NIOZ Royal Netherlands Institute for Sea Research, located on Texel and in Yerseke, is an institute of the Netherlands Organization for Scientific Research (NWO).

www.nioz.nl

NIOZ Texel
Visiting address:
Landsdiep 4
1797 SZ 't Horntje, Texel

Postal address:
P.O. Box 59
1790 AB Den Burg, Texel
The Netherlands
Telephone: +31(0)222 - 369300
Fax: +31(0)222 - 319674

NIOZ Yerseke
Visiting address:
Korringaweg 7
4401 NT Yerseke

Postal address:
P.O. Box 140
4400 AC Yerseke
The Netherlands
Telephone: +31(0)113 - 577300
Fax: +31(0)113 - 573616

The mission of NIOZ is to gain and to spread scientific knowledge on estuaries, coastal seas and oceans for a better understanding and a sustainable use of our planet, to manage the national facilities for sea research and to support research and education in the Netherlands and in Europe.

The annual report can be ordered free of charge, by preference on an exchange base, from the library of NIOZ Royal Netherlands Institute for Sea Research. It is also available at the NIOZ website:
www.nioz.nl/annual-report-2014

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

Realization:
Marianne Baas, Judith van Bleijswijk, Jan Boon, Taco de Bruin, Veronique Confurius, Joke van Houte, Kees Campuijsen, Henko de Stigter, Marcel Wernand, Sander Wijnhoven

Lay-out:
Nelleke Krijgsman

Interviews:
Joop Rommets - 'journalist en tekstschrijver'

Photo:
Front cover: Micha Rijkenberg
Back cover : Taco de Bruin

Printed by:
Zeeman Reclamegroep, Den Helder

ISSN: 0165-9162

ANNUAL REPORT 2014

ROYAL NETHERLANDS INSTITUTE FOR SEA RESEARCH

DELTA

INTERTIDAL

COASTAL

OPEN OCEAN

TROPICS

LABORATORY

SUPPORT

INTERVIEWS

OUTREACH

SUSTAINABILITY

FACTS & FIGURES

NIOZ 2014:
High waves and rocky shores

Gaining insight in the complex and ever changing marine ecosystems and environments from the deep oceans to the shallow deltaic coastal settings is of vital importance for modern society. Our mission, activities, multidisciplinary research, including frontier applied studies, modern research facilities, labs, and research vessels, and network of cooperating national and international universities and institutions are all dedicated to this task. Furthermore, NIOZ supports academic and applied marine and maritime research with know-how and infrastructure in the Netherlands and abroad.

In 2014, research at Royal NIOZ continued to focus on marine environments globally, in estuaries and deltaic settings, from polar regions via temperate zones to tropical coral reefs and sea-grass fields, and into the depths of the oceans. Royal NIOZ is a respected and trusted partner in a multitude of national and international efforts to improve our understanding of the changing seas and oceans, and for paving the way to improved and sustainable use of them in terms of coastal protection ('building with nature'), global food, energy and other natural resources for broad scientific and societal benefit.

2014 was in many respects a dynamic year for the institute, with high waves, rocky shores, and many highs and lows. The institute was faced with serious budgetary issues, and the troublesome times led to a change of the NIOZ board. A new NIOZ board was installed on October 1, composed of Ir Harry Baayen (chairman), and Dr Ir Bas Buchner, Prof Dr Jack Middelburg and Drs Luc Kohsiek. Central in 2014 was addressing the problems, and moving forward with a visionary plan A new course for NIOZ, composed by the board and directorate under the guidance of Harry Baayen. A key element in our approach was to find co-investors in the scientific efforts of NIOZ, and in this context, a crucial agreement between NIOZ, NWO and Utrecht University was reached in late 2014. This new collaboration and affiliation will eventually allow significant new investments in fundamental marine sciences for the coming decade, while our national role remains unchanged.

MUST directors Tammo Bult (IMARES), Henk Brinkhuis (NIOZ) and Jan Hoegee (TNO) address the audience at the MUST symposium in Amsterdam.

Other elements of the plan were an improved financial control and transparency, a new role for NIOZ Yerseke to be developed in a regional Delta context, and avenues to secure NIOZ's sea going national marine research facilities. The latter effort led to a report by a committee headed by Ir Hans Huis in 't Veld, the CEO of the national economic 'Top Sector Water', confirming the important, and to be sustained, national role of NIOZ MRF and seagoing capability. 2015 is a transitional year in the plan, with adaptation of the organisation, with a planned start of NIOZ 'new style' in January 2016. Another aspect was improving the collaborations in the frontier applied marine and maritime scientific domain, by the formation of the Netherlands Maritime consortiUm for environmental Science and Technology, MUST, with Deltares, IMARES-WUR and TNO as partners.

Meanwhile, NIOZ scientific productivity in 2014 reached a record highs with over 300 peer reviewed publications, 165 open access papers, 6 successful PhD thesis defences at three universities, and over 550 outreach, broad scientific, and media contributions. It was also the year where NIOZ was very successful in the various national NWO/STW 'top sector' calls, and where Prof Dr Theunis Piersma, one of the senior PIs of the marine ecology department (TX), and affiliated with Groningen University, received the prestigious personal NWO/OCW Spinoza award, the largest of its kind in the Netherlands. Moreover, Prof Dr Ir Jaap Sinninghe Damsté, head of NIOZ's marine organic biogeochemistry department (TX) and also Spinoza laureate in 2004, received the equally prestigious, personal academic Dr. A.H. Heineken prize for environmental sciences this year in recognition of his contribution to the field.

Other notable achievements in 2014 included professorship appointments of Dr Klaas Timmermans (NIOZ-TX; chair: marine plant biomass) and Dr Tjeerd Bouma (NIOZ-YE; chair: biomorphological changes and ecosystem services of coastal areas) at the Groningen University, and a professorship of Dr Bert Vermeersen (chair: planetary exploration) at Delft University. Furthermore, we celebrated a NWO-VIDI grant for Dr Dick van Oevelen (NIOZ-YE), and a VENI grant for Dr Kimberly Mathot (NIOZ-TX), but also the signing of a Memorandum of Understanding with MARUM (Bremen University, Germany) at the Hannover Messe in the presence of deputy minister of Education, Culture and Science (OCW) Sander Dekker.

Cheers on the signing of the MoU between MARUM and NIOZ at the Holland High Tech stand at the Hannover Messe.

Another 2014 highlight was the Royal opening of the new seaweed research centre by HRH King Willem Alexander of the Netherlands in April. It was a day of celebration of NIOZ's innovative scientific capabilities towards a sustainable blue economy. Later that month, festivities continued in the Caribbean with the official opening of the Caribbean Netherlands Science Institute at St Eustatius, 'enabled by NIOZ', with funding from the ministry of OCW.

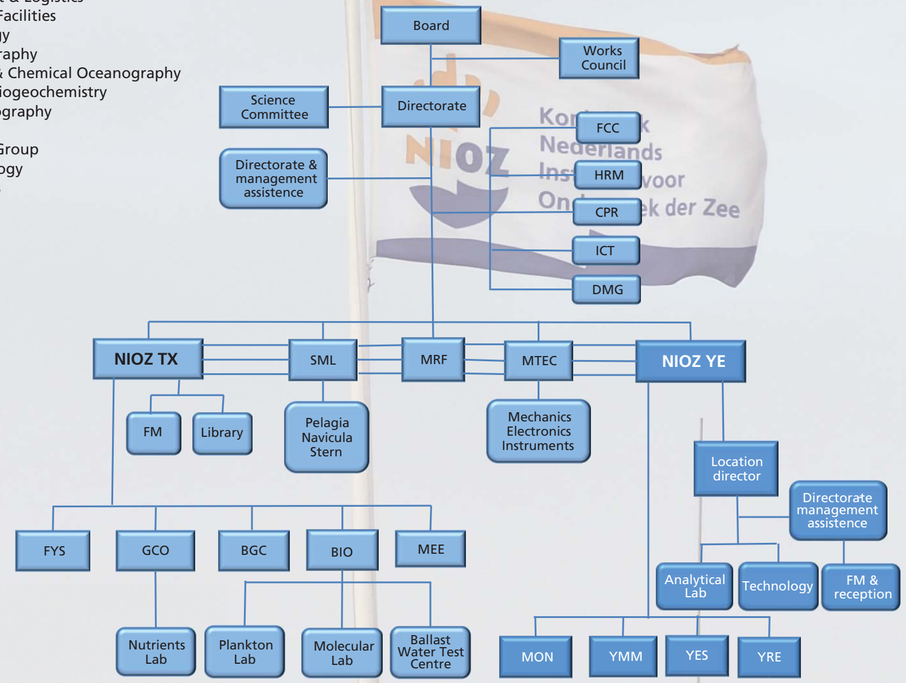
The building of CNSI at St. Eustatius.

NIOZ also successfully hosted the renowned North Sea Days on Texel, organised with its partners Deltares, WUR-IMARES Rijkswaterstaat, Maritime Campus Netherlands and the foundation Water & Media and Ecomare. At this symposium, the digital book De Staat van de Noordzee authored by prof. Peter Herman (NIOZ), Dr Olivier Beauchard and Dr Luca van Duren (Deltares), was launched. NIOZ also hosted the 9th European Workshop on the Molecular Biology of Cyanobacteria on Texel with the NIOZ Ocean auditorium fully booked!

All in all, 2014 was characterised by steep highs and deep lows. During the coming transitional year 2015, NIOZ will be evolving into a renewed, renovated and dynamic organisation, tailored to the future. We look forward in confidence, and wish NIOZ calmer seas and clearer waters in 2015.

