ANNUAL REPORT 2018

Royal Netherlands Institute for Sea Research

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

NWO

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.

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.

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NIOZ TX & YE

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

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: performing world class seagoing marine research with high scientific and societal impact.

NWO-Royal NIOZ is the national oceanographic institute, established in 1876, and operates from two strategic locations in the Netherlands, on Texel (TX) and in Yerseke (YE), and facilitates a research station at St Eustatius (CNSI) in the Dutch Caribbean. NIOZ has some 50 tenured marine scientists, working in four scientific departments, and a total of up to about 300 fulltime and part-time employees including students.

NIOZ is the national, often coordinating, hub for innovative, process-oriented, and seagoing fundamental and frontier-applied marine environmental studies. As such it will continue to fill a unique and critical regional, national and international position in research as well as in education and outreach. Within NIOZ, the **National Marine research Facilities (NMF)** department maintains a range of facilities and services, including research vessels and seagoing equipment, for the marine science and maritime community in the Netherlands. Some twenty NIOZ PIs have honorary or part-time professorships, and teach at the various national universities with marine programs. NIOZ's education officer coordinates national BSc and MSc courses, and co-organises the national MSc course that NIOZ provides on an annual basis. NIOZ also facilitates maritime technological research by providing knowhow and seagoing, and onshore experimental infrastructure.

NIOZ 2018: NEW HORIZONS

It is becoming increasingly clear that humanity faces huge challenges concerning the understanding, functioning and sustainable exploitation of the oceans and seas. This is noted by a multitude of international and national (governing) bodies, and is placed on virtually every global to regional agenda. Not for nothing is IOC-UNESCO proclaiming 2020-2030 as the *Decade of the Ocean*. Indications are that the Dutch government is also focussing more on the importance of the oceans, not only for the larger Kingdom of the Netherlands ("Oceanennotitie Rutte II"), but also globally, for example in the context of the UN Sustainable Development Goals.

Unknown oceans
Oceans in trouble
Oceans as opportunity

This is mainly SDG 14: *Life Below Water* or more formally *Conserve and sustainably use the oceans, seas and marine resources for sustainable development.*

Inspired by these international grand challenges associated with living with warming oceans in the Anthropocene, NIOZ research already aimed at focused, advanced fundamental and frontier-applied research with a longer-term, farther horizon, with high social and scientific relevance, and with high visibility. We called our science plan *Mission Blue Planet.* It formed the basis of a reorganisation of the institute along multidisciplinary and transdisciplinary lines so that it could approach the outstanding complex issues effectively. Our research efforts globally over the past years have yielded critical new insights into the complexity of the many environmental issues with the oceans, and have brought these "ocean troubles" very much to the forefront of public and political discussion. During 2018, in a bottom-up fashion, we worked on our follow-up strategic and research plan for 2020-2025, provisionally termed "*Our Ocean, Our Coast, Our Future*". This will be finalised in 2019. With this new plan, NIOZ aims to further strengthen and expand its role as the national marine "hub", serving the scientific and societal needs of the Netherlands in this broad context.

In order to further enhance interdepartmental and external cooperation and overall external visibility, a set of NIOZ virtual centres of interdisciplinary expertise from all departments with specific focal (societal) points were established over the past years, such as the NIOZ Deep Sea Science and Technology, Wadden Systems, and Seaweed Research Centres. In 2018, these were complemented with a NIOZ Sea Level Centre, a NIOZ Coastal Ecosystem Restoration Centre and a NIOZ North Sea Centre. These centres also involve links with many external national partners like Delft University of Technology, Utrecht University, Groningen University and the Royal Netherlands Meteorological Institute KNMI, as well as national institutes for applied sciences with a marine or maritime signature, industry, policymakers and NGOs.

The year 2018 marks an important transition in the history of the institute. In January 2018, the institute formally merged with the NWO Institutes Organisation (NWO-I), in which the eight other institutes of NWO reside. NWO also launched its new strategy, *Connecting Science and Society,* which fits in well with the mission and vision of NIOZ 2.0.

As part of building our new organisation we have successfully attracted and mentored new scientific talent. The positive trend of 2017 was continued in 2018 as we celebrated the successes of many of our new PIs receiving important personal and other large project grants. These included **Prof Tjisse van der Heijde** (VIDI, and Waddenfonds), **Dr Femke de Jong** (VIDI), **Dr Rob Middag** (VIDI), **Dr Lorenz Meire** (VENI) and **Dr Tamara Lok** (VENI). In addition, **Dr Katja Philippart** (COS department) and **Dr Karline Soetaert** (EDS department) were appointed honorary professors at Utrecht University. Other senior PIs, **Prof Klaas Timmermans** and **Prof Tjeerd Bouma** (both EDS department), were appointed special chairs HZ University of Applied Sciences in Zeeland. Bouma has also transferred his academic position from the University of Groningen to Utrecht University. Our senior PI **Dr Linda Amaral Zettler** (MMB department) was appointed an honorary professor at the University of Amsterdam. Many NIOZ PIs were honoured on the international podium, among which **Prof Stefan Schouten** (MMB department) who received the prestigious Alfred Treib medal for his outstanding achievements from the Geochemical Society. Also, our academic output remained at very high levels, with many **(252)** peer-reviewed papers appearing in high-impact journals, and increasingly **(70%)** in *open access* literature.

NIOZ communication and outreach was again instrumental in 2018. Important events included – after the launch mid December 2017 – the major national ocean going expedition '*Netherlands Initiative Changing Oceans*' or **NICO** in the first half of 2018. Together with NWO, we prompted the organisation of a truly national set of ocean expeditions along a route to and from the Netherlands Caribbean to put the spotlight on the importance of ocean research and the need for accompanying modern facilities and ships. Activities and early results of NICO were well covered by all media platforms, and very well received by Dutch government ministries and the general public. More importantly, NICO successfully brought together young and more senior scientists from virtually all national universities, applied research institutions and industry. It was also a key element in our quest for the required research fleet renewal (see www.nico-expedition.nl).

Of the many events organised by NIOZ in 2018, the **Noordzeedagen 2018** should be highlighted. Managed by NIOZ North Sea coordinator **Herman Hummel** (EDS dept), the two-day event, which attracted some 200 experts from a wide variety of national North Sea stakeholders, brought important new insights and new thinking together. Major infrastructural developments in 2018 included the long-awaited start of the dike elevation project to protect NIOZ TX, the acquisition of the grounds of NIOZ YE, and the instalment of large-scale outdoor, experimental basins at NIOZ YE.

Crucially, early in 2018 together with NWO, we appointed the dedicated **Taskforce Research Fleet Renewal**, with **Wouter Kruijt** as project coordinator. The taskforce has made tremendous progress, including arranging a nationwide survey of the needs and wishes of the marine and maritime communities. While this annual report rolls off the press, we are close to the key decisions that could allow the new ships to be operational by the end of 2022.

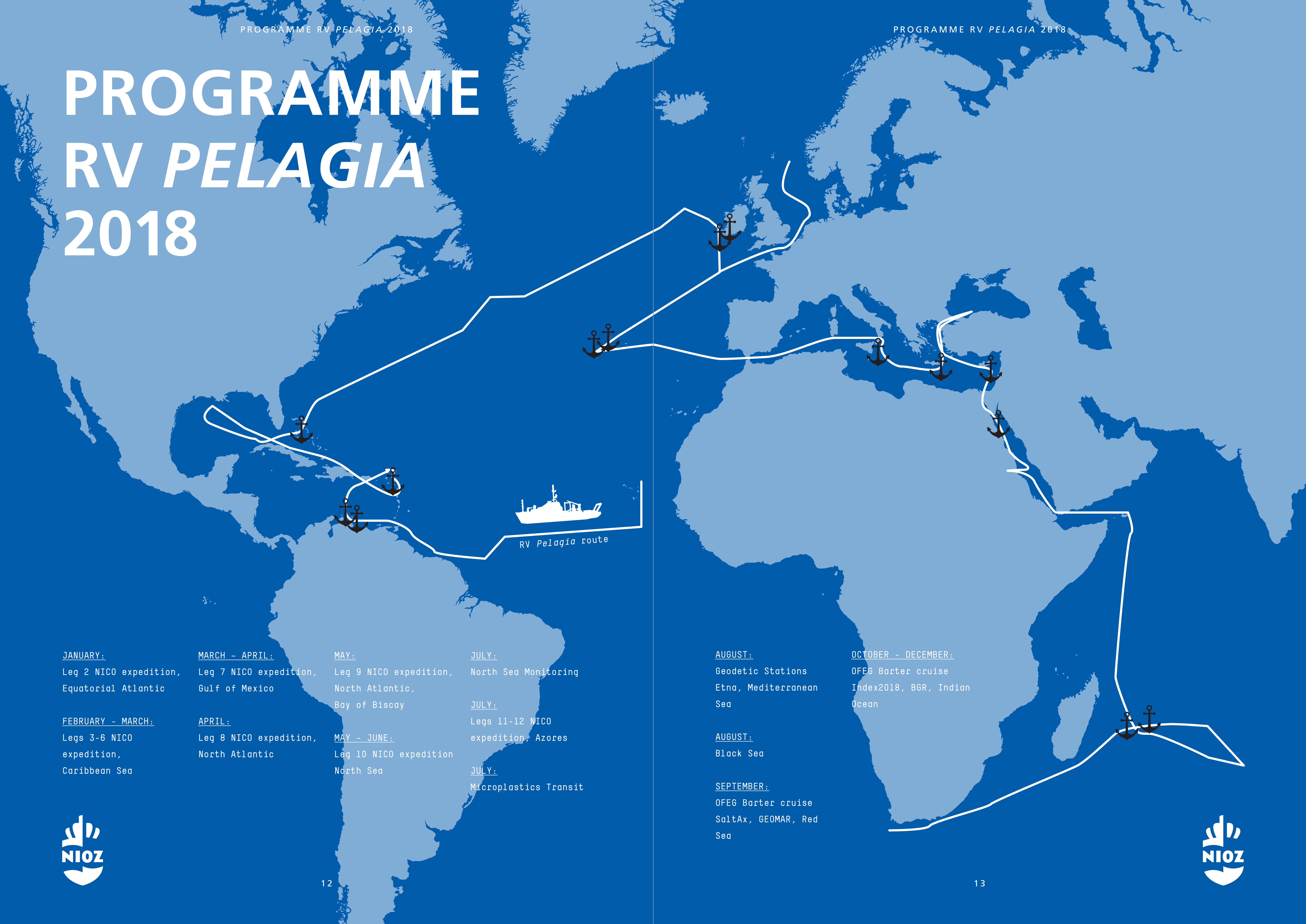
HENK BRINKHUIS, DIRECTOR

Internationally, in addition to our nearby EU partner institutes, NIOZ was active within the **European Marine Board**, and within the **Partnership for the Observation of the Global Ocean** (POGO). Furthermore, long-standing cooperation with our Japanese colleagues from **JAMSTEC** was manifested in a new MoU, adding them to the long list of NIOZ's international partner institutes.

The highlights mentioned above are just a small selection of all the activities and achievements of the institute in 2018. May they all lead to new horizons, and new avenues for our innovative research and a better understanding of our planet. I am proud of, and thankful for the dedication and relentless drive of all of NIOZ. We now operate from within the new NWO organisation with continued support from Utrecht University. Following the very positive outcome of the NIOZ international peer review in early 2018, NIOZ is well positioned to successfully find those new horizons during the *Decade of the Oceans 2020-2030* in terms of *Our Ocean, Our Coast, Our Future*. **Watch this space.**

