ANNUAL REPORT 2016

NIOZ

Royal Netherlands Institute for Sea Research

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Royal NIOZ is an institute of NWO, since 2016 in cooperation with Utrecht University

NWO | Netherlands Organisation for Scientific Research

Utrecht University

NIOZ Royal Netherlands Institute for Sea Research

MISSION BLUE PLANET:

PROTECTING AND USING OUR BLUE PLANET RESPONSIBLY STARTS WITH UNDERSTANDING OUR CHANGING SEAS.

NIOZ CONDUCTS EXCELLENT MARINE RESEARCH FOR SOCIETY, FROM THE DELTAS TO THE DEEPEST OCEANS.

OUR SCIENCE AND NATION-AL MARINE FACILITIES HELP SCIENTIFIC COMMUNITIES, BUSINESSES, NGO'S AND POLICY MAKERS TO ADDRESS SOME OF THE BIGGEST CHALLENGES AHEAD.

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NIOZ AT SEA

NIOZ department National Marine Facilities (NMF) organizes research missions at sea by managing the NIOZ fleet of research vessels and the Dutch national pool of large seagoing equipment. For seagoing research NIOZ operates two ships: RV Pelagia and RV Navicula.

NIOZ AT SEA

178

RV Pelagia had 178 science days (ex. transit days) at sea in 2016.

66 m

RV Pelagia, built in 1991 and overhauled in 2010, is the flagship of NIOZ. With an overall length of 66 m, this versatile and stable vessel is suited for research on both coastal seas and open oceans worldwide (except for the polar regions).

6

NIOZ and 5 European partners exchange ship-time via the Ocean Facilities Exchange Group (OFEG).

2016 CRUISE PROGRAM

1

JANUARY - FEBRUARY:
Black Sea, Mediterranean NIOZ RV Pelagia NESSC, transect of CTD and coring stations, piston cores for OGS, Italy; mooring for Utrecht University. Marcel vd Meer, Dept. Micro-biology and Biogeochemistry | Gert-Jan Reichart, dept. Ocean Systems

2

MARCH:
Trans-Atlantic Caribbean - Cape Verde Exchange-cruise on board RRS James Cook (NERC, UK). TRAFFIC/DUST: recovery and redeployment of moorings and surface buoys Jan-Berend Stuut, dept. Ocean Systems

3

MAY:
North Sea NIOZ RV Pelagia INSITE/ SHADOW artificial structures in the North Sea Furu Mienis, dept. Ocean Systems

4

MAY-JUNE:
NIOZ and UU VICI, Baltic Sea NIOZ RV Pelagia Marcel van der Meer, dept. Microbiology and Biogeochemistry | Caroline Slomp, VICI-grant Utrecht University

2016 CRUISE PROGRAM

5

JUNE-JULY:
Mid-Atlantic Ridge, near the Azores NIOZ RV Pelagia TREASURE | STW | MIDAS, deep-sea mining Gert-Jan Reichart, dept. Ocean Systems | Ian Stewart

6

JULY:
Irminger Sea and Iceland Basin Exchange-cruise on board RRS Discovery (NERC, UK) NACLIM-OSNAP: ocean circulation Laura de Steur/ Femke de Jong, dept. Ocean Systems

7

AUGUST:
Cape Verde Islands FS METEOR, BMBF, Germany Drifting TRAFFIC/DUST-buoy recovered by FS METEOR, Jan-Berend Stuut, dept. Ocean Systems

8

AUGUST-SEPTEMBER:
Saba Bank, Caribbean NIOZ RV Pelagia ALW Caribbean Call, coral reefs and ocean acidification. Lennart de Nooijer, dept. Ocean Systems

9

OCTOBER-DECEMBER:
Fiji, Pacific NIOZ RV Pelagia Charter KIOST for two 25-day-ROV-surveys Dr. Park | Dr. Kim KIOST

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 is based in Yerseke, on the Eastern Scheldt, focusing on the interactions between organisms and their physical and chemical environments in estuaries and delta's.

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 Dutch 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 ahead.

The Netherlands, literally as a lowland, and as a traditional sea faring nation, has an on-going intimate relationship with its surrounding water masses; fresh and salty: rivers, deltas, seas and oceans. Once again, the Netherlands, and 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 forms of marine pollution, have become important topics on the national, and international policy agendas (cf. the Paris climate conference, 2015). Meanwhile, the same areas are increasingly employed for global solutions in terms of energy, mineral resources, food and transportation, at 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 respectively into oceans as *unknowns,* oceans in *trouble,* and oceans as *opportunity*. By focusing on these broad themes, and building on our internationally acknowledged, fundamental and frontier-applied research and sea going marine scientific capabilities, we built a new organization ('NIOZ 2.0') in the course of 2015-2016. Our four brand-new scientific departments continue 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 call it our *Mission Blue Planet.*

UNKNOWN OCEANS

Once fully staffed (~by the end of 2017) the new departments will be equipped to play a strong, often leading, role in initiating and connecting regional, national and international fundamental and more applied research initiatives. Collaborating with colleagues within and outside NIOZ, they will explore new avenues towards innovative (and seagoing) science, with attention for valorization and studies with particular societal relevance, also e.g., in the frame of the 'National Research Agenda' (NWA), and notably the crucial so-called *NWA Blue Route,* of which NIOZ is one of the founding fathers.

To further optimize NIOZ' role as national *hub* for marine sciences, over the past years NIOZ has revitalized existing MoUs with many national universities (RUG, UvA, VUA, Radboud Nijmegen), including e.g. conditions associated with enrollment of NIOZ PhDs in the graduate schools and programs of these universities, installation of chairs in marine sciences by NIOZ PIs, and cooperation in teaching. By 2016, many NIOZ PIs now occupy key chairs in their respective fields. In addition, starting in 2016, Dörte Poszig started as our 'academic liaison' or education officer; this function supports and co-coordinates marine science educational programs at the universities (BSc, MSc levels), promotes awareness of NIOZ, our research internship possibilities, and coordinates our annual national MSc course.

Because of our high quality research and leading national role, *Utrecht University* was prompted to support the institute through a substantial financial contribution aimed at intensifying UU-NIOZ collaboration, and in general strengthening national fundamental marine science research. Following a formal agreement between UU, NWO and NIOZ, a first five-year program started in January 2016, also involving formal affiliation of NIOZ scientific productivity with UU. A special kick-off meeting on January 27th was organized at NIOZ TX, in celebration of this long term partnership.

Apart from the start of the new organization, in 2016 we continued to enjoy new scientific successes and breakthroughs, and major external funding including e.g., a *second* major ERC advanced grant of the European Research Council ERC to Prof Dr Ir Jaap Sinninghe Damsté (NIOZ department MMB) for his molecular microbiological research on the evolution of lipid molecules of different groups of microorganisms. Also our academic output remained at very high levels, with many peer reviewed papers appearing in high impact journals, and increasingly in open access literature.

OCEANS IN TROUBLE

While our core-business remains fundamental marine sciences, we participate in more applied maritime and offshore industrial related research including e.g., the international InSITE project on effects of decommissioning of man-made structures, and potential alternatives (PI's: Prof Dr Gert-Jan Reichart, Dr Furu Mienis). In addition, activities under the NIOZ Holding LLC included a name change of the *'NIOZ harbour'* into *'Seaport Texel',* headed by its director Thomas de Greef, and the birth of a second spin-off company for ballast water treatment testing together with Control Union (PI: Dr Louis Peperzak).

Again in 2016, NIOZ promoted and disseminated research to the broader public in various ways. One particular highlight includes the integrated Metawad Symposium and the well-known *Oerol* cultural festival in June. RVs Navicula and Stern were present at this well attended event (PI Prof Dr Theunis Piersma). Positive news was also received in terms of the continuation for another five years of the *Caribbean Netherlands Science Institute* (CNSI) on St Eustatius through prolonged support from the ministry of Education, Culture and Science (OCW). For OCW/NWO, NIOZ enables the CNSI project, with director Dr Johan Stapel running the show in the northern Caribbean.

Meanwhile, 2016 also witnessed the many lines of preparation towards the reorganization of our mother-organization NWO itself. Successfully, the 'new NWO' was launched on January 1, 2017 with its two branches: granting in NWO-D, and the institutes in NWO-I, initially composed of the four former FOM institutes. The remaining institutes, including NIOZ, are set to merge with NWO-I by the end of 2017.

While cherishing and celebrating our 140 year history, 2016 marked the start of a new NIOZ in many ways. We are confident that the new organization, our rejuvenation of research, and our young staff will be successful. All in all, NIOZ, in the near future (2018) as part of NWO-I, and with continued support from Utrecht University (until 2025 at least), and from other partners, when eventually fully developed and well-equipped, will be optimally positioned to meet our goals – *Mission Blue Planet.*

Henk Brinkhuis, director
Harry Baayen, chair

OCEANS AS OPPORTUNITY

NATIONAL RESEARCH AGENDA:

BLUE ROUTE

In 2016, NIOZ initiated and coordinated the 'Blue Route: Water as a pathway to innovation and sustainable growth'. This new route was added to the ~25 routes defined within the context of the National Research Agenda (NWA); this agenda aims at pointing the way for Dutch research over the next ten years. It identifies and emphasizes the strengths of Dutch research, pertaining to the challenges facing society and the economic opportunities.

The Blue Route focuses on understanding, using and protecting oceans, seas, deltas and rivers, as well as managing salt water, fresh water and ground water systems, in order to improve sustainability, well-being and prosperity worldwide.

More than seventy per cent of the Earth's surface consists of water. Water is vital to every known *form* of life. It is essential to many *aspects* of life, and to life itself. Water is essential to food production, to waste disposal and to transportation. It is also important to energy generation and to the circular economy.

The Blue Route addresses urgent issues. Sea levels are rising, climate change is impacting the oceans, water is polluted by plastic waste, clean drinking water is scarce, and habitable land areas are overcrowded. And it is precisely at the vulnerable interface between water and land that we find fertile soil and ever-growing populations.

