ANNUAL REPORT 2017

NIOZ Royal Netherlands Institute for Sea Research

ANNUAL REPORT 2017

Royal NIOZ is part of the institutes organisation of NWO, in cooperation with Utrecht University

NWO Netherlands Organisation for Scientific Research

Utrecht University

NIOZ Royal Netherlands Institute for Sea Research

FOR OVER 140 YEARS, ROYAL NIOZ NETHERLANDS INSTITUTE FOR SEA RESEARCH HAS PERFORMED EXCELLENT MARINE RESEARCH FOR SOCIETY, FROM THE DELTAS TO THE DEEPEST OCEANS.

MISSION BLUE PLANET

OUR RESEARCH AND NATIONAL MARINE FACILITIES HELP MARINE SCIENTIFIC COMMUNITIES, BUSINESSES, NGO'S AND POLICY MAKERS TO ADDRESS SOME OF THE BIGGEST CHALLENGES THAT LIE AHEAD.

TABLE OF CONTENTS

CRUISE PROGRAMME RV *PELAGIA* 2017

1

MARCH – APRIL:
Black Sea 2, Black Sea. Chief scientist: Laura Villanueva, dept. Marine Microbiology & Biogeochemistry.

2

APRIL – MAY:
VIDI Dick van Oevelen, Rockall Bank, North Atlantic. Chief scientist: Gert-Jan Reichart, dept. Ocean Systems.

3

JULY:
Stratiphyt 2, Iceland to Tenerife, North Atlantic. Chief scientist: Corina Brussaard, dept. Marine Microbiology & Biogeochemistry.

4

SEPTEMBER:
Denmark Strait Overflow, Denmark Strait, North Atlantic. Chief scientist: Kerstin Jochumsen, University of Hamburg.

CRUISE PROGRAMME RV *PELAGIA 2017*

5

OCTOBER – NOVEMBER:
Sandbox – Disclose, North Sea. Chief scientist: Karline Soetaert/Rob Witbaard, dept. Estuarine & Delta Systems.

6

DECEMBER:
NICO leg 1, North Atlantic. Chief scientist: Lennart de Nooijer, dept. Ocean Systems.

7

DECEMBER:
NICO leg 2, Equatorial Atlantic. Chief scientist: Frank Peeters, Free University Amsterdam.

NICO EXPEDITION

The NICO expedition (Netherlands Initiative Changing Oceans) started in December 2017. This multidisciplinary scientific mission investigates the changing conditions and marine life of the North Sea, Caribbean Sea and Atlantic Ocean. During 7 months 100 scientists from 20 Dutch and international scientific organisations join forces on the Dutch research vessel *Pelagia*, with behavioral ecologists, microbiologists, geologists, chemists, physicists and climatologists.

NICO expedition is powered by NWO and NIOZ. Follow the expedition via nico-expedition.nl

CRUISE PROGRAMME RV *NAVICULA* 2017

1

MARCH: Catching of shorebirds around the small Island of Griend for demographic research. Dept. Coastal Systems.

2

APRIL: Boxcore sampling of benthos and sediment in the Ameland outer delta and the gullies of the Borndiep tidal basin. Dept. Coastal Systems.

3

MAY: Placement of the mobile bird observatory, the Wadden PoNtoon 'De Richel'. Dept. Coastal Systems and Natuurmonumenten.

4

JUNE: Start of the SIBES season, sampling benthos and sediment from 6000 sampling points in the intertidal Wadden Sea. Dept. Coastal Systems.

5

July: Marine Masters Summer Course Texel, multidisciplinary oceanography masters' summer course. Dept. Ocean Systems.

6

JULY: Building receiving towers and radiotagging shorebirds around the Island of Griend. Dept. Coastal Systems.

RV *Navicula* is especially designed for research in the Wadden Sea. The ship's limited draft makes it particularly suitable for work in shallow channels and on the tidal flats.

7

AUGUST: SIBES subtidal: sampling benthos and sediment from 1500 boxcores in the gullies and subtidal areas of the Dutch Wadden Sea. Dept. Coastal Systems.

8

SEPTEMBER: SIBES sampling in the German Wadden Sea, reaching as far as the Jadebuschen. Dept. Coastal Systems.

9

SEPTEMBER: WUR course around Texel, an entrance course for the MSc Aquaculture and Marine Resource Management. Wageningen University & Research.

10

OCTOBER: Mudmotor Harlingen, looking at the potential for furthering the development of salt marshes in the Wadden Sea by making optimal use of the sediment transportation capacity of ambient flows. Dept. Estuarine & Delta Systems.

11

DECEMBER: Boxcore and water sampling in Haringvliet, Grevelingen and Eastern Scheldt. Dept. Estuarine & Delta Systems.

NIOZ YE & TX

NIOZ TX
Most NIOZ departments and facilities are located on the Wadden island of Texel, with two key research areas at our doorstep: the unique tidal environment of the Wadden Sea and the economically and ecologically important North Sea.

NIOZ YE
Our department of Estuarine & Delta Systems research is based in Yerseke, on the Eastern Scheldt, focusing on the interactions between organisms and their physical and chemical environments in estuaries and deltas.

INTRODUCTION

NIOZ 2017: MISSION BLUE PLANET CONTINUES

Innovative solutions to the challenges of sustainable and responsible use of our changing seas and oceans start with understanding the fundamental processes in the blue realm; this is what Royal NIOZ, the national oceanographic institute, is all about.

For over 140 years, Royal NIOZ Netherlands Institute for Sea Research has performed excellent marine research for society, from the deltas to the deepest oceans. Our research and National Marine Facilities help marine scientific communities, businesses, NGO's and policy makers to address some of the biggest challenges that lie ahead.

The Netherlands, literally as a lowland, and as a traditional seafaring nation, has a perpetual intimate relationship with its surrounding water masses, both fresh and salt: rivers, deltas, seas and oceans. Now, once again, in the Netherlands, and even globally, our coastal regions, seas and oceans are in trouble. The combined and cumulative effects of climate change and ever increasing human activities, including e.g. global warming, related hazards, extreme weather conditions, sea level rise, but also overfishing and many different kinds of marine pollution, have become important topics on the national and international policy agendas (cf. the Paris climate conference, 2015). However, at the same time, these regions are increasingly employed for global solutions in terms of energy, mineral resources, food and transportation, and to ever greater depths in the oceans (cf. the EU *Grand Challenges and Blue Growth* research agendas). It is in this context that oceanographic institutes like Royal NIOZ have a crucial and ever growing societal role; challenges and activities in the 'blue arena' now more than ever require fundamental knowledge and insight in the complex, still partly unknown and ever changing marine processes, ecosystems and environments from the deep oceans to the shallow delta areas.

In essence, NIOZ research is inspired by these notions which we translate into oceans as *unknowns*, oceans in *trouble*, and oceans as *opportunity*. Through focusing on these broad themes and building on our internationally acknowledged fundamental and frontier-applied research, including sea going marine scientific capabilities, during 2015-2016 we built a new organisation: 'NIOZ 2.0'. Our four brand-new multidisciplinary scientific departments took further shape in 2017 and continued to generate the multidisciplinary expertise and fundamental knowledge needed to underpin and improve longer term sustainable and responsible marine management. From fundamental understanding of key processes, to promoting innovative solutions to the coming challenges of sustainable and responsible use of the seas and oceans. We called it our *Mission Blue Planet*, a quest that continued in 2017.

Collaborating with colleagues within and outside NIOZ, in 2017 the departments sought and found new avenues for innovative (and seagoing) science, with attention for valorization and studies with particular societal relevance. As part of building our new organisation, in 2017 we were successful in attracting new scientific talent, including Dr Anja Spang, (MMB) who obtained a prestigious '*Women in Science Excel*' (WISE) NWO grant, Dr Aimee Slangen (EDS) who received an NSO-GO (NWO) grant, and Dr Helge Niemann, (MMB) with whom we celebrated his

UNKNOWN OCEANS

successful ERC starting grant. Meanwhile our more senior staff continued to receive various recognitions; notably Prof Dr Theunis Piersma (COS) who was honoured with the British Marsh Award for International Ornithology, and *knighted* for his scientific oeuvre by decision of HM The King of The Netherlands. Prof Dr Corina Brussaard (MMB) and Dr Jan van Gils (COS) both received large NWO Netherlands Polar Programme grants. Among our many promising PhD students, Alexander Ebbing MSc (EDS) received the NWO '*Open-Mind* grant' for his ideas regarding *artificial seaweed nurseries*. Furthermore, Anouk Goedknegt MSc/PhD (COS) received the VLIZ North Sea award 2017, and Julie Lattaud BSc (MMB) the best student presentation award during the 28th International Meeting on Organic Geochemistry. In addition, Dr Daphne van der Wal (EDS department) was appointed Professor of '*Spatial water quality and aquatic systems*' at the University of Twente, Faculty of Geo-Information Science and Earth Observation ITC, as of 15 October 2017. She will combine this position with her position at NIOZ. Furthermore, NIOZ became partner in two newly established national centers directed towards sustainability and climate mitigation, viz. the Utrecht-based *Netherlands Consortium on Climate Change Adaptation* (CCCA), and the Groningen-based *Global Centre of Excellence on Climate Adaptation* (GCECA).
Our academic output remained at very high levels, with many (~300) peer reviewed papers appearing in high impact journals, and an increasing number (~60%) in open access literature. While our core-business remains fundamental marine sciences, we increasingly participated in more applied maritime and offshore industrial related research such as the long-term international INSITE project on effects of (decommissioning) man-made structures in the marine realm (PI: Dr Furu Mienis, OCS department). Again in 2017, NIOZ promoted and disseminated its research to the broader public in various ways. Important events included the December launch of the major national ocean-going expedition '*National Initiative Changing Oceans*' or NICO. In order to put the spotlight on the importance of ocean research, on the need for accompanying facilities and ships, and on our aging research fleet, together with NWO we prompted the organisation of a truly national set of ocean expeditions, along a route to and from the Netherlands Caribbean. While this annual report 2017 rolls off the press, NICO is still ongoing, and with success. Activities and early results of NICO were well covered by all media platforms, and very well received by the Ministry and the general public. More importantly, NICO successfully brought together (very) young and more senior scientists from virtually all national academia, applied research institutions and industry, and is a key element in our quest for the now required research fleet renewal.

Also in 2017, NIOZ continued to enable the *Caribbean Netherlands Science Institute* (CNSI) at St Eustatius. We were relieved to learn by word of its director Dr Johan Stapel that the employees and facility withstood quite well the destructive forces of hurricane Irma.

Apart from our long term cooperation with fellow NWO Institute NIKHEF, the year 2017 saw interaction with NSCR, the NWO institute for the study of Crime and Law Enforcement with the co-organisation of a successful international conference on the *Globalization of Fisheries* on Texel, with 32 organisations from 14 countries participating. Internationally, besides with our nearby EU partner institutes, NIOZ was very active within the European Marine Board,

OCEANS IN TROUBLE

leading the production of two important, widely distributed science and policy briefs, and within the 'Partnership for the Observation of the Global Ocean' (POGO). In addition, increased cooperation with the marine sciences departments of Oldenburg University was manifested in a new MoU, adding them to the long list of NIOZ' international partner institutes.

