



BOOK OF ABSTRACTS

VLIZ MARINE SCIENCE DAY 2021

ONLINE EVENT | 3 MARCH 2021

VLIZ SPECIAL PUBLICATION #85





BOOK OF ABSTRACTS

VLIZ MARINE SCIENCE DAY

ONLINE EVENT
3 MARCH 2021

VLIZ SPECIAL PUBLICATION #85

This publication should be quoted as follows:

Jan Mees and Jan Seys (Eds). 2021. Book of abstracts – VLIZ Marine Science Day, Online event 3 March 2021. VLIZ Special Publication 85. Vlaams Instituut voor de Zee – Flanders Marine Institute (VLIZ): Oostende, Belgium. 129 + vi p.

Vlaams Instituut voor de Zee (VLIZ) – Flanders Marine Institute
InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
Tel. +32-(0)59-34 21 30 – E-mail: info@vliz.be – Website: www.vliz.be

Photo cover: VLIZ

The abstracts in this book are published on the basis of the information submitted by the respective authors. The publisher and editors cannot be held responsible for errors or any consequences arising from the use of information contained in this book of abstracts. Reproduction is authorized, provided that appropriate mention is made of the source.

ISSN 1377-095

Table of Contents

KEYNOTE PRESENTATION

Neukermans Griet - 2021: A Science Odyssey – A 15-year journey across oceans and seas, and the return home	2
--	---

AWARD PRESENTATIONS

Maes Sarah <i>et al.</i> - Microbiome and diet turnover as an indicator of rapid environmental change in the Arctic Ocean	4
Teunkens Bert <i>et al.</i> - Tracking marked plastic items on their journey through the Scheldt estuary, using the Permanent Belgian Acoustic Receiver Network (PBARN)	5
van der Loos Luna - Algal microbial interactions: beyond bacteria	6
Goedefroo Nanou - The spatio-temporal evolution of a newly created mussel bed and its effects on benthic communities	7
Gopakumar Anjali <i>et al.</i> - Mercury accumulation in fishes from North-East and North-West Barents Sea during the polar night.....	8
Gaulier Camille - Trace metals in estuarine and coastal waters: dynamics, speciation and bioavailability under various environmental conditions	9

PREDOC PRESENTATIONS

Deconinck Dumas <i>et al.</i> - Successful quantification of Atlantic salmon in mixed food products using Droplet Digital Polymerase Chain Reaction (ddPCR) to identify fraud	12
Geerts J.J. Luna <i>et al.</i> - Green beaches for a green future?	13
Herweyers Robin <i>et al.</i> - Can we track the possible influence of chemical warfare agents on microbial community in the marine environment?	14
Moshtaghi Mehrdad <i>et al.</i> - Integrating drone imaging with artificial intelligence to detect marine plastics.....	16
Niu Zhiyue <i>et al.</i> - Environmentally relevant concentrations and sizes of microplastic do not alter marine diatom growth	17
Ollevier Anouk <i>et al.</i> - Assessing feasibility and best practices of zooplankton observations with the Video Plankton Recorder in coastal turbid waters	18
Severin Marine <i>et al.</i> - In times of crisis: Effect of the Belgian coast on well-being during the COVID-19 pandemic	19
Van De Walle Ruben <i>et al.</i> - The importance of the spatial configuration of marram grass (<i>Ammophila arenaria</i>) on dune functioning and biodiversity.....	20
Van Landuyt Josefien <i>et al.</i> - How a WW2 shipwreck still influences the surrounding sediment 70 years later	21
Voet Helena <i>et al.</i> - Disentangling the effects of climate change on the offshore wind farm hard substrate fouling community.....	22

POSTER PRESENTATIONS

Amadei Martínez Luz <i>et al.</i> - Effects of de-eutrophication and changes in turbidity on phytoplankton blooms in the freshwater and brackish tidal reaches of the Schelde estuary (Belgium).....	24
Asante Frederick <i>et al.</i> - Assessing the regeneration status of the ankobra mangrove system, Ghana	25
Baptista-Metri Cassiana <i>et al.</i> - Health of mangroves and landing crab in Brazilian Ramsar site and its surroundings	26
Barradas José Felipe <i>et al.</i> - New methods for the detection of old munition in the sea	28
Benjamen Debora <i>et al.</i> - Genetic population structure, diversity and connectivity of the commercially important cephalopod <i>Octopus cyanea</i> (Gray, 1849) in the Western Indian Ocean	29
Bouguerche Chahinez <i>et al.</i> - Monogenean parasites: what can COI barcoding reveal?	30
Broos Sarah <i>et al.</i> - Seasonal dynamics of coastal North Sea macrobenthic communities from half a century ago.....	32
Buyse Jolien <i>et al.</i> - Offshore wind farms and their effects on plaice (<i>Pleuronectes platessa</i>) distribution and density.....	33
Carpintero Moreno Efrain <i>et al.</i> - Blue Accelerator: The new testing site in Ostend for maritime technology developments to enhance Blue Economy	34
Cernero Reine Sophie Marie <i>et al.</i> - Borderless nature and science: Dual aspects of opportunities and challenges of transboundary conservation: a role for science?	36
Chen Danyang <i>et al.</i> - Historical forestry for charcoal trade in Matang Mangrove Forest Reserve, Malaysia.....	38
Claerbout Hendrik <i>et al.</i> - Experimental testing of wave energy converters for the WECfarm project.....	39
Cunha-Lignon Marília <i>et al.</i> - Health status of the mangrove forest on the southeastern coast of the State of São Paulo (Brazil): From the bottom (soil salinity and vegetation biomass) to upwards (canopy).....	40
Dale Marina Vieitas <i>et al.</i> - A reflection on mangroves within Brazilian Protected Areas	42
De Beule Louis <i>et al.</i> - Control strategies of a wave energy converter for the WECfarm project.....	44
De Raedemaeker Fien <i>et al.</i> - Prospection for bioactive compounds in the North Sea: creating a knowledge base for blue biotech innovation in Flanders.....	45
De Vreese Steffen <i>et al.</i> - The dolphin external ear canal, from physical towards virtual reality	46
De Weerdt Joëlle <i>et al.</i> - Site choice depends on group type for endangered humpback whales occurring off the Pacific coast of Nicaragua, Central America.....	47
Defever Justin <i>et al.</i> - Computer vision and self-sampling in the Belgian beam trawl fisheries	48
Delacauw Sander <i>et al.</i> - Testing genetic tools for marine ecosystem health assessment: a pilot on non-indigenous species.....	49
Delgado Claudia <i>et al.</i> - OceanTeacher Global Academy: Delivering training for a sustainable ocean	50
Desmet Sam - Sustainable monitoring of commercial fish in the Belgian part of the North Sea through eDNA ddPCR analyses	52
Dourado-Batista Carlos Victor <i>et al.</i> - Mangrove forests under extreme events at the southeastern coast of the state of São Paulo, Brazil.....	53
Dupont Rémi <i>et al.</i> - What are the ecosystem goods and services in Colombian and Senegalese species-poor mangrove forests?	54

Fernández Bejarano Salvador <i>et al.</i> - Where did we take those samples from? Georeferencing your research with marineregions.org.....	58
Festjens Felien <i>et al.</i> - The pressure is on! How different human activities affect functional diversity in soft-bottom macrobenthos.....	59
Gil Marina <i>et al.</i> - Exotic oyster <i>Saccostrea cucullata</i> in mangroves in Protected Areas on the southeastern coast of São Paulo (Brazil).....	61
Goedefroo Nanou <i>et al.</i> - The application of longline mussel aquaculture to establish subtidal reefs: Nature-based solutions in coastal defense	62
Guilleminot Julie Jeannine Yvonne <i>et al.</i> - When tourism meets conservation in small tropical islands: The case of Pulau Kapas, Malaysia	64
Herdayanditya Ivandito <i>et al.</i> - Vessel motion prediction near a monopile offshore wind turbine.....	65
Herweyers Robin <i>et al.</i> - Can we track the possible influence of chemical warfare agents on microbial community in the marine environment?	67
Heyse Jasmine <i>et al.</i> - Microbiomes of live feed products have an important contribution to the rearing water microbiomes in <i>Litopenaeus vannamei</i> larviculture	69
Hooyberg Alexander <i>et al.</i> - Impacts of plastic and other hazards on the healing properties of the Belgian coast.....	70
Iborra Laura <i>et al.</i> - Diving impact: Frequentation, diver behavior and consequences on the mediterranean fish community	72
Ioannou Rafail <i>et al.</i> - Array of point absorbers in front of a wall-type coastal structures: Optimum layouts under regular waves.....	73
Jaramillo-Torres Melissa Gabriela <i>et al.</i> - Time-domain wave propagation modelling for assessing the impact of WEC farms on the wave field and the local morphodynamics and sediment transport	74
Koedam Nico <i>et al.</i> - Good questions on dispersal of mangroves by observers in the 19th and early 20th century – have we already answered them ?	76
Lemey Laura <i>et al.</i> - Raywatch - A study on the population biology and survival of seven ray species in the Northeast Atlantic.....	78
Loots Erika - Assessment of trace metal pollution in <i>Octopus cyanea</i> from the coast of Tanzania.....	79
Maes Ruben <i>et al.</i> - Insights in the occurrence of early life stages of sharks and rays in the North Sea area.....	80
Mantadakis Nikos <i>et al.</i> - On the development of a generic computational tool for the time-domain analysis of hybrid offshore wind and wave energy floating systems	81
Martin Bram <i>et al.</i> - Spying bacteria for dumped World War I munition at the coast of Knokke-Heist...83	
Mertens Géraldine <i>et al.</i> - Marine hotspots revealed outside the breeding season for the Olive Ridley turtles along the Pacific coast of Nicaragua	85
Meyers Nelle <i>et al.</i> - A novel, automated method to identify microplastic polymers based on fluorescent staining with Nile Red	86
Missiaen Tine <i>et al.</i> - The Brown Bank (Southern North Sea): a geo-archaeological investigation	87
Mtonga Cretus <i>et al.</i> - Phylogenetic relationships and biogeographic diversification of shallow water octopuses.....	88
Nair Amrita <i>et al.</i> - Global patterns of the varying degree of functional redundancy in mangrove ecosystem services: A geospatial analysis.....	89

Niu Zhiyue <i>et al.</i> - Microplastic formation from a newly developed biocomposite	91
Ofori Samuel A. <i>et al.</i> - Shrimp farming, a major threat to mangrove and lagoon ecosystem in the Pambala-Chilaw lagoon complex, Sri Lanka	92
Paredes-Coral Evelyn <i>et al.</i> - What it takes to go global? Lessons from a study on ocean literacy.....	93
Pintor Albert <i>et al.</i> - Analysis of the Ciara storm impact on a multibarred beach at the Belgian coast...	94
Pluym Thomas <i>et al.</i> - Probing the single-cell activity of <i>Alcanivorax venustensis</i> during deep-sea oil degradation	95
Roest Bart <i>et al.</i> - Higher dunes, deeper sea.....	96
Rubiera Rodriguez Servane <i>et al.</i> - Understanding mangrove utilization by local communities in Sri Lanka: A social-ecological approach	97
Saelens Ganna <i>et al.</i> - Allergenic activity of Anisakidae, fishborne parasites.....	98
Sandra Matthias <i>et al.</i> - Tide against marine aquaculture litter – A knowledge-sharing platform and app.....	99
Schlessner Marianne <i>et al.</i> - Wake up, safeguard & share your marine data with EMODnet-Ingestion.EU.....	101
Schlessner Marianne <i>et al.</i> - BICEpS wants you!.....	103
Schotman Kirsten <i>et al.</i> - Sand(de)fence: Testing short-term sand trapping capacity of natural solution materials.....	105
Scotty Lucy - The Ocean InfoHub Project: Exchanging oceans data and information through a global, distributed network.....	106
Seghers Stephie <i>et al.</i> - Habitat type and dredge dumping intensity determine the sensitivity of different benthic ecosystem components in the Belgian part of the North Sea	107
Semmouri Ilias <i>et al.</i> - Metabarcoding of marine zooplankton communities in the North Sea using nanopore sequencing	108
Sismani Georgia <i>et al.</i> - Analysis of flap-type Wave Energy Converters with OpenFOAM using the dynamic mesh method	109
Smolíková Vendula <i>et al.</i> - The potential of diffusive gradients in thin films (DGT) technique as a monitoring tool for uranium in the aquatic environment	111
Stechele Brecht <i>et al.</i> - Simulating offshore blue mussel aquaculture through remote sensing and a metabolic model: a Belgian case study	112
Strypsteen Glenn <i>et al.</i> - 'Building with Nature': Coastal Sand Dunes	113
Suominen Saara <i>et al.</i> - The PacMAN project: Building capacity in pacific small island developing states on marine bioinvasions	114
Thanne Walawwe Gedera Fathima Mafaziya Nijamdeen <i>et al.</i> - A multi-stakeholder strategy to delineate issues related to coastal forest conservation: A case study from mangrove ecosystems of the Eastern coasts of Sri Lanka	115
Thys Kelly Johanna Marie - Blondes do it better? A comparative study on the reproductive biology of blonde ray (<i>Raja brachyura</i>) and thornback ray (<i>Raja clavata</i>) in the Northeast Atlantic	116
Uhlmann Sven Sebastian - Snapping fish selfies - Hook-less fishing with a camera.....	118
Van Den Bulcke Laure <i>et al.</i> - Testing repeatability, testing repeatability, testing repeatability: How reproducible are DNA metabarcoding data for marine macrobenthos?.....	119
Van Der Knaap Inge <i>et al.</i> - Atlantic cod in an anthropogenic North Sea: effects of man-made sounds on cod movement behaviour	121

Van Der Stocken Tom <i>et al.</i> - No ocean too wide? Global-scale ocean dispersal simulations support genetic evidence for trans-oceanic dispersal and connectivity in mangroves.....	122
Van Hulle Koenraad <i>et al.</i> - Numerical modelling of a wave energy converter for the WECfarm project.....	123
Verhasselt Katrijn <i>et al.</i> - The corrosion rate of the gas shells at the “Paardenmarkt”	124
Vlaminck Ellen <i>et al.</i> - Burrowing macrofauna modifies climate change effects on sediment metabolism.....	126
Zhang Jianwei <i>et al.</i> - Interactive aggregation of phytoplankton communities and suspended particulate matter.....	127
Zupan Mirta <i>et al.</i> - Sensitivity of selected gravel bed species to burial.....	128

KEYNOTE PRESENTATION

2021: A Science Odyssey – A 15-year journey across oceans and seas, and the return home

Neukermans Griet^{1,2}

¹ Marine Optics and Remote Sensing Group (MarSens), Ghent University, Krijgslaan 281, 9000 Gent, Belgium

E-mail: griet.neukermans@ugent.be

Website: <https://grietneukermans.weebly.com/>

² Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium

I will take you through my multidisciplinary science odyssey and international career path in marine optics and remote sensing. I will show some examples of how space-based and in situ optical observations of marine particles (organic or mineral, from sub-micron to millimeter size) are developed and can be exploited to assess marine ecosystem health and climate change impacts. I will also discuss ongoing and near-future advances in ocean colour satellite remote sensing and robotic ocean observations for monitoring marine ecosystem health and change.

AWARD PRESENTATIONS

Microbiome and diet turnover as an indicator of rapid environmental change in the Arctic Ocean

Maes Sarah¹, Christiansen Henrik¹, Hellemans Bart¹, Flores Hauke² and Volckaert Filip¹

¹ Laboratory of Biodiversity and Evolutionary Genomics, KU Leuven, Charles Deberiotstraat 32, 3000 Leuven, Belgium
E-mail: sarah.maes@kuleuven.be

² Alfred-Wegener Institute, Helmholtz Center for Polar and Marine Research, Am Handelshafen 12, 27570 Bremerhaven, Germany

Climate change is rapidly altering the Arctic marine ecosystem and threatening cold-adapted species. Changes in community composition and increased competition and predation are expected to disrupt the trophic interactions among organisms in the Arctic marine ecosystem, including the microbial community. Despite the essential role of the microbial diversity in host health, trophic ecology and close interaction with the environment, studies on the gut microbial communities of Arctic fish remain scarce.

Polar cod (*Boreogadus saida*), an abundant endemic circumpolar fish, functions as key species in the Arctic marine food web and might be an indicator for the environmental status of the Arctic pelagic biosphere. In particular, its diet composition might be a proxy to monitor seasonal trophic links and borealization of prey species. Furthermore, the use of certain bacterial groups to evaluate fish health and environmental status has been suggested. We extracted dietary and gut microbial information from polar cod sampled in the Barents Sea during summer and the understudied Beaufort and Chuckchi Sea in autumn using DNA metabarcoding. We described diverse polar cod prey compositions at the species-level, revealing previously undescribed prey items. Polar cod caught in the Barents Sea mainly fed on amphipods, krill and fish, whereas copepods and ostracods were common prey items in the Alaskan Arctic. Several prey items, typically found in temperate and sub-Arctic waters, point to an increasing presence of temperate and boreal species in the Arctic. We unraveled high bacterial diversity in the polar cod gut microbiome, providing an ecological baseline. The observation of bacterial groups previously not observed in the Arctic, provides new insights in the distribution of polar microbes.

Keywords: Arctic ecosystem; DNA metabarcoding; Prey composition; Dietary analysis; Microbiome

Tracking marked plastic items on their journey through the Scheldt estuary, using the Permanent Belgian Acoustic Receiver Network (PBARN)

Teunkens Bert¹, Maris T.¹, Van Damme S.¹, Blust R.² and Meire P.¹

¹ Ecosystem Management Research Group (ECOBE), Universiteit Antwerpen (UA), Prinsstraat 13, 2000 Antwerpen, Belgium
E-mail: bert.teunkens@uantwerpen.be

² Systemic Physiological and Ecotoxicological Research (SPHERE), Antwerp University, Groenenborgerlaan 171, 2020 Antwerp, Belgium

Plastic waste in coastal areas and the expanding “Plastic Soup” in our oceans are a growing threat for the marine environment. In recent years the role of rivers as a potential main contributor to marine plastic pollution has been suggested. Yet, the scale of such input remains to be systematically quantified. If high contributions can be determined, considering the vastness of oceans and seas and the great depth of some, the feasibility of projects removing plastic in rivers might be better than those in which plastic is removed from the open oceans.

Therefore, the Ecosystem Management Research Group of the University of Antwerp, is studying the potential contribution of the Scheldt river to the worldwide “Plastic Soup”. In this project the focus is on macroplastics ($\geq 2.5\text{cm}$). For this fraction it is still realistic to design removal strategies in rivers, the ultimate goal of this study. From 2018 onward, samples have been taken in the river using different techniques, like: fyke nets, a fishing technique called anchor netting and a specially designed sampler. The latter is designed to study the vertical distribution of plastics in the water column. Additionally, clean up actions have been organized to study the composition of plastic waste that ends-up on riverbanks. The data collected to date has provided crucial insights, but many questions remain unanswered.

To answer such questions as: “How long does it take for plastic to end up in the North Sea?” and “What factors determine why some types of plastic are found more on riverbanks than in the river itself?”, it was decided to follow a variety of marked plastic items on their journey through the estuary of the Scheldt river.

In December 2019 and July 2020 marked plastic items, either fitted with GPS trackers or part of a Citizen Science project, were released at different location along the Maritime Scheldt. Thanks to the ‘Brilliant Marine Research Idea’ grant we were also able to equip a number of plastic items with acoustic telemetry tags, normally used to monitor the movement of fish or marine mammals. Using the Permanent Belgian Acoustic Receiver Network (PBARN) we were able to monitor the movement of submerged plastic items in a more detailed way than ever before.

Algal microbial interactions: beyond bacteria

van der Loos Luna

Department of Biology, Faculty of Sciences, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium
E-mail: Luna.vanderLoos@UGent.be

The marine world is a microbial one. Unseen, but present in vast numbers in seawater, microbes associate with all eukaryotic organisms. It is becoming increasingly clear that these microbes, which include archaea, bacteria, fungi, microalgae, protists and viruses, have a huge impact on the functioning of eukaryotic hosts. Marine macroalgae (seaweeds) are no exception in this. Many microbes play a crucial role in macroalgal health, functioning and development during the host's various life cycle stages.

The majority of algal-microbial studies, however, only focused on bacteria, while other components of the microbiome received little to no attention. Completely overlooked are viruses which have a large potential effect, as they are very abundant in seawater and can not only infect the algal host, but also other microbial players, thus adding an extra complex interaction to the whole community. This way, viruses may spread diseases among species or may be part of the host immune system and can thus have both positive and negative impacts on the host.

The number of studies focusing on macroalgal-associated viromes can be counted on the fingers of one hand. Double-stranded and single-stranded DNA viruses were found to be associated with several kelp species and the first characterization of a full viral community was completed on a red alga, *Delisea pulchra*. These studies demonstrated that macroalgae harbor a wide diversity of viruses, and that the occurrence of infection rates can be linked to the environment, thereby emphasizing the importance of viruses in the physiology of the host.

In my PhD project, I focus on the functional consequences of the macroalgae-microbiome association and how this is influenced by environmental change, using the green macroalgal species *Ulva* (Sea lettuce) as study organism. Growth of *Ulva* is influenced by many environmental factors, including incident light, nutrient concentrations, salinity and temperature. Likewise, these factors influence the microbiome composition associated with *Ulva*. Previous studies on sponges and corals demonstrate an immediate response of the virome composition to thermal stress, with an increased abundance of viruses that are known to infect the host. For macroalgae, such vital information is lacking, and comprises a great knowledge gap.

With the VLIZ Brilliant Marine Research Idea funding, I am currently working on a pioneering experiment: extending beyond the bacteriome and entering the virome of *Ulva* (unfortunately, due to the current pandemic, I cannot present my results as of yet). The objectives are twofold, namely: 1) To characterise the virome associated with a natural *Ulva* population, thus analysing for the first time ever the complete virome of a green macroalga. And 2) To assess the short-term response of the associated viral community to thermal stress using a metaviromic approach.

These experiments will be the first step towards unravelling the impact of viruses on macroalgae during thermal stress. If we want to understand the response of macroalgae to environmental change, we should not be limited to the bacterial communities: it is time to focus on viruses.

The spatio-temporal evolution of a newly created mussel bed and its effects on benthic communities

Goedefroo Nanou

Marine Biology, Faculty of Sciences, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium
E-mail: Nanou.Goedefroo@UGent.be

As sea levels keep rising and the pressure on coastal settlements increases, there is a need for sustainable coastal protection. In the past few years, nature-based solutions received increasing recognition in order to safeguard the coasts from erosion, floods and storms. The Coastbusters project aims to develop such a nature-based solution for coastal erosion by creating biogenic reefs built by mussels in front of the Belgian coast. The creation of a mussel bed in a soft-sediment environment is a complex endeavor as its development depends on many external factors. In order to benefit the mussel bed development, dropper lines and hard substrate bags were installed in situ. Creating a new mussel bed is also expected to have an impact on the underlying macrobenthic communities. Therefore, this study aimed to explain the spatio-temporal variability of the mussel bed and its effects on the macrobenthos.

In order to test these effects, a BACI (before/after control/impact) - approach was followed. Mixed models were used to detect the effect of the reef site on the macrobenthic density and diversity. The spatio-temporal variability of the mussel bed itself was qualitatively analysed based on video material. Mussel bed patterning, its temporal variability and the observed associated fauna were assessed.

Mussel beds were only present from the summer months till the beginning of fall. Predation by *Asterias rubens*, *Carcinus maenas* and *Psammechinus miliaris* and winter storms characterized by higher wave action were identified as possible factors limiting the development of the mussel beds. On the spatial scale, mussels didn't seem to prefer the hard substrate bags over the bare sediment in between. A minor impact on the underlying macrobenthic communities was observed. Only diversity indices differed significantly between control and reef sites, with lower values observed in the reef site. Regardless of the low dissimilarity in community composition between both sites, oligochaetes were slightly more abundant in the reef site and contributed most to this dissimilarity. These results might be a first indication of a shift towards a lower diversity and oligochaete dominated community as a response to the organic enrichment of the sediment by mussel biodeposits. Long-term observations and changes in the sampling design will be needed to draw hard conclusions on the spatio-temporal variability of the mussel bed and its effects on the underlying macrobenthic communities.

Keywords: Coastal protection; Biogenic reefs; *Mytilus edulis*; Ecosystem engineer; Softsediment; Benthic impact

Mercury accumulation in fishes from North-East and North-West Barents Sea during the polar night

Gopakumar Anjali^{1,3}, Julia Giebichenstein¹, Evgeniia Raskhözheva² and Borgå Katrine¹

¹ Section for Aquatic Biology and Toxicology, Department of Biosciences, University of Oslo, Postboks 1066, Blindern- 0316 Oslo, Norway
E-mail: anjali.gopakumar95@gmail.com

² Murmansk Marine Biological Institute of the Russian Academy of Sciences, 17 Vladimirskaia st. Murmansk - 183010, Russia

³ International Master of Science in Marine Biological Resources (IMBRSea), Marine Biology Research Group, Ghent University, Krijgslaan 281/S8 - 9000 Ghent, Belgium

In this study, we quantified total mercury (Hg) concentrations and dietary descriptors in three Arctic and sub-Arctic fishes sampled during the polar night, to study their interspecific and spatial bioaccumulation patterns in the Barents Sea food web. Hg and stable isotope values of carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) were analysed in the muscle tissue of polar cod (*Boreogadus saida*), Atlantic cod (*Gadus morhua*) and capelin (*Mallotus villosus*), sampled from the North-West and North-East parts of the Barents Sea.

Hg concentrations varied greatly among individual fish, but were well below the EU-accepted threshold of fishes for human consumption of 0.5 µg/g (wet weight). Hg concentration was found to significantly increase with relative trophic position in the food web ($\delta^{15}\text{N}$) and from pelagic to benthic fishes ($\delta^{13}\text{C}$). In the North-East Barents Sea, Atlantic cod had the highest Hg concentrations, reflecting its high trophic position and benthopelagic feeding. When comparing polar cod between the two locations, individuals from the North-East had higher Hg concentrations. These variations were partly explained by the larger size of polar cod from the North-East bioaccumulating more Hg, and partly by local influences. Atlantic cod were not spatially compared, owing to the considerable difference in sizes and trophic positions between the locations. This was the first study to quantify total Hg concentrations during the polar night and will be a valuable contribution to future studies and comparisons.

Keywords: Arctic; Polar cod; Atlantic cod; Capelin; Stable isotopes; Mercury

Trace metals in estuarine and coastal waters: dynamics, speciation and bioavailability under various environmental conditions

Gaulier Camille

Analytical, Environmental and Geochemistry (AMGC), Faculty Sciences and Bioengineering Sciences, Vrije Universiteit Brussel (VUB), Pleinlaan 2, 1050 Brussel, Belgium

Along with a worldwide growth of the human population, aquatic environments are facing an ever-increasing chemical input. With the aim of regulating chemical use and protecting both humans and the environment, several regulatory frameworks have been introduced at the European scale. Yet, these regulations only focus on a limited list of priority pollutants. Moreover, and regarding hazardous elements such as trace metals, the EQS-directive of 2013 (2013/39/EU) which defines environmental quality standards (EQS) only takes into account dissolved or particulate concentrations of trace metals, or concentrations in the biota. Thus, no appropriate EQS exists for bioavailable concentrations (i.e. the fraction which is likely to be assimilated by an organism). In addition, the behavior, transport, and fate of these concerning elements in the environment remains poorly understood. To partly address this analytical gap, new ways of monitoring trace metals along our coasts and seas were investigated. More precisely, this research work, which was carried out in the framework of the NewSTHEPS project (funded by the Belgian Science Policy Office BRAIN-be), focused on the development and use of alternative sampling techniques like passive samplers (Diffusive Gradients in Thin-films, DGT) and sediment traps, which were combined with classic analytical tools, to eventually better quantify trace metals and extend the study of their biogeochemistry and bioavailability in aquatic environments. This was combined with stable isotope analysis of Suspended Particulate Matter (SPM) to trace the SPM towards its origin, alongside with the measurements of various physico-chemical parameters inherent to the environments of study.

This unique approach was applied and evaluated in the Belgian Part of the North Sea (BPNS), in the Scheldt estuary as well as in the Baltic Sea, which are three regions of great ecological, economic, even touristic values and places of intense human and industrial activities. To make an assessment of the BPNS and its estuary was essential as an almost 10-years monitoring gap exists for trace metals (total dissolved and particulate phases), and allowed to highlight new insights into the presence, transport, exposure and ecological effects of harmful metals in the shallow coastal areas and estuaries of the Southern Bight of the North Sea.

In addition, the passive sampling technique of DGT was for the first time applied in the BPNS and in the Scheldt estuary, and a first database about labile metal concentrations was therefore obtained in these areas. Key results were obtained in conjunction with existing methods and laboratory experiments at various locations, revealing traces of historical and present contamination in the areas of study.

We focused our attention on the dynamic and speciation of trace metals from the Scheldt estuary to the coastal zone: they seem to be strongly affected by environmental features and gradients (salinity, water oxygenation, tides, shape of the estuarine/seabed), while several temporal and local variabilities were highlighted (seasonally, monthly, year after year by comparisons with literature data). Concurrently, the role of SPM in trapping and storing trace metals was also observed, which certainly decreases the direct impact of dissolved metals on marine organisms. However, this big reservoir may also become a source of pollution when trace metal resuspension and solubilization happen. Finally, the combination of field and analytical techniques allowed to generate a unique set of knowledge and data, supplying the most recent information for the policy makers, and challenging new European assessment criteria for the marine environment under the Water Framework Directive.

In the future, the use of DGT for evaluating the bioavailability of trace metals in fresh and marine waters should be recommended considering its unique features. Additionally, a detailed focus on SPM with the measurements of carbon and nitrogen stable isotopes has shown a good interest for tracing the origin of SPM, giving us supplementary information on trace metal sources and SPM organic composition. This

research ultimately contributes to the development of a toolbox to evaluate anthropogenic pressures on estuarine and coastal ecosystems, regarding trace metals. Thus, this extensive approach has the potential to be part of a new standard and legal framework for future environmental monitoring.

PRE-DOC PRESENTATIONS

Successful quantification of Atlantic salmon in mixed food products using Droplet Digital Polymerase Chain Reaction (ddPCR) to identify fraud

Deconinck Dumas¹, Hostens Kris¹, Volckaert Filip², Robbens Johan¹ and Derycke Sofie¹

¹ Eenheid Dier, Onderzoeksgruppe Aquatisch Milieu en Kwaliteit, Instituut voor Landbouw-, Visserij- en Voedingsonderzoek, Ankerstraat 1, 8400 Oostende, Belgium
E-mail: dumas.deconinck@ilvo.vlaanderen.be

² Laboratory of Biodiversity and Evolutionary Genomics, KU Leuven, Ch. Deberiotstraat 32, 3000 Leuven, Belgium

Seafood plays an important role in the human diet, and as fish stocks are on the decline, more fraudulent practices are prone to happen. Salmonids are important fish species in large parts of the world, both commercially and as game fish, with Atlantic salmon (*Salmo salar*) being the most farmed marine fish. Cheaper salmonid species are potentially used as substitutes for the more expensive salmon species. Up till now, no tool existed to reliably quantify Atlantic salmon in mixed food products. The most used technique for seafood identification is DNA barcoding through Sanger sequencing, which does not allow quantification and only works when the sample contains one single species.

By using Droplet Digital Polymerase Chain Reaction or ddPCR, we developed a quantification tool to assess the percentage of Atlantic salmon in mixed food products to allow for a quick identification of seafood fraud. A *Salmo salar* specific ddPCR assay was designed using the nuclear rhodopsin gene of Atlantic salmon and nine closely related salmonid species, i.e. pink salmon (*Oncorhynchus gorbuscha*), chum salmon (*O. keta*), Coho salmon (*O. kisutch*), rainbow trout (*O. mykiss*), sockeye salmon (*O. nerka*), Chinook salmon (*O. tshawytscha*), brown trout (*S. trutta*) and Arctic char (*Salvelinus alpinus*). No cross-amplification was detected and the limit of detection was set at 0.37 copies per μl (0.024 ng total DNA) and a limit of quantification at 5.51 copies per μl (3 ng total DNA). A linear relation ($R^2 = 0.96$) was found between total DNA added to the PCR mix and the measured target copies. This is in agreement with other qPCR studies, where multi-copy genes were used instead of the nuclear rhodopsin.

Subsequently, the accuracy of quantification was tested in multiple species samples by mixing both extracted DNA and tissues from different salmonid species with Atlantic salmon tissue. The ddPCR method was able to reliably estimate the percentage of Atlantic salmon DNA, even when mixing salmon tissues in different weight percentages. A linear relationship ($R^2 = 0.89$) was found between the DNA concentration of Atlantic salmon in the extract (i.e. DNA added to the PCR mix) and the concentration measured by the ddPCR. This confirms that the real percentage of Atlantic salmon in a mixed food product can be successfully deduced by the developed ddPCR assay.

We further tested the impact of four common processing techniques, since food processing can heavily impact the quality and quantity of DNA. Freezing samples led to significantly lower DNA copy numbers. Smoking, Bellevue boiling or gravad lax did not significantly impact the DNA copy number quantification. Finally, the ddPCR method was validated by testing 46 retail products (31 Belgian and 15 Polish) containing Atlantic salmon (30 samples) or Pacific salmon (16 samples) according to the labels. No Atlantic salmon was detected in any of the Pacific salmon products. In contrast, Atlantic salmon was detected in 27 out of 30 Atlantic salmon samples. No Atlantic salmon could be detected in three canned fully homogenised Polish products, although this was mentioned on the label. In conclusion, the developed ddPCR assay can reliably and accurately quantify Atlantic salmon DNA in complex food matrices, even in extremely low concentrations and in the presence of closely related salmonid species. The method may be used to quickly detect fraud through verification of the percentage of Atlantic salmon mentioned on the food product labels, with the proviso that the processing (especially freezing) and the ingredients mentioned on the label are taken into account.

Keywords: *Salmo salar*; ddPCR; Fraud; Substitution; Salmonids; Mixed samples; Seafood

Green beaches for a green future?

Geerts J.J. Luna¹, Burdorf D. W. Laurine¹, Vicca Sara² and Meysman J. R. Filip¹

¹ Centre of Excellence for Microbial Systems Technology, Department of Biology, University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium
E-mail: Luna.geerts@uantwerpen.be

² Centre of Excellence for Global Change Ecology, Department of Biology, University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium

The Paris climate agreement aims to limit global warming through a collective and ambitious effort. Scenario analyses however reveal that “traditional mitigation” (avoiding CO₂ emissions) alone is not enough. To reach the Paris targets, we also need to actively take up CO₂ from the atmosphere (i.e. negative emissions). This is done with so-called “negative emissions technologies”, which are currently in an early stage of research and development.

Enhanced silicate weathering (ESW) is a negative emission technology based on the natural weathering of silicate rocks, which is known to take CO₂ from the atmosphere. But natural weathering is slow, and so the idea is to speed up this process by:

- [1] using fast-weathering silicate rocks, like the green-colored olivine,
- [2] finely grinding these rocks (exposing more surface area to weathering), and
- [3] spreading silicate rocks into the dynamic coastal zone.

This concept has been succinctly described as “green beaches neutralizing CO₂”. The deployment of ESW within coastal systems can be done with currently existing infrastructure and technology (mining, transport, marine engineering), making coastal ESW readily deployable, scalable, and cost-effective. This provides ESW with a considerable advantage over other negative emission technologies. Yet, there are uncertainties regarding the efficiency of CO₂-uptake and the impact of the released weathering products on marine ecosystems.

The overall goal of my PhD-project is to investigate the global potential of coastal ESW. By constructing detailed biogeochemical models of coastal ecosystems, we aim to quantify the CO₂ uptake, trace metal release, and other impacts of a local ESW application. These results are subsequently used as input into an Integrated Assessment Model (IAM) FeLiX, which links the effects of coastal ESW to the global socio-economic system (accounting for energy use and other societal responses). This allows the assessment of the global application potential, CO₂ sequestration potential, and full-scale effect of ESW. By running varying societal responses (i.e. scenarios) in FeLiX, we can infer a range of potential outcomes for ESW. In the “coal phase-out scenario”, where we link the decrease of coal mining activities to an increase in silicate mining, thereby keeping global mining activity constant. In the “ambitious mitigation scenario”, we explore the maximum potential for ESW provided that society is accepting of large mining activity. Finally, in the “global panic scenario”, society remains hesitant about the deployment of ESW, but when climate warming consequences strike hard, society chooses an “all-we-can approach” to sequester CO₂ from the atmosphere. In my presentation, I discuss these scenarios, which offer a glimpse of the future role ESW can play in drawing down CO₂ from the atmosphere and associated societal responses.

Keywords: Coastal enhanced silicate weathering; Negative emission technologies; CO₂-removal; Carbon dioxide removal; Climate change

Can we track the possible influence of chemical warfare agents on microbial community in the marine environment?

Herweyers Robin¹, Van Landuyt Josefien¹, Mattelin Valérie¹, Martin Bram¹, Laduron Frédéric², Geukens Kris², Kundu Kankana¹ and Boon Nico¹

¹ Center for Microbial Ecology and Technology (CMET), Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, 9000 Gent, Belgium

E-mail: robin.herweyers@ugent.be

² Labo Chemische Analyse DLD, Martelarenstraat 181, 1800 Vilvoorde, Belgium

All across the globe, several locations are found where the seafloor is covered with conventional munition compounds and chemical warfare agents. These are the results of official and unofficial dumping events that took place right after World War I and II (Beck *et al.*, 2018). One of these dumpsites is the *Paardenmarkt* site which is located 500 m off the coast of Belgium. Here, approximately 35.000 tons of munitions were dumped in the sea. One of these compounds is mustard gas (a chemical warfare agent), which hydrolyses quickly to ThioDiGglycol (TDG) in seawater. This compound can interact with the microbial ecosystem in marine environment. So far, most of the studies on the microbial interaction with TDG were performed in soil environments (Medvedeva *et al.*, 2009). The knowledge on how the marine microbiome interacts with TDG is still limited. When properly understood, microbial interaction with TDG can become valuable for biomonitoring and targeted bio-engineering for bioremediation.