Henk Brinkhuis, Director

PROGRAMME RV *PELAGIA* 2018



JANUARY:
Leg 2 NICO expedition, Equatorial Atlantic

FEBRUARY - MARCH:
Legs 3-6 NICO expedition, Caribbean Sea

MARCH - APRIL:
Leg 7 NICO expedition, Gulf of Mexico

APRIL:
Leg 8 NICO expedition, North Atlantic

MAY:
Leg 9 NICO expedition, North Atlantic, Bay of Biscay

MAY - JUNE:
Leg 10 NICO expedition North Sea

JULY:
North Sea Monitoring

JULY:
Legs 11-12 NICO expedition, Azores

JULY:
Microplastics Transit

PROGRAMME RV *PELAGIA* 2018

AUGUST:
Geodetic Stations Etna, Mediterranean Sea

AUGUST:
Black Sea

SEPTEMBER:
OFEG Barter cruise SaltAx, GEOMAR, Red Sea

OCTOBER - DECEMBER:
OFEG Barter cruise Index2018, BGR, Indian Ocean

NICO EXPEDITION

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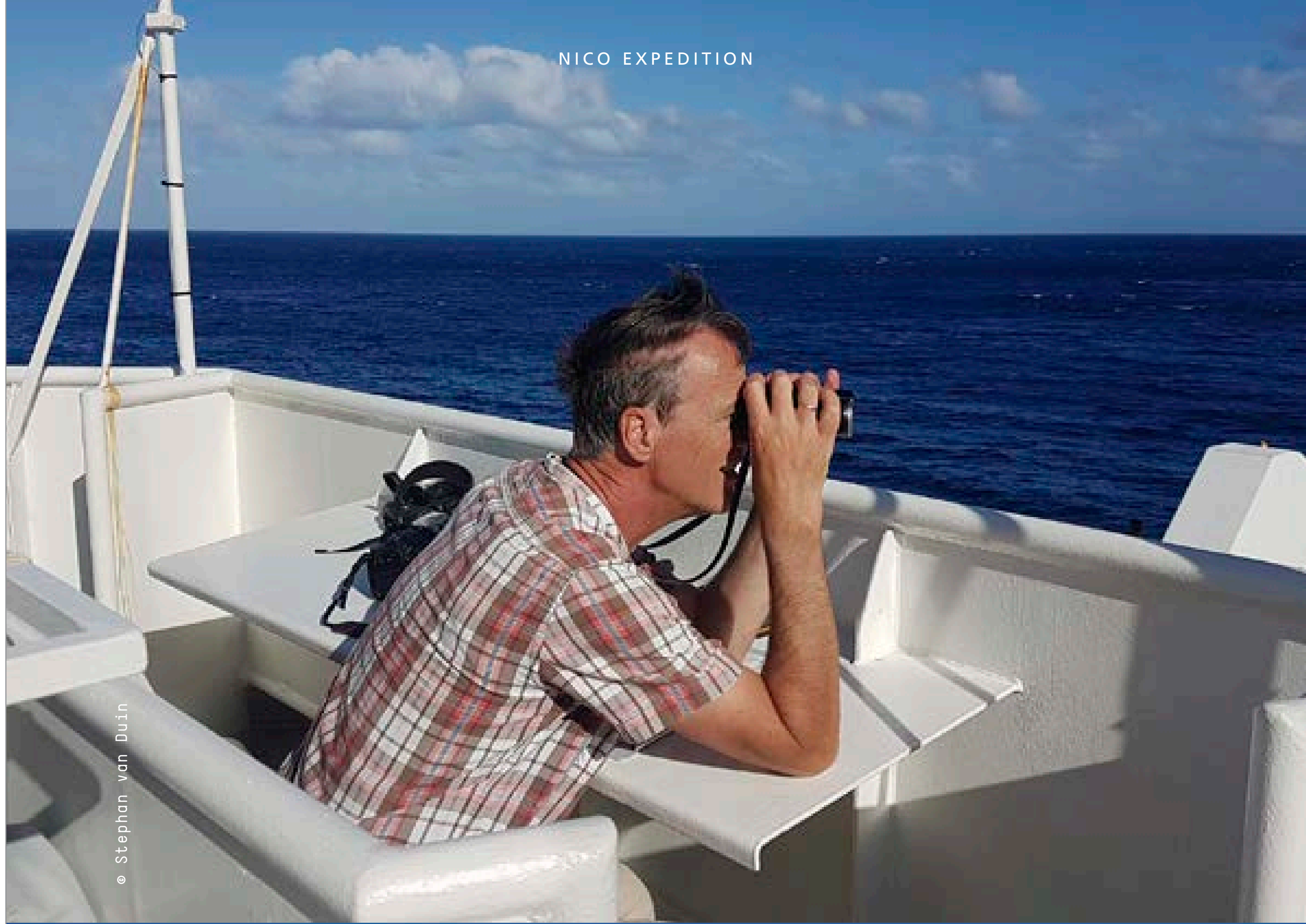
NICO EXPEDITION:
EXPLORING OUR CHANGING OCEANS

How are the world's seas and oceans changing? And how can we adequately respond to the threats and opportunities these changes bring? In the Dutch multidisciplinary expedition Netherlands Initiative Changing Oceans (acronym NICO) researchers from more than 20 organisations gathered knowledge to better equip the Netherlands for its response. Besides investigating important questions for science and society, the NICO expedition aimed to strengthen the Dutch marine science community, and to inform policymakers, industry and the general public about our changing oceans.

NICO EXPEDITION



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NICO EXPEDITION

The idea for the expedition was hatched mid-2017 when NIOZ and NWO made the research vessel the *Pelagia* available "free of charge" to the Dutch public and private sectors with an open invitation: share your ideas with us. This invitation resulted in an expedition plan that accommodated 40 different research proposals. Researchers only had to organise the funding of their research. NIOZ and NWO took care of the logistics. Besides 156 researchers from a wide range of disciplines, 22 master's students joined the expedition and gained invaluable experience. Journalists, writers, film producers, photographers and an ocean composer also came on board. This led to 186 media productions about the expedition that brought ocean research to the attention of both the general public and policymakers.

THE 12 LEGS

The voyage along five Atlantic and Caribbean ocean provinces was divided into 12 legs, and each leg had its own research themes. These ranged from seafloor samples for climate research to viruses, from coral reefs to whales, and from underwater noise caused by shipping to deep-sea mining and the testing of new maritime technology.

LEG 1: TEXEL – LAS PALMAS

13 to 27 December 2017

On board were researchers from Utrecht University, VU Amsterdam and NIOZ.
Leg 1 was the start of an overarching Trans-Atlantic research programme into different sea organisms and changing ocean conditions. Measurements of the ^{13}C-^{18}O isotope ratio in the sediment cores taken from the Atlantic seafloor will be used for prehistoric climate reconstructions that will contribute to better predictions of our future climate.

LEG 2: LAS PALMAS – WILLEMSTAD

28 December 2017 to 24 January 2018

On board were researchers from the University of Amsterdam, Utrecht University, VU Amsterdam, Naturalis Biodiversity Center and NIOZ.
The second and longest leg of the expedition yielded insights into the consequences of global warming, acidification and falling oxygen levels in the oceans. Water from the deepest part of the ocean was pulled up to find fungi that could be useful in the production of antibiotics. Biologists also studied megafauna by counting birds, fish and mammals. Where possible, e-DNA samples were taken during the fauna observations to see whether any correlations between the two could be found. In future, e-DNA from water samples may make it possible to detect which species are present at certain locations. Finally, and most unexpectedly, a new extinct volcano was discovered. Its sediment-filled crater stores 500,000 years of climate history.

LEG 3: THE CARIBBEAN REGION – LESSER ANTILLES

25 January to 2 February 2018

On board were researchers from the University of Amsterdam, Wageningen Marine Research, Delft University of Technology and NIOZ.
The underwater landscape in the region was mapped, and deep-water reefs, groundwater seepage and deep cyanobacterial mats were investigated. Water column profiles revealed that at 50 metres deep, a drop in temperature, increased salinity and more chlorophyll occur. Possibly, cyanobacterial mats grow at this intermediate level because it provides them with slightly more nutrients. The team also reported that, unlike cyanobacteria in shallow water, these deep-water cyanobacteria cannot fix nitrogen and are not toxic for other organisms like shrimps.

LEG 4: THE CARIBBEAN REGION – SABA BANK

4 to 11 February 2018

On board were researchers from Wageningen Marine Research, Delft University of Technology, Utrecht University and NIOZ. An eddy in the deep sea between Aruba and Sint Maarten was the focus of this leg. The researchers were surprised to encounter calm waters consisting of thin layers with different temperatures and salinities under the eddy. Another noteworthy find was the lifespan of the eddy, which was far shorter than current models predict. The data collected will be used to improve the accuracy of eddy models.

LEG 5: SINT MAARTEN – SINT MAARTEN

13 to 25 February 2018

On board were researchers from Naturalis Biodiversity Center, Wageningen Marine Research and NIOZ. This leg revealed clear differences between the reefs and other fauna, currents, turbulence and the concentrations of particles at Saba Bank's northern and southern slopes. On the northern side, a lot of nutrients are disappearing from the bank, while the southern currents were found to be important supply routes of nutrients for the corals. The data collected will help researchers understand how the Saba Bank reefs regenerate and, therefore, how the deteriorating health of other reefs could be improved.

LEG 6: SINT MAARTEN – SINT MAARTEN

26 February to 10 March 2018

On board were researchers from Wageningen Marine Research and NIOZ. With 2500 square kilometres, the Saba Bank is the largest submerged atoll in the Caribbean region and the biggest nature reserve in the Kingdom of the Netherlands. Its biological, chemical and hydrodynamical aspects are mostly still uncharted territory. Now, various seafloor communities on the bank have been mapped. On parts of the bank, very healthy coral reefs were discovered that appear to have escaped all negative consequences of climate change. The reef's apparent ability to survive rising sea levels as well as unusual seafloor depositions also merit further research.

LEG 7: SINT MAARTEN – NASSAU

12 March to 4 April 2018

On board were researchers from Utrecht University and NIOZ. The impact of the Mississippi and Atchafalaya rivers on the ocean carbon cycle, zero oxygen zones in the Gulf of Mexico and the production and breakdown of greenhouse gases was studied. Minimum oxygen conditions were found near the mouth of the Mississippi, but the consequences of this are not yet clear. Answers may be obtained from the data provided by sediment traps left behind to study the lack of oxygen and algae growth in the spring and summer.

LEG 8: NASSAU – GALWAY

6 April to 28 April 2018

On board were researchers from the University of Groningen, University of Amsterdam, Utrecht University, Naturalis Biodiversity Center and NIOZ. Research into the ecological consequences of changing Atlantic Ocean conditions yielded observations on the influence of dimethyl sulphide levels in the ocean on rain cloud formation as well as the sensitivity of sea snails to seawater acidity levels. The researchers also discovered that algal mortality caused by viral infections is comparable in size to that caused by grazing. This is an important discovery because algae form the base of the food chain.

LEG 9: GALWAY – TEXEL

30 April to 22 May 2018

On board were researchers from the Westerdijk Fungal Biodiversity Institute, Aarhus University in Denmark and NIOZ. During this voyage, the sensitivity of cold-water coral reefs growing on the Rockall Bank and nutrient flows in the deep water of the Whittard Canyon were studied. The canyon was found to contain more food and life than the slopes next to it. In the deposited materials, the scientists also discovered evidence of the effects of Hurricane Ophelia in 2017.

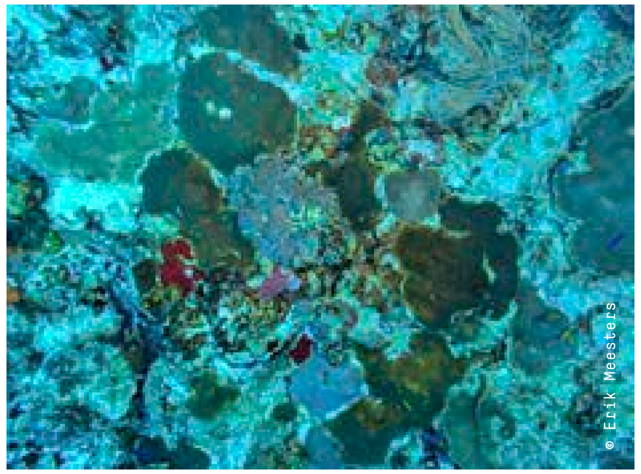
LEG 1: Texel - Las Palmas

LEG 2: Las Palmas - Willemstad

LEG 3: The Caribbean Region - Lesser Antilles

LEG 4: The Caribbean Region - Saba Bank

LEG 5: Sint Maarten - Sint Maarten



LEG 6: Sint Maarten - Sint Maarten

LEG 7: Sint Maarten – Nassau

LEG 8: Nassau – Galway

LEG 9: Galway – Texel

LEG 10: Texel – Amsterdam

LEG 11: Texel – Horta

LEG 12: Horta – Terceira

LEG 10: TEXEL – AMSTERDAM

24 May to 6 June 2018

On board were researchers from Naturalis Biodiversity Center, the Westerdijk Fungal Biodiversity Institute and NIOZ. This leg took stock of the biodiversity of the North Sea. Polyps from a known jellyfish species in the North Sea were found for the first time. Population data was also collected on the ocean quahog for comparison with similar data collected 20 years ago. This will allow researchers to estimate mortality rates for this threatened mollusc species and compare these to figures for the same species in the southern North Sea.

LEG 11: TEXEL – HORTA

3 July to 17 July 2018

On board were researchers from MARIN, Leiden University and NIOZ. Scientists investigated the underwater noise caused by ships and how this affects marine animals. They gathered a lot of data about noise produced by the ship's propeller and engine, and studied how the character of the ship's noise related to its manoeuvres and approach angles. This data will be used to analyse and mitigate behavioural disturbance of fish and marine mammals and also to make future ships quieter.

