Proposal for a

Dutch Bonner Lab Extension

at Rothera Research Station

In cooperation with the British Antarctic Survey

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

NWO
Nederlandse Organisatie voor Wetenschappelijk Onderzoek

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1. Introduction

The Dutch Ministry of Education, Culture and Science (OCW) aims to create a research climate that fosters world-class scientific achievements. In its policy it focuses on the acquisition of additional scope and resources for fundamental research. The Netherlands is a signatory partner of the Antarctic Treaty and as such has an obligation to maintain a high quality polar research programme. The Ministries of Foreign Affairs (BUZA), Agriculture, Nature and Food Quality (LNV), Housing, Spatial Planning and the Environment (VROM), Transport, Public Works and Water Management (V&W) and Economic Affairs (EZ) are financers of this Netherlands Polar Programme (NPP). The Netherlands Organisation for Scientific Research (NWO) operates this programme by order of the ministry of OCW. Dutch policy concerning the polar regions requires that we restrain from building our own research station in the Antarctic. Having no facility of our own, Dutch researchers will be depending on logistical support of other partners. Without this support Dutch Polar research would have been impossible. This, on the other hand, has gained us fruitful collaborations with partners in polar science. One of these partners is the British Antarctic Survey (BAS). NWO and BAS like to extend their existing collaboration in the field of polar research. Therefore a plan is created to invest in a joint science facility that extends the existing cooperation with the BAS and, on the other hand, meets our own obligation of restraining from building a Dutch research station in Antarctica.

2. Concept of investment

In the last five years the interest and importance of polar research has increased significantly in the international context. The successful International Polar Year (IPY) drew great attention to the importance of polar regions and the related research. The Dutch research in this field has an excellent international track record and is of high quality, but strongly depends on good international cooperation with countries that can provide access to the polar regions.

2.1 Purpose

The purpose of this investment is to provide the Dutch polar research community with an appealing, longer lasting Dutch commitment to polar research through intensifying the collaboration between the Netherlands and the United Kingdom in a strategic alliance beyond the current Memorandum of Understanding (MoU). Practically this means building a mobile science facility, containing five laboratory units to facilitate Dutch polar research in the themes *polar ecology*, *polar oceanography* and *ice, climate and sea level rise* (see fig. 1). The five units will be staffed with PhD's/ post doc researcher, who will be selected in an open science call within the new Netherlands Polar Programme (2010-2014). They will bring their own, specific equipment to further furnish the lab modules. Because of its mobility, the facility can be installed and used when necessary, and renewed or removed when this is required. An additional effect for the longer term is the possibility for other partners to use this facility, either one of the lab modules, or bringing their own lab module as one of the Dutch projects ends. The mobile science facility is expected to stay at Rothera Research Station for about ten years. At this moment funding has been secured until 2014. Continuation of the research beyond 2014 is subject to evaluation.
The special modular laboratories are all build according to a standard international size to make their deployment at all sorts of seagoing vessels highly flexible at relatively low costs. Once a docking station is established all sorts of already available modules operating for marine sciences become potentially available, once suitably insulated and fitted with fire exit/precautions for polar research. Wet labs, auto analyzer labs, clean rooms, cooled labs and others are existing examples already operational.

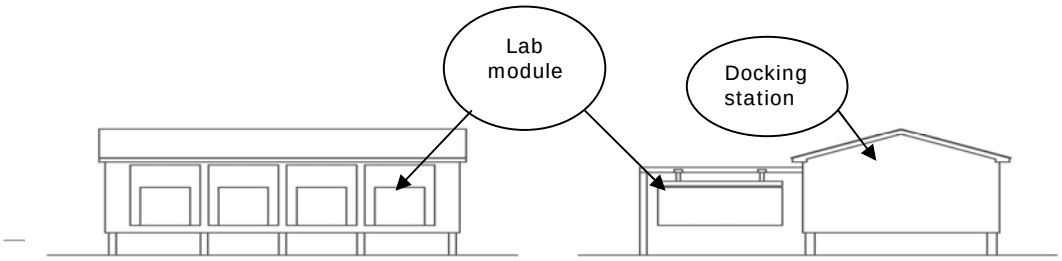

Figure 1: model of docking station with containerized laboratories
Drawing by BAS

2.2 Partner

A preferred partner in polar research for the Netherlands is the United Kingdom, a professional and reliable partner in science. Since 20 years a fruitful collaboration exists between the British Antarctic Survey (BAS) and NWO, since 1995 recorded in a Memorandum of Understanding between both parties. The present MoU ends in 2011 and both parties wish to extend and intensify this collaboration. Through this MoU access to facilities of the BAS is provided for Dutch researchers. The British research station Rothera, situated at 67º 34' S, 68 º 08' W, at Rothera Point, Adelaide Island, Antarctic Peninsula, has been an important place for Dutch researchers for years. The BAS is a very professional organization, having years of experience in building and managing science facilities in this hostile, though pristine environment. The BAS is very determent to preserve such an exceptional environment by measuring, understand and minimize the effects of human presence. BAS is committed to delivering polar science with the minimum environmental impact through the use of an Environmental Management System (certified to ISO 14001 standard). All of the activities continue to comply with the requirements of the Protocol on Environmental Protection to the Antarctic Treaty (*website BAS, April 2010).*