Besides all of the above, perhaps the most significant event of the year was the reporting to, and the site visits of, the international peer review panel in the frame of the six-year cycle of *in-depth* NWO institute-evaluation. The international panel, composed of renowned, internationally acknowledged, independent scientists was chaired by Dr Hessel Speelman. During October 9-13, 2017, all NIOZ departments, our PIs, PhDs, supporting staff, labs, facilities, vessels, etc. were critically interviewed and examined by the committee. Eventually, we were very pleased to celebrate the overall positive outcome and judgements of the panel, viz: scientific quality: *outstanding, world-leading*; societal relevance: *outstanding, exemplary*; and viability: *excellent*, provided that NWO can resolve the now necessary replacement of our aging research fleet. This is a big compliment to all of NIOZ, all our employees, and associated personnel, particularly when seen in the light of the major reorganisation we went through. The continued support of the NWO board during and since the process that lead to NIOZ 2.0 has been instrumental in this success. Congratulations and thanks to all! Meanwhile, in 2017, and as part of the ongoing 'transition' of NWO, Royal NIOZ further prepared towards the merger with the

HENK BRINKHUIS,
DIRECTOR

NWO-Institute organisation (NWO-I), which was successfully effected on January 1, 2018. This date also constituted the *de facto* demise of the NIOZ Foundation as a legal entity, and therefore, by default, also of our board, led by Ir Harry Baayen in recent years.

Here, and on behalf of all of NIOZ, I wish to express my most sincere thanks to Harry, and his fellow board members, Dr Ir Bas Buchner, Prof Dr Jack Middelburg, and Ir Luc Kohsiek for all of their efforts getting NIOZ in shape, and ready for the future. I am confident that within the new organisation NWO-I, and through our perseverance and innovative research we are indeed ready for that future, towards the UNESCO proclaimed 'Decade of the Oceans' 2020-2030.
– Hence, *mission Blue Planet continues*.

All I need is a tall ship, and a star to sail her by...
(Sea Fever, John Masefield)

Henk Brinkhuis, director

OCEANS AS OPPORTUNITY

IN-DEPTH EVALUATION OF NIOZ

In 2017, the overall performance of NIOZ was evaluated for the period 2011-2016.The evaluation was commissioned and organized by the Netherlands Organisation for Scientific Research (NWO) following the Standard Evaluation Protocol 2015-2021 (SEP, amended version September 2016). The primary aim of the assessment procedure was to reveal and confirm the research quality, relevance to society and viability.

EXCELLENT

In addition to an elaborate self-assessment, an international Evaluation Committee was established by NWO Executive Board and asked to visit the two NIOZ locations and produce a reasoned evaluation of the institute and its research programmes. Its independent scientific members were:

- Dr Hessel Speelman (chair) – Wadden Academy, The Netherlands
- Dr Justus van Beusekom – Helmholtz Zentrum Geesthacht (HZG), Germany
- Prof Dr Nicole Dubilier – Max Planck Institut für Marine Mikrobiologie, Bremen, Germany
- Prof Dr Katherine Freeman – PennState, NAS USA
- Prof Dr Michael Schulz – MARUM, University of Bremen, Germany
- Prof Dr David Sims – National Oceanography Centre Southampton, University of Southampton, UK

THEIR CONCLUSIONS WERE AS FOLLOWS:

"Over the past evaluation period NIOZ has been thoroughly reorganised. Its mission, strategy, and research programme were sharply focused to deliver excellent multidisciplinary basic and frontier applied marine research, to serve as a national marine research facilitator for the Dutch scientific community, and to stimulate and support education and marine policy development at the national and international level. The Evaluation Committee is impressed with the enormous transition that the organisation has undergone and what has already been achieved in such a short period. The Evaluation Committee congratulates the entire organisation for its flexibility and adaptability.

The Evaluation Committee finds that NIOZ is a world-leading marine research institute producing excellent science. The four marine research departments are all world-leading as measured by the highest quality research output, award of major prizes, and an outstanding record of external research funding. This all makes it evident that NIOZ is one of the most influential oceanographic research institutes world-wide.

NIOZ makes an outstanding contribution to society through its highly productive research collaborations with government, industry and non-governmental partners in key areas such as sea-level rise, environmental pollution, food production, coastal protection, habitat conservation and renewable energy. The Evaluation Committee is impressed that science for societal relevance is integral to how NIOZ 'thinks' as an organisation.

The NIOZ 2.0 structure with its four marine research departments and linked infrastructure facilities is ideal for performing cutting-edge research. It is capable of meeting its future targets in research and society. The Evaluation Committee is convinced that NIOZ makes a unique and indispensable contribution to Dutch academia and society: without NIOZ there would be no marine research of significance left in The Netherlands.

OUTSTANDING

The Evaluation Committee recognises that large investments like a new ocean-going research vessel are essential for guaranteeing the future success of NIOZ. However, securing these investments is beyond the control of NIOZ. Renewing the ageing research fleet within the next few years is of the utmost importance for maintaining the level of world-leading research at NIOZ.

NIOZ is a well-organised institution with committed and enthusiastic staff. The institution has a large and vibrant community of graduate students that are very positive about their research opportunities. The structures and procedures put in place to safeguard the integrity of NIOZ research are generally fit for purpose, including an ambitious Research Data Management strategy that, when fully implemented, will provide data quality assurance, future-proof archiving, data discoverability and open access to users.

The Evaluation Committee found that NIOZ expresses commitment to the success of a diverse scientific community and is very international (21 nationalities), with much effort expended to support integration. The Evaluation Committee recognises, however, that there is an absence of females in the institute leadership.

The Evaluation Committee praises the success of the National Marine Facilities infrastructure. It is recognised, however, that NWO investments have decreased in the review period to (500 K€) in 2015. As a consequence, financing the facilities is becoming increasingly dependent on the charter of ship time and equipment. Past years have indicated that this is not always feasible, plus it interferes with National marine research priorities and planning."

SITE VISIT TEXEL

The department National Marine Facilities develops and builds specialised equipment for marine research.

EXEMPLARY

WORLD-LEADING

INTERNATIONAL EVALUATION COMMITTEE

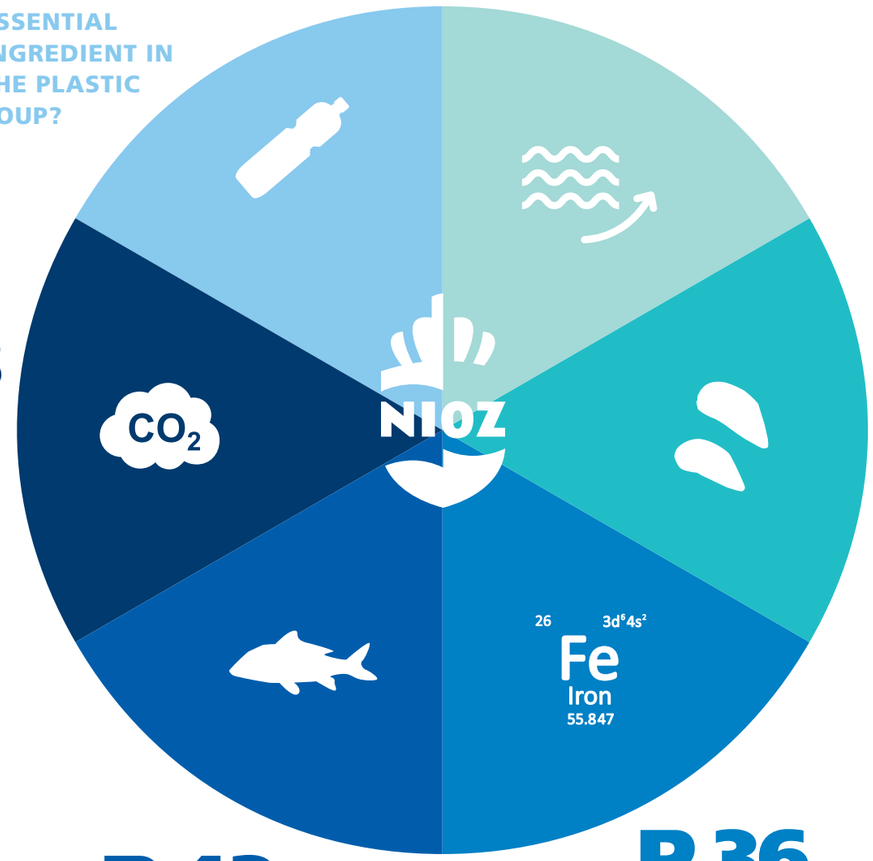
From left to right: Justus van Beusekom, Univ. Hamburg, Helmholz HZG, Wadden sea Ecosystem and Estuaries, Nicole Dubilier, MPI Bremen, Microbiology, Symbiosis, Michael Schulz, MARUM, Bremen, Marine Geosciences, Hessel Speelman (chair), Waddenacademie (NWO, TNO), (Marine) Geosciences, Katherine Freeman, PennState, NAS USA, Organic Geochemistry Isotopic Biogeochemistry Paleoclimate Astrobiology, David Sims, NOC Southampton, Marine Ecology.

SITE VISIT YERSEKE

The peer review panel visiting flume system for currents and waves at NIOZ Yerseke.

SCIENCE HIGHLIGHTS 2017

SCIENCE HIGHLIGHTS 2017



3 mm/yr

The currently observed global mean sea level rise of 3 millimetres per year equates to 30 cm per century on average; twice as high as it was in the past century.

600

million people's homes worldwide are estimated to be at some form of risk from sea level rise.

1.8 m

A 1.8 metre sea level rise this century is, though unlikely, not impossible in those areas expected to be hit hardest by Antarctica's ice mass reduction.

THE RISE (AND OCCASIONAL FALL) OF SEA LEVEL

The rise of sea level as a result of climate change is a subject of serious concern, particularly for low-lying countries like The Netherlands. Floods that were previously possible perhaps once a century will, within a generation, be seen every ten years or possibly even annually.

The mechanisms behind local sea level change and its consequences at the coast are not yet fully understood. That's why NIOZ's brand-new virtual centre of expertise called the Sea Level Centre has been established. Because fighting floods begins with understanding them.

UNDERSTANDING SEA LEVEL RISE

A major cause of sea level rise under climate change is the simple scientific fact that when water is warmed, it expands, thus taking up more volume. A second cause is the melting of land-based ice, for example in Greenland and Antarctica, increasing the total amount of water in the seas. This in turn leads to shifts in our planet's gravitational fields: less local mass means less local gravity. And so, perhaps unexpectedly, it is not the seas around Greenland and Antarctica that will experience the highest sea level rises (in fact the sea levels there may turn out *lower*) but those in areas further away from the poles – often areas of dense population.

Dr Aimée Slangen of the NIOZ Sea Level Centre studies and interprets such phenomena, focusing not only on global trends but also on local differences in sea level rise and how these affect the coast. The projected sea level change for this century ranges from 30 to 180 centimetres, depending on where you live and on the extent to which humanity manages to control the emission of greenhouse gases. North Western Europe is likely to experience higher values than the global average, because the change in gravitational pull will mean that Antarctic ice melt will be strongly felt here. As a result, up to 600 million people's homes could be at some form of risk from sea level rise within our lifetime.

ANTICIPATING THE FUTURE

The NIOZ Sea Level Centre already provides significant insights into possible upcoming challenges through data gathered and interpreted by multi-disciplinary international teams. For instance, NIOZ led the production of a science and policy brief within the European Marine Board in 2017.