UNIFYING APPROACH

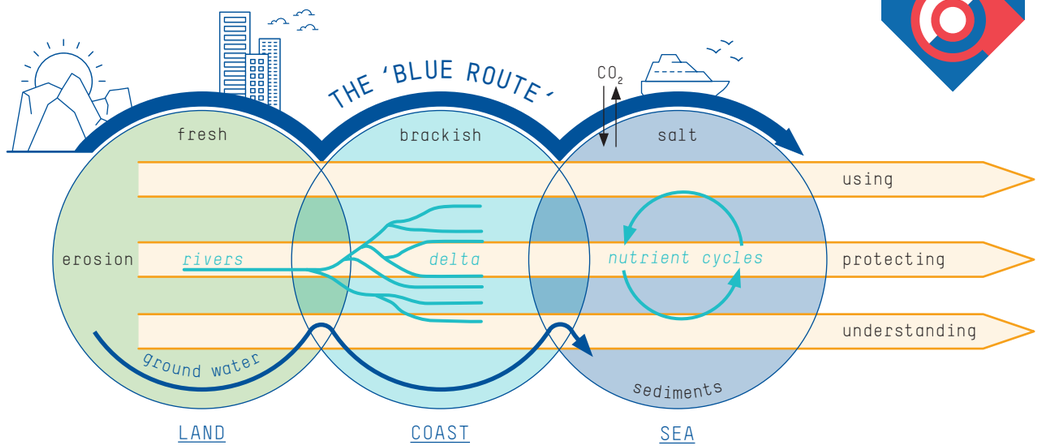
Therefore, this route is a very important one. On the one hand, it is about gaining a better understanding of interconnected aquatic, terrestrial, atmospheric and marine processes and ecology. On the other hand, we want to make sustainable use of the water by developing new technology and production systems and by creating new residential and commercial spaces. To do that, we need to protect the water, and to protect ourselves against it.

Royal NIOZ, together with Deltares, MKC, MARIN, TNO, TU Delft/KWR, Ministry of Infrastructure and the Environment, and Utrecht University, prepared a founding meeting with a much wider group of stakeholders, resulting in an innovative and unifying approach. The Blue Route encourages close and coordinated collaboration between science, technology and the social sciences, between basic and applied research, and between economics and ecology. The Blue Route aims to answer questions about the unknown. Humankind has been to the moon and is *en route* to Mars, but we still know little about our own oceans. To explore them, we must understand the links between ecology, life cycles and biochemical processes in deep and shallow waters. For example, the Atlantic Ocean drives the climate processes that determine the dynamics of the Dutch Delta. The North Pole region is similar in that respect. We need to know more about how these systems work.

The Blue Route entails a shift from 'the fight against water' to 'building with water' and on to genuinely 'living with water'. This offers us new prospects for food, energy, raw materials, transport and housing along, on and in the water. The Blue Route breaks with the traditional linear innovation process: innovations are created in open networks, with all the stakeholders in science, society and enterprise engaged in co-creation. We prefer a 'living lab' approach whereby specific regions – the Amsterdam-Rotterdam agglomeration, the south-western delta, the Wadden Sea Region and the North Sea – function as experimental sites for understanding the overall system.

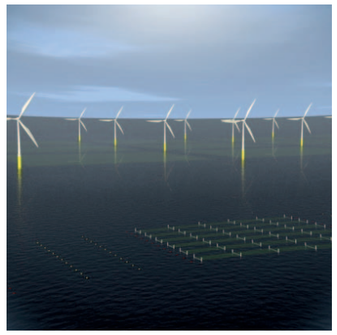
GAME CHANGERS

The following four lines of approach will produce four gamechangers: 1. Living in the Delta, 2. Water as a source, 3. Water as a blue pathway, 4. Living on water.



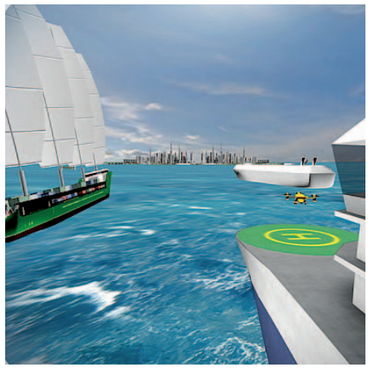
1. LIVING IN THE DELTA

How can we develop a Sustainable Urban Delta in which different populations can live, work and eat together safely, healthily and sustainably?



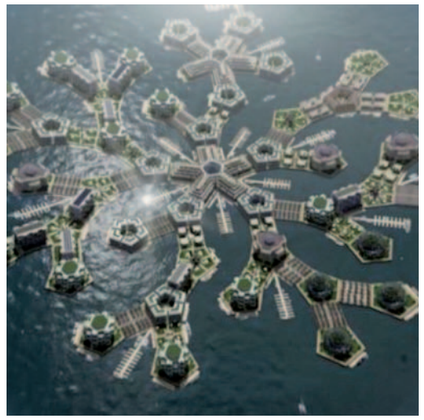
2. WATER AS A SOURCE

How can we make sustainable and economically responsible use of water and of energy, natural resources and food located on, in and under that water?



3. WATER AS A BLUE PATHWAY

How can we redesign vessels with carbon-neutral and autonomous navigation systems and 'future-proof' our ports and waterways in making shipping sustainable and safe?



4. LIVING ON WATER

What opportunities do floating homes and businesses, aquaculture, and hydropower offer at a time when the sea level is rising, the climate is changing and we are running out of space?

SCIENCE HIGHLIGHTS FROM DELTAS TO DEEP OCEANS

SCIENCE HIGHLIGHTS

130

Publication in *Science* on shrinking knots was picked up by over 130 international media like BCC, India News, The Atlantic, Xinhua News, Washington Post.

2 weeks

Due to Arctic warming, spring starts 2 weeks early and hatching chicks miss the insect peak, ending up lighter, smaller and shorter-billed.

60 hrs

non-stop-flight of satellite-tagged red knot Paula from the most northerly terrestrial habitat on Earth to the Dutch Wadden Sea; average speed on her 4,000-km track: 70 km/h.

WHAT MIGRATORY BIRDS TELL US ABOUT A CHANGING WORLD

Long-distance migratory birds, including shorebirds like the red knot, divide their time between very different ecosystems around the globe. And as habitats and climate change, they are finding it tough to successfully maintain their seasonal travels.

The red knots summer breeding grounds are to be found in the High Arctic. As a team of scientists led by NIOZ's Jan van Gils discovered, warmer summers there are *not* necessarily good news for knots. The earlier onset of spring means an earlier peak in insect numbers – before the chicks of the knots have hatched. The result: something between hunger and malnutrition. By the time the young knots are ready for their long-distance migration south to West-African intertidal flats, they are lighter, smaller and shorter-billed than previous generations. An increasing number may simply never arrive in Mauritania, West-Africa.

SHORTER BILLS

Those that do, face new problems. Their shorter bills are unable to eke out the most nutritious foods – mollusks hidden deep in the mudflats – and they have to make do with a poor alternative: seagrass. Again, this is not conducive to growth or health.
But Mother Nature remains resourceful: Van Gils expects an evolutionary force towards longer bills to manifest itself in the years to come as the knots adapt to change.

HOTTER MUDFLATS

Meanwhile, doctorate student Jimmy de Fouw discovered another fascinating and hazardous development. On the Mauritanian mudflats, rising temperatures cause a complex mix of reactions, affecting this important wintering area for knots. Initially, the nutritious mollusks may become easier to find as increasing temperatures thin out the seagrass that covers the mudflats. However, in the longer term, the ecosystem will impoverish, as toxic breakdown products will cause most seagrass to die. As seagrass is critical to the survival of the mollusks, this will also negatively affect knots. What was a paradise for knots will rapidly lose its attraction… And the knots have nowhere else to go.

CHINESE COAST DEVELOPMENT

A third team, led by leading migratory bird ecologist Theunis Piersma, has shown how the subspecies of red knots named after him, *Calidris canutus piersmai,* is suffering from Chinese coastal developments. A favorite refueling site of these birds *en route* from Australia to Siberia are the tidal flats on the Yellow Sea – flats that are increasingly being contained and reclaimed, leaving ever-smaller tidal areas. Less room means less food, and less food means fewer birds. Piersma expects a catastrophic population reduction of up to 50 % within three or four years as a result.

NEW BIRD-WATCHING WITH FEATHERLIGHT SATELLITE TRANSMITTERS

In 2016 the first red knot, named Paula, was equipped with a simple silicon harness, carrying the lightest available solar-powered transmitter, weighing just two grams. As a result, a permanent link to these birds can be established that allows our knowledge of their conduct to increase rapidly -and a number of myths to be debunked. Thanks to Paula, our test-pilot knot, we now know that knots can fly from the Arctic to Western Europe non-stop, negating previous stories of pit stops in Iceland or Norway. It took Paula about 60 hours to cover the 4000 or so kilometers, giving a highly impressive average speed of nearly 70 km/hour. The new generation of transmitters is expected to provide a huge and reliable data source for future research into the trials and tribulations of these fascinating long-distance travelers. And it has won PhD student Eva Kok the 'best poster' prize at an international symposium.

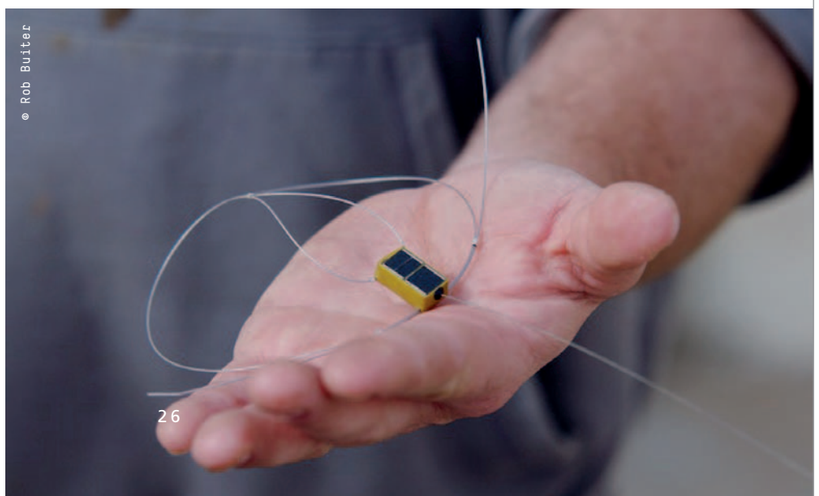
PAULA wearing a harness with satellite-transmitter and solar panel.