Here, we studied the effects of TDG at different concentrations (mg/L - µg/L) on a marine microbiome. Marine sediment was collected nearby the *Paardenmarkt* site in the Belgian part of the North Sea. Two types of microcosms were set up in triplicate, containing filter-sterile seawater supplemented with nutrients and 2 mg/L acetate, sediment with microorganisms, and different concentrations of TDG (300 µg/L and 2 mg/L). Two controls were taken into account. The first one contained only seawater with sediment (without TDG), and the second one contained seawater, TDG (2 mg/L) and autoclaved sediment. The latter served to assess the interaction between TDG and the sediment. Additional incubations were set-up in the presence of high concentration of TDG, 80 mg/L both in aerobic and anoxic conditions to enrich for microbes able to use TDG as a C source. Microbial growth was monitored through flow cytometry. The phenotypic diversity was assessed over time as described in Props *et al.*, (2016). Chemical analysis of TDG concentration was performed using LC-MS.

Our first results suggest that TDG, when present at low concentrations (300 µg/L and 2 mg/L), cannot support microbial growth. However, the live cell count was the same as the two control experiments. This indicates minimal toxic influence of TDG on marine microbiome. As a second result, the concentration of TDG in the microcosms rapidly decreased after spiking (within 2 days). The TDG concentration in the control experiments decreased correspondingly, thus leaving the distinction between adsorption and biodegradation difficult. Nevertheless, during enrichment with TDG as a sole C source, microbial growth was observed in line with the reduction of TDG. The phenotypic diversity assessment of the enriched samples revealed a shift in community structure over time. This provides us with a strong indication that TDG biodegradation occurred. Further analysis on biotransformation metabolites and adsorption kinetics together with Illumina sequencing is needed to draw the complete picture of TDG degradation in the marine environment.

References

- Beck, A. J., Gledhill, M., Schlosser, C., Stamer, B., Böttcher, C., Sternheim, J., Greinert, J., & Achterberg, E. P. (2018). Spread, behavior, and ecosystem consequences of conventional munitions compounds in Coastal marine waters. *Frontiers in Marine Science*, 5(APR), 1–26.
<https://doi.org/10.3389/fmars.2018.00141>
- Medvedeva, N., Polyak, Y., Kankaanpää, H., & Zaytseva, T. (2009). Microbial responses to mustard gas dumped in the Baltic Sea. *Marine Environmental Research*, 68(2), 71–81.
<https://doi.org/10.1016/j.marenvres.2009.04.007>
- Medvedeva, N. G., Polyak, Y. M., Zaytseva, T. B., & Zharikov, G. A. (2012). Destruction of mustard gas hydrolysis products by marine and soil bacteria. *Biology Bulletin*, 39(1), 77–84.
<https://doi.org/10.1134/S1062359012010050>
- Props, R., Monsieurs, P., Mysara, M., Clement, L., & Boon, N. (2016). Measuring the biodiversity of microbial communities by flow cytometry. *METHODS IN ECOLOGY AND EVOLUTION*, 7(11), 1376–1385.
<http://dx.doi.org/10.1111/2041-210X.12607>

Keywords: Chemical warfare; Biodegradation; Mustard gas; Thiodiglycol; Flow cytometry

Integrating drone imaging with artificial intelligence to detect marine plastics

Moshtaghi Mehrdad, Knaeps Els, Strackx Gert and De Keukelaere Liesbeth

VITO Remote Sensing, Boeretang 200, 2400 Mol, Belgium

E-mail: mehrdad.moshtaghi@vito.be

Waste plastic makes up 80% of all marine debris from surface waters to deep-sea sediments. Plastic has been detected on shorelines of all the continents, with more plastic materials found near popular tourist destinations and densely populated areas (Lebreton *et al.*, 2017). The majority of plastic waste comes from China, Indonesia, the Philippines, Thailand and Vietnam. Hence, tackling the problem in these countries will have the largest impact on reducing the amount of marine plastic litter (Ryan *et al.*, 2019). Remote sensing has already shown to be very valuable for the capturing of information of marine plastic debris over vast areas along shorelines (Martin *et al.* 2018; Nakashima *et al.* 2011; Kataoka *et al.* 2018, Knaeps *et al.* 2020). For calibration and validation of satellite datasets, small drones are essential. Besides, machine learning has been shown to be useful in automated detection of beach litter (Martin *et al.*, 2018).

With the scope of the AIDMAP project, we address this issue in Vietnam through use of small drones and in-situ observations combined with Artificial intelligence (AI). In order to tune drone flight parameters like altitude, camera setting, resolution of the image and performance of designed AI model, we did a first drone campaign over a lake in Mol, Belgium and here we present results of macro-plastic detection in this campaign.

Region Based Convolutional Neural Network (RCNN) showed good performance for macro plastic detection comparing to other deep-learning algorithms (Fulton *et al.* 2019). We applied Detectron2 (Wu *et al.*, 2019), which is a faster RCNN, for 3 flight scenarios with RGB and multispectral cameras and various flight altitudes from 5 to 90 meter. Over 10000 images were obtained, where 80 percent was used for calibration and 20 percent for validation. As a result, considering Intersection of Unit (IOU) between trained model and predictions at 50, average precision obtained over 78 percent which is a promising step toward real time plastic detection.

References

- Martin, C., Parkes, S., Zhang, Q., Zhang, X., McCabe, M. F., & Duarte, C. M. (2018). Use of unmanned aerial vehicles for efficient beach litter monitoring. *Marine pollution bulletin*, 131, 662-673.
- Lebreton, L. C., Van Der Zwet, J., Damsteeg, J. W., Slat, B., Andrady, A., & Reisser, J. (2017). River plastic emissions to the world's oceans. *Nature communications*, 8, 15611.
- Ryan, P. G., Dilley, B. J., Ronconi, R. A., & Connan, M. (2019). Rapid increase in Asian bottles in the South Atlantic Ocean indicates major debris inputs from ships. *Proceedings of the National Academy of Sciences*, 116(42), 20892-20897.
- Nakashima, E., Isobe, A., Magome, S., Kako, S. I., & Deki, N. (2011). Using aerial photography and in situ measurements to estimate the quantity of macro-litter on beaches. *Marine pollution bulletin*, 62(4), 762-769.
- Kataoka, T., Murray, C. C., & Isobe, A. (2018). Quantification of marine macro-debris abundance around Vancouver Island, Canada, based on archived aerial photographs processed by projective transformation. *Marine pollution bulletin*, 132, 44-51.
- Knaeps, E., Sterckx, S., Strackx, G., Mijnendonckx, J., Moshtaghi, M., Garaba, S. P., & Meire, D. (2020). Hyperspectral reflectance dataset of dry, wet and submerged marine litter. *Earth System Science Data Discussions*, 1-24.
- Fulton, M., Hong, J., Islam, M. J., & Sattar, J. (2019, May). Robotic detection of marine litter using deep visual detection models. In *2019 International Conference on Robotics and Automation (ICRA)* (pp. 5752-5758). IEEE.
- Wu, Y., Kirillov, A., Massa, F., Lo, W. Y., & Girshick, R. (2019). Detectron2.

Keywords: Artificial Intelligence; Marine litter; Drone; Remote Sensing

Environmentally relevant concentrations and sizes of microplastic do not alter marine diatom growth

Niu Zhiyue, Vandegehuchte Michiel B, Catarino Ana Isabel and Everaert Gert

Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: zhiyue.niu@vliz.be

Microplastic (MP), i.e. plastic debris smaller than 5 mm, are widely distributed in the global ocean. Considering such a wide distribution of MP in the marine environment and their high availability to marine biota, concerns have raised about their toxic effects on marine life. For example, the growth of marine diatoms, a primary producer organism at the basis of the marine food web, may be impaired by MP contamination. The current knowledge about the ecological effects of MP remains limited, and to-date ecotoxicity tests often utilize standard MP with one or two distinct size classes and expose the organisms to unrealistically high MP concentrations.

We exposed the marine diatom *Phaeodactylum tricornutum* to microplastic particles by mimicking a realistic size-frequency distribution complemented with serial experiments with distinct size classes. To do so, we exposed this diatom to a concentration series of differently sized polyethylene (PE) microbeads (sizes: 10 – 106 µm; 1.25×10^2 - 1.25×10^7 particles / L) in a 72-hour growth inhibition test. No significant effect was observed on the growth of *P. tricornutum* by virgin PE microbeads up to 1.25×10^7 particles / L (or 499 mg / L).

Our results indicate that environmentally relevant concentrations and sizes of MP do not alter the growth of marine diatoms. Results of smaller sized MPs (10 - 20 µm) did not differ from those obtained with larger MPs (90. – 106 µm) and mix sized MPs (10-106 µm), i.e. had no impact on the microalgae growth. As a pioneer work, our results contribute with high-quality dose-response data to an improved risk assessment of microplastic under realistic present and future marine MP pollution.

Keywords: Microplastic; Marine diatom; Growth inhibition; Environmentally relevant

Assessing feasibility and best practices of zooplankton observations with the Video Plankton Recorder in coastal turbid waters

Ollevier Anouk¹, Mortelmans Jonas¹, Deneudt Klaas¹, De Troch Marleen² and Vandegehuchte Michiel¹

¹ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: anouk.ollevier@vliz.be

² Marine Biology, Faculty of Sciences, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium

Zooplankton is of great importance to our marine ecosystems and is traditionally sampled through net sampling techniques. The use of discrete net samples however has limited spatio-temporal coverage and can destroy delicate organisms. The Video Plankton Recorder (VPR), provided through the LifeWatch observatory, offers a solution: the VPR is essentially an underwater microscope that records images of particles from 100µm up to a few centimetres. As photographs are made in the water column, the VPR has the advantage that it can observe living and delicate plankton such as gelatinous zooplankton (e.g. jellyfish), colonial forming organisms (e.g. Phaeocystis) and other fragile particles (e.g. marine snow) without damaging them. The VPR can be used in conjunction with CTD measurements and the collected images can be linked to location and depth to determine the relative contribution of environmental conditions on the dynamics and 3D distribution of plankton.

In general, the VPR is towed in clear, low turbidity waters such as Atlantic or Arctic environments. The Belgian Part of the North Sea (BPNS) is however characterized by very different conditions, with the biggest concern being the high turbidity zone near the coast as field observations indicate that a high turbidity can hamper the use of the VPR. Because turbidity varies with seasons, it was first investigated when and where the VPR can be used in the BPNS. The working limit of the VPR was determined by sailing through different turbidity zones. This limit was linked to suspended particulate matter (SPM) and Secchi depth measurements, proxies for turbidity, taken on the same campaign. Using LifeWatch data-series on SPM and Secchi depths, monthly and yearly maps with the deployment area for the VPR were developed. They showed that the high turbidity areas near the coast and the Scheldt Estuary have to be avoided. Adversely, the low turbidity areas offshore and on the western part of the BPNS, can be visited practically year round. Secondly, it was investigated which tow types and magnifications provide the most valuable information on the plankton community and abiotic environment and for which studies this can be useful, with a focus on monitoring programs. During deployment, the VPR is towed behind the research vessel on a dedicated winch that allows to undulate the VPR through the water column or to keep it at a fixed depth. The depth of the VPR, sailed trajectory and magnification can be chosen by the scientist depending on the research question and can heavily affect the VPR's measurements.

Three tow types and four magnification settings were compared between themselves, and were among others scored on practicality, plankton abundance, number of plankton taxa, ability to distinguish (a)biotic patterns and image quality. For monitoring purposes, it is suggested to deploy the VPR in an undulating way while sailing in a straight line. This way, the whole water column is sampled and both horizontally and vertically valuable (a)biotic data can be collected in which gradients and patterns are recognizable. Using the second highest magnification avoids that too large or small organisms are missed, while still having sufficient image detail whereas the lowest magnification are capable to observe larger gelatinous species, which are destroyed by net samples. Progress was made regarding the knowledge, feasibility and best practice of the VPR in coastal turbid waters such as the BPNS. We can conclude that the VPR can be an added value for future plankton research and monitoring.

Keywords: Zooplankton; Optical imaging techniques; Turbidity

In times of crisis: Effect of the Belgian coast on well-being during the COVID-19 pandemic

Severin Marine I.¹, Vandegehuchte Michiel¹, Hooyberg Alexander¹, Buysse Ann², Raes Filip³ and Everaert Gert¹

¹ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium

E-mail: marine.severin@vliz.be

² Department of Experimental Clinical and Health Psychology, Faculty of Psychology and Educational Sciences, Ghent University, Henri Dunantlaan 2, 9000 Gent, Belgium

³ Centre for Psychology of Learning & Experimental Psychopathology, Faculty of Psychology & Educational Sciences, KU Leuven, Tiensestraat 102, 3000 Leuven, Belgium

The COVID-19 pandemic has led to multiple disruptions of our normal daily lives. One of these disruptions resulted in a restricted access to the Belgian coast during the first-wave lockdown, due to governmental measures restraining circulation. In that period, this study evaluated whether access and visits to the coast were positively associated with well-being. We assessed the emotions of awe and nostalgia as potential mediators between coastal visits and well-being.

The sudden COVID-19 lockdown served as a unique ad hoc opportunity to study the potential beneficial effect of exposure to the coast on mental health. A total of 687 Flemish adults took part in an online survey that was launched April 22nd until June 8th 2020. Questions on participants' sociodemographic situation, visit frequency to outdoor spaces, emotions felt during these visits, and experiential and eudaimonic well-being were included. Participants were divided in two groups: coastal residents (having access to the coast during the lockdown) or inland residents (having no access to the coast during the lockdown). Coastal residents were further divided according to their visit frequency to the coast: once a week or less, more than once a week, or every day.

A multivariate analysis of covariance revealed a significant difference in well-being between coastal and inland residents after controlling for covariates ($p = .007$). More specifically, coastal residents experienced less boredom and worry and were happier than inland residents (-9.14% and +5.5% in estimated marginal means, respectively). Coastal visit frequency was not found to be positively associated with well-being ($p = .126$). Awe and nostalgia were not more frequently experienced at the coast than in other environments; however a negative correlation was found between coast-induced awe and boredom ($r = -.32$, $p = .003$).

The study suggests that exposure to the Belgian coast works as a buffer against negative psychological consequences of the COVID-19 pandemic, thereby confirming its importance for well-being even in times of crisis. The emotion of awe triggered by the coast could be a protective factor against boredom. Policy-makers should consider making use of the coast to potentially build resilience in mental health for future crises.

Keywords: Coast; Well-being; COVID-19; Awe; Nostalgia

The importance of the spatial configuration of marram grass (*Ammophila arenaria*) on dune functioning and biodiversity

Van De Walle Ruben, Hillaert Jasmijn, Vandegehuchte Martijn and Bonte Dries

Onderzoeksgroep Terrestrische Ecologie, Universiteit Gent (TEREC-UGent), Karel Lodewijk Ledeganckstraat 35, 9000 Gent, Belgium
E-mail: ruben.vandewalle@UGent.be

Dunes are beneficial to humans because they provide ample ecosystem functions such as recreation and flood protection (Van der Biest *et al.* 2017). Marram grass (*Ammophila arenaria*) is the keystone-species in dune development because of its effective sand fixation. This enables dunes to grow, counteracting sea-level rise due to climate change, and furthermore regenerate e.g. after a storm. The spatial configuration of marram grass influences its sand fixation capabilities (Reijers *et al.* 2019) and thus also the self-regenerating capabilities of the dune as a whole.

However, so far little research is done on the optimal spatial configuration of marram grass in relation to self-regeneration of dunes. We tried to gather more insights into (the strength of) the relation between the spatial configuration of marram grass in a dune and its self-regenerating capabilities by modelling the regeneration of a dune after a storm event. Our model is different to many other models in that we also model the growth of the marram grass itself instead of regarding it as something static. Further validation (field test/reverse modelling) are needed to test the outcome of our model, but so far it looks promising.

Dunes are not only pure coastal defence structures. They also form a unique habitat full of species that are exclusively found here (Provoost & Bonte 2004). In a second part of our research we investigated the link between the spatial configuration of marram grass and the biodiversity. To assess the biodiversity we sampled the invertebrate community from marram grass tussocks in the foredunes across the coast of the Netherlands, Belgium, France and the UK during 3 consecutive summers. We compared the species richness with the spatial configuration of marram grass in order to get a better understanding of the link between both. This knowledge will be used to assess what the effect of modifying the spatial configuration of marram grass will be on the invertebrate community. Hopefully we will be able to find a way to adjust spatial configuration of marram grass so that coastal protection and biodiversity can both be optimized.

References

- Provoost S., Bonte D. (2004). Levende duinen: een overzicht van de biodiversiteit aan de Vlaamse kust. Mededelingen van het Instituut voor Natuurbehoud 22, Brussel, 420 p.
- Reijers, V.C., Siteur, K., Hoeks, S. *et al.* A Lévy expansion strategy optimizes early dune building by beach grasses. Nat Commun 10, 2656 (2019) doi:10.1038/s41467-019-10699-8
- Van der Biest, K. *et al.* Ecosysteemvisie voor de Vlaamse kust: deel II. Visie en beoordelingsmethodiek. eCOAST Report, 2014016-4. eCOAST: Oostende. 81 pp. (2017).

Keywords: Dunes; Spatial patterns; Sand fluxes; Biodiversity; Nature based solutions

How a WW2 shipwreck still influences the surrounding sediment 70 years later

Van Landuyt Josefien¹, Kundu Kankana¹, Van Haelst Sven², Parmentier Koen³, De Rijcke Maarten² and Boon Nico¹

¹ Center for Microbial Ecology and Technology (CMET), Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, 9000 Gent, Belgium
E-mail: Josefien.VanLanduyt@UGent.be

² Flanders Marine Institute (VLIZ), InnovOcean site, Wandelstraat 7, 8400 Oostende, Belgium

³ Royal Belgian Institute of Natural Sciences (KBIN), 3de en 23ste Linieregimentsplein, 8400 Oostende, Belgium

Almost 300 shipwreck sites found in the Belgian part of the North Sea are registered in the database (www.maritieme-archeologie.be). These are mainly ships that were sunk during the First and Second World War. Shipwrecks often act as artificial reefs and are sometimes considered historical heritage. As solid heterogeneous substrates, shipwrecks are rapidly colonized by microorganisms, which allows other organisms to attach and form an assemblage with dynamic community interactions. These assemblages influence the shipwrecks' structural integrity and subject it to years-long (bio-)corrosion, which can ultimately cause leakage of fuels and heavy metals.

Sediment samples were taken around a Second World War shipwreck at increasing increments further away from the wreck in different directions. Ideally, this corresponds to a decrease in concentration of fuels and heavy metals, and a differential microbial response in the affected sediment. Subsamples were taken for both chemical and microbial analysis. Polycyclic aromatic hydrocarbon levels, as well as heavy metal levels, were determined for all sediment samples to investigate if there was any leakage visible in the sediments.

In addition, we performed DNA extractions on all sediment samples and on swaps taken from steel shipwreck fragments, after which we did 16S rRNA gene sequencing to map the microbial composition. The chemical and microbial fingerprint of the samples demonstrated that low-level leaking of the coal bunker still influences the surrounding sediments. Correlations between the pollutant concentrations and the differential relative abundance of specific OTU's indicated the microbial genera and families that might play a role in the biodegradation of the leaking pollutants. By understanding better how, even after 70 years, World War shipwrecks can still significantly influence the surrounding sediment, better management strategies could be developed to preserve these artificial reefs and remediate the areas surrounding them.

Keywords: Shipwreck microbiology; Polycyclic aromatic hydrocarbons; Heavy metal leaching

Disentangling the effects of climate change on the offshore wind farm hard substrate fouling community

Voet Helena¹, Van Colen Carl² and Vanaverbeke Jan¹

¹ Royal Belgian Institute of Natural Sciences, Rue Vautier 29, 1000 Brussels, Belgium

E-mail: hvoet@naturalsciences.be

² Marine Biology, Faculty of Sciences, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium

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. The installation of these artificial hard substrates, as well as their potential as a multi-purpose platform for combined aquaculture activities, introduce a completely novel ecosystem to these otherwise sandy environments. On top of these local anthropogenic stressors, a combination of global changes continues to affect the marine ecosystem. 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.

To investigate how this combination of local and global changes is affecting our coastal ecosystems, the hard substrate fouling community found on the OWF turbines has been characterised by three model species: the blue mussel (*Mytilus edulis*), the amphipod *Jassa herdmani* and the plumose anemone (*Metridium senile*). These three model species were subjected to long-term ecophysiological experiments at Ghent University and Marine Station Ostend between 2017 and 2020. All experiments had four environmental treatments in common: CTRL (control setting with ambient sea water temperature and current pH), OA (ocean acidification setting with ambient temperature and pH lowered by 0.3), OW (ocean warming scenario with elevated temperature and current pH) and CC (climate change scenario with combination of elevated temperature and lowered pH).

This presentation reports on the different, species-specific effects of temperature and pH on the ecophysiology of our three model species. Survival and volumetric growth are heavily impacted, with an overall negative effect of environmental manipulations on survival and a varying effect of elevated temperature and lowered pH on the shell-size and biovolume of *M. edulis* and *M. senile*, respectively. Metabolic stress was quantified by changes in individual respiration rate under different environmental stressors, resulting in a species-specific reaction in oxygen consumption. Production of the potent greenhouse gas nitrous oxide (N₂O) by the model species or their microbial biofilm was quantified as well, with emission rates varying across species and climate settings. The presence of this hard substrate fouling fauna, as well as extensive aquaculture plans in these areas, undoubtedly affect the local food web structure and biogeochemistry of the surrounding environment. Therefore, ecophysiological parameters and their behaviour in future climate settings can be an important tool to characterise and validate ecological models that can be used to run different application and upscaling scenarios.

Keywords: Climate Change; Ocean acidification; Offshore wind farm; Fouling fauna; Ecosystem functioning; Aquaculture; Nitrous oxide (N₂O)

POSTER PRESENTATIONS

Effects of de-eutrophication and changes in turbidity on phytoplankton blooms in the freshwater and brackish tidal reaches of the Schelde estuary (Belgium)

Amadei Martínez Luz¹, Renaat Dasseville¹, Daveloose Ilse², Verstraete Tine², Tackx Micky³, Maris Tom⁴, Meire Patrick⁴, Sabbe Koen¹ and Vyverman Wim¹

¹ Laboratorium voor Protistologie en Aquatische Ecologie, Universiteit Gent (PAE-UGent), Krijgslaan 281-S8, 9000 Gent, Belgium

E-mail: Luz.AmadeiMartinez@UGent.be

² Protistologie en Aquatische Ecologie, Universiteit Gent (PAE-UGent), Krijgslaan 281-S8, 9000 Gent, Belgium

³ Functional Ecology and Environment Laboratory (EcoLab), University of Toulouse, CNRS, Avenue de l'Agrobiopole - BP 32607 31326 Castanet, Tolosan Cedex, France

⁴ Ecosystem Management Research Group (ECOBE), Universiteit Antwerpen (UA), Prinsstraat 13, 2000 Antwerpen, Belgium

Estuarine ecosystems worldwide are changing as a result of human activities. The observed changes are complex however, most probably reflect composite and interacting effects of multiple stressors. Changes in biogeochemistry [e.g. (de-)eutrophication affecting nutrient dynamics and oxygenation], morphology (e.g. dredging and infrastructural works impacting suspended matter dynamics) and climate (e.g. global warming, weather patterns affecting temperature, discharge, salinity, etc.) directly impact estuarine phytoplankton, but also indirectly through concomitant changes in the food web structure.

We used a long-term data set of 17 years of phytoplankton and environmental monitoring in the freshwater and brackish zone of the Schelde estuary, obtained in the framework of the OMES project (<http://www.omes-monitoring.be>), to assess how human-induced environmental change affects estuarine phytoplankton bloom dynamics and community structure. Three main periods could be distinguished:

(1) 2002 (representative of the period before phytoplankton monitoring started), characterized by high levels of ammonium and oxygen depletion, with the dominance of the centric diatom order Thalassiosirales and green algae (*Tetrastrum*, *Crucigenia* and *Scenedesmaceae*);

(2) 2003-2011, with decreasing nutrient levels and increasing dredging and channel deepening activity (after 2008), dominated by the centric diatom genera *Actinocyclus* and *Aulacoseira* and cryptophyte algae;

(3) 2012-2018, with the phytoplankton community being characterized by a high relative abundance of Thalassiosirales when turbidity was higher and discharge lower, and characterized by an increase in cyanobacteria and green algae when the discharge was higher and turbidity and total phosphorous lower.

The recent increase of cyanobacteria blooms could have negative consequences for human and animal health and increasing costs for water treatment and may require future management actions. Our study shows modifications in suspended matter and nutrients dynamics but also hydrodynamics in the Schelde estuary have significantly altered the phytoplankton dynamics and community structure in the Schelde estuary.

Keywords: Long-term; Phytoplankton; Scheldt estuary; Biodiversity; Turbidity

Assessing the regeneration status of the ankobra mangrove system, Ghana

Asante Frederick¹, Hugé Jean², Asare Kwame Asare³ and Dahdouh-guebas Farid⁴

¹ Laboratory of Systems Ecology and Resource Management, Department of Organism Biology, Faculty of Sciences, Université Libre de, Via Fra Giovanni Angelico 5, 50121 Firenze, FI, Italy

E-mail: frederickasante34@gmail.com

² Open University of the Netherlands, Valkenburgerweg 177, 6419 Heerlen, The Netherlands

³ University of Cape Coast, School of Biological Sciences, Science Building Floor 3, University of Cape Coast, Cape Coast, Ghana

⁴ Laboratory of Systems Ecology and Resource Management, Department of Organism Biology, Faculty of Sciences, Université Libre de Bruxelles – ULB, 1050 Brussels, Belgium

Globally, mangrove ecosystems are vanishing at fast rate with annual loss of 1–2% per year. It is estimated that this loss is five times greater than the forest loss worldwide. On the local front in Ghana, the Ankobra in the Ellembelle District has not escaped this loss. It remains one of the most threatened ecosystems in Ghana, mainly due to uncontrolled harvesting of mangroves and the use of the mangrove system in general. Impacts of these activities in mangrove forest ecosystems are the changes in mangrove vegetation structure, which increases the vulnerability of surrounding communities. Again, uncontrolled harvesting is a potential loss of above ground biomass of the forest. Therefore, an assessment of the trends in the conditions of the forest over time through characterizing the structural complexity is important for long-term sustainable management of the mangrove ecosystem. Therefore, this study is to assess and give a detailed structure of the Ankobra mangrove system. This is to identify whether the forest has the potential to regenerate based on its tree, juvenile densities, and the maturity index. Along transects which will be laid perpendicular to the estuary, 10 m × 10 m and 5 m × 5m belt transects will be used to sample adult and juvenile mangrove vegetations, respectively, in the adjacent sites of the estuary. Height and stem diameter (trees with stem diameter above 2.5 cm) of plants in each plot will be measured and grouped into maturity classes. All trees and juveniles in each plot will be identified to their taxonomic level and counted. Important Value (IV) of each species of mangroves will be determined from the relative frequency, relative density and relative dominance will be calculated for all tree species. Complexity indices for each site will be calculated. Spatial differences in tree, sapling and seedling densities will be tested. Morisita's index will be used to find dispersion among plots. Maturity index of the forest will be estimated, which is the ratio of sum of frequencies of individual species in the habitat and total number of species in the habitat. It is expected that there will be significant spatial variation in density, height, and diameter of adult vegetation and in densities among different regeneration classes. We expect the juvenile densities at the different sites to be significantly higher than the adult densities, the result of which will trigger the needed recommendation for management.

Keywords: Mangrove; Regeeration potential; Density; Maturity index; Ankobra

Health of mangroves and landing crab in Brazilian Ramsar site and its surroundings

Baptista-Metri Cassiana¹, Cunha-Lignon Marília², Ferreira Cottens Kelly³, Gonçalves Gabriel Antonio Do Rosário⁴, Metri Rafael⁴, Avellar Fernanda Bellinfante² and Sarubo Sarah Charlier⁵

¹ Postgraduate Program in Coastal and Insular Environments, Universidade Estadual do Paraná, Paraná Campusaguá, Comendador Correia Junior, 117, 83203-560, Paranaguá - PR, Brazil
E-mail: cassiana.metri@unespar.edu.br

² Fishing Engineering Department, Universidade Estadual Paulista, Registro Campus, Avenida Nelson Brihi Badur, 430, 11900-000 Registro - SP, Brazil

³ Instituto Chico Mendes de Conservação da Biodiversidade/Ministério do Meio Ambiente - ICMBio/MMA, Paula Miranda, 10, Centro, Guarapuava, PR, Brazil

⁴ Postgraduate Program in Coastal and Insular Environments, Universidade Estadual do Paraná, Paranaguá Campus, Comendador Correia Junior, 117, 83203-560, Paranaguá - PR, Brazil

⁵ Laboratório de Ecologia e Conservação, Centro de Estudos do Mar (CEM), Universidade Federal do Paraná (UFPR), Pontal do Sul, 83255-000 Pontal do Paraná, Cx. Postal 61, Paranaguá - PR, Brazil

The southeast-southern region of Brazil holds one of the most contiguous fragments of the Atlantic rainforest. This region has scattered mangroves protected by several conservation units, building a mosaic of Protected Areas called Lagamar across two federal states: São Paulo and Paraná. Since 2017 the area is recognized as a Ramsar site (number 2305). Despite their importance for the health of the coast and the ecological connection between mangroves and the two states, the mangroves have been monitored only in São Paulo. The vegetation is composed of Rhizophora mangle, Avicennia schaueriana, and Laguncularia racemosa, and harbors several endemic species such as Ucides cordatus, a landing crab that builds burrows and feeding on mangroves leaves, aerating the sediment and contribute to the nutrients cycle.

In this study, we presented the main results from two years of mangrove monitoring in Paraná state ($25^{\circ}30'S$), specifically in three well-conserved sites inside protected areas (ESEC, PARNA, RPPN), compared with an urban site (PGUA), close to one of the major Brazilian ports and a city with the inadequate sewerage system. Plant patterns along with density and size of landing crab (*U. cordatus*) were evaluated as an indicator of the degree of site conservation. For vegetation assessment, 16 permanent plots, along four transects were delimited in mangrove forests. Data of mangrove species, Diameter at Breast Height (DBH), and height of mangrove trees were collected in March 2019 and October 2020. Thereafter, average DBH, relative density, and relative dominance of alive and dead trunks were calculated. An optical refractometer was used to verify interstitial salinity in sediment samples, which were collected at 10 cm and 50 cm depths. The size of crabs was estimated by the width of the burrow's opening, converted into animal sizes by a regression equation, whereas its density was estimated inside ten 25m² plots in each site, at the fringe and the basin of mangrove forests. The immediate extractive potential of this economically important species was also calculated by the fraction of the population with sizes larger than the minimum allowed for capture (Carapace Width > 7 cm). The three mangrove vegetation species in the study areas were recorded, and according to the environmental factors of each transect, a given plant species was dominant. In 2019, the dominance of the basal area of dead trunks did not exceed 20%, over the four transects studied. According to the literature, conserved mangroves monitored in permanent plots on the southeastern coast of São Paulo ($25^{\circ}02'S$) show a similar result, indicating a good state of conservation, considering vegetation approach. In 2020, there was an increase of 40% in the dominance of the basal area of dead trunks in the mangroves of the fringe inside one transversal (PARNA1), due to an extreme event that occurred on 1 July 2019. According to interstitial salinity, the results at 10 cm depth ranged from 16 to 26 ppm, while at 50 cm depth they ranged from 18 to 26 ppm. The salinity results were similar to those found in the permanent plots studied in the conserved areas of Cananéia (São Paulo coast). The densities of landing crabs were higher in legally protected mangroves, just like the largest animals, and high values of immediate extractive potential. The minimum extractive potential was found at PGUA, with less than 5%, and the maximum at RPPN with 80%. It is possible to observe as a preliminary result that mangroves in protected areas present better

conditions, both in aspects related to the mangrove forest and concerning landing crabs population. It demonstrates the need to continue monitoring the areas and values the importance of regional protected areas.

Keywords: Integrated monitoring; Permanent plots; Crab population; Conservancy; Protected areas

New methods for the detection of old munition in the sea

Barradas José Felipe, Mestdagh Thomas and Missiaen Tine

Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: jose.barradas@vliz.be

The detection of munition at sea is a time-consuming task. Within the BASTA project we seek to advance ultra-high-resolution 2D and 3D acoustic imaging using multi-transducer parametric echosounder data, and through correlation with multibeam data and magnetic/gradiometric mapping allow a better identification. First results from a munition dumpsite area in the Baltic Sea ("Kolberger Heide") are very promising. Munition detection is often based on one single method. Each method will provide certain information, but has its restrictions. For instance, multibeam (MB) data give information about objects lying on the seabed, but not when they are completely buried. Magnetic sensors allow to detect iron-containing objects, buried or not, but give little information on the exact burial depth and their precision is reduced in areas with a high object density. Sub-bottom profiling (SBP) data allow to detect buried and non-buried objects and pinpoint their depth with high accuracy, but do not distinguish between ferrous and non-ferrous objects. To improve the detection efficiency, multi-sensor integration is therefore crucial. Certain patterns in the interpretation of munition targets in the SBP data were found through the correlation with multibeam and magnetic data showing munition on the seabed or partially buried. A large number of targets were picked to feed the artificial intelligence (AI) algorithm for the automated identification of potential munition targets. Faster and improved generation of targets for AI-input will be done by automating and normalizing the target image extraction. Important steps were also taken with regard to ultra-high-resolution 3-dimensional sub-bottom imaging. In former years, this technique has been applied with success for buried archeological features. Advanced processing was now done on existing test data from Raversijde, which resulted in the identification of extremely small (≤ 30 cm horizontal resolution) buried objects. Similar processing will be carried out on data from munition dumpsites in the Baltic Sea to model small buried munition targets. This will further help to continue the AI training and improve the workflows.

Keywords: Sea-dumped munition; Parametric echosounder; Ultra-high-resolution visualization; Artificial intelligence (AI)

Genetic population structure, diversity and connectivity of the commercially important cephalopod *Octopus cyanea* (Gray, 1849) in the Western Indian Ocean

Benjamen Debora, Mtonga Cretus and Kochzius Marc

Marine Biology, Ecology & Biodiversity, Vrije Universiteit Brussel (VUB), Pleinlaan 2, 1050 Brussels, Belgium

E-mail: debora.mussa.benjamen@vub.ac.be

Octopus cyanea continues to be an important resource for artisanal fisheries and coastal livelihoods of communities in Tanzania, Mozambique and Madagascar (1). Substantial growth in international market demand worldwide causes a strong increase in artisanal fishing. This is leading to a high exploitation pressure (2), raising concerns regarding the sustainability of the fishery (3).

Marine Protected Areas (MPAs) have been suggested as the essential tools for conservation and sustainable management of octopus and other marine species (4). However, for the proper design of a fully functioning network of Marine Protected Areas (MPAs), information about connectivity among populations and larval dispersal need to be taken into consideration (5). Genetic tools using DNA markers can be used to reveal gene flow and hence larva exchange among populations (5).

Arm tip tissue samples have been collected from a total of 368 *O. cyanea* individuals originating from four sites in Tanzania (Tanga, Dar es Salaam, Kilwa, Mtwara and Zanzibar) and Mozambique (Pemba, Quelimane, Vilankulo, and Maputo), respectively. They were stored in 99.9 % ethanol before further analysis. DNA extraction, PCR, and sequencing will be performed to understand the genetic population structure, diversity and connectivity of *O. cyanea* in Tanzania and Mozambique. These data will be combined with existing data that have been collected previously in Madagascar.

The study will provide recommendations for fishery management and a proper design of a fully functioning network of MPAs in the Western Indian Ocean. Tanzania, Mozambique and Madagascar are signatories of the Convention on Biological Diversity (CBD) that aims to increase the protected areas by 10 % of their territorial waters, findings from this study will be critical for the designation process.

References

1. Guard, M., Mgaya, Y.D., 2002. The Artisanal Fishery for *Octopus cyanea* Gray in Tanzania. *Ambio* 31, 528–536.
2. The International Union for Conservation of Nature (IUCN), 2004. Managing Marine Protected Areas: A Toolkit for the Western Indian Ocean. IUCN Eastern African Regional Programme, Nairobi, Kenya.
3. Humber, F., Harris, A., Raberinary, D. & Nadon, M. Seasonal closures of no-take zones to promote a sustainable fishery for *Octopus cyanea* (Gray) in Southwest Madagascar. *Blue Ventures Conservation Report*, 1-19 (2006).
4. Rocliffe S, Harris A. Scaling success in octopus fisheries management in the Western Indian Ocean. *Blue Ventures Conservation report*. 2015.
5. PALUMBI, S.R. (2003). Population genetics, demographic connectivity, and the design of marine reserves. *Ecol. Appl.* 13: S146-S158.

Keywords: Genetic diversity; Connectivity; Marine Protected Areas; Livelihood; Management

Monogenean parasites: what can COI barcoding reveal?

