrological dynamics and surface productivity are supposed to play an important function in determining the community structure in three contiguous deep basins along Prince Gustav Channel. Secondly, the benthic diversity of PGC deep basins will be investigated in order to confirm its similarity to populations inhabiting the adjacent shelf rather

than to the bathyal fauna of the Weddell Sea. Finally, evident differences in benthic communities are supposed to occur comparing the shallower, most likely impacted areas of Duse Bay with deeper protected basins. These are also expected to act as carbon sink, thus providing more nutrients to benthic assemblages and suggesting the presence of abundant populations.

The study represents the first analysis of biodiversity in this area, and it would provide more information about the impact of global warming on Antarctic dynamics.

Keywords: Sustainable development goals; Climate change; Ice melting; Antarctica; Benthos; Nematodes

Age Determination and Growth Rate Investigation of *Solea solea* Juveniles Through the Reading of Otoliths' Daily Growth Rings

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Fishing pressure represents one of the main threats and drivers of change in a marine ecosystem, thus efficient management must be a priority for sustainable blue growth. This study aims to investigate the population dynamics of common sole (*Solea solea*) in the Southern part of the North Sea. Variation in survival and coastal recruitment in the species are believed to be caused by complex dispersal patterns and hydrodynamics. Limited but sufficient connectivity has been proven to shape metapopulations within the area, hence why a deeper knowledge about sole dispersal mechanisms is crucial for the understanding of yearly stock-sizes variations and promotion of a long-lasting sustainable exploitation of the species. This research will determine the age at capture and at the different life-history events of common sole juveniles through the reading of daily growth rings in their otoliths, which are discernible within the first year of life of an individual. From otolith-fish size relationship and daily rings width, larval and juvenile growth rates will be derived. Together with otolith microchemistry and shape analysis, this is a powerful informative tool to gain an insight into early events experienced by this species. This information could help display spatial and temporal variability of life-history traits such as pelagic larval duration, metamorphosis and settlement, but can also provide information on nursery habitat quality. The results of this study will be combined with an existing larval dispersal model for common sole in the North Sea, where local hydrodynamics, larval active behavior and possible climate change scenarios are combined and can possibly reveal the pattern followed by the juveniles. Finally, they will be compared with previous studies of otolith microchemistry and shape analyses performed on the same samples. The results of this study will provide important information about common sole in the North Sea, which is especially critical to Belgium and the surrounding countries because of their dependence on flatfish fisheries as an economic resource.

Keywords: Sustainable fishery; Solea solea; Daily growth rings; Otolith; Age determination; Growth-rate

Reconstructing population histories and biogeography of Antarctic *Charcotia* (Amphipoda, Crustacea)

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Historically, Antarctica underwent many environmental changes throughout time. Glaciation and deglaciation periods forced organisms to adapt to new conditions, undergo extinctions, or migrate. During glaciations, migrations occurred to different refugia such as the deep sea, ice-free regions of the Antarctic continent and sub-polar regions. These refugia created barriers with reduced gene flow and increased diversification and speciation. Now, Antarctica is undergoing new alterations induced by global warming and ocean acidification. The RECTO (Refugia and Ecosystem Tolerance in the Southern Ocean) project investigates the historical dynamics forced by previous glaciation periods and possible responses to future climate change. One part of the project reconstructs the population history of different taxa from various trophic levels. Here, we will specifically focus on the amphipod genus *Charcotia* (formerly known as *Waldeckia* sp.), of which two species are investigated: *C. obesa* and *C. amundseni*. Both species are scavenging amphipods, and are morphologically and genetically distinct. They most likely also have different bathymetrical distributions, with *C. amundseni* being more abundant at larger depth. The population history and biogeography will be reconstructed from different localities in the Southern Ocean with molecular tools, including sequencing the COI DNA barcoding region, to construct haplotype networks and test for cryptic diversity. We will also apply Next-Generation-Sequencing (NGS) techniques to unravel the complete mitochondrial genome of these amphipod species. Sequence data from complete mitochondrial genomes will allow us to design primers for long-range PCRs to obtain mitogenomic data from different populations of both species. This way, phylogenies for reconstructing the evolutionary history will be statistically better supported. Possible differences in mitochondrial genomes between species could also be non-neutral and indicate specific temperature adaptations. The latter will be assessed by comparisons with mitogenomes of closely and more distantly related Crustaceans from Antarctica.

Keywords: Amphipoda; Antarctica; Population history

Impact of climate change on storm surges and wave heights on the Belgian Coastal Zone

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In the framework of the CREST project, the RBINS aims at quantifying the impacts of climate change on the Belgian Coastal Zone both for physical parameters and sediment transport. Results of eight regional climate models were analyzed and were used to force a hydrodynamic model and a wave model. Two regional climate model simulations were prepared in the framework of the CORDEX.be project, i.e. simulation from the Royal Meteorological Institute and the Catholic University of Leuven while atmospheric forcings from six other regional models were obtained for an evaluation run for the period 1980-2010, a historical run (1976-2005) and for a climate run based on the IPCC RCP 8.5 scenario for the period 2070-2100.

To interpret the estimated impacts of climate change, an analysis of the wind forcing is firstly presented. Changes in wind speed and direction between historical and RCP 8.5-time series are assessed by computing the wind density function. To estimate the changes in storm surges and wave heights, a statistical analysis has been carried out at stations located along the Belgian Coast. The bias in the model results is corrected by applying the quantile mapping method.

Results for wave heights indicate a possible increase of about 20cm for return periods of 20, 50, 100 and 200 years at Bol van Heist. Concerning the storm surges at Ostend, the expected increase varies from 20 cm for return periods of 20 years up to 40 cm for return periods of 200 years. These changes are interpreted in terms of wind changes and are in good agreement with expected changes in wind speed and direction at these locations.

Keywords: Climate change; Numerical modelling; Statistical analysis

Polyhexamethylene guanidine as an effective biofouling inhibitor in marine paint

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One of the major elements which define the longevity and the performance of a ship, is the quality of the coating. Coatings help to protect against corrosion (e.g. of the hull or of the ballast tanks) as well as against the formation of biofouling layers (mostly on the outer hull). Low levels of biofouling ensure a low fuel consumption, whereas low levels of corrosion mean less profitless days in dry-dock for maintenance and inspection. Recent results on antibiofilm activity of cationic polymeric biocide polyhexamethylene guanidinine (PHMG) salts as an additive in polyamide plastics for medical use (Walczak et al 2014, Moshynets et al, accepted) hinted at a possible interaction between this molecule and the bacteria attempting to colonise an exposed surface. The presence of the compound effectively slowed down the formation of a functional biofilm. It was therefore hypothesised that this compound may be exhibiting a certain level of efficacity when introduced in paints, eg for ships' hulls. With lab testing on the exact mechanism still ongoing, a practical test was set up as well.