LEG 12: HORTA – TERCEIRA

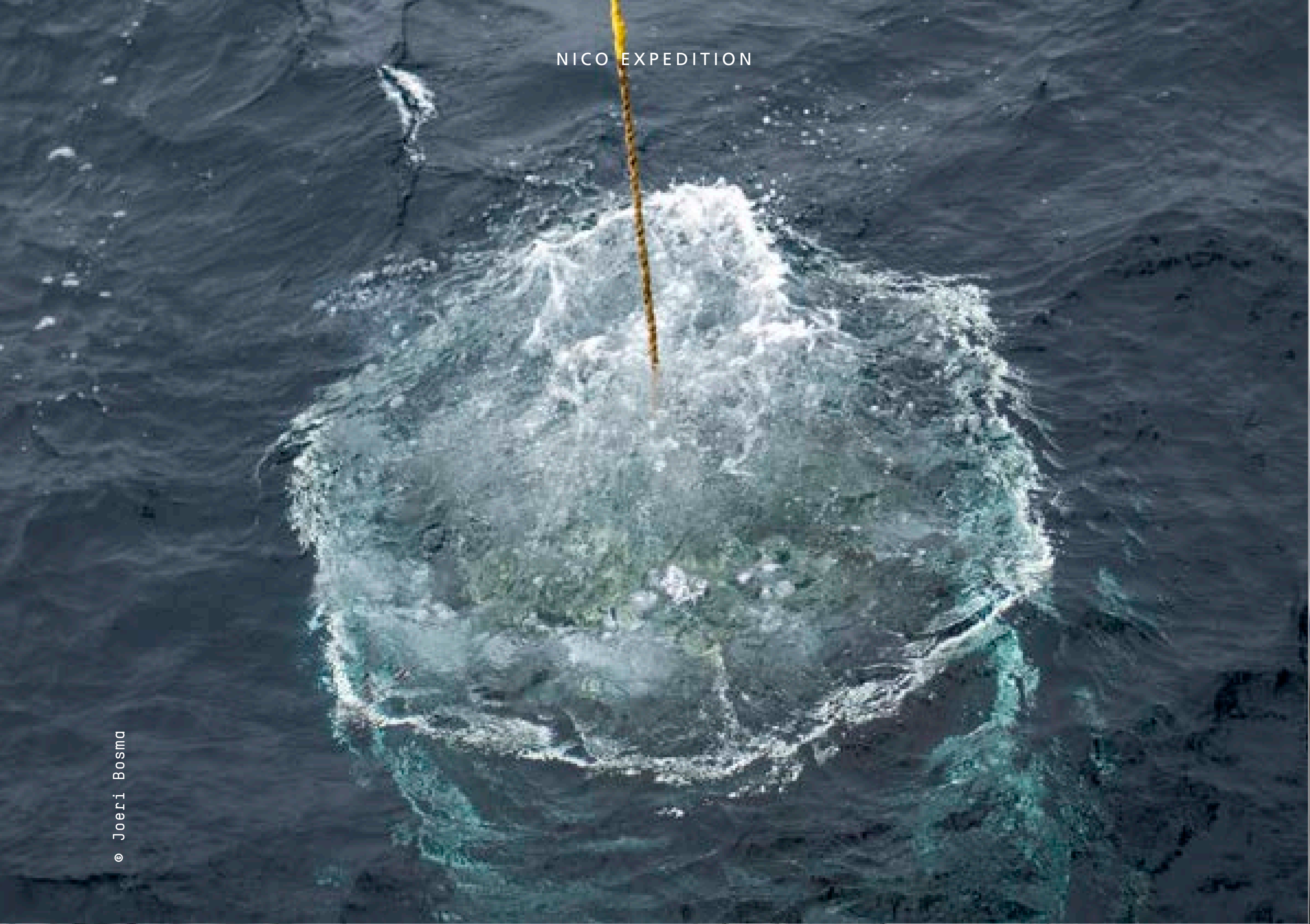
17 July to 28 July 2018

On board were researchers from Leiden University, University of Amsterdam, TNO and NIOZ. The final research leg focused on hydrothermal sources and the food of whales. Acoustic measurements around hydrothermal sources revealed that these produce noise that deep-sea animals may use to navigate. Technicians managed to adapt military sonobuoys for whale research, which made recordings of an echolocating sperm whale possible. This leg also generated data for research into microplastics which were discovered in the mid-Atlantic Ocean on its surface and at a depth of 100 metres.

THRIVING DUTCH OCEAN RESEARCH COMMUNITY

NIOZ director Henk Brinkhuis summarised the importance of the expedition as follows: 'The NICO expedition plays an important role in firmly putting ocean research back on the Dutch national agenda. An important spin-off of the expedition is the NICO community that has arisen from the multidisciplinary cooperation. People from different organisations now know each other. The community can serve as a bottom-up platform for national collaboration. Furthermore, it is a point of contact for the ministries and the top sectors involved with marine and maritime science.'

Please visit www.nico-expedition.nl for more details, pictures and background information



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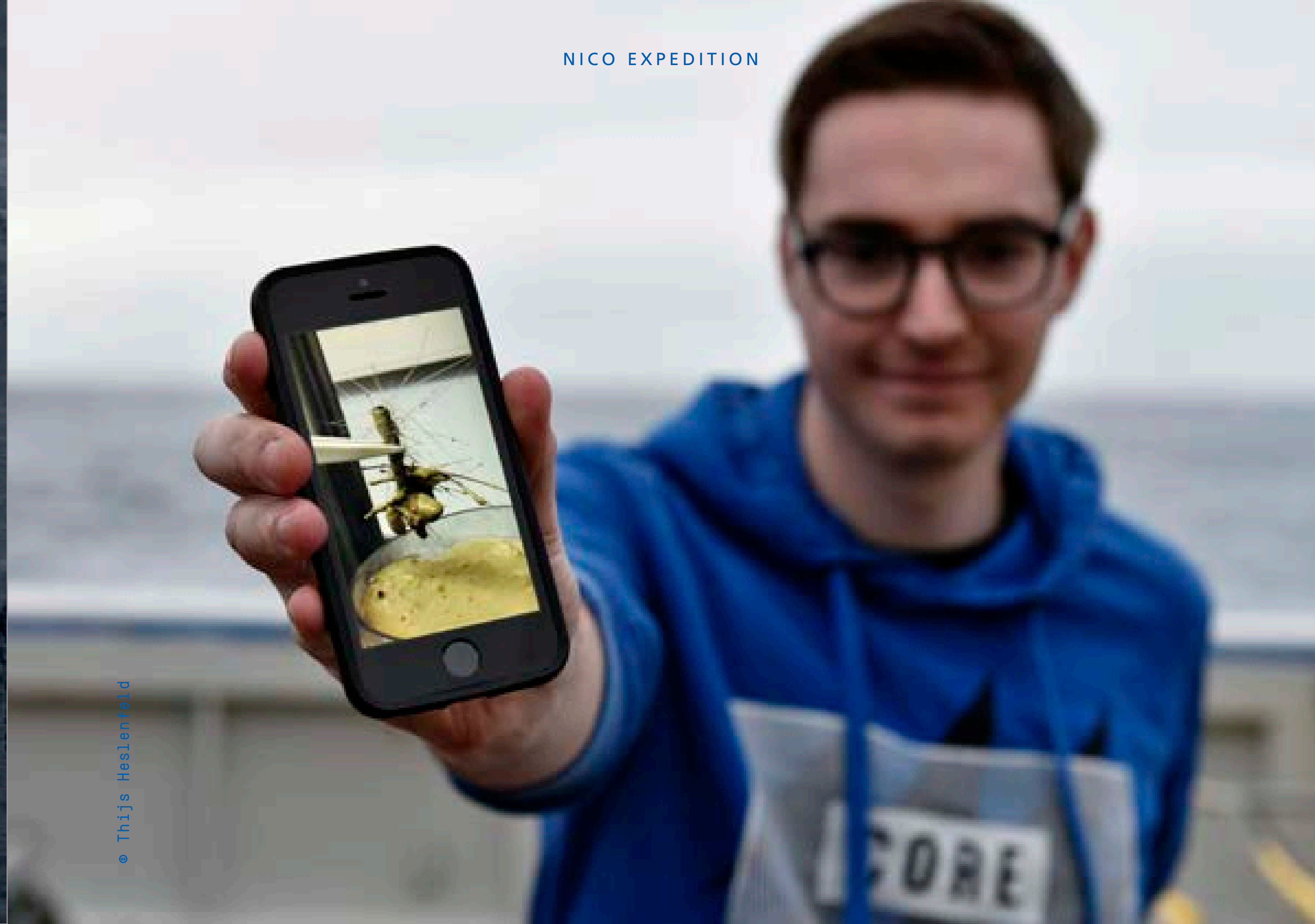

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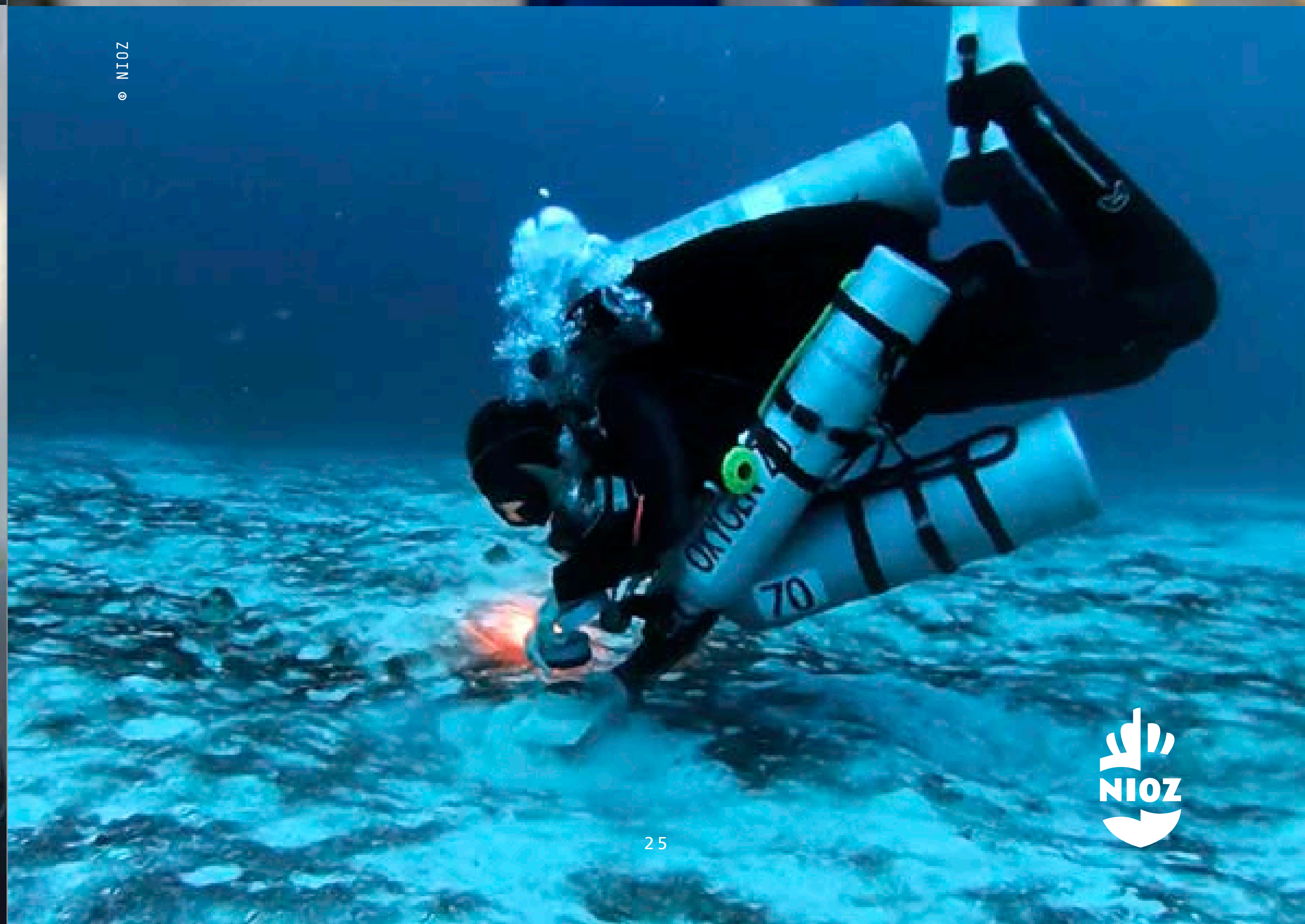

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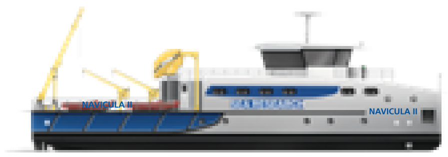
RENEWAL OF THE DUTCH NATIONAL MARINE RESEARCH FACILITIES

As the national oceanographic institute, the Royal Netherlands Institute for Sea Research (NIOZ) manages and exploits the national research vessels and equipment that support the Dutch marine and maritime research community via the National Marine research Facilities (NMF).

REPLACEMENT PELAGIA

REPLACEMENT NAVICULA



The vessels of NIOZ-NMF, the research vessels *Pelagia* and *Navicula*, urgently need replacing because both ships are far beyond their economic and technical lifespan. In November 2017, the NWO executive board made a budget available to NIOZ for realising a programme of requirements and a funding and exploitation model for the necessary fleet replacement. The preparation process has a duration of about two years. For the replacement of the RV *Navicula* (the smaller shallow water ship, 24 metres) the aim is to start the tendering process in mid-2019 and to have completed the construction of the ship by the start of 2021. For the RV *Pelagia* (the larger oceangoing ship, 66 metres) the plan is to start the tendering at the end of 2019 and to complete the construction during the first half of 2022.

PROGRESS IN 2018

Preparations for the Fleet Renewal proceeded according to plan in 2018.

- The NWO-NIOZ Taskforce Fleet Replacement did a nationwide survey of the needs and wishes of the marine and maritime communities. In addition, events were organised for both communities to exchange views on the requirements of the future research vessels.

- The NWO-NIOZ Taskforce further prepared the technical aspects of the tendering process, including the strong desire to make the ships more sustainable (zero emission in 2030). In March 2018, the NWO executive board approved the approach to make the ships not just available for the main marine users but also as a “living lab” for the maritime industry.

- Both investment plans were submitted to the executive board in June 2018, approval was given to initiate the design phase.

- Replacement RV *Pelagia:*
  At the start of July 2018, design agency CJob from Hoofddorp started designing the replacement for the *Pelagia*. This process will take until June 2019. It started with a definition phase in which the users from NIOZ as well as universities and institutes could provide input until October 2018. Based on this input, CJob will produce a global design of the ship and will subsequently elaborate the details. MARIN will be involved in this so that all knowledge present in the Netherlands will be deployed to realise an optimum ship that from the start will function primarily as a platform for marine research with a subsidiary role for maritime research too. The new ship will be about 75 metres long and will be able to accommodate a maximum of 49 people.

