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Scientific innovation and technical renovation of the research vessel Pelagia

NIOZ Royal Netherlands Institute for Sea Research

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NIOZ Royal Netherlands Institute for Sea Research

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Executive summary

Sea research is characterized by its multi-disciplinary questions and by the international cooperation within the research programs in which these questions are addressed. NIOZ Royal Netherlands Institute for Sea Research supports the participation of its own scientific staff and other Dutch scientists in the sea-going part of these international programs. This is done with the ocean-class RV Pelagia which is equipped with specialized marine equipment and has highly qualified technical support as part of her crew. Innovation of parts of the marine equipment pool and renovation of the RV Pelagia itself after 17 years in active service is now urgently needed in order to consolidate and further strengthen the position of the Netherlands in this growing field of research.

This is of importance not only to be able to carry out marine research with state of the art, up to date Dutch facilities, but also to have access to other sea-going facilities in Europe, i.e. global- and ocean- class research vessels and very specialized equipment that form part of the European Ocean Facilities Exchange Group (OFEG). Via OFEG these facilities are shared via a barter exchange mechanism, between the leading oceanographic research institutes of a number of European countries, including the Netherlands.

Sea-going research has been growing over the last decades firstly because of technological developments which have allowed discoveries in the oceans that simply could not have been made in the past and secondly because of the growing interest of society and industry for the oceans, the global commons of mankind covering 70% of the Earth's surface.

This growing societal interest is mainly caused by the major role of the oceans in the climate system and by the increasing exploitation of the oceans , especially for energy and food and for the global transportation of goods. A profound knowledge on the functioning of the sea is indispensable for quantification and modeling of the role of the oceans in the climate system, ultimately leading to better climate predictions, and the sustainable use of the ocean. Marine research based on in-situ observations from research vessels using specialized marine equipment and highly qualified technical support, is an essential tool to increase this knowledge on the oceans, the largest part of our planet.

The proposed innovation of the marine equipment pool consists of a part that will be shared with the Belgian institute RCMG. The core is formed by a Remotely Operated Vehicle (ROV), presently available at RCMG, and an Autonomous Underwater Vehicle (AUV), to be obtained via this proposal. The use and technical support of these instruments will be shared between NIOZ and RCMG. Some additional equipment is needed in order to be able to make very detailed surveys with these vehicles in the oceans up to a water depth of 2000 m.

Another part is needed to ensure that RV Pelagia is properly equipped for precise and accurate operations at sea. For this, the propulsion of the vessel has to be extended with a Dynamical Positioning (DP) system. In order to be able to track and monitor far-reaching underwater instruments, it is essential to install an underwater acoustic positioning system.

RV Pelagia was built in 1991. Apart from regular servicing and upgrading parts of the instrumentation no major renovation has been done since then. Such an upgrade, including an innovation of onboard available scientific instrumentation and an overhaul and/or replacement of many of the vessel's components, is needed in order to consolidate and further strengthen its function as platform for sea-going research in the Netherlands for at least 10-15 years.

The budget for the proposed innovation of marine equipment and renovation of the RV Pelagia is 10 MEuro.

1. Introduction

Planet earth is blue. More than 70 % of earth's surface consists of oceans and shelf seas. Moreover, over 60 % of the people live and work in coastal areas. The marine part of our planet is heavily used for the global transport of goods, and for exploitation of living (by fishery and aquaculture) and non-living (sand and gravel, oil and gas, wind energy etc.) resources. Also, oceans play a major role in the climate system, determining our weather and our safety.

Thus, a profound knowledge of processes in coastal seas and oceans is an absolute necessity to manage our planet in a sustainable manner. Because of the global and complex character, ocean-research is a multi-disciplinary and internationally coordinated enterprise. International research programs are often initiated and coordinated by the European Science Foundation (ESF), by the European Union and by international organizations like SCOR (Scientific Committee on Oceanic Research) or the Intergovernmental Oceanographic Commission (IOC) of the United Nations.

Such international research programs usually consist of a measurement-component, an analytical/laboratory component, and a modeling component. For the measurement component, ships as well as satellites are used. Although the latter are very useful since they oversee large parts of the oceans, their signals cannot penetrate below the ocean-surface and therefore satellites can measure only ocean surface parameters. For a good understanding of processes in the interior of the 4-6 km deep ocean and at and below the ocean seafloor, the use of ocean-going research vessels is indispensable .

NIOZ

NIOZ Royal Netherlands Institute for Sea Research is the National Oceanographic Institution of the Netherlands. The institute was founded in 1876 and is part of the Netherlands Organization for Scientific Research (NWO). NIOZ employs around 200 people and the annual budget is approximately €20 million. The institute is located on the island of Texel at the border between the North Sea and the Wadden Sea; two important coastal research areas.

The **mission** of NIOZ is to gain and communicate scientific knowledge on seas and oceans for the understanding and sustainability of our planet. The institute also facilitates and supports marine research and education in the Netherlands and Europe.

In order to fulfil this mission, the institute performs tasks in three specific fields.
Research: The emphasis is on innovative and independent fundamental research from shallow coastal seas to the open oceans. The institute also carries out research based on societal questions when this merges well with its fundamental work. The senior scientists at NIOZ all participate in international research projects and publish in high-ranking international scientific journals. During the last two years, 13 articles have been published in either 'Nature' or 'Science'
Education: The institute educates PhD and other students of universities and schools for professional education. A number of our senior scientists is appointed as professor at Dutch and foreign universities.Together with universities NIOZ organizes courses for PhD students and master students in the marine sciences.
Facilitary services: Marine scientists from Dutch institutes and universities can submit to NWO research proposals involving the institute's research vessels, laboratories, and the 'state of the art' large research equipment, which is often designed and built by the institute's own technical department.
More information: www.nioz.nl.

In 2005, NIOZ has been evaluated by an international peer-review committee with the qualification 'very good to excellent'.

It is evident, that research vessels are essential for an oceanographic institution. NIOZ exploits three research vessels: the 'Pelagia' for the oceans and the open North Sea and the 'Navicula' and 'Stern' for the Wadden Sea and the coastal area of the North Sea. This proposal is specifically written with respect to the scientific innovation of sea-going research equipment associated with the large RV Pelagia and her technical 'mid-life' renovation.

Dutch national facilities for sea research

Before 1990, fundamental research on the North Sea was carried out with the RV Aurelia of NIOZ. This 32 m vessel was not suitable for ocean-going research. This work was carried out using the hydrographic research vessel

'Tydeman' of the Royal Navy and the RV 'Tyro' of the Netherlands Council for Sea Research (NRZ, Nederlandse Raad voor Zeeonderzoek). The RV Tyro was originally built as a cattle transport ship and was adapted for the purpose of sea-research. With the RV Tyro, several large expeditions were undertaken. Examples are the Dutch-Indonesian Snellius-II expedition in Indonesian waters (1984-1985) and the Netherlands Indian Ocean Programme in 1992-1993.
In 1991, the new NIOZ RV Pelagia replaced the RV Aurelia for the North Sea and in 1994 the RV Tyro for the oceans. From that moment on, facilitating Dutch academic oceanographic research both with RV Pelagia and associated equipment and technical support became a formal part of the mission of NIOZ. From 1991, RV Pelagia carried out research cruises in the North Sea, the North and South Atlantic Ocean, the Indian Ocean and the Mediterranean. A large international effort was put in two voyages around Africa in 2000 and 2001.

Although RV Pelagia is owned and managed by NIOZ, it serves as a national facility for fundamental ocean-research. As such, the ship is also made available to scientists from Dutch universities and other institutes such as the Centre for Estuarine and Marine Ecology of the Netherlands Institute for Ecology of the Royal Academy of Arts and Sciences (NIOO-KNAW). This is organized by means of an annual 'open call for proposals' by the 'Earth and Life-Sciences' (ALW) division of NWO as the umbrella organisation of NIOZ. In this way, NIOZ fulfills part of its mission as the national facility of the Netherlands for fundamental ocean-going research. As an example: during the two voyages around Africa in 2000 and 2001, 290 scientist from 20 countries participated in the different research programs that formed part of this research programme.

The major institutes for applied sea-research in the Netherlands are the newly formed Deltares and Wageningen-IMARES. Scientists from these institutes use survey vessels from the Ministry of Transport, Public Works and Water Management (e.g. RV Arca), and the Ministry of Agriculture, Nature and Food Quality (RV Tridens). These ships are used for applied research for policy-related questions of the ministries (mainly monitoring) and therefore usually remain in the Dutch sector of the North Sea and in most cases in the nearby coastal zone. Therefore, they play a different role in Dutch national sea-research and are more of regional importance, whereas RV Pelagia is the only ocean-going national research vessel.