Prof. Dr Henk Brinkhuis, general director NIOZ,
Ir Harry Baayen, chair of the NIOZ board

FCC	= Finance, Control & Contracts
HRM	= Human Resource Management
CPR	= Communication & Public Relations
ICT	= Information & Communication Technique
DMG	= Data Management Group
FM	= Facility Management
SML	= Ship Management & Logistics
MRF	= Marine Research Facilities
MTEC	= Marine Technology
FYS	= Physical Oceanography
GCO	= Marine Geology & Chemical Oceanography
BGC	= Marine Organic Biogeochemistry
BIO	= Biological Oceanography
MEE	= Marine Ecology
MON	= Monitoring Task Group
YMM	= Marine Microbiology
YES	= Ecosystem Studies
YRE	= Spatial Ecology

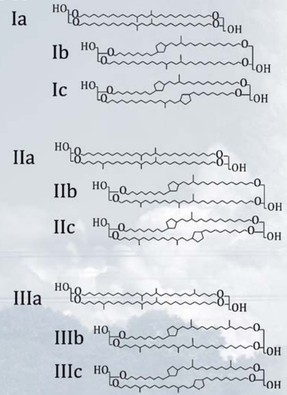


Measuring paleoenvironmental changes with microbial molecules

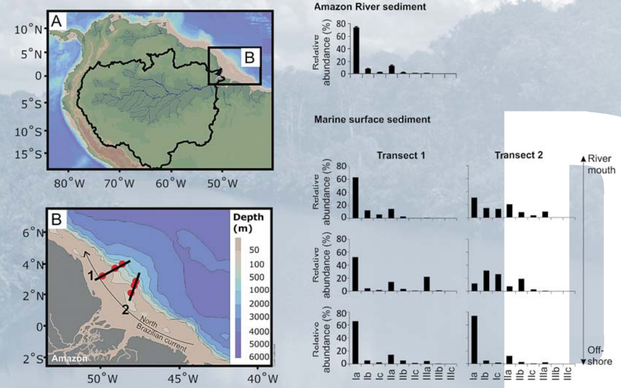
Claudia Zell, BGC

Microbial molecules in marine sediment cores are used increasingly to reconstruct the past environment. Some of these molecules are produced in high amounts in soil, thus the hypothesis was that these molecules were transported by rivers to the ocean. However, our research shows that these molecules are also produced in rivers and in the marine environment, complicating their use as tools for paleoenvironmental reconstruction.

Branched tetraethers (brGDGTs) are membrane lipids of still unknown bacteria mainly found in soil, which can adapt to changing environmental conditions. Earlier research showed that the temperature and pH of soil are the main influence on the distribution of nine different brGDGTs. These brGDGTs are eroded from soil and deposited in marine sediment. It has been hypothesized that brGDGT distribution remains unaltered during transport, and thus sediment cores close to the river mouth can be used to reconstruct river basin temperature and pH. To test this assumption, two river systems were studied, the Amazon River and the Tagus River. It was found that brGDGTs are not only derived from soils but also produced in river water and in the marine environment. Therefore, environmental reconstruction based on brGDGTs can only be done for river systems that have a strong input of soil organic matter and in marine sediment cores that are under strong influence of a river.



Molecular structure of brGDGTs



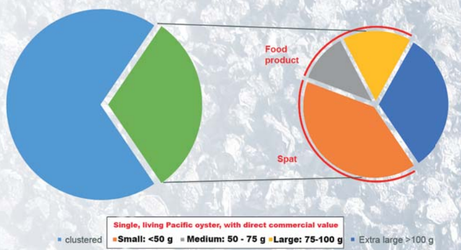
Change of brGDGT distribution from Amazon River mouth to open ocean.

DELTA

Management options for the Pacific Oyster

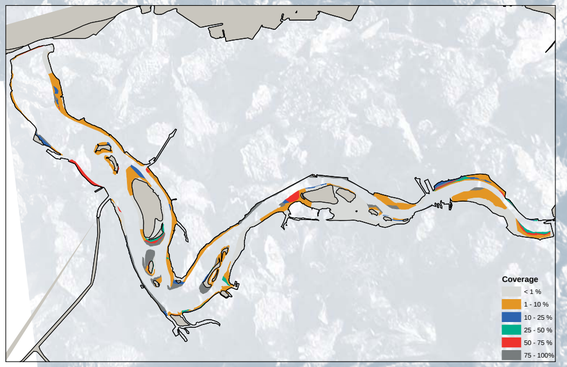
Pim van Avesaath, MON

Is the nuisance species Pacific Oyster commercially exploitable? The Monitor Taskforce participated in a consortium of public and private stakeholders as a scientific consultant to develop economic sustainable management options for the control of the feral Pacific oysters (*Crassostrea gigas*) to minimise the nuisance for water recreation.



Indication of the commercial value of living Pacific oysters depending on characteristics and size; as food or as oyster seed (spat) for grow-out in aquaculture

In Lake Veere field surveys were carried out to identify areas where oysters could cause problems for seaside visitors. This survey also revealed the first indication for the exploitation of wild oysters as commercial (food) products. Harvesting the oysters could cover the costs of the interventions and removal of this invasive alien species from the locations where it may cause problems. This observation may lead to a new kind of self-sustained management framework for Pacific oysters and other invasive species.
A feasibility study showed that, besides the surmountable technical, social and economic issues, the biggest challenge was legislative constraints regarding issuing permits for the collection of this species as a 'commercial product' (fishing activity). Irrespective of these legislative constraints, within this project, the Monitor Taskforce proved that the NIOZ, as a regional expertise centre, may act as incubator for innovative management and business approaches. This approach may lead to a new perspective within marine spatial planning at an intermediate scale, combining management of nuisance species, sustainable management of natural resources and nature conservation.



Overview of locations in the feasibility study on Pacific oyster removal in Lake Veere

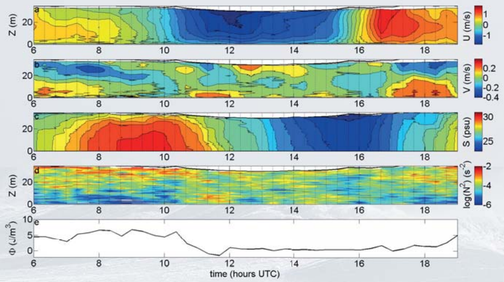
The project has been financed by RWS Z&D and VECTORS.

On the dynamics of currents in the estuarine Marsdiep basin

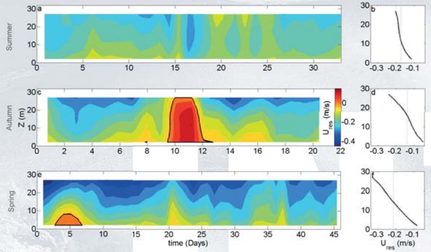
Jurre de Vries, FYS

In my PhD research, I studied the spatial and temporal variability of currents using a wide range of observations, which aimed at providing a better understanding of the small-scale hydrodynamics in the Marsdiep basin, and which can also serve as a reference case for the tidal energy plant.

Currents are an important aspect of environmental systems like the Wadden Sea because they distribute nutrients, pollutants and suspended matter, thereby partly determining the abiotic conditions and impacting the biological activity. Furthermore, tidal currents can be a potential source of energy, which will be explored in the near future by allocating a test tidal energy plant near Texel. In estuarine basins like the Marsdiep basin, the discharge of freshwater creates density gradients which modifies the shape of the vertical profiles of the instantaneous and residual currents. A wide variety of estuarine processes are able to impact the vertical profile of velocity. Our research has shown that the structure of the vertical profiles of velocity are characterized by processes which deviate from standard textbook estuaries. The complex bathymetry, the variable cross-stream circulation and the tidal distortion are some of the features that modify the estuarine hydrodynamics in the Marsdiep basin, an ideal area to study specific features and processes. Despite these atypical processes, a classical estuarine circulation is observed which is characterized by a great seasonal variability.



Results of a 13-hours anchor station during spring tide conditions. From the top down the vertical profiles of the buoyancy frequency N, the potential energy anomaly, representing the strength of the vertical stratification, that is the vertical difference in density, which is largest during late flood. Z (y-axis) indicates the height above the seabed and the time in hours in UTC on the x-axis.



Vertical structure of the residual along-stream current for three different moored deployments collected during three different seasons (Summer, Autumn, Spring). The positive values (red) around Day 11 of Autumn correspond with a major southwesterly storm.

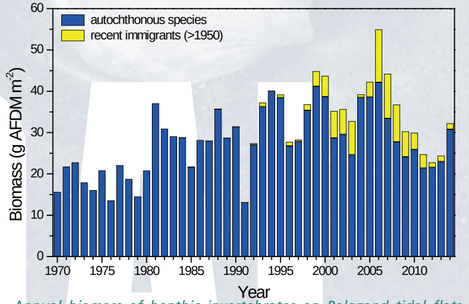
Long-term data on Wadden Sea ecology

Rob Dekker & Jan Beukema, MEE

Since the early 1970s, NIOZ runs a monitoring program for bottom invertebrates on the Balgzand tidal flats. Twice annually, at permanent sampling stations, hundreds of standardised bottom cores are sieved. The collected animals are identified, counted and weighed, yielding long-term records of numbers and biomass per m^2 in some 50 species.

Long-term data series are gaining importance by continuation. By consistently monitoring the bottom fauna, effects on the Wadden Sea ecosystem can be recorded on various continuing large-scale changes: warming climate, rising sea level, subsiding bottom, declining eutrophication. The Balgzand data series collected to date are sufficient to study trends and relationships between environmental conditions (e.g. temperature) and population characteristics (e.g. growth rates, mortality, and recruitment). Species richness increased over the years following the establishment of species originating from other continents or from southern Europe, without loss of northern species. Abundance increased particularly in winter-sensitive species. As winters became milder, higher numbers of shrimps and shore crabs occurred in spring. Accordingly, numbers of bivalve spat in summer were lower. As a consequence of higher winter temperatures, recruitment success in several bivalve species declined, leading to reduced bivalve production and biomass. It may not be coincidental that numbers of especially molluscivorous birds have declined in the Wadden Sea.