This 2017 science commentary aptly titled 'The ticking time bomb of climate change', makes the crucial point that decisions taken in the next ten years will profoundly influence life in the next 10,000 years, and places the task firmly on policy makers to ensure containment of a number of dramatic climate change effects.

In June 2017, NIOZ organized an international workshop where seventeen Dutch, German, Danish, Norwegian and English institutes were represented in preparation of a report on sea level rise in the Dutch Wadden Sea. Their findings are to be published September 2018 by the Waddenacademie, which commissioned the report.


© Stefan Krafft

THE NIOZ SEA LEVEL CENTRE, a new virtual centre of expertise launched in 2017, brings together different NIOZ departments and disciplines, to improve our understanding of climate change consequences.


© Shutterstock

NIOZ INITIATED the 2017 European Marine Board Science commentary about sea level rise.

INTERNATIONAL WORKSHOP organized by NIOZ in June 2017 in preparation of a report about sea level rise in the Dutch Wadden Sea (commissioned by the Waddenacademie, and to appear September 2018).


© NIOZ

EUROPE is likely to experience higher sea level rise than the global average. The change in gravitational pull will mean that Antarctic ice melt will be strongly felt here.


© Frans Neve

DR PAOLO STOCCHI co-authored an international publication explaining how ancient storms coupled to rising sea levels could have hurled these 900-ton-boulders ashore in the Bahamas.

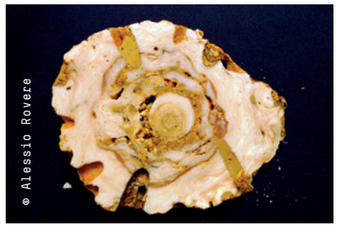

© Alessio Rovere


© Alessio Rovere

ANOTHER 2017 PUBLICATION by an international team led by Dr Paolo Stocchi from NIOZ, shows evidence for a sea level highstand 1.2 million years ago resulting from the Antarctic ice cap losing one-third of its mass. Stocchi et al. investigated the consequences of sea level rise in the past using a million years of climate data recorded in the Custonaci Stalactite (Sicily).


© Alessio Rovere


© Alessio Rovere


© Alessio Rovere

A MORE THAN 20 metre rise in sea level (above the present mean sea level) was recorded in the Mediterranean during the mid-Pleistocene transition (1.4 to 1.0 Million years ago).

80s & 90s

During the 1980s and 1990s the surface area of mussel beds in the Wadden Sea decreased dramatically, prompting the restoration of these beds.

50

There are at least 50 invasive species (like the Pacific oyster and the parasite *Mytilicola orientalis*) in the Wadden Sea.

11-13%

The parasite *Mytilicola orientalis* reduces the condition of mussels with 11-13%.

RESTORING MUSSEL BEDS AND HELP FROM INTRUDERS

The mussel is, to most of us, not the most impressive animal. But look below the surface, and what you find is a remarkable creature that both individually and as a team player displays great resourcefulness in dealing with changing circumstances.

RESTORING MUSSEL BEDS AND HELP FROM INTRUDERS

Spoiled brats? For decades, mussel beds have been dwindling from the Wadden Sea. Consequently, the plants and animals that depend on the mussel bed ecosystem also decreased significantly. Despite scientists deploying a wide array of tools designed to help restore the mussel to its native Wadden Sea, the task has proved unexpectedly difficult. As part of her 2017 PhD research into mussel beds, Hélène de Paoli found out why: both scientists and conservation managers had used the 'wrong' mussels to form the basis of future populations. Seeking strong and healthy tenants, these had been recruited from deeper water areas that are more conducive to mussel growth. Unfortunately, these deep-water mussels never had to deal with the extreme wave-pounding that can occur on tidal flats, and they proved unable to maintain a foothold under duress. They were simply washed away in all directions. Quirin Smeele of Natuurmonumenten: "This insight has really helped us to develop new techniques and temporary structures to protect mussels against waves, facilitating mussel bed restoration."

SELF-ORGANIZING PATTERNS BLUE PRINT FOR RESTORATION

Mussels are 'ecosystem engineers' that create suitable living conditions for themselves as well as for other species. Mussel beds are the 'coral reefs' of the Wadden Sea, and are constructed with consummate precision by huge teams of the youngest of mussel larvae. Because of the teamwork, the mussel beds develop a basic striped pattern of several metres wide, which is complemented by a net-like structure with 'strings' of 2 or 3 mussels wide *within* the stripes. The intricate, self-organized design of the beds, as a team of scientists including NIOZ researcher Johan van de Koppel discovered, actually contributes to resilience of the mussel beds. Indeed, a study reported in Hélène de Paoli's PhD thesis shows that experimental, human-made mussel beds copied from nature dealt more effectively with intense wave assaults than other designs: the mussels achieved improved adhesion to the sea bed. Science can lend nature a hand in providing biodegradable gauze bases on which the mussels can build their banks quickly and easily. According to Tjisse van der Heide (of Radboud University Nijmegen, now NIOZ), who co-authored the research, the 2017 experimental results are promising: the best of such gauze supports are those that most closely resemble the natural patterning designed by the mussels.

PACIFIC OYSTERS LEND WADDEN SEA MUSSELS A HAND

Several decades ago, Pacific oysters were deliberately introduced into Dutch coastal waters that were home to indigenous mussels, and soon the oysters flourished. This was good news for the oyster business, but seemed bad news for mussels that were suddenly confronted not only with an augmented battle for food but also with the dangers of new diseases and invasive parasites. How the mussel population responded was intensively studied by Anouk Goedknegt for her 2017 PhD thesis. She discovered that although mussels were highly prone to infection by *Mytilicola orientalis* – tiny parasitic oyster copepods – they somehow managed to mitigate the effects of such infection. The mussels survived, and damage was limited to a slight deterioration in physical condition as the copepods ate away parts of their hosts. Meanwhile, Anouk's NIOZ colleague Andreas Waser's PhD research showed that the resilience of mussel populations sharing their habitat with Pacific oysters actually improved. Survival rates for individual mussels and entire bivalve beds in such shared sites are higher than those in mussels-only locations. Why? Because the oysters are expert reef builders, and the mussels hide from predators like oystercatchers in the cover of the larger oyster structures. The trade-off here: a slight loss of plump flesh in return for a better home.

BAG OF MUSSELS
used for restoration
in the Wadden Sea.

SELF-ORGANIZING
mussels make
net-like patterns,
enabling them
to deal more
effectively with
strong currents and
waves.

THE PARASITE
Mytilicola
orientalis in
a mussel.

PREDATORS
like
oystercatchers
cannot get to
mussels easily
in mixed oyster-
mussel beds.

ANDREAS WASER doing field work
in the Wadden Sea.

ANOUK GOEDKNEGT
doing fieldwork on
oyster beds in the
Wadden Sea.

EMERGED INTERTIDAL MUSSEL BED in the
Dutch Wadden Sea near Holwerd.

ANOUK
GOEDKNEGT,
defended her
PhD Dissertation
at the Free
University
(Amsterdam).

MUSSELS BETWEEN
the oysters in
a mixed mussel
and oyster bank
(Karsten Reise of
AWI calls these
oysel reefs).

140

140 million tonnes of dust are blown annually from the Sahara into the Atlantic Ocean.

40%

40% of all seas contain too little surface iron to adequately support algae, which are crucial for life in the ocean.

IRON FEEDING THE OCEAN

5% Fe

Sahara dust contains 5% iron: important for algae growth. Iron content varies over continents, e.g. Australian dust is much richer in iron.

IRON FEEDS OCEAN LIFE

Life in the oceans largely depends on algae. At the bottom of the food chain, algae need iron for various processes including photosynthesis. However, in many parts of the ocean, iron is scarce. NIOZ researchers are investigating how natural and human-induced processes, including climate change, are affecting oceanic iron contents and their influence on marine ecosystems.

26 $3d^6 4s^2$
Fe
Iron
55.847

In many oceans iron is scarce, but nowhere more so than in the seas around Antarctica. Without iron, algae cannot convert light into energy and multiply. Natural iron is predominantly found in shallow seas and around submarine volcanoes, but melting glaciers may also be a source. Now that climate change is accelerating glacier melt, iron concentrations may rise and cause increased algae growth. To verify this, NIOZ scientist Rob Middag, together with PhD candidates Hung-An Tian, Mathijs van Manen and Charlotte Eich embarked on a 2017 cruise to the Amundsen Sea.

An on-board algae growth experiment demonstrated heightened efficiency in photosynthesis, but higher water temperatures also had an effect. So, climate change will definitely affect the marine ecosystems around Antarctica, although it is as yet unclear to what extent. Further research will be undertaken when the water samples finally arrive at NIOZ.

SAHARAN DUST

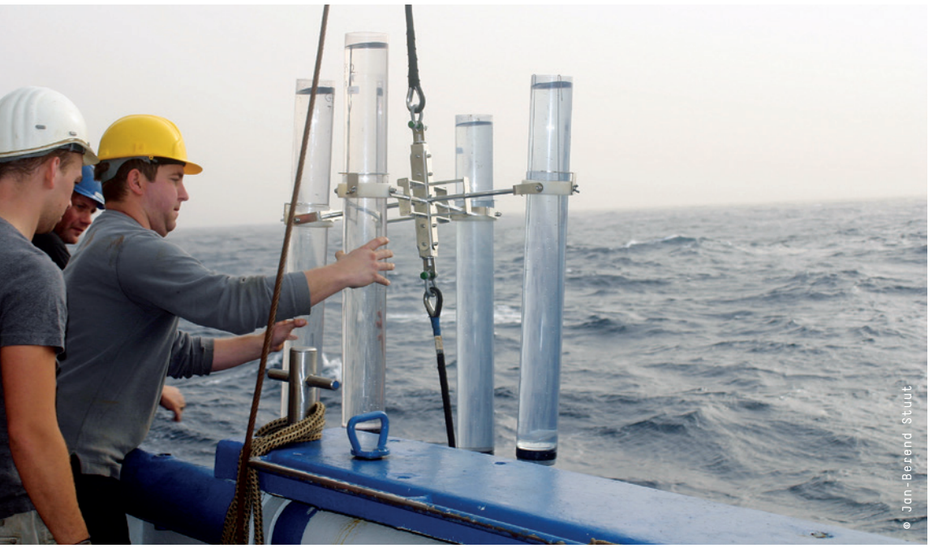
Dust that is blown from land to sea is another source of iron: not perhaps for Antarctica, but certainly for the Atlantic. There, NIOZ researcher Jan-Berend Stuut is investigating the transfer of iron and other nutrients from dust into the ocean. Saharan dust consists mainly of quartz, but it also contains 5% iron as well as many other components, including organic molecules. The source of such dust can be determined quite accurately, as PhD student Laura Schreuder ascertained in 2017, with a new proxy for burnt vegetation: the presence of sugar molecules (levoglucosan) indicates that it comes from an area of forest fires.

Stuut and his group have cruised the Atlantic since 2012, capturing desert dust in anchored equipment and floating buoys. Their measurements show that the dust particles tend to pull down the algae to the sea floor, which is a positive effect. Otherwise, the algae could release their freshly stored CO_2 back into the atmosphere.