You can follow Paula and other tagged birds via www.waddenflyways.nl

NIOZ-RESEARCHER
Jan van Gils found red knots are becoming smaller and shorter-billed.

THE BILL of a young red knot is measured.

A SATELLITE-TRANSMITTER in hand weighing 2-grams.



IT TOOK PAULA about 60 hours to cover the 4000 or so kilometers from the Arctic to the Wadden Sea, an average speed of nearly 70 km/hour. Estimated altitude: +5,000 meters.

THIS RED KNOT'S habitat on the tidal flats of the Chinese Yellow Sea is under threat. Ecologist Theunis Piersma expects a population reduction of up to 50% within three or four years.

LANDING red knot with satellite-transmitter.

MOLLUSKS are the favorite food of the red knot. Due to rising temperatures the Mauritanian mollusks will disappear.

20%

Gardening worms living on seagrass-sprouts are up to 20% heavier.

10x

Ribbed mussels repair American salt marshes 10 times faster.

500,000,000

Today, half a billion people live on islands that have become increasingly vulnerable to climate change.

BUILDING SAFE AND PRODUCTIVE DELTAS WITH NATURE

Estuaries and deltas are especially susceptible to the consequences of climate change, that is: stronger storms and higher water levels.

And man needs all the help he can get in equipping such areas appropriately for food and energy production, as well as providing flood safety. To that end, at NIOZ several Building with Nature projects make clever use of the interactions between animals, plants, currents and waves.

MUSSELS REPAIR AMERICAN SALT MARSHES – FAST

After periods of drought, salt marshes vegetation needs to recover. An international team of scientists including NIOZ's Johan van de Koppel discovered that Ribbed mussels are unexpected allies, helping marsh recovery. By creating holes around the roots of marsh grasses, they capture and retain water that helps control the salinity of the flats. This is good news for the grasses that survive drought in mussel area's up to ten times better than in mussel-free zones. More generally, Van de Koppel asserts, mussels are effective engineers of ecosystems that serve the resilience and biodiversity of many environments challenged by climate change.

WORMS TAKE UP GARDENING AND UNDERMINE COASTAL DEFENCE

Meanwhile, most tidal flats are host to a variety of worms of which some intent on sabotaging natural coastal defences. PhD student Zhenchang Zhu discovered some previously unknown conduct that is adversely affecting the salt marsh's ability to establish on tidal flats. The ragworms in question move the seeds from marsh plants into the sediment of the bare tidal flat. There, the seeds germinate into nutritious sprouts, superb food for the worms that as a result are up to 20% heavier than worms without such private gardens. Good news indeed, if you are a worm.

Unfortunately, the news is not so good for the marsh plants that no longer form the strong surface lawns so essential to wave breaking – and hence, to flood defence. The remarkable finding could help to outsmart the ragworms and make managing salt marshes more effective. Instead of planting seeds, successful restoration of marshes could be jump-started by planting bigger plants, which cannot be eaten by the worms.

CALL IN THE MUSSELS, AND PUT THEM TO WORK!

Mussel reefs are home to a huge variety of life forms, providing food and shelter in a biodiverse environment and helping tidal flats resist the ever-present forces of erosion. That's why NIOZ's Tjeerd Bouma along with scientists from the University of Nijmegen and Consultancy firm Bureau Waardenburg are investigating the options for creating artificial mussel banks on the Dutch tidal-flats. And not without success. In 2016, experiments with several biodegradable crate-like structures (called BESE) offering anchorage for mussel seed were introduced into the Scheldt estuary. Various surface structures were provided, to test which works best for the mussels. A similar set-up was previously tested at Ameland successfully, and is currently also being tested in Florida, USA. The ultimate aim of restoring endangered ecosystems such as mussel beds, is to restore the vital services they provide for humans and nature alike.

THESE BIODEGRADABLE crate-like structures made out of starch interlaced with coconut rope offers a home for musselseeds before they hatch.

EXPERIMENTS with building mussel reefs in Zeeland, NL.

MUSSELS rapidly repair American salt marshes after periods of drought. By creating holes around the roots of marsh grasses, they capture and retain water that helps control the salinity of the flats.

COASTAL DEFENSE is sabotaged by this little creature (ragworm) that takes the seeds from marsh grasses and plants them in the sediment of the bare tidal flat. Good for him, bad for the grass cover.

RAGWORM near algae patch.

THE MACRO MARSH ORGAN at Perkpolder near Walsoorden (Western Scheldt, Netherlands).

THE PURPOSE is to find out if after de-embankment the pioneering plants would benefit from drainage and at which height they would prosper. (The macro marsh organ is a controlled marsh in the field. This way you have a good way of testing the different parameters of interest.)

9%

Only 9 percent of the ocean floor around Curacao and Bonaire is still covered by coral reefs.

TOP 3

Water pollution, overfishing and coastal developments cause coral reef decline.

31°c

Climate change heats up water over 31 degrees Celsius, bleaching coral reefs.

DUTCH CORAL REEFS IN DECLINE

Dutch waters in the Caribbean, including Curacao and Bonaire, have traditionally been home to some fine tropical coral reefs. But, like many others, these are currently under threat. Monitoring data gathered meticulously at various depths by NIOZ since 1973 clearly show decline.

An observed reduction in ocean floor cover by corals from 32% to 9% is in itself spectacular. But there is more: a shift in coral species, from massive reef-building varieties to smaller, more fragile pioneer types. The result: significantly less calcium production. Less hiding places for fish and crustaceans. Less 3D-complexity in the reef itself. And an increased susceptibility to wave erosion.

IN SEARCH OF A NEW BALANCE

Other life forms are immediately taking advantage of this coral decline, and not always for the better. Reef ecologists of NIOZ and Wageningen Marine Research have established strong growth in floor-covering brown and green algae, as well as expanding carpets of cyanobacteria.
So what causes these major shifts?
The answer is: *we, humans*, do.

Human activities such as water pollution – especially with nutrients – overfishing and ill-advised coastal developments are major factors at the front of a complex chain reaction. Less fish means less grazing on algae, and hence less inherent growth control – particularly so since the reduction in sea urchins (due to a disease epidemic) back in the eighties: these sea urchins were (and are) important factors in reef maintenance. And rampant green/brown algae inevitably mean less young coral.

On top of that there is climate change. Warmer waters lead to bleaching of the corals. How? Symbiotic algae called zooxanthellae tend to desert their coral homes when temperatures rise above 31° C, and they take their coloring agents with them. The result: white corals that will likely die, unless the water temperature drops within a few weeks.

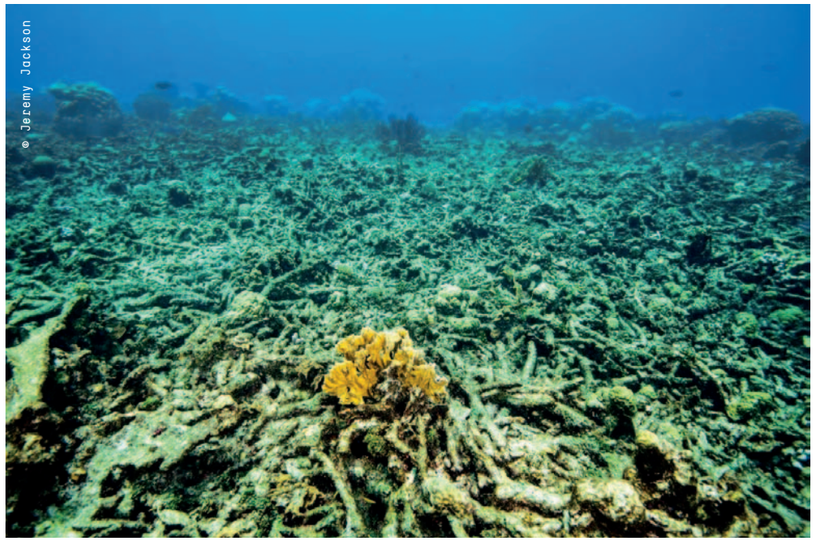
The only path to recovery is the return of the zooxanthellae, and for that to happen we need structurally lower ocean temperatures.

OCEAN ACIDIFICATION

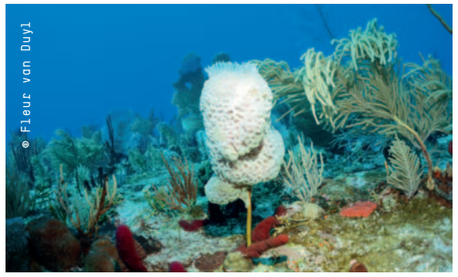
A team led by NIOZ scientists Lennart de Nooijer and Fleur van Duyl etc. focusses on how ocean acidification and eutrophication interact and how this affects the net calcification of coral reefs. Climate change not only means warmer water but also more carbon dioxide and hence: a lower pH. These effects are worsened by eutrophication. Corals grow by building an external calcium carbonate skeleton, which is more difficult in a hostile, acid environment. Usually after corals have died, specialized sponges, stimulated by ocean acidification and eutrophication, aggressively erode the coral calcium carbonate skeletons.

The Saba bank, located in remote, shallow and biodiverse waters, provides the ideal location to study a pristine coral reef systems over time. And NIOZ Research Vessel Pelagia in 2016 provided the ideal platform for such research into reef ecology and carbon metabolism, at differing depths and around differing parts of the reef. The result is an improved understanding of how the various environmental factors interact, and ultimately: what we need to do to save the reefs.