- Replacement RV *Navicula:*
  At the start of July 2018, design agency Conoship started with the design and this process will take until April 2019. The first step was also a definition phase in which the users could give input. As the *Navicula* has complex requirements (especially for the shallow draught, no similar ship has been developed in Europe) four hull concepts were defined. The final hull shape has now been chosen (longer aluminium monohull, ca 36 x 9 x 1 metre) and in collaboration with MARIN it will be elaborated in detail and calculated.

NIOZ director Henk Brinkhuis: ‘While this annual report rolls off the press, we are close to the key decisions that could allow the new ships to be operational by the end of 2022.’

SOCIETAL CHALLENGES

Which Dutch, European and global research and innovation policy programmes require modern Dutch research vessels?

DUTCH RESEARCH AND INNOVATION PROGRAMMES:
The Interdepartmental policy brief 'Oceanennotitie', Dutch Research and Innovation programmes of the ministries (Economic Affairs and Climate Policy, Infrastructure and Water Management, Foreign Affairs, Defence, Agriculture Nature and Food Quality, Education, Culture and Science), of the Topsectors (Water & Maritime, Energy, Agro & Food, Chemistry, HTSM, Logistics), of the Dutch National Research Agenda (Blue Route, Energy Transition, Sustainable Production of Safe and Healthy Food, Living Past, Origin of Life), and of the Dutch National Roadmap Large-Scale Scientific Infrastructure.

EUROPEAN RESEARCH AND INNOVATION PROGRAMMES:
Blue Growth (EU strategy for sustainable growth in the marine and maritime sector)
Grand Societal Challenges (policy priorities of the programmes Horizon 2020 and Horizon Europe).

GLOBAL RESEARCH AND INNOVATION PROGRAMMES:
The Paris Agreement (2015)
The Sustainable Development Goals (SDG's: 14 and 1, 2, 7, 8, 11, 13, 16).

USER NETWORKS RESEARCH VESSELS

MARINE SCIENCE:
Utrecht University, University of Groningen, University of Amsterdam, VU Amsterdam, Leiden University, Radboud University, Delft University of Technology, University of Twente, NWO-I DIFFER, NWO-I NIKHEF en NWO-I NSCR, Wageningen University and Research, Wageningen Marine Research, Naturalis Biodiversity Center, Westerdijk Fungal Biodiversity Institute, NWO-I NIOZ, TNO, KNMI, Deltares.

MARITIME RESEARCH AND INNOVATION:
Delft University of Technology, MARIN, TNO, Deltares, NLDA, Damen, Acta Marine, Bakker Sliedrecht, RH Marine, Allseas Engineering, Van Oord, Royal Boskalis Westminster, Royal IHC, Seatools, Bluewater Energy, Deme/Tideway, Shell, Marine Sampling Holland, Topsector Water & Maritime, Maritime Center of Expertise, Maritime Campus Netherlands, Defense Materials Organisation, Dutch Royal Navy, Ministry of Infrastructure and Water Management, Netherlands Maritime Country (NML).

INTERNATIONAL MARINE RESEARCH FACILITIES:
Ocean Facilities Exchange Group (OFEG), European Research Vessels Operators (ERVO), Eurofleets, International Research Ship Operators (IRSO), University-National Oceanographic Laboratory System (UNOLS), Research Vessel Operators Committee (RVOC).

INTERNATIONAL DATA NETWORKS:
European Marine Observation and Data Network (Emodnet), British Oceanographic Data Centre (BODC), International Oceanographic Data and Information Exchange Committee (IOC/IODE), Group on Earth Observations System of Systems (GEOSS), SeaDataNet/SeaDataCloud (SDN/SDC), Global Biodiversity Information Facility (GBIF), National Oceanographic Data Committee (NODC), SCAR Standing Committee on Antarctic Data Management (SCADM), IASC/SAON Arctic Data Committee (ADC).

CHALLENGES AND OPPORTUNITIES OF THE OCEANS

RESEARCH & INNOVATION

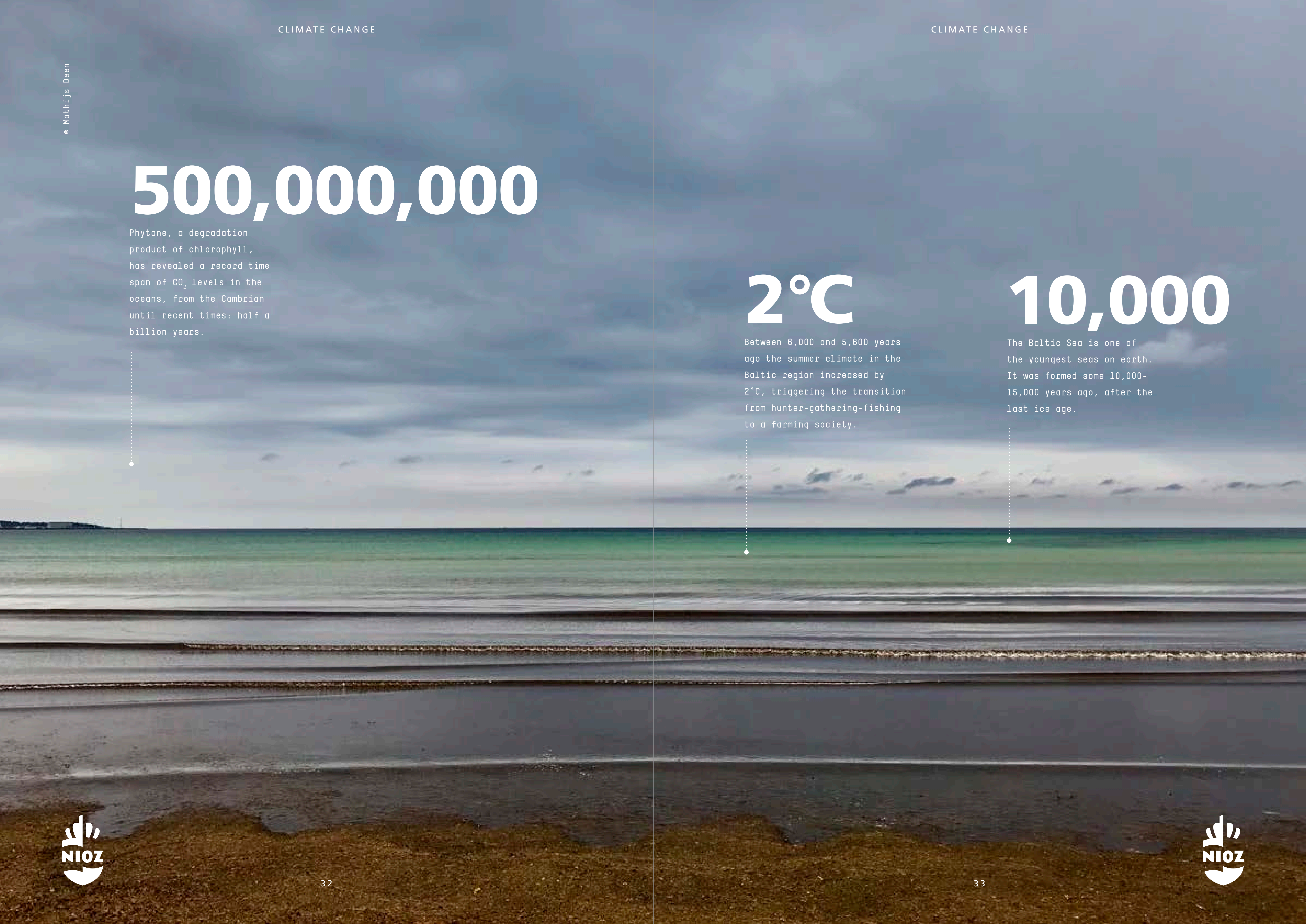
THE RESEARCH VESSELS URGENTLY NEED REPLACING

ON WORLD OCEANS DAY 2018, members of the Dutch maritime community visited RV *Pelagia* on Oranjewerf Damen Shiprepair, for a tour and to discuss their requirements for a new ship with 'living lab' functions.

RV *PELAGIA*, built in 1991, is beyond its economic and technical lifespan, maintenance costs are rising and it no longer meets all demands of today's users.

HIGHLIGHTED

CLIMATE CHANGE



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500,000,000

Phytane, a degradation product of chlorophyll, has revealed a record time span of CO_2 levels in the oceans, from the Cambrian until recent times: half a billion years.

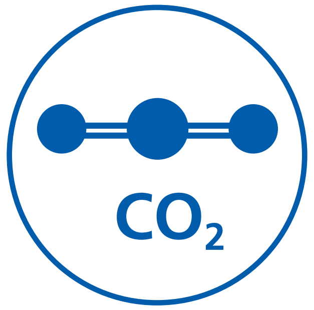
2°C

Between 6,000 and 5,600 years ago the summer climate in the Baltic region increased by 2°C, triggering the transition from hunter-gathering-fishing to a farming society.

10,000

The Baltic Sea is one of the youngest seas on earth. It was formed some 10,000-15,000 years ago, after the last ice age.

BACK TO THE FUTURE OF CLIMATE CHANGE



CO_2 is front-page news and understanding the impact of CO_2 emissions on the future of our climate is one of the most urgent challenges we face. Fortunately, researchers can explore the Earth's geological archive to discover the relationship between CO_2 concentrations and the climate in the past. A newly discovered, 500-million-years-old CO_2 record can now help climatologists produce more accurate models of how our climate will change.

Gas trapped in ice cores provides a direct measurement of past CO_2 levels. However, that record only goes back one million years. For longer time series of CO_2 levels, indirect measurements are made using other substances (proxies). Researchers from NIOZ and Utrecht University developed and validated a measurement technique using a new proxy: phytane, a degradation product of chlorophyll. Using the new proxy, the scientists made the longest continuous record of ancient CO_2 levels ever, covering 500 million years. 'This new data is invaluable for modellers who can now make more accurate predictions of the future', says Caitlyn Witkowski, who gained her PhD based on this research in 2018. The ancient record reveals that rises in CO_2 levels which took millions of years in the past, now occur in a century.

SWISS LAKES PROVIDE NEW PALEOCLIMATE KEY

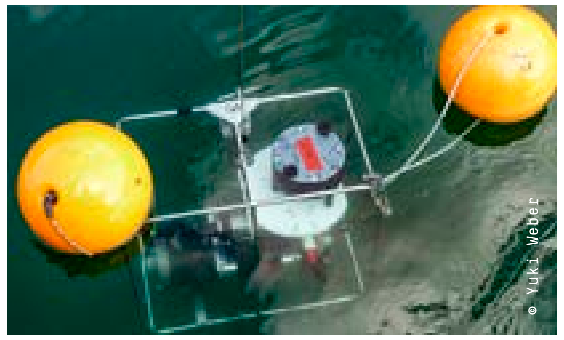
Terrestrial paleoclimatic records have a shorter timespan than their marine counterparts, as sediment formation is disrupted by erosion, bioirrigation and mountain formation. Undisturbed sediments that reveal the paleoclimate over a longer period are therefore typically found on the floor of deep lakes, like Lake Lugano in Switzerland. This model lake provided Helge Niemann and his team of scientists from NIOZ and the University of Basel with a wealth of accurate information about the geochemical environments to which specific microbes (most probably acidobacteria) have adapted. These microbes produce lipid compounds that can be used as molecular fossils to reconstruct atmospheric temperature from lake sediments.
The research revealed that the fossil lipids used to reconstruct the climate were formed deep in the lake where there was little oxygen. There, the microbes took up the greenhouse gas methane, which left an isotope signature in the lake floor sediment. The researchers measured that signature to determine the level of methane and thus derive the atmospheric temperature. These findings were validated by measurements from 35 other alpine lakes. As the structure of these lipids remains stable, fossil lipid molecules in the sediments of such lakes worldwide are a reliable proxy for helping to reconstruct the continental paleoclimate.
This is not the first temperature proxy developed by NIOZ. In 2002, the institute's researchers developed the TEX_{86} index, a proxy based on cell membrane lipids from archaea (the sister group of bacteria). This index is now widely used in climate research for IPCC assessments.

CLIMATE CHANGE TRIGGERED SWITCH FROM HUNTER-GATHERING TO FARMING

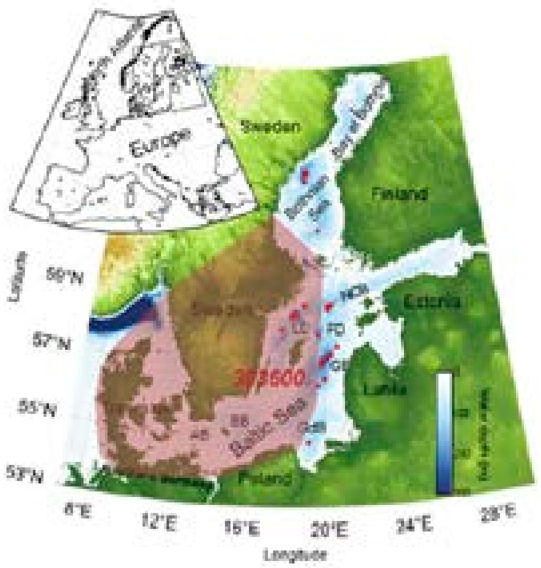
Temperature proxies are not only useful for climatologists. NIOZ researchers also took part in an international, multidisciplinary study into climate change in the Holocene (past 12,000 years) in the Baltic Rim. The study reconstructed the temperature using the TEX_{86} proxy. This revealed a distinctly warmer period in the Baltic Rim between 5900 and 4400 years ago.