2.3 Location

Rothera Research Station has been chosen as the preferred location because the research done at Rothera Research Station is complementary to research themes executed within the Netherlands Polar Programme. In addition, Rothera is quite easy accessible and has both space and possibilities available for extension of the research area. It is also a major hub into a larger area of the Antarctic relevant for Dutch researchers. All

necessary facilities to handle container sized labs are available at Rothera. There is a wharf available for appropriate ships to land and adequate cranes to move the labs around in and out to the docking station. If a research module for any reason requires special services or further special adaptation for the ongoing research programme it can be taken out of its docking station and easily be shipped to the Netherlands for a technical overhaul or update at the end of a summer season and be returned at the start of the next season.

Taking the concept of a mobile laboratory to the Antarctic at Rothera would mean the erection of an additional construction at Rothera Research Station that is able to provide the necessary docking facilities next to a main platform; a docking station. It needs laying down additional concrete foundations, erecting a roof structure and the extension of all kinds of lining for water, electricity and necessary gasses. Several alternative locations were evaluated on site and reviewed afterwards by the BAS based on the most recent blueprints of the existing infrastructure. It is necessary to have enough working space for heavy equipment to move the units in and occasionally out of the lab module facility. For safety reasons heavy traffic needs to be avoided over fuel pipes and existing service ducting. After investigation the Bonner laboratory site at Rothera turns out to be the best suited for this purpose. Four lab modules turn out to be best planned at the North-East side of the Bonner lab. Separate from the main building a docking station will be build to fit in these four laboratory modules. A roof will cover the modules providing additional dry storage capacity and to protect inlets and outlets into the lab modules from snow drift. Also the modules will be raised off the surface and these measures will prevent the modules becoming buried in snow. All services (water, gasses, electricity, local area network etc.) will be provided for from the Bonner Laboratory. To compensate for the additional power drain of the laboratory modules it will be investigated whether solar panels can be fitted to the extended roof to provide the modules partially with sustainable energy. Due to the use for research conducted in the region around Rothera Research Station an additional second location was identified for placement of 1 module (with the possibility to extend to 2 modules) of the modules, that is in the vicinity of the hangar. This facilitates logistics for field work. The map (figure 2) provides an overall view of the layout of the Rothera Research Station and the selected locations for the mobile science facility (red arrows).