Bouguerche Chahinez¹, Gharbi Kamilia¹, Tazerouti Fadila¹, Gey Delphine² and Justine Jean-Lou²

¹ Laboratoire de Biodiversité et Environnement: Interactions - Génomes, Faculté des Sciences Biologiques, Université des Sciences, BP 32 El Alia 16111 Bab Ezzouar Alger, 16111 Algiers, Algeria
E-mail: chahinezbouguerche@gmail.com

² Service de Systématique Moléculaire (UMS 2700), MCAM, Muséum National d'Histoire Naturelle, 57 Rue Cuvier, Paris, France

An attempt was made to predict the biodiversity of polyopisthocotyleans (Monogenea; Platyhelminthes) parasites of marine fish from the southern Mediterranean. From 2016 to 2019, fishes were obtained from local fishermen in three localities: Bouharoune, Zemmouri, and Cap Djinet, Algeria. A combined morphological and molecular approach was used for the depiction of new species and for critical review of known species or genera that remains taxonomically challenging. We present herein three species belonging to three different families: Microcotylidae, Gastrocotylidae and Diclidophoridae. Within the Microcotylidae, we discovered two new species, *Microcotyle visa*, and *Microcotyle isyebi*. The latest is a cryptic species that can be distinguished from its congeners only on the basis of sequences of cytochrome c oxidase subunit I (COI). Among the Gastrocotylidae, we recovered *Allogastrocotyle bivaginalis*, the sole species of Allogastrocotyle; we barcoded it (COI) and reported it for the first time in the Mediterranean. The Diclidophoridae *Cyclocotyla bellones* stands out by its way of life. It is a hyperparasite that attaches itself to the dorsal face of marine tongue-eating isopods, themselves parasites of the buccal cavity of fishes. We provide for the first time, molecular barcoding information of a hyperparasitic monogenean, the parasitic crustacean host *Ceratothoa parallela*, and the primary fish host *Boops boops*.

References:

- Bouguerche, C., Gey, D., Justine, J.-L., Tazerouti, F., 2019a. *Microcotyle visa* n. sp. (Monogenea: Microcotylidae), a gill parasite of *Pagrus caeruleostictus* (Valenciennes) (Teleostei: Sparidae) off the Algerian coast, Western Mediterranean. *Syst Parasitol* 96, 131–147.
- Bouguerche, C., Gey, D., Justine, J.-L., Tazerouti, F., 2019b. Towards the resolution of the *Microcotyle erythrini* species complex: description of *Microcotyle isyebi* n. sp. (Monogenea, Microcotylidae) from *Boops boops* (Teleostei, Sparidae) off the Algerian coast. *Parasitol Res* 118, 1417-1428.
- Bouguerche, C., Tazerouti, F., Gey, D., Justine, J.-L., 2019c. Redescription and molecular characterisation of *Allogastrocotyle bivaginalis*
- Nasir & Fuentes Zambrano, 1983 (Monogenea: Gastrocotylidae) from *Trachurus picturatus* (Bowdich) (Perciformes: Carangidae) off the Algerian coast, Mediterranean Sea. *Syst Parasitol* 96, 681-694.
- Euzet, L., Trilles, J., 1961. Sur l'anatomie et la biologie de *Cyclocotyla bellones* (Otto, 1821)(Monogenea-Polyopisthocotylea). *Rev Suisse Zool* 68, 182-193.
- Nasir, P., Fuentes Zambrano, J., 1983. Algunos tremátodos monogenéticos Venezolanos. *Riv Parassitol* 44, 203-408.
- Rahmouni, C., Vanhove, M.P.M., Šimková, A., 2017. Underexplored diversity of gill monogeneans in cichlids from Lake Tanganyika: eight new species of *Cichlidogyrus Paperna*, 1960 (Monogenea: Dactylogyridae) from the northern basin of the lake, with remarks on the vagina and the heel of the male copulatory organ. *Parasites Vectors* 10, 591.
- Scholz, T., Vanhove, M., Smit, N., Jayasundera, Z., Gelnar, M., 2018. A guide to the parasites of African freshwater fishes.
- Royal Belgian Institute of Natural Sciences Brussels. Van Steenberge, M., Pariselle, A., Huyse, T., Volckaert, F.A.M., Snoeks, J., Vanhove, M.P.M., 2015. Morphology, molecules, and monogenean parasites: An example of an integrative approach to cichlid biodiversity. *PLoS ONE* 10, e0124474.
- Vanhove, M.P., Tessens, B., Schoelinck, C., Jondelius, U., Littlewood, D.T., Artois, T., Huyse, T., 2013. Problematic barcoding in flatworms: A case-study on monogeneans and rhabdocoels (Platyhelminthes). *ZooKeys*, 355-379.
- Víllora-Montero, M., Pérez-del-Olmo, A., Georgieva, S., Raga, J.A., Montero, F.E., 2020. Considerations on the taxonomy and morphology of *Microcotyle* spp.: redescription of *M. erythrini*

- van Beneden & Hesse, 1863 (sensu stricto)(Monogenea: Microcotylidae) and the description of a new species from *Dentex dentex* (L.)(Teleostei: Sparidae). Parasites Vectors 13, 45.

Keywords: Biodiversity; Platyhelminthes; Marine; Fish; Parasites; Barcoding

Seasonal dynamics of coastal North Sea macrobenthic communities from half a century ago

Broos Sarah, Van Colen Carl and Vanreusel Ann

Marine Biology Research Group, Faculty of sciences, Ghent University, Krijgslaan 281, 9000 Gent, Belgium
E-mail: sarah.broos@ugent.be

Ecosystem services provided by the marine environment are affected by its health and functioning. The secondary production of macrobenthos is often used to assess its health and functioning. This secondary production is estimated on the basis of annual sampling in autumn, the season with highest secondary production. However, many marine ecosystems are subject to seasonal variability. Estimating secondary production on the basis of annual autumn sampling may overestimate the state of the ecosystem. In order to get an idea of the deviation from this estimate, data on seasonal variability in macrobenthic secondary production is crucial. Despite the importance of seasonal time series, these data are generally very scarce, as it is very time consuming and labour-intensive work. Nevertheless, in 1970, in the framework of the Lombardsijde project, monthly samples of macrobenthos were taken in the North Sea near the Belgian coast. Not all monthly samples were processed back in the days. Now, half a century later, the macrofauna densities and biomass of these unprocessed samples are being quantified as part of an ongoing master thesis. With the obtained data, an attempt is made to form a historical baseline of the seasonal variability of the macrobenthic communities at the Belgian coast.

Keywords: Macrofauna; Seasonal variability; Historical data; Belgian North Sea; Master thesis

Offshore wind farms and their effects on plaice (*Pleuronectes platessa*) distribution and density

Buyse Jolien^{1,2}, Hostens Kris¹, Degraer Steven³ and De Backer Annelies¹

¹ Instituut voor Landbouw-, Visserij- en Voedingsonderzoek, Ankerstraat 1, 8400 Oostende, Belgium
E-mail: jolien.buyse@ilvo.vlaanderen.be

² Vakgroep Biologie, Faculteit Wetenschappen, Universiteit Gent, Karel Lodewijk Ledeganckstraat 35, 9000 Gent, Belgium

³ Royal Belgian Institute of Natural Sciences, Vautierstraat 29, 1000 Brussels, Belgium

Offshore wind farms (OWFs) are built at high speed in European waters to meet with the targets for renewable energy production. The introduction of hard structures and their scour protection layers in sandy environments such as the Belgian part of the North Sea (BPNS) entails various opportunities for reef-associated species. For example, local attraction towards hard substrates and even increased local production in OWFs was found for pouting and cod, which was explained mainly by an increase in food availability (Reubens *et al.*, 2013 & 2014, van Hal., 2017). For flatfish species, which often prefer soft sediment habitats, knowledge about their affinity or aversity towards wind farms is still scarce. Therefore, this effect was studied for plaice (*Pleuronectes platessa*), a commercially important species in the BPNS, at two different spatial scales: large- (wind farm) and small-scale (turbine). Large scale attraction was investigated with a BACI (Before/After-Control/Impact)-design study using beam trawl data from within and outside two Belgian OWFs. The analysis of the data showed a significant wind farm effect for one wind farm, while no such effect was found for a second wind farm. The small-scale effect, on the other hand, was studied by standardized visual diving censuses that were carried out close to the wind turbines in the second wind farm. Using Generalized Linear Models, we could show that the number of plaice was higher on the scour protection layer compared to the surrounding sand habitat, thus showing an attraction effect towards the hard substrate. Furthermore, preliminary small-scale telemetry results of tagged plaice individuals in the same OWF indicated high residency and site fidelity of plaice during the summer period. We concluded that plaice is attracted to OWFs at both the small and large scale, but this effect can differ between wind farms.

Keywords: Offshore wind farms; North Sea; Flatfish; Attraction; Plaice

Blue Accelerator: The new testing site in Ostend for maritime technology developments to enhance Blue Economy

Carpintero Moreno Efrain¹, Stratigaki Vasiliki¹, Troch Peter¹, De Pauw Ben² and Baur Tom²

¹ Department of Civil Engineering, Ghent University, Technologiepark 60, 9052 Gent, Belgium

E-mail: efrain.carpinteromoreno@ugent.be

² Blue Accelerator, POM West-Vlaanderen, BlueBridge - Ostend Science Park, Wetenschaps-park 1, 8400 Oostende, Belgium

The Blue Economy established sectors are embedded within the overall EU economy with a stable contribution to the Gross Added Value, GAV, of 1.5 % from 2012 to 2018, while the employment has grown from 1.8 % to 2.2 % from 2015 to 2018 [1]. Some of these Blue Economy sectors (Marine living resources; e.g. aquaculture, Marine non-living resources; e.g. Oil and gas, Port activities, Maritime transport) are presented in Table 2.1 of [1].

However, still there are sectors such as marine energy that need support for further development in order to reach an established and commercial-stage [2-4]. To achieve further development in this sector, testing and numerical modelling for new and existing concepts of marine energy technologies is crucial. Therefore, the Blue Accelerator project was recently introduced by the Flemish consortium of Ghent University (UGent), the Public Provincial Economic Development Agency of West Flanders (POM West Vlaanderen), the Flanders Marine Institute (VLIZ), the Technical University Alliance for economic transformation in West Flanders (TUA West) and VITO NV. The Blue Accelerator project aims at providing a smooth development path for marine energy and maritime technology from early design stages to scaled models at the UGent wave flume and the Coastal & Ocean Basin (both managed by Ghent University, www.ugent.be), and to scaled prototype at the Blue Accelerator open sea test site.

The Blue Accelerator platform, is located about 500 m off the port of Ostend. At this location, the average water depth is about 10 m and the tidal range 4 m. The testing zone is delimited by a circular area with a diameter of 440 m. The annual average significant wave height, H_s, and the energy period , T_e, are 0.65 m and 4.9 s, respectively, with a wave power of 4.33 kW per metre of wave-front (wave energy resource assessment from historically recorded data at 51.247° N, 2.928° E. Data provided by [5]). A long-term statistical study has predicted extreme values up to 8.5 m of wave height, when considering a return period of 100 years [6]. Ocean currents between 0.15-0.9 m/s can be found at the Blue Accelerator testing site with values up to 1.87 m/s. Given the range of the local wave and current conditions, the Blue Accelerator test site is ideal for testing new marine energy and maritime engineering technologies; e.g. marine renewable energy, aquaculture, remote monitoring equipment for offshore applications, maritime transport, and leading research programmes in combination with other existing infrastructure offered by Ghent University.

References

- [1] European Commission (2020). The EU Blue Economy Report. 2020. Publications Office of the European Union. Luxembourg. Magagna D; Monfardini R; Uihlein A.
- [2] JRC Ocean Energy Status Report: 2016 Edition EUR 28407 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2016. JRC104799.
- [3] H. Chen, T. Tang, N. Aït-Ahmed, M. E. H. Benbouzid, M. Machmoum and M. E. Zaïm, "Attraction, Challenge and Current Status of Marine Current Energy" in IEEE Access, vol. 6, pp. 12665-12685, 2018, doi: 10.1109/ACCESS.2018.2795708.
- [4] Gürsel, K.Turgut. "A technological assessment of the wave energy converter", Scientific Bulletin of Naval Academy, vol. 19, no. 1, 2016, pp. 408–417.
- [5] Agency for Maritime Services and Coast. "The Meetnet Vlaamse Banken", wave data retrieved from <https://meetnetvlaamsebanken.be> in 18/08/2020. Last accessed 04/11/202.
- [6] Lucas Jorge, "Technical note: Long term statistics of the individual wave height for the Ostend site", internal report from NEMOS wave project.

Acknowledgements

To the supporting consortium of the Blue Accelerator; Agentschap Innoveren & Ondernemen, Europees fonds voor regionale ontwikkeling, Europese Unie, West-Vlaanderen. All project partners of the Blue Accelerator, particularly to Ghent University and POM, home institution of all authors. Vasiliki Stratigaki is a postdoctoral researcher (fellowship 1267321N) of the FWO (Fonds Wetenschappelijk Onderzoek - Research Foundation Flanders), Belgium.

To the Agency for Maritime and Coastal Services for providing the wave data for the resource assessment.

Keywords: Marine energy; Blue economy; Trails testing; Scale-model testing; Open test site

Borderless nature and science: Dual aspects of opportunities and challenges of transboundary conservation: a role for science?

Cernero Reine Sophie Marie¹, Van Puyvelde Karolien¹, Mohamed Mohamed Omar Said², Kairo James³, Mangora Mwita M.⁴ and Koedam Nico¹

¹ Plant Biology and Nature Management (APNA), Faculty of Sciences and Bio-engineering Sciences, Vrije Universiteit Brussels (VUB), Pleinlaan 2, 1050 Brussel, Belgium

E-mail: Reine.Cernero@vub.be

² Wildlife Conservation Division, Parks and Reserves Department, Kenya Wildlife Service, P.O. Box 40241-00100 Nairobi, Kenya

³ Hydrography and Oceanography, Kenya Marine and Fisheries Research Institute (KMFRI), P.O. Box 81651- 80100, Mombasa, Kenya

⁴ Institute of Marine Sciences (IMS), University of Dar es Salaam, P.O.Box 35091, Dar Es Salaam, Tanzania

Political borders do not stop nature. Transboundary conservation (TBC) aims at reaching conservation goals through cooperation between nations along a border. Many types of transboundary conservation areas (TBCAs) and different cooperation levels exist. The first cases of TBCA emerged in North America and Europe in the 1930s, reaching other continents afterwards and growing considerably from the 1980s onwards. (Vasilijević *et al.*, 2015). The current crisis in biodiversity loss calls for protection of species and species habitat and is a warning for the importance of connectivity in conservation (Lausche *et al.*, 2013; Vasilijević *et al.*, 2015). The connectedness within TBCAs does not only include landscape features, biota and biological processes, but also humans or even pollution and disaster. The consideration of local human populations is part of the most recent biodiversity discourse, 'people and nature' (Mace, 2014) and involves migration, welfare and peace components (Barquet, 2015). The potential benefits to TBC being numerous, motivations and objectives for the establishment of TBCA can differ. TBC needs however to deal with biological conservation besides the consideration of economic and social aspects and this from its initial steps. While being established with the purpose of conservation, initiatives are not always supported by scientific data. Baseline data and standardization are indeed not necessarily secured. Even when available, these scientific data are not necessarily translated into policy or legal frameworks (Lim, 2015). The science-policy interface (SPI) includes some serious challenges and calls for effective communication, translation and mediation between the science and policy spheres (WIOMSA, 2020). In this sense, the general objective of this research was the identification of opportunities and challenges of TBC as well as the need and usefulness of scientific data in support for TBCA initiatives. This is being studied through a case in East Africa, more specifically the proposed coastal TBCA between Kenya and Tanzania, over a coastal stretch of approximately 100 km. A scientific project, the Trans-Coast project (2016-2021) offers scientific support to this proposed TBCA. Trans-Coast aimed at implementing research on 'Transboundary coastal processes and human resource utilisation patterns as a basis for a Kenya-Tanzania conservation area initiative', while identifying further research needs and the SPI terrain between the two countries. A major terrestrial TBCA is already shared between Tanzania and Kenya and a marine TBCA between Tanzania and Mozambique. Cooperation for effective conservation does exist in the region. However, the proposed coastal TBCA might introduce unique challenges and benefits. The comparative framework can be used for informing coastal TBCA planning. The study is mainly based on scientific and grey literature and surveys or semi-structured interviews with actors in various sectors. We present the above-mentioned benefits and challenges to the proposed coastal TBCA as well as the sectors or stakeholders that might facilitate or challenge the TBC process. Moreover, a deep look into the results of the Trans-Coast project reveals knowledge gaps and potential levers for scientific arguments regarding the implementation of the TBCA. Finally, patterns in the attitudes of policy-makers regarding scientific input could be observed. It is indeed the potential uptake of science into policy that is what many scientists strive at.

References:

- Barquet, K.. (2015). "Yes to Peace"? Environmental peacemaking and transboundary conservation in Central America. *Geoforum*. *Geoforum*.

- Lausche, B., Farrier, D., Verschuuren, J., La Viña, A. G. M., Trouwborst, A., Born, Ch.-H., Aug, L.. (2013). The Legal Aspects of Connectivity Conservation. A Concept Paper, IUCN, Gland, Switzerland. xxiv +190 pp.
- Lim, M. (2015). Governance criteria for effective transboundary biodiversity conservation. International Environmental Agreements: Politics, Law and Economics, 16, 797-813.
- Mace, G. (2014). Ecology. Whose conservation?. Science. 345. 1558-60. 10.1126/science.1254704.
- Vasilijević, M., Zunckel, K., McKinney, M., Erg, B., Schoon, M., Rosen Michel, T. (2015). Transboundary Conservation: A systematic and integrated approach. Best Practice Protected Area Guidelines Series No. 23, Gland, Switzerland: IUCN. xii +107 pp.
- WIOMSA (2020). Enhancing Science-to-Policy Uptake in the Western Indian Ocean Region. Quick Guide. WIOMSA Series No 1. vi +28 pp.

Keywords: Protected area; Coastal; Transboundary conservation; Transfrontier; Science-policy interface; Science uptake; Usefulness; Challenges; Opportunities

Historical forestry for charcoal trade in Matang Mangrove Forest Reserve, Malaysia

Chen Danyang¹, Behara Satyanarayana², Amir Ahmad Aldrie³, Hugé Jean⁴ and Dahdouh-Guebas Farid⁵

¹ Systems Ecology and Resource Management, Department of Organism, Biology Faculty of Sciences, Université Libre de Bruxelles-ULB, Avenue Franklin Roosevelt 50, 1050 Bruxelles, Belgium

E-mail: chendanyang.v@gmail.com

² Institute of Oceanography and Environment (INOS), Universiti Malaysia Terengganu-UMT, Unnamed Road, 21300 Kuala Terengganu, Terengganu, Malaysia

³ Institute for Environment and Development (LESTARI), Universiti Kebangsaan Malaysia, Bangi, Malaysia

⁴ Department of Environmental Sciences Faculty of Science, Open University of the Netherlands, Valkenburgerweg 177, 6419 AT Heerlen, The Netherlands

⁵ Department of Organism Biology, Faculty of Science, Université Libre de Bruxelles-ULB, Avenue Franklin Roosevelt 50, 1050 Bruxelles, Belgium

Matang Mangrove Forest Reserve (MMFR) in Peninsular Malaysia is known as the longest-managed mangrove forests, as the 'working plans' can be traced back to as early as 1902. The production of Rhizophora poles and charcoal through intermediate thinning and clear-felling operations has been the main objective of this management. For this purpose, the mangrove silviculture yield was first reviewed in the 1950s. After decades of revision, the mangroves are now being harvested under a 30-year rotation in the productive zones. In this context, the 10-year working plans released by the Forestry Department are helping the local authorities to enforce efficient management for forestry purposes.

Despite the century-old management, the mangrove biomass and yield were found to decrease in recent years. Therefore, we are aiming at analysing all the available working plans between 1904 and 2019, together with relevant literature, for identifying changes in the mangrove management and the yields over 117 years. Specifically, we will summarise both qualitative and quantitative data from ecological and socio-ecological viewpoints. First, the qualitative assessment by making a summary of the mangrove management practices (e.g., forest type, zoning, silviculture, exploitation, etc.) mentioned in each working plan will be prepared as shown in Table 3. This will provide a general view of the existing information and data in the working plans (qualitative and quantitative).

Second, the quantitative analysis will be carried out in detail based on the text data, numbers given in Tables and Figures. Whereas text data will be extracted manually in combination with the software NVivo, which is a qualitative data analysis computer software that could help researchers to organise and find insights to un-structured data in the text. The numbers in Tables and Figures will be extracted manually. All the data will be incorporated into the Excel worksheets to produce graphs (e.g., trend lines) and statistical comparisons will be made to identify changes in the subgroups quantitative data between 1930 and 2019.

Third, the results will be compared and interpreted with relevant literature on the MMFR studies to evaluate changes in the management. In other words, the data will be checked if the growth and recruitment rate of mangroves meets the exploitation speed and is sustainable. This research is yet to begin, and we have two hypotheses. First, mangrove resource utilisation and exploitation in the MMFR are growing over time. Second, mangrove management practices are solely responsible for vegetation growth, biomass, and yield-related variations in the MMFR. This study will enable us to understand the history that led to the current practices of the management, the deficiencies in yield, etc., and help the managers to take appropriate decisions on the future monitoring and sustainable management of the MMFR.

Keywords: Matang Mangrove Forest Reserve (MMFR); Silviculture; Management; Mangrove; Social ecology

Experimental testing of wave energy converters for the WECfarm project

Claerbout Hendrik and De Witte Bono

Ghent University, Technologiepark 60, 9052 Zwijnaarde, Belgium
E-mail: hendrik.claerbout@Ugent.be

This abstract refers to an ongoing Master Thesis, conducted by Bono the Witte and Hendrik Claerbout, at the department of Civil Engineering of Ghent University (Belgium) on the optimal geometric configuration of multiple WECs in a WEC array. A new experimental campaign within the WECfarm project is planned in a new wave basin which has been constructed in Ostend, Belgium; the Coastal & Ocean Basin (COB). WECfarm will deliver a database for validation of new advanced numerical models which are worldwide employed for WEC array modelling. At this time (November 2020), dry-testing takes place at Ghent University of one single WEC. The importance of dry-testing is to check the proper working of all mechanic, electronic and control aspects before deploying the WEC in a wave flume or wave basin. The working principle of the WEC is the one of a point absorber operating in heave. The power take-off consists of a rack and pinion system in combination with a rotational Permanent-Magnet Synchronous Motor (PMSM). To control the WEC, a Simulink 'Real Time torque control' model is used. This model is built on a development computer and subsequently loaded on a Speedgoat Performance real-time target machine. In this context, real-time is the capability of the algorithm to execute within a prescribed update rate. The input of the control model consists of the position, velocity, acceleration of the buoy and the vertical force on the buoy. These are obtained with a laser sensor, motor encoder, accelerometer and configuration of three loads cells, respectively. The output of the control model is the torque to deliver to the motor. Within the present Master Thesis a single WEC is scheduled to be tested at the wave basin of Aalborg University, as part of the WECfarm collaboration with Aalborg University, Denmark (dr. Francesco Ferri). The test matrix will contain diffraction tests, radiation tests and power absorption tests. It will also contain (extreme) wave conditions to induce non-linear effects. If possible within the timeframe of this Master Thesis (to be completed by June 2021), a second WEC will be constructed which will be identical to the first one that is currently tested. Following that, an array of two WECs will be firstly dry-tested and secondly tested in the wave flume at Ghent University with a focus on interaction and control strategy. These steps will allow us to make recommendations for the WEC array experimental set-up where up to five WECs will be employed, which will be experimentally tested at COB wave basin in 2022. During the present Master Thesis, there is close collaboration with other Master Thesis work at Ghent University focusing on control strategies and on the testing of one single WEC in order to fully characterize the hydrodynamic performance of the WEC. The obtained dataset of the 3D testing of the first WEC at the wave basin of Aalborg University will serve as input for numerical model validation that is currently taking place at Ghent University based on Smoothed Particle Hydrodynamics methods.

Keywords: WECfarm; WEC; WEC array modelling; Experimental testing; Wave bassin

Health status of the mangrove forest on the southeastern coast of the State of São Paulo (Brazil): From the bottom (soil salinity and vegetation biomass) to upwards (canopy)

Cunha-Lignon Marília¹ and Gilma Beserra De Lima Nádia²

¹ Fisheries Engineering Department, Universidade Estadual Paulista, Registro Campus, Avenida Nelson Brihi Badur, 430, 11900-000 Registro – SP, Brazil
E-mail: cunha.lignon@unesp.br

² São Paulo State Geological Institute, Rua Joaquim Távora, 822, São Paulo – SP, Brazil

The Cananéia-Iguape Coastal System is located on the southeastern coast of São Paulo (Brazil) between latitudes 24°04'0"S and 25°02'0"S. The region has great landscape, biological and cultural diversity. The region has several Protected Areas (PAs) and sites recognized by UNESCO and the Ramsar Convention. Despite this, the region has undergone hydrological changes over time due to an artificial canal (AC) opened in the 19th century, which is currently 200m wide. The connection of the Ribeira River with the coastal system by the AC has led to socio-environmental changes, such as an increase in the macrophytes occurrence, reduction in salinity and in mangrove areas and impact on fishing.

The current study aims to assess the health of mangroves in different states of conservation, based on interstitial salinity, vegetation biomass and canopy condition on the southeastern coast of São Paulo (Brazil). For that purpose, mangrove forests were evaluated in 14 permanent plots of the Integrated Mangrove Monitoring research group. The plots are in three sectors. North 1 sector, in front of AC: 4 plots. North 2 sector, 10 km distant from AC: 4 plots. And south sector, 45km away from AC: 6 plots. An optical refractometer was used to evaluate interstitial salinity in sediment samples, collected at 10cm and 50cm depths. For vegetation biomass, data were obtained from Diameter at Breast Height (DBH) and height of mangrove trees, in July 2019. Posteriorly, average DBH, relative density, relative dominance of live and dead trunks were calculated. For canopy evaluation, hemispheric photographs were obtained in November 2019, with a NIKON camera, Model F-501, coupled by a NIKOR 8 mm fisheye lens with 180° angle of view. Subsequently, they were processed in the Gap Light Analyzer software to obtain the Leaf Area Indexes (LAI) and canopy opening.

Regarding interstitial salinity, the mangroves showed average values of 3ppm, 15ppm and 26ppm, in the sectors north 1, north 2 and south, respectively, indicating different influences of the waters of the River Ribeira carried to the coastal system via AC. As for vegetation biomass, in north 1 sector, mangrove forests showed high relative densities of dead trunks (40%) of individuals of intermediate diametric classes (> 2.5cm and <10cm). The north 1 sector, no seedlings or saplings were observed in the mature mangrove forests. In north 2 sector, there was less dominance of the basal area of dead trunks (<20%), confirming a better conservation status of mangrove forests. In this area, the occurrence of seedlings and saplings in mature forests were observed, indicating recruitment of individuals. In the south sector, dominance was observed in the basal area of live trunks in all the studied plots. Dead trunks (20%) in this area occur through natural thinning, especially in young forests, with trunks with a diameter class <2.5cm.

Mature mangrove forests have individuals with high values of trunk diameter and height, but also have seedlings and saplings, with less structural development. Thus, it can be said that forests with great structural development, which also had young individuals and few dead individuals, indicate good health status of the mangroves. Conserved mangrove forests showed higher LAI values compared to impacted mangrove forests. The mangroves in north 1 sector had lower LAI values, with an average of 0.23. Meanwhile, the north 2 and south sectors had higher LAI values, with averages of 0.91 and 0.88, respectively. As for the canopy opening, altered mangrove forests showed high percentages, as was registered in the north 1 sector, with an average of 80%. Conserved forests showed lower canopy opening values, as observed in the north 2 and south sectors (averages of 44% and 42%, respectively).

LAI and canopy opening data are important and complementary to the structural vegetation monitoring to analyze the health of mangroves.

The results of this study were made available to PA managers, to assist in management plans and conservation strategies of this Brazilian coastal zone.

Keywords: Leaf Area Index; Gaps; Anthropic impacts

A reflection on mangroves within Brazilian Protected Areas

Dale Marina Vieitas¹ and Cunha-Lignon Marília²

¹ Biology Department, Universidade de São Paulo, Rua do Matão, 321, 05508-090 São Paulo - SP, Brazil
E-mail: marinavdale@gmail.com

² Fishing Engineering Department, Universidade Estadual Paulista, Registro Campus, Avenida Nelson Brihi Badur, 430, 11900-000 Registro - SP, Brazil

Of the 17 coastal states of Brazil, 16 have mangrove forests, which extend from 04°20'N to 28°30'S, for about 6,000 km of the country's 7,408 km coastline¹, and represent 7% of all mangrove cover worldwide². Due to its socio-environmental importance, the entire ecosystem is under permanent protection and more than 87% of its extension is within any of the following types of Protected Areas (PAs): Indigenous Lands (ILs), Ramsar Sites (RSs), or Conservation Units (CUs). Brazilian PAs play a very important role in the protection of mangroves by, among other reasons, ensuring the conservation of their biodiversity in situ and demonstrating its importance and functioning, through environmental education and associated activities, such as ecotourism.

This research aims to survey the mangroves in PAs, showing data on their distribution and emphasizing their importance. There is not much information about mangroves protected by ILs, but at least six of them, considering only the delimited and regularized ones, present the ecosystem, which is linked to the subsistence of part of the populations living in these areas³. CUs, on the other hand, targeted by a bigger amount of research on mangroves, protect 87% of its area of distribution in the country, of which 83% (distributed between 85 CUs) belong to the "Sustainable Use" category, which allows sustainable use of its natural resources (making it compatible with nature's conservation), while the remainder belongs to 35 areas in the "Full Protection" category, which presupposes the indirect use of resources, not allowing their consumption, collection or damage¹. The seven Brazilian RSs that contain mangroves in their interior, although they overlap with many CUs, are extremely important for the conservation of this ecosystem, as they guarantee international visibility, facilitate the obtaining of financial support for protection projects and oblige the signatory country to preserve those areas⁴. Mangroves extend for about 14,000 km² of the Brazilian coast, with the northern region of the country presenting 44% of this area, which is protected by 16 CUs, two RSs and one IL, distributed through only two states (Amapá 2°20'N and Pará 0°25'S)¹. The northeast region (08°03'S) shelters around 50% of the country's mangrove area, with Maranhão state alone accounting for 36%, and has 49 CUs, 3 ILs and 3 RSs. One of the 3 northeastern RSs, known as "Amazon Estuary and its mangroves", also covers the northern region and is composed by 23 CUs, constituting the world's largest continuous portion of mangroves under legal protection, extending over 700 km of the coastline, and protecting nearly 70% of the country's ecosystem⁴. The southeast region (20°29'S), like the southern (28°30'S), presents about 3% of mangroves' distribution area, with the first one presenting 41 CUs, one IL, and one RS, and the second presenting 14 CUs, one IL, and two RSs.

Even though many strategies seek the conservation of mangroves, placing them inside of PAs, factors such as institutional deficiencies and lack of financial resources present themselves as limitations to mangroves' protection, resulting in a scenario where its occurrence areas are still threatened by aquaculture, coastal development (tied to the advancement of the real estate market), super-exploitation of its resources, pollution, etc⁵. In this context, it is crucial to collect data on the current situation of mangroves within different categories of PAs, reinforcing their importance and understanding how they are managed.

References

1. ICMBio. Atlas dos Manguezais do Brasil / ICMBio - Brasília, 2018.
2. UNEP. The Importance of Mangroves to People: A Call to Action. van Bochove, J., Sullivan, E., Nakamura, T. (Eds). UNEP World Conservation Monitoring Centre, Cambridge, 2014.
3. FUNAI. Situação Fundiária das Terras Indígenas do Brasil, 2020. Available at .
4. Ramsar Website. Available at .

5. Gasparinetti *et al.* Os valores dos serviços ecossistêmicos dos manguezais brasileiros, instrumentos econômicos para a sua conservação e o estudo de caso do Salgado Paraense. Brasília: Funbio, 2018.

Keywords: Mangrove distribution; Indigenous lands; Ramsar sites; Conservation units; Impacts; Management

Control strategies of a wave energy converter for the WECfarm project

De Beule Louis, Vervaet Timothy, Quartier Nicolas, Stratigaki Vasiliki and Troch Peter

Civil Engineering, Ghent University, Technologiepark 60, 9052 Zwijnaarde, Belgium

E-mail: Louis.DeBeule@UGent.be

This abstract refers to an ongoing master's thesis at the department of Civil Engineering of Ghent University (Belgium) on control strategies of a wave energy converter which is being prepared for the upcoming WECfarm project. A new experimental campaign within the WECfarm project is planned in a new wave basin; the Coastal & Ocean Basin (COB) in Ostend. WECfarm will deliver a database for validation of new advanced numerical models which are worldwide employed for WEC array modelling. The working principle of the WEC is the one of a point absorber operating in heave. The power take-off consists of a rack and pinion system in combination with a rotational Permanent-Magnet synchronous motor (PMSM). To control the WEC, a Simulink 'Real Time torque control' model is used. This model is built on a development computer and subsequently loaded on a Speedgoat Performance real-time target machine. In this context, real-time is the capability of the algorithm to execute within a prescribed update rate. The control model on the target machine processes the input signals from the laser sensor, accelerometer and load cells to provide, depending on the control strategy, the torque request as output to the drive. Within this master thesis, the performance of a single WEC (the so-called "Master WEC") will be evaluated for different control strategies. The baseline strategy will be a passive controller, consisting of a force proportional to the velocity. A literature study will identify possible other advanced strategies. Model Predictive Control (MPC), Latching control, Reactive loading control and Linear Quadratic (LQ) Control are among the possibilities [1], [2]. Although the performance evaluation will be for the single Master WEC, the later extension to an array of five WECs will be taken into account as this is the WEC number that will be used in the WECfarm project. The passive control and the selected advanced control strategies will be implemented in the MATLAB Simulink model. Firstly, the efficiency of the MATLAB Simulink control model will be evaluated in a dry set-up. Secondly, the passive controller will be evaluated in wave flume tests. Tests in a wave basin will allow to determine the power production for the passive control strategy. If possible, tests with the selected advanced control strategies will be executed to compare the power production relative to the baseline strategy. These consecutive steps will allow us to make recommendations for the control of the arrays of up to five WECs, to be experimentally tested at the COB in 2022.

References

- [1] D. Wilson, G. Bacelli, R. G. Coe, D. L. Bull, O. Abdelkhalik, U. A. Korde, and R. D. Robinett III, (2016) A comparison of WEC control strategies. Sandia National Labs, Albuquerque, New Mexico, Tech. Rep. SAND2016-4293.
- [2] Beatty, S., Ferri, F., Bocking, B., Kofoed, J.P., Buckham, B., (2017). Power Take-Off Simulation for Scale Model Testing of Wave Energy Converters. Journal Article, Energies.

Acknowledgements

This work is supported by the the FWO (Fonds Wetenschappelijk Onderzoek - Research Foundation Flanders), Belgium, through the following funding: 1) Timothy Vervaet is Ph.D. fellow (fellowship 11A6919N); 2) Nicolas Quartier is an SB Ph.D. fellow (fellowship 1SC5419N); Vasiliki Stratigaki is a postdoctoral researcher (fellowship 1267321N) and has been also granted an 'FWO Research Grant' for constructing the WEC experimental set-up (FWO-KAN-DPA376).

Keywords: WECfarm; Control strategies

Prospection for bioactive compounds in the North Sea: creating a knowledge base for blue biotech innovation in Flanders

De Raedemaeker Fien¹, Sandra Matthias¹, Devriese Lisa¹, Goeminne Geert², Bicalho Keylla², Montoye Tony², Tytgat Jan³, Bernaerts Hans³, Coenye Tom⁴, Van Vlierberghe William⁴ and Loosvelt Lien⁵

¹ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelkaai 7, 8400 Oostende, Belgium

E-mail: fien.deraedemaeker@vliz.be

² VIB Metabolomics Core, Vlaams Instituut voor Biotechnologie (VIB), Herestraat 49, Campus Gasthuisberg bus 602, 3000 Leuven, Belgium

³ Laboratory of Toxicology and Pharmacology, KU Leuven, Herestraat 49, O&N2 bus 922, 3000 Leuven, Belgium

⁴ Laboratory of Pharmaceutical Microbiology, Ghent University, Ottergemsesteenweg 460 9000 Gent, Belgium

⁵ De Blauwe Cluster, Bluebridge – Ostend Science Park, Wetenschapspark 1, 8400 Oostende, Belgium

The potential of bioactive compounds from marine bioresources is currently hugely underexplored in our seas and oceans, and will offer a ‘sea of opportunities’ in several sectors. Primary and secondary metabolites in marine organisms are of particular interest because they have unique properties and a broad valorisation potential in e.g. pharma, cosmetics, agriculture, nutraceuticals, chemicals and functional bio-based materials. Nevertheless, the biodiscovery of new bioactive compounds has so far been limited in the North Sea region. The PROBIO project aims at the discovery and characterisation of bioactive compounds derived from local North Sea species. Therefore, a reproducible and scalable high-throughput workflow was established for the analytic screening of extracts regarding multitarget bioactivity and toxicity. In a first step, 50 North Sea species possibly containing bioactive compounds with a commercial potential have been identified and collected. Existing information of these species on bioactive compounds, cultivation opportunities and spatial/seasonal distribution are summarized in “Bioprospection Index cards”. Next, the sampled species are analytically screened using a high-throughput method and will result in a fingerprint of metabolites for each species (including alkaloids, terpenes, ether/ketal, steroids, lactones, hydroxybenzene/quinones and peptides). The extracts are further tested on their electrophysiological activity based on a set of pharmacological targets and on their antimicrobial activity based on biofilm-inhibitory and -eradicating activity. Structures of the hit compounds and mechanisms of action are further characterized if relevant. All data on structural, (analytical) mass spectral and biological activity of these compounds and other metadata dedicated to marine organisms will be combined in an open-source comprehensive database, as a tool for industry and knowledge institutions to identify promising applications of marine compounds for biorefinery, aquaculture and biotechnology. Careful considerations will be made in collaboration with industrial partners to file a patent on a single isolated bioactive compound or define a strategy to delay patent filing until structure analogues have been tested and found sufficiently active to claim a class of compounds. Opportunities to couple blue biotechnology with (offshore) aquaculture to produce tailor-made biomass will be explored.