Archaeologists already knew that a sharp population increase occurred during that period, together with a switch from hunting-gathering to farming as agrarian groups moved up from the South. Now they know the trigger for this too: a warmer climate. But that was not all. Biogeochemist Professor Jaap Sinninghe Damsté from NIOZ and German geologist Matthias Moros from the Leibniz Institute for Baltic Sea Research analysed the sediment structure and discovered a change in oxygen conditions on the sea floor triggered by the temperature rise. This change would have reduced the fish stocks, also contributing to the switch from hunter-gathering-fishing to farming in the Baltic Rim.

BACTERIA and other particles from Lake Lugano were collected on a glass fibre filter.



HUNDREDS OF LITERS WATER from Lake Lugano were filtered, using an *in situ* pump at maximum depths of 275 meters.

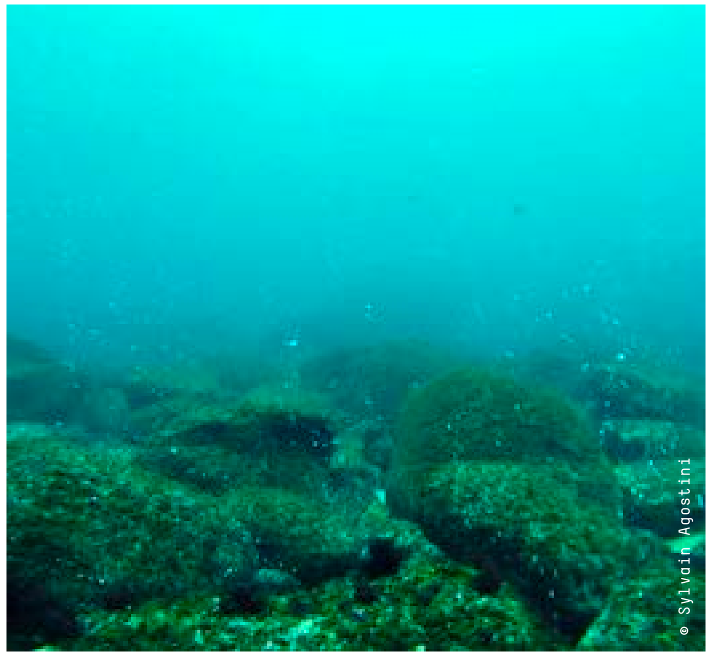


SEDIMENT CORING STATIONS and archaeological sites in the Baltic Sea region.

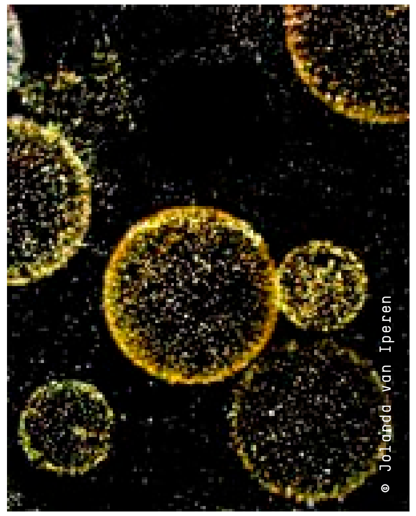
COLLECTING SEAWATER FILTERS, plankton net filters, and sediment samples at Shikine Island, Japan.

ARCHIVE OF THE WORLD in a sediment core: each layer represents a different period in the past.

CULTIVATION of algae.



CO_2 BUBBLING from the bottom of the ocean. The gas is formed during tectonic activity and is vital for the growth of algae. CO_2 concentrations have varied over millions of years and we can now track these changes by using molecular fossils made by algae throughout time.



PHAEOCYTIS GLOBOSA ALGAE
All algae make the pigment chlorophyll to harness the sun's energy. Phytane, a degradation product of this pigment preserved in rock, sediment and oil, can now be used to reconstruct CO_2 levels of the past 500 million years.

© Wim van Egmond

3.5 billion

Microbial mats are among the oldest life forms on earth. Fossil microbial mats of 3.5 billion years old have been found.

COASTAL DEFENCES

30%

Cyanobacteria are responsible for 30% of all oxygen production on earth.

1

A single grain of sand in a microbial mat can host as many as 10,000 up to 100,000 bacteria, including cyanobacteria.

COASTAL DEFENCES: PLANTS VERSUS WAVES

Rising sea levels and worsening storms are stretching coastal defences, making traditional coastal engineering approaches increasingly expensive. Researchers are therefore studying how natural engineering solutions like colonising flora, seagrass and microbial mats can help us keep pace with the tide.

Caribbean coasts are renowned for their rich biodiversity and beach tourism revenues account for 25% of the region's GDP. However, many beaches have disappeared into the sea due to erosion. Climate change is expected to exacerbate this situation by further damaging coastal ecosystems due to rising sea levels and increasingly severe storms.

Seagrass helps to prevent beach erosion in such situations. Researchers from NIOZ, Radboud University and the National Autonomous University of Mexico compared beaches along the Mexican peninsula of Yucatan and discovered that more seagrass means less erosion. PhD student Rebecca James and her supervisor Professor Tjeerd Bouma (NIOZ and Utrecht University) did a simple but convincing experiment. They used a device called a field flume to regulate the flow of water in a Caribbean Bay and watched when particles on areas of the seabed with seagrass and without seagrass started moving. 'We showed that seagrass beds were extremely effective at holding sediment in place', says James.

The tourism industry often considers seagrass a nuisance, as it spoils the appearance of beaches. 'This study could help to change that perspective', says Bas Roels of WWF Netherlands. And that would pave the way for new tropical beach protection schemes that integrate ecology in engineering solutions.

MICROBIAL ENGINEERS

Another solution to coastal erosion could be found in microbial mats. The Dutch shoreline is continuously eroded by the wind and waves from the North Sea, but the beaches at the Wadden Island of Schiermonnikoog suffer less from this problem. Minuscule algae and bacteria form dense layered structures called microbial mats that protect the beach sand against erosion. This microscopic partnership represents quite a feat of natural engineering.

During the day, cyanobacteria in these mats excrete large quantities of sugars and other nutrients that the other mat organisms use as food. The sugars left in the mat cause the sand particles to stick together. The nutrient-rich, sticky sand forms a good stable base for plants to grow. In turn, these plants trap even more sand so that less gets blown off the beaches. During the night the cyanobacteria produce organic acids, and the other organisms change their metabolism accordingly.

The cyanobacteria's biological clock therefore sets the rhythm of the entire mat and ensures an optimum interaction between all mat species. 'If we understand the interaction in these mats better, we can use them to protect our coastline', says NIOZ researcher Henk Bolhuis. 'Such a sustainable coastal defence would help save a lot of money and a new generation of tourists may value the rich plant, insect and bird life of the saltmarsh created.'

PLANTS SHAPE COASTAL LANDSCAPE

How plants colonise coastal areas plays a crucial role in the formation of coastal landscapes and contributes to climate-proof coasts. This is because a plant's physical properties, like its size and root density, influence water movements and help trap sand and silt. In 2018, researchers from NIOZ, Utrecht University and the University of Antwerp discovered that the rate at which different plant species colonise the coast is a key driver of how coastal landscapes are formed and whether or not they will be climate-change proof. Rapidly colonising plants produce homogenous vegetation patterns that consolidate the existing landscapes. Slow colonisers, however, help build a range of different, new landscapes with more and deeper channels between patchy vegetation. These channels contribute to the supply of sediment and nutrients that are essential in helping coastal landscapes face climate change.

A CROSS SECTION of a microbial mat pictured by photographer Wim van Egmond. As from 2018, he has been working (with scientists Henk Bolhuis and Michele Grego) on a film installation about the microbial life on the tidal flats that can be admired on the Island of Texel in the summer of 2019 during the S.E.A Art Tour, Science Encounters Art.

NEW SAND nourishments on Cancun beach start eroding immediately.

A PORTABLE WATER FLUME was used to measure sediment stabilisation.

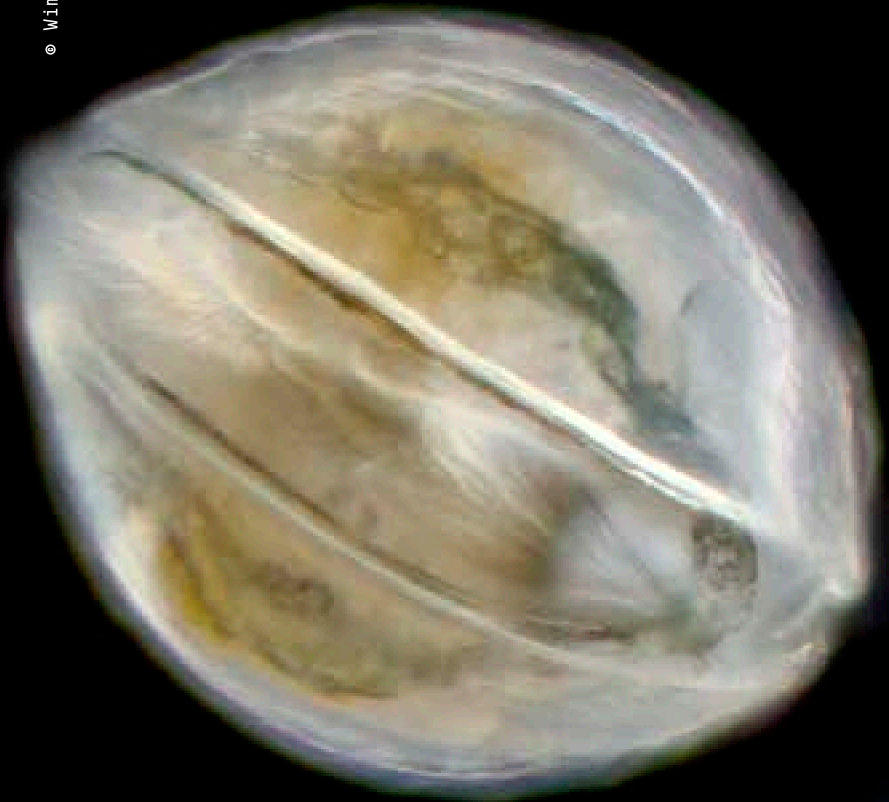
CALCYFYING HALIMEDA ALGAE produce sand which provides a natural nourishment for seagrass.

SAMPHIRE (*SALICORNIA*) is one of the first plants that can grow on a microbial mat.

DURING THE WOODS VERSUS WAVES-EXPERIMENT, willows were positioned in the large Ducth Delta Flume to put the protective power of woods to the test.

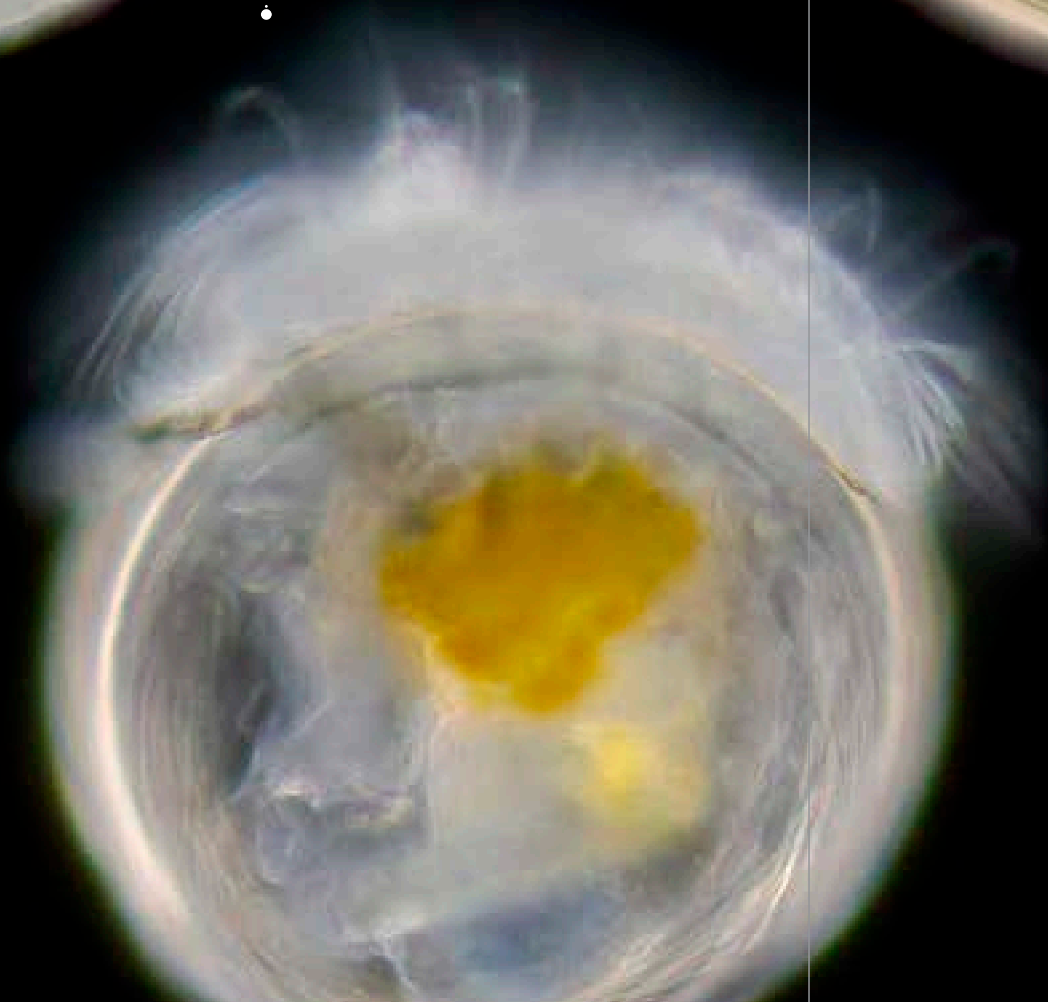
FOR THE PROJECT RESIST, NIOZ joined an international research team that conducted an experiment in the Large Wave Flume of Leibniz University Hannover and TU Braunschweig. The aim was to test the role of tidal marshes in providing protection against coastal erosion.