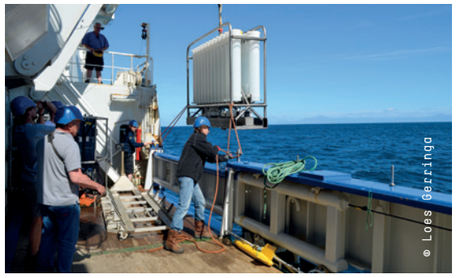
Researchers also found *giant dust particles* in their buoys, the presence of which is hard to explain by wind and gravity alone. Stuut and PhD candidate Michelle van der Does established that air turbulence and vertical atmospheric motions during cloud formation could be the cause.

INSOLUBLE

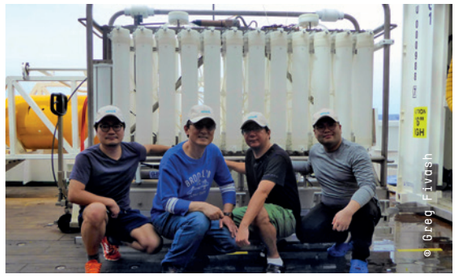
Desert dust contributes to ocean iron concentrations but iron is not easily dissolved in seawater, rendering it useless to algae. Here, rain comes to the rescue. PhD candidate Laura Korte discovered that the ferrous deposits dissolved in acidic raindrops make that iron available for algae. NIOZ researcher Loes Gerringa is also investigating iron solubility. During a Mediterranean cruise she found iron concentrations up to 20 times higher than expected. What she discovered was that organic compounds in the sea accelerate the process. These humic substances, produced by bacteria from animal and vegetable remains in the sea, together with iron-loving siderophores designed to transport iron across cellular membranes, were making their mark. Unfortunately, their presence is hard to measure accurately because of their low concentration. Gerringa, Middag and their colleagues are currently developing high-accuracy tools and methods that will allow a more complete analysis of the ferric cycle.



DRIFTING TRAPS deployed from RV *Pelagia* to collect Saharan dust and other aerosols like tracers for burnt vegetation such as levoglucosan.

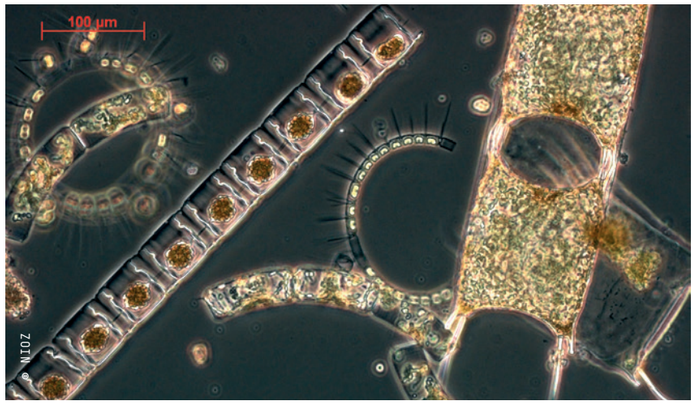


NIOZ-DEVELOPED ultra clean water sampler *Titan* takes a dive from RV *Pelagia* in search of trace metals.

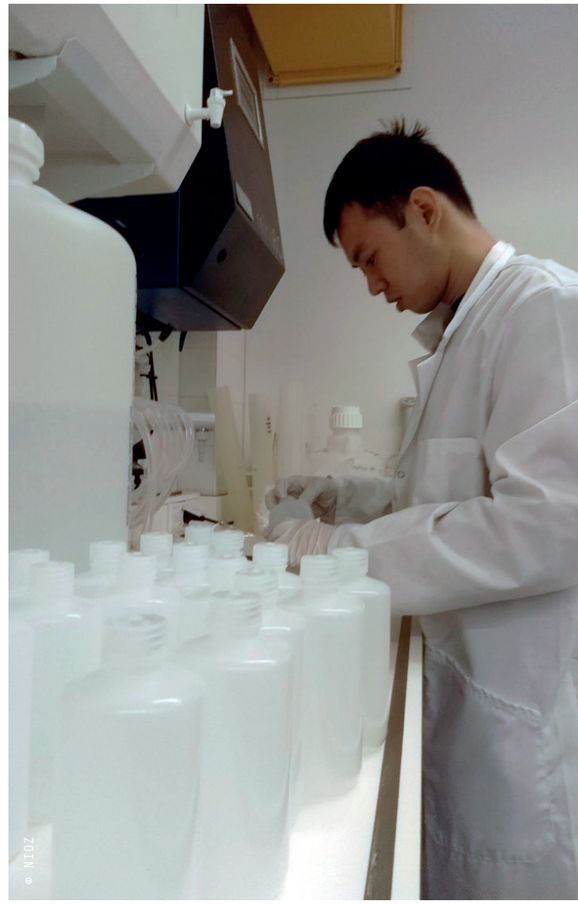


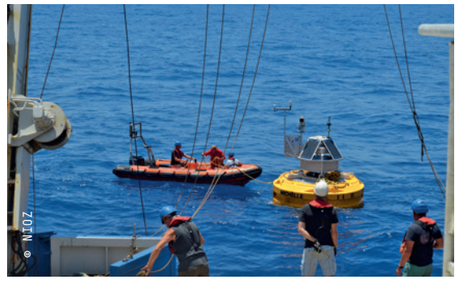
THE KOREAN INSTITUTE of Ocean Science and Technology (KIOST) purchased this Pristine Ultra Clean CTD (UCC) system from NIOZ after a successful sea acceptance test near the Mariana Trench.

ALGAE and other single-celled organisms represent 99% of all ocean biomass. Hence, their accelerated or restricted growth can strongly affect ecosystems.



NIOZ PHD STUDENT Hung-An Tian cleaning bottles before the Antarctic FePhyrus cruise in 2017. It takes strong acids and three months to thoroughly cleanse sample bottles prior to use, removing any traces of previous contents.





NIOZ dust collector 'Michelle'.

BEFORE EACH CRUISE, Jan-Berend Stuut has t-shirts made with suitably dusty quotes.

RESEARCHERS MEASURE more than ferrous content of samples, also identifying concentrations of fourteen other elements including zinc, manganese, copper, cobalt and nickel. The NIOZ FePhyrus-expedition crew: Mathijs van Manen, Scott McCain, Rob Middag, Stanley Tian, Charlotte Eich and Sven Pont.

50%

Fuel consumption and bycatch of pulse trawl is about half that of beam trawl.

1.5°C

Over the past 25 years seawater temperatures have risen more than 1.5 degrees Celsius in the Wadden Sea, resulting in more Southern species like the gilthead in the NIOZ Texel Fyke.

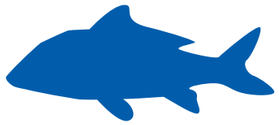
FISHY BUSINESS

60V

Standard pulse fishing equipment uses 60 volts (electric eels stun their prey with shocks up to 800 volts).

FISHY BUSINESS

International fishery is a complex business, in which local populations and international industry can collide. Notoriously hard to legislate and regulate, global agreement is nevertheless essential in bringing together economy and ecology, and it was to this end that the Globalization of Fisheries conference was organized at NIOZ headquarters in February 2017. Tellingly, the conference was co-hosted by the Netherlands Institute for the Study of Crime and Law Enforcement (NSCR).



Against a backdrop in which illegal, unreported and unregulated activity throughout the world compound what was already a challenging sector, balancing market needs against fish stock control is just one of the focal points discussed by a heterogeneous group of experts. Conference attendees included representatives of disciplines as diverse as economy, ecology, animal welfare, criminal justice, fisheries science, food quality and law application. Here, scientists interacted with NGO's, political bodies, bankers, consultants and practitioners, who all have roles to play in combating what is known as the IUU-problem: illegal, unreported or unregulated fisheries around the world. The results after three days of intensive debate: new research proposals, new collaborations, new publications. And last but not least: new hope for protected species including seabirds, marine mammals and turtles that frequently feature as 'bycatch' of high-pressure fishing, for instance in coastal Africa.

PULSE FISHING

In Europe, pulse fishing is one of several hot topics that divide many if not all the fraternities mentioned above. Advocates point to the advantages of catching flatfish using electrical pulses rather than coarse physical means to bring them out of hiding: less sea floor damage, and less energy consumption. Opponents speak of potential increased animal hardship. In a collaboration between Wageningen University and NIOZ, scientists are responding to a Dutch government request for an informed opinion. In laboratories, fish response to electrical pulses, and any trauma involved in the catching process (for example skeletal damage) is thoroughly investigated. Meanwhile, at NIOZ, PhD candidate Justin Tiano is establishing the consequences of pulse fishing on the ecosystem in general and sea floor in particular: an aspect of the debate previously under-researched. Tiano combines high-precision laboratory methods with A-B comparisons using real-life fishing vessels (state-of-the-art cutters from fishing village Urk), as well as special seabed research devices called benthic landers that are dedicated to data gathering. His first findings suggest that the role of ecology in the pulse fishing debate should become more prominent. The focus in the past has tended towards a one-sided *economic* debate. These two (and other) studies will be combined into a comprehensive pulse fishing recommendation, scheduled for publication by the International Council for the Exploration of the Sea (ICES) in 2019.*
In the interim, initial results are encouraging, and the researchers just hope their findings will be properly considered by current and future European legislators.

NORTH SEA FISH AND THEIR REMAINS

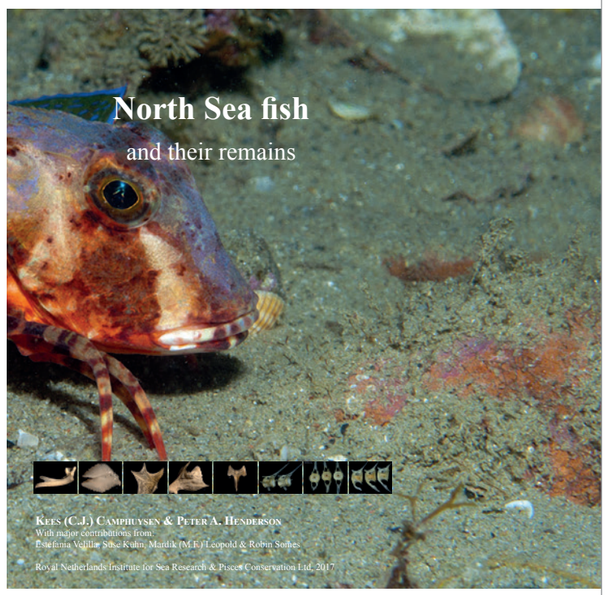
In October 2017, in a collaboration between NIOZ and Pisces Conservation, authors Kees Camphuysen and Peter Henderson presented the ultimate guide to North Sea fish, and how to identify them. Uniquely, they include identification methods to be used on fish remains as discovered inside predators, in archaeological sites or in geological deposits, as well as on living examples. No less than 150 species are catalogued, including the monstrous oarfish and the extremely rare John Dory. The book (North Sea Fish and their Remains) builds on Henderson's 40 year study of fish around the British Isles, and on Camphuysen's studies of piscivorous megafauna since the mid 1980s. Camphuysen reorganized the content, changed the focus and extended the scope to include the North Sea and Wadden Sea areas, and wrote all the texts on fish bones and other 'remains'. Unique data on seasonality and catch rate trends were integrated, profiting from the findings of NIOZ Texel's trusty fish fyke that has been an index for fish abundance and catchability since the 1960's. The bringing together of all such rigorous and comprehensive knowledge into a single volume is destined to form a scientific treasure-trove for generations to come.