A development in the last decade which has been very important for the Dutch oceanographic community has been the participation of RV Pelagia in the 'Ocean Facilities Exchange Group' (OFEG). In this group, 21 research vessels from 6 European countries participate: BMBF-Germany, IFREMER-France, IMR/UoB Norway, CSIC-Spain, NERC/NOCS-United Kingdom, and NIOZ-Netherlands. For an optimal use of the research vessels in this pool, ship time is exchanged via a barter system between OFEG members. This development has increased the potential of Dutch sea research considerably, since at this moment 15-20% of our national sea-going research is carried out on foreign OFEG ships. Since participation in OFEG is only open to parties who offer the use of their own research vessels to the pool, RV Pelagia plays also this essential role for the oceanographic community in the Netherlands.

The keel of RV Pelagia was laid in 1990 and the ship started its operational life in the spring of 1991. The expected technical and economical life-span of ships like RV Pelagia is 30-35 years. Now, RV Pelagia needs a thorough update to guarantee a scientifically successful and technically safe and sound second half of its life-time. This applies to the ship itself as well as to the basic on-board research equipment.

Below, the different arguments for these scientific updates and technical renovations are given. Subsequently, this proposal is discussed in terms of the 'Nijkamp' criteria of NWO and the additional considerations of the Roadmap Committee. Appendix A shows the conclusions and recommendations of the Dutch 'Bureau voor de Scheepsbouw' (ship's consultancy firm) with respect to the technical condition of the vessel which has led to the proposed renovation. Appendix B contains a letter of intent from the Belgian RCMG expressing their willingness to make a shared use of some specialized Belgian marine equipment (ROV) and part of the proposed new Dutch marine equipment.

Scientific Innovations and Technical Renovations

Remotely Operated Vehicle (ROV)
In today's sea-research, the use of Remotely Operated Vehicles (ROVs) is highly necessary to increase the access to the underwater environment. This is for scientific reasons as well as for public outreach, to inform the public about the interior of our seas and oceans. From a scientific point of view, an ROV allows a high resolution study of the sea floor with its highly diverse ecosystems and associated benthic communities. Benthic communities can

be studied at ROV-selected sites with in situ sampling and measuring techniques. This minimizes the disturbance of sensitive ecosystems like cold-water coral reefs situated on the slopes of carbonate mud mounds on the continental slope of the Northeast Atlantic Ocean which are presently often sampled by literally 'grabbing in the dark', e.g. with a box-corer.
Within OFEG, a number of large ROV's for large depths (> 6 km) and some ROVs for shallower layers of the ocean are already available. In view of the ROV park of the OFEG and the planned research in our Science Plan 2008-2012 on the continental slope of the North-Atlantic Ocean, an ROV that can be used until 1500-2000 m water depth is most appropriate.

Autonomous Underwater Vehicle (AUV)
AUVs are used for very detailed spatial surveys. These instruments are either used to measure high spatial variability in great detail, e.g. in frontal zones, or for surveys to find optimal places where an ROV can take samples. Recently, NIOZ has successfully tested the use of an AUV (owned by the Royal Dutch Navy) for studies in the Dutch coastal zone.

Deep-sea ultraclean sampling facility
The deep ocean still is very pristine with regard to the natural ultralow concentrations of dissolved trace metals and isotopes. Several of these trace metals are essential for marine ecosystems (notably iron and zinc are essential for all living organisms) but their distribution and cycling in the oceans still remains to be discovered. NIOZ scientists are among the initiators of the international GEOTRACES program of SCOR and recently have made the first-ever complete observations of trace metals in the Arctic and Antarctic Oceans. NIOZ is internationally leading in the development of ultraclean sampling systems. An improved sampling system will become part of the OFEG equipment pool to be used jointly with colleagues of Belgium (and other nations) for the first-ever complete observations in the Atlantic and Indian Oceans, aboard RV Pelagia and/or another ship of the OFEG research vessels pool. Scientists and the technical staff of NIOZ are jointly developing the third generation sampling system comprising of ultraclean modern plastics (now available for use in the semi-conductor and pharmaceutical industry) in combination with titanium. This contamination-free sampling system will also benefit the ultraclean sampling and study of organic molecules and microbial biodiversity in the oceans, two disciplines where NIOZ scientists also have international leadership status.

Technical renovation and innovation of RV Pelagia
RV Pelagia can become a very suitable platform for an ROV after some adaptations. For precise navigation of an ROV, a long range highly accurate ultra short baseline (USBL) positioning system needs to be installed. To keep RV Pelagia in position during ROV cruises, the propulsion and navigation system needs to be expanded with a Dynamic Positioning (DP) system.
The ICT network – a data acquisition and logging system - on board of RV Pelagia is outdated. Through the years, new instruments have been installed, such as a multi-beam echo sounder to make 3D images of the sea-bottom. As a consequence the strongly increased amounts of data that are generated now overload the ICT-network on board. Therefore the system needs to be replaced.
In the autumn of 2007, a specialized ship consultancy firm (BvS,'Bureau voor de Scheepsbouw') has investigated the expected economical and technical life-span of RV Pelagia with respect to the age of the vessel.
The main conclusion of this investigation is the advice to carry out a mid-life conversion of RV Pelagia within 1-2 years. When this gets done properly, the vessel will be fully operational for another 10-15 years.

2. Nijkamp-criteria

2.1 Science case (de kans op wetenschappelijke doorbraken)

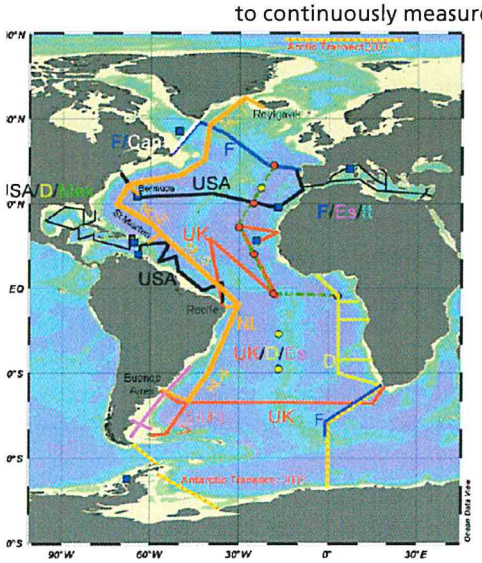
Oceans and seas form by far the largest part of our planet and their scientific exploration continues to result in new, often spectacular, discoveries. These discoveries are mainly due to the simple fact that the oceans are vast and, especially the deeper parts, extremely difficult to observe and study.
Sea-going research requires the combined input of specialized scientists from different oceanographic disciplines (physics, chemistry, biology and geology) in a multidisciplinary framework, and the support of technical engineers who, in close collaboration, design, build and operate specialized equipment for observing the water column and the seafloor. Most of marine research is carried out within multidisciplinary themes and international research programs, both on a European and on a global scale.
Major scientific breakthroughs in marine research occur regularly within all classical disciplines and especially at

their interfaces. Often, these breakthroughs have a large impact on society. Research themes in which Dutch oceanographers play an important role at this moment are 1) the role of the ocean in the climate system and 2) marine biodiversity in relation to the functioning of ecosystems.
Below some examples of research themes in which the RV Pelagia and specialized marine equipment play an important role are discussed briefly.

The role of the ocean in the climate system
The oceans play an important role in the redistribution of heat over the globe. Heat is transported from the tropical areas towards the poles both by atmospheric and oceanic circulation. This redistribution results in large climate variations on a regional scale. For instance, the northward transport of heat in the North Atlantic Ocean combined with a westerly atmospheric circulation results in the climate of western Europe being much warmer than at similar latitudes in North America. However, recent studies on past climates have shown that large and rapid changes can occur, especially on a regional scale. Such rapid changes have been attributed to changes in the ocean circulation.
Global research programs like CLIVAR (CLImate VARiability) have been set up to study this climate variability with the ultimate goal to be able to better predict the climate of the future. The design of a global network of in-situ measurements on currents, temperature and salinity in the deep sea is an important component of CLIVAR (see www.oceansites.org). Via NIOZ the Netherlands contributes to this program by maintaining sites in the North Atlantic Ocean, near Greenland, and in the Indian Ocean, in between Mozambique and Madagascar. At these sites moorings, i.e. *in situ* continuous measurement systems attached to long lines that extend from he seafloor to just below the surface, have been placed.
These field observations have shown that the deep ocean circulation is far more complicated than previously thought with eddies dominating the current field. One of the consequences is that the ocean part of present climate models needs to be improved to obtain better climate predictions. Ultimately these observations will form part of a global 'early warning system' for climate change, similar to the system that operates in the Pacific Ocean to predict the occurrence of El Niño.
The yearly deployment, servicing and recovery of these deep sea moorings require the availability of an up-to-date research vessel. In practice, nowadays such operations are carried out by one of the research vessels from the OFEG fleet. During a single cruise, several moorings from different member countries are serviced. The Dutch RV Pelagia is one of the OFEG vessels that is used for these operations.