Keywords: Bioprospection; Biotechnology; North Sea; Aquaculture; Bioactivity

The dolphin external ear canal, from physical towards virtual reality

De Vreese Steffen^{1,2}, André Michel² and Mazzariol Sandro¹

¹ Dipartimento di Biomedicina Comparata e Alimentazione (BCA) - Università degli Studi di Padova (It), Viale dell'Università 16, 35020 Legnaro, Padova, Italy

E-mail: steffen.devreese@studenti.unipd.it

² Laboratori d'Aplicacions Bioacústiques (LAB) - Universitat Politècnica de Catalunya (ES), Puerto Pesquero s/n, 08800 Vilanova i la Geltrù, Barcelona, Spain

The issue of underwater noise pollution is of concern to the community at large, while the effects it can have on marine fauna and its sensory systems are not yet understood. Also, it is not fully clear how cetaceans, dolphins and whales, receive sound through the alternative auditory pathways, including the acoustic fat bodies. Although the external ear canal is no longer considered a direct actor in this process, it shows interesting evolutionary adaptations in its morphology. Despite that the function of the ear canal is unclear at the moment, and basic knowledge on its morphology is inconclusive, studies of the peripheral nervous system could shine a light on the functional morphology of this small but possibly vital organ.

In this work, we focus on the techniques used in a more extensive study of the small-scale soft tissues of the external ear canal of toothed whales. In an international effort, post-mortem samples of the external ear canal of a variety of toothed whales were gathered and processed using conventional histological techniques and the digital recreation of the tissues in a virtual environment.

The results provide attractive visual representations of the ear canal and its associated soft tissue, of which here, we focus on a 400 micrometre-long reconstruction of the nervous tissues of the intramural auricular plexus in the superficial third of the external ear canal of a striped dolphin.

All of the software used is open-source, which makes the workflow available to anyone, independent of the resources available. The obtained visual representations can be complementary to other morphological studies and can provide intriguing perspectives for scientific outreach and education.

Keywords: Toothed whales; External ear canal; Morphology; Histology; 3D reconstruction

Site choice depends on group type for endangered humpback whales occurring off the Pacific coast of Nicaragua, Central America

De Weerdt Joëlle¹, Calambokidis John², Vanschoenwinkel Bram³ and Kochzius Marc¹

¹ Marine Biology, Ecology and Biodiversity, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: joelle.de.weerdt@vub.be

² Cascadia Research Collective, 218½ W 4th Avenue, Olympia, Washington 98501, USA

³ Community Ecology Lab, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium

Previous research has shown the presence of an endangered humpback whale population breeding off the Pacific coast of Central America. However, little is known about the density, size, social structure and habitat use of this subpopulation. To fill this knowledge gap, boat-based surveys were conducted between November and April at two study sites along the Pacific coast of Nicaragua between 2004-2008 and 2016-2020. Whenever a group was encountered, the number of animals, geographical position (determined by a GPS unit), SST and group composition were assessed. Photo-identification (hereafter photo-ID) allowed us to identify individual whales, with the method developed by (Katona *et al.* 1979), using natural marks on the ventral surface of flukes as well as the shape, size and scarring patterns of the dorsal fin. Our main objective is to define the primary characteristics of this humpback whale population, including abundance, encounter rates, group composition, distribution, and habitat use patterns. First, we estimated population size and density through abundance estimates and encounter rates. Second, we analyzed group size and composition, behaviors and spatio-temporal distribution patterns to infer whether the observed sites likely represent breeding areas. Third, we assessed the impact of environmental parameters on observed distribution patterns. Last, we compared our findings between northern and southern Nicaragua to see if humpback whales were using the areas in the same way. For instance, due to previous observations of feeding behaviors it is possible that there is a differential habitat use for each location. Humpback whale groups with calves, singers and competitive groups were detected from January to April confirming that Nicaragua is a breeding area. This study shows the presence of a rather small breeding population (estimated at 167-236 individuals). Different habitat use patterns exist between northern and southern Nicaragua, suggesting that Central American humpback whales might use different breeding areas within the broader Central American breeding ground according to their needs and activity. Future research should include a focus on the ecology of groups with a calf and without a calf to understand specific habitat use patterns

Keywords: Abundance estimate; Breeding ground; Distinct Population Segments (DPS); Habitat use; Northern Hemisphere; Occurrence; Photo-identification

Computer vision and self-sampling in the Belgian beam trawl fisheries

Defever Justin and Vanhoorne Sam

Instituut voor Landbouw-, Visserij- en Voedingsonderzoek, Ankerstraat 1, 8400 Oostende, Belgium
E-mail: justin.defever@ilvo.vlaanderen.be

At ILVO we are trying to be innovative at finding solutions for today's challenges in the Belgian Fisheries. Due to a shortage of fisheries data and the fact that for some fish species like Brill and Turbot, overall data is lacking (data-limited species), we are working on an innovative tool that can solve these problems. A team of scientists at ILVO is therefore developing a hardware and software system (FishScan) that can measure fish with high accuracy and identify them on species level by using just a camera and an Industrial Computer. The system is initially built to be put on top of conveyor belts in fisheries auctions and on commercial fishing vessels to collect information of the catches (ID and length of fish). With the focus on commercial fish species, we are today already able to identify sole (*Solea solea*) and plaice (*Pleuronectes platessa*) with high accuracy and measure them with high precision. Although the implementation of image recognition systems in fisheries is nothing new, we are trying to implement this system in the Belgian beam trawl fisheries with the future focus on identifying mixed catches and discards on the onboard conveyor belts. With the cooperation of the crew on board of these beam trawl vessels, a self-sampling protocol will be set up, where our newly developed system can be used to collect catch data for scientific purposes as well as for the fisheries industry.

Keywords: Machine learning; Species identification; Computer vision; Beam trawl fisheries; Self-sampling

Testing genetic tools for marine ecosystem health assessment: a pilot on non-indigenous species.

Delacauw Sander, Deneudt Klaas, GEANS Consortium and Hablützel Pascal

Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: sander.delacauw@vliz.be

GEANS (Genetic tools for Ecosystem health Assessment in the North Sea region), an Interreg North Sea region project aims to introduce DNA-based methods in biological monitoring. Within this project, seven North Sea countries collaborate to develop standard operating procedures (SOPs), test them by means of pilot studies and translate the results into a decision support framework to support stakeholders in biological monitoring. Among the pilot studies, one specifically aims for the detection of non-indigenous species (NIS), since accurate monitoring is a key prerequisite to limit the spread of NIS among harbours. While traditional survey methods require species identification upon visual inspection of each sampled individual organism, they heavily depend on taxonomic expert knowledge. Alternatively, species can be distinguished based on their unique DNA sequence. Such species-specific DNA barcodes can be read from DNA extracted from bulk samples consisting of many species without prior sorting (so-called meta-barcoding). During late spring, VLIZ initiated a NIS pilot study in the harbor of Ostend. Three sample sites were selected at which plankton samples and eDNA samples were collected. Also, settlement plates were installed at each location. Later, in high summer, these plates were recovered along with plankton, eDNA and scrape samples. These samples are now being processed using both traditional morphological analysis and DNA-based techniques. Through GEANS, traditional NIS monitoring in harbours could be improved and rendered more cost- and time-efficient as well as more accurate. HELCOM and OSPAR developed a port survey protocol to monitor non-indigenous species. This protocol is customized for morphological species identification of the sampled organisms. Using the HELCOM/OSPAR protocol as a baseline, we investigate to which extent morphological examination can be complemented or replaced by meta-barcoding. Since organisms will not be examined individually, but simultaneously from a bulk sample, identification should be more time- and as such more cost-efficient. In addition, we expect a significant improvement in detection power for non-indigenous species that are difficult to distinguish from similar native or other non-indigenous species. This particularly applies to planktonic larval stages, which are often impossible to identify at species level using morphological examination. While focusing on the North Sea region, the methods we apply are highly generic and can readily be transferred to other use cases worldwide. As such, our efforts to improve NIS monitoring will also improve standardization at the international level.

Keywords: GEANS; Non-indigenous species; Pilot; Monitoring; DNA-barcoding

OceanTeacher Global Academy: Delivering training for a sustainable ocean

Delgado Claudia, Reed Greg and Pissierssens Peter

UNESCO/IOC Project Office for IODE, InnovOcean site, Wandelaarkaai 7/61, 8400 Oostende, Belgium
E-mail: c.delgado@unesco.org

Background Capacity development is an essential tenet of IOC's mission: it enables all Member States to participate equitably in, and benefit from, ocean research and services that are vital to sustainable development and human welfare on the planet. The OceanTeacher Global Academy (OTGA) Project builds upon the legacy of decades of training delivered by IODE for its data and information management stakeholder community. A key development of OTGA was the change in approach from a single Training Centre at the IOC Project Office for IODE, Belgium, to a network of Training Centres around the world. This approach enabled capitalizing on the technical capacity already existing in the regions (teachers, experts, facilities) as well as an increase in the number of courses organized and people trained in/from the regions. Additionally, it enabled the delivery of courses in languages other than English, namely Spanish, Portuguese and French. The use of ICTs also enabled the possibility of inviting experts to contribute to courses remotely and connecting classrooms. Between 2010-2020 the OTGA successfully delivered over 220 courses and instructed over 3,300 learners from 134 Member States. OTGA Approach IOC's OTGA is a network of Regional (geography focused) and Specialised (topic focused) Training Centres (RTCs and STCs respectively) delivering training on ocean sciences, services and ocean data and information management (including marine biodiversity data and ocean best practices) using the OceanTeacher e-Learning Platform. The OT e-Learning Platform, now with over 7000 registered users globally, enables the sharing of standardised, quality training content in a coordinated framework, whilst allowing the use of different languages as well as local/regional case studies. It is a comprehensive Learning Management System (LMS) that supports classroom training (face-to-face), blended (combining classroom and distance learning), and online (distance or e-) learning. Courses cover a wide range of topics across the IOC mandate and contributing to the implementation of the IOC Capacity Development strategy (2015-2021). Furthermore, OTGA supports the organisation of and hosts training courses for other international organisations and projects. OceanTeacher Quality Management In 2018, the IOC Project Office for IODE, host of the OTGA project, achieved ISO-29990 certification as a "Learning Services Provider" for non-formal education and training. This certification is a recognition of the quality of learning opportunities offered by OTGA and the high standard of quality learning services delivered. OTGA: ready for the Ocean Decade A new phase of OTGA was approved for funding late 2019 by the Flanders-UNESCO Science Trust Fund (FUST). The new project started in April 2020, in the midst of the COVID-19 pandemic. Building on the experience accumulated, OTGA was able to quickly adapt to online training and delivered several training courses in 2020, and also hosted online training courses for other organisations. In 2021-2022 new, ready to deliver, course content will be made available online. The OTGA network of 16 Regional and Specialised Training Centres will provide a portfolio of courses in ocean sciences, spanning the physics, chemistry, and biology of marine systems, including aspects of ocean circulation, marine biology, ecology, biogeochemical cycles, ocean temperature and salinity, and marine carbon and carbonate chemistry. Topics will include tsunami warning and preparedness, marine spatial planning, ocean data management, ocean governance, transfer of marine technology and marine scientific research. OTGA will contribute to the 2030 Agenda and its SDGs and the UN Decade of Ocean Science for Sustainable Development. Training topics will include tools that can help Member States achieving the SDGs as well as emerging topics such as Ocean Acidification and Blue Carbon, etc. OTGA will build partnerships with other national and international training organizations with the aim of (i) expanding global awareness of learning opportunities, (ii) increasing learning content, (iii) developing new cross-cutting learning services, and (iv) developing and implementing quality standards for delivery of learning services. Finally, OTGA will foster collaborations beyond UNESCO/IOC to position itself as the training platform for ocean-related topics within the UN and beyond. Furthermore OTGA will be a key partner in the implementation of the Capacity Development chapter of the implementation plan of the UN Decade of Ocean Science for Sustainable Development.

Keywords: OceanTeacher Global Academy; SDGs; IOC; Ocean Sciences; Regional Training Centres (RTCs); Specialised Training Centres (STCs); Training platform; e-learning

Sustainable monitoring of commercial fish in the Belgian part of the North Sea through eDNA ddPCR analyses

Desmet Sam

Aquatic Environment and Quality, Flanders Research Institute for Agriculture, Fisheries and Food (ILVO),
Ankerstraat 1, 8400 Oostende, Belgium
E-mail: sam.desmet@ilvo.vlaanderen.be

Traditional monitoring of fish stocks in the North Sea mainly occurs via trawling, yet this method is invasive and destructive to the environment as it disturbs the seafloor and causes bycatch of non-target species. Furthermore, due to regulations it is not allowed to monitor via trawling in certain regions, such as windfarms. Recent advancements in environmental DNA (eDNA) applications offer opportunities as more sustainable alternatives for fish monitoring. eDNA comprises all intra- as well as extracellular genetic material present in an environmental sample. In the case of fish, this DNA can come from the shedding of scales and mucus or the release of gametes for example. A great advantage of using eDNA is that only a small amount of water is required to analyse it. Therefore, samples can be taken from smaller vessels or even automated samplers, without having to catch any fish or disturbing the environment. By analysing the eDNA, species presence/absence and community composition can be inferred. This method is very sensitive and often detects rare and elusive species that traditional methods tend to miss. In this study, we wanted to take this one step further and investigate whether species-specific eDNA concentrations in marine water samples may be used to estimate local fish abundances, by determining eDNA concentrations through droplet digital PCR (ddPCR), a very sensitive technique that can detect and quantify even a few molecules of DNA in a sample. We tested whether eDNA concentrations of three economically important species, common sole (*Solea solea*), plaice (*Pleuronectes platessa*) and whiting (*Merlangius merlangus*), correlate with their abundances based on traditional beam trawling data. To this end, water samples were collected in tandem with beam trawl 1 km transects in March 2020 at 12 sites in the Belgian part of the North Sea (BPNS). These sites were selected based on previous monitoring data, indicating absence, low and high abundances of the three fish species. Species-specific ddPCR primer/probe assays were developed for sole and whiting, and an existing assay was implemented for plaice. Results indicate promising correlations for all three species, although with some "false" positives. Yet, these may actually be true positive detections, which were as such not recorded within the beam trawl samples. This warrants further investigation to see at what distance a fish eDNA signal can still be detected. Therefore, 50 water samples were collected in Autumn 2020, involving more locations with and without the three fishes, again based on traditional beam trawl data. This time samples were taken at the beginning, middle and end of the 1 km transects to assure that the eDNA better represents the trawling transect and to investigate local variation in eDNA concentrations. These results will allow to fine tune the eDNA abundance correlations for the BPNS. In a next step, species-specific DNA shedding rates and local eDNA patterns will be investigated, which are likely to be more complex in the marine environment compared to freshwater systems. The combined results of these experiments will show whether the correlations allow for accurate abundance estimations, in order to evaluate if eDNA can serve as a potentially efficient and sustainable alternative or addition to traditional abundance estimates.

Keywords: Environmental DNA; Fish abundance estimation; Genomics; Sustainable monitoring

Mangrove forests under extreme events at the southeastern coast of the state of São Paulo, Brazil

Dourado-Batista Carlos Victor¹, Dahdouh-Guebas Farid¹ and Cunha-Lignon Marília²

¹ Systems Ecology and Resource Management Research Unit, Département de Biologie des Organismes Université Libre de Bruxelles, Avenue F.D. Roosevelt 50, CPI 264/1, 1050 Bruxelles, Belgium

E-mail: carlos.victor.db@gmail.com

² Universidade Estadual Paulista, Campus Registro, Av. Nelson Brihi Badur, 430 - Vila Tupy, Registro - SP, 11900-000, Brazil

The Cananéia-Iguape coastal system (CICS) is one of the most biodiverse, extensive and well conserved examples of the Atlantic forest in southeastern Brazil (from 24°40'S to 25°20'S). The system is within the Atlantic Forest South-East Reserves, a World Heritage Site, and the Mata Atlântica Biosphere Reserve both from UNESCO. It is also referred to as a RAMSAR site, as it is encompassed by the Environmental Protection Area of Cananéia-Iguape-Peruíbe. Among the ecosystems and habitats the CICS hosts, well conserved mangrove forests can be found. Mangrove ecosystems are widely known to bring social, economic and ecological benefits to people and coastal biota, such as providing protection against ocean surges, fishery resources, nursery sites for coastal biota, cultural amenities such as ecotourism, medicinal and landscape resources, as well as spiritual values such that leading to the acknowledgement of the care for the Common Home.

In 2018, this coastal system was affected by two extreme events - strong winds and the opening of a barrier-inlet system, which led especially to mangrove vegetation disturbance. The last, was also known to have impacted local communities by displacing them from their villages because of the risk they were found in. Extreme events, such as these, are likely to increase due to the continued emissions of greenhouse gases into the atmosphere, and are likely to worsen the negative impact on humans and ecosystems, especially the most exposed and vulnerable as coastal environments. Hence, the objective of this study is to assess the impacts that the two extreme events brought in 2018 to mangroves and their traditional communities in the CICS. Sentinel-1 Synthetic Aperture Radar (SAR) imagery will be used to accompany mangrove vegetation loss and the changes in the opening of the barrier-inlet from 2017 to 2020. High resolution optical imagery provided by 'Secretaria de Infraestrutura e Meio Ambiente do Estado de São Paulo', Brazil and Sentinel-2 Imagery from the Sentinel Explorer Platform will be used to assess the mangrove greenness by Normalized Difference Vegetation Index and to detect mangrove vegetation loss through maximum likelihood classification for 2016, 2018 and 2020.

To assess the impact on local traditional communities, a socio-ecological questionnaire will be used to evaluate their perceptions on the event itself, and on its impacts on mangroves and people. Partial results have shown a continuous decrease of vegetation and area of mangrove patches which were disturbed by the barrier-inlet breaching, since it continues to widening. In the meanwhile, changes on vegetation cover were detected for those mangroves disturbed by strong winds through the optical imagery assessment. Although the survey that will be conducted by questionnaires is still to be done, it is expected that a more representative view of the impact caused in 2018 by extreme events in the CICS will be reached. The survey of traditional knowledge and their relationship with the mangrove ecosystem already have shown how people rely on mangroves and how important their knowledge and perspectives were to address changes in mangroves. Since the CICS is in frontline of extreme events, a more integrative research will provide a step further for the understanding of the impacts of extreme events on people and mangroves.

Keywords: Traditional knowledge; Mangrove use; Climatic anomalies; Wind extreme events; Ocean surges; Bar opening; Vegetation disturbance; Impacted people

What are the ecosystem goods and services in Colombian and Senegalese species-poor mangrove forests?

Dupont Rémi¹, Georis Sylvestre², Polanía Vorenberg Jaime Henning³ and Dahdouh-Guebas Farid⁴

¹ Systems Ecology and Resource Management Research Unit, MSc student, Vrije Universiteit Brussel (VUB), August de Smedtstraat 38, 1702 Groot-Bijgaarden, Belgium

E-mail: remi.quentin.dupont@vub.be

² Systems Ecology and Resource Management Research Unit, MSc student, Université Libre de Bruxelles (ULB), Rue Victor Horta 31/201, 1348 Louvain-la-Neuve, Belgium

³ Department of Forestry (Medellín), Professor Doctor, Universidad Nacional de Colombia, Sede Medellín, Carrera 65 N°59A-110, 20-208, Medellín, CP 050034, Colombia

⁴ Systems Ecology and Resource Management Research Unit, Professor Doctor, Université Libre de Bruxelles (ULB), Avenue F.D. Roosevelt 50, CPi 264/1, 1050 Bruxelles, Belgium

This study will investigate the use and the utilization of different mangrove goods and services in Senegal and Colombia. Both countries are located in the Atlantic-East Pacific biogeographical region of mangroves and are characterized by a low number of mangrove species (Ellison et al., 1999). The use and utilization of these species will be assessed and compared with each other. In addition, the change in mangrove forests will be evaluated based on perceptions of local communities. The data were obtained through a social-ecological semi-structured questionnaire with open-ended and closed-ended questions administered face-to-face at approximately the same time period. The current COVID-19 crisis has a considerable impact on the discipline of ethnobiology (Vandebroek et al., 2020). International travels under current measures and distrust of local communities towards researchers hinders fieldwork abroad. This forces us to work with previously obtained data, which has never been compared before (Georis, 2015; Surlemont, 2014). Mangroves in Colombia and Senegal have both suffered degradation in the past, mostly from anthropogenic activities (Friess et al., 2019). The Sine-Saloum delta in Senegal and Cispatá Lagoon System in Colombia provide numerous ecosystem services and a range of mangrove goods to local communities. This unique ecosystem provides the essential support for local livelihoods, consequently urging its conservation and adequate management. (Walters et al., 2008) The two respective areas are dominated by the mangrove species Rhizophora mangle (red mangrove) and Avicennia germinans (black mangrove) (Gallup et al., 2020; Agudelo et al., 2015). During this study, the importance and different uses of these species will be assessed in the two areas. The comparison made in this on-going study is expected to show the versatility and similarities of the goods and services mangroves provide on two different continents. The study also incites further research: the replication of these social-ecological questionnaires worldwide contributes to a global analysis giving an idea on how universal the use and utilization of mangrove goods and services are. Finally, the study enables us to understand how mangrove forests have changed through the experience of local inhabitants.

References

- Agudelo, C.M., Bolívar, J., Polanía, J., Urrego, L.E., Yepes, A. & Sierra, A. Estructura y composición florística de los manglares de la bahía de Cispatá, Caribe colombiano. *Revista de Biología Tropical*. 63(4), 1137–1147 (2015).
- Ellison, A. M., Farnsworth, E. J. & Merkt, R., E. Origins of mangrove ecosystems and the mangrove biodiversity anomaly. *Global Ecology and Biogeography*. 8, 95–115 (1999).
- Friess, D.A., Rogers, K., Lovelock, C.E., Krauss, K.W., Hamilton, S.E., Lee, S.Y., Lucas, R., Primavera, J., Rajkaran, A. & Shi, S. The State of the World's Mangrove Forests: Past, Present, and Future. *Annual Review of Environment and Resources*. 44(1), 89–115 (2019).
- Gallup, L., Sonnenfeld, D. A. & Dahdouh-Guebas F. Mangrove use and management within the Sine-Saloum Delta, Senegal. *Ocean and Coastal Management*. 185 (2020).
- Georis, S. (2015). Etude des Effets Anthropogéniques sur les Mangroves Adjacentes à Sokone (Sine-Saloum, Sénégal) (Unpublished master's thesis).
- Université Libre de Bruxelles, Brussels, Belgium. Surlemont, K.P. (2014). Changing Livelihoods and Environmental Degradation in an area for Sustainable Mangrove Management A case study in the Bahía de Cispatá, Colombia (Unpublished master's thesis).

- University of Copenhagen, Copenhagen, Denmark. Vandebroek, I., Pieroni, A., Stepp, J. R., Hanazaki, N., Ladio, A., Alves, R. R. N., Picking, D., Delgoda, R., Maroyi, A., van Andel, T., Quave, C. L., Paniagua-Zambrana, N. Y., Bussmann, R. W., Odonne, G., Abbasi, A. M., Albuquerque, U. P., Baker, J., Kutz, S., Timsina, S., Shigeta, M., Oliveira, T. P. R., Hurrell, J. A., Arenas, P. M., Puentes, J. P., Hugé, J., Yeşil, Y., Jean Pierre, L., Olango, T. M. & Farid Dahdouh-Guebas, F. Reshaping the future of ethnobiology research after the COVID-19 pandemic. *Nature Plants*. 6, 723–730 (2020).
- Walters, B. B., Rönnbäck, P., Kovacs, J. M., Crona, B., Hussain, S. A., Badola, R., Primavera, J. H., Barbier, E. & Dahdouh-Guebas, F. Ethnobiology, socio-economics and management of mangrove forests: a review. *Aquatic Botany*. 89, 220–236 (2008).

Keywords: Mangroves; Ecosystem services; Mangrove resources; Livelihoods; Mangrove biodiversity anomaly

Sediment Profile Imagery (SPI) applicability for environmental impact assessment in shallow coastal environments

Fernandes João¹, Van Hoey Gert², Braeckman Ulrike³, De Backer Annelies², Depetele Jochen², Lefaible Nene³, Tiano Justion⁴, T'jampens Michiel⁵, Toussaint Elise⁶, Vanaverbeke Jan⁶ and Hostens Kris²

¹ CETEMARES, MARE-IPL, Politécnico de Leiria & MAREFOZ - Parque Industrial e Empresarial da Figueira da Foz, Inc. de Empresas da Figueira da Foz Parque Empresarial e Industrial da, R. Acácias lote 40A, 3090-380 Figueira da Foz, Portugal
E-mail: joao.fernandes@imbrsea.eu

² Instituut voor Landbouw-, Visserij- en Voedingsonderzoek (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

³ Marine Biology Research Group, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium

⁴ Royal Netherlands Institute for Sea Research (NIOZ), Korringaweg 7, 4401 NT Yerseke; The Netherlands

⁵ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium

⁶ Royal Belgian Institute of Natural Sciences, Vautierstraat 29, 1000 Brussel, Belgium

The Marine Strategy Framework Directive (MSFD), descriptor 6 (Seafloor integrity) requires an assessment of the areal extent in physical loss and disturbance, and adverse effects caused by the ongoing anthropogenic activities within an area (EU guidance article 8). This requires monitoring the benthic environment on a large spatial scale and for many anthropogenic activity types. To accomplish this, a search is done for more cost-efficient tools. The sediment profile imaging (SPI) allows a quick examination of the benthic habitat quality and consists of a wedge-shaped prism with an inverted periscope that penetrates the seafloor to reflect the sediment-water interface (SWI). Therefore, the SPI camera provides an undisturbed 20 cm (maximum), high resolution, cross-sectional profile image which can be analyzed for biological, physical and chemical parameters. Each picture provides several parameters, such as sediment type (e.g. muddy, very fine, fine, medium, coarser sand); prism penetration (proxy for sediment compaction); surface reliefs & bedforms; surface and sub-surface fauna; sediment apparent redox potential discontinuity depth (aRPD) (estimates the oxidized sediment depth); and the % of anoxic surface area. Those parameters form the basis for the benthic indicators: the organism sediment index (OSI) [1] and benthic habitat quality (BHQ) [2]. Several studies test SPI applicability in deep-sea and estuarine environments, although very few studies were taken in shallow coastal areas. In this study, we tested the performance and applicability of the SPI derived parameters for environmental impact assessment (EIA in the dynamic coastal environment of the Southern North Sea. Therefore, a total of 600 SPI images were collected based on a control-impact design across 4 EIA cases (dredge disposal, sand extraction, offshore wind farms and fishery (beam trawl & pulse fishery)). The images were analyzed using the SpiArcBase software [3], which allows us to create and manage a database with the original SPI pictures and derived parameters. The SWI, penetration depth and aRPD (depth, surface area) were directly calculated within the software. The remaining features were catalogued in a pre-defined Excel table. The sediment classes were relevant information for each case and sediment changes (e.g. mud clasts) were most obvious for the dredge disposal case. The prism penetration depth revealed slight changes in sediment compaction due to fishery, dredge disposal and sand extraction activity. The surface fauna and % of anoxic sediment surface indicated to be relevant to assess the redox sediment stage and fauna quality for all the cases. However, the evaluation of sub-surface fauna, based on SPI, could only be done in areas where infauna was very abundant. This was true for the fishery case, where we observed a decline in Lanice conchilega after the fishery disturbance. The BHQ (adapted version from Nilsson & Rosenberg [2]) indicator allowed to detect changes due to the impacts, whereas the OSI indicator was not sensitive at all. Our study indicates the importance of the SPI derived parameters for EIA purpose in shallow coastal environments by combining information from multiple anthropogenic stressors. This comprehensive approach showcases the adaptability and ease of use of the SPI for benthic impact assessments. The SPI provides important information regarding specific features in-situ that other methods struggle to achieve, and its applicability must be seen as a complementary tool to improve the traditional sediment sampling programs.

References

- [1] Rhoads D.C., Germano J.D. (1987) Interpreting long-term changes in benthic community structure: a new protocol. In: Heip C., Keegan B.F., Lewis J.R. (eds) Long-Term Changes in Coastal Benthic Communities. Developments in Hydrobiology, vol 38. Springer, Dordrecht. https://doi.org/10.1007/978-94-009-4049-9_25
- [2] Nilsson H.C., Rosenberg R. (1997) Benthic habitat quality assessment of an oxygen stressed fjord by surface and sediment profile images. Journal of Marine Systems, Vol 11, Issues 3–4, Pages 249–264, ISSN 0924-7963. [https://doi.org/10.1016/S0924-7963\(96\)00111-X](https://doi.org/10.1016/S0924-7963(96)00111-X)
- [3] Romero-Ramirez, A. et al. (2016) Development and validation of a video analysis software for marine benthic applications. J. Mar. Syst. 162, 4–17. <https://doi.org/10.1016/j.jmarsys.2016.03.003>

Keywords: SPI; Sediment; EIA; Applicability; Anthropogenic activities

Where did we take those samples from? Georeferencing your research with marineregions.org

Fernández Bejarano Salvador, Lonneville Britt, Vanhoorne Bart and Schepers Lennert

Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: salvador.fernandez@vliz.be

MarineRegions is a open access database of georeferenced names of marine places. Surely, you can say your sampling points were located at the Bay of Plenty, Point Dissapointment or Dummy Bay (yes, these are real places you can find in MarineRegions.org!). But how do you make sure your concept for 'Strait of Gibraltar' is the same as your peer's? Thanks to the Marine Regions gazetteer you can pinpoint the exact place, so you and your colleagues won't need to share your phone location to find each other anymore. Furthermore, we digitize the legal maritime boundaries of the world countries so you can visualize them in any Geographic Information System software. And for those true geeks out there, we provide access the boundaries and the gazetteer with the R package mregions and the web services. In 2020 we had plenty of time to sit at home and improve MarineRegions. One of the issues always hanging around our heads was the exploitation of the seabed resources. The oceans provide us with wonderful materials, but we believe they must be harvested following international treaties. To facilitate the research and policy making in this domain, we have started developing a Continental Shelves product. This is a brand new product that will show the official continental shelf claims that countries have submitted to the United Nations. MarineRegions is the geographical backbone of the LifeWatch Species Information backbone and it is used by many partners such as the World Register of Marine Species (WoRMS), the Ocean Biodiversity Information System (OBIS), Sea Around Us, Global Fishing Watch or EMODnet. Join us at the VLIZ Marine Science Day if you want to dive deeper into the places of the sea from the comfort of your couch.

Keywords: Maritime; Law of the Sea; Oceans, World; Gazetteer; Boundaries

The pressure is on! How different human activities affect functional diversity in soft-bottom macrobenthos.

Festjens Felien¹, Breine Naomi¹, Lefaible Nene², De Backer Annelies¹ and Van Hoey Gert¹

¹ Aquatic Environment and Quality, Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Ankerstraat 1, 8400 Oostende, Belgium
E-mail: felien.festjens@ilvo.vlaanderen.be

² Marine Biology Research Group, Biology Department, Ghent University, Krijgslaan 281-S8, 9000 Ghent, Belgium

There is an increasing awareness that knowledge of the functional diversity of a community is key to understand how the community responds to environmental and anthropogenic stressors. It is also expected that indicators derived from biological traits could be more suitable to quantify the sensitivity of benthic communities. These functional indicators can then be used to detect changes in ecosystem functioning within environmental impact assessment programs. The Belgian Part of The North Sea (BPNS) represents a highly dynamic area that is subject to a variety of human activities. Within this study, the impact of three different activities - dredge disposal, sand extraction and offshore wind energy – was evaluated by assessing differences in functional diversity.

A total of ten relevant traits were selected, subdivided in 44 modalities, incorporating both response- and effect traits. Effect traits are those which affect ecosystem properties while response traits explain a species' response to disturbances in the environment (Bolam *et al.*, 2016). Functional diversity was then quantified by calculating different indices: functional richness, functional divergence, functional evenness, functional dispersion and Rao's quadratic entropy. Shifts in trait composition due to anthropogenic pressure were determined by Fuzzy Correspondence analysis (FCA). These FCA biplots were produced for each case and location, focusing on the response and effect traits separately. By comparing the pairwise distances of the impact categories within the FCA plot, the trait modalities that drive or explain the shift in communities were identified.

The analyses were performed on data from 2006-2016 at the dredge disposal sites, linked to three macrobenthos habitat types (*Abra alba*-, *Limecola balthica*- and *Nephtys cirrosa*-habitat; Breine *et al.* 2018), data from 2009-2016 at three main sand extraction areas and data from 2017-2018 at two offshore wind farms (C-Power and Belwind). Dredge disposal and sand extraction stations were divided into four impact categories ranging from 'none' to 'high', while the windfarm stations were allocated to either 'impact' or 'control' according to their distance from the turbines.

Apart from FDiv, all of the indices showed a response to the different impact levels and type of disturbance. FRic between the highest impact level and control was significantly lower in two of the habitats for the dredge disposal case, but nearly significantly higher for the heaviest impacted sand extraction area. FDis and RaoQ followed the same trend and were highest at high levels of dumping but lower at the highest level of sand extraction. FEve had a varied (decrease/increase) response according to case and impact category. Within the offshore wind farms, findings for the functional diversity indices were less pronounced and only FRic was significantly elevated at impact sites of C-Power at Thorntonbank. Nevertheless, impact and control stations of both windfarms were fairly well separated in the FCA biplots and had the same five trait-modalities associated with the impact stations: small maximum body size, short lifespan, active brood care, exoskeleton and no larval stage. This visual separation on one of the two FCA ordination axes was less pronounced for the sand extraction and dredge disposal cases, indicating minor shifts in trait-modality composition.

The different types of impacts and levels of disturbance provided the ideal platform to assess the potential of biological trait-based indicators. While responses appear to be complex and case-dependent, results from this study show that the implementation of this type of analysis should be considered as a complementary tool in future environmental impact assessments.

Keywords: Functional diversity indices; Biological trait analysis; Fuzzy correspondence analysis; Macrofauna; BPNS; Dredge disposal; Offshore windfarms; Sand extraction

Exotic oyster *Saccostrea cucullata* in mangroves in Protected Areas on the southeastern coast of São Paulo (Brazil)

Gil Marina, Avellar Fernanda and Cunha-Lignon Marília

Fisheries Engineering Department, Universidade Estadual Paulista, Registro Campus, Avenida Nelson Brihi Badur, 430, 11900-000 Registro – SP, Brazil
E-mail: marina.paixao@unesp.br

The exotic oyster *Saccostrea cucullata*, originally from the Indo-Pacific, was first recorded in 2014 on the Brazilian coast in the Bertioga region (SP, 23°S). Its arrival in the country is due to the activities of ships in the Port of Santos (SP), the largest in Latin America. In 2019, the mapping of the distribution of *S. cucullata* in the mangroves on the southeastern coast of São Paulo (24°S) was carried out. But this species had already been observed in the region by the local community, in 2017. The region is recognized by UNESCO and the Ramsar Convention and has several for Integral Protection and Sustainable Use Conservation Units (CU) categories. More recently, this exotic species was registered in the states of Rio de Janeiro (22°S), Paraná (25°S) and Santa Catarina (27°S). The current study aims to evaluate the population of exotic oyster *Saccostrea cucullata* in mangroves in Protected Areas (PAs) on the southeastern coast of São Paulo (Brazil). In a joint action between the university, the management of APs and the local fishing community, four Sustainable Use CUs were selected to assess the population of exotic oysters. For this, two approaches were defined. In the first approach, only exotic oysters were collected, on different substrates, in three Sustainable Use CUs: Taquari Extractive Reserve (EXTRE), Itapinhapima Sustainable Development Reserve and Cananéia-Iguape-Peruíbe Environmental Protection Area, in September / 2019. In the second approach, four plots (P1 to P4) were defined in mangrove forests in EXTRE Ilha do Tumba in winter (August / 2019) and summer (March / 2020). In 9m² subplots, all native (*Crassostrea brasiliiana*) and exotic (*S. cucullata*) oysters fixed in the red mangrove rhizophores Rhizophora mangle were collected, as well as the interstitial salinity at 10 cm depth. In the laboratory, all oysters were counted, and the total weight were obtained using a digital scale. In the first approach, a total of 516 exotic oysters, weighing 22.2 kg, were collected in red mangrove rhizophores and on the sandy sediment. In the 2nd approach, in winter, 3,963 totals of native and exotic oysters were collected, with P1 15%, P2 15%, P3 4% and P4 17% of exotic oysters, with a total weight of 8.3 kg. In summer, a total of 4,137 native and exotic oysters were collected, with P1 16%, P2 9%, P3 9% and P4 9% exotic oysters, weighing a total of 7.7 kg. Regarding interstitial salinity, in the region of study of the 1st approach, the salinity value was 29 ppm, showing that it is similar values carried out in previous years in the mangroves on this same coastal sector. In the EXTRE of Ilha do Tumba, in the winter samples, the salinity values varied between 27 and 37 ppm and in the summer between 24 and 35 ppm. The highest values were obtained in the southernmost plots of the estuary. It is believed that they are due to the contribution of salt water from the new connection between the Atlantic Ocean and the estuary, due to the rupture of a sandbar. The effort between the three spheres, university, local community, and CU management (state government level) improved the current study. The recent connection between the Atlantic Ocean and the coastal system has contributed to the increase in salinity further south of the estuary, favoring the development of the exotic oyster. The important presence of exotic oysters in PAs on the southeastern coast of São Paulo highlights the urgent need for monitoring and management strategies to assist in the conservation approaches of this coastal system.