(*) In early 2018 the EU banned pulse fishing without waiting for these scientific facts, which will be published in 2019. At that future time, the pulse fishing debate could well reopen.

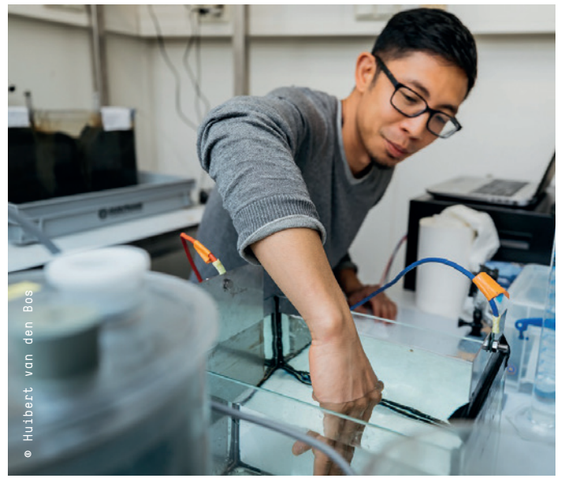
ATTENDEES at the Globalisation of Fisheries conference (February 3-5, 2017), organised by NIOZ together with Netherlands Institute for the Study of Crime and Law Enforcement (NSCR) included representatives of Rutgers School of Criminal Justice and the World Bank as well as a cross-section of relevant sciences.

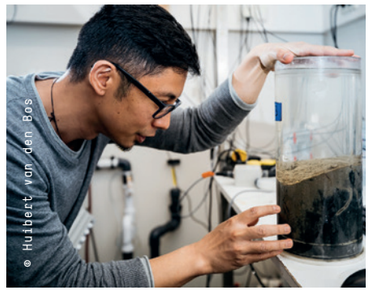
GILTHEAD, normally found South of the English Channel, but now caught in NIOZ Texel fyke nets due to higher temperatures.

THE BOOK North Sea Fish and their Remains also features the rare find of Giant Oarfish, also known as 'King of Herrings', washed ashore on the Dutch islands of Texel and Vlieland in 2009.

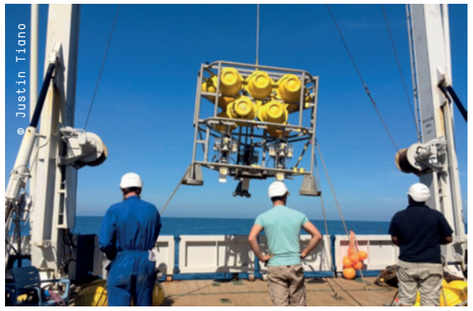


PHD STUDENT Justin Tiano's hand in water for pulse fishing experiment with 60-volt-electrodes.

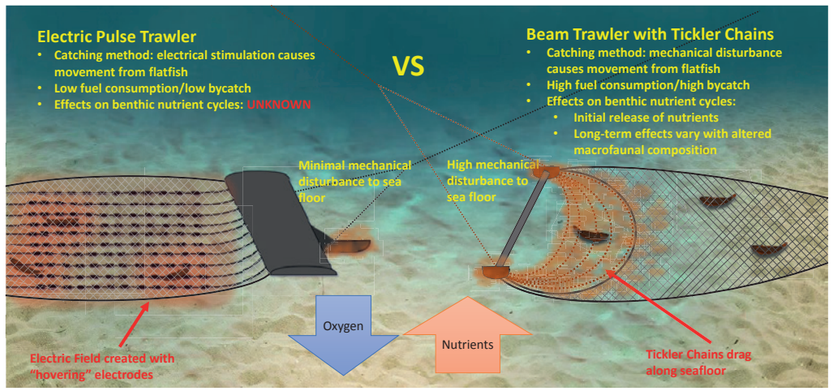




TESTING the effects of electric pulses on bottom-dwelling animals in the lab at NIOZ Yerseke.



A BENTHIC ALBEX LANDER being deployed to measure in-situ oxygen and nutrient fluxes after experimental pulse fishing in the North Sea.



ELECTRIC PULSE TRAWLER vs Beam Trawler Tickler Chains (infographic: Justion Tiano).

CO_2

The ocean is an important storage location for the greenhouse gas carbon dioxide.

1/2

Dissolved CO_2 (carbon dioxide) is an essential building block for marine animal calcium carbonate skeletons. Of all open ocean calcification, half is performed by foraminifera, tiny shell-forming organisms that play a vital role in the global CO_2-cycle.

98%

Of all available CO_2, 98% is in the oceans in dissolved form.

TINY SHELLS AND THE CO_2-CYCLE

Tiny shells tell huge tales of climate change. When the concentration of CO_2 in the atmosphere increases, the oceans absorb more of it. The uptake of carbon from the atmosphere also acidifies the ocean, affecting shell-building organisms, such as foraminifera. To build their shells, they need a dissolved form of carbon. But since calcification (such as shell building), in turn, disturbs the carbonate balance, the capacity of oceans to absorb CO_2 from the air also decreases.

NIOZ cultivates various forams in aquaria under controlled circumstances to better understand how these miniature 'chemical factories' go about their business. In addition, fossilised foram skeletons are studied to reconstruct past climate change and improve climate modelling tools.

THE MIGHTY FORAM

Forams are important producers of calcium carbonate, which in turn is important in the global CO_2-cycle. Since it is poorly understood how the production of these shells is affected by changes in environmental conditions, NIOZ is interested in understanding how these single-celled creatures build their miniature skeletons. To get to the bottom of their biomineralisation, the creatures in both bottom-dwelling (benthic) and floating (planktonic) forms are captured and cultivated under controlled circumstances in which temperature, salinity and acidity can be varied. The effects on calcium carbonate production and, indeed, on its chemical composition are carefully monitored. In such calibration studies, the biomineralisation processes of different types of forams can be compared. NIOZ is specialised in the analysis of the chemical composition of the shells of forams. One of the techniques involved is laser ablation, in which tiny holes are drilled into the shells after which mass spectrometry is used to analyse the exact composition of the debris. This is important since the presence of trace elements accurately reflects temperature and ocean chemistry. Precisely knowing the relation between the chemical composition of the foraminiferal shell and the environment allows the use of fossil specimens to reconstruct the earth's climate of the past.

A GLOBAL APPROACH

International cooperation is a vital factor in this kind of project, such as that between NIOZ and the Japanese marine research institute JAMSTEC that is specialised in applications involving microelectrodes. Such microelectrodes were instrumental in Dr Lennart de Nooijer's research into bottom-dwelling foraminifera and how they adapt to environmental acidification. The membrane of forams prevents charged CO_3^{2-}molecules from passing, so the resourceful foram first acidifies the surrounding water by pumping out hydrogen ions (protons or H^+) to increase the carbon dioxide concentration directly outside its cell. This gas easily leaks back in on the other side of the membrane, allowing the foram to convert it back into CO_3^{2-}: a building block for calcium carbonate and hence, for a skeleton.

SMALL CREATURES, LARGE CONSEQUENCES

The use of such a 'proton pump' by a bottom-dwelling foram called Ammonia has been conclusively demonstrated by NIOZ/JAMSTEC. This finding can impact heavily on our understanding of the CO_2-cycle, because it now seems likely that forams produce more calcium as oceans acidify, which in turn limits the ocean's capacity for carbon dioxide absorption due to a shift in the chemical balance of dissolved CO_2. NIOZ marine geologist professor Dr Gert-Jan Reichart, head of the department of Ocean Systems, therefore advocates factoring in changes of calcium carbonate production by forams caused by ocean acidification in all climate change scenarios. It could cast a whole new light on existing and future climate goals.

A BIGGER PICTURE

It was not only forams whose calcium carbonate-forming habits were studied by NIOZ in 2017. Just as forams control their environment in order to obtain the calcium needed to produce their skeletons, so other marine creatures including different varieties of sponge do the opposite: encourage calcium carbonate to *dissolve*. They do so by drilling into the skeletons of corals. These corals too will feel the consequences of ocean acidification as it affects both calcium formation and decline.

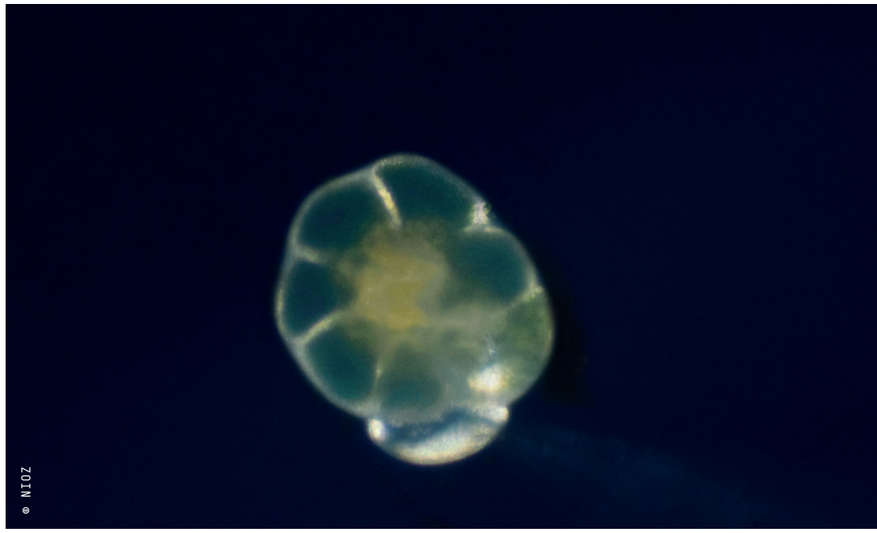
UU MASTERSTUDENT
Carlijne Wijngaarden sampling the plankton pump on board the RV *Pelagia* during the first leg of the NICO expedition, December 2017.

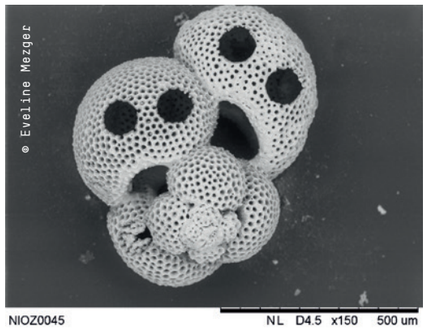
THIS CORE
from the sea bed – containing fossilised forams – was taken during the first leg of the NICO expedition, December 2017.

TO CATCH TROPICAL planktonic forams, you need extremely clear water, keen eyesight, a great deal of patience and… a jam jar.

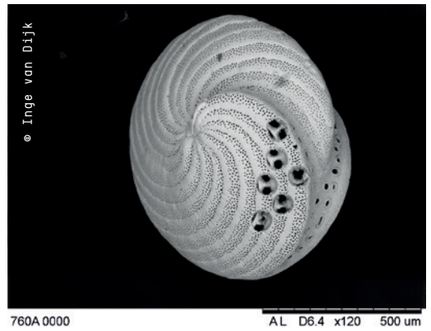
DR LENNART DE NOOIJER and Alice Webb catching tropical forams in Caribbean Sea near Curaçao/ St. Eustatius.

THIS BENTHIC FORAM *Ammonia tepida* from the Wadden Sea has just added a new chamber (bottom most part of the shell), the calcite visibly bright under cross-polarized light.