Rob Dekker and Dennis Waasdorp sampling on Balgzand



Annual biomass of benthic invertebrates on Balgzand tidal flats. Recent immigrants in yellow, including substantial shares of the worm Marenzelleria viridis and the bivalve Ensis directus, both species originating from N-America.

A turbidity maximum zone in the Dutch coastal area

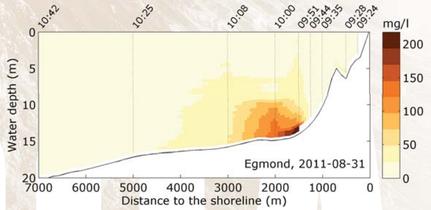
Carola van der Hout, FYS

Satellites reveal high concentrations of suspended matter close to the surface in the coastal zone, with even higher concentrations found near the seabed. New measurements have shed more light on the main transport route of suspended matter along the Dutch coast.

The North Sea is quite a turbid sea. Along the Dutch coast large volumes of suspended matter are transported, like a river of silt. This can clearly be seen from satellite images. Most of the material enters the North Sea through Dover Strait. Previous estimates of the amount of sediment that passes along the coast are very broad and do not indicate where the suspended matter may be found, and how it varies with time. This information is crucial to understand whether sand nourishments, harbor extensions or other changes to the coast affect the natural transport to ecologically important areas, such as the Wadden Sea. Within the Building with Nature program we have now found that a persistent turbidity maximum exists near the seabed at just 1.5 km from the coastline. This zone may well be the location where most of the suspended matter is transported. We performed several surveys during spring, summer and autumn at three transects perpendicular to the coast to identify the location of the turbidity maximum zone along the coast.

Water samples are filtered to determine concentrations of suspended matter. Differences in colour show concentration variations and variations in material type.

Satellite image of the Dutch coastal zone showing high suspended matter at the surface close to the coast in brown. The sediment transport direction and estimated volumes are indicated. Three black lines indicate the locations of the measurements.



The distribution of suspended matter from the coastline (right) to 7 km offshore (left) during one survey. Most concentrations are up to 25 mg/l, but there is a distinct patch (turbidity maximum zone) where concentrations >200 mg/l are found.

The beach maintained by worms?

Simeon Moons, YRE

Who doesn't like to stroll along the waterside, enjoy the warm sand or dive into the cool water? The beach must be one of our favourite places to go, and yet, we know so little about it.

In a struggle to live as close as possible to the sea without drowning, we have allowed society to domesticate the coastline. To keep the coast from eroding we feed it large amounts of sand, referred to as nourishments. Although effective, nourishments pose a frequent disturbance to the coastal ecosystem. Hence the pilot project the Sand Motor was created to investigate alternative methods of coastal maintenance. The Sand Motor is a very diverse and dynamic perturbation of the coastline, which provides many research opportunities. This prompted the idea for an interdisciplinary fieldwork campaign to study coastal processes, which was realised in 2014. For 6 weeks an international group of >20 researchers combined their efforts to measure sediment transport and its physical and biological driving forces, from depths of 18 meters all the way into the dunes. With the resulting dataset we hope to quantify the influence of macrobenthic animals, e.g. worms and shellfish, on the shape of the coast. Dunes are 'built' by grasses, and the same may apply to benthic creatures in the sea. Understanding coastal processes is key to optimising coastal management, so we can all enjoy the beach in the years to come.

Tube building worms in the intertidal zone of the Sand Motor lagoon. The physical presence of these tubes affects sediment deposition.

Measuring bed elevation in an artificial bed of tube building worms.

COASTAL

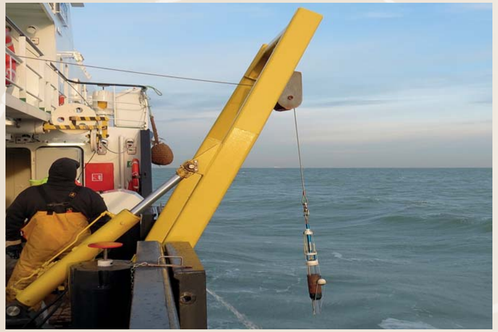
Microbial electricity from the seafloor

Filip Meysman, YES

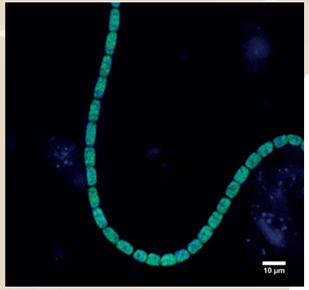
Long filamentous bacteria that create a natural living battery in the ocean floor. It seems hard to believe, but these fascinating microbes were discovered in 2014 in North Sea sediments by NIOZ researcher Filip Meysman and his team. These electrical bacteria perform a whole new form of microbial respiration, and their electron-conducting capabilities could eventually lead to entirely novel bio-electrical applications.

The newly discovered 'cable' bacteria form a true surprise from the seafloor, because they are capable of conducting electricity over centimeter distances. The bacteria are a hundred times thinner than a human hair, and consist of thousands of cells that pass electrons on to each other. In a study published in the ISME Journal, the NIOZ team shows that cable bacteria occur in many seafloor habitats, such as mangrove swamps, underneath fish farms, and even in the deep ocean. By making electricity, the cable bacteria have an advantage in the competition for energy-rich resources in the seafloor. The electricity inside cable bacteria implies a whole new way in which biological cells are cooperating, and shows how inventive biological evolution can be. The discovery also opens promising opportunities for applied research into novel bio-electrical materials and applications. Cable bacteria have evolved a biological material that is highly conductive, and maybe within some years, smartphones or photo-voltaic panels could be equipped with minuscule conducting wires of bacterial origin.

Filip Meysman explains his Royal Highness the mechanism how cable bacteria are making electricity.



Sampling for cable bacteria in North Sea sediments on board ship



Microscopic image of a cable bacterium

Grey seals found guilty of porpoise attacks

Judith van Bleijswijk & Harry Witte, BIO

Grey seals have been identified as the killers behind the mysterious deaths of harbour porpoises found with distinct mutilations on Dutch beaches over the past decade.

A NIOZ CSI-team analysed DNA from the bite wounds on three stranded harbour porpoises and found traces of three different grey seals. The study is the first successful application of forensic techniques on carcasses recovered from the marine environment.
DNA-positive wounds showed signs of bleeding, indicating that the porpoises were alive when bit. As a next step, the bite mark patterns were used to analyse pictures from autopsy reports of 1,081 porpoises that were stranded between 2003 and 2013 along the Dutch coastline. It appeared that one in five had been killed by seals, making seal attacks one of the major causes of harbour porpoise deaths in the Netherlands, alongside disease and drowning in fishing nets.
Grey seals were known as fish eaters, they can eat large fish, up to half a metre in length. Why they started eating mammals is not yet completely clear. The porpoises are targeted by the seals for their calorie-rich blubber, and healthy and fat juveniles are the favoured prey.
The study, a combined effort of NIOZ, Utrecht University and Imares, received a lot of attention in the national and international press and was published in two back to back scientific papers.

Stranded harbour porpoise with mutilations typical of grey seal attacks (photo: Cees van Hoven).

Harry Witte extracts DNA from cotton swabs of bite wounds on porpoise carcasses...

Not always as friendly as he looks here.

... and Judith van Bleijswijk extracting the data.

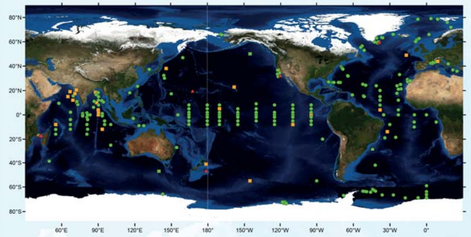
COASTAL

The Internet of ocean data

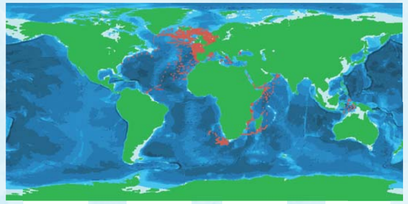
NIOZ research is global and generates large amounts of high quality and extremely valuable data. These data are made available through many online channels, thus contributing to exciting, new science and further promoting the excellent reputation of the NIOZ scientists.

Taco de Bruin, DMG

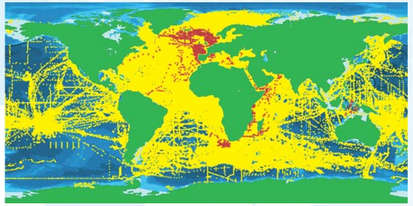
These channels include the NIOZ website, the NIOZ portals in NL-BIF/ GBIF, the portal of the Netherlands National Oceanographic Data Committee (NL-NODC) and various EMODNet portals. Two more channels merit closer attention: SeaDataNet and OceanSITES.
SeaDataNet (SDN) is a European initiative of 49 partners from 35 countries in and around Europe. The vast majority of the members are National Oceanographic Data Centres (NODC). SDN provides easy access to oceanographic data in a uniform and standardised way from one portal. NIOZ was the first institute in Europe to fully comply with the SeaDataNet standards and currently contributes over 5500 datasets of a total of over 1.5 Million.
According to its website: 'OceanSITES is a worldwide system of long-term, open-ocean reference stations'. In 2014, NIOZ contributed data on temperature, salinity, current speed and direction from its long-term moorings in the Mozambique Channel between East Africa and Madagascar (data processed for 2004-2009) and in the Irminger Sea between Greenland and Iceland (data processed for 2003-2012).



Map of all mooring and observatory locations in the OceanSITES Network (from http://www.oceansites.org). The NIOZ moorings are in the Mozambique Channel and East of Greenland.



NIOZ data available through SeaDataNet, clearly showing the world-wide coverage of NIOZ research



NIOZ data (red) super-imposed on all data (yellow) from 35 European countries, available at http://www.seadatanet.org

Mercury rising

Micha Rijkenberg, GCO

Concentration of the toxic metal mercury in the upper ocean has tripled since the beginning of the Industrial Revolution. This is the outcome of a worldwide survey of metal concentrations in the ocean.