Keywords: Invasive species; Natural and anthropic impacts; Management

The application of longline mussel aquaculture to establish subtidal reefs: Nature-based solutions in coastal defense

Goedefroo Nanou¹, Benham Peter¹, Debusschere Elisabeth², Deneudt Klaas², Mascart Thibaud³, Semeraro Alexia⁴, Sterckx Tomas³ and Van Hoey Gert⁵

¹ IMBRSea, Marine Biology Research Group, Ghent University, Campus Sterre, Krijgslaan 281/S8, 9000 Gent, Belgium

E-mail: goedefroo.nanou@gmail.com

² Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium

³ Dredging, Environmental & Marine Engineering NV (DEME), Haven 1025, ScheldeDijk 30, 2070 Zwijndrecht, Belgium

⁴ Fisheries and Aquatic Production, Research Institute for Agriculture, Fisheries and Food (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

⁵ Aquatic Environment and Quality, Research Institute for Agriculture, Fisheries and Food (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

As the pressures on coastal communities increase due to climate change, there's a growing need for coastal protection that is resilient, adaptable, and ecologically beneficial. In recent years, nature-inspired designs have been recognized as possible sustainable solutions to safeguard the coasts from erosion, floods and storms. The Coastbusters project aims to develop such a solution by adapting a traditional aquaculture technique to establish mussel beds of the coast of Belgium. In order to facilitate this bed development, a longline aquaculture technique was adopted where dropper lines were hung into the water column to collect mussel spat. Instead of harvesting the mussels from the dropper lines after reaching commercial size, the mussels were left growing on the lines until they became too heavy and fell on the seabed, initiating the formation of a mussel bed. This technique provides a constant supply of mussels to the seafloor to help combat the external pressures associated with such a harsh environment.

This work aimed to analyze the success of the Coastbusters bivalve reef set-up on establishing a mussel bed as well as the potential effects it might have on surrounding infaunal communities. Hence, four questions were put forward: (1) Did a mussel bed evolve under the dropper lines? (2) Which environmental pressures were encountered? (3) Which dropper line material and structure was found to be most suitable in order to create the mussel bed? (4) Did infaunal communities change at the reef site? To answer these questions, the state of the different dropper lines and the seabed was recorded in-situ by divers seasonally after the installation of the dropper lines. Additionally, dropper lines of different materials and designs were removed, and the attached mussels were gathered and analyzed in the lab. Van Veen samples were taken according to a BACI - design under the dropper lines and in two control sites. Video fragments were qualitatively analyzed while dropper line and Van Veen samples were quantitatively analysed. From the video surveys it was apparent that mussels had successfully settled on the bare sediment in a high-energy environment. However, a seasonal variability was determined in the presence of the mussel patches, being most abundant in late summer, early fall and absent during winter and spring months. This variability suggests that storms and strong wave action associated with winter months could have wiped out the young mussel patches. Predation might be another explanation to the sudden disappearance of mussel patches, as many predators, such as *Asterias rubens* and *Cancer maenas*, were observed feeding on the mussel beds. The two different dropper line designs tested were a filamentous and non-filamentous design. The filamentous design hosted the highest number of mussels, but at a smaller size-class. The non-filamentous designs had a smaller number of mussels but at a larger size class. A structure incorporating both designs may be the best in future iterations, to take advantage of the high recruitment capabilities of the filamentous dropper lines and the ability of the non-filamentous dropper lines to foster larger mussels that are more robust and can resist predation. No significant changes in infaunal communities were detected between the reef and control sites. With a trend towards lower diversity and a higher abundance of oligochaetes in the reef site, the first effects of organic enrichment by the mussels might become clearer in the long term.

This study will help future projects to create mussel reefs effectively in a high stress environment, leading to novel nature inspired solutions to protect our coastlines.

Keywords: Coastal protection; Ecological engineering; Biogenic reefs; Soft-sediment; *Mytilus edulis*; aquaculture

When tourism meets conservation in small tropical islands: The case of Pulau Kapas, Malaysia

Guilleminot Julie Jeannine Yvonne^{1,2,3}, Poti Meenakshi¹, Rizal Azlan⁴, Hugé Jean^{1,5}, Dahdouh-Guebas Farid¹ and Satyanarayana Behara²

¹ Vrije Universiteit Brussel, Université Libre de Bruxelles, Avenue F.D. Roosevelt 50, 1050 Brussel, Belgium

E-mail: juls.guille@hotmail.fr

² Université Malaysia Terengganu, 21300 Kuala Terengganu, Terengganu, Malaysia

³ Sorbonne Université, 79 Route des Coteaux, 31320 Pechbusque, France

⁴ Terengganu Nature Guide Association, Jeti Pelancongan, Marang, Malaysia

⁵ Open University of the Netherlands, PO Box 2960, 6401 DL Heerlen, The Netherlands

Close your eyes and imagine waking up with the sound of the waves and the sight of palm leaves, heading for a sunny day, ideal to dive in to experience the coral reefs... For sure, tourists in search of a gateway on white sandy beaches are having a good time in small tropical islands. But wherever the main source of income is nature-based tourism, impact on socio-ecological systems (SESS) must be carefully monitored to preserve touristic attractiveness and the well-being of the local communities for the long term. How can conservation and tourism coexist in a form of ecotourism, while the cultural identity and relationships with the ecosystem are preserved? On small islands, natural resources are limited and trade-offs necessary for the coexistence of tourism and conservation of the nature. Protection status should allow the development of tourism activities in a sustainable way for conservationists, tourism workers and local communities. To this end, the building of durable agreements on ecosystem conservation and tourism must include the diversity of perceptions among all stakeholders.

Focusing on Pulau Kapas, a small island located off the coast of Terengganu on the east coast of Peninsular Malaysia, we combine stakeholder-based methods (Mukherjee *et. al.*, 2018) – namely Q-Methodology and Social Network Analysis – with conservation science to understand tourism-conservation interactions and challenges in the SES. We conducted 18 interviews, where in stakeholders selected statements that resonated the most with their conceptions of conservation and tourism in Pulau Kapas. These selections were statistically studied through a principal component analysis (Schmolck, 2018), and were translated into several “worldviews” (Zabala *et. al.*, 2018) about tourism and conservation on Pulau Kapas. Additionally, these worldviews were linked with the stakeholder positions and interconnections in the social network.

We expect to find phase disagreements between the stakeholders who perceive different interests in Pulau Kapas (*i.e.* business opportunity *versus* conservation priority); those who have different backgrounds (*i.e.* academic education *versus* holding the family business); and those who nurture different conceptions of “sense of place” (*i.e.* islanders *versus* outsiders). In a nutshell, this research is aimed at (i) identifying stakeholders relevant to conservation or tourism in Pulau Kapas; (ii) mapping the degree of connectivity between them; and (iii) overlaying this map with the differences or similarities in opinions about conservation and tourism.

Concepts like ecotourism, local ecological knowledge (Rist and Dahdouh-Guebas, 2006) and spiritual value of the nature will be discussed, to explore the ties between conservation of the nature and economic viability in Pulau Kapas SES. Sustainable management depends on acknowledgement of social influences among stakeholders and their perceptions of what constitutes a desirable future for tourism in the island. Results of this research may prompt joint efforts for integrating conservation in tourism practices in Pulau Kapas, and support conservation-sound governance in small islands. This research may provide guidance for the study of similar SESS in Malaysia and beyond. Research ongoing (August 2020 to August 2021).

Keywords: Small islands; Tourism; Conservation; Socio-ecological system; Q-Methodology; Social Network Analysis

Vessel motion prediction near a monopile offshore wind turbine

Herdayanditya Ivandito¹, Rauwoens Pieter¹ and Lataire Evert²

¹ Technology Cluster Construction, Department of Civil Engineering, KU Leuven, Spoorwegstraat 12, 8200 Sint-Michiels, Belgium
E-mail: ivandito.herdayanditya@kuleuven.be

² Maritime Technology Division, Department of Civil Engineering, Ghent University, Technologiepark Zwijnaarde 60, 9052 Zwijnaarde, Belgium

Offshore wind energy is regarded as key renewable energy source to help global energy transition. There has been a sustained growth in the industry where the biggest annual new installation capacity, 6.1 GW, was recorded in 2019 [1]. Within 6.1 GW of global new installed power capacity, 370 MW came from Belgium which also set up Belgium's national record [2]. Although offshore wind industry is moving in the right direction, both globally and specifically in Belgium, there are some aspects in the current practice that can be optimized to reduce energy cost. The current research project will enhance personnel access operability analysis where the industry can expect 0.6% energy cost reduction opportunity from the crew transfer operation improvement [3]. In order to do that, interaction between vessel and waves near a wind turbine needs to be correctly assessed, e.g. by using proper numerical simulations. Further, numerical simulations are employed to define thresholds for marine operations, depending on meteo-marine conditions [4].

This specific research will focus on the crew transfer operation from a Crew Transfer Vessel (CTV) to a monopile wind turbine and investigate several numerical strategies for wave-structure interaction analysis near the monopile to reduce uncertainty in weather-window estimation. Monopiles are the most common wind turbine foundations in the industry, taking 81% of all installed wind turbines [2]. This topic has been investigated by some researchers. Wu [5] delivered an operability analysis of a CTV to a wind turbine where the friction force between the CTV and the structure was accounted for in frequency domain analysis assuming a transparent structure (*i.e.* same wave field with or without wind turbine under potential-flow assumption). Further, Konig *et al.* [6] accounted for both the friction between the CTV and the monopile and the diffraction of the wave field around monopile but without considering a boundary condition on the free surface in potential-flow theory. They found that, compared to the experiment, the heave and pitch motions were underestimated in short wave cases because the free surface boundary condition was neglected [6]. Thus, the complex nature of the wave field around monopile should be captured correctly in numerical simulations of a vessel near a wind turbine. Navier-Stokes (NS) simulations have demonstrated to be able to capture wave dynamics around a monopile [7]. However, the computational cost of a NS simulation is significantly higher than the cost of a potential-flow simulation.

This research, which is planned for the next 4 years, will investigate the possibilities of combining potential-flow and NS theory for the vessel-monopile interaction. Three numerical strategies are defined in the research: potential-flow in frequency domain, NS simulation, and combination of those two. These three approaches will be validated and contrasted to experimental results. Operability analysis will also be checked at the end of the research to assess the sensitivity of different numerical methods as a basis for weather window estimations.

References

- [1] GWEC, "Global Wind Report 2019," GWEC, Brussels, 2020.
- [2] WindEurope, "Offshore Wind in Europe Key Trends and Statistics 2019," WindEurope, Brussels, 2020.
- [3] InnoEnergy, "Future renewable energy costs: 57 technology innovations that will have greater impact on reducing the cost of electricity from European offshore wind farms," InnoEnergy, Eindhoven, 2017.
- [4] W. G. Acero, L. Li, Z. Gao and T. Moan, "Methodology for assessment of the operational limits and operability of marine operations," Ocean Engineering , pp. 308-327, 2016.
- [5] M. Wu, "Numerical analysis of docking operation between service vessels and offshore wind turbines," Ocean Engineering , vol. 91, p. 379–388, 2014.

- [6] M. König, D. F. González, M. Abdel-Maksoud and A. Düster, "Numerical investigation of the landing maneuver of a crew transfer vessel to an offshore wind turbine," Hamburg, 2016.
- [7] B. Devolder, P. Rauwoens and P. Troch, "Application of a buoyancy-modified $k-\omega$ SST turbulence model to simulate wave run-up around a monopile subjected to regular waves using OpenFOAM®," *Coastal Engineering*, vol. 125, p. 81–94, 2017.

Keywords: Offshore wind turbines; Hydrodynamics; Crew transfer operation

Can we track the possible influence of chemical warfare agents on microbial community in the marine environment?

Herweyers Robin¹, Van Landuyt Josefien¹, Mattelin Valérie¹, Martin Bram¹, Laduron Frédéric², Geukens Kris², Kundu Kankana¹ and Boon Nico¹

¹ Center for Microbial Ecology and Technology (CMET), Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, 9000 Gent, Belgium

E-mail: robin.herweyers@ugent.be

² Labo Chemische Analyse DLD, Martelarenstraat 181 1800 Vilvoorde (Peutie), Belgium

All across the globe, several locations are found where the seafloor is covered with conventional munition compounds and chemical warfare agents. These are the results of official and unofficial dumping events that took place right after World War I and II (Beck *et al.*, 2018). One of these dumpsites is the *Paardenmarkt* site which is located 500 m off the coast of Belgium. Here, approximately 35.000 tons of munitions were dumped in the sea. One of these compounds is mustard gas (a chemical warfare agent), which hydrolyses quickly to ThioDiGglycol (TDG) in seawater. This compound can interact with the microbial ecosystem in marine environment. So far, most of the studies on the microbial interaction with TDG were performed in soil environments (Medvedeva *et al.*, 2009). The knowledge on how the marine microbiome interacts with TDG is still limited. When properly understood, microbial interaction with TDG can become valuable for biomonitoring and targeted bio-engineering for bioremediation.

Here, we studied the effects of TDG at different concentrations (mg/L - µg/L) on a marine microbiome. Marine sediment was collected nearby the *Paardenmarkt* site in the Belgian part of the North Sea. Two types of microcosms were set up in triplicate, containing filter-sterile seawater supplemented with nutrients and 2 mg/L acetate, sediment with microorganisms, and different concentrations of TDG (300 µg/L and 2 mg/L). Two controls were taken into account. The first one contained only seawater with sediment (without TDG), and the second one contained seawater, TDG (2 mg/L) and autoclaved sediment. The latter served to assess the interaction between TDG and the sediment. Additional incubations were set-up in the presence of high concentration of TDG, 80 mg/L both in aerobic and anoxic conditions to enrich for microbes able to use TDG as a C source. Microbial growth was monitored through flow cytometry. The phenotypic diversity was assessed over time as described in Props *et al.*, (2016). Chemical analysis of TDG concentration was performed using LC-MS.

Our first results suggest that TDG, when present at low concentrations (300 µg/L and 2 mg/L), cannot support microbial growth. However, the live cell count was the same as the two control experiments. This indicates minimal toxic influence of TDG on marine microbiome. As a second result, the concentration of TDG in the microcosms rapidly decreased after spiking (within 2 days). The TDG concentration in the control experiments decreased correspondingly, thus leaving the distinction between adsorption and biodegradation difficult. Nevertheless, during enrichment with TDG as a sole C source, microbial growth was observed in line with the reduction of TDG. The phenotypic diversity assessment of the enriched samples revealed a shift in community structure over time. This provides us with a strong indication that TDG biodegradation occurred. Further analysis on biotransformation metabolites and adsorption kinetics together with Illumina sequencing is needed to draw the complete picture of TDG degradation in the marine environment.

References

- Beck, A. J., Gledhill, M., Schlosser, C., Stamer, B., Böttcher, C., Sternheim, J., Greinert, J., & Achterberg, E. P. (2018). Spread, behavior, and ecosystem consequences of conventional munitions compounds in Coastal marine waters. *Frontiers in Marine Science*, 5(APR), 1–26. <https://doi.org/10.3389/fmars.2018.00141>
- Medvedeva, N., Polyak, Y., Kankaanpää, H., & Zaytseva, T. (2009). Microbial responses to mustard gas dumped in the Baltic Sea. *Marine Environmental Research*, 68(2), 71–81. <https://doi.org/10.1016/j.marenvres.2009.04.007>

- Medvedeva, N. G., Polyak, Y. M., Zaytseva, T. B., & Zharikov, G. A. (2012). Destruction of mustard gas hydrolysis products by marine and soil bacteria. *Biology Bulletin*, 39(1), 77–84. <https://doi.org/10.1134/S1062359012010050>
- Props, R., Monsieurs, P., Mysara, M., Clement, L., & Boon, N. (2016). Measuring the biodiversity of microbial communities by flow cytometry. *METHODS IN ECOLOGY AND EVOLUTION*, 7(11), 1376–1385. <http://dx.doi.org/10.1111/2041-210X.12607>

Keywords: Chemical warfare; Biodegradation; Mustard gas; Thiodiglycol; Flow cytometry

Microbiomes of live feed products have an important contribution to the rearing water microbiomes in *Litopenaeus vannamei* larviculture

Heyse Jasmine¹, Props Ruben¹, Kongnuan Pantipa², De Schryver Peter², Rombaut Geert², Defoirdt Tom¹ and Boon Nico¹

¹ Center for Microbial Ecology and Technology (CMET), Department of Biochemical and Microbial Technology, Ghent University, Coupure Links 653, 9000 Gent, Belgium
E-mail: jasmine.heyse@ugent.be

² INVE Technologies NV, Hoogveld 93, 9200 Dendermonde, Belgium

Outbreaks of microbial diseases have posed one of the main impediments to the sustainable growth of the aquaculture industry. To allow for effective microbial management, a thorough understanding of the composition, drivers and dynamics of the microbiomes present in these systems is needed. An aquaculture farm consists of several microbial compartments, including the water column, the cultivated organisms, the feed products, etc. Most studies up till now have focussed on the rearing water and host-associated microbiomes, but did not investigate the community composition and dynamics of the peripheral microbiomes such as those of dry and live feeds.

In our study, we performed a sampling campaign on *Litopenaeus vannamei* larviculture and investigated the extent to which bacterial taxa present in the rearing water originate from the peripheral microbiomes (i.e. live and dry feeds or the exchange water). For each of the peripheral microbiomes a high batch-to-batch variability in community composition was observed. These batch-differences were mainly attributed to large differences in the relative abundances of members within a set of 'core' taxa. Also in terms of bacterial abundances we observed a high variability both within and between batches. Since each source had a different bacterial abundance and was added in a different quantity and with a different frequency, it introduced different microbial loads to the rearing water. Through a source tracking analysis, we found that 37% of all bacteria in the rearing water were introduced via one of the peripheral microbiomes. The contribution of the algae was the largest, followed by the Artemia, the exchange water and the dry feeds.

Together, our results illustrate that these peripheral microbiomes have an important contribution to the rearing water microbiome. Given this contribution, careful preparation and storage of these inputs will be paramount to maintain stable, healthy systems.

Keywords: Aquaculture; Source tracking; *Litopenaeus vannamei*; Artemia; Algae; Community composition; Microbial management

Impacts of plastic and other hazards on the healing properties of the Belgian coast

Hooijberg Alexander¹, Michels Nathalie², Roose Henk³, Allaert Jens⁴, De Hennauw Stefaan², Vandegehuchte Michiel¹ and Everaert Gert¹

¹ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: alexander.hooijberg@vliz.be

² Department of Public Health and Primary Care, Faculty of Medicine and Health Sciences, Ghent University, Corneel Heymanslaan 10, UZ-4K3, 9000 Gent, Belgium

³ Department of Sociology, Faculty of Political and Social Sciences, Ghent University, Korte Meer 3, 9000 Gent, Belgium

⁴ Department of Head and Skin, Faculty of Medicine and Health Sciences, Ghent University, Henri Dunantlaan 2, 9000 Gent, Belgium

Background/Aims

Natural coastal environments are good for healing people's mental and physical health through the replenishment of depleted cognitive resources. These cognitive resources are necessary to deal with everyday challenges and demands, and form the basis to protect ourselves from mental and even physical illness. However, coastal environments have usually been researched as being natural blue spaces containing only natural views, while coasts are actually spatially heterogeneous mosaics of predominantly urban, green, blue or mixed landscapes, especially in Belgium. As such, the degree to which cognitive resources are replenished and so-called 'restoration' occurs can differ between diverse coastal landscapes. Therefore, the primary aim of this study is to compare the perceived restoration of ten coastal landscapes in Belgium (i.e. beach, dune, nature park, pier, dike, town, recreational harbour, docks, historical site and inland green space). Besides these landscape-specific quantifications, we also assessed the impacts of anthropogenic disturbances (i.e. litter, vehicles and benches) on the restoration potential.

Methods

Ninety-four pictures were taken along the Belgian coast to represent combinations of coastal environments and anthropogenic disturbances. Participants (students aged 18-30y, 16% males) rated each picture on a derivative of the perceived restorativeness scale, scaled from 0 to 10. In addition, objective measures of cognitive and physiological restoration were quantified through eye-tracking and indices of sympathetic and parasympathetic nervous system activation (i.e. electrocardiogram and skin conductance) and quantification of picture characteristics in terms of colour values (RGB), fractal dimension and pixels covered by natural and urban elements allows to precisely investigate these potential explaining factors. Linear mixed modelling standardized for age, sex, socio-economic status and other personal and demographic covariates.

Results

Preliminary results revealed that inland green space (ref), salt marshes, beaches and dunes without litter or vehicles scored best on all five restoration scores, while the urbanized environments dike, town, harbours and historical places scored all equally worse ($p < 0.05$, piers were scored moderately). Pictures with litter or vehicles were rated on average $17.2\% \pm 1.8\%$ and $14.1\% \pm 2.7\%$ lower than similar pictures without litter or vehicles, respectively (the presence or absence of benches did not differ). The negative effect of litter and vehicles on the restoration potential was stronger in natural environments (e.g. on beach $25.5\% \pm 7.4\%$ decrease due to plastic) compared to urbanized environments (e.g. on dike $10.68\% \pm 7.4\%$ decrease due to plastic). Differences in eye movements, indices of heart rate variability and skin conductance, and picture characteristics are yet to be statistically analysed.

Conclusions

Our results support the hypothesis that the perceived restoration differs within coastal landscapes. Natural undisturbed sceneries were perceived as more restorative than urban and disturbed natural

sceneries with litter or vehicles, supplementing earlier research. Hence, researchers that evaluate people's coastal experiences should consider the inter-landscape variability in perceived restoration. Coastal residents, visitors and policy makers can make use of this knowledge to optimize people's coastal experiences for the prevention of mental and physical health burdens, e.g. through minimizing litter.

Keywords: Coastal environments; Plastic; Blue space; Restoration capacity; Attention restoration theory

Diving impact: Frequentation, diver behavior and consequences on the mediterranean fish community

Iborra Laura¹, Leduc Michèle¹, Cuny Philippe² and Gobert Sylvie³

¹ Station de Recherche Océanographiques et sous-marines (STARESO), Punta Revellata, BP33, 20260 Calvi, France

E-mail: laura.iborra@stareso.com

² Mediterranean Institute of Oceanology, Aix-Marseille University, Bât. Méditerranée, Campus de Luminy-Océanomed, 163 avenue de Luminy, Case 901, 13009 Marseille, France

³ Département Biologie, Ecologie et Evolution (BEE), University of Liege, B6C, Allée du 6 Août, 15 Sart Tilman, 4000 Liège, Belgium

Popularization of recreational scuba diving has increased in recent years, adding a new dimension to the human impacts on aquatic systems. Although impacts at the individual level have been identified, what causes these behaviors and how the Mediterranean fish community responds is not clear. In this research, we studied during high season: (i) the frequentation of a diving site in the bay of Calvi (Corsica, France), using the dive sheets of local diving structures but also taking aerial photographs (ii), the behavior of the divers by observing their diving practice in 10-minute-increments in order to determine how many contacts they had with the environment, what type of contact there was (voluntary or involuntary) and which part of the body or instrument was involved, and finally (iii) the composition of the fish assemblage (i.e. abundance, size structure and species composition) through Underwater Visual Census (UVC) counts carried out before and after the divers' arrival on site. In addition, a particular attention was paid to patrimonial species, namely the brown grouper (*Epinephelus marginatus*), by noting the size and reaction of the individuals when confronted to divers, according to 5 behavioral typologies: "Close flight <10 m", "Distant flight >10 m", "Attraction", "Indifference" and "Change of position, observation of the diver".

Our results show that the monitored diving site is particularly popular with an average of 82 divers per day during high season. Divers' awareness of the impacts of diving is relatively low and more than 80 % of them made contact with the environment during the diving session, with an average of 7 contacts per 10 min. The majority of involuntary contacts involve fins, while the rest of contacts are very diverse, involving both the body and the equipment (octopus, diving bottle, pressure gauge, safety sausage, etc.). Additionally, divers holding a camera are more likely to make intentional contact with the substrate. Divers' experience is also a major factor; their ability to control their buoyancy has an impact on the various types of contacts observed. The divers with good buoyancy control are more prone to make voluntary contact, while divers with poor buoyancy control tend to make more involuntary contact. Fish populations respond differently depending on the species involved. Indeed, Brown meagre (*Sciaena umbra*) and Dusky groupers (*Epinephelus marginatus*) seem to be the most disturbed by the divers' presence. Their biomasses decrease significantly following diving sessions, which indicates an attempt to escape or a desire to hide. We also found that the bigger the groupers, the further away they would flee. On the contrary, small individuals are curious and more likely to show an attraction to diver. Furthermore, there is no significant difference between the "distant flight" and "change of position" behaviors, which shows that large groupers (> 70 cm) are more wary of divers, by observing them, preparing for an escape or even fleeing more than 10 m away. On the contrary, the "Indifference" and "Close flight" behaviors do not show a significant difference, meaning that smaller groupers (50 - 70cm) are less fearful. Lastly, the number of divers per site, their environmental sensitivity and knowledge, their level of technicality, as well as their type of practice determine their impact on the marine environment.

Our research stresses out the importance of delivering messages about the environment and the right conduct to adopt underwater during the pre-diving briefing: divers who received information before diving will potentially make less contact with the marine environment.

Keywords: Diving; Mediterranean fish community; Frequentation; Diver behavior

Array of point absorbers in front of a wall-type coastal structures: Optimum layouts under regular waves

Ioannou Rafail and Loukogeorgaki Eva

Department of Civil Engineering, Aristotle University of Thessaloniki, University Campus, 54124 Thessaloniki, Greece
E-mail: ikrafail@civil.auth.gr

Arrays of heaving Point Absorbers (PAs) deployed at near-shore areas may be installed on existing coastal structures, such as vertical (wall-type) breakwaters, facilitating cost reduction. In those cases, hydrodynamic interactions between the vertical barrier and the PAs are introduced, which can improve the array's power absorption ability (e.g. [1]-[2]). It is evident, however, that this improvement depends strongly upon the location of the PAs with respect to the wall and within the array. Hence, optimizing the layout of the array is a key factor towards the efficient deployment of heaving PAs in front of wall-type coastal structures. Motivated by this, in the present work, we investigate optimum, in terms of power absorption optimization, layouts of an array of five, semi-immersed, oblate spheroidal heaving PAs situated in front of a bottom-mounted vertical wall of finite length under the action of regular waves. The optimum layouts are determined for a given incident wave frequency and incident wave direction and they satisfy spatial constraints related to: (a) the perpendicular distance of the PAs from the wall, (b) the PAs' in-between distances, (c) the length of the wall available for the PAs' placement and (d) symmetry considerations (for perpendicular to the wall waves). The required diffraction/radiation problem is solved in the frequency domain by utilizing the conventional Boundary Integral Equation method, which is numerically realized using WAMIT software (www.wamit.com). For solving the constrained optimization problem, a Genetic Algorithm solver is developed and it is coupled with WAMIT in the MATLAB computational environment. The developed algorithm is validated by comparing its results with the parametric results of Loukogeorgaki *et al.* [2] for the case of a linear PA array. Under the action of perpendicular to the wall waves with frequency equal to the PAs' heave natural frequency, the formation of the array's optimum layout depends upon the length of the wall available for the PAs' placement. When the total available length of the wall is utilized, an "arrow"-shaped optimum layout, situated at a large perpendicular distance from the wall, is formed. However, by exploiting part of the total available length of the wall, a "trapezoidal" optimum layout is realized. Under the action of perpendicular to the wall waves with frequency smaller than the PAs' heave natural frequency, the devices are arranged as close as possible to the wall along a straight line parallel to the boundary regardless of the wall length utilized for the PAs' placement. Moreover, the PAs are grouped into 2-body "clusters". The above optimum layouts satisfy symmetry considerations with respect to the incident wave direction, which enhance the array's power absorption ability compared to the case of a totally random PAs' placement. Finally, the action of oblique incident waves leads to optimum layouts that show a significantly decreased power absorption ability compared to the layouts obtained for perpendicular to the wall waves.

References

- [1] Loukogeorgaki, E., Chatjigeorgiou, I.K., 2019. Hydrodynamic performance of an array of wave energy converters in front of a vertical wall. 13th European Wave and Tidal Energy Conference, Napoli, Italy, September 1-6, 2019, Paper No. 1464.
- [2] Loukogeorgaki, E., Boufidi, I., Chatjigeorgiou, I.K., 2020. Performance of an array of oblate spheroidal heaving wave energy converters in front of a wall. Water, 12(1), 188.

Keywords

Wave energy; Wave energy converters; Heaving point absorbers; Power absorption; Layout; Optimization; Genetic algorithm

Time-domain wave propagation modelling for assessing the impact of WEC farms on the wave field and the local morphodynamics and sediment transport

Jaramillo-Torres Melissa Gabriela¹, Carpintero-Moreno Efrain², Stratigaki Vasiliki² and Troch Peter²

¹ Instituto de Investigaciones Oceanológicas, Universidad Autónoma de Baja California, Carr. Transpeninsular 3917, 22870, Ensenada, México
E-mail: mgiatorres@gmail.com

² Department of Civil Engineering, Ghent University, Technologiepark 60, 9052 Gent, Belgium

Ocean waves carry part of the energy transferred from the atmosphere to the sea surface over long distances. Some of this energy can be harvested using wave energy converters (WECs). The performance (energy extraction) of isolated WECs and WEC arrays is strongly dependent on: i) the dominant sea-state [1]; ii) its temporal and spatial variability; iii) the wave-structure interaction within the WEC array; and iv) on the local environmental features. The most common approach to estimate the power absorbed by WECs is considering bulk parameters to represent the directional wave spectrum [2,3]. This approximation is not entirely accurate, particularly at regions with complex and variable wave conditions [4]. Through the directional wave spectrum or the sea surface elevation is desirable for such cases. Both can be approached by employing numerical simulations. In the literature, the wave energy redistribution around WECs has been widely simulated using the spectral numerical model SWAN (Simulating WAves Nearshore) [5,6], where WECs are represented as obstacles [7]. However, the SWAN model cannot solve the evolution of individual waves nor wave-structure interactions. Consequently, the wave-induced velocity field is not resolved, and hence the sediment transport cannot be adequately estimated using this model. For that reason, using a phase-resolving model is more convenient. Different numerical models have been used to resolve the wave propagation and far-field wake effects by the presence of WEC arrays [8, 9].

In this work, we propose to use the MILDwave phase-resolving wave propagation model, developed at Ghent University [9, 10, 11], coupled with a wave-structure interaction solver to take into account the WEC performance and its effects on the near and far-field [12]. For the numerical simulations, the boundary and initial conditions will be determined to carry out test cases with different WEC array configurations and for different scenarios of incident wave conditions. Finally, with the results of MILDwave, it is intended to obtain the wave-induced velocity field, which will be used to solve the advection-diffusion equation to analyze the sediment transport and morphodynamics due to the presence of WECs.

References

- [1] G.A. Aggidis, C.J. Taylor (2017). Overview of wave energy converter devices and the development of a new multi-axis laboratory prototype. IFAC-Papers OnLine, Pages 15651-15656.
- [2] Babarit (2015). A database of capture width ratio of wave energy converters. Renewable Energy, Elsevier. Volume 80, Pages 610-628, ISSN 0960-1481.
- [3] N. Guillou, G.Lavidas, G. Chapalain (2020). Wave Energy Resource Assessment for Exploitation. A Review. Journal of Marine Science and Engineering. 8, no. 9: 705.
- [4] J-B. Saulnier, A. Clément, A. F. de O. Falcão, T. Pontes, M. Prevosto, P. Ricci (2011). Wave groupiness and spectral bandwidth as relevant parameters for the performance assessment of wave energy converters, Ocean Engineering, Volume 38, Issue 1, Pages 130-147.
- [5] O'Dea, M. C. Haller, H. T. Özkan (2018). The impact of wave energy converter arrays on wave-induced forcing in the surf zone. Ocean Engineering, 161: 322–336.
- [6] R. Atan, W. Finnegan, S. Nash, J. Goggins (2019). The effect of arrays of wave energy converters on the nearshore wave climate. Ocean Engineering, 172: 373–384.
- [7] The SWAN Team (2019). SWAN Cycle III version 41.20AB, April 15, Delft University of Technology, SWAN Scientific and Technical Documentation. Vol 104.

- [8] V. Fernandez, V. Stratigaki, P. Troch (2019). "Irregular Wave Validation of a Coupling Methodology for Numerical Modelling of Near and Far Field Effects of Wave Energy Converter Arrays." *Energies* 12 (3).
- [9] V. Stratigaki & P. Troch(2016). Phase-resolving wave propagation array models. In M. Foley (Ed.), Numerical modelling of wave energy converters : state-of-the-art techniques for single devices and arrays (pp. 191–216). Elsevier.
- [10] P. Troch (1998). A Numerical Model for Propagation and Transformation of Linear Water Waves; Internal Report; Department of Civil Engineering, Ghent University: Zwijnaarde, Belgium.
- [11] P. Vasarmidis, V. Stratigaki, P. Troch (2019). Accurate and Fast Generation of Irregular Short Crested Waves by Using Periodic Boundaries in a Mild-Slope Wave Model. *Energies*, 12, 785.
- [12] V. Stratigaki, P. Troch, D. Forehand (2019). A fundamental coupling methodology for modelling near-field and far-field wave effects of floating structures and wave energy devices. *Renewable Energy*, 143, 1608–1627.

Keywords: WEC; MILDwave; Sediments; Morphodynamics

Good questions on dispersal of mangroves by observers in the 19th and early 20th century – have we already answered them ?

Koedam Nico¹, Van Der Stocken Tom¹ and Dahdouh-Guebas Farid²

¹ Ecology & Biodiversity, Department of Biology, Faculty of Science and Bioengineering Sciences, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
E-mail: nikoedam@vub.be

² Systems Ecology and Resource Management (SERM), Department of Organism Biology, Faculty of Sciences, Université Libre de Bruxel, Avenue Franklin D. Roosevelt 50, CPi 264/1, 1050 Brussels, Belgium

In natural sciences, we all may have a tendency to overlook historical sources which sometimes had addressed research questions we unknowingly reformulate. Encountering historical observations is not always straightforward, as they may consist of concise notes or remarks in undigitized sources or be inaccessible because of language. English has not always been the only and not even the main vehicle of scientific data, far into the 20th century.

When considering mangrove research, one can expect that the colonial powers reaching areas with tropical coasts were amongst the first to put forward scientific questions regarding these ecosystems after initial observation (Koedam *et al.*, 2017). The colonial process with all its damaging impacts, indeed went hand in hand with observation and research from the earliest days. While much early research, exploration probably being a better qualification, clearly had a commercially competitive and exploitative objective, sometimes explicitly, in later phases scientific endeavour could become a genuine goal. This is well illustrated in mangrove-related observations. Initially their potential for the colonial enterprise was explored, subsequently this apparently subsided (probably because of lack of colonial usefulness as a commodity).

The Netherlands and Belgium had major colonial empires into much of the 20th century, in the case of the Netherlands for several centuries. These countries' scientists mostly published their work in Dutch and French. It can be expected that a little explored set of observations on mangroves had been published. Are these relevant for the 21st century researcher? Old sources can be crucial as baselines for present-day research, but this would apply mostly to cartographic or administrative archiving (Dahdouh *et al.*, 2005, 2008).

We considered a triple incentive for another perspective of searching and presenting older sources in mangrove research: (1) curiosity, (2) highlighting Dutch and Belgian sources and rendering them better known to an international audience, and most importantly (3) gauging whether we have made progress in answering questions already put forward more than a century ago. We here mainly address questions related to mangrove dispersal, a core topic in our research group (Van der Stocken *et al.*, 2019), and present valuable observations of historical Dutch and Belgian sources.

References

- Dahdouh-Guebas, F., S. Hettiarachchi, S. Sooriyarachchi, D. Lo Seen, O. Batelaan, L.P. Jayatissa, & N. Koedam, 2005. Transitions in ancient inland freshwater resource management in Sri Lanka affect biota and human populations in and around coastal lagoons. *Current Biology* 15(6): 579-586. <http://doi.org/10.16/j.cub.2005.01.053>
- Dahdouh-Guebas, F. & N. Koedam, 2008. Long-term retrospection on mangrove development using transdisciplinary approaches: a review. *Aquatic Botany* 89(2): 80-92. <http://doi.org/10.1016/j.aquabot.2008.03.012>
- Koedam, N., F. Dahdouh-Guebas, R. Limas Barcellos & T. Van der Stocken, 2017. Mangroves – Captured by the keen eye of a 17th century landscape painter. *Dutch Crossing* 41(3): 247-263. <http://doi.org/10.1080/03096564.2016.1246166>

- Van der Stocken, T., A.K.S. Wee, D.J.R. De Ryck, B. Vanschoenwinkel, D.A. Friess, F. Dahdouh-Guebas, M. Simard, N. Koedam & E.L. Webb, 2019. A general framework for propagule dispersal in mangroves. *Biological Reviews* 94: 1547-1575. <https://doi.org/10.1111/brv.12514>

Keywords: Mangrove; Dispersal; Historical sources; Colonial science

Raywatch - A study on the population biology and survival of seven ray species in the Northeast Atlantic

Lemey Laura, Van Bogaert Noémi, Vandecasteele Loes, Sys Klaas and Torreele Els

Instituut voor Landbouw-, Visserij- en Voedingsonderzoek (ILVO), Ankerstraat 1, 8400 Oostende, Belgium
E-mail: laura.lemey@ilvo.vlaanderen.be

The Common Fisheries Policy (CFP) strives to create profitable and sustainable fisheries based on healthy fish stocks. An important stepping stone in the reformation of the CFP, was the introduction of the Landing Obligation (LO). Since the first of January 2019, all TAC-regulated fish have to be brought to land. Skates and rays have been granted a three year exemption on the LO based on high survival probability. As part of the temporal exemption for rays and skates, the EC mandated a research trajectory as outlined in a “Roadmap for skates and rays” to improve the current scientific knowledge about these species.