In this study, hydrophobic polymeric biocide PHMG 2-mercaptobenzothiazolate (PHMG-MBT) has been synthesized. Moreover, PHMG was intercalated into a smectic clay, montmorillonite (MMT) to develop hybrid organic/inorganic biocide (PHMG-MMT). To study the antifouling performance of PHMG based additives in a maritime setting they were mixed into a classic ship's hull epoxy based paint in the content of 5 wt%. The coupons were exposed to seawater at our pilot station in the Ostend port for three months. Afterwards, the coupons were carefully dried, pictures were taken and the abundance of the fouling was assessed by measuring the percentage of the coupon surface that was covered (with algae and slime, mostly), using the image processing software ImageJ.

ANOVA testing (for treatment type and the position of the coupon on the rack) showed that the treatment of the coupons was shown to be highly significant in the determination of the fouling ($p<0.001$). Subsequent t-tests indicated that only one of the two treatments, the PHMG-MMT, affected the development of the fouling layer ($p<0.001$). The position of the coupon had a significant effect as well ($p<0.05$) even though the difference between top and bottom coupons was only 30 cm.

In short, cationic polymeric biocide, PHMG may be useful as an additive in commercial paint formulations, to enhance the paint's anticorrosion and antifouling behavior. As its behavior in polyamide plastics did not depend on leaching out the surrounding medium, one of the parameters to be tested will be whether this is also the case for epoxy paints. In that case, the use of such a formulation may well provide for a more durable way of coating ships.

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Keywords: Antifouling; Paint additive; Biofilm

Comparative study of the hydrodynamics of a heaving wave energy converter using linear and non-linear wave theory

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Wave Energy is a potential source of clean electricity that can make a significant contribution to the de-carbonization of the world's electricity supply, and can be harvested by using wave energy converters (WECs). In order to assess the performance and survivability of WECs, the hydrodynamic forces and body motions of the floating devices have to be calculated. Most investigations concerning WECs apply linear potential flow theory, which has the major drawback of assuming small amplitude oscillations of the WECs, resulting in an underestimation of the acting forces under extreme sea states [1]. Therefore, it is more appropriate to use fully rotational non-linear models, e.g. models based on Smoothed Particle Hydrodynamics (SPH), which is a Lagrangian meshless method used within the field of Computational Fluid Dynamics (CFD).

The defining characteristic of a WEC, distinguishing it from a simple floating body, is the power take-off (PTO) system, which converts the mechanical energy into useful electricity. In most cases this PTO system is modelled as a simple linear damper, which is oversimplified compared to e.g. a more realistic hydraulic PTO system. These numerical simplifications can result in an overestimation of the absorbed wave power by the WEC of up to 150% [2].

The aim of the present research is to perform numerical SPH simulations and compare the obtained results to those from the simplified linear potential flow theory. More specifically, a heaving WEC will be simulated using a coupled NEMOH – WEC-Sim model [3,4] and the average absorbed power and acting forces will be determined in different sea states. Thereafter, the heaving WEC will be simulated using DualSPHysics, a non-linear SPH solver. Again, the average absorbed wave power by the WEC and the hydrodynamic forces acting on the WEC will be calculated and compared to the results obtained using the linear method. This will allow to define in which cases applying linear potential flow theory leads to excessive errors.

DualSPHysics will be coupled to an accurate model of the PTO system, which will clarify its impact on the hydrodynamics of the WEC and on its average absorbed power. The WEC will be moored to the seabed and thus in order to assess the effect of the mooring lines on the WEC's hydrodynamic behaviour, a DualSPHysics – MoorDyn coupling will be further developed. This coupling also allows modelling of moored floating structures in general, such as floating wind turbines.

Finally, the obtained numerical results will be validated using the experimental data of the 'WECfarm' project, which will be carried out in the Coastal & Ocean Basin (COB), Belgium. During this project, several heaving cylindrical WECs will be installed in a farm configuration and subjected to various wave conditions. These experiments will provide data of the WECs' motion, the forces acting on the WECs and the modified wave field surrounding the WEC farm.

Acknowledgement
The first author is Ph.D. fellow of the Research Foundation – Flanders (FWO), Belgium (Ph.D. fellowship 1SC5419N).

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Keywords: Wave Enercy Converter; Power take-off system; Smoothed particle hydrodynamics; WEC-Sim; WEC farm; Mooring

The tale of the river Scheldt as told by historic maps – Building an RShiny 'side-by-side viewer' to visualize 16th-20th century maps

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The river Scheldt has always been a prominent and ever-shifting feature in the topography of its surrounding landscape, and holds a rich history of gradual changes and forced alterations. Human hand has played their part in these alterations, ever since Roman settlements, as mankind always acknowledged the river's economic, social and strategic values.

To gain insight into the changes over the last few centuries, the near-modern history of the river, historic maps have proven to be an ideal medium. Especially because the Scheldt passes through Flanders and The Netherlands, where the art of cartography became of a leading standard from the 16th century onwards. Therefore, to fully take advantage of this medium, Flanders Marine Institute has created the 'Side-by-Side Map Viewer'. This application, made using the Shiny package from R studio, lets users access and visualize 16th to 20th century maps directly alongside modern-day maps. By doing so, the app allows direct comparison of the historic features of the Scheldt and its surrounding regions, with the present-day situation visible on ESRI or OpenStreetMap base maps.

At this time, the application contains 128 historic maps, obtained through collaboration with multiple partners. Additionally, the user can choose from three different modern-day images to compare with. All maps are accompanied by metadata information as well as links to the source, the meta-metadata and an option to download the map as a GeoTIFF. The collection of maps will be updated and expanded in the future, both with material from current partners as well as new sources.

The app is developed for, featured by, and freely accessible via the ScheldeMonitor-website (www.scheldemonitor.org). ScheldeMonitor is a knowledge and information portal, operating since 2004, that was set up for research and monitoring in or concerning the Scheldt. It offers information (e.g. literature, projects), data (e.g. datasets, measurements), and data products (e.g. maps, graphs).

Keywords: Spatial data; GIS; Historic maps; RShiny; Scheldt; Cartography; Topography

The forester, the form and the geometer: An accuracy analysis of mangrove tree heights measured using forestry techniques, UAVs and hypsometers

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Tree height is a fundamental measurement in forest inventory studies and a critical variable for the assessment of vegetation biomass, carbon stock and site productivity that authorities use in decision-making. However, measuring tree height is often a challenging task, especially in the mangroves, and may generate significant errors. Mangroves are one of the most productive ecosystems in many tropical and subtropical coastlines. Irregular forms of trees in these intertidal forests pose a major challenge to measuring structural parameters necessary for evaluating its status. This study conducted an accuracy analysis of tree height estimation through different methods ranging from traditional (thumb rule and pole) to geometric and trigonometric equipment (SUUNTO clinometer, Nikon 550 laser rangefinder, Blume-Leiss 60 altimeter), and advanced technologies (Unmanned Aerial Vehicle or UAV – DJI Phantom 3 professional, Leica distometer). These measurements were carried out in natural and urban vegetation settings (mangrove vegetation at Matang as closed canopy and on UMT campus as open canopy). In total, 173 mangrove trees (open canopy-146; close canopy-54) were measured from the both sites and grouped into different stem diameter size classes (0-20 cm, 20-40 cm and 40-60 cm). Height measurements obtained from the Leica distometer were considered as control. This was achieved by shooting the Leica distometer at a UAV flying at the tree's canopy level.