Mercury occurs as inorganic mercury or as methylmercury. Especially methylmercury accumulates in aquatic organisms reaching concentrations that can become toxic for organisms and their consumers.
Mercury enters the oceans naturally as a result of the breakdown, or 'weathering,' of rocks on land. Human activities like mining and coal burning pollute the oceans further with mercury. Until now, only models could tell us which part of the oceanic mercury content resulted from human activity. NIOZ scientists cooperated with scientists from Woods Hole Oceanographic Institution, Wright State University, and Observatoire Midi-Pyrénées in France investigating mercury concentrations in seawater samples collected during multiple research cruises across the world. Using these measurements we estimated the mercury in the ocean that originated from natural sources and the amount of mercury that entered the oceans due to human activities. We found that mercury in the upper ocean increased three times and that the ocean as a whole showed an increase in mercury of roughly 10% since the beginning of the Industrial Revolution.

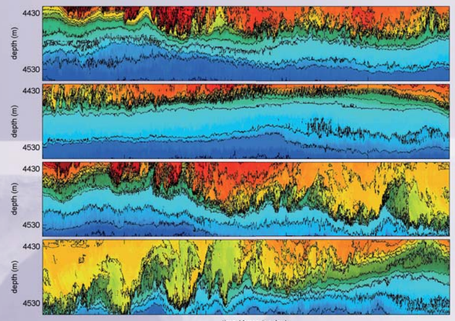
The titanium frame with 24 NIOZ developed 'pristine' ultra-clean water samplers is ready to be launched.

Extremely long Kelvin-Helmholtz billow trains in the Romanche Fracture Zone

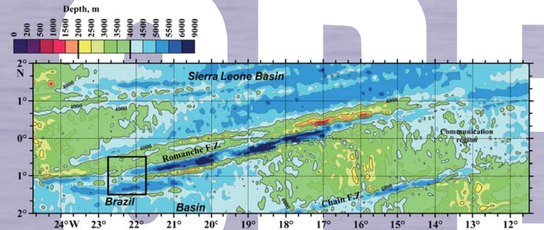
Hans van Haren, FYS

At the sill-slope in the deep Romanche Fracture Zone of the Mid-Atlantic Ridge, the rapidly flowing 'Antarctic Bottom Water' causes strong turbulent mixing with the overlying water masses. This is demonstrated and quantified in detail using moored high-resolution temperature sensors.

In the Atlantic Ocean, the densest water mass 'Antarctic Bottom Water' (AABW) can only cross the Mid-Atlantic Ridge from its southwestern to northeastern basins in deep conduits. At the southwestern entrance of one of these conduits, the equatorial 'Romanche Fracture Zone' (RFZ), AABW crosses a sill at a depth of 4550 m in a 7 km narrow channel before plunging into the deep. During the Russian-Netherlands collaboration project a 200 m long cable with 99 NIOZ temperature sensors was moored between October 2013 and April 2014.
A one day example from half-year long moored observations at the southwest entrance of the RFZ using NIOZ temperature sensors. It demonstrates the turbulence details of mainly current shear-induced mixing between cold, deep AABW and relatively warmer overlying Atlantic waters. The AABW-inflow into the RFZ and the tide constitute a means for an extremely long train of >250 consecutive Kelvin-Helmholtz billows (turbulent overturns) that vary between 5 and 100 m in vertical scale.



One day example from half-year long moored temperature observations. The colour range [dark-blue, dark-red] represents the temperature range [0.5, 1.2]°C. This figure together with the background picture formed the cover-image of the 2014 (V41, 23) Geophysical Research Letters issue.



Working area within the black rectangle around the southwestern entrance of the Romanche Fracture Zone.

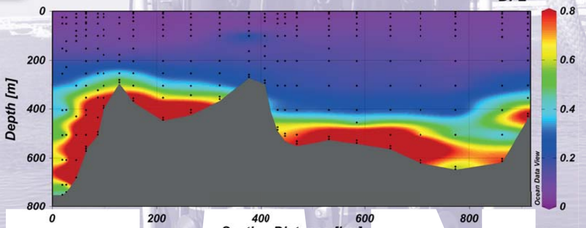
Where do phytoplankton shop for iron in the Ross Sea?

Loes Gerringa, GCO

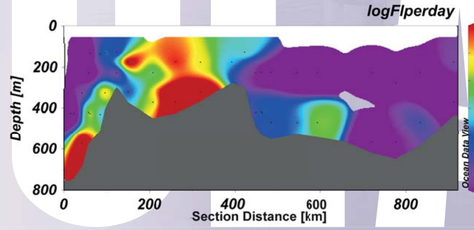
Dissolved iron, an essential nutrient for marine phytoplankton growth, is extremely scarce in Antarctic surface waters. A study in the Ross Sea revealed an unexpected source of iron, sustaining local phytoplankton production. In turn, the phytoplankton is at the base of the Antarctic food chain.

On board the American ice breaker N.B. Palmer we studied sources of iron in the Ross Sea and iron transport to the photoactive upper 50m of the ocean. This 'Phantastic' project, carried out in collaboration with researchers from Stanford University, was funded by the US-NSF.
Dissolved iron concentrations are extremely low in the upper 50 m of the Ross Sea. We discovered, however, that concentrations near the bottom were more than 20 times higher, and highest in layers containing fine-grained suspended sediment particles. We concluded that these layers must be the main sources of iron. This is surprising because it was generally accepted that these layers adsorbed iron, thus removing it from the water column. We found that dissolved iron transport from near the bottom to the surface is favoured by water turbulence generated over shallow submarine banks.

Loes Gerringa in front of the Nathaniel B Palmer in the Ross Sea



Dissolved iron, DFe in nmol per liter, in the Ross Sea. The dissolved iron is very low in the upper 50m, and relatively high near the bottom.



Transport of dissolved iron (mol m^{-2} day^{-1}) to the upper mixed layer (50 m). The upward transport is expressed as logarithmic values, ranging from -8 (=10^{-8}) to -6.8 (=$10^{-6.8}$). Transport is highest near banks.

OPEN OCEAN

Molecular analysis of bacterial diversity of an acidified tropical Bornean estuary

Henk Bolhuis, YMM

The tropical Brunei estuary system is characterized by a spectacular double gradient between acidic (pH 5) fresh water from the Brunei River to the basic (pH 8) marine Brunei Bay. We studied the effect of these factors on microbial mat communities along this gradient.

In a unique collaboration with the University Brunei Darussalam and the Utrecht University, we performed one of the first microbial studies in Brunei, a wonderful tropical country in north east Borneo. The acidity of the river is caused by drainage of acid rain forest soils during the rainy season. This low acidity had a clear effect on the morphology of some of the local shellfish of which the shell was more eroded upriver than downstream in the neutral bay. As microbiologists we are interested in how these strong gradients affect the microbial community composition and function. In a pilot study we sampled several microbial mats along the Brunei River into the marine part of the bay. Molecular analysis revealed that the composition was mainly affected by the salinity gradient and that most of the identified bacteria are novel and have no cultivated close relatives.

Bolhuis H, Schluepmann H, Kristalijn J, Sulaiman Z, Marshall DJ (2014) Molecular analysis of bacterial diversity in mudflats along the salinity gradient of an acidified tropical Bornean estuary (South East Asia). Aquatic Biosystems 10: 10.

Sampling at the mudflats of the Brunei River at low tide.

Mangrove intertidal system at the island Pulau Pepatan

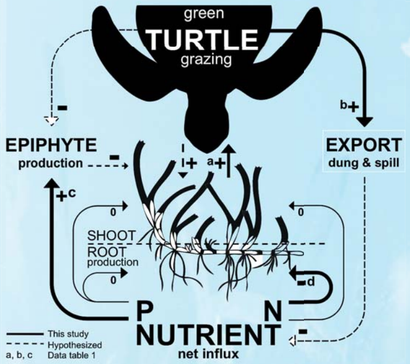
Sea grass habitat collapse due to turtle overgrazing

Marjolijn Christianen, MEE

With field experiments and mathematical models, the effects of turtle grazing and wave actions on sea grass meadows near East Kalimantan were evaluated. Results indicate that a tipping point is almost reached

Green turtles Chelonia mydas and sea grass meadows heavily depend on one another. Sea grasses act as ecological engineers that manipulate their own environment as they alter the water flow, nutrient cycle and food web structure. Green turtles graze on the sea grass meadows, which also stimulates the growth of the plants. The study site, a sea grass meadow near East Kalimantan in Indonesia, is a marine protected area with a particularly high density of green turtles of about 20 animals ha-1. This is so large that the turtles have adopted a new grazing strategy which is actually damaging the meadows. These have now started to erode and our computer model predicts that they are close to a collapse. As a solution we have proposed to enlarge the marine protected area.

Source: Christianen M.J.A. (2013) Seagrass systems under nutrient loads, hydrodynamics & green turtle grazing – Do green turtles rule the seagrass world? PhD thesis, Radboud University Nijmegen.



Conceptual model of seagrass functioning under turtle grazing and high nutrient loads. Leaf grazing by green turtles increases seagrass production (arrow a) and export of daily primary production (arrow b). When nutrients are added, rhizome biomass decreases (arrow d), resulting in a destabilization of the sediment. Plus, minus and zero signs indicate positive, negative, and absent effects of one flux or turnover rate on another.

Green turtle Chelonia mydas

TROPICS

Bivalve larvae in the picture

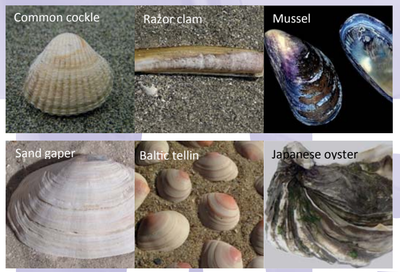
Anneke Bol, MEE & Judith van Bleijswijk, BIO

Bivalves reproduce via larvae that float in the water column. These larvae cannot be identified to the species level with a microscope. Therefore, diagnostic DNA tests for six common bivalve species were developed in the laboratory.