IN DECEMBER 2018, after four years of field work and lab work, scientists from NIOZ and the University of Antwerp presented what the new intertidal nature of the Dutch-Flemish Hedwigepolder will look like after letting in sea water. Project manager Professor Johan van de Koppel: 'The Hedwigepolder, which was reclaimed around 1900 and lies rather low at present, will silt up in the next 50-100 years to become one of the highest areas of Zeeland and can easily keep up with the sea level rise that is now expected.'



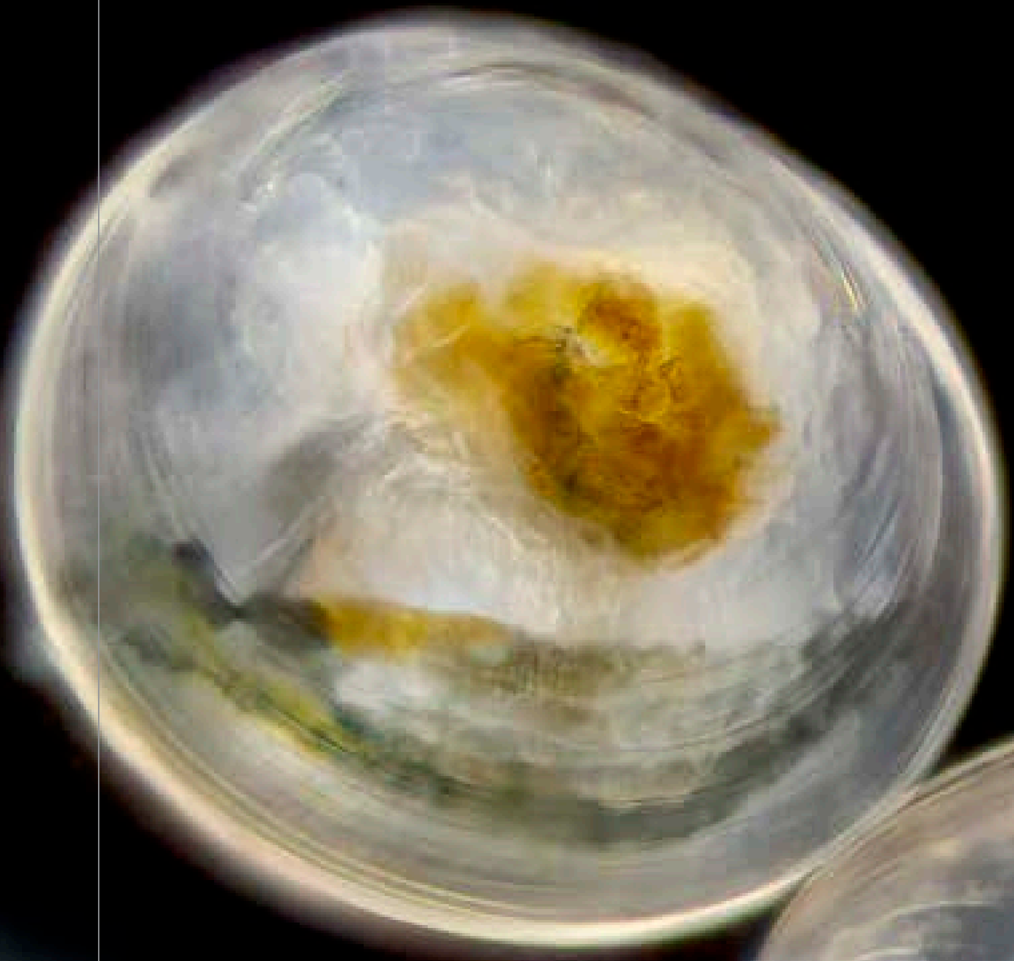
2030

From 2030 onwards, the tidal flats to the south of the Wadden Island of Vlieland could drown, and by 2050 large areas of the Dutch Wadden tidal flats could be submerged if the melting of the Antarctic ice cap accelerates.



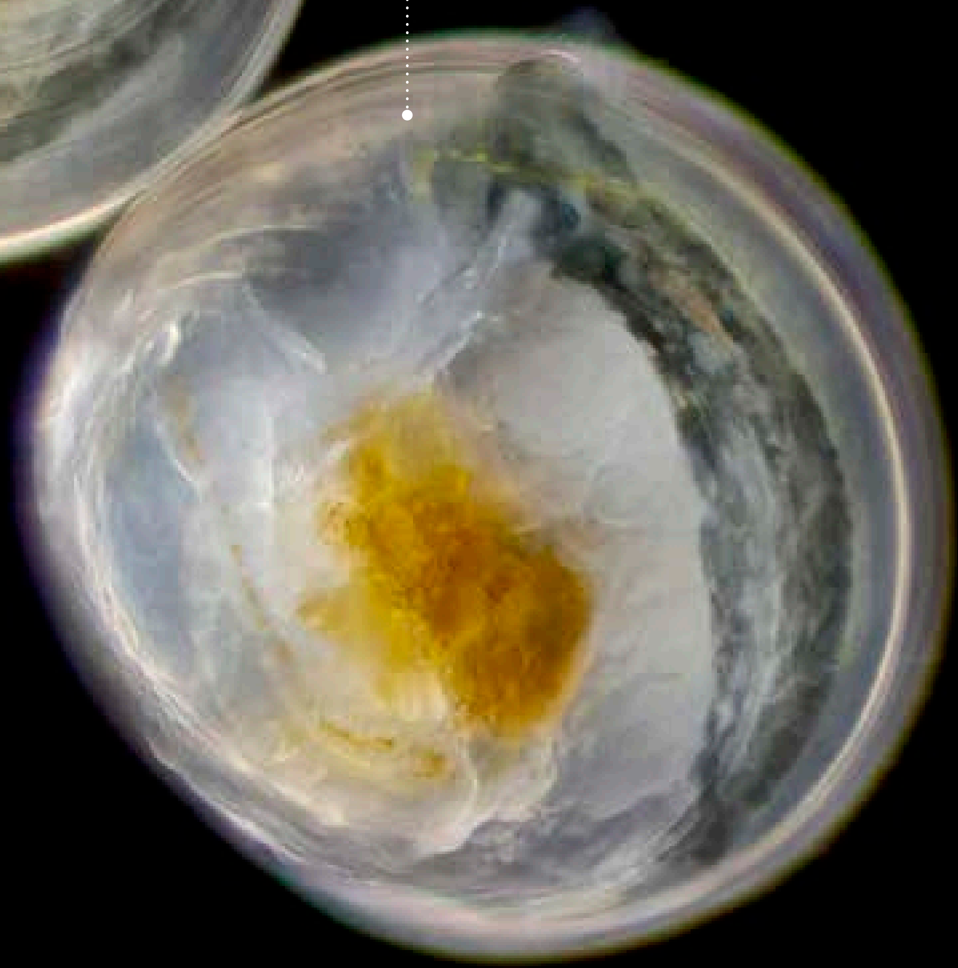
2

Rising coastal water temperatures can lead to bivalves having two birth peaks per year instead of one.



100

After having been absent from the Wadden Sea for a century, larvae of the European flat oyster (*Ostrea edulis*) were successfully bred by NIOZ scientists.



THE WADDEN SEA: TREASURES AND THREATS

The Wadden Sea is a biodiversity hotspot and a UNESCO World Heritage Site, but despite this status, all is not well. Many species are in decline and the marine landscape is becoming less diverse. The complexity and sensitivity of Wadden ecosystems make it challenging to discover the underlying causes of these changes. Such information is, however, vital for devising effective conservation strategies.

A diverse and healthy Wadden Sea floor is a beautiful mosaic of landscapes. Unfortunately, this landscape seems to be growing more monotonous with huge consequences for marine life. In 2018, the Wadden Fund awarded a large grant to the Mosaic project (a collaboration between NIOZ, University of Groningen and *Natuurmonumenten*) that will accurately map the underwater landscape and its biodiversity. The researchers will also study the effect of potential management measures to protect and restore permanently submerged Wadden Sea areas. Examples are banning bottom trawling in certain areas, restoring seagrass fields, and reintroducing large rocks on the seabed.

HOT IS THE NEW COLD

Extremes in the Dutch climate are shifting from cold winters to hot and dry summers. How does this impact Wadden Sea ecosystems? NIOZ scientist Katja Philippart discussed this during her inaugural lecture in 2018 as Professor by Special Appointment of Productivity of Coastal Marine Ecosystems at Utrecht University. She discovered, for example, that rising coastal water temperatures can lead to bivalves having two birth peaks per year instead of one. She now wants to know if this results in extra food for fish and migratory birds and whether this will change the grazing pressure exerted by shellfish populations on microalgae.

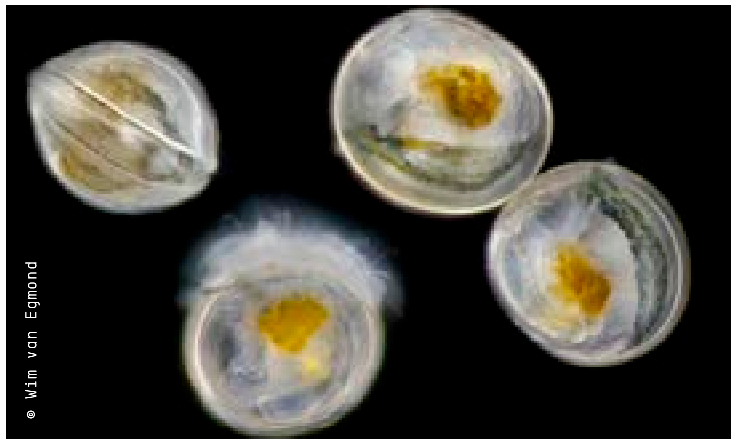
Climate-induced shifts in the flora and fauna will also influence the tidal flats, such as changes in the balance of bio-builders and bio-breakers. Bottom-dwelling microalgae, mussels and oysters (bio-builders) cover the surface of tidal flats, protecting them from erosion. However, lugworms and cockles (bio-breakers) constantly disturb the surface sediment making the flats more sensitive to erosion. Changes in this balance affect a tidal flat's height and therefore its probability of being drowned when sea levels rise.

TRILATERAL RESEARCH AGENDA

The combination of climate change, mineral extraction and sedimentation could lead to the permanent submergence of Wadden Sea tidal flats by the end of this century. Such an alarming prospect underlines the importance of ongoing international monitoring and research efforts. NIOZ scientists, together with a team of Dutch, German and Danish researchers, published the 2018 Quality Status Research Report about the current condition of the Wadden Sea Region. This revealed, for example, the vulnerable position of migratory birds, declining fish stocks and falling numbers of many breeding bird species.

In 2018, several NIOZ researchers also contributed to an expert report commissioned by the Dutch Wadden Academy and the Programme *Towards a Rich Wadden Sea*. The report concludes that sedimentation in the Wadden Sea currently occurs faster than sea level rise. Consequently, the sea is becoming shallower and tidal flats larger. Long-term scenarios predict that sea level rise and subsidence due to mineral extraction will outstrip the expected sedimentation rate. From 2030 onwards, tidal flats to the south of Vlieland could drown, and by 2050, large areas of Dutch Wadden tidal flats could be permanently submerged if the melting of the Antarctic ice cap accelerates. Even the most ambitious climate policy efforts could fail to prevent this.

Unfortunately, we still know too little about the impact of climate change and human interventions on the Wadden Sea Region to take effective action. The Wadden Academy therefore presented the Trilateral Research Agenda to the Wadden Ministers of Denmark, Germany and the Netherlands, who signed an agreement to increase collaboration, research and nature conservation in the Wadden region.



AFTER HAVING BEEN ABSENT from the Wadden Sea for a century, larvae of the European flat oyster (*Ostrea edulis*) were successfully bred by NIOZ scientists. With this knowledge they aim to increase the chances of natural recovery of this native species in the Wadden Sea.

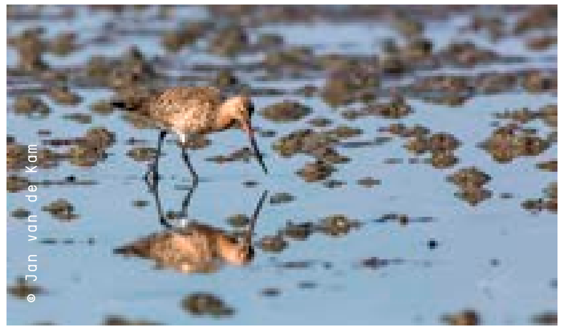
NIOZ SEA-LEVEL EXPERTS contributed to the report, commissioned by the Dutch Wadden Academy and Program Towards a Rich Wadden Sea, which appeared as a Special Issue of the Netherlands Journal of Geosciences: *Sea-level-rise, subsidence and morphodynamics; 2030, 2050, 2100.*

NIOZ SCIENTIST contributed to the Wadden Sea Quality Status Report (QSR) that reviews the ecological status of the entire Wadden Sea based on a trilateral monitoring programme carried out by Denmark, Germany and the Netherlands. It provides an important scientific basis for decision making, policy development and management issues surrounding the UNESCO World Heritage Site.