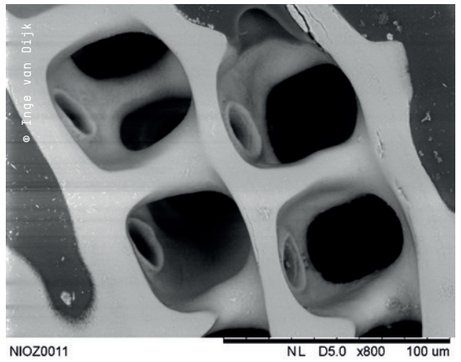




SCANNING ELECTRON MICROSCOPE image of foraminifer *T. sacculifer* after laser-ablation has perforated its shell for chemical analysis.



TROPICAL BENTHIC FORAMINIFER *Archais angulatus*.



THE 20-80 MICROMETRE holes are man-made with the NIOZ laser-ablating system to develop 'proxies' based on foraminiferal calcite, in order to reconstruct climate change.

90%

Microbes represent up to 90% of the ocean's biomass.

MICROBES: ESSENTIAL INGREDIENT IN THE PLASTIC SOUP?

5%

About 5% of plastic produced on land ends up in the ocean, which amounts to 13 million tonnes per year.

2050

If plastic production rates and human disposal behaviour don't change, fish biomass and plastic in the ocean could be of the same order of magnitude by the year 2050.

MICROBES: ESSENTIAL INGREDIENT IN THE PLASTIC SOUP?

A general rule in microbiology goes: if there's a way to harvest energy from a resource, there's a microbe that can use it. Plastics are long chain hydrocarbon molecules – in a way similar to crude oil. Just as oil can be used by specialized microbes, plastics may thus serve as an energy source for microbial life as well. But in marine environments, the existence of these specialists seems hard to find. That's about to change.

Some of our knowledge gaps about the interplay between marine microbes and plastics are about to be filled by the new research groups of Linda Amaral-Zettler and Helge Niemann at NIOZ.

In 2017, senior scientist Linda Amaral-Zettler moved her research group to NIOZ to collaborate with others in the area of marine plastic debris research under the umbrella of the Marine Microbiology and Biogeochemistry Department. A pioneer in the field, she coined the term 'Plastisphere' to mark a new kind of ecosystem that microbiologists are only starting to discover.

THE PLASTISPHERE

The Plastisphere is characterized by a rich biodiversity of microscopic life on the surface of plastic particles. It even seems that different kinds of polymers (PE, PET, PS, PVC, …) attract different species that can act as ballast allowing plastic that normally floats at the surface to sink to the ocean depths. Amaral-Zettler's work suggests that these coatings are often formed by diatoms, oxygen-producing photosynthetic microbes that can cover a large portion of the biofilm surface. Her group uses molecular and microscopy approaches to study the diversity, function and fate of microplastics in the sea. One of her new projects at NIOZ centers on biodegradation of biodegradable and compostable plastics in the marine environment, the topic of her new PhD student's thesis.

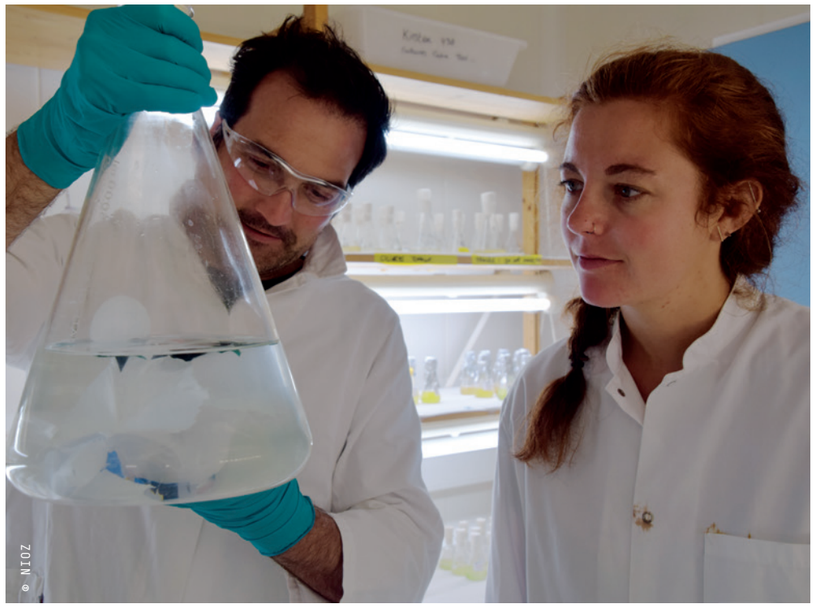
2-MILLION EURO ERC GRANT FOR MICROBIAL BREAKDOWN OF PLASTIC

Also in 2017, NIOZ senior scientist Helge Niemann was awarded a 2-million euro, 5-year ERC VORTEX project, that will consolidate his team of scientists to investigate the degradation of (micro)plastics in marine environments. From estuaries and coastal areas to offshore seas and the deep ocean, biogeochemist and microbiologist Niemann aims to explore how the process of microbial degradation works in the ocean.

One of the key unknowns in this field is the 'survival time' of plastics in the ocean. Only a fraction of the plastic litter that has entered the ocean can be accounted for, while most is lost at sea. Some has been consumed by marine animals, and some has been overgrown by fouling communities and sunk to the seafloor. While this alone cannot explain the 'missing plastics problem', microbial degradation could be the missing link.

Niemann and colleagues want to identify plastic-degrading microbes and measure their rate of degradation. For this, they will feed microbial communities with plastics containing isotopically-labelled carbon. This labelled carbon can then be traced into microbial food webs. They will look at the environmental conditions under which degradation proceeds to address questions like: Does degradation happen more quickly in warm conditions? Can it also happen in oxygen-free environments?

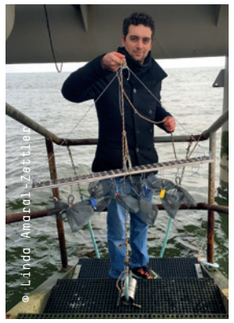
Inputs of plastic into the ocean are dramatically increasing, which calls into question whether this can be counteracted by microbial breakdown. Furthermore, degradation leading to smaller and smaller pieces of plastic might cause another problem with unforeseeable consequences: small organisms at the base of the food web can consume the minuscule plastic particles. In the end, these plastics can then travel through the food chain and even end up on our own dinner table. Alternatives to conventional plastics may offer some relief, but there is still lots to understand about the basics.



NIOZ VORTEX TEAM members Helge Niemann and Maaike Goudriaan have set up a condensed plastic soup in the laboratory to investigate microbial degradation of plastic.

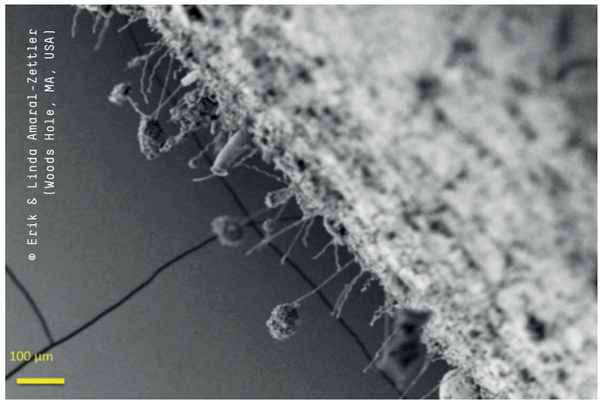
European Research Council
Established by the European Commission

DR HELGE NIEMANN was awarded a 2-million euro, 5-year ERC VORTEX project, to investigate the degradation of (micro)plastics in marine environments.



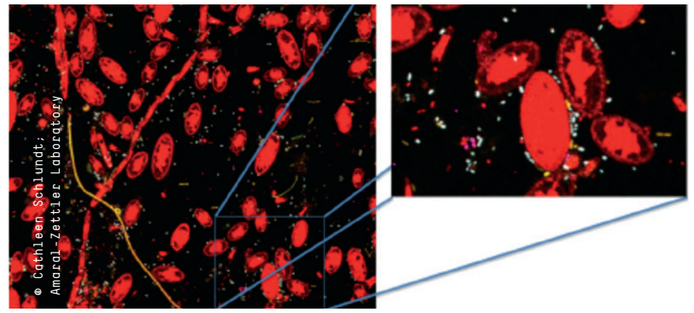
NIOZ PDH STUDENT Fons de Vogel looking at the surface colonisation of various plastic polymers.

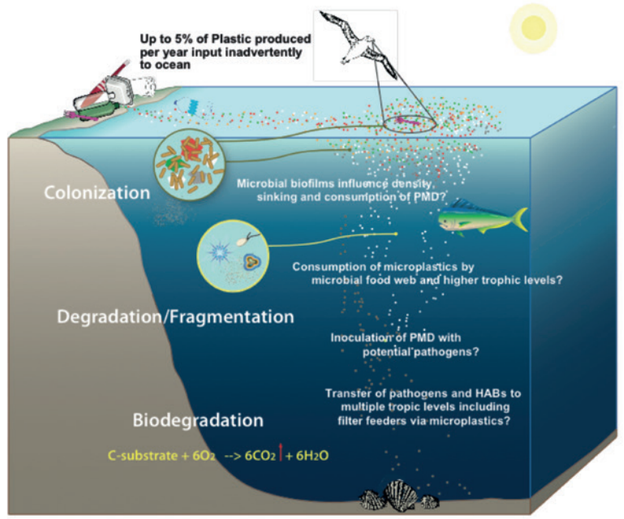
DR LINDA AMARAL-ZETTLER performing water filtration on ship board.



"LIKE THE BIOSPHERE (the thin film of life around the surface of planet Earth), the Plastisphere represents a little world of life that exists on the surface of plastic particles" (Zettler, Mincer, Amaral-Zettler, 2013). Scanning Electron Micrograph of the surface of a piece of microplastic.

A FLUORESCENCE PHOTOMICROGRAPH of a diatom biofilm and associated bacteria covering the surface of a piece of polypropylene microplastic. NIOZ hopes to acquire the infrastructure for the technique used: CLASI-FISH.





HOW MAY MICROBIAL COMMUNITIES on plastic marine debris contribute to plastic sinks in the ocean and ultimately consumption by higher trophic levels in the marine food web? Infographic: Linda Amaral-Zettler for expert module on *Plastics: Colonization and Degradation* for the *Encyclopedia of Microbiology* (in press).

FIGURES 2017

BUDGET 2017

The overall budget for 2017 amounted to 34.1 M€. The basic structural funding by NWO amounted to 17.6 M€; incidental NWO contributions added up to 4.9 M€ (together equivalent to 66% of the total budget). NWO project funding totaled 1.8 M€. Other project-related additional funding was received through EU projects (2.1 M€; 6%) and other national and international projects acquired in competition (5.1 M€; 15%). Chartering of RV *Pelagia* to third parties yielded a revenue of 0.8 M€ (2%). Other shipping funding was received from ENW-NWO (0.5 M€; 1%). Miscellaneous and *ad hoc* funding amounted to 1.3 M€ (4%).