Six bivalve species dominate the Wadden Sea: the common cockle, the razor clam, the mussel, the sand gaper, the Baltic tellin, and the Japanese oyster. To understand the wax and wane of these species, knowledge on the dispersal patterns of their offspring is important, both in time (seasonal variation in spawning) and in space (vertical distribution of larvae). In the NIOZ molecular biology laboratory, the presence of bivalve larvae is detected on an agarose gel after species specific multiplication of DNA. Samples that contain larvae show a DNA band whereas samples without larvae remain blank. Results of a year round screening of samples from the Wadden Sea show interesting seasonal patterns that differ per bivalve species. Typically, larvae of the Baltic tellin are found early in the year only, whereas larvae of Japanese oyster appear in late summer, and larvae of the razor clam are present almost year round. The results are used for ecological models by Dr. Katja Philippart.

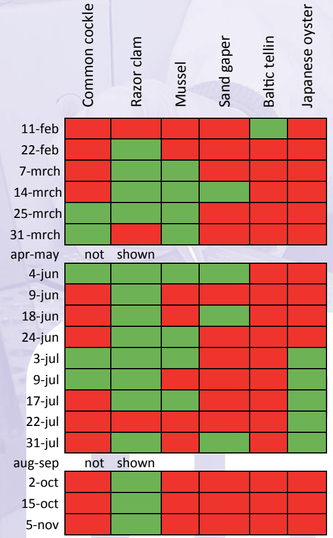
Publication: J. Plankton Res. (November/December 2014) 36(6): 1512-1527. doi: 10.1093/plankt/fbu073

Anneke Bol



Dominant bivalves in the Wadden Sea

Agarose gel with DNA ladder (L) and samples s1-s10. Bands (1) indicate that larvae were present, blanks (0) indicate larvae were absent



Year round presence (green) and absence (red) of larvae of six bivalve species in the Marsdiep tidal inlet sampled during high tide.

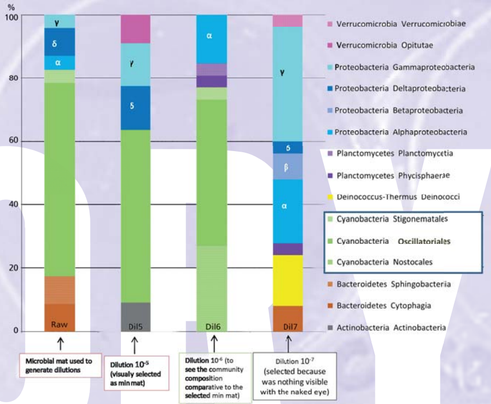
Marine Microorganisms: Cultivation Methods for Biotechnological Applications

Lucas Stal, YMM

Marine microorganisms form an almost untapped resource of biotechnological potential. However, its use is hindered by the low success rate of isolation of novel microorganisms and often by poor growth efficiency. Hence, the vast majority of marine microorganisms has not been cultivated and is often considered as 'uncultur-able'.

MaCuMBA (www.macumbaproject.eu) aims at improving the isolation rate and growth efficiency of marine microorganisms from conventional and extreme habitats, by applying innovative methods, and the use of automated high throughput procedures. The approaches include the co-cultivation of interdependent microorganisms, as well as gradient cultures and other methods mimicking the natural environment, and the exploitation of cell-to-cell communication. MaCuMBA grows thousands of cultures simultaneously using gel microdroplet technology. Single-cell isolation methods facilitate the isolation of specific target cells. The department of Marine Microbiology studies microbial mats as a model ecosystem. The microorganisms are characterized and deposited in the Culture Collection Yerseke (CCY) (www.ccy.nioz.nl). MaCuMBA (Brazilian-Portuguese word) stands for witchcraft and black magic, as still much of the cultivation of marine microorganism is to us.

Two different ways to cultivate microorganisms.



Microbial mats are complex and highly diverse microbial ecosystems formed by cyanobacteria (green) The 1st bar shows the community composition. Stepwise dilution (to extinction) is a method to produce a more simple microbial community. In the 4th bar, cyanobacteria were extinct (no green) and no mat was formed. The 2nd bar shows the community composition of what we call a minimal microbial mat and the 3rd bar shows the microbial community 10x less diluted than the minimal mat.

MARINE RESEARCH FACILITIES

Erica Koning, MRF

For the NIOZ flagship RV Pelagia 2014 was a year filled with highlights. The most remarkable event took place on April 15, when King Willem Alexander visited the ship and enjoyed lunch on board.

The 2014 cruise program was a succession of barter (exchanges with our European OFEG research partners) and semi-commercial charter cruises, and 2 cruises for national science programs. The program started in Ponta Delgada, Azores, with the first barter for the US National Science Foundation, followed by a charter in the North Sea and Baltic Sea for the German Hydrological Survey. After an 8-day 3D-seismic charter for Deltares in mid-April, Pelagia returned to Ponta Delgada for 'Treasure', carried out in the framework of the 'Topsectoren' on the effects of deep sea mining. In June Pelagia was moored in front of the Scheepvaartmuseum in Amsterdam for a 9 day public event. Approximately 3000 people visited the ship.
In July, a 28-day barter cruise in the Norwegian Sea for NERC produced a record 0.5 km of piston core and 1200km of seafloor mapping. At the end of September, after the biogeochemical HCC cruise that ended in Barbados, Pelagia made her way to Mauritius for a 75-day charter for the German Bundesdienst für Geowisseschaften und Rohstoffe (BGR). During this cruise, as yet unknown, black smokers were discovered along the Southwest Indian Ridge. The area was subsequently named 'Pelagia field'.

RV Pelagia moored next to the 'scheepsvaartmuseum' in the centre of Amsterdam. The schip was open to all visitors of the museum in June.

King Willem Alexander visits RV Pelagia in the harbour of Oudeschild, Texel on 15th April.

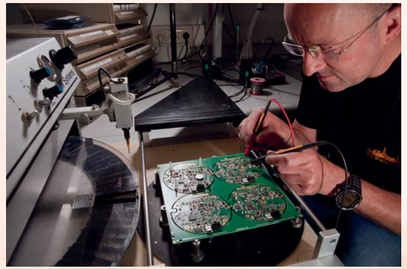
Recovering a TRAFFIC buoy that has collected Saharan dust for the past year.

SUPPORT

MARINE TECHNOLOGY

Walther Lenting, MTE

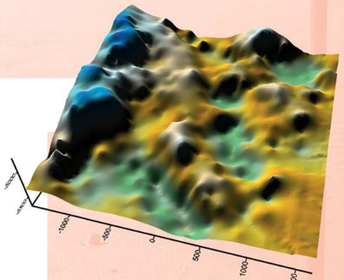
The Marine Technology Department offers technical solutions to answer scientific questions. For this purpose, we design, build and maintain scientific equipment. Here, we highlight two of them.



Development of a new data logger to meet future needs.

The HD Stereo Photo Cam is ready to map a coral reef on one of the Dutch Caribbean Islands.

The upper part of the sediment meter.



3D architectural complexity image in a 3 by 3 m quadrat of the coral reef bottom. Maximum elevation is approximately 40 cm .

Measuring the height of intertidal flats
Can intertidal flats keep up with the rise in sea level? If not, then they will slowly drown, which will have enormous consequences for intertidal ecosystems. This was the starting point for our electronics division (MTE) to develop a sensor for Prof Tjeerd Bouma. The sensor can simply be stuck into the sand and uses a vertical array of 200 light sensors to monitor the height of the sediment surface. It autonomously logs the data, which can be retrieved via WiFi.

HD stereo photo cam for coral reef mapping
NIOZ scientist Fleur van Duyl and IMARES scientist Erik Meesters needed a system to map the 3-dimensional structure of the coral reefs of Dutch Caribbean islands. MTE developed a system in which two HiRes photo cameras are coupled with forward and downward looking video cameras. Two parallel laser beams are used for targeting and visual sizing of the reef community. The system can be used either by a diver, or from a vessel using an umbilical.


NIOZ
Royal Netherlands
Institute for
Sea Research, Texel
000050 9
22G1
NIOZ
TEXEL
NIOZ
22G1

NIOZ investigates potential impact of deep-sea mining near the Azores

Yvo Witte, MTM & Henko de Stigter, GCO

The ocean floor is locally rich in precious metals. Harvesting these submarine treasures is a challenging task, however, because of the extreme water depths involved. Also, it hasn't been settled which countries are entitled to exploit these deposits. Yet, in view of the increasing scarcity on land of certain high-tech metals, it seems merely a matter of time before deep-sea mining will be a booming industry. But how will the deep-sea environment cope with industrial extraction of metal deposits? And in what state will the seabed be left to future generations?

To answer these important questions, NIOZ scientists along with partners from Delft University of Technology, IMARES, TNO and Dutch shipbuilding and dredging companies have initiated the 'Treasure' project, short for 'Toward Responsible Extraction of Submarine Mineral Resources'. The project is funded by NWO and Dutch industry partners. Methods for assessing the environmental impact of deep-sea mining are being tested in practice in an area southwest of the Azores where metal-rich mineral deposits occur around deep-sea hot springs located more than 2 km below the sea surface. 'With the growing demand on raw materials it will sooner or later become economically profitable to exploit these deposits' says Henko de Stigter, researcher at NIOZ's Marine Geology and Chemical Oceanography department. 'The mineral deposits are rich in copper, lead and zinc, but also contain some rare metals which are indispensable for the production of laptops, mobile phones, electric cars and wind turbines. The western industrial nations are keen to exploit these resources in order to become less dependent on export from China.' De Stigter: 'We know still very little about the deep-sea life of the area, and even less about how it will be impacted by mining. We can only hope that the ecosystem will recover after mining, but will it really do? And if so, how long will it take? Our challenge is to investigate this all.'