“Raywatch” is a two-year EMFF-funded project that aims to improve data collection for rays within the National Data Gathering Programme (NDGP). Raywatch will focus on collecting more biological, catch and survival data for seven ray species; thornback ray (*Raja clavata*), blonde ray (*Raja brachyura*), spotted ray (*Raja montagui*), undulate ray (*Raja undulata*), small eyed ray (*Raja microocellata*), sandy ray (*Leucoraja circularis*) and cuckoo ray (*Leucoraja naevus*) in the Western Waters and English Channel. A data collection protocol was established as part of the existing standardized NDGP programme. Total catch weights and length frequencies for the discard and landing fraction will be collected per sex. A vitality score will be given to several individuals (A (excellent condition), B (good condition), C (poor condition) or D (dead)) based on the amount of injuries and the liveliness of the individual (Catchpole, et al., 2017; Ellis, McCully Phillips, & Poisson, 2017; Schram & Molenaar, 2018). A subset of the sampled (dead) rays will be taken to the lab, where maturity will be assessed based on the stages discriminated in the ICES Workshop on Elasmobranchs Maturity (Workshop on Elasmobranchs maturity (WKSEL 3; outputs from 2018 meeting), 2020). Additionally, various techniques for age determination will be reviewed and tested. Environmental and technical data that was collected on board (e.g. fishing duration, wind speed, sea temperature, depth, etc.) will be used in models predicting the immediate (“at vessel”) and delayed mortality of rays. In order to improve catch advice for rays in the future, discard and landing data will be extrapolated to fleet level and historical catch data will be integrated too. A length-based stock assessment model will be made for thornback ray based on the estimated life history parameters, stock structure and landing and discard data collected during the project.

With this biological data, more insight will be granted in the distribution of rays, the appearance of seasonal patterns, the proportion of landings and discards as well as the length, age and maturity structure of the ray populations. This data will provide a basis for stock assessment models for rays and will result in a better, more accurate catch advice for the species.

Keywords: Rajidae; Fisheries management; Population biology; Stock assessment

Assessment of trace metal pollution in *Octopus cyanea* from the coast of Tanzania

Loots Erika

Vrije Universiteit Brussel, Pleinlaan 2, 1050 Elsene, Belgium
E-mail: erika.kathelijne.loots@vub.be

Octopus cyanea is a crucial fishery resource for human consumption in Tanzania. There is also high demand on an international scale, which creates a rather lucrative octopus trade. However, *O. cyanea* is often overexploited due, on the one hand, to the high demand on a local and global scale and, on the other, to the unsustainable management of the octopus' fisheries. Furthermore, large scale industry and fishing activities often result in bioaccumulation of trace metals (Cd, Hg, Pb, Zn). To assess the bioaccumulation, various liver, kidney and arm samples of *Octopus spp.* were taken at five different sites along the Tanzanian coast (Dar es Salaam, Tanga, Mtwara, Kilwa Masoko and Zanzibar). Sediment samples were also retrieved to estimate environmental contamination. The assessment of the trace metal concentration in *Octopus Cyanea* and sediments is crucial to unveil the potential problems of metal pollution at the Tanzanian coast. Due to the industry and fishing activities in the coastal waters of Tanzania, it is hypothesized that there is a high concentration of detrimental trace metals present in the tissue and sediment samples.

Prior to trace metal analysis, the identification of the tissue samples is required by DNA barcoding. Tissues identified as *Octopus cyanea* and sediment samples were then lyophilized as pre-treatment. Subsequently, the sediment and tissue samples were submitted to trace metal analysis by using a high-resolution inductively coupled plasma mass spectrometer (HR-ICP-MS) Thermo Element I (Thermo Scientific). To determine the percentage of particulate organic carbon (POC) present in the sediment samples, a CN Elemental Analyser was used.

Keywords: *Octopus cyanea*; Bioaccumulation; Trace metals; Tanzania

Insights in the occurrence of early life stages of sharks and rays in the North Sea area

Maes Ruben¹, Vandecasteele Loes² and Van Bogaert Noémi²

¹ HAS Hogeschool, Onderwijsboulevard 221, 5223 DE 's-Hertogenbosch, Nederland
E-mail: R.Maes@student.has.nl

² Instituut voor Landbouw-, Visserij- en Voedingsonderzoek (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

Sharks and rays are cartilaginous fish belonging to the class of the Elasmobranchii. As slow-growing species that mature at later ages, they are vulnerable to external pressures such as overfishing. Around ten species of sharks and twelve species of rays and skates are found in the North Sea region. These benthic species are taken as bycatch in demersal fisheries targeting species such as sole (*Solea solea*) and plaice (*Pleuronectes platessa*). Skates are oviparous and deposit their egg cases on different types of substrates. These egg cases are often washed up on the beach and collected during various “citizen science projects” in different countries. However, little is known about the place of deposition of these egg cases, also referred to as the spawning or nursery grounds.

To explore where potential spawning or nursery areas may occur, scientific catch data coming from beam trawl surveys (BTS) from the time period 2004 - 2019 in the North Sea was used. The data from these surveys is freely accessible through DATRAS, the online database of trawl surveys hosted by the International Council for the Exploration of the Sea (ICES). Based on the Belgian and Dutch BTS data, temporal and spatial trends and hotspots in egg case and juvenile counts of different elasmobranch species of the North Sea were investigated. These hotspots can be an indication of a nursery or spawning area of the species.

The results of this study show that juveniles of thornback ray (*Raja clavata*), starry ray (*Amblyraja radiata*) and small-spotted catshark (*Scyliorhinus canicula*) were most abundantly caught during the past 15 years. Juveniles of thornback ray and small-spotted catshark reside mainly in the southern part of the North Sea, in the area of the Thames estuary (ICES rectangle 4c). Starry ray juveniles are mainly caught in the northern ranges of the North Sea (ICES rectangle 4a). Based on the outcomes of this study, sustainable strategies for a better long-term management of these species can be developed.

Keywords: Egg cases; Juveniles; Elasmobranchs; North Sea

On the development of a generic computational tool for the time-domain analysis of hybrid offshore wind and wave energy floating systems

Mantadakis Nikos¹, Loukogeorgaki Eva¹, Troch Peter² and Stratigaki Vasiliki²

¹ Civil Engineering Department, Aristotle University of Thessaloniki (AUTH), University Campus, 54124 Thessaloniki, Greece
E-mail: mantadaki@civil.auth.gr

² Civil Engineering Department, Ghent University, Technologiepark 904, 9052 Gent, Belgium

The efficient exploitation of the vast offshore wind and wave energy potential can contribute to reduction of CO₂ emissions, economic growth and security enhancement. Although the offshore wind and the wave energy industries show, nowadays, a different level of maturity, they both share a common objective; namely, the development of sustainable solutions, satisfying energy effectiveness, cost efficiency, safety requirements, adequate resistance and durability in harsh sea environmental conditions, as well as environmental considerations. Along these lines, it may be beneficial to boost the development of synergetic systems (Hybrid Offshore Wind and Wave Energy Systems - HOWWESs) that enable the simultaneous exploitation of the offshore wind and wave energy by combining into one structure an Offshore Wind Turbine (OWT) with multiple Wave Energy Converters (WECs).

The utilization of HOWWESs can have many advantages, such as costs reduction through costs sharing, increased energy yield, smooth and highly available power output, common grid infrastructure etc. [1]. It is evident, however, that an HOWWES is characterized by high complexity due to its inherent characteristics (e.g. variability and intense interaction of components) and its operation in the complex marine environment. Hence, a key factor for advancing the HOWWES technology is the development/application of suitable integrated numerical tools enabling the efficient investigation/assessment of the performance of an HOWWES, while, supporting, at the same time, the realization of novel relevant concepts, especially in deep waters. Motivated by this, a generic computational tool within the OpenFAST environment [2] is currently being developed, capable to conduct aero-hydro-servo-elastic time-domain analysis of an HOWWES consisting of any type of moored Floating OWT (FOWT) and several WECs, which absorb wave power through oscillations at specific Degrees of Freedom (DOFs).

The whole methodology is based on the utilization of the generalized modes concept for describing the relative to the FOWT motions of the WECs, additionally to the six rigid-body modes. In this way: (a) all hydrodynamic interactions between the FOWT and the WECs and between the WECs themselves can be taken into account, while (b) the computational time of the analysis is anticipated to be reduced. The frequency-dependent exciting forces along with the hydrodynamic and the hydrostatic coefficients are initially calculated in the frequency domain using a traditional numerical model based on the boundary element /boundary integral equation method (e.g. WAMIT [3]). The required generalized mode shapes are determined through appropriate vector shape functions, derived in accordance with the WECs' working direction. As for the time-domain analysis, specific subroutines of OpenFAST are appropriately extended (e.g. extension of Cummins equation of motion for more than 6 DOFs) in order to consider the additional generalized DOFs as well as the power take-off mechanisms. The hydrodynamic coupling between the FOWT and the WECs and between the WECs themselves will be taken into account through the inclusion of non-zero non-diagonal hydrodynamic and hydrostatic coefficients in the time-domain equation of motion. Finally, the developed tool will be validated with available numerical (based on the multi-body approach) and experimental results corresponding to existing in the literature floating HOWWES concepts.

References

- [1] Perez-Collazo, C., Greaves, D., Iglesias, G. A review of combined wave and offshore wind energy. *Renew. Sustain. Energy Rev.* 2015, 42, 141-153
- [2] National Renewable Energy Laboratory (NREL), OpenFAST. Available online: <https://www.nrel.gov/wind/nwtc/openfast.html>

[3] WAMIT Theory Manual. Available online: <https://www.wamit.com/Publications/tmanual.pdf>

Keywords: Offshore wind energy; Wave energy; Hybrid floating systems; Generalized modes; Time-domain analysis

Spying bacteria for dumped World War I munition at the coast of Knokke-Heist

Martin Bram¹, Van Landuyt Josefien¹, Mattelin Valérie¹, Herweyers Robin¹, Neyts Marijke², Parmentier Koen², Kundu Kankana¹ and Boon Nico¹

¹ Ghent University, Coupure Links 653, 9000 Gent, Belgium
E-mail: bram.martin@ugent.be

² Royal Belgian Institute of Natural Sciences (KBIN), 3de en 23ste Linieregimentsplein, 8400 Oostende, Belgium

In the years after World War I and II, several countries were confronted with a surplus of both chemical and conventional warfare agents. A way to deal with these bombshells was to dump them at sea since storage on land was too dangerous. Those munition dumpsites can be found worldwide, with major hotspots at the coast of Japan and in the Baltic and Adriatic sea. Due to the sensitive nature of the dumped materials, proper records are often missing. However, it is estimated that at least a staggering 1.6 million tons of munition are dumped worldwide (Wilkinson, 2017). After World War I, Belgian leftover munition was dumped on the sandbank *Paardenmarkt* at the coast of Knokke-heist. This is only a mere 500 m off the Belgian coast and located next to one of the biggest harbors in Northwest Europe, Zeebrugge. This sandbank was chosen with the assumption that the bombshells would sink in the sand layers over time, which also happened. The dumpsite is three km² in size, and an estimated 35.000 tons of munition were dumped (Missiaen, 2013). Multiple types of conventional and chemical warfare agents were used during World War I, with all of them one thing in common: tri-nitro-toluene (TNT). This compound poses ecotoxic threats to the immediate surroundings of the buried shells and poses explosion danger.

Monitoring the leakage of the bombs is difficult as analytical tests face issues with the high degree of dilution at sea and the low detection limits. Therefore, a microbial approach could offer a solution. Small concentrations of TNT could influence the microbiome, inducing a community change which could be used as a biomonitoring tool.

We conducted experiments with marine sediment sampled close to the *Paardenmarkt* site. Filter-sterilized seawater supplemented with nutrients and acetate (1 mg/L) as C source was added. We tested out two TNT concentrations (300 µg/L and 2 mg/L) under aerobic conditions to see the microbial shift caused by TNT exposure. Secondly, a degradation experiment with a TNT range of 40-80 mg/L under different conditions (aerobic, anoxic) was also performed. The microbial community was monitored with flow cytometry. GC-MS was used to quantify TNT and TNT degradation products.

Our results suggest that bacteria can degrade TNT when concentrations of 2 mg/L, 40 mg/L, or even 80 mg/L were used. TNT concentration dropped to zero fast, in 7 days for aerobic flasks and 15 days for the anoxic flasks. In the experiment where 2 mg/L TNT was added, total cell count remained unaltered with the reduction in TNT concentration. However, the total cell concentration and live-cell count were the same as in control without TNT. Nevertheless, TNT metabolites were detected, which shows some bacteria can bio-transform TNT.

For the experiments with 40-80 mg/L TNT, the biodegradation of TNT was correlated with a 2 log unit growth. This suggests the bacteria could grow using this toxic product as C source. The decrease in TNT was also correlated with an increase in TNT degradation products. Degradation products found in the experimental set-ups were different. Combined with the condition-specific phenotypic fingerprinting, the role of different microorganisms/phenotypes for the degradation of TNT in different environmental conditions is confirmed.

In the future, the degradation of TNT at a constant low concentration (<1 µg/L) and assessment of degraders by Illumina sequencing will be performed.

References

- Missiaen, T., 2013. Paardenmarkt bank, a wwi ammunition dump site off the belgiancoast. De grote rede 36 53–60
- Wilkinson, I., 2017. Chemical weapon munitions dumped at sea: An interactive map,Middlebury Institute of International Studies at Monterey, retrieved on 29th of november 2020.URL<https://www.nonproliferation.org/chemical-weapon-munitions-dumped-at-sea/>

Keywords: Biodegradation; Trinitrotoluene; Paardenmarkt; World War I; Munition dumpsite, Flow cytometry; Phenotypic fingerprinting

Marine hotspots revealed outside the breeding season for the Olive Ridley turtles along the Pacific coast of Nicaragua

Mertens Géraldine¹, Kochzius Marc¹ and De Weerdt Joëlle²

¹ Vrije Universiteit Brussel, Pleinlaan 2, 1050 Elsene, Belgium

E-mail: geraldine_387@hotmail.com

² Association ELI-S, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Elsene, Belgium

Olive Ridley turtles (*Lepidochelys olivacea*) are classified as vulnerable on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Abreu-Grobois, 2008) and are known to migrate between breeding and foraging sites (Da Villa, 2011). Most research studies and conservation efforts focus on nesting beaches, but coastal distribution and habitat use patterns have been poorly investigated (Peavey, 2017). It is unclear where Olive Ridley turtles exactly occur and how their distribution overlaps with anthropogenic activities, especially with fisheries. Nicaragua is a known breeding area for olive ridley turtles, but little is known on their ecology and marine distribution. This study aims to identify hotspots outside the breeding season and critical habitats to ensure effective and successful management plans for the recovery of Olive Ridley turtles.

To reach this objective, sightings of turtles were collected on boat-based surveys initially planned for cetacean research expeditions along the Pacific coast of Nicaragua. Two study sites were considered: Padre Ramos (northwestern site) a pristine area compared to the second site San Juan del Sur (southwestern site) that is facing coastal anthropogenic pressure such as fisheries and unregulated ecotourism. Research expeditions took place between January and April from 2016 until 2020 (except 2019) which are outside breeding season. Whenever a turtle species was encountered, the number of individuals, their behaviour (Surfacing, Swimming, Mating), gender, time, date and the geographic position were gathered. The presence of any type of boats was assessed every 30 minutes during survey effort. The Kernel Density Estimation algorithm of GIS allowed to generate maps of marine hotspots of Olive Ridley Turtles. Our preliminary result shows that turtle occurrence vary between sites. Two hotspots were identified; one in the North further away from the coast and one in the South located closely to a beach known for hosting mass-nesting events (arribada) of Olive Ridley turtles.

Increasing knowledge of turtle distribution will help increase conservation measures in the future. Our research will further investigate the influence of environmental parameters on their distribution patterns and verify whether they overlap with fishing activities, which will give important information for decision makers to reconsider the size of their marine protected areas.

Keywords: Marine Biology; Olive Ridley, Turtles, Opportunistic sighting; Pacific Ocean; Nicaragua

A novel, automated method to identify microplastic polymers based on fluorescent staining with Nile Red

Meyers Nelle^{1,2,3}, Catarino Ana¹, Janssen Colin², De Witte Bavo³ and Everaert Gert¹

¹ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: nelle.meyers@vliz.be

² GhEnToxLab, Department of Applied Ecology and Environmental Biology, Faculty of Bioscience Engineering, Ghent University, Campus Coupure, Coupure links 653, 9000 Gent, Belgium

³ Aquatic Environment and Quality Research Area, Animal Sciences Unit, Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

There has been a growing concern about the microplastic levels in the marine environment and their potential adverse effects for ecosystems and human health. Due to the increased demand for microplastic pollution monitoring at national and global levels, there is an urgent need for a standardized, reliable method that reduce the time, efforts and costs spent on plastic identification in the marine environment and allow for long-term monitoring. An optical microplastic detection method that has gained considerable attention lately because of its time- and cost-effectiveness makes use of the hydrophobic fluorescent dye Nile Red (NR). This method has proven useful for discriminating plastic particles from non-plastic materials in several matrices, but the possibility to use a fluorescent dye to obtain polymer-specific identification has not been explored intensely. In this ongoing study, an automated approach is being developed that makes use of the solvatochromic nature of Nile Red and allows for the identification of individual plastic polymers using fluorescence microscopy. The theoretical principle behind the new method is that the fluorescence emission spectrum of NR shifts depending on the polarity of its environment. The latter means that based on a large and qualitative training set of emission spectra of different polymers (collected under standardized conditions) automated algorithms can be developed for identification of polymers. Hence, the new method combines imaging of fluorescent particles with machine learning algorithms for the accurate and automated detection of different plastic polymers in various matrices at microscale. Based on the developed preliminary algorithms, this study show that polymers can be categorized based on their coloration following staining with Nile Red. We demonstrated that the identity of individual plastic particles can be predicted using this new technique. Based on the results so far this method could be a promising approach for the rapid, cost-effective and reliable identification of microplastics, and it could support the long-term monitoring of microplastics in various matrices.

Keywords: Microplastics; Polymer identification; Nile red; Fluorescence; Machine learning; Automation; Monitoring

The Brown Bank (Southern North Sea): a geo-archaeological investigation

Missiaen Tine¹, Plets Ruth¹, Fitch Simon², Harding Rachel², Muru Merle³, Fraser Andy², De Clercq Maikel⁴, Garcia Moreno David⁴, Versteeg Wim¹ and Gaffney Vince²

¹ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: tine.missiaen@vliz.be

² University of Bradford, School of Archaeological and Forensic Sciences, University of Bradford, Bradford BD7 1DP, United Kingdom

³ University of Tartu, Department of Geography, Institute of Ecology and Earth Sciences, University of Tartu, Vanemuise 46, Tartu, Estonia

⁴ Formerly Ghent University, Current address: Jan De Nul NV, Tragel 60, B-9308 Aalst, Belgium

The Brown Bank is a stable sand ridge nearly 30 km in length, located in the central part of the North Sea. At its base, water depths reach c. 30 m below sea level, with the maximum top of the bank sited 16 m below sea level. Seeing that relative sea level was significantly lower in the past (up to 100 m after the Last Glacial Maximum, this area would have been a dry land surface which subsequently became inundated during the rapid Early Holocene sea-level rise, sometime between 10 and 8 ka BP. Proof of this once dry land is evidenced by faunal and archaeological artefact recoveries, including Late Pleistocene fossil remains from land mammals including woolly mammoths, reindeer and bison, as well as (sometimes decorated) Mesolithic tools and human remains. These finds are mostly trawled-up by fishermen in the vicinity of the Brown Bank and, as such, their stratigraphic origin is mostly unknown.

This project aims to detect, image and map the submerged landscape now mostly buried beneath a cover of sands. In particular, it targets the Holocene inundation surface, which is most likely linked to the archaeological finds. Through mapping of such surface(s), we intend to find the maximum extent of the submerged landscape as well as to identify areas which may form the source deposit of the archaeological material. Some ground-truthing has been performed (vibro-cores) which are being investigated for palaeo-environmental purposes. These data will aid the reconstruction of the landscape and environments in which Mesolithic people lived and travelled. Moreover, it will allow us to better determine the timing of the inundation of the land surface, adding to our understanding of relative sea-level rise in the North Sea.

This poster presents some geophysical, acoustic and core data that were acquired as part of surveys conducted in 2018 and 2019, and which will act as the base for the planning of two more surveys lined up for 2021.

Keywords: Archaeology; Palaeo-landscape; North Sea; Brown Bank; Sea-level rise; Holocene; Geophysics

Phylogenetic relationships and biogeographic diversification of shallow water octopuses

Mtonga Cretus and Kochzius Marc

Marine Biology, Ecology & Biodiversity, Vrije Universiteit Brussel (VUB), Pleinlaan 2, 1050 Brussels, Belgium

E-mail: cretusi.joseph.mtonga@vub.ac.be

With more than 200 species, octopus constitute an important fishery resource in the world. The close similarity in morphological features, life strategies and behaviour has hampered taxonomic and phylogenetic studies. In this study, mitochondrial COI and 16S gene sequences of 67 specimens belonging to 54 species from previous studies were analysed. The phylogenetic analyses suggest that the genus Octopus is polyphyletic and that the species *O. conispadiceus* and *O. hongkongensis* might belong to another genus. Biogeographical analyses proposed that the most recent common ancestor of octopus lived in the Pacific Ocean about 42 mya. This ancestor gave rise to lineages between 39 – 24 mya that underwent diversification due to various vicariance and dispersal events (up to 3 mya), resulting in the present-day distribution of octopuses. The most recent diversification between *O. tetricus* and *O. vulgaris* took place between 6 – 3 mya. This study indicated that there is a need for a taxonomic revision to resolve the classification in the genus Octopus.

Keywords: Octopus; Taxonomy; Phylogeny; Diversification; Ancestor

Global patterns of the varying degree of functional redundancy in mangrove ecosystem services: A geospatial analysis.

Nair Amrita¹, H.Y. Chong Fiona², Aubry Albane² and Dahdouh-Guebas Farid²

¹ Ecology & Biodiversity, Department of Biology, Faculty of Science and Bioengineering Sciences, Vrije Universiteit Brussel (VUB), Pleinlaan 2, 1050 Elsene, Belgium
E-mail: Amrita.nair@vub.be

² Faculté des Sciences, Département de Biologie des Organismes, Écologie des Systèmes et Gestion des Ressources, Université Libre de Bruxelles, F.D. Rooseveltlaan 50, 1050 Brussel, Belgium

Being such a widespread diverse and social-ecological system, the mangrove forest supports and contribute to a multitude of ecosystem processes and functions which in turn produce a substantial line-up of ecosystem goods and services (Dahdouh-Guebas *et al.*, 2020). For these, the definitions we use are those introduced by (Costanza *et al.*, 2017) and (Dahdouh-Guebas *et al.*, 2020) i.e.: "Ecosystem processes and functions contribute to ecosystem services, but they are not synonymous. Ecosystem processes and functions describe biophysical relationships that exist regardless of whether or not humans' benefit. By contrast, ecosystem goods and services are those processes and functions that benefit people, consciously or un-consciously, directly or indirectly". Mangroves provide services to us by being sources of food nutrition, places for near and offshore commercial fisheries, harvesting forestry products for fuel and construction and eco-tourism (Curnick *et al.*, 2019; zu Ermgassen *et al.*, 2020). Coastal protection through wave attenuation is one of their key functions. Mangroves serve as the first line of defence during coastal flooding. They can reduce the wave energy by almost 66% with only the first 100m of their forest width (Menéndez *et al.*, 2020). By being large carbon sequestration sinks, mangrove ecosystems are among the most productive ecosystems. For example, in the tropics, these carbon sinks account for 49-98% of carbon storage (Donato *et al.*, 2011). Despite all these benefits, they have been severely influenced by degradation, deforestation and anthropogenic pressures, to such an extent that 20-30% of global mangrove cover has been lost in just half a century (Duke *et al.*, 2007 Goldberg *et al.*, 2020). Anthropogenic factors like overexploitation, land-use change, and pollution are among the leading causes of their depletion and destruction, endangering species in different parts of the world (Polidoro *et al.*, 2010; Saenger *et al.*, 2019). In eastern Africa, the out of control extraction of wood for construction work led to a huge loss in mangrove area, threatening the Rhizophora, Bruguiera and Ceriops species (Saenger *et al.*, 2019). This reduction in species number could also alter the strength of ecosystem functions and services (Worthington *et al.*, 2020). The loss of functions is seen to be a bigger threat to ecosystem processes and services than that of species, however not much is known about what this depletion in mangrove biodiversity does to their ecological and socio-ecological functioning (Mouillot *et al.*, 2014). Chong (2019) investigated biological trait compositions of different mangrove forests from all over the world to establish an understanding between mangrove resilience and their ecological functioning. Tree diameter, root type, absolute maximum height and seed mass were among the eighteen traits explored. Here, the trait compositions were found to be more similar than species compositions, hence indicating that globally most mangrove forests are functionally similar and species redundancy is prominent (Chong, 2019). A study done by Aubry (2021, Un monde sans mangrove: déclin global des services écosystémiques dans une ère de pression anthropique croissante, Université Libre de Bruxelles - ULB, Brussels, Belgium) examines similar relationships between the species redundancy and socio-ecological functioning of the forest. In our ongoing study, we will further examine this relationship, globally map the findings of Chong (2019) and Aubry (2021) and perform geospatial analyses using geographic information systems. Significant differences in the species and trait compositions for regions with available datasets, in the Indo-West Pacific (116 datasets) and Atlantic East Pacific (85) distribution, will be subsampled more since some regions have been found to show more trait diversity than species diversity (Chong, 2019). The input data that we will use exist under the form of tabulated data with ecosystem processes and functions and with ecosystem goods and services which will be merged. As the redundancy of keystone species seems to play an integral role in mangrove resilience against disturbances, it is important to map out global patterns on these varying degrees of redundancy in processes and functions on one hand and goods and services on the other. Further serving as an early warning map highlighting where they are at risk. In turn, the study can serve

as a basis to establish a Red List of Mangrove Ecosystems using a social-ecological systems approach (Rodríguez *et al.*, 2012).

Keywords: Mangrove ecosystem; Processes and functions; Good and services; Global mangrove cover; Species redundancy; Spatial analysis; Trait diversity; IUCN Red List of Ecosystems

Microplastic formation from a newly developed biocomposite

Niu Zhiyue¹, Catarino Ana Isabel¹, Davies Peter², Le Gall Maelenn², Curto Marco³, Jiang Chulin³, Dotcheva Mariana³, Vancoillie Gertjan⁴, Dhakal Hom³, Vandegehuchte Michiel¹ and Everaert Gert¹

¹ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: zhiyue.niu@vliz.be

² Marine Structures Laboratory, IFREMER, Centre Bretagne CS 10070, 29280 Plouzane, France

³ Advanced Materials and Manufacturing Research Group, School of Engineering, University of Portsmouth, Portsmouth PO1 3DJ, United Kingdom

⁴ Functional Thermoplastic Textiles, Centexbel, Industriepark Zwijnaarde 70, 9052 Gent, Belgium

Concerns have arisen about the environmental persistence and biological impacts of microplastic (MP, < 5 mm) in the global ocean. An important source of MP in the marine environment is the degradation of fossil-based polymers such as polypropylene (PP) and polyethylene (PE) induced by the hydromechanical forces and UV radiation. Polymers and composite materials made from a natural-sourced feedstock, like polylactic acid (PLA) and thermoplastic starch (TPS), known as biopolymers and biocomposites, are seen as a sustainable alternative with lower environmental impacts. However, to date, few studies have focused on the degradation behaviour of biopolymers and biocomposites in the marine environment.

As part of the Interreg 2 Seas Mers Zeeën project SeaBioComp (<http://seabiocomp.eu/>), we compared and quantified the MP formation of a newly developed biocomposite and a fossil-based polymer during their degradation under UV radiation. To do so, we exposed self-reinforced PLA and PP specimens in seawater to UV radiation simulating natural exposure of 18 months. To identify and characterize MP particles, we applied a combination of fluorescence microscopy, scanning electron microscopy coupled to an element detection system (SEM-EDX), and infrared technology (μ FT-IR).

Our results show a significant number of PP MP formed due to UV exposure while no significant number of PLA MP, indicating that this biocomposite is more resistant to UV radiation than the reference fossil-based polymer. We anticipate that our results will contribute to assessing the risk of biocomposites which can present a more sustainable alternative to fossil-based polymers.

Keywords: Biopolymer; Microplastic formation; Fragmentation; Photo-degradation; Size frequency distribution; SeaBioComp

Shrimp farming, a major threat to mangrove and lagoon ecosystem in the Pambala-Chilaw lagoon complex, Sri Lanka

Ofori Samuel A.¹, Arachchilage Sunanda K.², Jayatissa Loku P.², Madarasinghe Sanduni K.³, Gunathilaka Udara V.², Wijesundara Isuru², Thisera Douglas⁴ and Dahdouh-Guebas Farid¹

¹ Écologie des Systèmes et Gestion des Ressources, Département de Biologie des Organismes, Université Libre de Bruxelles (ULB), Avenue Franklin D. Roosevelt 50, Cpi 264/1, B-1050 Bruxelles, Belgium

E-mail: samuel.ofori@ulb.be

² Department of Botany, University of Ruhuna, Wellamadama, Matara, Sri Lanka

³ Department of Physics, University of Ruhuna, Wellamadama, Matara, Sri Lanka

⁴ Sudeesa, Pambala, Kakkapalliya, Chilaw, Sri Lanka

Amongst the several mangrove forests present in Sri Lanka, those in the Puttalam district have suffered the highest level of degradation arising from human activities, particularly shrimp farming. The occurrence and spread of the White Spot Disease (WSD) on shrimps both in shrimp farms and natural waters of Sri Lanka during 1994-1995 caused the abandonment of infested ponds and the cutting down of mangrove forests to create new shrimp farms. In Chilaw lagoon, this situation coupled with pollution by effluents from the shrimp farms has led to the reduced potential of the current mangrove and lagoon ecosystem to provide all potential ecological services. Owing to the existing nearness between the shrimp farms, the lagoon and the surrounding mangrove forests in the Pambala-Chilaw Lagoon complex, the chances of organic contamination occurring across these systems are very high. The continual discharge of effluents from shrimp farms into the Chilaw lagoon since the 1980s has led to the enormous growth of algae and seaweeds at the surface and bottom waters, respectively. The additional consequence has been a high reduction in the population of some fish and shrimp species in the Chilaw lagoon. Moreover, there has been a decline in the population of some bird species that found their habitats around the lagoon and/or in the mangrove forest. Therefore, the objectives of our ongoing research are: (i) To quantify the areal extent of change in the mangrove forest and shrimp farms in the Pambala-Chilaw lagoon complex from the year 1980 to 2020 using very high spatial resolution (VHSR) imagery; (ii) To discriminate between the active and inactive shrimp farms in the Pambala – Chilaw lagoon complex using VHSR satellite imagery; (iii) To measure the physico-chemical parameters of mangrove soil samples, water and sediments samples of the Chilaw Lagoon; (iv) To measure the levels of Nitrates and Phosphates present in mangrove soil samples, water and sediment samples of the Chilaw Lagoon; (v) To assess the sociological impacts of mangrove forest destruction and lagoon water contamination on the fisherfolk communities. This study will therefore serve as a more detailed report on the influence of shrimp farming on mangrove forest and lagoon water in the Pambala-Chilaw lagoon complex and bring to light the extent to which the local community has been impacted.

Keywords: Ecological monitoring; Remote sensing; GIS; Nutrient analysis; Coastal ecosystems; Mangroves

What it takes to go global? Lessons from a study on ocean literacy

Paredes-Coral Evelyn¹, Deprez Tim¹, Mokos Melita² and Vanreusel Ann³

¹ Marine Training Platform, Marine Biology Research Group, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium

E-mail: evelyn.paredescoral@ugent.be

² Department of Ecology, Agronomy and Aquaculture, University of Zadar, Trg kneza Višeslava 9, 23000 Zadar, Croatia

³ Marine Biology Research Group, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium

In recent years, ocean literacy has evolved from a local to a global scale movement. The challenge taken by this movement is to connect people to the ocean while, at the same time, being an incentive for positive change in people's behavior. Ocean literacy has first caught the attention of researchers in the USA, expanding then to Canada, Europe and worldwide. Researchers from several disciplines work in a collaborative basis using a broad range of approaches and methods that result in several scientific publications. However, it remains unclear how ocean literacy scaled up and gained acknowledge in the international research community. It is necessary to have an updated outlook to investigate how this research advancements are developing in structure and change the relationship between research communities.

In the present study, we applied a combination of bibliometric analysis and science mapping to a dataset of scientific publications on ocean literacy between 2005 and 2019, obtained from Web of Science and Scopus databases. In order to represent the development of the field and to analyze the level of collaborations, we first used bibliometric analyses to describe the field's main features, including indicators of growth and research collaboration. We then used science mapping techniques to build collaboration networks among institutions and countries and to identify research communities.

Our results suggest that collaboration formed the basis for the evolution of ocean literacy from a USA initiative to a global scale movement. Our data reveal a promising trend for collaboration among authors, countries and institutions. These findings confirm that ocean literacy is gaining more acknowledgment within the scientific community worldwide but still face considerable limitations to its dissemination in Latin America and Africa. Promoting cross-institutional and cross-disciplinary cooperation is critical to support this purposeful movement and represents an urgent challenge.

Keywords: Ocean literacy; Science mapping; Bibliometrics; Collaboration; Sustainable Development Goal 14

Analysis of the Ciara storm impact on a multibarred beach at the Belgian coast

Pintor Albert, Anne-lise Montreuil, Chen Margaret and Bogaert Patrick

Vrije Universiteit Brussel (VUB), Avenue de l'Hippodrome 190, 1050 Ixelles, Belgium

E-mail: albertpk1824@gmail.com

Ciara storm took place between the 8th and 12th of February 2020 in Belgium and lashed with significant economic and environmental damages. The aim of this study was to analyze the effect of the Ciara storm on the morphodynamical and volumetric changes of the intertidal bars at Groenendijk beach, Belgium.

Ciara event was one of the strongest storms recorded in the recent years. During this storm, the meteo-marine conditions were recorded with a maximum water level of 5.78m (TAW) and a maximum wave height of 2.80m with a wave direction approaching from the South-West, a maximum wind speed of 23.18 m/s blowing from the west and an average wave period of 4.5 s.

To investigate the impact of this storm, an intensive daily cross-shore profiles monitoring campaign after Ciara storm was carried out with a Real Time Kinematic GPS (RTK-GPS) from 22/02/2020 till 26/02/2020. Also, a pre-storm Light Detection And Ranging (LiDAR) topographic survey on 13/01/2020 and post-storm airborne LiDAR survey on 28/02/2020 were performed. They were both provided by the Coastal Division.

The acquired cross-shore profiles were re-projected and interpolated at 1 m interval. Then morphological analyses were carried out to determine bar dynamics over the study period. Bar parameters were obtained such as the different bars width and height, distance between adjacent bars, seaward and landward bar slopes, bar volume etc.

A high difference of elevation in the crest and troughs of the bars between pre- and post-storm was found with values up to 0.3m and up to 0.15m by focusing only on the post-storms daily campaign with SD higher values on the seaward slopes of the bars.

A high difference of elevation between consecutive days was of 0.15m while it was up to 0.30m between the pre- and post-storm surveys. The most significant changes occurred on the seaward slope of the bar. Interestingly, the most inner bars were dynamics while the bar near the mean low water level was stable. Furthermore, the results indicate that the storm impacted the beach and produced an overall loss of sand (up to 0.5 m³/m).

This study has provided insight into post-storm bar behavior which can be beneficial for coastal management and future research.

Keywords: Intertidal bar; Storm impact; Morphodynamical changes; Coastal erosion

Probing the single-cell activity of *Alcanivorax venustensis* during deep-sea oil degradation

Pluym Thomas, Van Landuyt Josefien, Boon Nico and Props Ruben

Center for Microbial Ecology and Technology, Ghent University, Coupure Links 653, 9000, Gent, Belgium
E-mail: pluymthomas.1103@gmail.com

Marine oil spills originating from leaking ships, drilling rigs, and anthropogenic activities have detrimental effects on various levels of the marine ecosystem. This form of pollution, which mainly consists of liquid petroleum hydrocarbons, affects the biota via direct contact with the contaminants, as well as via the disturbances caused by the oil spill cleanup process. A considerable amount of spilled oil is dissimilated by active microbial degradation. The *Alcanivorax* genus, usually found in marine environments has been shown to proliferate in these contaminated environments. The capability of the *Alcanivorax* to dissimilate oil compounds (e.g. acyclic saturated hydrocarbons) into harmless compounds presents an as-of-yet untapped potential for both bioremediation and biotechnology applications (e.g., anti-oil spill agent and biopolymer production). While *Alcanivorax* taxa are frequently found at oil spills at the ocean's surface, there are questions about *Alcanivorax*' oil degrading capacity at greater depths where oil can precipitate and accumulate. There exists only limited information on the in-situ activity of *Alcanivorax* taxa during the biodegradation process at elevated hydrostatic pressures.