In a part of the world that is economically dependent on tourism, and hence on intrusive human activities, that will prove to be quite a challenge.

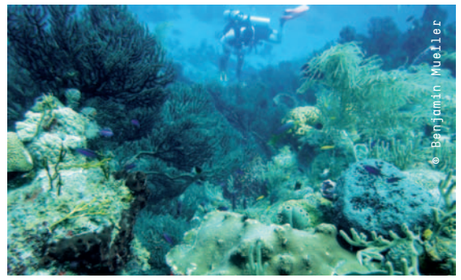


BOTTOM covered with dead coral.

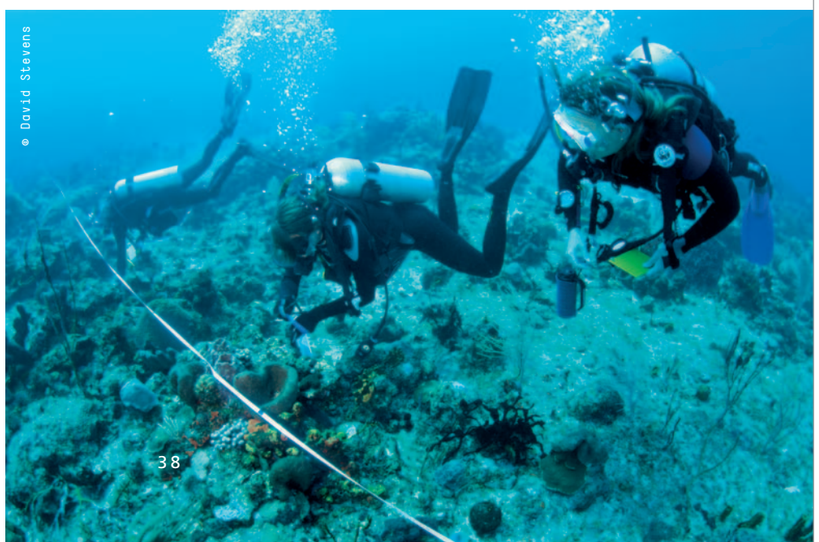


THE SPONGE in the middle, Callyspongia, compete with corals for living space.

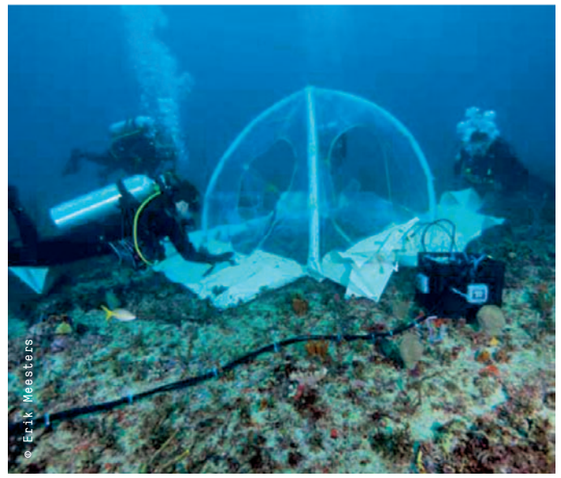
THE SABA BANK, located in remote, shallow and biodiverse waters, provides the ideal location to study complex systems over time.



SCUBA DIVERS record the cover of corals, sponges and other benthic organisms under a transect line on the Saba Bank.



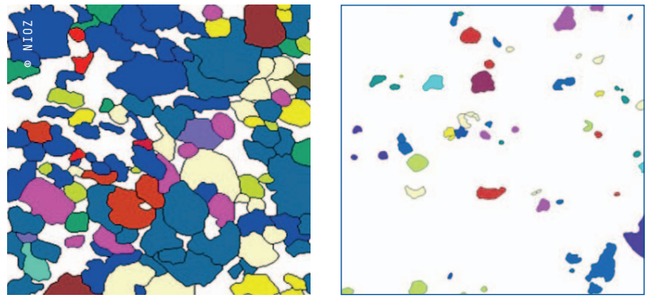
MEASURING calcification of the reef with a tent incubator at Saba.



THE STONE CRUNCHER on Saba to produce building material, but also producing dust that causes huge siltation problems for the coral reefs near the coast.

SEWAGE WASTE TREATMENT is crucial to minimize the nitrogen and phosphate loadings to the reef areas. Proper and working treatment sites are needed on all Dutch islands.

GRAPHIC representation of different living corals covering the sea floor around Bonaire at 20m depth in 1974 (left) and 2012 (right).



375:1

In summer, the N:P ratios in the North Sea vary enormously, between 1:1 offshore to as much as 375:1 near the shore, indicating a severe shortage of P for algal growth in Dutch coastal waters.

KEEPING THE NORTH SEA IN SHAPE

The North Sea, NIOZ's home in more ways than one, is both ecologically and economically of huge importance to the Netherlands, a large part of Europe – and beyond. The North Sea is undergoing major changes, some of which are a direct result of changes in land-use policy or marine spatial planning, some of which are more indirect as a result of climate change. A big unknown is how these processes and their interactions will shape the ecology and ecosystem services in the future.

Are man-made structures like oil rigs or wind mills in the North Sea ecologically good, or bad? The answer to that question is not as obvious as you might think. An increasing number of North Sea oil (and gas) platforms are falling into disuse. The hard substrate formed by the solid structure of the platforms on top of the soft bottom, plus a considerable no-trawling zone surrounding the platforms, have led to interesting enrichments of the marine epifauna, forming reef-like habitats in an otherwise barren North Sea.

That's why eight European research institutes, including NIOZ, are working together in INSITE (INfluence of Structures In The Ecosystem), funded by eight energy companies/platform owners. The goal: to provide scientific evidence to allow informed decision making about the role of man-made structures in the North Sea.

Within INSITE, NIOZ scientist Furu Mienis is involved in the analysis of the footprint/shadow of artificial structures on the entire soft-bottom community. Her initial findings suggest that in the immediate vicinity of the platform, physico-chemical conditions and particle flux in the water column seem to be altered. Further modeling and analysis will have to show whether the specific epifauna on the platform consisting of mussels (*Mytilus edilus*) and anemones (*Metridium senile*) are acting as a biofilter, and may also locally alter water column conditions. On basis of these outcomes final answers to the good/bad question can be provided. It seems likely that such answers will, like the ecosystems themselves, prove complex.

HOW WATER QUALITY MATTERS

The European environmental policy aims to improve North Sea water quality through the reduction of both phosphorus (P) and nitrogen (N) loads in the surface water. N and P are essential building blocks for life. However, starting in the 1960s, intensive agriculture and phosphate in washing detergents were responsible for strongly increased concentrations of N and P in the North Sea, causing massive algal blooms and even oxygen shortage following bloom decline. The last decades, the removal of phosphorus (P) has been much more effective than nitrogen (N), resulting in severely imbalanced N to P ratios. Scientists from the University of Amsterdam and NIOZ (Corina Brussaard) embarked on four cruises to systematically chart these N:P ratios and assess their impact on the growth, nutritional quality and composition of the algal community. They found that N:P ratios in the North Sea varied enormously, between 1:1 offshore to as much as 375:1 near the shore, indicating a severe shortage of P for algal growth in Dutch coastal waters. This shortage not only results in a poor nutrient diet for predators living on algae, but also alters which algal species dominate (potentially favouring blooms of toxic dinoflagellates). To restore the balance, policy measures that result in a more effective reduction of nitrogen are necessary.

Algae growth essential to the food chain

Jerico-Next (the next step in the Joint European Research Infrastructure network for Coastal Observatories) brings together physicists, biogeochemists and biologists from 33 organisations in 15 countries to provide methodologies suitable for routine monitoring data of the state of the sea.
Why? Because improved understanding of how the seas work begins with all these organisations bringing together and sharing their knowledge in open access databases.

The involvement of NIOZ focuses on the monitoring of algae growth and CO_2-fixation. Why: because a healthy food chain needs a healthy base. Working closely with Rijkswaterstaat (The Dutch national water authority), NIOZ scientist Jacco Kromkamp utilizes the power of fast repetition rate fluorometry, allowing semi-continuous assessment of phytoplankton activity.

PLATFORM L7A, located 47 nautical miles northwest of Den Helder. Used for gas production from 1988-1999. Now all production facilities have been mothballed and are no longer in use.

Parts of oil rig platforms are removed and examined. Initial findings suggest that a very specific epifauna is supporting rare and endangered species.

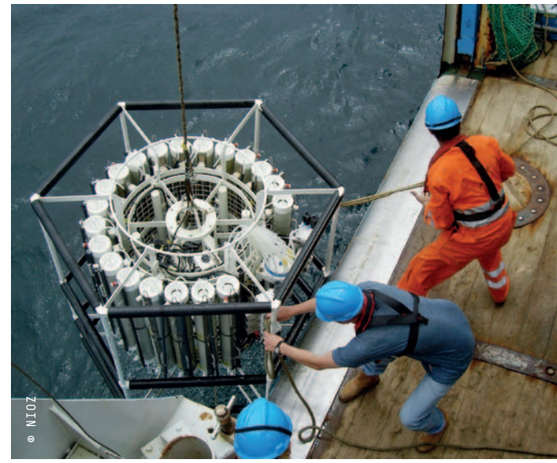
INSITE - Divers inspecting the underwater part of an off-shore platform.

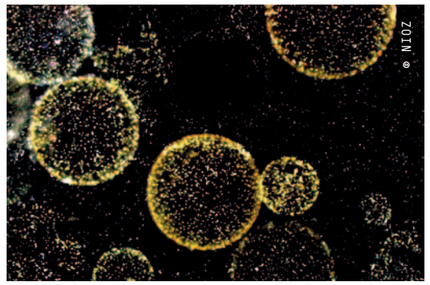
BLUE MUSSELS, sea stars and sea urchins at the top of a sediment trap.

URCHINS and mussels crawling over a sediment trap.

MEASURING water flow velocities.