Moreover the oceans play a very important role in the uptake of carbon dioxide, CO2, and thereby the redistribution of CO2 between the atmosphere, the oceans and the continents. Estimates on the uptake of the oceans of fossil fuel CO2 emissions are very uncertain. Better knowledge on processes regulating primary production in the oceans is urgently needed. As a part of this there is a great need to obtain more insight in the spatial distribution of elements that limit primary productivity of algae in the open oceans. For this, very specialized equipment is needed. Recently, NIOZ has developed such equipment, the so-called Ultra Clean CTD (UCC) system. It has been applied successfully in 2007-2008, in the framework of the International Polar Year (IPY) on cruises with the German icebreaker RV Polarstern to determine the concentration of iron in the Arctic and Antarctic polar ocean in unprecedented detail. As part of an international program (GEOTRACES) cruises with the RV Pelagia are planned in the Northern and Southern Atlantic Ocean in 2010-2011. For an efficient use of the Pelagia on these cruises, a rigorous upgrade of the underway measurement system is highly necessary. Novel sensors that are able to continuously measure ocean surface parameters that are relevant for global change monitoring (like pCO2, oxygen, primary production) need to be installed for this purpose.

Furthermore this uptake of CO2 into the oceans leads to a change in ocean chemistry. The ensuing ocean acidification, may likely have impacts on marine biota, where calcifying organisms (such as shellfish, corals, squid and certain algae) are at greatest risk. For example the cold-water coral ecosystems and carbonate mud mounds which only recently have been discovered at European continental margins (see below), are predicted to be the calcifying biota to be the first at risk. NIOZ scientists are partners in the new European Project on Ocean Acidification (EPOCA) for an assessment of ocean acidification impact on marine biota.



The intended West Atlantic Ocean section of The Netherlands GEOTRACES (shown in thick orange; thin orange lines for transit to ports) comprising four transects NL-1 through NL-4, in context of the international Atlantic GEOTRACES plan in given colors for each nation. Checkered yellow-orange joint German-Netherlands IPY sections aboard icebreaker Polarstern (Germany) completed in 2007 and early 2008.

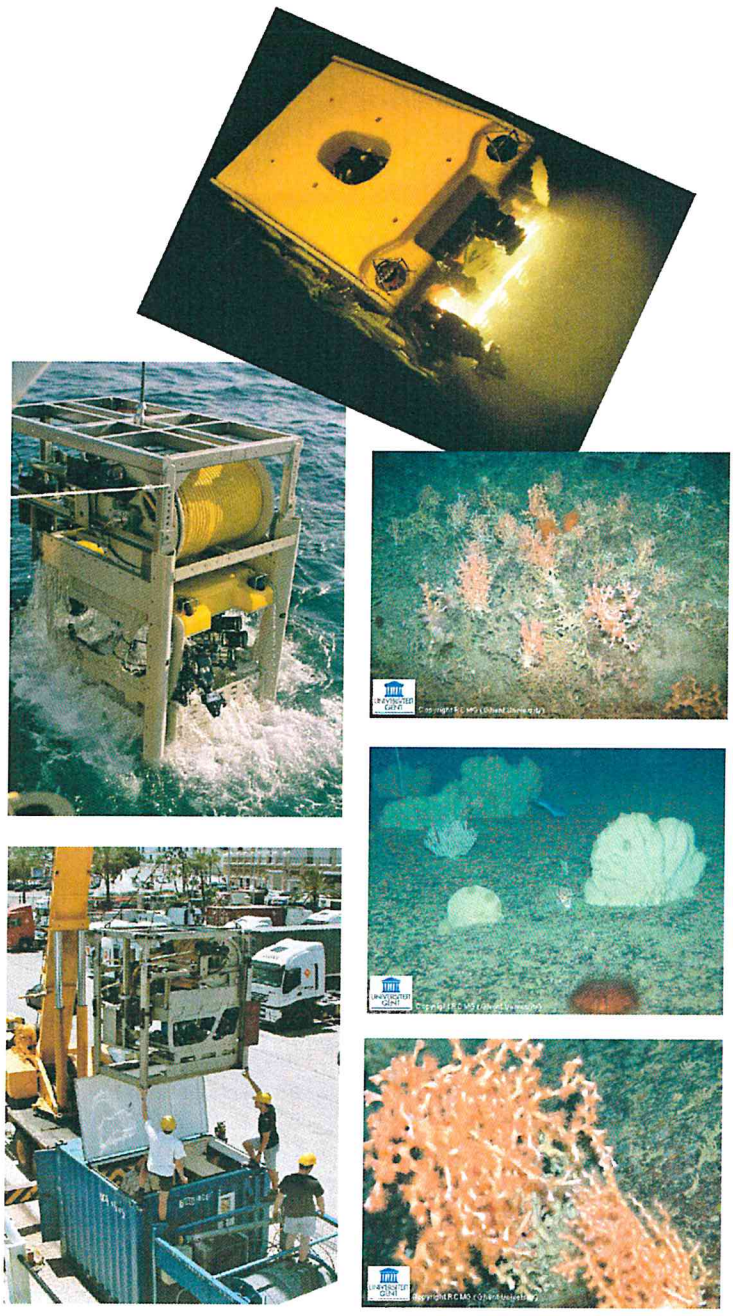
Most of our knowledge on past climate variability is based on the analysis of sediment cores from the ocean floor as sediments form an archive of past climatic and oceanographic conditions. In the last decades knowledge on past climate variability by analyzing these sediment cores has increased enormously. From biogeochemical studies on well-preserved organic and inorganic molecules it has become clear that changes in climate have sometimes occurred very rapidly in the past. Dutch oceanographers have contributed to this new knowledge by coring and studying sediment cores from different locations in the world ocean, which where taken partly during research cruises with RV Pelagia. Recently such studies of NIOZ have shown amongst others that variability in the ocean circulation in the Indian Ocean may influence the climate in the Atlantic ocean because the inflow of (warm) water from the Indian Ocean into the Atlantic Ocean may have halted under certain, specific conditions. Presently, such studies on past climate variability receive much attention because they are used to determine the validity of predictions made by climate models. Since there are large regional differences in the climate system and sediment cores have been taken only from restricted parts of the seafloor, up to date research vessels with advanced coring facilities and supported by state of the art technical expertise, are urgently needed.

Marine biodiversity

In the past decade technical developments have revealed the widespread presence of earlier unknown ecosystems such as giant cold-water coral reefs and cold-seeps. Many of these were found along the European continental margin that covers an ocean space from the Arctic via the Eastern Atlantic Ocean to the Iberian Margin and further through the Mediterranean and the Black Sea. This marine realm encompasses sedimentary basins with a different lithosphere structure, contrasting geological and tectonic environments, and a distinct network of water masses ranging from shallow water to over 4000 meters of water depth. Such environmental heterogeneity promotes development of diverse and teeming biomes in highly dynamic marine systems influenced by ocean currents, land-slides, and seepage of hydrocarbons, especially methane. The cold water coral reefs are one of the novel ecosystems recently found in deep and dark parts of the ocean. At first it was thought that they would be fueled by hydrothermal vents or seabed hydrocarbon seepage, but according to the most recent knowledge, this does not seem to be the case.

The European margin is also rich in other, ecologically distinct ecosystems thriving in habitats shaped by fluids, petroleum and greenhouse gases, particularly methane, from the sea-bottom. These emitted toxic chemicals feed a fascinating diversity of microbes as primary producers, which in turn feed a wide varity of primary consumers and higher organisms. Several of these were only discovered recently, such as the common occurrence of Archaea.

Earlier, deep-sea ecosystems have been intensively studied using "traditional" equipment such as box, gravity, piston corers, current meters and diverse seismic and acoustic techniques. However, the biogeochemical understanding of biodiversity "hotspots" such as cold water coral reefs and cold seeps is still very limited and it remains to be seen what role these systems play in a global context. For a better understanding of these environments and related biotopes, it is vital to have a multitasking tool that allows to perform direct observation, directed sampling, in situ measurements of current dynamics and chemical gradients (e.g. oxygen, pH), as well as incubation experiments at the selected environments within a coral reef or a cold seep. The application of ROV and AUV technology will open possibilities for an array of new studies and will allow innovative research



Pictures from a deployment of the Belgian ROV ('Genesis') and images from cold water corals in the Bay of Biscay as taken by this ROV

into these poorly constrained deep-sea habitats. For instance, ROV based detailed in situ observations, sampling and measurements of the microorganisms that consume the greenhouse gas methane will gain our understanding of their role as "biological shield" against methane emissions by the formation of peculiar carbonate fabrics. These carbonates provide records of geosphere-biosphere interactions through time and are of interest to understand the biochemical exchanges between the earth and the ocean in the past, present and possibly (near) future.