In this study, we optimized a single cell activity approach called Bioorthogonal Non-canonical Amino Acid Tagging (BONCAT) for studying *Alcanivorax venustensis*, a recently isolated culture able to withstand higher hydrostatic pressures. The BONCAT procedure labels active cells through an *in vivo* incubation with synthetic L-methionine analogs (e.g., L-homopropargylglycine (HPG) or L-azidohomoalanine (AHA)), which become incorporated in the protein content of the cells, and can be made fluorescent via a Click-it reaction. This protocol was integrated with SYBR Green I as a counterstain for labeling all cells, and was then used to probe the alkane degradation activity of *A. venustensis* at elevated hydrostatic pressures (i.e. 10 bar, 20 bar) for an incubation period of 72 hours using high-pressure reactor systems. Counterstaining with SYBR green I enabled us to make a distinction between active and non-active cells. The protocol optimization consisted of varying the click-it dye concentration from 0.01 to 10 µM and testing different cell fixation methods (no fixation, EtOH PFA, and glutaraldehyde fixation). The final protocol was compatible with both flow cytometric and microscopic analysis and consisted of a 10 µM dye concentration, combined with a sequential ethanol fixation procedure. It was also crucial to incorporate an ultrasonication step as *Alcanivorax venustensis* created aggregates during cultivation. The controls, consisting of treatments with 150 µM mL⁻¹ chloramphenicol to inhibit protein synthesis, and a sample incubated without methionine analogues resulted in no labeled cells, as verified by flow cytometric and microscopic analysis. During incubation at elevated hydrostatic pressures, preliminary data suggests that *A. venustensis* exhibited a lower activity at higher pressures. These results will now be further complemented by gene expression analyses to associate the translational activity of *A. venustensis* with its gene expression.

Keywords: Oil degradation; *Alcanivorax venustensis*; Bacterial activity; BONCAT; Flow cytometry

Higher dunes, deeper sea

Roest Bart and Rauwoens Pieter

Hydraulics and Geotechnics, Department of Civil Engineering, KU Leuven, Spoorwegstraat 12, 8200 Bruges, Belgium
E-mail: bart.roest@kuleuven.be

The Belgian coastline separates the North Sea from the low-lying hinterland. This sandy coast is fringed by alternating stretches of natural dunes and man-made sea dikes, that protect the hinterland from flooding. These structures are required to meet the safety standards, recently revised in the *Masterplan Coastal Safety* (Afdeling Kust, 2011). Currently, the *Complex project coastal vision* (Weyts, 2017) aims for further improvements towards 2100. To assess coastal safety, each year the coast's altitude is measured. These measurements reach from the dunes up to 1500 m offshore. With measurements starting already in the 1970's, the Belgian coast is amongst the best monitored in the world. On decadal time-scales, the Belgian nearshore zone has gained sediment at a rate of $10^6 \text{ m}^3/\text{year}$. Natural feeding and artificial sand nourishment contribute equally to this increase (Roest, 2019). Furthermore, Strypsteen et al (2019) concluded that natural dunes grow linearly in time, at an average rate of $6 \text{ m}^3/\text{m/year}$. Historically the survey data were only processed to sediment volumes per coastal section (Houthuys, 2012). While useful for the determination of long-term trends, these volumetric data do not provide information on changes in the coastal profile shape. Raw point-clouds, on the other hand, are difficult to compare or to process. A standard grid of cross-shore oriented transects overcomes these difficulties.

Digitally available surveys covering the entire Belgian coast are available as of 1997. These surveys are merged in a continuous Digital Elevation Model (DEM) per year. From these newly derived data, it appears that erosive trends are mostly found in tidal channels (Kleine Rede, Grote Rede, Appelzak) and next to dredged access channels (Oostende). Erosion rates there average around 2 cm/year, with significant extremes in access channels due to dredging. Along the Grote Rede, the transition from the sloping shoreface towards the flat seabed is migrating onshore, manifesting itself as erosion up to 10 cm/year. Contrastingly, accretive trends are concentrated on the dune front and dry beach, with an average rate in the order of 2 cm/year, much larger than current sea level rise. Both natural feeding (Aeolian transport) and beach nourishments contribute to this accretion. Furthermore, accretive zones are found in the wave shadow zones of the Zeebrugge and Oostende breakwaters. Continued accretion of the dry beach and dune front combined with erosion of the shoreface leads to an overall steepening of the beach profile. Eventually this may harm the overall stability of the coast.

Bibliography

- Afdeling Kust. (2011). *Masterplan Kustveiligheid*. Oostende: Maritieme Dienstverlening en Kust. Afdeling Kust.
- Houthuys, R. (2012). Morfologische trend van de Vlaamse kust in 2011. Agentschap Maritieme dienstverlening en Kust, Afdeling Kust, Oostende.
- Roest, L.W.M., (2019). Sediment budget of the Belgian coast, in: Crest Scientific report.
- Roest, L.W.M., (2019). Combined topography and bathymetry of the Belgian coast, interpolated to cross-shore transects (1997-2019), dataset.
- Strypsteen, G., Houthuys, R., and Rauwoens, P. (2019). Dune evolution at decadal timescales and its relation with potential aeolian transport. *Journal of Marine Science and Engineering*, 7(10), 357.
- Weyts, B. (2017). Startbeslissing Complex Project Kustvisie, Nota aan de Vlaamse regering.

Keywords: Coastal morphology; Coastal engineering; Dunes; Sea level rise

Understanding mangrove utilization by local communities in Sri Lanka: A social-ecological approach

Rubiera Rodriguez Servane¹, Thanne Walawwe Gedera Fathima Mafaziya Nijamdeen², Jung Julia³, Hugé Jean⁴ and Dahdouh-Guebas Farid¹

¹ Laboratory of Systems Ecology and Resource Management, Département de Biologie des Organismes, Université Libre de Bruxelles, Avenue Franklin D. Roosevelt 50, CPI 264/1, 1050 Brussels, Belgium

E-mail: servane.r@hotmail.fr

² Department of Biological Sciences, Faculty of Applied Sciences, South Eastern University of Sri Lanka, Sammanthurai, Sri Lanka

³ Marine Biology Research group, Ghent University, Krijgslaan 281/S8, 9000 Gent, Belgium

⁴ Department of Environmental Sciences Faculty of Science, Open University of the Netherlands, Valkenburgerweg 177, 6419 AT Heerlen, The Netherlands

⁵ Systems Ecology and Resource Management, Département de Biologie des organismes

Mangrove restoration is expensive and time consuming, especially when compared to the protection and management of existing forests. Typically, local communities are aware of the importance of mangroves, from which they derive direct benefits.

Our study focuses on how people along the east coast of Sri Lanka perceive and live off these mangrove ecosystems, with the aim of promoting the development of a management plan that considers the needs of nature and people. To assess the impacts of mangrove ecosystems on coastal communities, their usage was assessed through an ethnobiological questionnaire in 83 households in 5 communities along the eastern coast of Sri Lanka considering differences in religion, ethnicity, economic status, gender and age. Local people were aware of the importance of mangroves to their livelihoods; in most cases they were unable to explain particular ecological benefits of mangroves.

In the current study, a higher percentage of people utilizes mangroves for fishery, fuelwood and edible fruits. They rarely used mangrove wood for construction or medicine. Men answered the questions related to fisheries whereas most women did not. Older people seemed to be more dependent on mangroves. Local communities who live in close proximity to mangroves used them more often, regardless of their religion. However, there were some differences between villages in the usage of mangroves for fuelwood as most villagers tend to use coconut leaves, husks, and other commercial woods instead. They refer to the government-led ban in mangrove wood product use as a reason for such changes. In general, respondents were in favor of mangrove conservation, but dissatisfied with the measures taken by the government, preventing them from using the environment they strongly depend on. Developmental projects such as the Oluvil harbor and bridges have had negative effects on the mangrove ecosystems as locals relate it to the loss of diversity of plants and animals, reduced fishery and water quality. Mangroves were perceived as very important for people's livelihoods, and most respondents are not optimistic about the future of mangroves in the east coast of Sri Lanka.

Keywords: Mangroves; Sri Lanka; Ethnobiology; Local communities

Allergenic activity of Anisakidae, fishborne parasites

Saelens Ganna¹, Planckaert Sören², Martínez-Sernández Victoria³, Gabriël Sarah⁴, Ubeira Florencio³ and Devreese Bart^{2,4}

¹ Laboratory of Foodborne Parasites, Department of Veterinary Public Health and Food Safety, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium
E-mail: ganna.saelens@ugent.be

² Department of Biochemistry and Microbiology, Ghent University, K.L. Ledeganckstraat 35, 9000 Gent, Belgium

³ Department of Microbiology and Parasitology, Instituto de Investigación en Análisis Químicos y Biológicos, Rúa Lope Gómez de Marzoa, s/n. Campus Vida. 15782 Santiago de Compostela, Spain

⁴ Department of Veterinary Public Health and Food Safety, Ghent University, Salisburylaan 133, 9820 Merelbeke, Belgium

The presence of parasites in marine fish poses a serious problem for the fishing industry in many countries worldwide. The family Anisakidae, mainly represented by the species *Anisakis simplex* and *Pseudoterranova decipiens*, are nematodes infecting the muscles and gastrointestinal tract of a wide range of marine fish species and can induce severe pathologies in humans. First, both are causative agents for acute gastrointestinal disease in humans after ingestion of a live larva by consumption of raw or undercooked fish. Secondly, in the case of *A. simplex*, human health may be compromised by an allergic reaction against its proteins after consuming or even handling infected fish. Besides being highly resistant to heating and freezing, some of the allergens are excretory-secretory (ES) products. As such, people may be exposed to them not only through the direct ingestion of a larva, but also when the larva was removed during the processing of the fish leaving these ES-allergens behind (Adroher-Auroux & Benítez-Rodríguez, 2020). Limited information on *P. decipiens* allergenicity is available, however, due to its phylogenetic relatedness with *A. simplex* and a high degree of homology of its proteins with *A. simplex* allergens, *P. decipiens* might also have an allergic potential (Kochanowski et al., 2020). Therefore, the aim of this work was to confirm whether or not one or more *A. simplex* allergen(s) were also to be found in *P. decipiens*. This was studied by subjecting extracts of crushed whole *P. decipiens* larvae as well as *P. decipiens* ES-extracts to two different *A. simplex* allergen detection techniques. Specifically, 55 *P. decipiens* larvae were excised from highly infected fresh codfish obtained from a Belgian fish distributor. Fifty of them were cultivated in a nutrient rich medium to obtain an extract of ES proteins, while another five larvae were crushed to obtain whole crude *P. decipiens* proteins. Both extracts were subsequently subjected to an immune-mediated detection technique (an enzyme-linked immunosorbent assay; ELISA) based on the recognition of an antibody against one specific *A. simplex* allergen (Ani s 7). Additionally, both extracts were inserted into a mass analyser (tandem mass spectrometry) used for the detection and identification of proteins and their fragments. In both detection tools, crude and ES *A. simplex* extracts were used as positive controls. The results of the ELISA confirmed the presence of one *A. simplex* allergen (Ani s 7) in both *P. decipiens* extracts. Moreover, using tandem mass spectrometry, six and two *A. simplex* allergens respectively were detected in both ES and crude *P. decipiens* extracts. This work confirms that not only *A. simplex*, but also *P. decipiens* should be considered a potential source of allergens that could lead to severe hypersensitivity in humans. Future work entails clinical studies investigating the actual allergenic potential of *P. decipiens* in humans.

References

- Adroher-Auroux, F.J., & Benítez-Rodríguez, R. (2020). Anisakiasis and Anisakis: An underdiagnosed emerging disease and its main etiological agents. Research in Veterinary Science, 132, 535-545. doi:10.1016/j.rvsc.2020.08.003
- Kochanowski, M., Dąbrowska, J., Rózycki, M., Karamon, J., Sroka, J., & Cencek, T. (2020). Proteomic Profiling Reveals New Insights into the Allergomes of *Anisakis simplex*, *Pseudoterranova decipiens*, and *Contracaecum osculatum*. J Parasitol, 106(5), 572-588. doi:10.1645/19-75

Keywords: Fish parasites; Food safety; Allergens; Detection

Tide against marine aquaculture litter – A knowledge-sharing platform and app

Sandra Matthias¹, Devriese Lisa¹, De Raedemaeker Fien¹, Lonneville Britt¹, Altvater Susanne², Lukic Ivana², Deudero Salud³, Alomar Carme Mascaro³, Vidal Maria Rigo³, Ferrer Montserrat Compa³, Gin Iwona⁴, Lheureux Guillaume⁴, Vale Maria⁵, Hipolito Claudia⁵, Paramio Luz⁵, Zorgno Margherita⁶ and Mata Lara Mariana⁷

¹ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: matthias.sandra@vliz.be

² s.Pro – sustainable projects GmbH, Kärntener Strasse 20, 10827 Berlin, Germany

³ Instituto Español de Oceanografía, Calle del Corazón de María 8, 28002 Madrid, Spain

⁴ Centre national de la mer – Nausicaa, Boulevard Sainte Beuve, B.P. 189, 62203 Boulogne-sur-Mer Cedex, France

⁵ Fundo Regional Para a Ciência e Tecnologia (FRCT), Rua do Mercado 21, 9500-326 Ponta Delgada, Portugal

⁶ EurOcean - European Centre for Information on Marine Science and Technology, Avenida Dom Carlos I, 126-3º, 1249-074 Lisboa, Portugal

⁷ Geonardo, Graphisoft Park, building A, 7 Záhony street, 1031 Budapest, Hungary

Until recently, there were no global estimates of the amount of plastic waste generated by the aquaculture sector (FAO, 2017). ‘Identifying the options to address key waste items from aquaculture activities which could contribute to marine litter’ is a priority action at global level included in the G7 Action Plan on Marine Litter (2015). Nevertheless, the necessary knowledge base to take policy actions and effective measures was largely lacking. Therefore, the AQUA-LIT project (EU EASME-EMFF) carried out a comprehensive assessment of the available data and knowledge on aquaculture as a source of marine litter in the North, Baltic and Mediterranean Seas.

The AQUA-LIT assessment compiled a Marine Litter Inventory of 65 different items of marine litter attributable to aquaculture, including ropes, nets, floats and buoys, collecting material, strapping material, tags, clothing and structure parts, of which almost three-quarters are partially or completely made of plastic. Nineteen items are unique to aquaculture (e.g. plastic mesh screens, mussel socks and “Tahitians”), and especially related to bivalve farming. Nevertheless, the current OSPAR and HELCOM databases only define four aquaculture categories of beach litter. As a consequence, all other collected mariculture related litter items are categorised in other more general groups and not taken into account. A further subdivided and harmonised European or international classification system is therefore recommended.

The global and European policy framework for the prevention and management of marine debris exists, but needs to be further translated into implemented tailor-made actions and measures depending on the source (e.g. aquaculture) of marine debris. To gain inspiration and knowledge from experts, multi-actor workshops were organised in the North Sea, Baltic Sea and Mediterranean Sea region. For the North Sea Learning Lab, the differentiation between consumables (single use, short use) and durables (long use), and the better labelling of aquaculture gear and items, including quality standards came out as key outcomes. The sector also proposes a mass-balance system: paying for what you leave offshore, and/or being rewarded for (collected) waste you bring on land. A deposit system can work very effectively for large items, but is unfeasible for frequently lost small items. Taxes on small and cheap disposable plastic gear items makes them more expensive for farmers to use and lose. Following the idea of Extended Producers’ Responsibility (EPR), measures and related incentives have to be extended to individual or group-specific obligations and measures (on a voluntary basis, with a code of conduct, with new legislation etc.). Also, decommissioning plans for aquaculture facilities, based on the life investment cycle of the materials and infrastructure should be mandatory. Concerning waste management, a waste collection point in all ports and harbours is seen as a crucial factor for the success of the implemented measures.

The Marine Litter Inventory and Learning Lab outcomes are implemented in the AQUA-LIT Toolbox, which acts as a platform that provides regional available solutions and tools against marine littering from aquaculture activities to innovators, farmers, and other actors along the chain. Furthermore, the toolbox gives stakeholders an overview of the port reception facilities in several European countries and sums up the existing funding opportunities on different policy levels for stakeholders to apply and become 'bluer' in their practices. Lastly, the toolbox serves as a science-policy-society interface and supports sustainable policy-making and governance of the marine litter problem in the aquaculture sector by providing targeted actions plans and policy recommendations.

The AQUA-LIT toolbox is freely available in the AppStore and the AQUA-LIT website.

Keywords: Plastic; Marine litter; Aquaculture; Stakeholder engagement; North Sea

Wake up, safeguard & share your marine data with EMODnet-Ingestion.EU

Schlessner Marianne¹, Strobbe Francis², Schaap Dick³, Iona Sissy⁴ and Beja Joana⁵

¹ Belgian Marine Data Center, OD Nature, Royal Belgian Institute of Natural Sciences, Vautierstraat 29, 1000 Brussel, Belgium

E-mail: bmdc@naturalsciences.be

² EMODnet Secretariat, InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium

³ MARIS, Gildeweg 7 A, 2632 BD Nootdorp, Netherlands

⁴ Hellenic Centre for Marine Research – HCMR, Institute of Oceanography, P.O. Box 712, 190 13 Anavyssos, Greece

⁵ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium

The European Marine Observation and Data Network (EMODnet) consists of a network of 160 organisations supported by the EU's integrated maritime policy to work together on assembling, harmonising and making marine data, products and metadata more available to public and private users. They are geographically anchored in the countries bordering all European marine basins. These organisations work together to observe the sea, process the data according to international standards and make that information freely available as interoperable data layers and data products. EMODnet provides access to European marine data, products and metadata across seven discipline-based themes (bathymetry, biology, chemistry, geology, human activities, physics and seabed habitats). The data centres work together on pan-European and international scales in organisations such as IODE, ICES, EuroGeoSurveys, EuroGOOS, and IHO, and for pan-European marine data management infrastructures such as SeaDataCloud, EurOBIS and EGDI.

EMODnet supports data providers and data users by:

1. Giving access to data already collected, reducing costly and expensive sampling campaigns;
2. Providing ready-to-use digital data products that can support the daily work of researchers, expediting their research and career development;
3. Making diverse datasets available through which they can enrich their own research data;
4. Stimulating further research in marine environment, promoting open data and favouring open dialogue (Every year there are plenty of opportunities to get in touch with EMODnet representatives. In 2021, you can meet us at our upcoming EMODnet Open Conference and Jamboree on 14-18 June);
5. Maximising the impact and re-use of research data by sharing with EMODnet.

You are invited to submit your data and data products via the free-of-charge EMODnet Data Ingestion Portal. Submit now to EMODnet-Ingestion.EU! Research institutes, academic institutions, university departments and, more generally, any organisation heavily involved in promoting, supporting and enabling research producing activities in the Blue Growth sector, play an essential role in the marine and maritime ecosystem. They are also key users and data providers of EMODnet, together with the industry. Potential data providers outside the network are supported by partners to release their datasets for safekeeping and further processing, publishing as open data and contributing to applications for society.

The EMODnet Data Ingestion partners (e.g. RBINS and VLIZ in Belgium) are national and regional marine and oceanographic data repositories and data management experts. In the life cycle of a data submission, we make a distinction between 2 phases: Phase I - from submission to publishing of the submitted datasets package 'as is'; Phase II - further elaboration of the datasets and integration (of subsets) in national, European and EMODnet thematic portals. This split allows the publishing, in an early stage, of the original data package with high quality metadata. If you want to know more on the EMODnet Ingestion process, have a look at the movie "Wake up your data" (3'30" on YouTube). Successful operation!

So far, the work of EMODnet has resulted in many submissions and use cases, such as for monitoring data from offshore renewable energy projects or minting DOIs for research data to support data citing

for data submitters. Please, have a look at the Use Cases webpage to see how other organisations have benefited from EMODnet' services and products since 2010.

More information on the poster!

www.emodnet-ingestion.eu/media/emodnet_ingestion/org/documents/emodnet_postera0_21-10-20.pdf

Contact us at EMODnet-Ingestion.EU

Keywords: Marine data; Research; Data sharing; Data publication; Open data; Standardisation; Data products; Bathymetry; Geology; Seabed habitats; Chemistry; Biology; Physics; Human activities

BICEpS wants you!

Schlesser Marianne¹, Degraer Steven¹, Hostens Kris², Moreau Kelle¹, Polet Hans², Scory Serge¹, Torreele Els² and Vandendriessche Sofie²

¹ Royal Belgian Institute of Natural Sciences (RBINS), OD Nature, Vautierstraat 29, 1000 Brussel, Belgium

E-mail: biceps@naturalsciences.be

² Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

ICES or the International Council for the Exploration of the Sea is an intergovernmental scientific organization established in 1902, that brings together 20 Member States bordering the North Atlantic, Baltic and Arctic Circumpolar Zone. Through strategic partnerships, the work of ICES extends into the Arctic, Mediterranean, Black Sea and North Pacific. ICES develops science and advice to support the sustainable use of global seas and oceans. ICES answers to the needs of managers and society in their search for credible, salient and legitimate evidence to understand the broad range of risks and opportunities.

In 2020, 84 Belgian scientists participated in 57 expert Working Groups across all priorities of the ICES Science plan. We are active in Working Groups on: Shipping Impacts in the Marine Environment, Open Ocean Aquaculture, Cumulative Effect Assessment Approaches in Management, Benthos Ecology, Application of Genetics in Fisheries and Aquaculture, Economics, Fishing Technology and Fish Behaviour, Marine Litter, Machine Learning in Marine Science, Recreational Fisheries Surveys, Seabirds, Marine Mammal Ecology, Oceanic Hydrography, Integrative Physical-Biological and Ecosystem Modelling, Social indicators, Marine Planning and Coastal Zone Management, Marine Habitat Mapping, Effects of Extraction of Marine Sediments on the Marine Ecosystem, Assessment of Demersal Stocks in the North Sea and Skagerrak, Ecosystem Effects of Fishing Activities, Eels, Bay of Biscay and the Iberian Waters Ecoregion, Biodiversity Science, Technology Integration for Fishery-Dependent Data, Commercial Catches, Biology and Assessment of Deep-sea Fisheries Resources, Ballast and Other Ship Vectors, Introductions and Transfers of Marine Organisms,... Additionally, Belgian experts are (co-)chairing six scientific working groups: Electrical Trawling, the Celtic Seas Ecoregion, Marine Chemistry , Fisheries Benthic Impact and Trade-offs, Marine Benthal and Renewable Energy Developments, Methods for Estimating Discard Survival. Since 2020, we also chair the Ecosystem Processes and Dynamics Steering Group. Each year, our experts (co-)chair several workshops and we are active throughout the whole advisory process, with representatives in several Advice Drafting Groups and in the above laying Scientific and Advisory Committees of ICES.

So far, our scientists represent nine Belgian institutions, including Federal, regional and governmental research institutes, universities and agencies (i.e. ILVO, RBINS, UGent, VLIZ, KULeuven, UAntwerpen, ULiège, INBO and FPS Mobility).

BICEpS was launched in 2018 as a joint ILVO – RBINS initiative (both institutes represent 70% of the Belgian researchers involved in ICES) to reinforce the Belgian ICES people. The BICEpS community is progressively growing and now encompasses about 100 junior and senior members from different horizons, including PhD students, researchers, administrators and advisers. The general aim of BICEpS is to offer a platform to the Belgian ICES community to get to know each other better, to improve collaboration, to share information, and to promote ICES to the wider Belgian scientific community.

Through the ICES network, BICEpS envisages (1) to be the marine science broker in Belgium, and (2) to support ICES as a world-leading organization on and beyond marine fisheries science. Our mission is (1) to contribute to sustainable seas, (2) to unite Belgian marine scientists, (3) to catalyse “extended collaborations”, and (4) to strategically position Belgian marine sciences. BICEpS will promote ICES activities and voice the BICEpS community to ICES by e.g. organizing interactive annual colloquia, promoting the Belgian membership to the diverse ICES expert groups, communicating about ICES to

Belgian scientists and vice versa. We are also investigating opportunities for fund raising to host an ICES Annual Science Conference during the UN Decade of Ocean Science for Sustainable Development.

BICEpS WANTS YOU! We are considering the possibilities of launching a mentoring programme for early career marine scientists. Do not hesitate to contact us at biceps@naturalsciences.be if you want more information on how to join an ICES expert groups or meeting or if you simply want to join the BICEpS community and receive our newsletter. Please have a look at the compilation of Mini CV's of our BICEpS members, browse through our webpage and for sure watch our YouTube video (<http://ices.dk/community/groups/Pages/BICEpS.aspx>).

In social media, we use #ICESbelgium.

Keywords: ICES; Marine science; Data; Advice; BICEpS, Fishery; Ecology; Ecosystem; Expert groups, Belgium

Sand(de)fence: Testing short-term sand trapping capacity of natural solution materials

Schotman Kirsten¹, Montreuil Anne-Lise² and Chen Margaret²

¹ Architectural Engineering, Vrije Universiteit Brussel, Terwouwenstraat 51, 3800 Sint-Truiden, Belgium

E-mail: kirsten.schotman@vub.be

² Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium

In the light of global change, coastlines all around the world are under a lot of stress due to sea level rise, beach erosion and other factors. Building with nature and nature based coastal defense solutions try to counter this problem by leaving a minimum impact and a maximum durability and resilience. Since nature based solutions have gained a lot of interest over the last two decades, worldwide research on different strategies provide already a lot of information on this topic. However, information on the feasibility of nature based solutions on the Belgian coast remains limited.

The solution materials chosen to be tested are drawn from a complete literature review. These materials are used to create sand fences to initiate dune growth through sand trapping. In choosing these materials, two important characteristics were taken into account. All materials should be biodegradable and relatively local in order to leave no impact on site. Brushwood fences show promising results in locations like northern France during fair weather conditions. This makes brushwood a fine candidate for the material of one of the fences. An experiment conducted in Taiwan showed interesting results for fences made from a local reed species. Since reed is also available on the Belgian coast, this can also be a suiting material. The fences will be deployed perpendicular to the main wind direction, in a zigzag formation. For the formation of embryo dunes, a zigzag setting proves to be very efficient. This fence setting will be able to not only trap sediment blown from the main wind direction, but also from other directions.

The testing will be done at Groenendijk beach in Koksijde (Belgian coast). After deployment of the solution materials, a Terrestrial Laser Scanning survey will capture the initial beach topography. After a period of a few days, a second survey will be carried out to determine the amount of trapped sand. It is expected that the brushwood fence in zigzag setting will be one of the most efficient solutions to trap sand. Lastly, some recommendations will be provided for future research and practical implication at the coast.

Keywords: Building with nature; Sand fences; Sand trapping; Beach topography; Belgian coast

The Ocean InfoHub Project: Exchanging oceans data and information through a global, distributed network

Scott Lucy

IOC project office for IODE, Wandelstraat 7, 8400 Oostende, Belgium
E-mail: lscott@unesco.org

The IOC Ocean InfoHub Project (OIH) is a new initiative to help realise a global digital commons to empower ocean science for sustainable development across scales. Funded by the Government of Flanders (Kingdom of Belgium), the project started in April 2020 and will run for three years. The OIH is coordinated by the IOC Project Office for IODE (Oostende, Belgium), building on its 60-year history of supporting member states in the exchange and management of marine data and information. The OIH will establish a network of regional and thematic nodes that will improve online access to and synthesis of existing global, regional and national data, information and knowledge resources. The OIH will center on an openly accessible web platform designed to support interoperability between distributed resources including existing clearinghouse mechanisms.

The project will first work with IOC-associated online resources - including OceanExpert, OceanDocs/Aquadocs, the Ocean Best Practices System, the Ocean Biodiversity Information System (OBIS), the World Ocean Database (WOD) and Ocean Data Portal (ODP) – extended by partnerships with EurOcean, Marinetraining.eu, EMODNET, and other sources in the IOC ODIS Catalogue of Sources (ODIScat). The Ocean Data and Information System (ODIS) will provide the interoperability layer and supporting technology to allow existing and emerging ocean data and information systems, from any stakeholder, to interoperate with one another. This will enable and accelerate more effective development and dissemination of digital technology and sharing of ocean data, information, and knowledge. As such, ODIS will not be a new portal or centralised system, but will provide a collaborative solution to interlink distributed systems for common goals. Together with global project partners and partners in three pilot regions (Africa, Latin America and the Caribbean, and Pacific Small Island Developing States), a process of co-design will enable a number of global and regional nodes to test the proof of concept for the ODIS. The Ocean InfoHub Project will therefore provide an opportunity for partners and users to contribute to, and access the UN Ocean Decade global data ecosystem while also offering capacity development opportunities to all to participate equitably.

Keywords: Ocean; Marine; Data; Information; Online; Interoperability; Co-design; Decision-support; Knowledge

Habitat type and dredge dumping intensity determine the sensitivity of different benthic ecosystem components in the Belgian part of the North Sea

Seghers Stephie, Van Hoey Gert, Lefranc Charles, Wittoeck Jan and Hostens Kris

Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Ankerstraat 1, 8400 Oostende, Belgium
E-mail: Stephie.Seghers@ilvo.vlaanderen.be

Multiple human activities are executed in the Belgian part of the North Sea (BPNS), such as sand extraction, fisheries, offshore wind energy installations and dredging of navigation channels, with the associated disposal of dredged material at sea. We assessed the impact of the dredge disposal activities on the benthic ecosystem, i.e. organisms living in, on and near the bottom, to evaluate the sensitivity of different habitat types and ecosystem components to different dredge disposal intensities.

In the BPNS, dredged sediments are dumped with different intensities at five designated disposal sites. Two sites are situated in the muddy *Limecola balthica* habitat near Ostend (LOO; low intensity) and Zeebrugge (LZO; high intensity). Two sites are located in the fine muddy and sandy *Abra alba* habitat in front of Nieuwpoort (LNP; very low intensity) and on the Sierra Ventana (LS1; high intensities). The fifth disposal site is located in the sandy *Nephtys cirrosa* habitat on the Vlakte van de Raan (LS2; moderate intensity).

Dredge disposal may influence the benthic ecosystem directly by for example the burial of organisms and indirectly by changing the sediment composition. During the period 2005-2019, macrobenthos samples were taken in autumn using a Van Veen grab at the five dumping sites and at predetermined control sites, while epibenthos and demersal fish were collected in spring and autumn by means of an 8m shrimp trawl at the same sites. The BEQI-tool (Benthic Ecosystem Quality Indicator, www.beqi.eu) was used to assess differences in species richness, species composition, density and biomass, according to a control-impact design. The use of a standard indicator approach allows for an objective evaluation of the impact across sites, habitats and ecosystem components. The indicator gives scores between 0 and 1, where 1 means high similarity between control and impact. A BEQI score of 0.6 was set as a threshold, where values <0.6 reflect a clear difference between control and impact sites, indicating a real impact of the dredge disposal activity.

Despite the high dredge disposal intensity at LZO, high BEQI scores were noted for both LOO and LZO disposal sites. This indicates that the *Limecola balthica* habitat is not very sensitive to dredge disposal activities. Equally high BEQI values were calculated for the LNP disposal site, while the BEQI score for LS1 was <0.6, indicating a low similarity with the control site for the latter. This is probably related to a higher sensitivity of the fine muddy sand *Abra alba* habitat in combination with the high dredge disposal intensity at LS1. For the LS2 disposal site, high (>0.6) to very high (>0.8) BEQI scores were found, indicating a relatively low impact of moderate dredge disposal intensity in the sandy *Nephtys cirrosa* habitat. Part of the higher BEQI score for LS2 may be attributed to a slightly 'positive' effect of dredge disposal, related to the creation of a new habitat by dumping fine sediments in a sandy environment. That way, mud-loving species can co-occur together with typical benthic species already living in that sandy environment.

The observed differences in fauna characteristics were similar across ecosystem components, but more pronounced for the macrobenthos, due to the more sessile mode of life of these animals compared to epibenthos and fish. This mid-term environmental impact assessment proves that the impact of dredge disposal activities depends on both the sensitivity of the benthic habitat and the intensity of dredge disposal. This means that multiple factors have to be considered for a sound management of dredge disposal and other human activities in the BPNS.

Keywords: Dredge disposal; BEQI; Impact assessment; Benthic habitat; BPNS

Metabarcoding of marine zooplankton communities in the North Sea using nanopore sequencing

Semmouri Ilias¹, De Schampelaere Karel¹, Janssen Colin¹ and Asselman Jana²

¹ Laboratory of Environmental Toxicology, Ghent University, Coupure Links 653, 9000 Gent, Belgium
E-mail: ilias.semmouri@ugent.be

² Blue Growth Research Lab, Ghent University, Bluebridge Ostend Science Park, Wetenschapspark, 8400 Oostende, Belgium

Zooplankton are crucial organisms both in terms of biodiversity and their unique position in aquatic food webs. As such, it is crucial that we improve our insights into how anthropogenic and natural factors may affect these pelagic organisms. Although easily collected in large numbers, the subsequent processing and identification of specimens has usually been a barrier to large-scale biodiversity assessments. DNA barcoding, the use of standardized short gene regions to discriminate species, has been increasingly used by non-taxonomists to identify species. Here, we measured the diversity and community composition of zooplankton in the Belgian part of the North Sea over the course of one year. We identified zooplankton using both a traditional approach, based on morphological characteristics, and by metabarcoding of a 650 bp fragment of the 18S rRNA gene using the MinION™, a portable nanopore-based DNA sequencing platform. We established a method for characterizing zooplankton communities in marine samples using nanopore sequencing. We were able to identify several taxa at the species level, across a broad taxonomic scale and we thus could obtain several diversity metrics, allowing comparisons of diversity and community composition.

Keywords: Nanopore sequencing; Minlon; Metabarcoding; Biomonitoring; Zooplankton; Copepods; *Temora longicornis*

Analysis of flap-type Wave Energy Converters with OpenFOAM using the dynamic mesh method

Sismani Georgia¹, Wu Minghao², Stratigaki Vasiliki², Loukogeorgaki Eva¹ and Troch Peter²

¹ Department of Civil Engineering, Aristotle University of Thessaloniki, University Campus, 54124, Thessaloniki, Greece
E-mail: gsismani@civil.auth.gr

² Department of Civil Engineering, Ghent University, Technologiepark 904, 9052 Zwijnaarde, Belgium

Over the years, various configurations of flap-type Wave Energy Converters (WECs) have been proposed by many researchers. Flaps have been investigated as standalone devices or combined in multi-body systems, while different characteristics (e.g. geometry of the flaps, location of the rotation axis, installation depth) have been considered in the proposed WECs. In this context, a new multi-body floating system with multiple flap-type WECs has been proposed in [1]. In that study, the hydrodynamic response and the power performance of the proposed system were investigated in the frequency domain using the potential flow theory. The flaps' rotation relatively to the platform was described by introducing the generalized modes' concept, while emphasis was given on the interactions between the system's flaps.

The results of this investigation indicated extreme values in the response of the WECs, at frequencies where resonance phenomena occur, attributed probably to viscous damping effects. Motivated by this, the present research aims at assessing and quantifying viscous damping effects on the response of the aforementioned system by conducting a Computational Fluid Dynamics (CFD) analysis. To this end, the free-decay motion of a flap-type WEC is simulated in a CFD model. The numerical model was set up in OpenFOAM, considering a rectangular flap and an elliptical flap similar to the one proposed in [1]. Within the context of COST Action CA17105, a Short Scientific Mission (STSM) was granted to the first author of this abstract for implementing the numerical set up of the CFD model. The examined flap configurations are fully-submerged and their initial position is defined by applying an initial rotation to the flap. Several tests have been performed with different angles of release. Since the examined flap is rotating about a fixed axis, the mesh has to be adapted at every time step. Accordingly, the dynamic mesh method is selected for the CFD simulations along with the 'interDyMFoam' solver. This solver utilizes a Volume-Of-Fluid (VOF) phase-fraction based interface capturing approach and it can apply adaptive remeshing for addressing the required mesh motion. The rotation of the flap is specified as a combination of constraints in the 'sixDoFRigidBodyMotion' library of the solver. Since the dynamic mesh is a complex process in CFD modelling, a series of trial simulations was implemented to address correctly the physical problem and achieve the required motion of the mesh.

The results of this research will be further utilized for enhancing the numerical modelling of the system proposed in [1] and for optimizing its design.

Reference

- [1] Sismani G and Loukogeorgaki E (2020). "Frequency-based investigation of a floating wave energy converter system with multiple flaps", Applied Mathematical Modelling Journal, 84C, pp. 522-535.

Acknowledgements

The present research was granted in terms of a Short Scientific Mission (STSM) by the COST Action CA17105 "WECA Net: A pan-European Network for Marine Renewable Energy with a focus on Wave Energy". The aforementioned STSM was conducted by Georgia Sismani on October 16, 2019 – November 4, 2019 in collaboration with the Coastal Engineering Research Group of Ghent University. Minghao Wu has a PhD funding through a Special Research Fund (BOF) of Ghent University. Vasiliki Stratigaki is a postdoctoral researcher (fellowship 1267321N) of the FWO (Fonds Wetenschappelijk Onderzoek - Research Foundation Flanders), Belgium.

Keywords: Wave energy; Rotating flaps; Hydrodynamic response; Computational Fluid Dynamics (CFD); Free-decay motion

The potential of diffusive gradients in thin films (DGT) technique as a monitoring tool for uranium in the aquatic environment

Smolíková Vendula¹, Pelcová Pavlína², Ridošková Andrea² and Leermakers Martine¹

¹ Department of Analytical, Environmental and Geochemistry, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium

E-mail: vendula.smolikova@vub.be

² Department of Chemistry and Biochemistry, Mendel University in Brno, Zemedelska 1, 613 00 Brno, Czech Republic

Since the majority of the planet's surface is covered in water, which is an essential premise of life on Earth, the issue of its pollution receives nowadays increasing attention from researchers as well as the decision-makers and public. Although the trends in water pollution monitoring have turned over the years towards microplastic or organic pollutants such as antibiotics, hormones, pesticides, or drugs, monitoring of trace elements remains at the centre of research attention. This is not only because of the increasing pollution by toxic trace elements and their persistent and bioaccumulative nature in the environment but also because of the need to understand the biogeochemical behaviour of those elements that represent essential nutrients in the aquatic environment. The diffusive gradients in thin films (DGT) is a passive sampling technique that can not only overlap the lack of knowledge in the biogeochemical cycling of trace elements and their bioavailability for living organisms but also represent a useful tool for long-term monitoring of trace metal concentrations in-situ. The field application of newly developed DGT technique designs utilizing different sorbents is a crucial part of its validation. Therefore, we present development in the use of the DGT technique for the evaluation of uranium concentrations in the aquatic environment that was performed in the Scheldt estuary. The salinity gradient found in estuaries represents an ideal location for evaluation of the DGT technique performance which may be hampered by the complex nature of seawater in contrary to freshwaters. In this work, we provide a comparison of different DGT designs utilizing various sorbents (i.e., Chelex-100, Diphonix, Lewatit FO 36, and PIWBA) that were deployed in water along the Scheldt estuary. Results show that an improper selection of the binding phase can lead to providing skewed results that do not correspond to reality. On the contrary, the use of sorbents with high selectivity for the targeted analyte that have been thoroughly evaluated in a wide range of natural conditions may provide a DGT design that has the potential not only to quantify the labile fraction of uranium that may pose a risk to biota but may be used as a long-term monitoring passive sampler in seawater.