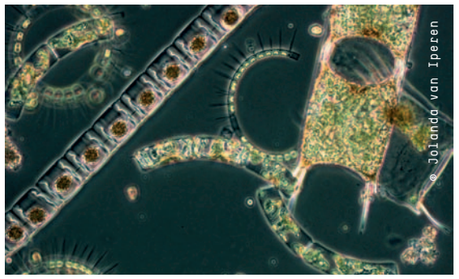
WATER samples are obtained by a CTD-Rosette sampler.

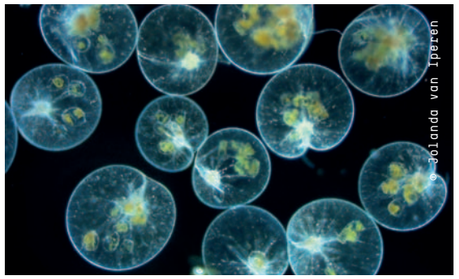




BLOOMS of the 'foam algae' (Phaeocytis globosa) have become less frequent in recent years.

DIATOMS are the most frequently occurring algae in North Sea coastal waters.





DINOFLAGELLATE Noctiluca scintillans, the fluorescent type of algae.

A MEASURING TOOL for profiling phyto-plankton activity in the water column. Working closely with RWS (The Dutch national water authority) and utilising the power of fast repetition rate fluorometry, a semi-continuous assessment of phytoplankton is in the final stages of development.

2-6 km

Deep-sea mining research takes place at 2-6 km water depth.

500 billion

500 billion metric tons of polymetallic nodules lie scattered in the Pacific, Atlantic, and Indian Oceans.

NIOZ researchers were on an expedition with the German oceanographic institute GEOMAR, to study the bottom of the Pacific Ocean where manganese nodules can be found.

10 years

Mineral mining in the deep sea may start within the next 10 years.

DEEP-SEA MINING: TREASURE OR TRAGEDY?

Increasingly, the world needs cobalt, nickel, molybdenum, neodymium, gold and copper to satisfy consumer's growing demands of computers, mobile phones, electrical cars and solar panels. In the face of scarcity of certain mineral ores on land, the mining industry is exploring new sources for these metals and the ocean floor looks appealing. However, to this day, we know very little about the remote and generally unexplored environments where deep-sea mining may take place in the near future.

In 1989, a team of German scientists experimentally ploughed 1000 acres of Pacific Ocean seabed off Peru, in more than 4 km water depth, to simulate the disturbance of the deep-sea environment resulting from mineral mining. In the framework of the European MIDAS and Mining Impact research projects, the experimental site was revisited 26 years later, to find out to what extent the ecosystem had recovered from the disturbance. NIOZ ecologists Dick van Oevelen and Tanja Stratmann participated in two expeditions to the site, bringing specialized equipment to assess the status of the seabed and its inhabitants. Findings from the two expeditions are food for thought: the plough marks created back in 1989 are still very visible. Many varieties of animal life that were previously found in the area have vanished or show only poor recovery.

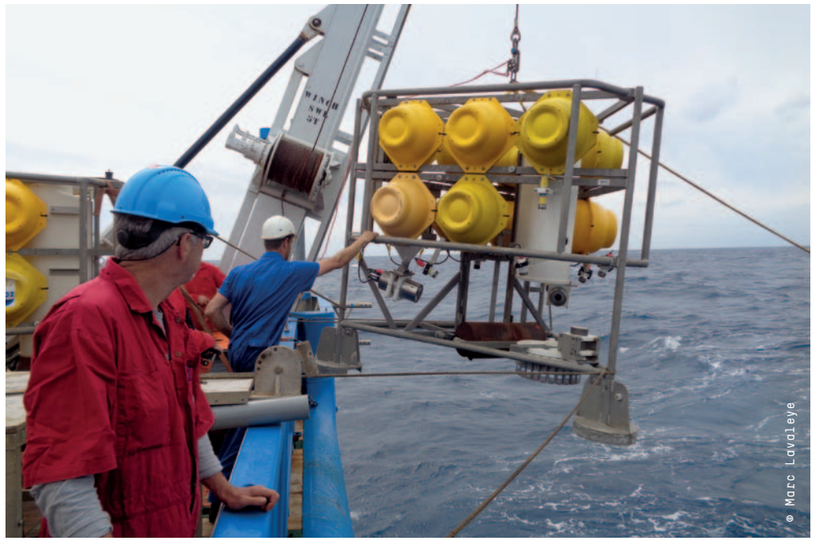
Whilst the biota observed in the Peru Basin appear poorly adapted to cope with human interference, those living in the surroundings of mineral-rich hot water vents associated with submarine volcanisms are naturally exposed to the risk of episodic eruptions with an impact potentially far exceeding that of mining. Studying how deep-sea animal life around those vents copes with such natural disturbance, NIOZ biologist Sabine Gollner found that larval dispersal traits and connectivity with populations in adjacent areas are keys to understand and predict recovery potential of deep-sea organisms.

THE DEEP UNKNOWN

Scientific knowledge of the inhabitants of these remote environments is extremely sparse, when compared to the vast areas of deep ocean that remain uncharted and deep-sea life that remains unseen to the human eye. In the framework of the TREASURE project, deep-sea ecologists Gerard Duineveld and Marc Lavaleye carried out experiments with state-of-the-art bottom landers deployed in an area with hydrothermal activity on the Mid Atlantic Ridge southwest of the Azores. With baited cameras mounted on the landers, and using infrared illumination, they were able to capture unique close-up images of deep-sea fish and crustaceans which normally avoid the bright glare of conventional camera lights used in deep-sea surveys. Potentially, observing the behaviour of such mobile fauna may be used for detecting early indications of mining-induced ecological stress. Local destruction of deep-sea habitats is the most apparent impact of mineral extraction from the seabed. But plumes of fine particles stirred up by mining and spreading out over the surroundings of the mining site may cause further harm to the environment. Small animals may get buried, and animals like sponges and corals which filter their food from the bottom water are hindered in their feeding and respiration by the added load of suspended particles. Using equipment moored on the seabed, NIOZ geologist Henko de Stigter studies the dispersion of suspended particle plumes under influence of local bottom currents. More knowledge of these phenomena is essential in preparing informed go/no go decisions for all concerned.

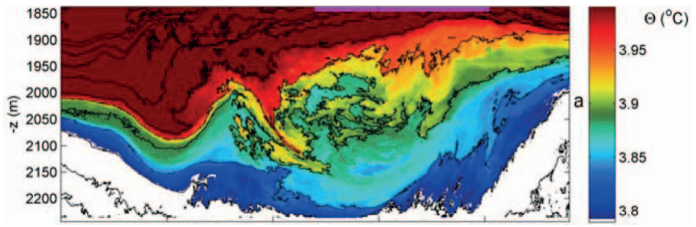
THE INDUSTRY CONNECTION

Identifying problems is part of a scientist's job. But so is proposing solutions. Therefore, NIOZ does not only engage in discussions with fellow scientists, policymakers and NGO's, but also co-operates with industry in an effort to jointly develop an environmentally sustainable mining practice. Marck Smit, business development manager at NIOZ: 'Blue Nodules is a good example of this. In this European project, scientists and technical personnel of NIOZ assist engineers from the maritime industry in developing deep-sea mining machinery that causes as little disturbance to the surrounding environment as possible'. As stated by Gert-Jan Reichart, head of the NIOZ Ocean Systems department and participating in Blue Nodules: 'An open communication with the industry is important, because deep-sea mining may be unavoidable, and the job of scientists is not only to point out the dangers, but also to help mitigate them.'

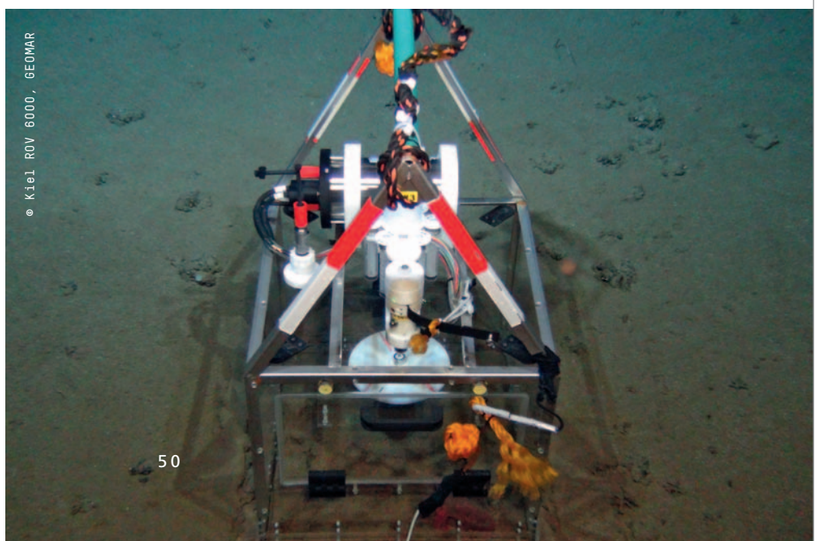

© Marc Lavaleye

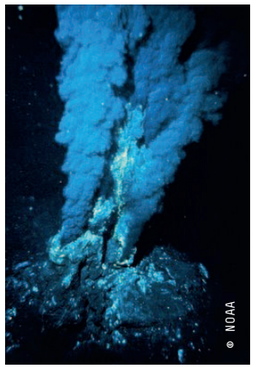
BENTHIC LANDER ALBEX used by NIOZ deep-sea ecologists Gerard Duineveld and Marc Lavaleye to investigate deep-sea fauna near the Azores.

TEMPERATURE IMAGE of a collapsing internal wave above the Mid Atlantic Ridge near the Azores, portrayed by means of the NIOZ-built thermistor string mooring developed by oceanographer Hans van Haren. Such turbulent motions will cause significant dispersal of suspended sediment plumes into the surroundings of mining sites.



NIOZ-BUILT deep-sea inCUBEator encaging a sea cucumber (holothurian) on the seafloor at 4000 m water depth near Peru, where the ocean floor was disrupted in 1989.