A clever combination of ROV and AUV surveys results in multiple scientific benefits. Detailed mapping of selected habitats and sediment dynamics using an AUV can be efficiently used to prioritize a research program and to plan ROV dives for observations, video-records, multitasked in situ measurements, and specific sampling of sediments, fluids, biota, and mineral precipitates. Importantly, a ROV would also allow accurate, well controlled sampling without unnecessary disturbing the deep marine ecosystems, as is often the case at present when using other sampling equipments, e.g. a box core, kasten corer, etc.

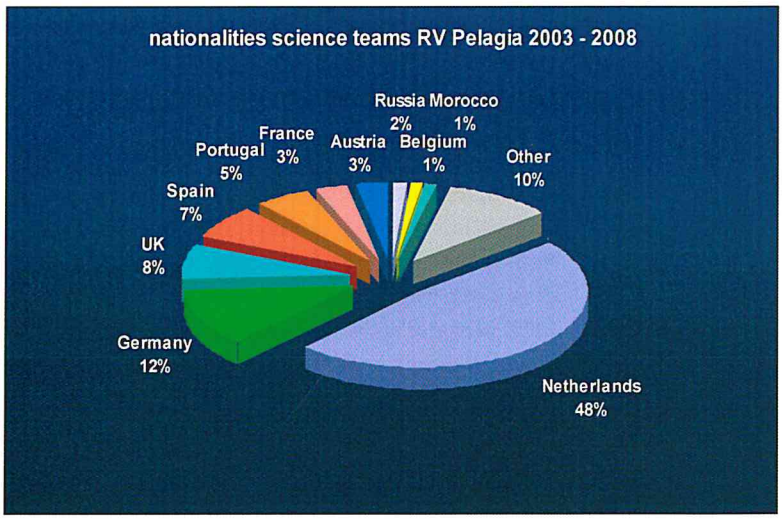
In order to continue the sea research as sketched above and thereby to continue the Dutch visibility in this field, it is a conditio sine qua non to have available an up-to-date research vessel and the state-of-the-art technical equipment that is needed to make the necessary research and experiments in the deep sea.

2.2 Talent case (de potentie tot brain gain)

The Netherlands can only maintain its prominent role in several forefronts of international sea research if there is at least one research vessel in its fleet that is suitable for ocean-going research.

A research vessel functions as a scientific platform and attracts scientists not only from NIOZ and the Dutch universities but also from institutes and universities all over the world by mutual participation in joint research programs. Yearly a large number of scientist participate in research cruises. By its availability for the Dutch community the vessel forms a very important tool for scientific networking of Dutch researchers, for national participation in international research programs and thereby for the visibility and quality of the Dutch seagoing research. The availability of such a vessel, combined with up to date technical equipment for observations at sea, not only attracts foreign scientists. It also prevents that talented Dutch scientists move to other countries if such facilities would not be available in the Netherlands. Moreover, it ensures that the Netherlands remains attractive for Dutch scientists that have moved abroad during an early part of their career, e.g. a first or second post-doc employment. The participation in international research programs with seagoing components is also of great importance for the (theoretical) sea research that is concentrated mainly at Dutch universities. This ensures that Dutch ocean scientists can act as a full partner in those international programs that often consist of both theoretical and seagoing components.

The sea is part of the basic societal and economic fabric in the Netherlands. Dutch society is highly interested in the sea, and many children and students have great fascination for the mysteries of the oceans, the last part of the planet that still yields major new discoveries. NIOZ feels it as its mission to support this sense of discovery, to support knowledge and information transfer and to attract talented young people to marine research.



Nationalities science teams RV Pelagia: 48 % Netherlands, 52% foreign
Total number of different nationalities next to Netherlands: 28
Total number of scientists: 600 in 5.5 years on 60 cruises
Total number of marine technicians for technical support on board: 113 (not included in the overview)

2.3 Innovation case (het belang voor maatschappij of bedrijfsleven)

Sea research is important, also for society and industry. Research that is made possible by a research vessel like RV Pelagia makes important contributions to the international research effort on climate variability (among others CO2 uptake by the oceans, rapid climate changes by changes in ocean circulation,) and marine biodiversity (e.g. studies on cold corals along continental margins and cold seep chemosynthetic communities). Both themes are of utmost importance for society.

Apart from this the energy sector, presently mainly oil and gas but with increasing activities to exploit bio-, wind- and tidal energy, is continuously searching for new areas where exploration of oil and gas can be done and for new areas (and knowledge!) where other sources of energy can be commercially exploited. Traditionally, this search was confined to shelf seas. Nowadays, this sector enters more and more deeper waters, starting at the continental margins and now even moving to deeper parts of the oceans.

Knowledge on the environmental parameters, both in the water column and on the seafloor, is needed in order to be able to plan exploration activities. Such knowledge can only be obtained by using research vessels combined with multitasking deep sea instrumentation like sea bed observatories, ROVs, AUVs etc. Moreover, such knowledge is needed to ensure a sustainable exploration of the ocean. Another potential important industry sector that shows more and more interest in the oceans is the food sector. New ways are presently explored to use the oceans for food production for mankind, not only in a traditional way by catching fish, but also by producing algae and certain fish species in a controlled way (ocean farming). Better knowledge on the ocean environment, including the structure of the marine food web is urgently needed, for a sustainable use of our planet.

2.4 Partnership case (samenwerking en concurrentie)

In ocean sciences international co-operation is paramount. NIOZ is an active participant and initiator of a number of international organizations on research ship operations, such as the International research Ship Operators Meeting (ISOM), a worldwide discussion platform convening once a year in different countries. The purpose of ISOM through its discussions is to assist the marine scientific community in the provision of ever better support services for research at sea. The exchange of knowledge and experience at a strategic and technical level is of considerable importance in an era of decreasing budgets, whilst the requirement for knowledge of the coastal seas and oceans and their relationship with mankind is rapidly increasing. On a European level NIOZ is a partner in the European Research Vessel Operators (ERVO), a flexible forum meeting annually to share experiences of common interest, and to explore opportunities for co-operation activities on a European scale.
Through the EU funded ERA-NET project MarinERA, a partnership of the leading Marine RTD Funding Organizations in 13 European Member States, NIOZ participates in its Marine Infrastructure Forum (MIF).

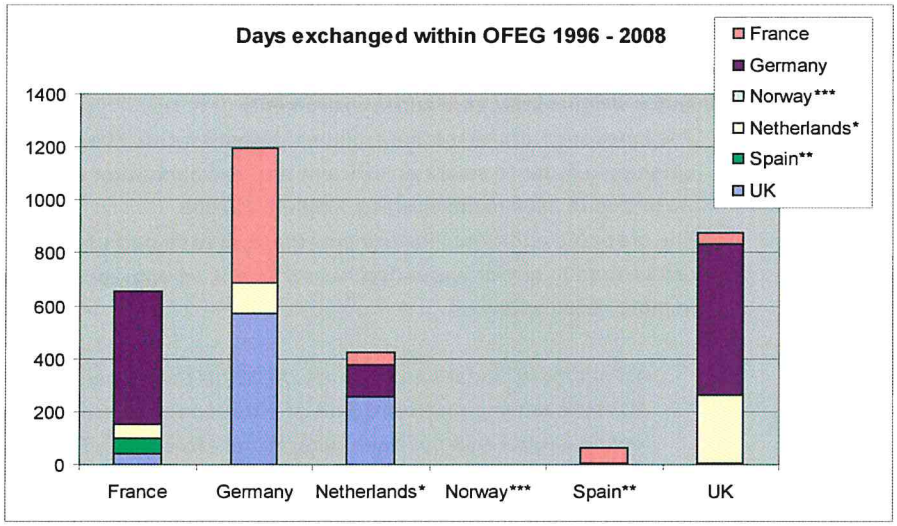
OFEG
The most striking partnership is the Ocean Facilities Exchange Group (OFEG), which constitutes a bottom up approach of research fleet co-ordination and harmonization minimizing bureaucracy and overheads. OFEG represents Europe's leading oceanographic research organizations and provides a forum to consider barter exchange and co-operation opportunities for the Global and Ocean class research fleet. NIOZ has a strong position within OFEG, which main objective is the exchange of ship time and major equipment based on 'bartering', i.e. without exchange of money. Exchange is based on value points according to scientific capacity as agreed between members.
OFEG members at present are Ifremer (France), BMBF (Germany), NIOZ (Netherlands), IMR-UoB (Norway), CSIC (Spain), NERC (UK). All present OFEG members, except NIOZ, run multiple fleets - totaling 18 of the 26 Ocean and Global Class academic research ships in Europe, as well as most heavy equipment. The advantage for the Netherlands' scientific community is significant. With one ocean class research ship it has access to a wide range of research ships with different capacities, as well as access to sea areas that would be beyond reach. Moreover OFEG provides access to heavy equipment that is not available in the Netherlands. At the same time NIOZ can use it own ship time on RV Pelagia more efficiently by reducing wasted cost and time on long passages.