Acknowledgments

This work was supported by the project PROFISH CZ.02.1.01/0.0/0.0/16_019/0000869, which is financed by the European Regional Development Fund in the Operational Programme Research, Development and Education and The Czech Ministry of Education, Youth and Sports.

Keywords: DGT; Uranium; Estuary

Simulating offshore blue mussel aquaculture through remote sensing and a metabolic model: a Belgian case study

Stechele Brecht¹, Van Der Zande Dimitry², Delbare Daan³, Lacroix Geneviève², Barbut Leo², Bossier Peter¹ and Nevejan Nancy¹

¹ Laboratorium voor Aquacultuur en Artemia Reference Center, Universiteit Gent, Coupure Links 653, Blok F, 9000 Gent, Belgium

E-mail: brecht.stechele@ugent.be

² Koninklijk Belgisch Instituut voor Natuurwetenschappen (KBIN), Vautierstraat 29, 1000 Brussel, Belgium

³ Instituut voor Landbouw-, Visserij- en Voedingsonderzoek (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

With the implementation of the Belgian Marine Spatial plan 2020-2026, new nearshore areas are now open for licensing commercial and industrial activities. These areas can host extractive aquaculture activities and commercial enterprises have already shown interest in large-scale shellfish aquaculture close to the harbor of Nieuwpoort. In addition, new multi-use areas have been allocated offshore where a combination of renewable energy generation and extractive aquaculture is encouraged. In the last few years, several iconic projects (Edulis, Value@Sea, Coastbusters) have actually shown that it is feasible to culture Belgian mussels in both nearshore and offshore Belgian waters.

By collecting data of these projects, a Dynamic Energy Budget model (DEB) for blue mussel was calibrated. The DEB model for blue mussel was forced with optimized remote sensing observations (CMEMS, Sentinel-3/OLCI) made available through the EUNOSAT tool. In addition, the DEB model has been coupled to a larval dispersal model for blue mussel larvae which provided the day of spat arrival in order to account for variability in growth based on arrival time.

Forcing historical, high-resolution, or real-time satellite data on the DEB model allows for the prediction of industry-relevant information such as best-suitable areas, inter-annual and individual growth variability, harvesting time, mortality events, size distribution, or real-time monitoring of growth.

Keywords: Blue mussel; Offshore aquaculture; Dynamic Energy Budget; Remote sensing; Belgian part of the North Sea

'Building with Nature': Coastal Sand Dunes

Strypsteen Glenn and Rauwoens Pieter

Department of Civil Engineering, KU Leuven, Spoorwegstraat 12, 8200 Bruges, Belgium
E-mail: glen.strypsteen@kuleuven.be

The concept of 'Building with Nature' is gradually being recognized worldwide as a cost-effective approach to improve coastal protection against sea level rise and future flooding events. Opposed to hard engineering structures, this innovative approach, with emphasis on soft measures provides long-term sustainable solutions for restoration and protection of coastlines where possible. At the Belgian coast, the soft dune-before-dike solutions are receiving considerable attention: traditional sea dikes are reinforced with engineered dunes offering higher levels of protection of coastal infrastructure and at the same time offering a more natural appearance and higher ecological and socio-economical values. Vegetation, like marram grass, plays a vital role in the formation and development of these engineered dune areas. On windy days, sand grains from the beach get picked up by the wind and move towards the dune area to fall back to the surface as vegetation reduces wind speed and thereby trapping and holding the sand. To this day, no clear protocols or guidelines exist on how to design or construct engineered dune areas and plant vegetation, and often knowledge is drawn from other projects. Despite the value of dune areas and environmental benefits, their basic function as dynamic landforms and their role in providing these benefits are therefore not always well understood or appreciated by coastal landowners and beach users. In this study, we fill in the knowledge gap by measuring and monitoring early-stage dune development along an engineered dune area with different planting strategies at Oosteroever, Oostende by means of dedicated field campaigns focussing on the interaction between aeolian (wind-blown) sand transport and vegetation. The dune area of 120x20 m² is created in front of the traditional sea dike where marram grass is planted in six successive zones (20x20 m²) with plant densities varying from 6 to 15 plants/m² covering different spatial distributions (regular, random and clustered). Our hypothesis is that early-stage dune development and initial topographic changes in the dune area can be expressed as a function of aeolian sediment supply from the beach, vegetation characteristics, and sediment erosion by wind and storm surges.

Keywords: Early-stage dune development; Aeolian sand transport; Vegetation distributions; Field campaigns

The PacMAN project: Building capacity in pacific small island developing states on marine bioinvasions

Suominen Saara, Provoost Pieter and Appeltans Ward

OBIS, Wandelaarkaai 7, 8400 Oostende, Belgium
E-mail: s.suominen@unesco.org

The introduction of non-indigenous species (NIS) to new marine environments is one of the main threats to biodiversity. Small Islands Developing States, SIDS (or better called large ocean states) are particularly vulnerable, because they are highly dependant on the marine environment. Novel technologies in environmental DNA (eDNA) analyses could allow the rapid and cost-effective evaluation of biodiversity in hotspots with elevated threat of NIS invasions, which in turn can greatly facilitate environmental management practices. The Pacific Islands marine bioinvasions Alert Network (PacMAN) project aims to build capacity in the SIDS for monitoring and evaluating the state of their marine environment through eDNA analyses.

This 3-year project funded by the Government of Flanders (Kingdom of Belgium) and the Richard Lounsbery foundation, started in September 2020. The OBIS secretariat hosted at the IOC Project Office in Oostende (Belgium) will be responsible for the overall coordination and implementation of the project, supported by a local project team hosted at the University of the South Pacific in Suva, Fiji. Through engagement of scientists and local stakeholders an initial bioinvasions monitoring plan will be developed based on a comprehensive needs assessment of the local community. The monitoring plan will comprise of protocols for sampling, sample handling, as well as bioinformatics analyses and data management workflows, based on current best practices in marine sciences. The collected data will be absorbed into the global OBIS database while conserving links to other global data infrastructures storing standardized metadata, sequence data and taxonomic information. Based on the output data stored in OBIS, a decision-support tool will provide the observations in a user-friendly dashboard indicating the presence of invasive species to support local management. Early warnings will be generated and will provide a service for local managers and decision makers to set up targeted monitoring programmes.

The project will enter the operational phase by training local researchers and environmental managers, and will enable the long-term monitoring of the state of the marine environment in these tropical hubs of marine biodiversity. This capacity can ultimately deliver policy relevant science-based services that can trigger a rapid response at national and regional management level, which is crucial to secure the Islands biosafety.

Keywords: Marine; Invasive species; Environmental DNA; Pacific small island developing states; Decision-support; Biodiversity

A multi-stakeholder strategy to delineate issues related to coastal forest conservation: A case study from mangrove ecosystems of the Eastern coasts of Sri Lanka

Thanne Walawwe Gedera Fathima Mafaziya Nijamdeen^{1,2}, Jung Julia³, Rubiera Rodriguez Servane¹, Hugé Jean^{1,4,5,6} Sunanda Kodikara Arachchilage⁷, Hajaniaina A. Ratsimbazafy¹ and Dahdouh-Guebas Farid^{1,5}

¹ Laboratory of Systems Ecology and Resource Management, Département de Biologie des Organismes, Université Libre de Bruxelles, ULB, Av. F.D. Roosevelt 50, CP 264/1, 1050 Brussels, Belgium

E-mail:

² Department of Biological Sciences, Faculty of Applied Sciences, South Eastern University of Sri Lanka, Sammanthurai, Sri Lanka

³ Marine Biology Research group, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium

⁴ Centre for Environmental Science, Hasselt University, 3500 Hasselt, Belgium

⁵ Ecology & Biodiversity, Laboratory of Plant Biology and Nature Management, Biology Department, Vrije Universiteit Brussel (VUB), Pleinlaan 2, 1050 Brussels, Belgium

⁶ Open University of the Netherlands, Valkenburgerweg 177, 6419AT Heerlen, The Netherlands

⁷ Department of Botany, Faculty of Science, University of Ruhuna, Matara, Sri Lanka

Sri Lanka, with its rapid economic growth after three decades of civil war, exemplifies the problems related to coastal conservation faced by many countries in the Global South. This is especially the case in Sri Lanka's Eastern province which has seen major infrastructure investments - following the end of the civil war in 2009 and the recovery from the Indian Ocean tsunami in 2004. Coastal development has exacerbated erosion processes and contributed to the degradation of many coastal ecosystems. Here we present the results of three a multi-stakeholder engagement studies from August 2019 to October 2020, with a focus on coastal management and resource use. Ethnobiological surveys were carried out in 83 households to understand the usage and perception of mangrove forests of the east coast, one of the most severely degraded coastal ecosystems. The second study used an action research approach in to explore changes in the coastal landscape from a community perspective. The final study focused on stakeholders from organizations directly involved in coastal management and consisted of in-depth interviews with 19 key stakeholders thought to be involved in mangrove conservation in the Eastern province.

Mangroves were used for fuelwood, construction, medicinal, chemical and alimentation purposes in the Eastern coast. Seventy three percent of the respondents observed a change in the coastal ecosystems and the prominent changes were increased construction in the coast, loss of mangroves, agricultural land, and coastal erosion. Fifty eight percent said that the quality of drinking water has decreased over the past 10 years. Furthermore, all respondents emphasized the need to protect the coast for future generations. From a community perspective it was apparent that the degradation of coastal ecosystems also led to decreases in social cohesion among community members. It was recognized that there is a need to focus on re-establishing a sense of community besides focusing on the physical restoration or conservation of coastal ecosystems.

Out of all the stakeholders interviewed from government and NGO's, only five stakeholders directly deal with most of the issues related to coastal forest conservation. The major reasons for coastal forest degradation were land pollution (60%), illegal logging (40%) and disputes in land ownership (40%). A proper way of communication between organizations and awareness were highlighted as important steps for better conservation and collaboration. All stakeholders suggested that maintaining a healthy lagoon and coast is a responsibility of the government as well as the coastal communities. Our findings suggest that there is a need to develop a more participatory and community-based approach to coastal management in Eastern Sri Lanka with an equal focus on the social and environmental aspects.

Key words: Action research Coastal development; Ethnobiology; Mangroves; Stakeholders

Blondes do it better? A comparative study on the reproductive biology of blonde ray (*Raja brachyura*) and thornback ray (*Raja clavata*) in the Northeast Atlantic

Thys Kelly Johanna Marie

Marine Biology Research Group, Ghent University, Krijgslaan 281 B-9000 Gent, Belgium
E-mail: kelly.thys@ugent.be

The Rajidae family of the hardskates are slow-growing K-strategists that reach sexual maturity at a late age (Ellis *et al.*, 2010). They are primarily caught as bycatch in otter- and beam-trawl fisheries and are also targeted, with lower effort, with gill- and trammel nets. In the context of various existing EU policies striving for sustainable fisheries, the identification of potential nursery and spawning grounds is a crucial component to improve management of commercially interesting species of rays and skates (EC, 2008). In 2019, blonde ray (*Raja brachyura*) comprised the largest proportion of skate landings in Belgian ports, followed by thornback ray (*Raja clavata*). Stocks of these two species are labelled as "data-limited" i.e., lacking population estimates from which catch options can be derived using the existing MSY framework. To improve stock assessments and advice for skates in the future, detailed life-history data are urgently required. In this comparative study, we investigated the reproductive biology of *R. brachyura* and *R. clavata* and explored potential nursery areas.

Within the framework of the EMFF project "Raywatch", whole individuals were collected during trips on board of commercial beam trawlers and during scientific surveys in the Northeast Atlantic region. Morphometric measurements of total length, disc width, disc length and caudal length were taken. Sexual maturity of the skates was assessed based on the morphology of the reproductive tract. The following stages were discriminated: immature, developing, spawning capable, actively spawning, regressing stages for both sexes and additionally the regenerating stage for females (ICES Maturity Scale for Oviparous Elasmobranchs, 2020). For females, ovaries, oviducal glands, uteri and oviducts were measured in detail and weighed to the nearest decigram in mature individuals (Serra-Pereira *et al.*, 2011). Developing and yolky oocytes were counted and measured to the nearest millimetre, when possible (Capapé *et al.*, 2007; Serra-Pereira *et al.*, 2011). For males, clasper length was measured in all individuals following Collenot (1969). Measurements from epididymis and vas deferens were taken in mature individuals (Serra-Pereira *et al.*, 2011). Age was estimated by visual inspection of growth bands on the vertebrae (Coelho & Erzini, 2002). Following maturity and age assessment, size and age at sexual maturity were determined (Capapé *et al.*, 2007). With the resulting data, comparisons of reproductive biology between males and females of *R. brachyura* and *R. clavata* were made. Additionally, by assessing these reproductive traits for a large number of individuals and by comparing with previously published data for different geographical areas, we investigated any spatial or temporal changes in reproductive behaviour. Using the coordinates linked to each individual, areas of particular importance to the reproductive biology (e.g., nursery grounds) were mapped. The outcomes of this study are valuable for the development of robust stock assessment models for skates and delivering accurate catch advice.

References

- Capapé, C., Guélorget, O., Vergne, Y., Jean-pierre, Q., & Siau, Y. (2007). Reproductive biology of the thornback ray *Raja clavata* (Chondrichtyes: Rajidae) from the coast of Languedoc (Southern France, Northern Mediterranean). *Vie et Milieu*. 57: 83-90.
- Coelho, R., Erzini, K. (2002). Age and growth of the undulate ray, *Raja undulata*, in the Algarve (Southern Portugal). *Journal of the Marine Biological Association of the United Kingdom*, 82: 987-990.
- Collenot, G. (1969). Étude biométrique de la croissance relative des ptérygopodes chez la roussette *Scyliorhinus canicularis* L. *Cah Biol Mar* 10: 309-29.
- Ellis, J.R., Silva, J.F., McCully, S.R., Evans, M., Catchpole, T. (2010). UK fisheries for skates (Rajidae): History and development of the fishery, recent management actions and survivorship of discards. *ICES CM 2010/E:10*.

- Serra-Pereira, B., Figueiredo, I., Gordo, L. S. (2011). Maturation, fecundity, and spawning strategy of the thornback ray, *Raja clavata*: Do reproductive characteristics vary regionally? *Marine Biology*, 158(10), 2187–2197.

Keywords: Rajidae; Reproductive biology; K-strategists; Fisheries management

Snapping fish selfies - Hook-less fishing with a camera

Uhlmann Sven Sebastian

Drsnapper.com, Stationsstraat 27, 8470 Gistel, Belgium
E-mail: drsnapper@drsnapper.com

The proliferation of consumer-ready underwater camera technology offers a new approach to aquatic observation, surveys, and recreational fishing. It is a very simple idea and technology already exists that allows the consumer to vividly observe fish in their natural environment. The fish themselves actively trigger an underwater camera when attacking a (hook-less) bait. So to speak, the fish snaps a selfie by rigorously pulling on the bait, which then sets the camera to record a fixed video sequence. The angler will feel the nibble and will ultimately be thrilled to find out what has been “caught” on video. This video is then “unhooked” via an app and automatic wifi transmission when surfaced. All video files can be (re)viewed instantly. This exciting method of user-friendly underwater observation may not only appeal to conservation-conscious recreational fishers, or a young gadget-keen generation of outdoor enthusiasts, but also to (citizen) scientists wanting to non-invasively survey aquatic fauna. To give such opportunistic observations a purpose, shared, validated, and geo-tagged images could be used to document range expansions of species on the move, either because of warming waters or their invasiveness potential.

Keywords: Recreational fishing; Fish welfare; Citizen science; Climate change

Testing repeatability, testing repeatability, testing repeatability: How reproducible are DNA metabarcoding data for marine macrobenthos?

Van Den Bulcke Laure¹, Martinez Arbizu Pedro², Christodoulou Magdalini², Van Der Hoorn Berry³, Sapkota Rumakanta⁴, De Backer Annelies¹, Hostens Kris¹, Maes Sara¹ and Derycke Sofie¹

¹ Aquatic Environment and Quality, Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Ankerstraat 1, 8400 Oostende, Belgium

E-mail: laure.vandenbulcke@ilvo.vlaanderen.be

² Senckenberg am Meer, Marine Research Division, Südstrand 44, 26382 Wilhelmshavven, Germany

³ Naturalis Biodiversity Center, Biodiversity discovery, Darwinweg 2, 2333 CR Leiden, The Netherlands

⁴ Department of Environmental Science - Environmental Microbiology and Circular Resource Flow, Aarhus University, Frederiksborgvej 399, 4000 Roskilde, Denmark

Macrobenthos is worldwide accepted as a good indicator to evaluate the potential effects of human activities on the marine benthic ecosystems. In traditional environmental impact assessments (EIAs), macrobenthic species identification is based on morphological characteristics, a time-consuming and labor-intensive process for which specific taxonomic knowledge and experts are needed. DNA metabarcoding can circumvent most of these shortcomings. However, to be applicable in EIAs, a standardized protocol that allows for reproducible and reliable DNA metabarcoding results is a prerequisite. We already know that specific changes to the lab protocol, such as the choice of the DNA extraction kit, primer pair or PCR conditions, can influence macrobenthos diversity estimates. In this study, we investigated whether a certain 'fixed' DNA metabarcoding protocol is repeatable across different institutes, an important step to convince stakeholders that this new and quick method generates reliable and comparable results, regardless of who has conducted the work.

Within the international Interreg NSR project GEANS, we developed a ring test where subsamples of 12 bulk macrobenthos samples, originating from four different macrobenthic communities in the Belgian Part of the North Sea (differing in species density and diversity), were distributed to and further processed following the same standardized lab protocol by four different institutes located in Belgium, the Netherlands, Germany and Denmark. DNA was extracted from each subsample by each institute and part of the mitochondrial cytochrome c oxidase subunit I (COI) gene was amplified and sequenced using Illumina MiSeq. The resulting sequences were processed through the DADA2 pipeline to generate amplicon sequence variants (ASVs), and a custom-made macrobenthos DNA reference database was used to assign taxonomy to these ASVs. Both alpha and beta diversity patterns were compared between institutes. The number of ASVs and the number of species reflected the morphological diversity patterns, i.e. highest values for the replicates from the highly diverse macrobenthic community, lowest numbers in the low diversity replicates and intermediate values in the samples from the medium diversity community. These patterns were identical between the four institutes, showing high repeatability for alpha diversity when using the same protocol. In total, 100 macrobenthic species were detected through DNA metabarcoding, of which 60 species were picked up by all four institutes, while the number of species recorded by only one institute, ranged between zero and 14 species for the different institutes. Also beta diversity patterns were comparable between the four institutes, as the nMDS plot clearly showed clustering based on the different macrobenthic communities, independent of the institute that conducted the work.

This ring test shows for the first time that DNA metabarcoding offers a highly repeatable assessment of alpha and beta macrobenthos diversity patterns, which supports the suitability of DNA metabarcoding of marine macrobenthos in monitoring studies. In a next step, we tested the robustness of DNA metabarcoding, by changing some steps in the lab protocol, and by using different bioinformatics pipelines to estimate macrobenthos diversity. Together with the ring test, these results are highly valuable to establish a harmonized and uniform DNA metabarcoding protocol, to be used by all institutions in Europe when implemented as a new standard method in EIAs of the benthic ecosystem.

Keywords: Environmental Impact Assessment; North Sea; Macrofauna; Metabarcoding; COI; Standardized operational protocol; Harmonization

Atlantic cod in an anthropogenic North Sea: effects of man-made sounds on cod movement behaviour

Van Der Knaap Inge^{1,2}, Slabbekoorn Hans² and Reubens Jan³

¹ Marine Biology Lab, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium
E-mail: inge.vanderknaap@ugent.be

² Institute of Biology, Leiden University, Sylviusweg 72, 2333 BE Leiden, The Netherlands

³ Flanders Marine Institute (VLIZ), InnovOcean site, Wandelaarkaai 7, 8400 Oostende, Belgium

The increase in offshore human activity, including shipping, construction, extraction and exploration for energy resources, has resulted in underwater sound pollution at a global scale. This affects the habitat of marine fish and mammals worldwide, with potential consequences for local populations. The North Sea is one of the busiest areas oceanwide and recently published sound maps indicate that the underwater sound levels along the Belgian and Dutch coast exceed the median level by 30dB. Two pronounced sources of noise come from seismic surveying and pile driving, both causing locally excessive acoustic events. Seismic surveys are commonly used to explore the seabed for fossil fuel deposits and site selection for offshore wind farms and carbon sequestration. Pile driving is an often-used technique for the construction of offshore wind turbines for which piles are hammered 30m deep into the seabed. Both activities can last for months and cause high intensity low frequency sounds that can be heard over hundreds of kilometres potentially impacting a wide range of marine habitats and species. The effects of sounds on marine fish range from physical injuries when fish are present at close proximity, 5 - 300 m, to the sound source, to more subtle effects on physiology and behaviour, which may extend to tens of kilometres from the source. However, data exist for only a few species and are restricted in their scope. Here we present the results of two studies investigating the effects of a real full-scale seismic survey and piling activity on the behaviour of free-swimming Atlantic cod (*Gadus morhua*). The movement behaviour of cod at the wind farm, was tracked using acoustic telemetry. Mixed models and Hidden Markov models were used for data analysis. From the behavioural analysis we found that during seismic survey, cod decreased their activity. Additionally, diurnal activity cycles were disrupted with lower locally active peaks at dusk and dawn, periods when cod is known to actively feed. Piling effected the movement of the cod and resulted in altered distances travelled during noise exposure. Changes in movement behaviour may ultimately lead to changes in the time animals spend in certain behaviours which can affect their overall fitness and thus have consequences at a population level. Our results underline the relevance to further assess impacts of man-made sounds on population consequences, and also stress the validity of conservation concerns about anthropogenic noise pollution in the marine environment.

Keywords: Offshore development; Acoustic telemetry; Noise pollution; Marine fish behaviour

No ocean too wide? Global-scale ocean dispersal simulations support genetic evidence for trans-oceanic dispersal and connectivity in mangroves.

Van Der Stocken Tom¹, Carroll Dustin¹, Menemenlis Dimitris¹, Simard Marc¹ and Koedam Nico²

¹ Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, United States of America

E-mail: tom.van.der.stocken@jpl.nasa.gov

² Department of Biology, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussel, Belgium

Mangrove forests provide a broad range of ecosystem services and are among the most productive ecosystems on Earth. Various studies have demonstrated that these intertidal forests are shifting geographically in response to climate change, with important implications for human welfare, ecosystem functioning and the marine and global carbon cycles. Understanding the future of mangrove range dynamics is challenging and requires estimates of the way their hydrochorous (i.e., water-buoyant) propagules disperse via tidal, near-shore, and open-ocean surface currents. Here we use a high-resolution ($1/24^\circ \times 1/24^\circ$), eddy- and tide-resolving numerical ocean model to simulate mangrove propagule dispersal across the global ocean and generate connectivity matrices between mangrove habitats using a range of floating periods. Our numerical approach allowed identifying mangrove dispersal routes, barriers, and stepping-stones, as well as connectivity between regions globally, and supports findings from genetic studies. Results show high rates of along-coast transport, and transoceanic dispersal routes across the Atlantic, Pacific, and Indian Ocean. The American and African continents present important dispersal barriers. Archipelagos, such as the Galapagos and those found in Polynesia, Micronesia, and Melanesia, act as critical stepping-stones for dispersal across the Pacific Ocean. Direct and reciprocal dispersal routes across the Indian Ocean via the South Equatorial and seasonally-reversing monsoon currents, respectively, allow connectivity between Western Indian Ocean and Indo-West Pacific sites. We demonstrate the isolation of the Hawaii Islands and help explain the presence of mangroves on the latitudinal outlier Bermuda. Finally, we find that dispersal distance and connectivity are highly sensitive to the minimum and maximum floating period. We anticipate that our findings will guide future research agendas to quantify biophysical factors determining mangrove dispersal and will help improve our understanding of observed mangrove species distributions and expected range shifts under climate change.

Keywords: Biogeography; Climate change; Ocean-circulation model; Lagrangian particle tracking; Global

Numerical modelling of a wave energy converter for the WECfarm project

Van Hulle Koenraad, Quartier Nicolas, Stratigaki Vasiliki and Troch Peter

Civil Engineering, Universiteit Gent, Technologiepark 60, 9052 Zwijnaarde, Belgium
E-mail: Koenraad.Vanhulle@UGent.be

This abstract refers to my ongoing master's thesis at the Civil Engineering department of Ghent University (Belgium) on numerical modelling of Wave Energy Converters (WECs). The numerical modelling is performed using the open-source software DualSPHysics (Crespo *et al.*, 2015). This program applies smoothed particle hydrodynamics (SPH), which is a non-linear Lagrangian meshless method. This means that the fluid is described as a set of particles for which the physical properties are determined using Navier-Stokes equations as opposed to a Eulerian model where the fluid is discretized into control volumes.

The objective of this thesis is to implement the so-called "Master WEC", developed at Ghent University for the upcoming WECfarm project with arrays of point absorber type WECs, in the numerical domain and simulate the involved physical processes. One of the challenges in simulating a WEC compared to a normal floating body is the power take-off (PTO) system which is necessary to capture the wave energy and convert it into electricity. The modelling of this PTO system is done by coupling Project Chrono (an open source physics simulation engine) to DualSPHysics (Canelas *et al.*, 2018). Initially one single WEC will be modelled and the dynamic response, the PTO system and the wave field effects will be simulated. As such this research is situated in the topics of "Working Group 1: Numerical hydrodynamic modelling for WECs, WEC arrays/farms and wave energy resources". Subsequently these results will be validated using experimental data obtained from wave flume tests. Since a single WEC will not generate a sufficient amount of power the goal is to construct WEC arrays within the WECfarm project. As such, once this single Master WEC model is validated, additional WECs will be implemented in the numerical domain and the interaction between multiple WECs will be studied. This should allow further research into different array geometries and different WEC spacings.

This thesis runs in parallel with two additional experimental theses at Ghent University which will enable back and forth interaction between both numerical modelling and experimental scale testing.

Keywords: Wave Energy Converter (WEC); WECfarm project; Smoothed Particle Hydrodynamics (SPH)

The corrosion rate of the gas shells at the “Paardenmarkt”

Verhasselt Katrijn, Potters Geert and De Baere Kris

Antwerp Maritime Academy, Noordkasteel Oost 6, 2030 Antwerpen, Belgium
E-mail: katrijn.verhasselt@hza.be

The “Paardenmarkt” is one of many munition dumpsites in our seas and oceans (Liebezeit, 2002). A few meters below the sea surface, a huge quantity of WWI chemical munition is buried (Missiaen & Henriet, 2002). Estimations vary between 9.000 tons up to 35.000 tons or more. The exact origin, quantity and composition are unknown. Little is known about the state of the munition. Shells discovered by accident on the seabed during expansion works at the port of Zeebrugge in the early 1970's were described as being ‘in a remarkable good condition’. The munition became buried under 2-4 m of marine sediment afterwards and regulations prohibit any new salvages to date (Vandeweyer, 2015, Koninklijk besluit tot vaststelling van het marien ruimtelijk plan voor de periode van 2020 tot 2026 in de Belgische zeegebieden, 2019). In order to assess the physical state of the munition to date, it is necessary to build a statistical model taking into account all different corrosion processes (aerobic, anaerobic, galvanic, chemical) and all governing environmental parameters at the “Paardenmarkt”.

The first part of this project is a pilot set-up consisting out of a three year sampling campaign, based on a protocol developed by Petersen *et al.* (2019). About 4000 metal plates (60x60x3mm) will be immersed in seawater, fresh and brackish water for 2 and 6 months, 1, 2 and 3 years. Besides the water quality, the influence of certain gasses such as CO₂, CH₄, nitrogen will be taken into account. Other criteria such as microbially induced corrosion (MIC), composition of the marine sediment, the corrosiveness of the chemical content of the grenades, formation of concretion, orientation of the shells on the bottom and the galvanic effect will also be considered. The metal plates represent the construction materials present in a typical German 77 mm grenade being brass, iron and zamac. They will be put in smaller containers in different positions: completely buried, lying upon the sand and standing upright (half buried). Besides new test coupons, the corrosion rate of fragments of real grenades will be measured in close collaboration with Dienst voor Opruiming en Vernietiging van Ontploffingstuigen (DOVO).

The second part of the project will be focused on developing a model, based on Melchers (2003), to describe and predict the amount of corrosion of the munition shells at the “Paardenmarkt” as a function of exposure period and various influencing factors. Both mass loss and corrosion pit depth will be considered. Research on the corrosion rate of shipwrecks in the Belgian North Sea (De Baere, *et al.*, 2020) showed that the corrosion rate is significantly influenced by local environmental conditions. The parametrization of the model will be modified to represent the environmental conditions at the “Paardenmarkt” and finetuned according the observations during the pilot project to minimize the difference between the observed values and the values predicted by the model. The model will be parametrized with the data from the samples and validated using the data from the fragments of the real shells. The model will then be used to assess the current physical state of the munition shells and to predict their future condition in function of the time. A well-tuned model will be an important tool allowing faster and better conclusions when the time comes to decide what to do with the “Paardenmarkt”.

References

- De Baere, K. *et al.* (2020). Corrosion Engineering, Science and Technology. doi:10.1080/1478422X.2020.1807163
- Koninklijk Besluit tot vaststelling van het marien ruimtelijk plan voor de periode van 2020 tot 2026 in de Belgische zeegebieden. (2019, May 22). Belgium: Federale overheidsdienst volksgezondheid, veiligheid van de voedselketen en leefmilieu.
- Liebezeit, G. (2002). Dumping and re-occurrence of ammunition on the German North Sea coast. Brussels: Federal Office for Scientific, Technical and Cultural Affairs.
- Melchers, R. E. (2003). Corrosion, 59(4), 319-334.

- Missiaen, T., & Henriet, J. (2002). Paardenmarkt site evaluation. Brussels, Belgium: OSTC.
- Petersen, R.*et al.* (2019). Corrosion & Prevention, (p. Paper 023). Melbourne.
- Vandeweyer, L. (2015). Shrapnel, 1-9.

Keywords: Corrosion; Paardenmarkt; Modelling

Burrowing macrofauna modifies climate change effects on sediment metabolism

Vlaminck Ellen¹, Vanaverbeke Jan², Moens Tom¹ and Van Colen Carl¹

¹ Marine Biology Research Group, Biology Department, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium

E-mail: evlaminck@ugent.be

² Operational Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, Gullelelle 100, 1200 Brussels, Belgium

Along the Belgian coast, coastal areas are under an increasing pressure both from local and global sources. On a global scale, climate change challenges the ecosystem, while aquaculture and the increasing amount of offshore windfarms create challenges on a local scale. The PERSUADE project (ExPERimental approaches towards Future Sustainable Use of North Sea Artificial HarD SubstratEs) investigates the combined effect of those stressors on the coastal area. Climate change stressors such as ocean warming and acidification challenge coastal ecosystems. They can influence benthic communities and the way in which they contribute to ecosystem services such as biogeochemical cycling. Macrofauna reworks the sediment, altering physical structure and chemical composition through bioturbation and bio-irrigation, facilitating microbial activity. In this research the combined effect of different climate scenario's and the presence of macrobenthos on benthic processes and sediment metabolism was investigated to estimate the effects of climate change and possible species loss on the functioning of the benthic environment.

In two long term experiments, sediment was incubated under four different climate scenario's; a control environment, a scenario with elevated temperature, a scenario with decreased pH and a scenario with elevated temperature and decreased pH combined, to mimic climate change. *Lanice conchilega* and *Abra alba* respectively were added to the microcosms in the two experiments in natural densities. Similar to literature findings, a stimulating effect of the presence of macrofauna on sediment metabolism was found in both experiments (Braeckman *et al.*, 2010; Mermilliod-Blondin *et al.*, 2004). The magnitude of this effect differed between the two experiments as the irrigation behaviour of *L.conchilega* facilitates benthic respiration more than the bioturbation behaviour of *A. alba*. Oxygen consumption doubled in cores with *L. conchilega* and was 1/4Th higher in cores with *A. alba*, compared to empty cores. A lower pH was the only climate factor influencing benthic respiration; higher respiration was observed with decreasing pH in the *L. conchilega* experiment. The difference in benthic respiration was larger in cores containing *L. conchilega* individuals, indicating the modifying effect this species. In the experiment with *A. alba* there was an opposite effect on the sediment metabolism observed. Data from further experiments investigating changes in macrofauna behaviour under the different climate conditions to link them with the observed effect on metabolism respiration is under analyses.

References

- Braeckman, U., Provoost, P., Gribsholt, B., Van Gansbeke, D., Middelburg, J., Soetaert, K., Vincx, M., Vanaverbeke, J., 2010. Role of macrofauna functional traits and density in biogeochemical fluxes and bioturbation. Mar. Ecol. Prog. Ser. 399, 173–186. <https://doi.org/10.3354/meps08336>
- Mermilliod-Blondin, F., Rosenberg, R., François-Carcaillet, F., Norling, K., Mauclare, L., 2004. Influence of bioturbation by three benthic infaunal species on microbial communities and biogeochemical processes in marine sediment. Aquat. Microb. Ecol. 36, 271–284. <https://doi.org/10.3354/ame036271>

Keywords: Macrobenthos; Climate change; Offshore windfarms; Biogeochemistry; Ocean warming; Ocean acidification

Interactive aggregation of phytoplankton communities and suspended particulate matter

Zhang Jianwei

Protistology and Aquatic Ecology, Ghent University, K.L. Ledeganckstraat 36, 9000 Gent, Belgium
E-mail: jianwei.zhang@ugent.be

Flocculation is an important mechanism for the removal of suspended particles from the water column in streams, lakes, estuaries and oceans. Floc growth in flocculation processes occurs over several phases. Initially, aggregation is dominant, and flocs rapidly increase in size, forming large, open structures. Eventually, floc aggregation and breakage balance to create a steady-state particle size distribution (PSD), meanwhile flocs reaching a limited size. The effect of flocculation on suspended particulate matter (SPM) was widely investigated. However, its effects between phytoplankton communities and SPM is poorly understood. Hence, a rotated chamber set-up was developed to investigate its mechanism. The rotor was used to simulate shear rate in natural waters, and a camera and a laser were used to capture images. Salinity, nutrient abundance were controlled and act as environmental parameters in this chamber. Both temporal PSD and phytoplankton communities development will be studied under previously mentioned conditions.

Keywords: Flocculation; Phytoplankton communities; Suspended particulate matter; Rotated chamber

Sensitivity of selected gravel bed species to burial

Zupan Mirta^{1,2}, Van Colen Carl², Degræer Steven¹ and Vanaverbeke Jan¹

¹ Marine Ecology and Management, OD Nature, Royal Belgium Institute of Natural Sciences, Vautierstraat 29, 1000 Brussel, Belgium

E-mail: mzupan@naturalsciences.be

² Marine Biology Research Group, Faculty of Sciences, Ghent University, Krijgslaan 281-S8, 9000 Gent, Belgium

Changes in sedimentation regimes in the marine environment occur naturally (e.g. storms, wave and tidal action) and due to the increasing human activities (e.g. dredging, trawling, construction of marine renewable energy). Increases in sediment deposition can lead to burial of underlying organisms. Their survival following burial depends on their tolerance to sediment deposition and their ability to escape from burial. Sediment deposition may have substantial effects on hard substrate communities, such as those of gravel beds that are not used to such dramatic sediment fluctuations and host several sessile organisms.

This study aimed at understanding the sensitivity to burial of typical hard substrate species from gravel habitats. To do this, we first conducted laboratory experiments to investigate the effects of different levels (2, 5 and 7 cm) and different durations (2 and 10 days) of burial on four gravel bed species. We selected the species based on their conservation importance and representativeness of the variety of life forms found in the gravel bed habitat. At the same time, we focused on species for which quantitative information on tolerance to burial was missing.

Our results indicate that the common whelk *Buccinum undatum* and the plumose anemone *Metridium senile* were unaffected by sediment burial up to 7 cm. Their high survivorship is linked to their ability to escape burial: the former by using their foot to push upwards, and the latter by crawling out of the sediment. On contrary, the mortality of the common starfish *Asterias rubens* significantly increased with burial depth, while the mortality of the soft coral *Alcyonium digitatum* significantly increased after 10 days of burial. Their low tolerance to burial was related to their inability to vertically emerge from the deposited sediment, which may have resulted in suffocation and/or starvation. All the surviving individuals exhibited similar behaviour: in a very short period after burial, they re-established contact with the sediment surface followed by full emergence at a short/intermediate-term (depending on the species). Regaining contact with the sediment-water interface is important to maintain basic physiological needs, such as feeding and respiration.

To increase our understanding of gravel bed species responses to burial, we integrated our results with literature-based quantitative assessments of tolerance to burial of other gravel bed species reported from the North Sea. This integration indicates that tolerance to burial is species-specific and variable, but often related to the species ability to emerge from burial. We also show that permanently attached, sessile species are those most susceptible to complete burial by sediment. These findings can be used to assist in managing various human activities that result in increased sedimentation in the gravel bed habitat.

Keywords: Sedimentation; Hard substrates; Gravel; Behaviour; Vertical migration; *Alcyonium digitatum*; *Asterias rubens*; *Metridium senile*; *Buccinum undatum*