In order to assess the original state of the deep-sea environment in the area, bottom landers equipped with various sensors and cameras have been deployed in the area, during an expedition with research vessel Pelagia in 2014. The landers, designed and built by NIOZ's Marine Technology department, will be recovered during a subsequent expedition in spring 2015. 'Exciting moments, whether or not our equipment will return in good state to the surface', comments technician Yvo Witte. 'At those depths, the instruments are exposed to extreme conditions.'

He and his colleagues are well prepared for their job. 'We participate in the yearly Inmartech conferences, where marine engineers from all over the world meet to exchange ideas. Deep-sea research is technically challenging, requiring innovative solutions. The need to improvise and find out by ourselves is what makes our job really exciting.'

NIOZ technicians develop a weighing robot for samples from the intertidal flats

Johan van Heerwaarden, MTI, Sander Holthuijsen, MEE & Roel Bakker, MTI

'That must be possible in a more convenient, more accurate and much faster manner' stated Sander Holthuijsen after he and his Marine Ecology colleagues finished yet another year in which they took between 50,000 and 70,000 weighing cups from a tray and put it on the scales by hand.

Instrument maker Johan van Heerwaarden remembers the first visit of Sander Holthuijsen still very well. 'Can't you make something?' Sander asked us. 'Of course we can; that is what we do all the time' he answered dryly. The result is operational for a year now. Together with his colleague Roel Bakker, van Heerwaarden designed and built a weighing robot. The robot plays a main role in the SIBES project, for which almost 5000 samples from the soft sea bottom are taken over the entire intertidal area of the Dutch Wadden Sea between the 'Balgzand' and the isle of Borkum. The samples have a diameter of 15 cm and consist for a large part of sand, mud and other dead material. 'But they also contain worms and shellfish, which are both important food sources for sea birds and fish. Therefore we sieve out all organisms larger than 1 mm, name and count them and put each species in a weighing cup and register the samples. Weighing is repeated two more times for each cup' says Sander Holthuijsen. 'The second time after the sample has been dried at 60˚C to determine the dry-weight, and a third time after the sample has been burnt to ash at 560 ˚C to determine the ash-weight. What we want to know is the biomass, the difference between the dry-weight and the ash-weight. This tells us how much a bird must eat to be able to survive'.

Weighing by hand is very labour intensive. 'For one person it would be a full-time job for a whole year. The robot designed by van Heerwaarden and Bakker saves us a lot of work. You can put 96 cups on a plate and four plates in a rack. In less than an hour they are all weighed. Each weighing cup has its own unique code, which is detected in a light sluice. A computer programme developed by our colleague Frans Eijgenraam recognizes them. In this way, the computer knows for example that cup 15 in rack 20 contains one lugworm and it also knows where this lugworm was found in the Wadden Sea. This method is so successful that in the mean-time other groups are also using our weighing robot.'

'But we aren't ready yet' tells Bakker. 'Changing the plates is still done manually, but we are planning to automate this step too. Then we could weigh 5300 cups in one day. In this way we are improving the system continuously. We are the only team in the world who can do this type of research on such a large scale.'

The customer can trust our data

Olaf van Hoesel & Pim van Avesaath, YMT

Customers must be certain that the data they get are accurate and do not depend on the bias of the researcher. For this reason the NIOZ Monitor Taskforce has developed a quality management system and submitted it for accreditation according to the NEN-EN-ISO-IEC-ISO 17025-standard.

The Monitor Taskforce (MON) in Yerseke is a semi-commercial department, which conducts applied marine science. Clients like 'Rijkswaterstaat', the Port of Rotterdam, and government agencies are often obliged by law to compose environmental impact assessments describing the ecological situation of, for example, a harbour or an estuary for which they are responsible.' 'We investigate life in the sandy bottom. Which animals are living there? In what numbers? How does this compare to earlier measurements? These are the most important questions we try to answer. Based on this we make ecological analyses' tells Pim van Avesaath, Quality Manager of MON.

In 2008, Olaf van Hoesel developed an ISO 9001 certified quality management system which described all processes and steps between sampling and the final publication of the data in a report. 'Reacting on questions from the market, after some slight hesitation, we took this system one step further with respect to the analyses of the samples. The most important reasons to do this were the stiff competition and the economic crisis, which lead to a clear decrease in demand of our skills.' The new system according to ISO 17025 is better related to the scientific needs and shows that we have the knowledge to deliver what we promise. It obliges us to use the same set of methods in the vast majority of cases and when we choose to use an alternative method, this should be underpinned with a sound argumentation.'

This way of working asks quite a lot from the people involved. 'Besides the analyses, quite a lot of work is added for proper reporting and quality control' tells van Avesaath. 'MON has 10 employees of which about half are involved in research while the other half carries out support work. We train people. They have to pass a test before they are allowed to determine the animal fauna of the sea floor by themselves. This implies that we must stimulate all the people involved to work within a framework, also when this is more time-consuming.' Van Avesaath experiences it can be difficult to enforce this. 'Sometimes I am a colleague yet on other occasions I can be an annoying 'boss' who checks whether everybody is working according to required high quality standards.'

'But finally we all benefit from a good result' he thinks. 'The customer can rely on the data. Besides this, we also assemble a dataset covering samples taken over a period of many years. Because they have been analysed with exactly the same methods, they are directly comparable. There has also been keen interest of other NIOZ departments for the experience we gained on the way towards accreditation. The chemistry lab in Yerseke and the ballast water test & research centre on Texel also want to set-up a similar quality management system. As pioneers we can share our experience and knowledge with them. They could benefit a lot from that; accreditation is not simply a cheap swimming certificate.'

A unique collection of photo-synthetic micro-organisms

Henk Bolhuis, Lucas Stal & Michele Grego, YMM

Cyanobacteria and algae are fundamental life forms. Their contribution to the global biomass is enormous, and therefore receive worldwide scientific interest. Scientists expect that they can play a role in various technological applications. The Culture Collection Yerseke (CCY) is a unique collection of 500 microbial species maintained by the department of Marine Microbiology of NIOZ in Yerseke, led by Lucas Stal, and receives increasing attention worldwide.

Three billion years ago, cyanobacteria were the first to produce massive amounts of oxygen using light, water and carbon dioxide (a process called photosynthesis). The presence of oxygen was crucial for the development of higher life forms. Recently, scientists discovered other interesting functions of cyanobacteria and algae. They can regenerate polluted soil or water, produce antibiotics, and produce sustainable energy in the form of biofuel.

NIOZ maintains a unique culture collection of these photosynthetic micro-organisms. This is a golden egg according to scientist Henk Bolhuis. 'Because we maintain this collection we are granted large projects. We are a popular partner for other institutes because we have something unique, something they do not have.'

Every micro-organism has its own specific growth characteristics. One is restricted to fresh water, the other requires sea water, whereas a third only thrives in pools of 40 degrees Celsius. Also the rhythm of day and night is a crucial factor for cyanobacteria. 'Tropical species require 12 hours darkness and 12 hours light', explains curator Michele Grego.

This all makes maintaining a large culture collection a specialist's job, requiring special knowledge and attention. 'Michele is really dedicated. It is more than a job for him. He never takes off more than two weeks', says Bolhuis in admiration.

To prevent fungi and other contaminants infecting the vulnerable culture collection, Grego has a special lab with air filters to maintain sterility. This was quite an investment. Money is also needed to extent the collection. Bolhuis stresses that it is important to not become dependent on companies. 'Financial input from commercial companies is welcome but can also complicate our job. They want to keep new discoveries for themselves, whereas we serve the public community. Accessibility of the collection to everybody is important. That's science.'

For more information: www.ccy.nioz.nl.

Ups-and-downs of migrating birds

Theunis Piersma, MEE

Why is it that spoonbills were threatened to extinction thirty years ago, whereas currently they arrive with thousands in the Wadden Sea to raise their chicks? Such questions are tackled by Theunis Piersma and co-workers.

To support his work, Piersma was honoured in the presence of HRH Willem-Alexander with a Spinoza-prize, worth of 2.5 million euro. A big success for his research group, housed at NIOZ in the so called 'birdwing'. 'Twenty-eight years ago we started with two people in a small room', Theunis says. Good research has led to a steady growth of the number of participating scientists. 'We now count twenty people who are very productive scientifically, with publications in high impact journals. Moreover, we contribute knowledge that is valued by nature conservation organisations such as Staatsbosbeheer and Natuurmonumenten. And this, in turn, helps to obtain new money for new science. We are an international group, composed of scientists from Russia, Canada, Mauritania, China, Ghana, Australia, Spain and Argentina. Sometimes visiting scientists bring their own money.'

Piersma and co-workers are focussing on migrating birds like red knots, bar-tailed godwits, sanderlings and spoonbills. In the past, questions about food (what and how much) were already tackled, but currently scientists go further and also study the interactions between population size and changes in food availability. 'In the 1960s, in Europe only 200 breeding spoonbill couples survived. Currently, we are back at 3000 breeding pairs in the Netherlands alone. The increase is levelling off, however, despite the fact that 150 years ago 30,000 breeding couples bred in the Netherlands. The fact that numbers fail to reach these past high values is probably best explained by the Wadden Sea and inland waters now containing less food for birds. Spoonbills, and other birds in the Wadden Sea, are limited by food availability.'

To better understand migrating birds, they are tagged with colour rings. 'Subsequently we try to spot them with binoculars as often as possible.' A small number of birds are labelled with GPS trackers that register the exact locations of the bird. 'Let's say a spoonbill is born on Texel, and returns the next year to the exact spot. What has it been doing in the intermediate time? How did it learn which route to take? We do not know anything of the way that birds learn their ways of life. By tagging young birds and their parents we soon hope to discover how spoonbills discover how to migrate and how they respond to changes in their environment.'