Using percentage errors, our results show that height measurements obtained from the DJI drone (3.5%), rangefinder (7.1%), pole (7.4%), altimeter (7.5%), clinometer (7.7%), stick method (14.8%) and thumb rule (15%) were from most to least accurate in that order. This trend was consistent regardless of the sites and size class being considered. Our next step of analysis is aimed at investigating how the angle of inclination affects the accuracy of tree height.

Keywords: Height; Accuracy; Mangrove; UAV; Hypsometer

Metatranscriptome of a marine pelagic crustacean community using nanopore sequencing

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Due to their rapid responses to environmental variation, planktonic organisms are used as bio-indicators of ecosystem changes. With the need for better understanding the impact of a changing environment on zooplankton communities, zooplankton monitoring programs have been carried out in the marine environment globally since the early 20th century. Most zooplankton monitoring studies focus mainly on variability in biodiversity and biomass. However, this approach is hindered by challenges in the identification, which is time-consuming, complicated and requires biological expertise. Advances in practical, cost-effective molecular approaches, such as (meta)barcoding, helped overcome the issues with morphology-based biomonitoring. Yet, a more comprehensive molecular data set would be able to identify and assess the impact of the main drivers of changes in the marine ecosystem, rather than only determining species richness. Studying the functional activities of a community has been facilitated by metatranscriptomics, the study of community gene transcription. Metatranscriptomics is generally employed to assess both the functional and the taxonomic components of a community. Here, we sequenced the metatranscriptome of a pelagic crustacean community in the BPNS, using the MinION™, a portable nanopore-based DNA/RNA sequencing platform (Oxford Nanopore Technologies). We establish a method for capturing the metatranscriptome of zooplankton communities in marine samples.

Keywords: Zooplankton; Copepods; Metatranscriptome; Nanopore sequencing; MinIon

Can reef-building corals face environmental changes through trophic plasticity?

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Most reef-building corals can derive nutrition either autotrophically or heterotrophically, which allows them to exploit diverse trophic pathways. When facing environmental changes, therefore, these organisms are expected to demonstrate an intrinsic ability to acclimatise through trophic plasticity. Despite the ecological importance of these corals, however, our understanding of their trophic plasticity is currently impaired by a lack of rigorous research approaches; a failure to consider the intraspecific variability of coral species and an oversimplification of the proxies for determining heterotrophic habits (e.g. corallite diameter). In order to understand how trophic plasticity may allow reef-building corals to acclimatise, this study aimed to assess the trophic plasticity of four morphologically contrasted coral species (i.e. *Stylophora pistillata*, *Porites lutea*, *Isopora palifera* and *Psammocora profundacella*). We determined the stable isotope ratios of carbon and nitrogen in the corals' host tissues and algal symbionts and compared them in corals inhabiting areas around Taiwan that are characterised by contrasting temperatures (from high to low latitudes) and light levels (from shallow to mesophotic waters). In these areas, we evaluated interspecific and intraspecific trophic variability by estimating and comparing coral isotopic niches as a proxy for trophic niches. Our results suggest a variable degree of trophic plasticity in reef-building coral species. Trophic plasticity was important for *P. lutea* and *P. profundacella*, while it was lower for *I. palifera* and *S. pistillata*. Although trophic plasticity was low for the latter species, the results revealed no overlap of the isotopic niches for the host and symbiont from different locations, suggesting that these coral colonies are supported by different core resources. Moreover, the isotopic niche of higher-latitude coral colonies was larger than that of lower-latitude coral colonies, highlighting a certain trophic plasticity that may be related to the more variable environmental conditions in the higher latitudes. Analyses of additional species and locations will provide essential insights into the trophic plasticity of reef-building corals and how these species might adjust their nutrition in response to global environmental changes.

Keywords: Scleractinian corals; Trophic plasticity; Stable isotopes; Global change

Optimization of the preparation technique for the age reading of vertebrae of thornback ray (*Raja clavata*)

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Age composition of a fish stock is essential to determine the status of a fish stock and formulate advice for ICES and the European Commission. To be able to perform qualitative stock assessments, it is imperative to develop reliable age determination methods. The use of vertebrae to study age of rays and skates has proved to be a valuable method in the past. However, each species requires adapted cleaning, staining and drying methods. Therefore, during the SUMARIS project, an optimized protocol for age reading of thornback ray was developed.

Before observing and interpreting the growth rings on the vertebrae of rays, some preparatory steps are necessary such as vertebrae selection, cleaning, possibly embedding followed by sectioning of the vertebrae and band pattern enhancement by staining or burning. A segment of 10 to 20 vertebrae of the vertebral column were removed starting from behind the eyes up to the beginning of the tail. Cleaning is an essential step to observe the growth bands, but care needs to be taken not to denature the structure of the centra. Different cleaning methods were tested, from using hot tap water and ethanol to enzymatic cleaning using pepsin. Alizarin red, chrystal violet and silver nitrate illuminated with an UV-light were tested as staining methods for band pattern enhancement. The staining was tested on whole as well as on sectioned vertebrae.

As a result of the tests, an optimized protocol for age reading of thornback ray was developped. The used vertebral segment always needs to be sampled at the same place, because the number of growth marks may vary depending on the location of the vertebra on the skeletal axis of the same animal. Therefore, the first 10 vertebrae will be used because they are the largest. For cleaning the vertebrae, the enzymatic pepsin digestion was selected as best and for the band pattern enhancement chrystal violet was selected on whole vertebrae.

Keywords: Thornback ray; Vertebrae; Age reading

Potential drivers of species coexistence of marine nematodes

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Species with similar ecological functions strongly compete in nature. Their local co-occurrence can be established when confunctional species have specialised ecological niche. Mechanisms to differentiate the niche include resource partitioning, microhabitat partitioning and different preferences to environmental conditions. We examined these three potential drivers of niche differentiation on marine nematodes, which co-occur in their natural habitat at the Westernschelde Estuary. Resource partitioning was examined by investigating resource utilization of confamiliar or congeneric bacterivorous species from the field, using Next Generation Sequencing for characterizing their microbiome. Microhabitat differentiation was assessed by differences in occurrence of three cryptic species of the *Litoditis marina* complex on different algal species from the field, using qPCR identification. Differential preferences in abiotic conditions were tested in lab-controlled experiments with congeneric species isolated from the same habitats. Our results showed differential responses to daily temperature variations of congenerics under thermal stress. Microhabitat partitioning was apparent for cryptic *L. marina* species which showed different preference to algal species or to parts of the same algal individual. Differentiation in resource utilization was less clear, as close related species had a significant overlap of their microbiomes. However, temporal resource and microhabitat differentiation can increase niche partitioning and allow species coexistence.