© Kiel ROV 6000, GEOMAR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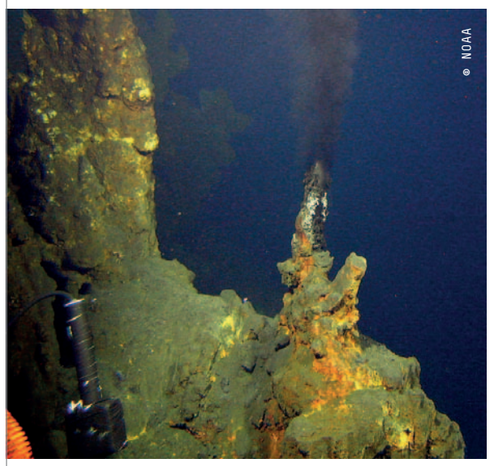
HYDROTHERMAL SOURCES, home to unique life forms that use warmth for energy and are unable to survive elsewhere.

IN THE BLUE NODULES PROJECT, NIOZ assists in developing and monitoring equipment to harvest deep-sea minerals with the least impact on the surrounding ecology regarding plumes, noise and disturbance.

© Blue Nodules, IHC Mining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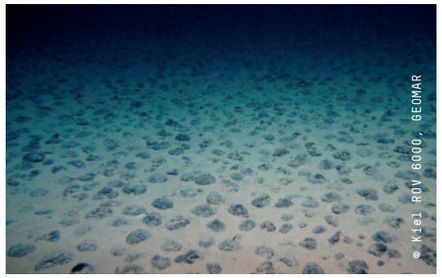
MANGANISE NODULES on the ocean bottom in the Peru basin.


© Kiel ROV 6000, GEOMAR

CRUMBLED MANGANESE nodules after passing an experimental pump setup in the hyperbaric test tank at NIOZ.


© Kiel Marck Smit


© NIOZ

A CLOSE-UP of the deep-sea fish *Antimora rostrata* captured by time-lapse infrared camera mounted on the NIOZ ALBEX lander. The white disk below the fish, which is a bait dispenser, is 50 cm in diameter.

11 km

Powerful submarine waves feed fish and crabs at 11 km depth.

30-50 %

of lead found in the tropical part of the North Atlantic can be traced back to the Sahara using stable isotopes.

INTO THE DEEP

Exploration of the deep oceans is the final frontier, still lagging behind the exploration of space. New discoveries are made continuously and more is to be unveiled. Our capacity to observe, understand, and model marine systems past and present is increasing dramatically. This should allow us to better constrain future changes and their consequences for the oceans, and ultimately, for the entire Earth system.

The twentieth century may well go down in history as the age of leaded gasoline. The far-reaching effects of lead pollution caused by leaded gasoline were first discovered in the Atlantic Ocean. There, researchers found lead concentrations that were 200 times higher than normal, showing that harmful quantities of lead were emitted into the atmosphere, and from there made their way both into the ocean surface and onto the land. Lead was taken out of gasoline, and following these environmental measures, lead concentrations in the surface North Atlantic are now decreasing towards natural values.

For the first time, this good news has become visible in new measurements at the ocean surface: concentrations of lead are becoming so low that researchers can now even distinguish lead related to human activities from naturally occurring lead that comes from Sahara dust. Dust contains all earth elements – including lead, in very small concentrations. The dust is swept into the atmosphere during storms and carried over huge distances before descending into the oceans. Studies by international teams, including NIOZ scientists Rob Middag and Loes Gerringa, show that between 30% and 50% of lead currently found in the surface Atlantic ocean below the Sahara dust plume is of natural origin: The Sahara.

GLOBAL WARMING, LOCAL COOLING

The phrase “Global Warming” suggests that warming occurs everywhere, but in some areas, local cooling trends are found. For instance, the Irminger Sea, an area south-east of Greenland, has recently attracted the attention of the media because it shows temperatures that are lower than usual. Some have suggested that the phenomenon is caused by increased melt water from the icecap flowing into the ocean and slowing down the North Atlantic Ocean circulation. The melt water, which is fresher and lighter, is assumed not to mix with the heavier layers underneath. This would affect the northward flow of warm waters at the surface. Plausible... but wrong.

NIOZ introduced deep sea measuring equipment into the Irminger Sea in 2003, and in 2015 revisited the site to collect data. What scientists Femke de Jong and Laura de Steur found was, to say the least, surprising. It turns out deep mixing has actually increased, and that surface waters have mixed with lower layers to a depth of as much as 1400 meters – a new local record! The cause: the extremely long and cold winter of 2014-2015, during which the surface waters cooled dramatically.

SUBMARINE WAVES MOVING NUTRIENTS INTO THE DEEP OCEAN

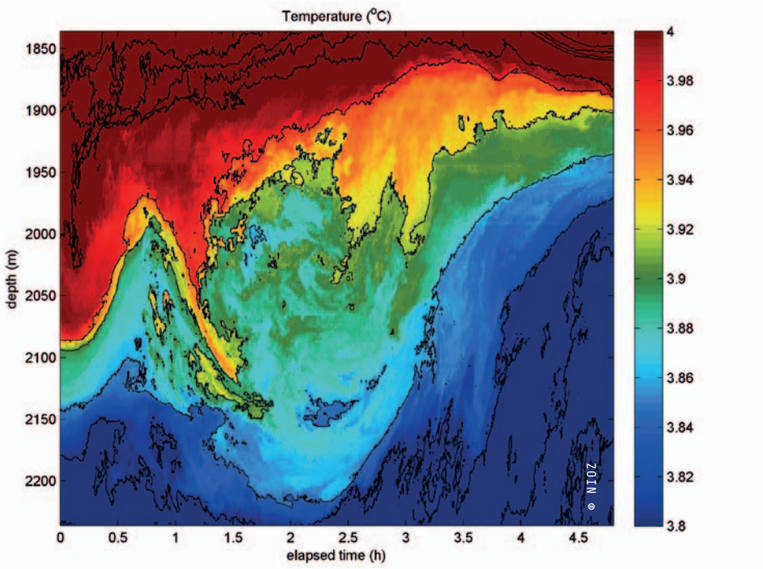
Physical oceanographer Hans van Haren took matters eight times deeper, when travelling on the German Research Vessel Sonne to the Mariana Trench between the Philippines and New Guinea. Hans knew that below depths of, say, 5 kilometers, the vertical structure of water columns as caused by differences in temperature and salinity becomes very weak. So how come he witnessed a strong mixing process that took both oxygen and food down to depths of 11 km, enabling higher life forms such as fish, crabs and shrimps?

The surprising answer: waves. Large, submarine breakers, caused by tides, further excited by the smallest of temperature differences and growing to heights of no less than 200 meters. Such waves harness huge amounts of mechanical energy: enough to cause serious turbulence that acts as a nutrient escalator into the darkest and deepest places on earth.

A CHIMAERA captured by time-lapse infrared camera mounted on the NIOZ ALBEX-lander. These 'rabbit fish' live in temperate ocean floors down to 2,600 m deep.

SURPRISINGLY, NIOZ-scientists found that due to the long and cold winter of 2014-2015, melt water mixed with lower layers as deep as 1,400 m in south-east Greenland.

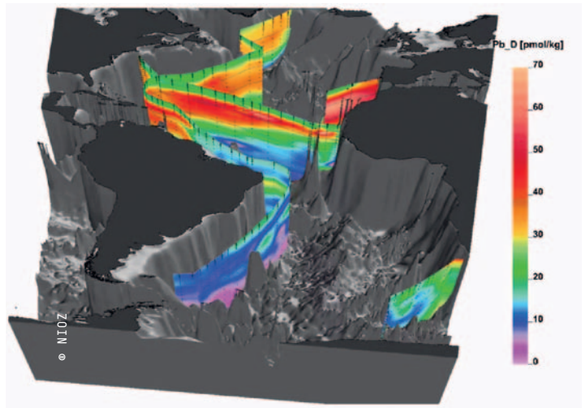
A 200-M HIGH turbulent overturn by mixing warm (less dense) waters with cooler, denser waters below due to an internal wave breaking, measured in the deep ocean using moored high-resolution temperature sensors.



THE CREW of RV Pelagia is waiting to hook on to the top float of the LOCO mooring.

THE LOCO MOORING was recovered by RV Pelagia in summer 2015. Here the profiler, which drives daily along the cable while doing measurements, and one of the Acoustic Doppler Current Profiler are visible.

AFTER THE DATA has been collected and the instruments are serviced the LOCO mooring is redeployed in the Irminger Sea and will stay there for some years.



DISSOLVED LEAD (PB) concentrations in the Atlantic Ocean from the international GEOTRACES project. In the surface ocean, concentrations are lower (green) than the deeper concentrations (in red) which still reflect the input from gasoline. In the deep ocean it can be seen that the highest concentrations (pinkish) are near the African continent, where unleaded gasoline was phased out last. In this figure dissolved Pb is shown, but the isotopes of lead made a distinction possible between gasoline as an anthropogenic source and dust as a natural source in the paper from Bridgestock et al in Nature Communications.

FIGURES 2016

BUDGET 2016

The overall budget for 2016 amounted to 31.1 M€. NWO contributed 17.4 M€ as basic structural funding (equivalent to 56% of the total budget) and 2.2 M€ project funding (7%). Other project-related additional funding was received through EU projects (2.5 M€; 8%) and other national and international projects acquired in competition (5.1 M€; 16%). Chartering of RV Pelagia to third parties yielded a revenue of 2.9 M€ (9%). Other shipping funding was received from ALW-NWO (0.5 M€; 2%). Miscellaneous and ad hoc funding amounted to 0.5 M€ (2%).