Other OFEG advantages are opportunistic interventions, i.e. mutual help when equipment get lost, recovery of drifting moorings, when within reach; en-route servicing and turn-around of partners' moorings, combined sampling and measurements for partners. Research cruises are scheduled jointly: OFEG meets twice a year for fine tuning of cruise planning and cruise scheduling, such as geographical cruise schedules.

Regarding the exchange of heavy equipment, OFEG has installed a Virtual Pool of Major Exchangeable Equipment (http://www.nioz.nl/ofeg). Examples of such exchanges are:

- Dutch Ultra Clean CTD system with deep sea winch and cable on German RV
- German ROV CHEROKEE on Dutch RV
- Dutch Piston coring system on UK RV
- German DTS-1 on Dutch RV
- French ROV VICTOR on German RV's
- UK TOBI on Dutch and German RV's
- UK ROV ISIS on French RV

Within the OFEG Pool an adequate range of large exchangeable equipment should provide optimal utilization and reduction of idle time. With the well established national equipment pool and the support of its Marine Technology department NIOZ has a strong position in the OFEG Major Equipment Pool.



Ship days exchanged between OFEG Partners 1996 - 2008
* OFEG full member since 2002
** OFEG full member since 2006
*** OFEG full member since 2006

Besides exchange of ship time and equipment, the revenues are further optimized by exchange of supporting marine technicians, who are trained to operate specialized winches and equipment on the partners' ships. In this way know-how is distributed to other members of the group, and bottlenecks in technical support can be solved.

Following the recommendations of the ESF Marine Board's OFWG Report[1] of March 2007, OFEG fully supports the conclusion and accepts that it will act as a forum for the European Global and Ocean Class fleet. Also OFEG will endeavor to maintain its much-praised flexibility and exchange of know-how, and will ensure that there is an optimal mix of Ocean and Global Class vessels together with a range of effectively utilized heavy equipment.
For the harmonization and fine tuning of plans for replacement and upgrade of research vessels OFEG has issued its first roadmap of renewal of the OFEG fleet in spring 2008.
With the innovation of RV Pelagia the Netherlands will consolidate and further strengthen its strong position. This innovation is strongly supported by OFEG to compensate for the current tendency to replace Ocean class ships by Global class ships. To guarantee an optimal mix the present capacity of Ocean class ships should be maintained. An upgraded and scientifically innovated RV Pelagia will be a great asset within the OFEG fleet, thus providing an additional incentive to further stimulate international participation and collaboration.

OFEG-TECH

In 2007 OFEG has created OFEG-TECH as a forum for its marine technicians for communication and networking in order to support 1) the development of major equipment and to improve cooperation between the OFEG partners and 2) to develop an understanding of each others organization, structure and contacts, and to identify and develop the opportunity for exchange of knowledge and experience. OFEG-TECH met for the first time at IMR in Norway in 2007. In 2008 the OFEG-TECH will be organized and hosted by NIOZ.

Dutch – Belgian bilateral collaboration

Many close collaborations already exist between Dutch and Belgian scientists within a range of EU and ESF research programs. In the framework of this proposal it is intended to extend the scientific collaborations also with a strong collaboration on the technical level by sharing parts of large, complex and therefore expensive marine equipment and technical support (see letter of intent, appendix B).

: Marine Board Position
r 10: European Ocean
arch Fleets, Towards a
mon Strategy and
nced Use, March 2007

It is proposed to start with sharing marine equipment for which a high level of technical support is needed but that is not used during cruises on a day to day basis. Devices that are used for high-resolution surveys and deep-sea sampling, like ROVs and AUVs are ideally suited for this purpose. Moreover, RCMG (Renard Centre of Marine Geology, University of Gent) obtained an ROV in 2006 that has been successfully used in recent research cruises. In the framework of this application it is proposed to upgrade the Belgian ROV with additional features, and to make a common pool for high-resolution surveys available by adding AUVs and an elevator system for faster and safer handling of this large equipment. This common pool of instruments will be serviced and operated by 2 engineers made available by the Dutch Marine Research Facilities and by 2 engineers from the Belgian RCMG. Yearly the use of this equipment, including the technical support, will be planned following procedures similar to the OFEG procedures.
The cooperation between the Netherlands and Flanders in the framework of the Marine and Coastal Programme ZKO of NWO has been discussed recently between ZKO and the Flemish Ministry of Science Policy and Innovation and will be further discussed in an Expert Group meeting in September 2008. During this meeting also the sharing of infrastructure will be further elaborated.

2.5 Business case (financiële aspecten)

Dutch-Belgian pool of scientific instruments
The innovation of the marine equipment pool consists of a number of instruments that will be shared with Belgium in order to assure an efficient use. The budget for the Belgian ROV ('Cherokee') that can be deployed in waters up to 2000 m depth was 1.2 MEuro in 2006.
The proposed additional instruments that will form part of the shared pool (i.e. an upgraded ROV, an AUV that can be used in similar water depths as the ROV, an upgraded winch, cable and an elevator system), are described in more detail below.

Autonomous Underwater Vehicle (AUV) for use in shallow and deep water
AUVs are moving platforms (sort of a torpedo) that are deployed from a vessel and move through the sea following a route that has been determined afore hand. They are equipped with a side scan sonar to determine the bathymetry in great detail and with a variety of sensors to measure all kind of parameters like temperature, salinity, currents, fluorescence etc. AUVs are used to survey the sea water and sea floor in such great spatial detail that cannot be reached in another way. Such surveys are a.o. of great importance prior to the deployment of sea bed observatories and the use of an ROV in spatially inhomogeneous areas like cold coral zones on continental margins. An AUV is also a very useful instrument for bathymetric surveys in the North Sea, including its potential use to survey biogenic structures, and for observational studies in areas with a high spatial variability like frontal areas and the coastal zone.
Costs of 1 AUV including sensor packages that is suitable for deployments to 1500 m: 1100 kEuro

Additional sensors for the Belgian ROV (Cherokee)
An ROV is deployed from a research vessel in the water column and remains connected to the vessel via a wire. An operator on the research vessel steers the ROV to the desired location where it can make observations and take selected samples both from the water column and from the seafloor. The present Belgian ROV is equipped with a standard package of sensors. Extension of this set is needed for an optimal use of the instruments. We propose to extend the present ROV with a high resolution camera and an hydraulic arm.
Costs of an ROV upgrade: 150 kEuro

Elevator system for efficient ROV use
The total number of samples that a ROV can take and store is limited. Especially in deep waters this hinders an optimal use of a ROV because a lot of (expensive) time is spent with transporting samples with the ROV from the seafloor to the vessel. Autonomous Vertical Transporters (AVTs), more commonly referred as "sample elevators", are autonomous devises that are capable of raising numerous benthic samples, additional equipment (benthic chambers, sensors, etc.), and other payloads from the seafloor to the ocean surface. Elevators are reasonably priced for construction and can by cycled up and down independently from an ROV that is sampling at the seafloor. Such an elevator system will be designed and built at the NIOZ workshop.
Costs of elevator system: 100 kEuro

Upgrade of winch and cable
The depth at which the present ROV can operated is limited by the length of the cable on the winch. In order to allow for the operation to a maximum depth of 2000 m, a new cable with a length of 2500 m is needed.
Costs of new cable: 135 kEuro

Technical innovations of RV Pelagia needed for ROV surveys

DP system

Presently, RV Pelagia does not have a Dynamical Positioning (DP) system which is required to keep the vessel at a fixed position in open sea. A specialized shipping consultancy has studied the possibilities to install such a system on RV Pelagia. The conclusion is that this is possible if a 500 kW thruster is installed roughly below the center of the vessel.