Keywords: Niche differentiation; Microhabitat; Resource utilization; Temperature

SLIM: A multi-scale model of the land-sea continuum

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SLIM is an unstructured-mesh hydrodynamic model that can seamlessly simulate flows from the river to the coastal ocean. It relies on the Discontinuous Galerkin finite element method to achieve unprecedented accuracy, even for very complex coastlines and bathymetry. SLIM includes the following modules to model a range of different water environments:

- SLIM1D for flows in branching river networks
- SLIM2D for shallow barotropic flows with or without wetting and drying
- SLIM3D for more complex barotropic or baroclinic flows where the vertical structure cannot be neglected
- A Lagrangian particule tracker to simulate the transport of larvae or debris
- A Eulerian transport model to simulate the dynamics of tracers such as pollutants and sediments

In this talk, we will present several applications of SLIM in challenging environments such as the Columbia and Congo rivers estuaries and the Great Barrier Reef. In each case, we will show how the use of novel computational methods allows us to improve the prediction of the physical and biological processes at play.

Keywords: Ocean modelling; Multi-scale model; Unstructured mesh

Sea spray exposure to man: an initial risk-benefit assessment

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Recreational and psychological benefits of spending time along the shore or in coastal areas, i.e. the so-called “Blue Gym” effect, have long been recognized. The mechanisms responsible for beneficial physiological effects, as observed in epidemiological studies, are however still unclear. The biogenics hypothesis published by Moore (2015) states that the regular inhalation of marine natural products via sea spray aerosols (SSAs) is beneficial as these products directly or indirectly affect important health promoting cell signalling pathways. In previous studies we examined and demonstrated the effects of such respiratory SSA exposure, using in vitro experiments with lung cell-lines (Asselman, Van Acker et al., 2018).

Here, we aim to “translate” the results from these in vitro experiments, via a quantitative extrapolation, to realistic environmental air concentrations that would produce the same in vivo exposure and thus effects. Based on these and measured environmental concentrations, we attempt to assess the risks and benefits of SSA exposure for the different scenarios and endpoints we examined: (1) the effects of pure phycotoxins on cell viability and the mTOR cell signaling pathway and (2) the effects of a natural SSA extract on gene expression. The conclusions of this work provide an initial answer to the question whether sea spray exposure can be health promoting and if so what the minimal exposure should be. In other words, addressing the question: “how long do I need to be exposed to SSAs (e.g. a walk along the beach) to have beneficial health effects?”

Keywords: Biogenics hypothesis; Sea spray aerosols; In vitro in vivo extrapolation; Human risk and benefit assessment; Phycotoxins

Rise of the thornback ray in the North Sea

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Thornback ray (*Raja clavata*) is an important species in the North Sea and is taken in fisheries targeting sole (trawl and gillnet), cod (trawl, gillnet and longline), as well as in targeted ray gillnet fisheries (ICES, 2017a). Species-specific landings data for rays and skates are missing up until 2012, mostly because these species are managed by one general TAC (Total Allowable Catch). However, market sampling indicates that thornback ray is one of the most frequently landed skates (ICES, 2017a; ILVO fisheries observer data).

According to ICES, the North Sea stock of thornback ray has steadily declined since the start of the 20th century and its distribution is largely reduced (ICES, 2017a). Data from International Bottom Trawl Surveys (iBTS) shows that over the past 40 years the distribution of thornback ray has been concentrated to the southern-western North Sea, especially in the Greater Thames Estuary and the Wash (Walker & Heessen, 1996; ICES, 2017a). However, in more recent years, scientific surveys such as the International Bottom Trawl Survey iBTS and the Celtic Ground Fish Survey (CGFS) show that the abundance of thornback ray has increased (ICES, 2017a; ICES, 2017b). Beam trawling is another efficient method to catch rays and skates, so ILVO decided to analyse Beam Trawl Survey (BTS) data from the period 2004-2017. For this, we focussed on the Belgian, German and Dutch surveys which cover the entire southern North Sea until the German Bight. Our analysis confirmed the increasing trend in the southern North Sea (ICES area 4c) with the survey index (individuals/km²) for thornback ray in 2017 being a fivefold of the index calculated for 2004. Moreover, thornback ray was caught in areas where it has not been seen for a long time (*e.g.* the German Bight).

This ILVO study delivers various important new insights on the abundance and distribution of these rays, which could be linked to fishing pressure and a number of environmental factors as well as changes in fish community structure. For example, with the rise of sea surface temperatures, thornback ray might receive a competitive advantage over other species that are less resilient to warmer waters (Sguotti et al., 2016). The outcomes of our study deliver important new insights for stock assessments and fisheries management of rays and skates in the North-East Atlantic.

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Keywords: Thornback ray; North Sea; Trawl surveys; Fisheries management

Alternative nourishment methods for the Belgan coast

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The natural dynamics of the Belgian sandy coast system are severely disturbed nowadays. Coastal defense structures have changed the natural patterns for the sediment transport, which has resulted in accretion and erosion issues along the coast in agreement with the state of the world's beaches. The anticipated acceleration of the sea level rise will increase the vulnerability of the Belgian coast to extreme events.

To strengthen the safety of the coast, the Flemish government has approved the Masterplan for Coastal Safety. This Masterplan consists of a suite of measures to prevent flooding related to a 1000-year flood event. Nourishment of beaches is considered one of the most important measures to maintain and enhance coastal safety. Nowadays, beach nourishments along the Belgian coast (~annual volume 0.5 million m^3) are constructed using a traditional method: by heightening the upper and intertidal beach.

A possible alternative for creating a more resilient and dynamic Belgian coast are feedere-type mega nourishments such as the so-called Sand Engine along the Dutch coast. This innovative soft engineering intervention makes use of natural processes (i.e. waves, currents, wind) to redistribute the nourished sand across the entire coastal profile (i.e. shoreface, subaqueous and subaerial beach, and dune area) and represents a paradigm shift in coastal management.

The present study aims to quantitative predictions of the shoreline change across decadal timescales as part of an exploratory study on the potential for a mega nourishment along the Belgian coast. Using the coastline model UNIBEST-CL+ we aim to i) evaluate the alongshore sediment transport post-construction for a range of idealized mega nourishment with varying dimensions (alongshore and cross-shore extent, volume), ii) quantify the dissipation time of these mega nourishment designs, and iii) explore the sensitivity of the predicted shoreline changes and lifespan predictions to the hydrodynamic (i.e. waves and tidal currents) and sedimentologic (i.e. grain size and sediment transport formulation) conditions.