Budget 2017	M€
Basic structural funding NWO	17.6
Incidental NWO contributions	4.9
NWO project funding	1.8
EU project funding	2.1
Other project funding	5.1
Pelagia charters	0.8
ENW-NWO	0.5
Miscellaneous funding	1.3
	34.1

STAFF 2017

On average, NIOZ employed a staff of 250 full-time equivalents (FTE), representing a total headcount of 291 employees. Of this total, 54 employees were of foreign nationality, representing 25 different countries. Total staff increased by 6 FTE compared to 2016. The relative distribution in percentage of personnel over the different staff categories remained fairly constant. Scientific staff, including tenured senior scientists, postdocs and PhD students accounted for 44% (2016: 45%) of the total staff, scientific support staff 22% (2016: 21%), and technical staff, ship crew, and services & administration accounted for 34% (2016: 34%).

Staff 2017	FTE
Tenured Scientists	42
Postdocs	23
PhD students	45
Scientific support staff	55
NMF technical staff	20
NMF ship crews	23
Services and administration	42
	250

SCIENTIFIC OUTPUT 2017

NIOZ scientists authored or co-authored 293 peer-reviewed journal articles, 1 book (monograph), 3 chapters in books, 7 non-refereed publications and 17 scientific reports. Out of the 293 peer-reviewed journal articles, 192 appeared as open access publications (66%, similar to 2016). 8 PhD students received their degrees from the Utrecht University (3), University of Groningen (2), Radboud University Nijmegen (2), and the Free University of Amsterdam (1).

In 2017, several NIOZ scientists received major research grants and awards: Dr Helge Niemann (Marine Microbiology & Biogeochemistry, MMB) received an ERC advanced research grant for research on the microbial breakdown of plastic. Dr Anja Spang (also MMB) obtained a '*Women in Science Excel*' (WISE) NWO grant. Julie Lattaud BSc (MMB) won the best student presentation award at the 28th International Meeting on Organic Geochemistry. Both Prof Dr Corina Brussaard (MMB) and Dr Jan van Gils (Coastal Systems, COS) received large Netherlands Polar Programme NWO grants. Prof Dr Theunis Piersma (also COS), was honoured with the British Marsh Award for International Ornithology and *knighted* for his scientific oeuvre by decision of HM The King of The Netherlands. Anouk Goedknegt PhD (COS) won the VLIZ North Sea Award 2017. Dr Aimee Slangen (Estuarine & Delta Systems, EDS) received an NSO-GO NWO grant. And PhD student Alexander Ebbing (EDS) received the NWO '*Open-Mind* grant'.

146 of our scientists participated in scientific committees and editorial boards of scientific journals.

Shiptime: In 2017, RV *Pelagia* sailed 209 days for NIOZ scientific programmes and projects (19 out of 209 days for the NICO expedition) and 22 days for foreign scientific teams as barter cruises within the European OFEG (Ocean Facilities Exchange Group) framework. RV *Navicula* sailed 143 days for the NIOZ scientific community. Our ships were chartered by private partners for 56 days.

Scientific output 2017	
Peer-reviewed journal articles	293
Books (monographs)	1
Book chapters	3
PhD Dissertations	8
Scientific reports	17
Non-refereed publications	7
Prizes/awards	6
Major research grants	4
NIOZ scientists in scientific committees & editorial boards	146
Ship time (days): RV Pelagia for NIOZ	209
Ship time (days): RV Pelagia for OFEG	22
Ship time (days): RV Navicula for NIOZ	143
NMF ship charters by private partners (days)	56

OUTREACH & TEACHING 2017

NIOZ issued 26 press releases on scientific highlights and the institute was mentioned 42 and 85 times in national and regional newspapers, 165 and 213 times on national and international websites, respectively.

Journalists in professional journals wrote 66 publications after interviewing NIOZ scientists. Our scientists appeared 66 times on radio or TV (source: Meltwater News Database), and gave 30 public lectures for a broad audience. 66 Groups visited the institute for presentations and guided tours.

NIOZ scientists participated in 3 societal advisory bodies.

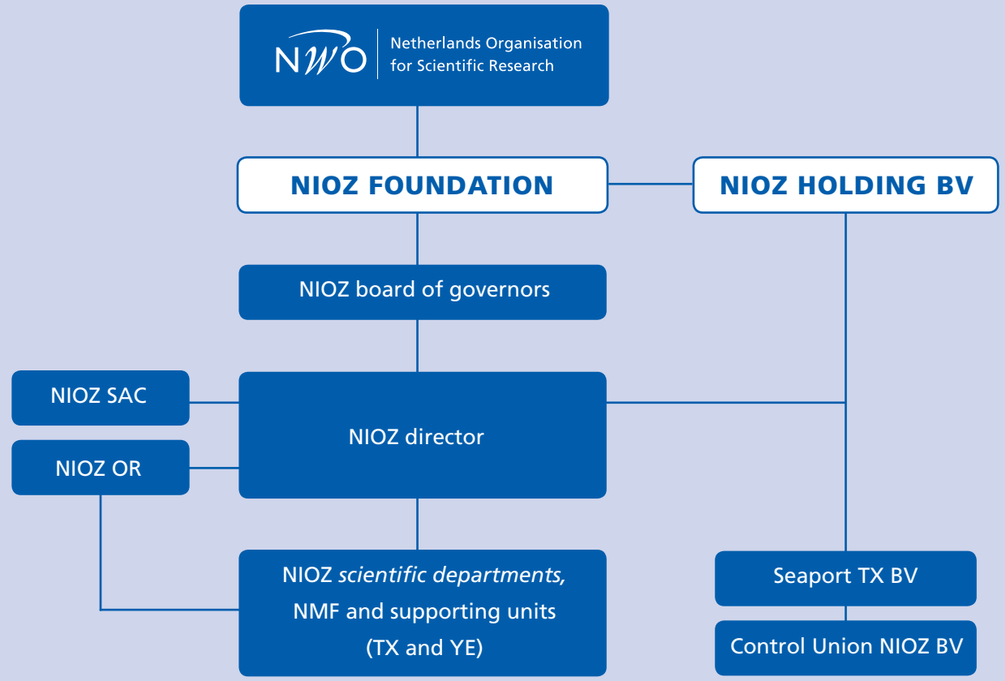
NIOZ scientists were involved in the organisation of 36 courses and 123 students performed an internship as part of their study at NIOZ.
19 symposia were either organized at NIOZ, or were organized by NIOZ staff and held elsewhere.

Outreach & Teaching 2017	
Press releases	26
National Newspapers	42
Regional newspapers TX and YE	85
Professional publications after interview	66
Radio & TV	66
Internet NL	165
Internet INT	213
Public lectures	30
Visiting groups	66
NIOZ PI's in Societal Advisory boards	3

Capacity building Courses	36
Capacity building Internships	123
Symposia at or by NIOZ	19

ORGANISATION 2017

NIOZ BASIC STRUCTURE 2017

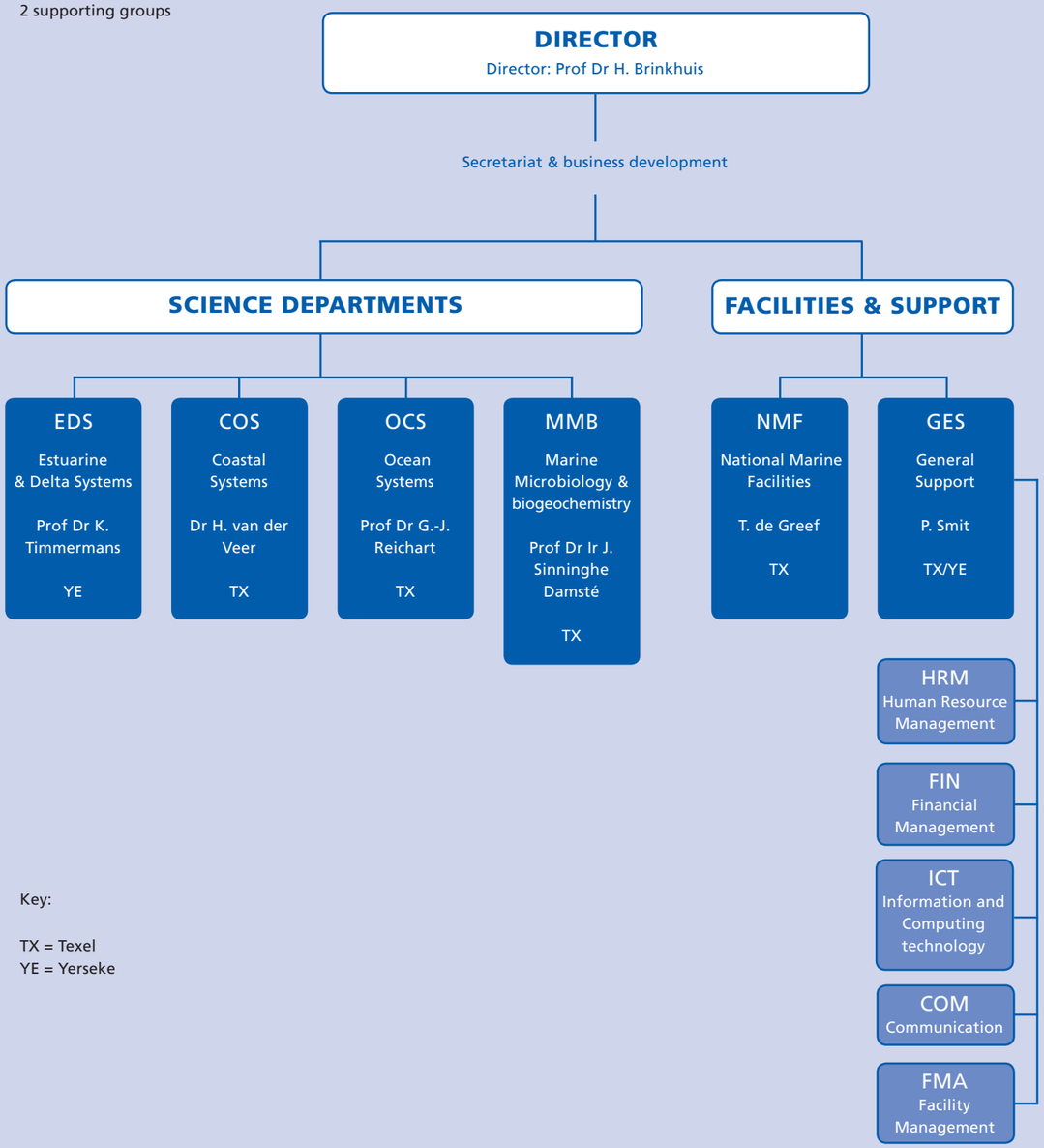


Key:

NIOZ SAC = Science Advisory Committee
NIOZ OR = NIOZ workers council
TX = Texel
YE = Yerseke