Budget 2016	M€
Basic structural funding NWO	17.4
NWO project funding	2.2
EU project funding	2.5
Other project funding	5.1
RV Pelagia charters	2.9
ALW-NWO	0.5
Miscellaneous funding	0.5
	31.1

STAFF 2016

On average, NIOZ employed a staff of 244 full-time equivalents (FTE), representing a total headcount of 282 employees. Of this total, 50 employees were of foreign nationality, representing 22 different countries. Total staff decreased by 16 FTE compared to 2015. 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 45% (2015: 41%) of the total staff, scientific support staff 21% (2015: 23%), and technical staff, ship crew, and services & administration accounted for 34% (2015: 36%).

Staff 2016	FTE
Tenured Scientists	44
Postdocs	24
PhD students	41
Scientific support staff	51
NMF technical staff	20
NMF ship crews	23
Services and administration	41
	244

SCIENTIFIC OUTPUT 2016

NIOZ scientists authored or co-authored 289 peer-reviewed journal articles, 6 books (monographs), 8 chapters in books, 5 non-refereed publications and 16 scientific reports. Out of the 289 peer-reviewed journal articles, 191 or 66% appeared as open access publications, again an increase from 57% in 2015). Thirteen PhD students received their degrees from the University of Amsterdam (4), University of Groningen (3), Utrecht University (2), Radboud University Nijmegen (2), Ghent University (1), and the Free University Brussel (1).

Prof Dr Corina Brussaard was invited to become Fellow of the American Academy of Microbiology. Prof Dr Theunis Piersma became member of the 'Koninklijke Hollandsche Maatschappij der Wetenschappen'. The international research project 'Atlantic canyons, pathways to the abyss', won the 'Excellence in Partnering Award' of the US National Oceanic Partnership Program (NOPP), with NIOZ team members Dr Furu Mienis, Dr Gerard Duineveld and Dr Marc Lavaleye.

In 2016, two NIOZ scientists received a major Research Grant: Dr Furu Mienis received an NWO-vidi grant for research on the role of underwater canyons in the transport of carbon from continental seas to the abyss. Prof Dr Jaap Sinninghe Damsté received a second ERC advanced research grant for research on the evolutionary pathways of microbial lipid molecules. In total, 148 of our scientists participated in scientific committees and editorial boards of scientific journals.

Shiptime: In 2016, RV Pelagia had 178 science days at sea for NIOZ scientific programmes and projects (excluding transit days), and 33 days for foreign scientific teams as barter cruises within the European OFEG (Ocean Facilities Exchange Group) framework. RV Navicula sailed 163 days for the NIOZ scientific community.

Scientific output 2016	
Peer-reviewed journal articles	289
Books (monographs)	6
Book chapters	8
PhD Dissertations	13
Scientific reports	16
Non-refereed publications	5

Prizes/awards	3
Major research grants	2
NIOZ scientists in scientific committees & editorial boards	148
Ship time/science days RV Pelagia for NIOZ	178
Ship time/science days RV Pelagia for OFEG	33
Ship time/science days RV Navicula for NIOZ	163

SOCIETAL RELEVANCE 2016

We collaborated with private company partners in 57 projects (public-private partnerships), representing a total value of 2.72 M€. The spin-off company Control Union Water BV (LLC) was founded as a cooperation between Control Union BV and NIOZ for testing ballast water treatment equipment. Total contract research by NIOZ amounted to a value of 11.1 M€.

NIOZ scientists were involved in the organization of 31 courses and 131 students performed an internship as part of their study at NIOZ.
8 symposia were either organized at NIOZ, or organized by NIOZ staff and were held elsewhere. NIOZ scientists participated in 6 societal advisory boards. Our ships were chartered by private partners for 115 days.

NIOZ issued 23 press releases on scientific highlights and the institute was mentioned 32 and 99 times in national and regional newspapers, 164 and 308 times on national and international websites, respectively. NIOZ scientists were interviewed for 33 publications in professional journals. Our scientists appeared 44 times on radio or TV (source: Meltwater News Database), and gave 51 public lectures for the general public. In all, 31 groups visited the institute for presentations and guided tours.

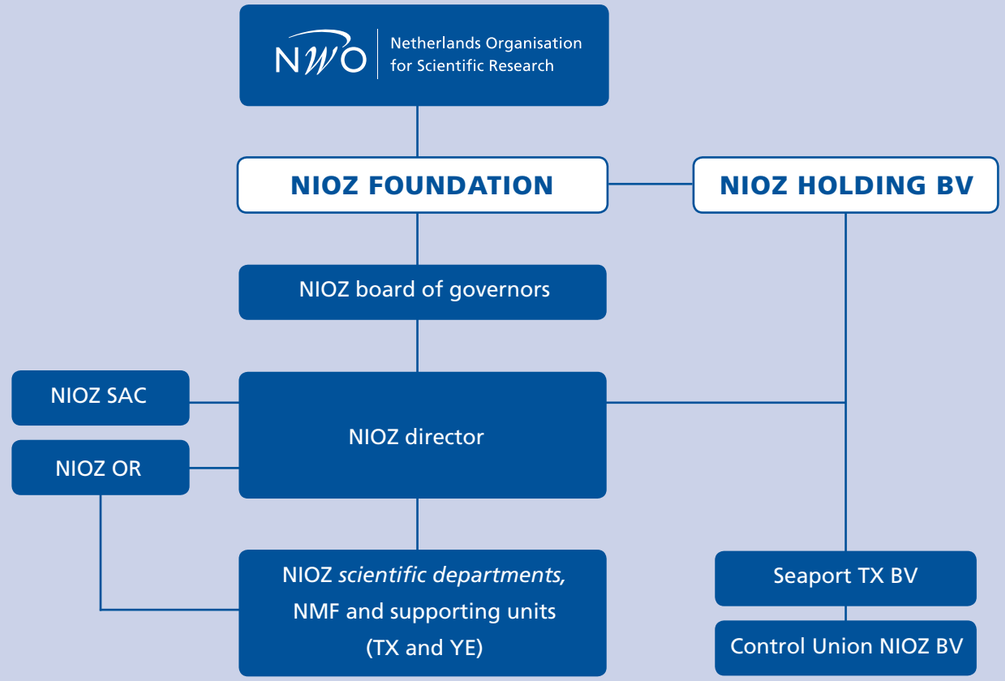
Societal Relevance 2016	
PPC projects	57 (representing 2.72 M€)
Contract research	11.1 M€
Spin-off companies	1

Capacity building Courses	31
Capacity building Internships	131
Symposia at or by NIOZ	8
NIOZ PI's in Societal Advisory boards	6
NMF ship charters by private partners	115 days

Press releases	23
National Newspapers	32
Regional newspapers TX and YE	99
Professional publications after interview	33
Radio & TV	44
Internet NL	164
Internet INT	308
Public lectures	51
Visiting groups	31

ORGANIZATION 2016

NIOZ BASIC STRUCTURE 2016



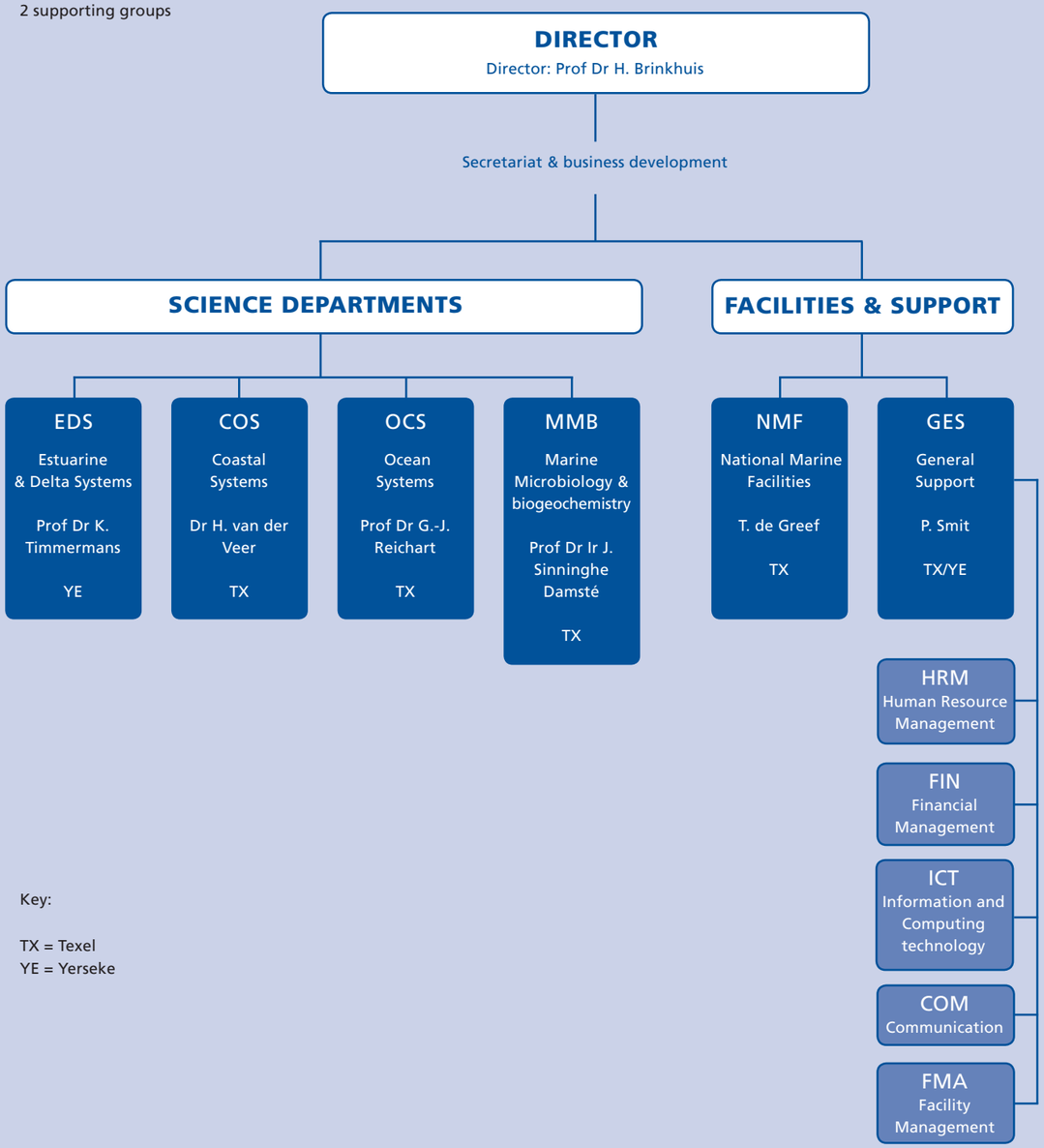
Key:

NIOZ SAC = Science Advisory Committee;
NIOZ OR = NIOZ workers council.