A calibration of the UNIBEST-CL+ model on data from the Mariakerke nourishment was performed first. The combined beach-shoreface nourishment had a total volume of about 1Mm^3 of sand and was constructed in early 2014. UNIBEST-CL+ simulations using daily wave observations and the Bijker sediment transport formulation showed the best agreement with the observations on cross-shore evolution and volume decay. This finding indicates that the model is capable of replicating shoreline changes following the construction of a large nourishment along the Belgian coast.

Then, thirteen idealized nourishments were designed. The nourishments had a seaward extent ranging between 150 m and 900 m with variable alongshore lengths to evaluate the effect of geometry on resultant shoreline changes. The smallest nourishment had a volume of 1 million m^3 of sand and the largest one was 30 million m^3. All nourishment designs showed a morphological reshaping from the original trapezoidal shape to a smoother bell shape during the first years post construction. As a result of the reshaping, the head of the nourishment retreated and sand was being fed to the adjacent beaches, leading here to coastal advance. A

key finding is that the dissipation time scaled approximately linear with the initial nourishment volume for the same width-to-length ratio.

Simulations indicate that the volume decay of mega nourishments is much slower than predicted for the Dutch coast, primarily due to a smaller sensitivity to gradients in alongshore sediment transport. The behaviour of intertidal bars in the Belgian North Sea remains poorly understood and it requires further investigation for robust morphologic simulations. A mega nourishment makes use of nature's ecosystem services and provides a sustainable alternative to current nourishment practices allowing for a more flexible and adaptable management of the Belgian coast in response to climate change.

Keywords: Feeder-type nourishment; Sea level rise; Sediment transport; Numerical modeling

ICES support for development of catch sampling programmes

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According to European legislation, each Member State involved in European fisheries has to collect data on its fisheries and aquaculture. Collected data serve all sorts of purposes for a broad range of stakeholders, with one of the main goals to set the TACs (Total Allowable Catches) and quota each year. The Flanders Research Institute for Agriculture, Fisheries and Food (ILVO) is the coordinator of the Data Collection Framework for Belgium. The Belgian commercial fishing fleet is sampled by seagoing observers, who register and analyse the catch. For several commercial species, information on weight, length, age, sex and maturity is collected on a trip-by-trip basis. In order to ensure the quality of the collected data, ILVO is a member of the ICES (international council for the exploration of the sea) expert group WGCATCH (Working Group on Commercial Catches) for many years now. WGCATCH supports the development and quality assurance of regional and national catch sampling schemes and estimation procedures that can provide reliable quality input data to stock assessment and advice, while making the most efficient use of sampling resources.
Keywords: Fisheries; Catch sampling programmes; Quality; ICES; ILVO

Supertree: Toward a comprehensive phylogeny for brown seaweeds (Phaeophyceae, Ochrophyta)

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Large and comprehensive phylogenetic trees are desirable for studying macroevolutionary processes. The brown seaweeds or Phaeophyceae comprise of over 2000 species (Guiry and Guiry, 2018). Over the past few years, molecular-assisted taxonomic studies have significantly contributed to our knowledge of the biodiversity within several phaeophycean groups. Phylogenetic efforts have nonetheless been directed towards lower taxonomic ranks, notable genera or family at best. Silberfeld et al. (2011, 2014) provided the first phylogenetic tree for the Phaeophyceae including representatives of most orders, refinining our understanding of ordinal-level phylogenetic relationships. A comprehensive phylogeny of the Phaeophyceae, encompassing all presently known species, is nevertheless still lacking. This project aims to provide the first all-inclusive tree of life of the brown seaweeds, by applying a supertree approach. This will be done by compiling sequences of all species of brown seaweeds for twelve well represented nuclear, mitochondrial and chloroplast markers from online nucleotide databases. Phylogenies at the ordinal-level will be first constructed using a maximum likelihood and Bayesian analyses, and latter grafted to an updated backbone phylogeny.

Keywords: Phaeophyceae; Phylogeny; Supertree; Brown seaweeds

DNA barcoding of larval morphotypes of economically important fish in the Galapagos Marine Reserve and characterisation of their populations

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The waters of the Galapagos Islands have a very rich biodiversity, with 20% endemism [1], at least partially due to the five currents surrounding the island. [2] (Fig.1) The waters contain multiple economically important species, such as sea cucumbers (popular in Asia thanks to their medicinal properties [3]), spiny lobsters and multiple finfish species. In recent years, the economic importance of fishery in the Galapagos Islands has decreased significantly, due to the decreasing population of economically important species. [4] This raises concern about the management of marine protected areas. As an example, densities of sea cucumbers and spiny lobsters are higher in some touristic and fishing areas than in protected areas. [5] [6] A solution would also be improved sustainability of the fishery. However, making these changes happen is impossible without sufficient knowledge about dispersal and population structure of economically important species in the Galapagos Marine Reserve. [4] The goal of this study is to determine the taxonomy of fish larvae collected in the Galapagos Marine Reserve, on the islands of Santa Cruz, Floreana, Darwin and Wolf, using COI as a marker using a DNA barcoding approach and to characterise the population structures of the economically important species among them.

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Keywords: Galapagos Marine Reserve; MPA; Larval morphotypes; DNA barcoding; COI

Internal wave generation in numerical models

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One of the most important ecological and economic issues related to coastal engineering is the protection of the coastal areas and the unique ecosystems and economic activities they host. Moreover, coastal areas around the world should be able to cope with new challenges caused by sea level rise and by more frequent and intense storms due to climate change, phenomena that require human's high attention.

Nowadays, numerical models are commonly used as engineering tools for the study of wave propagation and impact on coastal areas. Depending on the problem under investigation and the corresponding time and space scales, different numerical models are used. In the field of wave transformation in coastal areas, SWASH (Zijlema et al., 2011), which is a phase-resolving wave propagation model based on the nonlinear shallow water equations with added non-hydrostatic effects, has already reached a fairly mature stage (Suzuki et al., 2017).

In order to simulate waves in the nearshore zone correctly, the generation and absorption of waves at the boundary of models need to be modelled accurately. In the SWASH model, waves are generated by prescribing the horizontal velocity component normal to the boundary of the computational domain over the vertical direction. However, this method is weakly reflective for directional, dispersive waves. The purpose of this research is to deal with these issues and improve the performance of the generated wave fields. To achieve this aim, an internal wave generation technique has been implemented in SWASH, where a source term in the form of mass is added to the governing equations. The first obtained results show that the method is working very well.

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Acknowledgement

The first author is Ph.D. fellow of the Research Foundation – Flanders (FWO), Belgium (Ph.D. fellowship 11D9618N).