IN 2018, the Waddenfonds awarded funding to the large-scale project Wadden Mosaic (by Natuurmonumenten, NIOZ and University of Groningen) to map the less known underwater landscapes and biodiversity of the Wadden Sea.

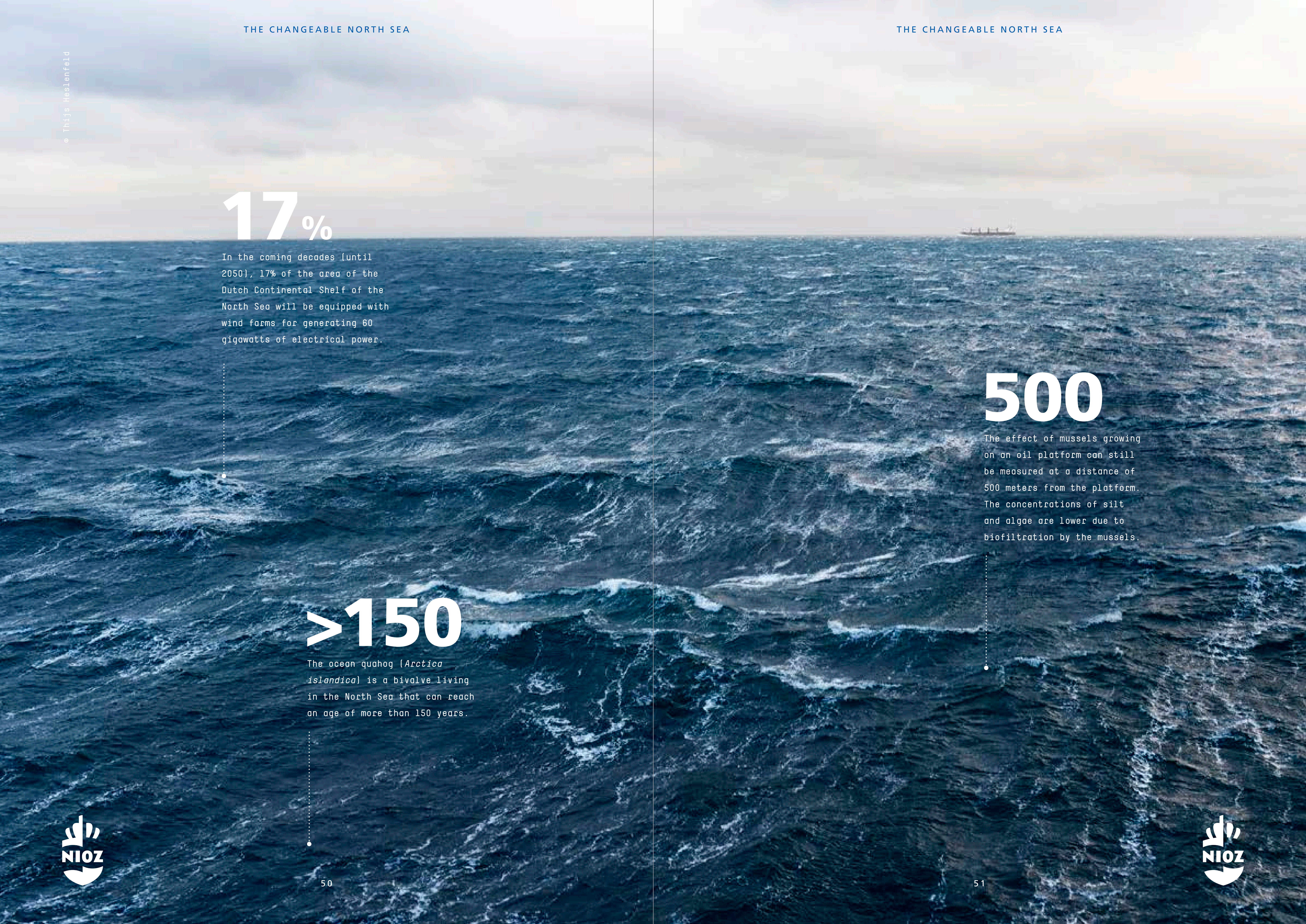
THE WADDEN SEA

IN 2018 KATJA PHILIPPART was appointed as a Professor by Special Appointment at Utrecht University on the chair 'Productivity of Coastal Marine Ecosystems', established by NIOZ. She investigates causes of global differences in coastal productivity relating to developments such as climate change.



DUE TO THE CHANGING CLIMATE, bar-tailed godwits need to arrive in Siberia a bit earlier every year, in order to benefit from the shifting peak in insect abundance. Whether or not they are able to make this adjustment, is determined by the number of worms in the Wadden Sea, according to a NIOZ-publication in *Nature Communications*.

TJISSE VAN DER HEIDE of NIOZ and the University of Groningen was awarded a VIDI to investigate how coastal landscapes are built by plants organising their shoots to optimize patch formation. Using this organisation capacity of plants, novel management indicators and restoration techniques can be developed.



17%

In the coming decades (until 2050), 17% of the area of the Dutch Continental Shelf of the North Sea will be equipped with wind farms for generating 60 gigawatts of electrical power.

>150

The ocean quahog (*Arctica islandica*) is a bivalve living in the North Sea that can reach an age of more than 150 years.

500

The effect of mussels growing on an oil platform can still be measured at a distance of 500 meters from the platform. The concentrations of silt and algae are lower due to biofiltration by the mussels.

THE CHANGEABLE NORTH SEA

The North Sea has played a crucial role in Dutch history and is still the gateway to much of our country's prosperity. But what is the status of one of the world's busiest waterways? How can we take good care of its ecological health and how will sea level rise affect Dutch coastlines? NIOZ research into the past, present and future of the North Sea will give us a more accurate picture of the impact of climate change and the effects of the use of various goods and services from the North Sea.

THE CHANGEABLE NORTH SEA

The North Sea, like the rest of the world's seas and oceans, absorbs much of the excess CO_2 in the atmosphere. This leads to a rise in dissolved CO_2 concentrations, causing the acidity of the seawater to increase as CO_2 reacts with water to form carbonic acid. NIOZ and Rijkswaterstaat (Directorate-General for Public Works and Water Management) are monitoring the acidification of the North Sea as part of international efforts to better understand this process. Knowing how the North Sea's acidification might change is important because shellfish are very sensitive to pH levels, and their ability to adapt to more acidified conditions is unknown.

NORTH SEA EXPEDITION 2018

As a follow-up of the 2017 North Sea expedition, researchers from NIOZ, TNO, Deltares, Utrecht University and VU Amsterdam took part in a multidisciplinary expedition on the RV *Pelagia*. Their research included studies of past sea level rise and the microbial breakdown of the greenhouse gas methane.

During the last ice age, the North Sea was a vast plain stretching from the Rhine over the Dogger Bank to the Thames. Rapidly melting ice sheets in the early Holocene (12,000 to 8,500 years ago) caused a sea level rise of 120 metres within just a few thousand years, driving the people who lived on the plains to higher ground. But just how fast did the sea level rise and what does this mean for our future? To find out, researchers took core samples from various peat layers at different depths. The analysis of these will reveal how realistic predictions about rapid sea level rise due to collapsing ice sheets are.

The Dogger Bank (Central North Sea) releases methane, a potent greenhouse gas. Researchers sampled the water column there for methane to discover its origin, how fast it is being released and how much ends up in the atmosphere, thus adding to global warming. Their measurements will help us to more accurately predict the global warming impact of methane released from the North Sea's dynamic coastal systems as well as from melting permafrost sediments in the Arctic Ocean. The release of methane from the seabed is not all bad news. Some microbes in the methane-rich water at the Dogger Bank use the gas as an energy source, which limits the amount of methane reaching the atmosphere.

NORTH SEA DAYS

During the Dutch North Sea Days on 4 and 5 October 2018, more than 140 researchers, policymakers and other stakeholders from 41 organisations met at NIOZ on Texel. They discussed and elaborated various themes for North Sea Research described in the Dutch National Research Agenda and the forthcoming North Sea Programme 2030.

Initial steps were taken to further harmonise various efforts, such as research into important ecological processes and joint North Sea research expeditions. The need for coherency between the themes energy, food, and nature was emphasised. There were also calls to intensify monitoring efforts in the North Sea and transform them into an integrated monitoring-modelling effort with good data accessibility and improved analyses of existing data sets.

Finally, participants called for the creation of a broader base of support within Dutch society for the conservation and, where possible, restoration of North Sea flora and fauna.

HELGE NIEMANN and multicore during the North Sea expedition.

NORTH SEA EXPEDITION TEAM looking at a core with peat layers on board RV *Pelagia*.

THE EFFECTS of acidifying conditions of the North Sea on shellfish and other organisms is still largely unknown.

IN 2018, NIOZ launched the online North Sea Research Centre, a virtual centre offering expertise and assistance to researchers, policy-makers, industry, ngo's and other stakeholders interested in the environmental health status of the North Sea.

THE CHANGEABLE NORTH SEA

DURING THE DUTCH NORTH SEA DAYS on 4 and 5 October 2018, researchers, policymakers, and other stakeholders from 41 organisations met at NIOZ on Texel.

NIOZ LEADS a consortium of 83 partners that has submitted a pre-proposal to the NWA 'Blue Route' programme of NWO, entitled "North Sea in Transition". The project aims to establish the optimal pathway to achieve the transition to sustainable energy and food production in balance with nature.

DURING THE NORTH SEA LEG of the NICO expedition, for the first time, polyps were discovered of a compass jellyfish (*Chrysaora hysoscella*). This jellyfish species was already known in the North Sea, but the polyps had previously never been seen.

FIGURES 2018

BUDGET 2018

The overall budget for 2018 amounted to 36.1 M€. NWO contributed 16.2 M€ as basic structural funding (equivalent to 45% of the total budget), € 4.7 M€ incidental contributions (13%) and 2.5 M€ project funding (7%). Other project-related additional funding was received through EU projects (2.4 M€; 7%) and other national and international projects acquired in competition (5.3 M€; 15%). Chartering of RV *Pelagia* to third parties yielded a revenue of 2.5 M€ (7%). Miscellaneous and ad hoc funding amounted to 2.5 M€ (7%).

Budget 2018	M€
Basic structural funding NWO	16.2
Incidental NWO contributions	4.7
NWO project funding	2.5
EU project funding	2.4
Other project funding	5.3
Pelagia charters	2.5
Miscellaneous funding	2.5
	36.1

STAFF 2018

On average, NIOZ employed a staff of 289 full-time equivalents (FTE), representing a total headcount of 325 employees. Of this total, 193 employees were men, 133 women and 76 employees were of foreign nationality, representing 29 different countries. Total staff increased by 39 FTE compared to 2017.
The relative distribution in percentage of personnel over the different staff categories shifted to slightly more scientific staff. The scientific staff, including tenured senior scientists, postdocs and PhD students accounted for 51% (2017: 44%) of the total staff, scientific support staff 20% (2017: 22%), and technical staff, ship crew, and services & administration accounted for 29% (2017: 34%).

Staff 2018	FTE
Scientific staff	43
Tenure-track scientists	13
Postdocs	27
PhD students	64
Scientific support staff	57
NMF technical staff	14
NMF ship crews	22
Services and administration	49
	289

SCIENTIFIC OUTPUT 2018

NIOZ scientists authored or co-authored 252 peer-reviewed journal articles, 1 book (monograph), 5 chapters in books, 6 non-refereed-publications and 15 scientific reports. Out of the 252 peer-reviewed journal articles, 177 or 70% appeared as open access publications, more than in 2016. 10 PhD students received their degrees from Utrecht University (1), Ghent University (1), University of Twente (1), University of Groningen (3), and the VU Amsterdam (4).

Prof Stefan Schouten (Microbiology & Biogeochemistry department) received the prestigious Alfred Treib medal for his outstanding achievements from the Geochemical Society.

The Dutch Research Council (NWO) granted VIDI funding to three experienced NIOZ researchers to develop their own, innovative research lines and research groups. The laureates were Dr Femke de Jong for the impact of melting ice on heat transport in the Atlantic Ocean, Dr. Rob Middag for the key role played by metals in the cycling of nutrients and Prof Tjisse van der Heide for managing and restoring coastal ecosystems with self-organising plants. In addition, Van der Heide also received a large Waddenfonds grant for Waddenmozaiek.

NWO-VENI grants were awarded to two highly promising early career NIOZ scientists. Dr Tamar Lok, (Coastal Systems department) investigates the development of migration routes of spoonbills. Dr Lorenz Meire (Estuarine & Delta Systems department) investigates the melting of the Greenland Ice Sheet and its impact on the physical, chemical and ecological functioning of Greenland's fjords.

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

Shiptime: In 2018, RV *Pelagia* sailed 38 days for NIOZ scientific programmes and projects and 180 days for the national NICO-expedition (Netherlands Initiative Changing Oceans). Foreign scientific teams used RV *Pelagia* 27 days for barter cruises within the European OFEG (Ocean Facilities Exchange Group) framework. RV *Navicula* sailed 161 days for the NIOZ scientific community. Ship charters by private partners totalled 32 days.