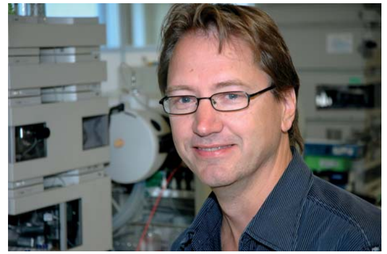
Chemical fossils help to predict climate warming

Jaap Sinninghe Damsté, BGC

The idea that climate change results in global warming seems widely accepted nowadays. But how much temperatures will rise appears hard to predict. On average rises between two and six degrees is the rather broad range given by current prognoses. More precise predictions may be obtained, however, by making use of chemical fossils of tens of millions of years old, preserved at great depth within seabed sediments.

That is the basis of the innovative research conducted at NIOZ's Marine Biogeochemistry and Toxicology department, led by Jaap Sinninghe Damsté, who was awarded in 2014 with the Dr. A.H. Heinekenprijs for Environmental Sciences.
For reconstructing the history of the Earth, geologists commonly make use of plant and animal remains preserved as fossils in rocks. Sinninghe Damsté extended this methodology to include also organic substances remaining from unicellular organisms from past geological times. 'Archaea play a major role in our research. In these micro-organisms, the chemical structure of the cell membrane is variable according to the ambient temperature. With higher temperature, more cyclic carbon structures are formed. By detailed chemical analysis of seabed samples, the temperature in past geological times may thus be reconstructed', explains the researcher.

Sinninghe Damsté and his co-workers are particularly interested in the relationship between CO_2 (carbon dioxide) concentration in the atmosphere and global temperature. 'Currently this concentration is rapidly increasing. Over the past million years the concentration fluctuated between 180 and 280 parts per million, but in recent years it rose to over 400. And according to predictions the combustion of fossil fuels will lead to a further increase to over 1000 ppm by the end of this century.'
Such high concentration is comparable to that of the middle Cretaceous, 90 million years ago. The ocean surface water was about 7 degrees warmer than at present and deeper water masses were almost completely depleted of oxygen. 'Under those conditions the CO_2 fixed by algae was less rapidly returned to the atmosphere but instead it was buried in seabed sediments. During periods of oxygen depletion the fast removal may lead to a drastic reduction in atmospheric CO_2. We were able to confirm this by analysing the chemical fossils of plants. In a mere hundred thousand years the atmospheric CO_2-content halved and ocean temperature decreased by about 5˚C. On geological timescale this is exceptionally fast.'



These interesting conclusions have resulted from the particular collaboration of various disciplines. 'On average 35 people work in our department, with background in geology, biology and chemistry. About 70 percent of the research is directed at the ocean. With almost 75 publications over the last year, we have been quite productive.'
Even so, a better understanding of the oceans is urgently needed. 'Not just for scientific interest, but also from a societal point of view, it is vital to know how global temperature will evolve in the future', comments Sinninghe Damsté. 'Fortunately we have been able to acquire funding for two major projects during the past one and a half years. Budget cuts are reason for considerable concern for scientific research nowadays, but despite that our department is coping reasonably well.'

Pioneer explores potential of Seaweed

Klaas Timmermans, BIO

‘Seaweed farming can be a world wide solution to food and energy shortage and environmental pollution.’ We are quoting Professor Timmermans, project leader of the NIOZ Seaweed centre that was opened last year by HRH Willem Alexander.

‘Seaweed farming is hot’ says Timmermans. Whereas many scientists are experiencing difficulties with funding, seaweed pioneers can increasingly count on investments from both companies and organisations. ‘Seaweed is intriguing. One can easily watch and grab it, and scientifically it is very interesting’ according to Timmermans as he tries to explain his success.

He immediately adds that his research is still in its infancy. ‘There are many things we still don’t know.’ Growth characteristics of seaweed are pretty much well known but losses caused by predation or viral lyses are yet not quantified adequately. The same counts for effects on the ecology. ‘By building seaweed farms at sea, environmental conditions are affected e.g. light and nutrient conditions change and refuges are created for a variety of animals that can hide and reproduce in the weeds.’

Although not yet fully explored, it seems that seaweed farming has great potential. Seaweed is stocked with carbohydrates and protein and can be a good food source for humans and cattle. It also has potential as biofuel. Moreover, it can purify the water from excess nutrients. ‘Rivers discharge high amounts of nitrate and phosphate into the seas, which often have negative effects on the ecosystem. When seaweed farms are positioned in the discharge area, seaweeds take up the nutrients, preventing negative effects.’

Ten kilometres west of Texel the Stichting Noordzee Boerderij started a first pilot with NIOZ as independent controller. ‘The pilot farm is still limited in size. The ambition is to harvest the first few kilos soon.

When we succeed, we will tackle new questions, e.g. how do we extract sugars from the weed most efficiently, and how can we influence the sugar content. We are only at the beginning of this trajectory.’

The group of seaweed pioneers is still small. ‘But our Seaweed Centre is growing rapidly. Last month we were granted a large project. In cooperation with Hogeschool Larenstein we are going to explore how protein from seaweed can be processed as fish-food. Currently fish-food is processed from fishmeal and soya, but this has disadvantages. It is all very exciting and interesting. As a scientist I am happy to take part in this development.’

Tammo Bult, IMARES

Henk Brinkhuis, NIOZ

Jan Hoegee, TNO

Frank Hoozemans, Deltares

Maritime Consortium Of Environmental Science and Technology MUST

The MUST consortium took off with a symposium in the Maritime Museum Amsterdam on 20 June, organised by partners IMARES, TNO and NIOZ. Recently, Deltares also joined as the fourth renowned Dutch marine research institute. Here, the four directors express their vision on the future of MUST.

IMARES/Tammo Bult
The MUST consortium makes a difference. By combining the strengths of our organisations we aim to improve our understanding of the ocean and from this, our ability to manage ocean resources sustainably. One of the topics I personally hope to develop within MUST is the subject of deep-sea or off-shore mining, a new development, requiring a pro-active approach of government, industry and knowledge partners. It is a subject the Dutch Maritime industry could excel in, by developing the technology and knowledge towards a careful, responsible and respected industry.

NIOZ/Henk Brinkhuis:
The four MUST partners clearly have complementary strengths and together we can investigate a large range of topics from purely (high-)technical to ecological and from fundamental to highly applied marine science. NIOZ will be instrumental in providing the required fundamental scientific component along the way to the eventual frontier applications. In that way we can strengthen the name of the Netherlands as a High Tech maritime nation and we can be highly competitive in the global community. Besides sustainable and responsible usage of the oceans, ‘Blue sustainable growth’ is the topic I would like to tackle first with MUST and that in a wider sense, involving Blue energy as well as sustainable food production from the sea.

TNO/Jan Hoegee
The MUST consortium will create and catalyze sustainable global ocean innovation technologies based on ecology, biology and technology fertilization. The Netherlands is, by tradition, a maritime country. Its prosperity is largely based on its position at the shores of the North Sea. The consortium will contribute to a sustainable ‘Blue Growth’, together with Dutch knowledge partners and the maritime & offshore industry. Also they will contribute to positioning the Netherlands towards a top innovative, durable maritime position in the world. TNO’s contribution will be focused primarily at an efficient and safe seafloor and deep-sea mining and sustainable new fish(farm)ing techniques.

Deltares/Frank Hoozemans
Deltares was invited to join MUST at the end of 2014 in order to complete the playing field in marine science and system-knowledge. With a strong position in our backyard covering tidal inlets, the dynamic North Sea and estuaries, the challenge will be to join forces within MUST to support (international) communities and stakeholders. With deep sea mining identified as an interesting prospect, the recently held workshop ‘Nature meets design’ is a (first) promising step.

The 9th EWMBC was the largest symposium ever at NIOZ-Texel

9th EWMBC

The 9th European Workshop on the Molecular Biology of Cyanobacteria was organised by Prof. Lucas Stal and his team from 7-11 September at NIOZ on Texel. With the Ocean auditorium fully booked (215 participants), this was the best attended symposium ever at NIOZ. For cyanobacteria the phrase 'microscopically small but giants in evolution' is very true. Cyanobacteria were the first organisms that could produce sugars and oxygen from carbon dioxide, sunlight and water in earth's history and developed already close to 3 billion years ago. The chloroplasts in all higher multicellular plants originate from incorporated cyanobacteria, giving them the possibility for photosynthesis. Cyanobacteria also have a lot of modern applied science possibilities, which was an important topic at the symposium.

North Sea Days

The North Sea Days (NSD) are organised annually to bring together scientists, policy makers and the maritime industry. The main organizing partners are Deltares, IMARES, NIOZ and Rijkswaterstaat. This year, the NSD took place on 2 and 3 October at NIOZ-Texel with the theme 'Living with a changing North Sea; Horizon 2050'. The symposium was attended by 119 participants. One of the highlights was the presentation of the digital book De Staat van de Noordzee (in Dutch), compiled by Prof Peter Herman, Dr Olivier Bouchard and Dr Luca van Duren (Deltares). The book gives infographic overviews of the many changes that took place in the North Sea during the past decades. Together with the report of the NSD 2014, it can be downloaded from the website www.noordzeedagen.nl.

Participants could vote by putting there caps on or off.

NIOZ fyke

The NIOZ fyke is assembled each year in spring by Hans Witte and Sieme Gieles.

The NIOZ fyke has been standing in the Mokbaai since 1960. Since that time many changes in the fish population of the Marsdiep have occurred. These data are now easily accessible to everybody via the website www.waddenzeevismonitor.nl. Many fish species declined but some became more populous in the Marsdiep, among them species from more southern latitudes, such as sea bass, suggesting climate change as one of the possible causes.

Clearly a talent for the future!