TX = Texel
YE = Yerseke

ORGANIZATION OF NIOZ 2.0

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

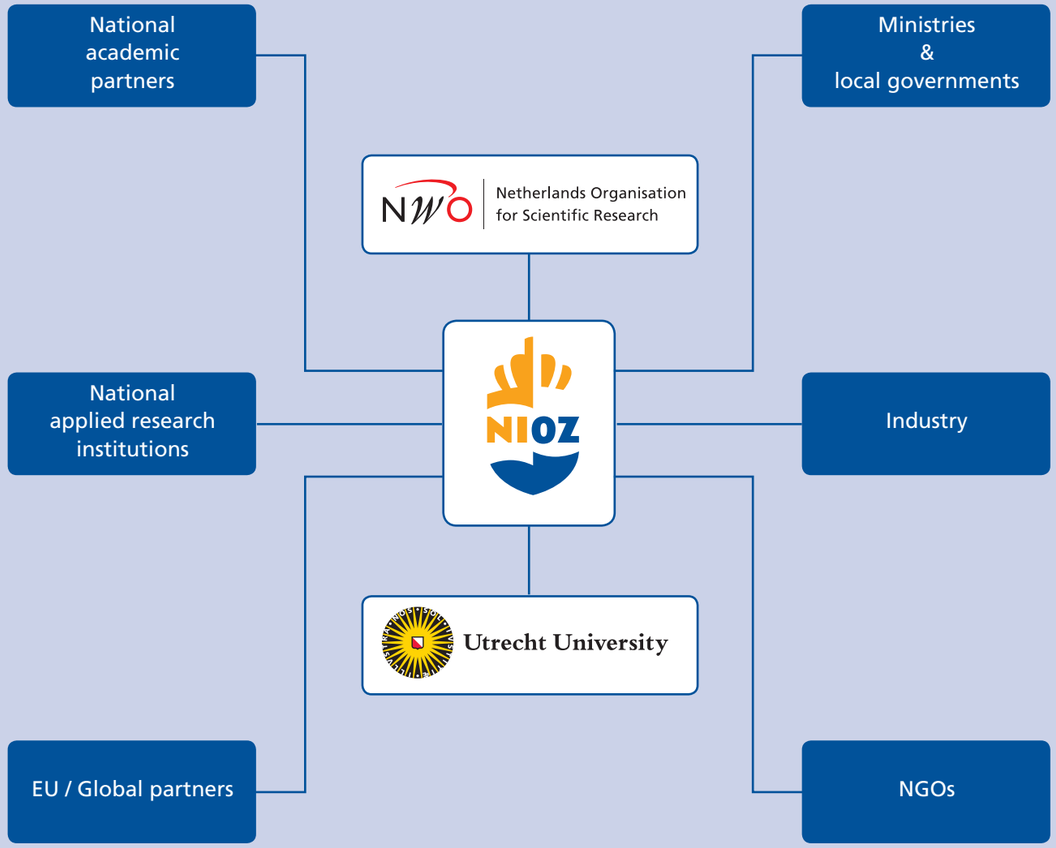


Key:

TX = Texel
YE = Yerseke

POSITIONING OF NIOZ 2.0 AMONG IMPORTANT NATIONAL AND INTERNATIONAL STAKEHOLDERS

NWO/NIOZ 2016: National *hub* for marine research in cooperation with Utrecht University



PICTUREBOOK 2016

27 JANUARY: Chairman of the General Board of NWO Dr Jos Engelen, Chairman of the NIOZ board Ir Harry Baayen and Rector Magnificus of Utrecht University Prof Dr Bert van der Zwaan embarked on the long-term (10-year) scientific cooperation agreement between NIOZ, Utrecht University and NWO.

16 FEBRUARY: Start INSITE project 'Shadow'. Dr Furu Mienis on deck of RV Pelagia near an offshore platform in the North Sea.

11 MARCH: Prof Dr Corina Brussaard was elected as fellow of the American Academy of Microbiology (AAM), based on 'scientific excellence, originality and leadership in her field of microbiological research'.

23 MARCH: Prof Dr Jaap Sinninghe Damsté receives a €2.5M advanced grant from the European Research Council for his molecular micro-biological research into the evolution of lipid molecules from different groups of micro-organisms.

31 MARCH: Presentation of the children's book Uitblinkerz!, inspired by NIOZ bird research on knots, written by NIOZ communication officer Thomas Leerink and illustrated by NIOZ scientist Pia Drent.

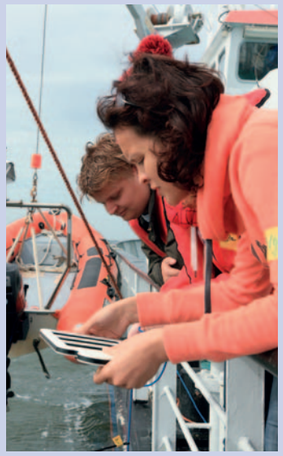
9 JUNE: Metawad Symposium and RV Navicula present at Oerol art festival on the Wadden island of Terschelling. NIOZ Wadden Research explained to visitors attending Oerol art festival on deck of RV Navicula.

9 JUNE: Metawad symposium 'in the field'.

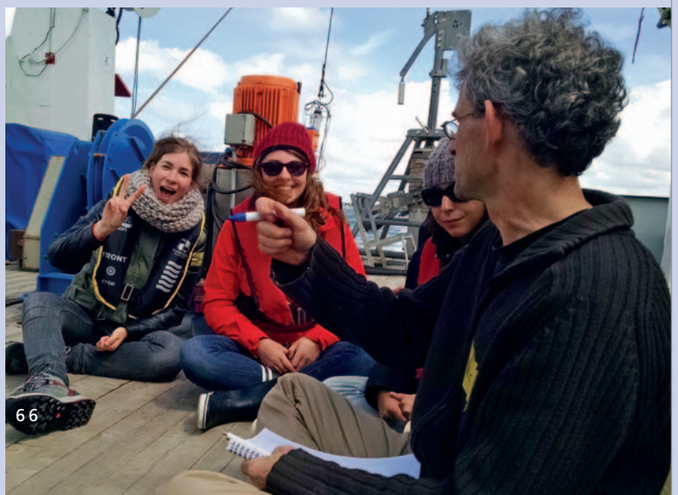
10 JUNE:
Launching 'the Blue Route' of the National Science Agenda (NWA): Water as a pathway to innovation and sustainable growth.

20 JUNE:
Dr Jan-Berend Stuut explains the importance of Sahara dust as an ocean fertilizer in debate centre De Balie, Amsterdam.

SUMMER 2016:
NIOZ Marine Masters' Summer Course.



SUMMER 2016:
Master students gain valuable hands-on experience in oceanographic research on NIOZ RV Navicula during the annual two-week NIOZ Marine Masters' Summer Course.



SUMMER 2016:
'NIOZ harbour' becomes 'Seaport Texel' as an independent LLC. Director: Thomas de Greef. Screenshot website Seaport Texel (left). Aerial view of seaport Texel with the entire NIOZ research fleet (and TESO ferry 'Schulpengat') in the harbour.

22 AUGUST:
Minister Martijn van Dam of the Ministry Economic Affairs brushes up his knowledge of seaweed cultivation as a possible food and energy source.

24 AUGUST:
Restoration of sea-grass meadows in the Wadden Sea threatened by marine 'potato-disease-like' Phytophthora fungi. Laura L. Govers (RU & RUG), Tjeerd Bouma et al. Proceedings of the Royal Society B. Seagrass (Zostera marina) near the isle of Sylt.

15 SEPTEMBER:
NIOZ and Control Union start Control Union Water BV as a spin-off; initially for ballast water treatment testing. The signing of the agreement by the Directors of Control Union and NIOZ.

28 OCTOBER: All good things come from above, for cold water coral communities. Publication Scientific reports (Nature.com). Cold water coral community at Oreo mound on Rockall bank with crinoids and sponges. The mound was named after the fish in the picture.

29 NOVEMBER: Minister of Education, Culture and Science Ms Dr Jet Bussemaker visits Caribbean Netherlands Science Institute on St. Eustatius, announcing a five year extension of support for the institute.

6 DECEMBER:
NIOZ Symposium at the Royal Palace in Amsterdam on the ecological and socio-economical future of the coral reefs of the Caribbean. Hosted by Their Majesties King Willem-Alexander and Queen Maxima and chaired by Prof Dr Han Lindeboom.

21 & 22 DECEMBER:
Celebrating the 140th anniversary of NIOZ during NIOZ Science Days 2016.

WISE:
Dr. Anja Spang was one of the five scientists elected for the 'Women in Science Excel' (WISE) tenure-track NWO program. She will join the NIOZ department of Marine Microbiology and Biogeochemistry, to discover more about a recently discovered, globally important group of ultra-small microorganisms.

VACANCIES:
As the result of the scientific restructuring of NIOZ aims to play an important role in marine microbiology; eight vacancies for tenure-track and permanent scientists were offered by the Department of Marine Microbiology and Biogeochemistry (MMB).

NIOZ Royal Netherlands Institute for Sea Research
is an institute of The Netherlands Organisation
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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

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70 %

of our Blue Planet
is covered by water.

80 %

of all life on earth can
be found in the oceans.

98 %

Oceans contain 98% of all
CO_2 on planet earth.

5 %

Less than 5% of the ocean
floor has been mapped.

NIOZ

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