Scientific output 2018	
Peer-reviewed journal articles	252
Books (monographs)	1
Book chapters	5
PhD Dissertations	10
Scientific reports	15
Non-refereed publications	6

Prizes/awards	10
Major research grants	6
NIOZ scientists in scientific committees & editorial boards	136

OUTREACH & TEACHING 2018

NIOZ issued 24 press releases on scientific highlights and the NICO expedition and the institute was mentioned 82 times in national newspapers, 160 times in regional newspapers, 243 on Dutch websites and 269 on international websites.

Journalists wrote 73 articles in professional journals after interviewing NIOZ scientists. Our scientists appeared 130 times on radio or tv (Source Meltwater News Database). In all 26 public lectures were given to the general public. NIOZ was visited by 45 groups for presentations and guided tours.

The NIOZ communications department managed the outreach of the national NICO expedition. Journalists and artists were invited to join different legs. In 2018, 186 media productions about NICO (articles, radio and tv broadcasts) appeared across 50 different platforms.

NIOZ scientists participated in 11 societal advisory bodies.

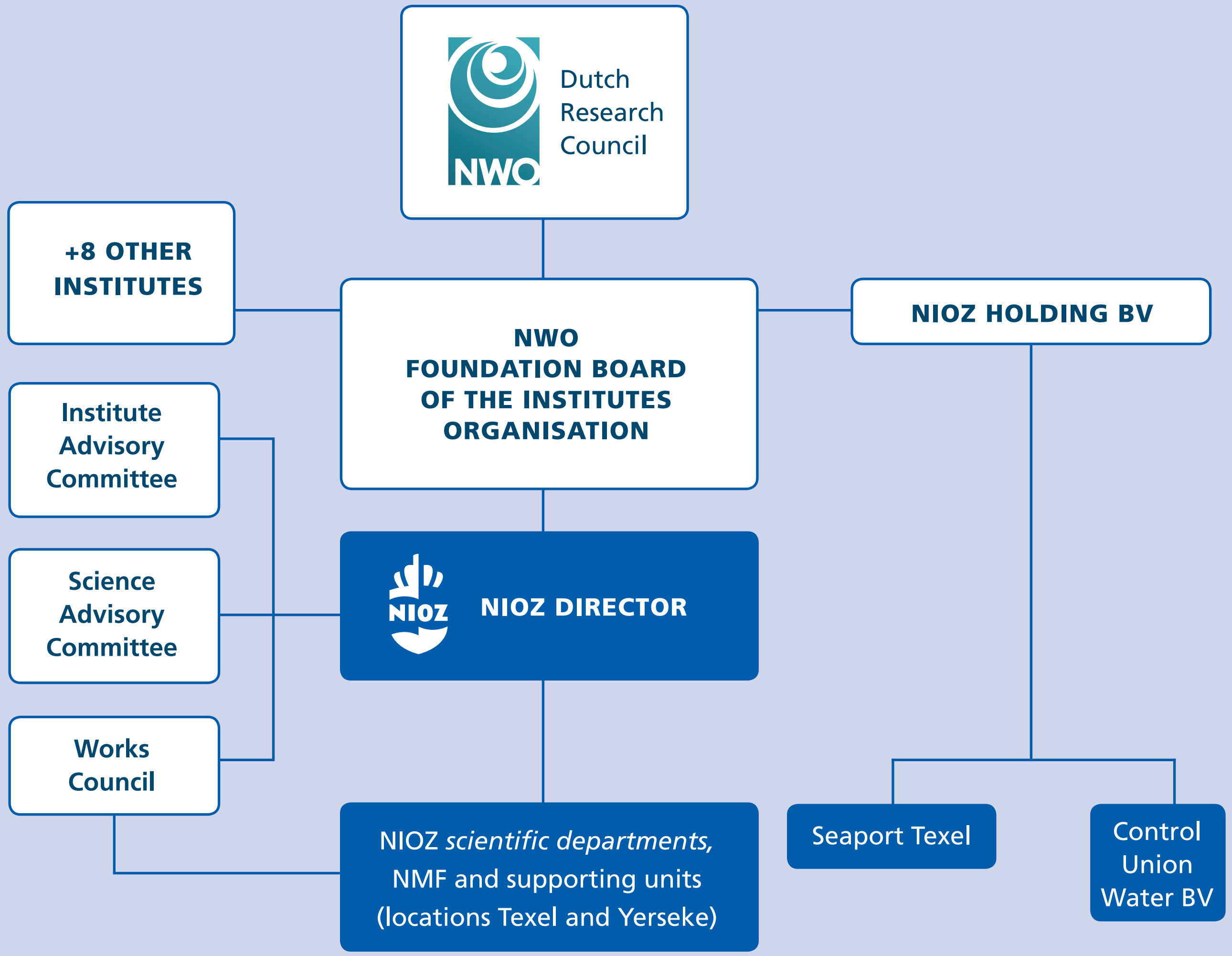
14 symposia were organised by NIOZ staff at the institute or elsewhere.

NIOZ scientists were involved in the organisation of 37 courses, and 159 students did internships at NIOZ.

Outreach & Teaching 2018	
Press releases	24
National newspapers	82
Regional Dutch newspapers	160
Professional publications after interview	73
Radio & TV	130
Internet NL	243
Internet International	269
Public lectures	26
Visiting groups	45
NICO expedition media productions	186
Platforms featuring NICO	50
Symposia at or by NIOZ	14
NIOZ PI's in Societal Advisory Boards	11
Capacity Building Courses	37
Capacity building Internships	159

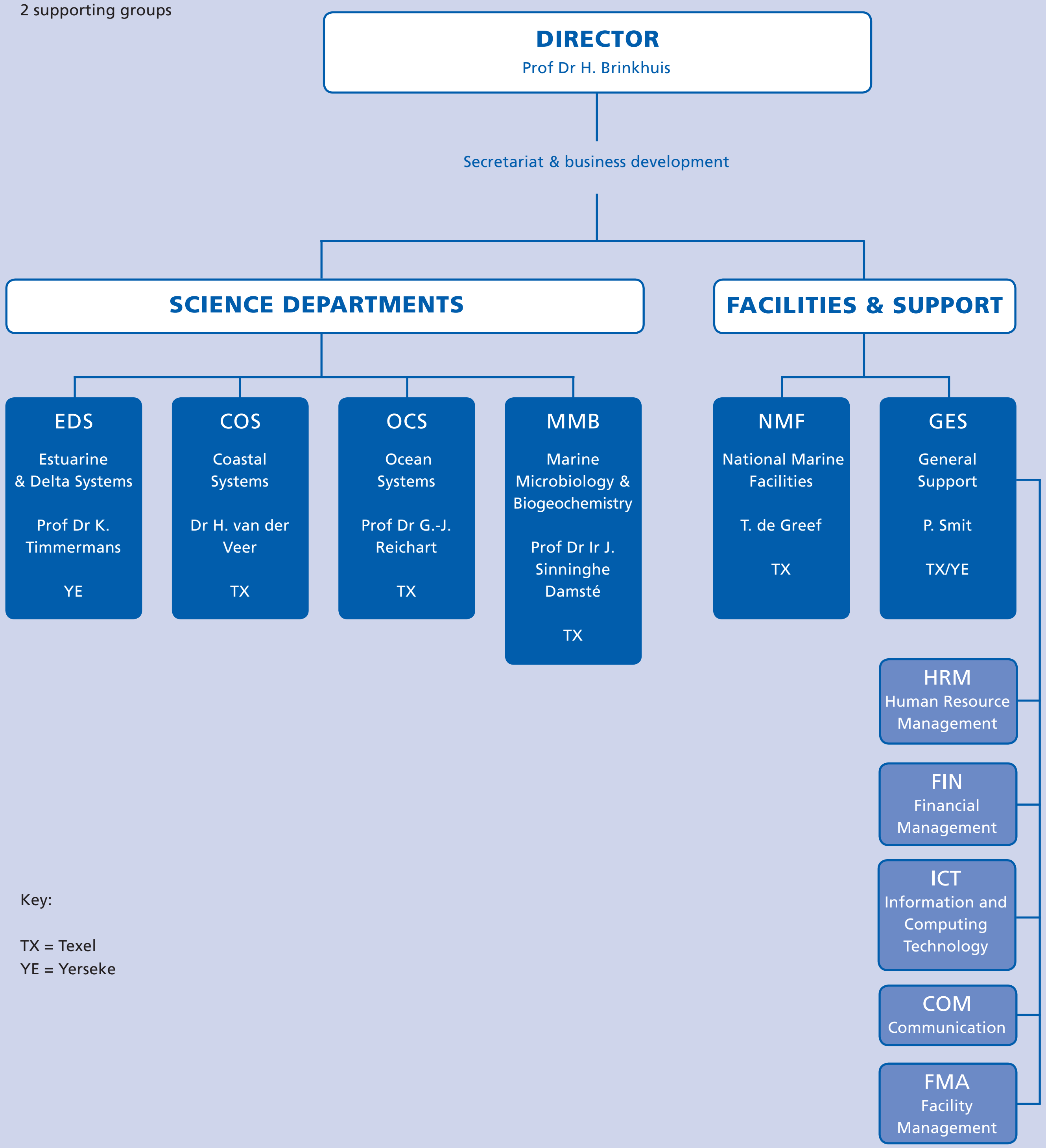
ORGANISATION 2018

NIOZ BASIC STRUCTURE 2018



ORGANISATION OF NIOZ 2.0

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

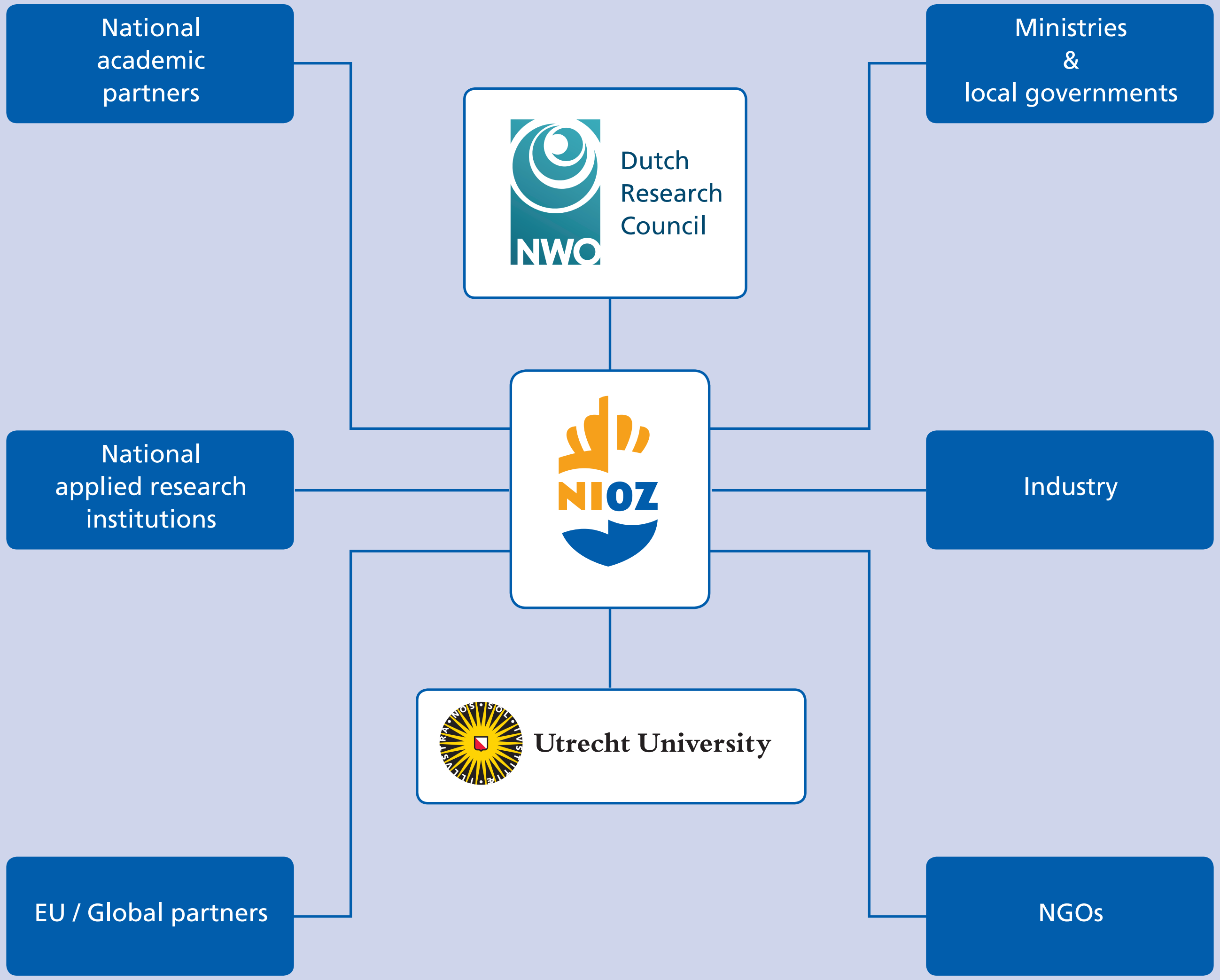


Key:

TX = Texel
YE = Yerseke

POSITIONING OF NIOZ 2.0 AMONG IMPORTANT NATIONAL AND INTERNATIONAL STAKEHOLDERS

NWO/NIOZ 2018: National *hub* for marine research
in cooperation with Utrecht University



COLOPHON

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

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

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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.

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

NIOZ Royal Netherlands Institute for Sea Research

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SUPPLEMENT

Annual Report 2018

Royal Netherlands Institute
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