Keywords: Numerical modelling; Coastal and offshore engineering; Wave generation; SWASH

DNA barcoding of larvae of commercially important fish species in the Galapagos Islands

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The lack of available information on fish species surrounding the Galapagos Islands poses a problem in assessing their status and the resilience of their populations. For some of the main targeted species by the artisanal fishery, there is little more knowledge than a description of adult individuals. Data about the larval stages of fish provide efficient means of understanding their distribution, growth and early life history. The aim of this study is to identify fish species through the establishment of a link between larval morphotypes and their corresponding cytochrome oxidase I sequences by DNA barcoding. Subsequent to this, the occurrence, abundance and temporal distribution of the determined species throughout the sampling stations will be investigated. To our knowledge, this will be the first study to date identifying fish larvae in the Galapagos Islands through DNA barcoding. Therefore, the results will provide the groundwork for the design of an identification guide of the documented larvae, an important tool for further scientific research. Concurrently, the results of the occurrence, abundance and temporal distribution of fish larvae will be relevant information for sustainable management of the artisanal fisheries and the coastal waters of the Galapagos Islands.

Keywords: Sustainable management; Artisanal fishery; Mitochondrial DNA; DNA barcoding; COI; Galapagos Island

Experimental study of combined near-field interactions and far-field effects of wave energy converter farms: Development of a single 'Master WEC'

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To make wave energy converters (WECs) economically attractive as an alternative energy source, the levelized cost of energy (LCOE) needs to be competitive with other renewable energy sources. The size of a point absorber wave energy converter is designed based on the prevailing wave conditions, wavelength in particular. This implies that, contrarily to wind and solar energy, size scaling to increase power output can only be achieved to a certain extent. Therefore, increasing the power output can be achieved by placing a large number of WECs at the same site in an array geometrical layout, which is called a WEC farm. Since an efficient wave absorber is also an efficient wave generator, one can theoretically benefit from placing the WECs in a well-considered geometrical layout.

WECs placed in a farm are responsible for the occurrence of two general phenomena: near-field interactions between the WECs, and far-field effects of the WEC farm on the surrounding wave field. The motion of a single WEC will positively or negatively affect the power absorption of neighbouring WECs. These near-field interactions are dependent on the incoming wave conditions, the WEC farm layout and the WEC inter-distance. On the other hand, the power absorption of the entire WEC farm reduces the wave height behind the farm. The possible influence of WEC farms on neighbouring farms, offshore activities, marine ecology and the coastline is expressed by the far-field effects.

In the framework of the EU Hydralab IV 'WECwakes' project coordinated by Ghent University (UGent), the above phenomena have been investigated for an experimental layout of up to 25 heaving WECs [1]. The obtained unique database served for validation purposes of numerical models, such as for numerical coupling methodologies for studying wave-WEC interactions (near-field effects) and wave propagation through WEC farms (far-field effects) [2, 3, 4].

However, since the completion of the 'WECwakes' project, many numerical models have progressively advanced. To allow validating these new advanced models, the new 'WECfarm' project has been introduced by UGent and its partners. Main objective is to experimentally investigate near-field interactions and far-field effects for different WEC farm layouts and WEC inter-distances. These tests aim to cover the gap of available experimental data which can be used for validation of recently developed (non-linear) numerical models. As such, the new WEC farms will be also tested under (extreme) wave conditions that induce non-linear effects. Experiments with WEC farms will be conducted in the Coastal and Ocean Basin (COB) in Ostend in 2020, while in 2019 a single 'Master WEC' will be developed, tested and fine-tuned prior to the 'WECfarm' tests.

The hydrodynamic part of the 'Master WEC' design constitutes the floating buoy. Regarding the geometry, a cylindrical float is designed with a relative large diameter compared to the draft, which aims at maximizing wave radiation and thus inducing positive near-field interactions. The

small draft is to limit the surge force, since the WEC will operate according to the heave mode only.

The mechanical part of the WEC design constitutes: (i) the power take-off (PTO) for which a rack and pinion system is chosen. The helical gear will allow a smooth transition for the heaving motion of the WEC; (ii) air bushings to exclude friction effects in the power absorption measurements. A permanent layer of pressurized air between the interface of the bushing's guide with the exterior frame results in a situation where the contribution of friction to the total power absorption is negligible. A configuration of three non-collinear air bushings is sufficient to convert moments, originating from surge force resultants for every possible direction, to normal forces on the bushings.

The constructed 'Master WEC' is a first step towards the final objectives of the 'WECfarm' project.

Acknowledgements
The first author would like to acknowledge his PhD Aspirant Research Fellowship by the Research Foundation Flanders, Belgium (FWO).

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Keywords: Wave energy. WEC farm. Near-field interactions. Far-field effects. Power absorption. Experimental modelling. Float. Power take-off. Air bushings. Numerical modelling

Experimental approach towards the understanding of food web interactions in an offshore wind farm environment under different climate and aquaculture scenarios

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Coastal areas are under an increasing pressure originating both from local and global sources. On a local scale, the pressures are often induced by a local human activity. The installation of offshore wind farms (OWFs) in the Belgian part of the North Sea (BPNS) results in a large change in the marine environment. The introduced artificial hard substrates (AHSs) are rapidly colonised by large quantities of fouling fauna, which are expected to modify the local food web by introducing new trophic links. Modifications of this local food web will possibly affect the stability and resilience of the trophic network. The planned aquaculture activities within the wind farms will further increase change in the local food web by affecting both trophic-and non-trophic links. In addition to these local changes, coastal ecosystems are also challenged by global climate change stressors, such as ocean warming and acidification.

The aim of the PERSUADE (ExPERimental approaches towards Future Sustainable Use of North Sea Artificial HarD SubstratEs) project is to investigate ecosystem-wide responses to combined global and local stressors by quantifying interactions between biotic and abiotic compartments in the OWF environment. To this end, a large-scale mesocosm experiment was conducted, using the EMBRC tank facilities at VLIZ (Ostend). Both fouling fauna harvested from an artificial hard substrate garden and the sediment community collected in the vicinity of OWFs were incubated in the mesocosms, together with area-typical mobile predators, under three conditions: (1) a “control” treatment reflecting the current situation, (2) a “Climate Change” treatment with an elevated temperature and lowered pH according to the IPCC 2100 scenario, and (3) a “Climate Change + Aquaculture” treatment reflecting the scenario where blue mussel aquaculture takes place within an OWF under a future climate setting.

The carbon flow through the three experimental food webs was quantified by means of a pulse-chase experiment and bio-deposition of organic matter by the fouling fauna on the benthic community was determined using sediment traps. By investigating the carbon flow through the food web, an understanding of the effect of global and local stressors on the coastal carbon budget will be obtained.