ORGANISATION OF NIOZ 2.0

2 centres located at Yerseke & Texel
4 science departments
2 supporting groups

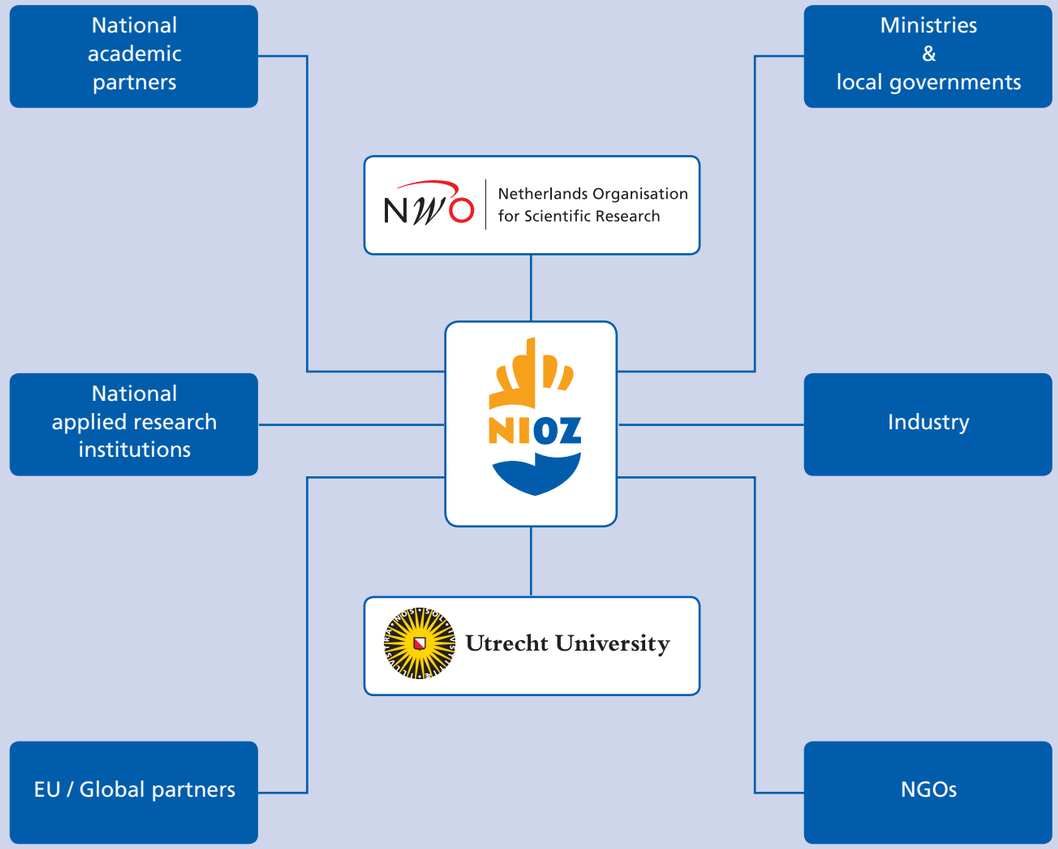


Key:

TX = Texel
YE = Yerseke

POSITIONING OF NIOZ 2.0 AMONG IMPORTANT NATIONAL AND INTERNATIONAL STAKEHOLDERS

NWO/NIOZ 2017: National *hub* for marine research
in cooperation with Utrecht University



PICTURE BOOK

CONFERENCE

NIOZ and NSCR, both NWO-institutes, organized the international Conference 'Globalisation of Fisheries' on Texel: 32 organisations from 14 countries were represented.

DUTCH RESEARCH AGENDA

The NIOZ-led 'Blue Route' of the Dutch Research Agenda was presented at the Ministry of Defence, Ministry of Foreign Affairs, and the Ministry of Infrastructure and Water Management.

POLICY BRIEFS EMB

NIOZ initiated and led the production of two European Marine Board (EMB) science and policy briefs.

2017

Global Centre of Excellence on Climate Adaptation

CCCA Netherlands Consortium on Climate Change Adaptation

PARTNERSHIP SUSTAINABILITY & CLIMATE

NIOZ became partner in two newly established centers for sustainability and climate mitigation: the Utrecht-based *Netherlands Consortium on Climate Change Adaptation* (CCCA), and the Groningen-based *Global Centre of Excellence on Climate Adaptation* (GCECA).

EXPOSITION

The new *Welcome to Wadden City* exposition in Ecomare on Texel, invites visitors to follow the footsteps of NIOZ researchers.

OUTREACH EVENT

PhD student Alexander Ebbing and Peter van der Linden with fresh seaweed in preparation for the popular public 'Mosseldagen' in Yerseke.

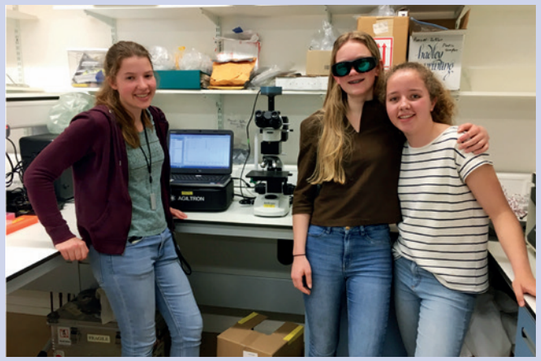

© Dörte Poszig, NIOZ

EDUCATION
Participants of the NIOZ Marine Masters Summer Course taking benthos samples in the Mokbaai for later food web analysis.

COASTAL ECOLOGY WORKSHOP
The international Coastal Ecology Workshop (CEW2017), celebrating its 25th anniversary, was organized by the NIOZ department of Estuarine & Delta Systems near Eastern Scheldt.


© Marcelle Davids

IN OCTOBER 2017 - De Wylde Swan set sail with secondary school students Aniek Wansink, Ariënne Dijkstra and Elona Wiersma on board to look for microplastics in the North Atlantic Garbage Patch. The students visited NIOZ hosted by the Amaral-Zettler lab and learned how to differentiate between different types of plastic polymers.



NWO '*OPEN-MIND* GRANT'
PhD-student Alexander Ebbing received a NWO '*Open-Mind* Grant' for artificial seaweed nurseries. His proposed Seaweed Continuous bioReactor (SeCoRe) will make the production of seaweed hatchlings efficient, reliable, mobile, and therefore cheaper.

PROF DR CORINA BRUSSAARD received a major Netherlands Polar Programme NWO grant for research into polar marine viral diversity and dynamics.


© Benjamin Gnep

POLAR PROGRAMME
Dr Jan van Gils received a major research grant from NWO's Netherlands Polar Programme to investigate Arctic warming-induced body shrinkage of long-distance migrants.


© Dr Jan van Gils

NWO WISE GRANT
NIOZ scientist Dr Anja Spang received a NWO WISE grant to dive into novel micro-world of Archaea. With her new research team at NIOZ she will address fundamental questions on the metabolic diversity and evolution of archaea in little explored oceanic environments.

ERC GRANT

NIOZ scientist Dr Helge Niemann received a 2 million euro research grant from the European Research Council to study the microbial breakdown of plastics in the ocean.

BRITISH MARSH AWARD

The British Marsh Award for International Ornithology was awarded to NIOZ scientist Prof Dr Theunis Piersma in recognition of his scientific work on migration, ecology and evolution of birds and other taxa. Scientific work that holds 'high policy relevance' according to the jury. He was also knighted by decision of HM The King of The Netherlands for his scientific work.

APPOINTED PROFESSOR

In 2017 NIOZ scientist Dr Daphne van der Wal was appointed Professor of 'Spatial water quality and aquatic systems' at the University of Twente.

CARIBBEAN NETHERLANDS SCIENCE INSTITUTE

LURKING THREAT: HURRICANES

Two near misses of disaster for NIOZ/CNSI on St. Eustatius: September 2017 hurricanes Irma and Maria (category 5) caused damage and disrupted work until the end of November, but fortunately no CNSI-staff or guests were injured.

THE DEPARTURE of the NICO expedition mid-December was covered by many Dutch national news media.

NICO EXPEDITION
leg 1, Texel-Las Palmas,
13-27 December 2017.
Follow NICO expedition via
www.nico-expeditie.nl


© Thijs Heslenfeld


© Thijs Heslenfeld


© Thijs Heslenfeld

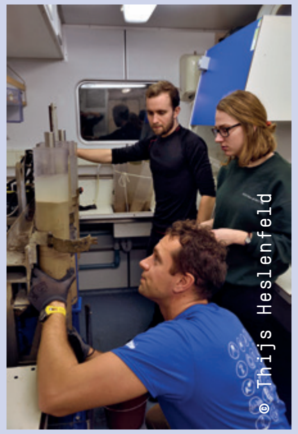

© Thijs Heslenfeld


© Thijs Heslenfeld

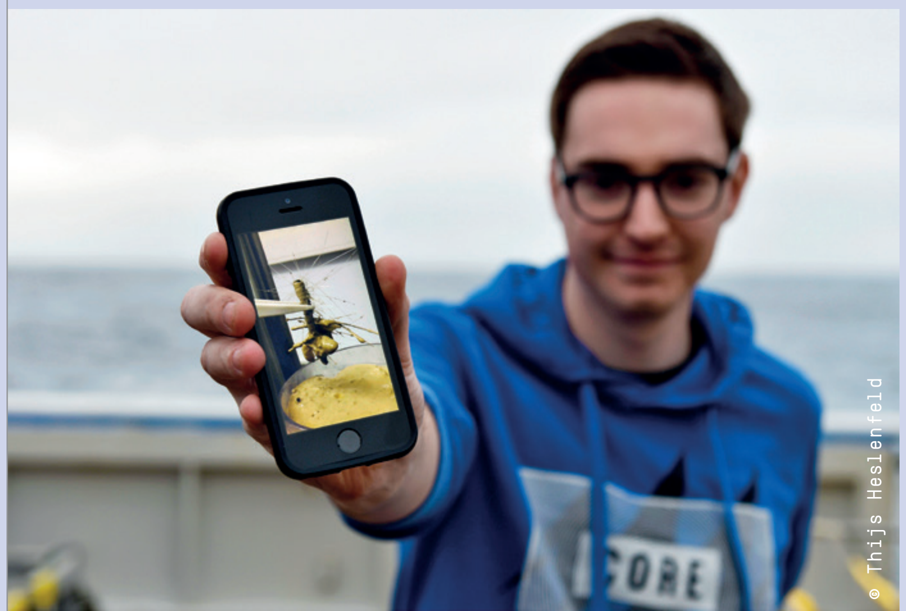

© Thijs Heslenfeld


© Thijs Heslenfeld


© Thijs Heslenfel


© Thijs Heslenfeld


© Thijs Heslenfeld


© Thijs Heslenfeld


© Thijs Heslenfeld

COLOPHON

NIOZ Royal Netherlands Institute for Sea Research is part of the institutes organisation of NWO, since 2016 in cooperation with Utrecht University.

NIOZ TEXEL
Visiting Address: Landsdiep 4, 1797 SZ ‘t Horntje Texel
Postal address: PO Box 59, 1790 AB Den Burg, Texel
Telephone: +31(0)222-369300

NIOZ YERSEKE
Visiting Address: Korringaweg 7, 4401 NT Yerseke
Postal address: PO Box 140, 4400 AC Yerseke
Telephone: +31(0)113-577300

The annual report can be ordered free of charge from the library of NIOZ. It is also available online: www.nioz.nl/en/about/annual-report.

This annual report was produced under the responsibility of the director Prof Dr Henk Brinkhuis.

Editors:
Kim Sauter
Nina Aalberts
Alan Parfitt
Senne Starckx
Annemieke van Roekel
Renée Moezelaar

Design: das Studio (Barbara Pilipp)
Print: PrintConsult

Omslagfoto’s: RV *Pelagia* © Thijs Heslenfeld


70 %
of our Blue Planet
is covered by water.
98 %
Oceans contain 98% of all
CO_2 on planet earth.
80 %
of all life on earth can
be found in the oceans.
5 %
Less than 5% of the ocean
floor has been mapped.
NIOZ
Royal NIOZ is part of the institutes organisation of NWO, in cooperation with Utrecht University
NWO
Netherlands Organisation
for Scientific Research
Utrecht University