Costs of installing a DP system: 1000 kEuro

Ultra Short Base Line (USBL)

An USBL positioning system is necessary to determine the position of the ROV relative to the research vessel with great accuracy. It will be fixed to RV Pelagia. The USBL will be used not only to determine the exact location of the ROV but also for other equipment that is deployed into the sea. Acoustic transponder attached to this equipment will make this technically possible. Examples are bottom landers, box corers, multi corers and the MOVE (Moving Vehicle)

Costs: 310 kEuro

Upgrade of RV Pelagia related measurement systems

Underway sensor system

The use of RV Pelagia as a 'moving observation platform' can much further be enhanced by making use of the nowadays available sensor technology. This includes systems that measure all kind of standard parameters (like salinity, temperature, fluorescence) from a through flow system and recently developed new sensors to monitor all kind of global change parameters (like p CO2, pH, oxygen etc.).

Costs: 400 kEuro

Ultraclean laboratory container

An upgraded version of the recently developed ultraclean laboratory container as part of the ultra-clean deep sea sampling and measurement system is needed. This will allow unprecedented observations in the deep sea of low-concentration trace elements. The system will form part of the OFEG equipment pool and can thereby be used on other research vessels as well. The system will also be available for scientists of Belgium for their own expeditions, where prof. Frank Dehairs (VUB) serves as coordinator of the colleagues in Belgium.

Costs: 150 kEuro

Flowcytometer

Flowcytometers are increasingly used to measure algae, bacteria and viruses *in situ* in an electronic manner. A system dedicated for use on research vessels like RV Pelagia is urgently needed as part of the national available marine facilities. A complete system includes a flowcytometer, a centrifuge and a container.

Costs: 120 kEUro

Technical renovation of RV Pelagia

Midlife conversion

The RV Pelagia was built in 1991. In 2007 the study by BvS on the technical/economical condition of RV Pelagia concluded that if RV Pelagia undergoes a major technical overhaul in 2009-2010, the vessel can be made in an optimal condition such that she can be used for Dutch and European sea research for another 10-15 years. The conclusions and recommendations of this extensive study are given in appendix A (in Dutch). An extensive report is available in which a budget is presented for all parts of the vessel that have to be renewed and/or revised (inclusive of the electrical installation, engines, hydraulic system, cranes, winches, nautical instruments, accommodation, tanks etc) , based on offers by different companies (this report is available upon request). In particular renewal of the engines is attractive, since present day engines with similar power use less gasoil and have less emission.

Costs for technical renovation, including consultancy: 3780 kEuro (price level 2007 + 8%)

New ballast water treatment system

All vessels will have to install a ballast water treatment system before 2016 (these systems are presently being tested using NIOZ knowledge and facilities). The planned overhaul of RV Pelagia in 2009-2010 will be used to install such a system.

Costs: 400 kEuro

Computer and data management system

Many sensors on board the vessel measure continuously parameters both by through flow systems and by acoustic devices like an ADCP (Acoustic Doppler Current Profiler) and a Multi Beam echo sounder. The present hardware and software on board (installed in 1998) has to be renewed especially since limits of the capacity are reached. A new software system is needed for the data management and presentation and new hardware (servers, cables) is necessary to accommodate the strongly increased data flow.
Total costs for replacement: 250 kEuro

Personnel

Initially, personnel are needed for engineering and building the new marine equipment, the upgrade of the ROV and the development and installation of the new computer and data management system.
For the first three years 2 fte's are needed for the ROV, 1 for IT and 3 fte for R&D of the new marine equipment.
Total initial personnel costs (65 k€ fte/yr): 1170 kEuro

For the maintenance and operation of the Dutch-Belgian pool of equipment 2 fte's are needed per year. The instruments are expected to function at least 10 years.
Total personnel costs year 4-10: 910 kEuro

Summary of Costs

In the table below, the costs for innovation and renovation of RV Pelagia and related instrumentation is shown. Total costs are 10 MEuro.

Item	Budget in kEuro
Dutch- Belgian pool of instruments	1485
Innovation RV Pelagia	1310
Innovation measurement systems	670
Renovation RV Pelagia	4430
Personnel	2080
Total	**9965**

2.6 Technical case (technische haalbaarheid)

All proposed marine equipment is either available on the market or are improvements of current equipment which has been developed at the NIOZ workshops. Therefore hardly any risks are foreseen. In principle, a start can be made with building and/or buying equipment immediately. This process will be managed by the NIOZ Marine Technology Department which has ample experience with the management of the Dutch pool of marine equipment.

The renovation of RV Pelagia has been advised by the ship consultancy firm BvS, see appendix A for their conclusions and recommendations. Parts of the proposed renovations are of a pure technical, ship-related, nature (like renewal of engines, cranes etc.). Presently BvS is continuing with all necessary actions that have to be taken in order to be able to carry out the technical overhaul in the end of 2009 or the beginning of 2010.

With respect to the budget the consequence is that roughly 80% is needed before early 2010.

3. Additional considerations of the Roadmap committee

3.1 Possible focus for the Netherlands (mogelijke focus voor Nederland)

The Netherlands is one of the few relatively small countries that fully participate in internationally oriented sea research with important scientific contributions to major European and global research programs. A variety of reasons (historical, cultural and strategic) has brought our country in this position. Foremost is the recognition that knowledge on the functioning of the sea is of pivotal importance for a low-lying country nearby the sea that is not only threatened by but also benefits from the sea. This generated a long tradition of active sea research in our country, initially mainly oriented on the coastal zone and the nearby North Sea, but in the past decades more and more also in the global ocean.

This extension of sea research into the deep sea coincides with a growing interest both from the political arena and the industry in the oceans, the global commons of mankind. As sketched before, there are various reasons behind this growing interest, e.g. their potential for exploration of energy and food and an ever increasing ships traffic for the world-wide transportation of goods. Ships move by far the majority of goods around the globe and from an oil consumption/ greenhouse gas emission point of view, ships are by far the most efficient mode of transport. This growing attention triggers our society to develop a policy for these global commons. The Maritime Policy as recently developed by the EC is an example of this. For a large part, such a policy is based upon (present) knowledge of the sea.
Thus, a strong scientific position of the Netherlands in marine science will enhance the Dutch influence on new policies for the use of the sea that is in turn of great importance for the Dutch economy and society.

3.2 Critical mass (Kritische massa)

Scientific users of the Pelagia and its scientific equipment consists of research groups from the research institutes NIOZ and NIOO-CEME and from different universities in the Netherlands (mainly both universities of Amsterdam, and the universities of Utrecht and Groningen). These institutes and universities have recently agreed to develop a masters degree in marine sciences. The sea-going research always forms part of research programs in which also other components, like laboratory analyses of samples and mathematical modeling, forms a part. This increases the number of users of data and samples that is obtained at sea considerably.

All research groups that make direct use of the Pelagia and its equipment have recently been reviewed by international peers, resulting in qualifications ranging from 'very good' to 'excellent'. A similar qualification was given to the Marine Technology department of NIOZ that carries out the technical support as part of the Dutch Marine Research Facilities. Moreover, very recently, external parties (FUGRO and Maersk) have evaluated the management of the Pelagia. The conclusion was that this occurs in an efficient and cost-effective manner. This shows that Dutch sea research is of high quality, both from a scientific, technical and financial point of view.

RV Pelagia is not only used for research by scientists from the academic community but also, roughly during a month per year, hired by industrial parties. There appears to be growing interest from industry despite the fact that the daily commercial rate of the vessel is above commercial levels for vessels of similar size. The combination of a research vessel with high-quality equipment and highly skilled dedicated technical support apparently makes these facilities very attractive.

The use of RV Pelagia, as measured by the number of operational days per year increased from 245 in 2005 to 317 in 2007 and to 327 in 2008 with an expected further increase in 2009. This lies above the average of comparable vessels that form part of the OFEG fleet. This relative simple measure, combined with the fact that only part of the originally proposed research cruises, are funded and carried out, shows that there is enough (high-quality) critical mass in the Netherlands to maintain such a facility.
Increasingly, the use of very specialized equipment is shared among scientists from different countries. This holds especially for equipment that is not used on a day to day base and for which specialized technical support is needed. This is also the case for some of the equipment that forms part of this proposal, i.e. the instruments for high resolution surveys and sampling (amongst others ROV, AUV and ultraclean) in the deep sea. This instrumentation will be used mainly by marine geologists, chemistst and biologists. It is expected that both in the Netherlands and in Belgium this instrumentation will be needed during roughly 1-2 months per year. Therefore, it is intended to make a common Dutch-Belgian pool for this instrumentation, including the technical support. Procedures similar to the OFEG mechanisms will be followed for the planning of the use of this equipment.