Keywords: Climate change; Aquaculture; Food webs; Wind farm; North Sea; Biodiversity-Ecosystem functioning

The curious asymmetry of flatfish

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Flatfish are known to be the most asymmetrically-shaped vertebrates of the planet. Although they start as a symmetric larva, this symmetry gets lost during metamorphosis due to the migration of one eye across the top of the head onto the other side and linked craniofacial remodeling, resulting in a blind and an eye side. The blind side is non-pigmented and glides over the seabed. The eye side faces the water column and is pigmented, showing colors resembling the seabed. The difference in pigmentation between the eye and blind side is well-studied but information on possible morphological, functional or histological differences is rather scarce.

Hence, this study, aimed to obtain more information on possible histological differences between both sides. Sections of normal skin of both sides (pigmented and non-pigmented) of 20 common dab (Limanda limanda) fish were histological examined. A H&E staining was used to determine the thickness of the epidermal layer and a PAS staining to count the number of mucus producing goblet cells.

The epidermal layer was 49.8 ± 16.0 µm on the pigmented side and 52.3 ± 13.0 µm on the non-pigmented side. The number of goblet cells was also comparable with on average 5.7 ± 3.4 cells on the pigmented side and 5.2 ± 2.7 cells on the non-pigmented side.

In contrast, Faílde et al. (2017) already reported more goblet cells on the eye side. The variation between different fish was considerable and will be studied in more detail whereby differences such as age, length, condition and gender will be taken into account to eliminate possible bias.

The hitherto obtained results combined with previously published results, might suggest that differences in pigmentation might be the only morphological difference between the eye and blind side of common dab. Nevertheless, other parameters such as tight junctions, differences in collagen, possible differences in the basement membrane, etc… should be examined.

Keywords: Flatfish; Asymmetry; Histology; Skin

Virulence differences between GFP-tagged pathogens and their parental strains for blue mussel (*Mytilus edulis*) larvae

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Pathogens, especially vibrios, are largely responsible for larval diseases in shellfish aquaculture. Clarifying the mechanisms of *Vibrio* infections during the first hours is quite necessary for disease prevention. To make sure pathogens can be tracked *in vivo*, two strains of known pathogens of blue mussel (*Mytilus edulis*) larvae, *Vibrio hemicentroti* (ME09) and *V. anguillarum* (NB10) were labeled with green fluorescence protein (GFP), provided by *Escherichia coli* DH5α. Following a previously developed challenge model (Eggermont, et al., 2017), healthy two-day-old D-larvae were challenged with the GFP-tagged pathogens and their parental strains *in vivo,* at concentration of 10^4, 10^5 and 10^6 CFU·ml^{-1}, respectively. ME09-GFP and ME09 showed stronger toxicity to blue mussel larvae than NB10 and NB10-GFP. But all four strains showed less than 7% mortality at day 1. Specifically, ME09-GFP and ME09 caused a high mortality from 48 h onwards and a mortality of 85% at day 4 was observed for all concentrations. There was, however, a very low mortality among NB10 and NB10-GFP treatments at day 2. A significant larval mortality was only observed and was concentration-dependent from day 3 onwards. Besides, compared to their parental strains, the GFP-tagged vibrios were less virulent because they obviously delayed blue mussel larvae mortality. As more energy is required for this extra protein, incorporation of GFP can be a metabolic burden for the bacterial cells (Allision & Sattenstall, 2007). In the future, the invasion pathway of GFP-labeled pathogens is set up to be determined and the homochronous histological damage can be followed.

Keywords: Blue mussel; Larvae; *Vibrio spp.;* Green fluorescence protein (GFP)

Ecosystem services in the Coastbuster Project

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Due to climate change, the sea level is rising with coastal erosion as a result. To prevent millions of people living in coastal areas from losing their homes, humankind started building defensive structures to protect our shores. Only the last decades, studies showed us that these constructions drastically change the local ecosystems they are placed in. Engineers looked for more sustainable low-cost alternatives and started using nature-based elements to build artificial reefs. The Coastbusters Project in Belgium tests these techniques to investigate if they could be used for coastal protection. Ecosystem services describe the benefit our society gains from these natural components by which an identification of the possible positive (and negative) effects of the reef on the local environment can be made. In this way, ecosystem services can help us to evaluate the ecological/sustainable aspect of the project. This thesis gives an overview of expected tendencies in ecosystem services caused by the installation of the artificial reef. Further, an attempt is made to quantify the effect of the reef on wave attenuation and in extension coastal erosion.

Keywords: Ecosystem services; Coastal protection

Large-scale experimental modelling of scour protection around wind turbine monopile foundations

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Introduction

Offshore wind farms contribute significantly to contemporary renewable energy production. To ensure the safety of the wind turbine structure and reduce the installation cost, the design of the foundation is crucial. When exposed to waves and currents, the wind turbine foundation faces the risks of scouring, therefore, an armour layer protection is usually applied to prevent the scouring hole around the monopile foundation. Experiments with scale models of monopiles in physical wave flumes are proved to be a powerful way to estimate the performance of the scour protection layer. Previous research by De Vos et al. (2012) has resulted in the proposal of scour protection design formulae for both static and dynamic stability, while the extended work of Loosveldt and Vannieuwenhuyse (2012) analysed the feasibility of the design method using a wider range of environmental conditions. As scale effects exist in small scale model test and may lead to an over conservative design, the large scale modelling is necessary to investigate the relationship between the ocean conditions and corresponding armor layer damage. Therefore, within a European Hydralab+ research project, large-scale physical modelling of monopile foundation with scales of 1:8.33 and 1:16.66 has been carried out in the Fast Flow Facility (FFF) infrastructure of HR Wallingford. The Coastal Engineering Research Group of Ghent University is coordinating this project, with partners from the University of Porto, the Ludwig-Franzius-Institute for Hydraulic, Estuarine and Coastal Engineering, IMDC NV and HR Wallingford.

Objectives

These large scale tests have been conducted during May and July in 2018. The main objective of this research is to establish a benchmark dataset on the stability of scour protection around monopile foundations which will serve as a valuable reference for future wave flume model tests, for numerical validation purposes and for future foundation design. The hydrodynamic data is recorded by various high resolution instruments and the scour protection profiles are measured by underwater laser scanner. Based on the data processing, several researches are being carried out after the experiments. Firstly, different damage evaluation methodologies proposed by participating partners will be compared and analyzed, this helps to establish a proper economic concept for scour protection design. Secondly, the scale effects between previous small tests and current large scale tests are to be analyzed and quantified which would reveal the fundamental mechanism of the physical process. Thirdly, the performance of narrow-graded and wide-graded single layer protection will be tested and compared. Moreover, as combined wave and current conditions are applied, the research will investigate the hydrodynamic interactions between waves and currents based on laboratory data as well as the impact on scour protection stability.