Open Day Texel

An Open day for the public was held on Texel on 4 October attracting 900 visitors to the institute. Scientists told them about species changes in the Wadden Sea, the danger of microplastics, and climate change. Our scientists gave lectures on a wide variety of subjects, from the importance of internal waves for mixing in the deep ocean to the trips of individually tagged sea gulls. Children were given the opportunity to do various experiments and explore the NIOZ facilities. The youngest visitors could do their own experiments and participate in a contest during their exploration through the building The winners visited the NIOZ fyke in the Mokbaai and they had a 'Royal Excursion' to the NIOZ Seaweed Centre.

sustainability

Sampling plot for seaweed growth in the intertidal zone.

Cold water coral reefs provide a home for a large abundance for species.

King Willem Alexander is clearly impressed by the size in the experimental tanks.

The first 'expert centre' at NIOZ, bringing the deep sea experise of all departments together.

As the NIOZ mission is to gain and communicate scientific knowledge of seas and oceans for the understanding and sustainability of our planet, the NIOZ respects the environment and takes action to work in a sustainable way. On the one hand the NIOZ makes efforts to optimise its daily working processes and chooses for the most sustainable solutions, whereas on the other hand sustainable management of resources and dealing responsibly with our environment, and the seas, oceans and coastal zones in particular, is the scope of a substantial part of our research.

Tangible steps that have been made in 2014 regarding health, safety and environment include:

- A start has been made to draw up procedures for working alone in laboratories and working outside office hours, to find a balance between energy saving and safety on the working floor. There has also been special attention (formation of a working group) for working with dangerous substances. In addition to the periodic medical inspections for ship crew and fire service, several non-routine medical inspections for personnel on foreign vessels have taken place.
- Clear procedures have been formulated about working with exotic or potentially invasive species. For example, in 2014 at NIOZ-Yerseke a system was installed to prevent the transfer of species from the experimental facilities into the environment (as is already operational at NIOZ-Texel).
- The oil- and gasoil-tanks at NIOZ-Texel have been replaced with new tanks and a new pump that meet the quality standards for the coming years. All light fixtures that were in need of replacement have been replaced with energy efficient lamps; e.g. outdoor lighting was replaced by LED lighting, and the separate collection of plastic waste appeared to be efficient.
- The Monitor Taskforce (MON) of the NIOZ will include principles of the Corporate Social Responsibility (CSR) guidelines in the next update of its Quality Management System. The operating procedures are ISO 9001 certified. Additionally, MON is preparing the extension of the scope of its NEN-EN-ISO/IEC 17025 accreditation of the technical analysis. The aim is to include the analyses of the Yerseke Analytical Laboratory and the NIOZ Ballast Water Test Facility & Research Centre.

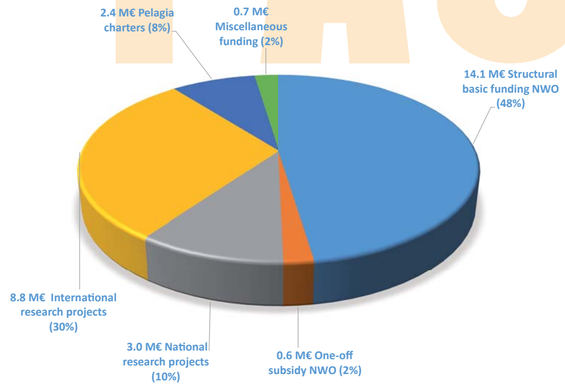
Examples of research projects with important sustainability aspects for 2014 are:

- The NIOZ, and the department of Marine Microbiology in particular, plays an important role in the InteSusAL (Integrated Sustainable Algae) project. The overall project objective is to demonstrate an integrated approach to generate biofuels from algae in a sustainable manner on an industrial scale. Both economic and environmental sustainability receive attention in the project where production technologies to achieve algae cultivation targets (90-120 dry tons per hectare per annum) are demonstrated and where working with a closed carbon loop across the whole process is considered. The ultimate goal is that high quality biofuel will widely replace mineral fuels.
- The Netherlands Seaweed Science Centre at NIOZ-Texel performs and facilitates important research on the cultivation of seaweeds. Seaweeds are an attractive source of biomass for energy (polysaccharides), food and feed (proteins), and high added value bio-active products, which do not need precious freshwater and do not claim agricultural soil. They grow on available nutrients in the sea (even reducing eutrophication) and do not need application of pesticides. Seaweeds also fix the greenhouse gas CO_2, and produce oxygen. Therefore seaweed cultivation can give a substantial boost to the development of a bio-based economy.
- The Netherlands Deep Sea Science & Technology Centre of the NIOZ aims to do independent research for a sustainable management of emerging open ocean resources. With a growing world population, sources for raw materials, food, water, and energy might become limited. Deep sea mining and exploration might be a solution. NIOZ will investigate the potentials of resource utilisation, while coping with the general threats like climate change, loss of biodiversity and habitat destruction, overfishing, and pollution, whilst maintaining the delicate balance between People, Profit and the Planet.
- In 2014 the NIOZ and its Monitor Taskforce in particular was involved in research on 'native macro algae-friendly concrete columns' in order to support weed community restoration, where the potentials for seagrass reintroduction are also still under investigation. One of the NIOZ projects in close cooperation with the stakeholder community focused on opportunities to counter negative impacts of invasive exotic species (i.e. the Japanese oyster) on recreational sites. In another project, the NIOZ was involved in providing a science-based opinion on which marine exotic species are most eligible for selection in the EU exotic species regulation, for which EU countries will have to formulate specific policy and management to prevent introduction, further distribution, and adverse effects on indigenous species, ecosystems, and ecosystem-functions.

This is just a small sample of all the research initiatives ongoing in 2014 that are directly related to sustainability issues. Reviewing our projects will teach you that sustainability is in our genes.

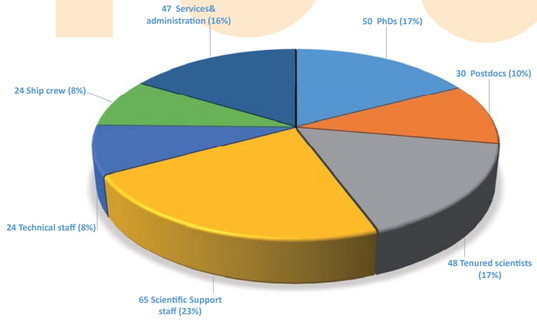
FACTS & FIGURES

Budget



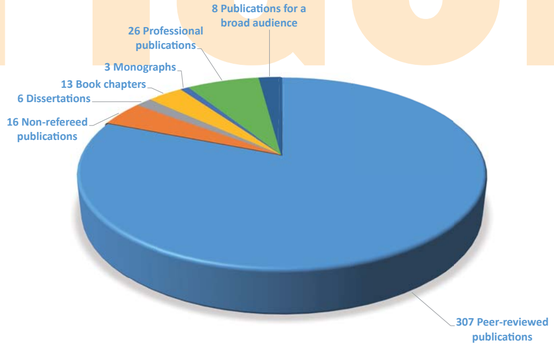
The overall budget for 2014 amounted to 31.2 M€. NWO contributed 14.1 M€ as basic structural funding (equivalent to 45% of the total budget) and 1.4 M€ (4%) as a one-off subsidy. Project related additional funding was received through national (3.8 M€; 12%) and international (8.8 M€; 28%) projects acquired through competition. Chartering of RV Pelagia to third parties yielded a net revenue of 2.4 M€ (8%). Miscellaneous and ad hoc funding amounted to 0.7 M€ (2%).
From a financial point of view, 2014 was better than 2013 due to the release of reserves and increased income from the RV Pelagia charters.

Staff



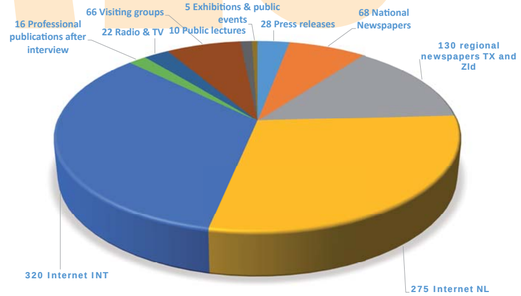
At 31 December 2014, NIOZ employed a full-time equivalent (FTE) of 288, with a total headcount of 323 employees. Of this total, 88 employees were of foreign nationality, representing 20 different countries. Total staff decreased by 21 FTE from 2013. The numbers and relative distribution in % of personnel over the different staff categories remained fairly constant. Scientific staff, including tenured senior scientists, postdocs and PhD students accounted for 44% (2013:45%) of the total staff, scientific support staff 23% (25%), and technical staff, ship crew, and services & administration accounted for 33% (30%).

Scientific output



NIOZ scientists authored an all-time record of 307 peer-reviewed publications, 3 books (monographs), 13 chapters in books, 16 non-refereed publications and 26 publications in journals for a professional audience. Six PhD students received their degrees at the Groningen University (3), Utrecht University (2), and VU University Amsterdam (1). Out of this total, 45 % appeared as open access publications, also a record high and a large increase compared to 2013 (16%). 263 oral presentations were given and 127 posters were presented at symposia and workshops throughout the world. For our colloquium series, Texel and Yerseke are now well connected via a web-conferencing system; 35 presentations were given by NIOZ and guest scientists.

Public outreach



NIOZ research was mentioned 68 times in national newspapers, 130 times in regional newspapers from the Texel and Zeeland area, 275 times on the internet nationally and 320 times internationally (source meltwater News database) and 16 publications were written by journalists in professional journals following interviews with NIOZ scientists. This annual report features some of these highlights. Our scientists appeared 22 times on radio or TV and gave 10 public lectures. Highlights for public outreach included the opening of the Seaweed Research Centre to the public in the afternoon directly after the official opening by HM King Willem Alexander on 10 April and the open day for the entire institute on Texel on 4 October. Additionally, NIOZ had a stand in 5 exhibitions or markets.