3.3 Embedding (Inbedding)

Science

Sea research is characterized by its international and multi-disciplinary character. This is especially the case for sea-going research, in which the multi-disciplinary approach results from the scientific questions that are addressed and the international character is caused by the often global interest for the answers to these questions. This has led to international research programs in which different countries and disciplines, including the Netherlands, participate, ranging from world-wide programs like CLIVAR, GEOTRACES, European programs that are often partly funded by the EC- Framework Program like HERMES, CARBOCEAN and EurOceans, and regional or bilateral

Pelagia ship days per year	2003	2004	2005	2006	2007	2008
NWO National Program (incl. ESF EUROCORES) - ALW funded	121	119	65	67	92	54
NWO National Program (incl. ESF EUROCORES) - NIOZ funded			4	67	98	42
(Inter)national Program (BSIK, NSW, EU, CLIVAR, LOICZ, OFEG)	124	69	149	98	82	150
NIOZ Programs & courses (incl. equipment tests & en-route projects)	16	11	27	6	17	12
Chartering out	27	26	0	20	28	69
Total PELAGIA	288	225	245	258	317	327

Average number of ship days RV Pelagia over the past 6 years: 275 per year

programs like the Dutch-Flemish collaboration (VLANEZO) and the Dutch-Bremen collaboration in NEBROC (Netherlands Bremen Oceanography). Dutch sea researchers participate in these research programs that all have both sea-going, laboratory, and modeling components.

Within the Netherlands the embedding of sea-going research in the universities is ensured by jointly carrying out research programs and by the appointment of some 10 senior NIOZ scientists as professor at Dutch universities.

Facilities

All items in this proposal form part of the Marine Research Facilities, housed at NIOZ (NIOZ-MRF). NIOZ, and thereby NIOZ-MRF, is very well embedded in the Dutch research infrastructure since NIOZ is part of NWO, the Netherlands Organization for Scientific Research.

The entire Dutch academic research community, both from universities and academic research institutes, has access to the sea-going facilities that are managed and supported by NIOZ-MRF. As a granting organization, NWO, has a yearly budget available in support of sea-going research. Via an open call for proposals this budget is allocated to the best proposals for research programs with sea-going components. Subsequently NIOZ-MRF is responsible for supporting and carrying out the complete sea-going part of the funded proposals. Preferably, use is made of RV Pelagia and the available marine equipment and technical support at NIOZ-MRF. If the use of an other research vessel or specific equipment is more appropriate, NIOZ-MRF arranges a barter exchange within OFEG, the common European pool of marine facilities.

3.4 Proven willingness to co-operation (Bewezen wil tot samenwerking)

Science

Co-operation occurs on all research cruises of RV Pelagia, since the research question addressed is always shared by a group of scientists. These co-operations can be in the form of co-operation between different disciplines from the same institute and between scientists from different institutes and universities. By far, the latter situation dominates in practice. Moreover, most often scientists from different countries participate in sea-going research programs. This co-operation not only results in joint scientific publications, as is illustrated among others in the NIOZ annual reports, but also in established collaboration with different international parties in a a number of regional, European and global frameworks.

The shared use of part of the proposed instrumentation in the framework of a Dutch-Belgian co-operation is based on a long term scientific co-operation between Dutch and Belgian scientists.

Both RCMG and NIOZ have been and still are partners in EU and ESF programs over the last decade devoted to

study cold water coral occurrences and forcing, while collaboration with the Biology department of Gent University has also been strong (OMEX I and II projects) and is ongoing in the HERMES and HERMIONE EU projects. Moreover long term collaborations exist on trace elements, now in context of SCOR-GEOTRACES.

Facilities
Sea-going facilities within the Netherlands are shared because it is (part of) the mission of NIOZ to facilitate and support sea-going research by scientists from all Dutch academic research institutes and universities.
Within Europe research vessels and very specialized equipment are shared through OFEG in the form of barter exchanges (see paragraph 2.4. for more details on OFEG). NIOZ is a very active partner in OFEG and has maintained its high profile with 15 exchanges, totaling 244 exchanged days, in the past four years.
These exchange activities also comprise interventions for the recovery of drifting and/or un-recovered moorings for OFEG partners, and use of NIOZ marine technicians for training of OFEG partners' marine techs.

3.5 Societal relevance (Aansluiting bij maatschappelijke ontwikkelingen)

As discussed in several parts of this proposal, sea research has been, is and will be of great importance for society for a large number of reasons. Knowledge of the sea, the largest part of our planet, is of utmost importance for a sustainable use. The recognition that the oceans play a very important role in the climate system combined with the increasing need to enhance the capacity of the global energy and food industry have enhanced society's interest in the oceans considerably.
Therefore, and especially for a low-lying country like the Netherlands, it is of great societal relevance to actively participate in sea research. For this, up to date facilities, including an ocean going research vessel and a pool of specialized marine equipment, is indispensable.

4. Appendices

Appendix A: Conclusions and recommendations from the report: "Onderzoek Technische en Economische Levensduur PELAGIA" by Bureau voor de Scheepvaart (BvS)

CONCLUSIES EN AANBEVELINGEN

De Pelagia is een goed en degelijk gebouwd schip waarmee intensief wordt gevaren. Na ruim 17 jaar inzet van het schip, onder zeer uiteenlopende omstandigheden, is het echter evident dat belangrijke onderdelen/systemen dringend aan groot onderhoud/vervanging toe zijn.

Voorgesteld wordt om het schip binnen afzienbare tijd (1 à 2 jaar) een groot onderhoud ("midlife conversion") te laten ondergaan.

De voorgestelde uit te voeren her-motorisatie van het schip geeft een aanzienlijke besparing op toekomstige onderhoudskosten, mede door de langere standtijd van dit moderne type motoren. Bovendien hebben de voorgestelde motoren een veel lagere uitstoot aan CO2, etc. Tegen die tijd zullen de motoren naar alle waarschijnlijkheid aan de nieuwe CCR2-norm voldoen.

Er zijn verschillende overwegingen om het voorgestelde groot onderhoud binnen een tijdsperiode van 1 à 2 jaar uit te voeren. Momenteel wordt de operationele inzet steeds meer bedreigd doordat onderdelen/systemen onverwacht falen en niet meer leverbaar zijn. Het doel is dat na de "midlife conversion" de bedrijfszekerheid gegarandeerd en het comfort aan boord verbeterd is. Bovendien heeft men dan zelf het meeste rendement van de conversie.

Teneinde tot een zo gunstig mogelijke prijs/kwaliteitsverhouding te komen, wordt voorgesteld om een gedetailleerde tenderaanvraag op te stellen en hiermede bij een aantal gepreselecteerde West-Europese werven een aanvraag te doen.

Het verdient voorkeur om de aanvraag te baseren op een gedetailleerde specificatie die bij voorkeur is opgezet volgens de in dit rapport gebruikte SFI-code. Voordeel van een dergelijke opzet is dat de werven een in detail uitgesplitste aanbieding moeten maken waardoor onderlinge prijsvergelijking goed mogelijk is en bij opdracht ook mogelijk aangepast/geschrapt kunnen worden om binnen een vooraf opgezet budget te blijven.

Teneinde een zo kort mogelijke doorlooptijd van de "midlife conversion" bij een scheepswerf te realiseren, zullen door het NIOZ belangrijke onderdelen zoals motoren, hydraulische componenten b.v. pompen en winchmotoren, vooraf bij leveranciers besteld moeten worden. Deze componenten worden dan bij aanvang van de werkzaamheden op de werf als "owners deliveries" aan de werf overgedragen. Gezien de mogelijk lange levertijd (dieselmotoren 6 – 12 mnd) van deze componenten is het van belang dat deze tijdig besteld worden.

Een concept tijdsplanning is aan dit rapport toegevoegd als bijlage 17. Deze planning geeft aan dat op korte termijn het project opgestart moet worden, indien de "midlife conversion" in het 2e kwartaal 2009 uitgevoerd moet worden.

Essentiële componenten zoals b.v. motoren, hydrauliek pompen e.d. dienen nog voor de zomer 2008 besteld te worden i.v.m. de lange levertijd van deze toeleveringen.

I.v.m. de toestand van de ballasttanks is het dringend noodzakelijk om deze structureel aan te pakken. Gebeurt dit niet dan zal de surveyor hier bij een volgende "intermediate", uit te voeren tussen 23 januari 2008 en uiterlijk 23 juli 2009, ongetwijfeld aanmerkingen maken die kunnen leiden tot een conditie of class.

Werkzaamheden die eventueel in 2008 nog uitgevoerd worden bij een dokking, worden tegen relatief hoge kosten uitgevoerd. Het is veel economischer om alle noodzakelijk uit te voeren werkzaamheden samen te voegen en deze tijdens een langdurig onderhoud/midlife conversion in 2009 uit te voeren.

De kosten voor de uit te voeren "midlife conversion" worden begroot op circa € 3,0 miljoen. Hieraan moeten toegevoegd worden kosten voor voorbereiden van de tender, bouwmanagement en bouwtoezicht tussen uitvoering van de werkzaamheden e.d. Deze kosten worden begroot, afhankelijk van de plaats van uitvoering, op circa € 150.000.