Acknowledgement

The work described in this publication is supported by the European Community's Horizon 2020 Research and Innovation Programme through the grant to HYDRALAB-PLUS, Contract no. 654110.

Moreover, the first author would like to acknowledge his PhD funding through a Special Research Fund of UGent, (BOF).

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Keywords: Scour protection; Wind turbine monopile foundations

In vitro experiment on spawning induction of *L. Conchilega* and substrate preference during settlement of the larva

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Counteracting the undesired impacts of coastal erosion in the most beneficial way for both society and the ecosystem has been a topic of discussion many times. In Belgium, concrete dykes are placed perpendicular to the shoreline to diminish the wave impact and flood risk. Besides, regularly a huge amount of sand is nourished on the beaches to counteract the continuous loss. The consistent use of this costly and intensive engineering approach has led to the search for a more sustainable, ecosystem friendly alternative. The COASTBUSTERS project, formed by an agreement between ILVO, DEME, Jan De Nul, Sioen Industries and eCoast, plans on solving this issue by implementing 3 types of bio engineers in the field: mussel reefs, seaweed banks and sand mason worm (*L. conchilega*) aggregations. Reef forming bio engineers enhance resilience of the sediments, making them less susceptible to erosion, and promoting proliferation of abundance and biodiversity of organisms (Alves, 2007; Rabaut, 2009; Callaway, 2010). This work investigates the potential of using *L. conchilega* for coastal defense, by trying to cultivate them and enhancing the settling process by using artificial substrates.

L. conchilega is known to be an important eco system engineer in the intertidal zone. The tubeworms create a local hydrodynamic regime within the aggregations, hereby clogging up the sand and increasing abundance and diversity of other infaunal species (Alves, 2007; Rabaut, 2009). To induce the formation of an *L. Conchilega* aggregation, its pelagic larvae need the appropriate benthic conditions for settlement (Keßler, 1963). The research question is if this can be enhanced? Preliminary *in vitro* observations in the lab revealed that artificial substrate structures are also used as anchoring structure by the larvae, next to adult tubes. On top of this, *in situ* placement of a substrate mat in Bredene seemed to facilitate settlement of the larvae, as multiple *L. conchilega* tubes were detected after a month, in an environment too turbid and dynamic for settlement under normal circumstances. For these reasons, the first *in vitro* substrate preference experiments of the aulophore larvae of the sand mason tubeworm are executed. Both spawning induction of the adults and substrate settlement preference of the larvae are assessed in one recirculating aquaculture system (RAS). The adult containing breeding tanks are linked to Kreisel tanks, that will capture the larvae after each spawning cycle. Within the Kreisel sections, 3 different substrates and a control are carefully positioned, in search for the optimal artificial substrate for larval attachment & settlement. The cultivation of larvae, which is possible based on initial trials, allows to execute substrate tests independently of the availability of larvae from the field. This way, we can consistently repeat the substrate

tests after each spawning induction, whenever in time. The experiment is repeated 2 times with 3 replicate systems each session, to increase the statistical power of the results obtained. With this experiment we hope to statistically quantify this enhanced settling effect previously observed. The results will help to improve the field set-up of *in situ* tests that will follow. If all successful, COASTBUSTERS plans on integrating the use of such biodegradable substrate mats in the field as a barrier against the impact of storm surges, wave erosion and sea level rise on sandy beaches, worldwide.

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Keywords: *Lanice conchilega;* In vitro; Larval settlement; Coastal defense; Coastbusters

Effects of nitrogen starvation on the pigment content and chemical composition of *Rhodomonas* sp. Hf-1 strain

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Species of the cryptophyte genus *Rhodomonas* have been well known as an excellent feed for some marine animals in aquaculture. In this study, effects of nitrogen starvation in culture medium on the pigment content and chemical composition of *Rhodomonas* sp. Hf-1 strain were examined. Two nitrate concentration of 0.9 mM (Low-N) and 3.5 mM (High-N) were supplemented to the medium, and the Hf-1 strain was cultured for 7 days.

In Low-N medium, the nitrate concentration in the medium was nearly exhausted on day 3, and the growth rate was significantly declined compared to High-N medium. The phycoerythrin and protein contents in the cells decreased by 75% and 30%, respectively, from day 3 to 7, whereas High-N medium showed few changes in these chemical compositions during the entire experiment. The major fatty acid in the cells in Low-N medium was poly-unsaturated fatty acid on day 3, which accounted for 37.4% of total fatty acid. However, this content reduced to 24.7% and the major fatty acid shifted to saturated fatty acid by the end of the experiment. On the other hand, the major fatty acid content in High-N medium was relatively abundant even on day 7 and still remained as the major fatty acid until the end of the experiment. These data indicate that nitrogen starvation in the medium greatly affect the nutritional value of cryptophytes.

Keywords: Microalgae; Nitrogen starvation; Biochemical composition; Aquaculture

Communication Award

Fishermen help to get to the bottom of fish diseases in a citizen science project

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Wild flatfish may develop various lesions or deformities. Searching for a cause of these abnormalities often is comparable with finding a needle in a haystack. Therefore, it is challenging to pinpoint an exact cause of a certain disease. Various environmental factors might play a role in the susceptibility of an individual animal to develop a certain lesion or deformity. Moreover, characteristics of the fish, such as gender, condition or the activity of the immune system might act as predisposing factors.

One important piece of information is the prevalence of a certain disease and its variability in space and time. With regard to this, various scientific institutes over the world organize regular monitoring studies to measure the prevalence of certain diseases. One of the Belgian institutes is the Research Institute for Agriculture, Fisheries and Food (ILVO) which has already been conducting surveys on the occurrence of different diseases in the Belgian part of the North Sea for a long time. This information is used for, amongst others, designing the 'Marine Strategic Framework Directive (MSFD)'. From 2015 onwards, the data collection was intensified with a two-monthly monitoring campaign on board of the RV Simon Stevin at eight fixed sampling locations in the Belgian part of the North Sea. This data collection mainly focused on the research regarding skin ulcerations of flatfish.

To increase the dataset, we recently launched a citizen science project whereby the sea-going communities (professional or recreational fishermen, marine scientists…) are involved in the data-gathering process. They can deliver useful information on various diseases and areas that are not (intensively) covered in the scientific surveys. The citizen science project is supported by a website (www.platvisziekten.be) which contains some general information on various diseases and the goal of the scientific surveys. Furthermore, the sea-going community has the opportunity to notify scientists through the website if they encounter any flatfish with an abnormality by filling in a simple form and send it, along with a picture of the deformity. Using observations of these lesions or deformities will considerably strengthen the data collection and substantiate the scientific surveys for trends in prevalence and sudden changes of various diseases. This data may be used to study the cause of various diseases but also to monitor the health of the marine ecosystem in which the fish reside.

The website was constructed at Flanders Marine Institute (VLIZ).