Voorts dienen in het budget kosten voorzien te worden voor o.m. vervanging/uitbreiding van het computer netwerk aan boord en mogelijke uitbreiding van andere hulpsystemen voor uitvoering van het wetenschappelijk onderzoeksprogramma. Kosten hiervoor worden begroot op € 300.000. Ter overweging aan het totaal budget van € 3.450.000 nog een post onvoorzien van € 250.000 toe te voegen.

Na uitvoering van het groot onderhoud mag verwacht worden dat het schip bij verder regelmatig onderhoud en survey-beurten, nog zeker voor een periode van minimaal 10 jaar, goed inzetbaar zal blijven. Als het schip in 2021 weer toe is aan een "special survey" zullen de onderhoudskosten naar verwachting zeer hoog worden. Tegen die tijd zal het schip dan ook vervangen moeten worden.

Wensen van de wetenschappelijke staf t.a.v. uitbreiding van geïnstalleerde apparatuur teneinde de operationele inzetbaarheid van het schip te vergroten, zijn in het kader van dit onderzoek thans nog niet geïnventariseerd.

Appendix B: Letter of intent by the Renard Centre of Marine Geology (RCMG), Ghent University.

Letter of Intent

1. Within the framework of a Flanders call for large research infrastructure, the Renard Centre of Marine Geology (RCMG) at Ghent University has acquired a remotely operated vehicle type Cherokee (SubAtlantic), named "Genesis". The system, comprising a tethered management system (TMS), a cable of 1600 m and winch, an IXSEA Gaps USBL positioning tool and various instruments, among which a hydraulic arm, a sidescan sonar, CTD, forward looking sonar, etc., can be shipped worldwide as one single 20 ft container, for minimizing mobilization costs.

2. The application for this large infrastructure has been supported by a.o. the Flanders Institute of the Sea (VLIZ) and the Belgian Management Unit of the Mathematical Model of the North Sea (MUMM). ROV Genesis consequently is a university infrastructure with a broad multidisciplinary and national support platform, and is consequently a suitable nucleus of international cooperation.

3. RCMG initially develops the Cherokee ROV into a "Deep Reef Surveyor" concept, a dedicated vehicle for exploring cold-water coral reefs and carbonate mounds, typically found in the depth range 500-1200 m. It has the capacity of further investigating cold seep environments, mud volcanoes, gas hydrate sites, canyons, etc. with their specific ecosystems. The ROV is the ideal exploratory tool which, equiped in addition with a dedicated sidescan sonar (still to be installed), will groundtruth targeted sites and will support the development of the interpretational keys, linking acoustic and visual images. Through such keys, subsequent areal surveys can be planned with an AUV for the purposes of habitat mapping, biodiversity studies and the delineation of candidate areas for deep water Marine Protected Areas.

4. Genesis has operated from R/V Belgica in the Celtic Sea, from R/V Discovery in Denmark Strait, from R/V Sonne off New Zealand and from R/V Belgica again off Morocco. After a major maintenance, it has operated June 2008 from R/V Belgica on the Gascogne margin, and commitments have been made for an operation on board of R/V Pelagia on the Nile delta (2008) and an expedition on board of the US R/V Palmer in the Antarctic 2009-2010 (Larsen B Ice shelf area, cold seeps).

5. Ghent University has provided one tenured position of a ROV mechanical engineer/pilot and a 5 years support for the senior ROV System Manager (geophysicist/system analyst). Two other ROV engineers/pilots (electronics) have to be supported by external funding.

6. With this letter, we confirm – in agreement with our main scientific partners and subject to the expected institutional support from either side – our intent to develop under terms, suitable to both parties, a cooperation between RCMG and Royal-NIOZ, with the purpose of optimally pooling and sharing ROV/AUV equipment and staff, in a win-win spirit.

7. The object of this cooperation comprises in principle, subject to further desktop studies and agreements, the following actions:
   - extending the instrumental and operational capabilities (depth range), the sampling and sample recovery capacity and the imaging capability of Genesis,
   - developing joint bilateral or multilateral projects to consolidate the engineering and operational staffing of the ROV/AUV pool,
   - exploring further opportunities for scientific and technological co-operation, bilateral and multilateral, beyond the excellent cooperation fostered in the past ten years,
   - bringing further developments towards large equipment and shiptime bartering and sharing between Belgium and The Netherlands on the appropriate political agenda, with the objective of consolidating a "Lowlands Pool" within the successful OFEG consortium.

Ghent, July 3rd, 2008

Prof. Dr. J.P. Henriet and Prof. Dr. M. De Batist
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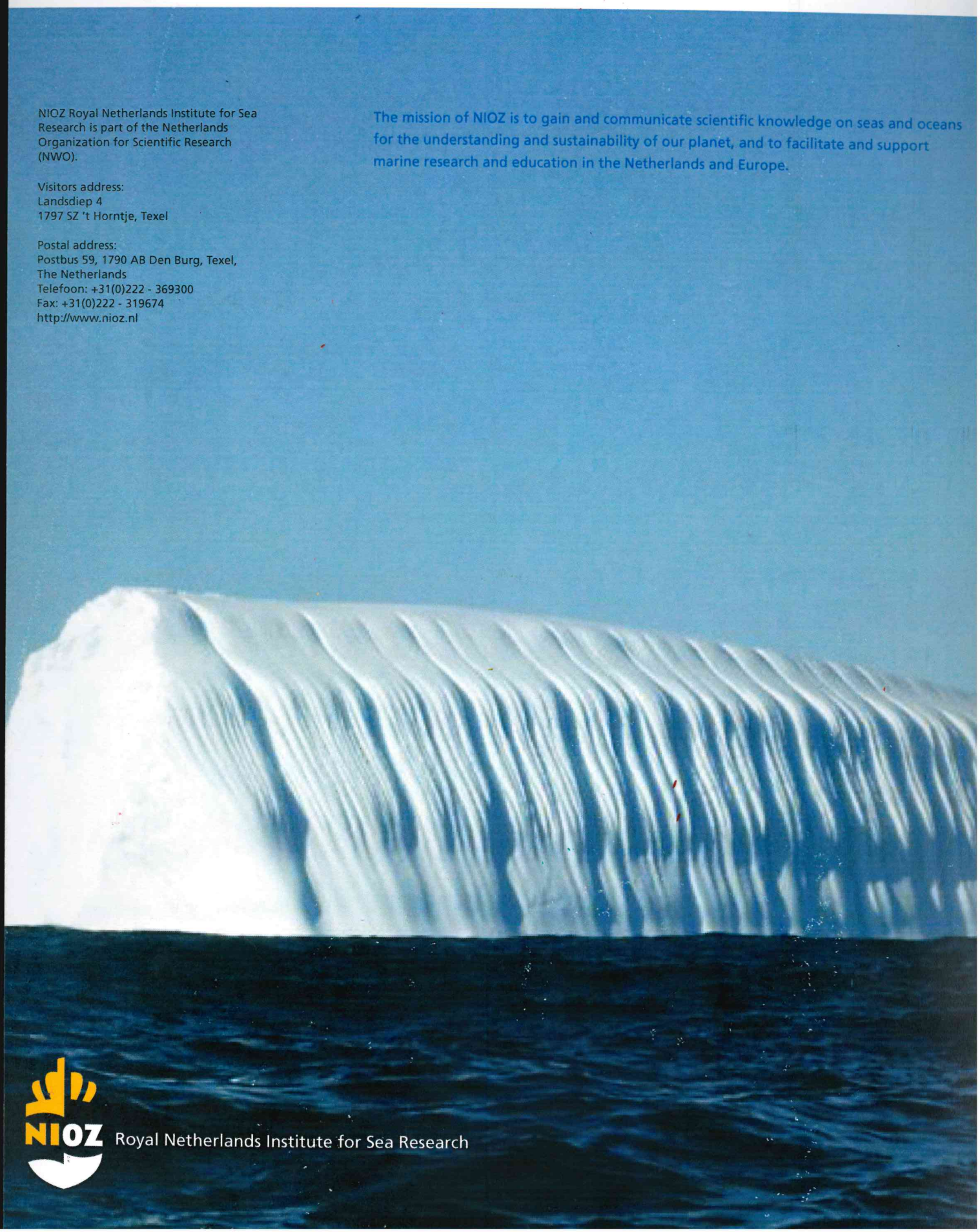
The mission of NIOZ is to gain and communicate scientific knowledge on seas and oceans for the understanding and sustainability of our planet, and to facilitate and support marine research and education in the Netherlands and Europe.



NIOZ Royal Netherlands Institute for Sea Research