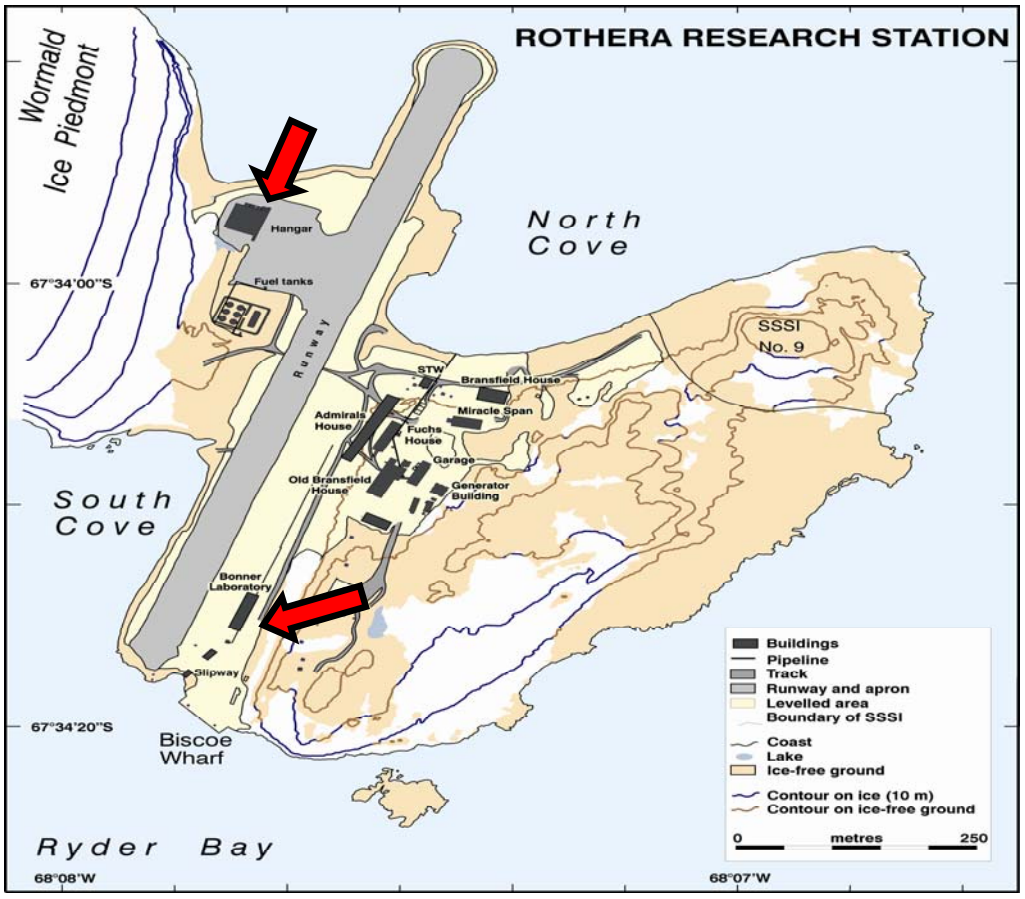

Figure 2: Map with overview Rothera Research Station. Arrows indicate intended location lab modules, near the Bonner lab and near the hangar.

2.4 Identity

It is to be avoided that the Dutch contribution on the ground at Rothera Research Station could be seen as a territorial claim. In this respect Antarctica still is a complex continent. For this reason formally waiving a Dutch flag relating to our contribution is to be avoided. An elegant solution that marks our presence in a cultural way will be sought.

3. Lab modules

Five special lab facilities will be established at Rothera Research Station in close collaboration with the BAS. These will trigger increased synergy between Dutch and UK/BAS research and can be developed into inspiring Dutch nuclei embedded in an ongoing long term science programme. As such it will attract new promising young researchers and increase Dutch commitment to polar research. The lab modules will be supported with a dedicated associated science programme. The science conducted in the mobile laboratories is preferably linked. Synergy between the research projects will enhance its range. An open call will be used for selection of excellent researchers and research projects that will be conducted in the modules. The modules are standard 20 foot (high cube) sea containers (6.1m x 2.44m x 2.89m). The lab modules are:

1. **Dry lab container**
   Standard 20 foot container including ventilation and heating. Inside, the lab is equipped with 2 lab tables and a sink. Some cupboards will be placed below the lab tables.
   Constant temperature: between 15 °C and 20 °C.
   Utilities: 220 V and fresh water.

   This module will be suitable for analyses. Analytical instruments that can be placed in the lab module include coulometry, IR Spectophotometry, optode sensors (O_2), high accuracy spectrophotometry (pH at <0.001 accuracy), and others.

2. **Clean room container lab**
   Standard 20 foot container including ventilation and heating, with an Air handling system creating a Clean Room Class of 10.000. Inside, the lab is equipped with 2 lab tables, 2 laminar flow benches and a sink. Some cupboards will be placed below the lab tables.
   Temperature: between 5 °C and 20 °C.
   Utilities: 220 V and fresh water.

   Lab module 2 is an ultraclean laboratory container equipped with special filters in the air-handling system designed for continuous recycling and filtering of the air inside the clean laboratory. Analytical instruments can comprise Flow-Injection-Chemiluminescence analyzers and a high purity water supply system.

3. **Wet lab cultivation container**
   Standard 20 foot container including ventilation and air-conditioning. Inside, the lab is equipped with 2 lab tables, a sink and a fume hood. Some cupboards will be placed below the lab tables. The floor will be equipped with a drain pipe.
   Constant temperature: between 2 °C and 15 °C.
   Utilities: 220 V, fresh water and CO_2.

   Incubation set-ups can be installed in this temperature controlled module, in which pCO_2, pH, temperature, salinity and turbidity can be varied. Possible analytical approaches include radio-isotope labeling, flow cytometry and molecular tools.

4. **Workshop / lab container**
   Standard 20 foot workshop container for data recovery, storage, repair and maintenance of instruments for scientific measurements. Inside, the lab is equipped with 1 work bench and 1 storage rack
   Temperature: between 5 °C and 20 °C.
   Utilities: 220 V, internet connection (limited bandwidth)

   To facilitate research activity in the region surrounding Rothera Research Station it is necessary to have a suitable place for preparation and testing of equipment. Lab module 4 will be suitable as an electronics as well as mechanical workshop. Additionally after the summer season such a lab module would also be suitable for storage and protection of sensitive equipment over the winter, until their next time of deployment.

5. Measuring / storage container

Standard 20 foot workshop container for installation and storage of scientific measurement equipment. Inside, the lab is equipped with 1 work bench.
Temperature: between 5 °C and 20 °C.
Utilities: 220 V, internet connection (limited bandwidth), optional: ref gasses
Module 5 will be a temperature-stabilized laboratory suitable for various atmospheric analyses instrumentation. It will contain an air inlet and an automatic dried air flask filling facility.

Figure 3 Inside of 2 mobile labs (these are examples of already existing modules) Pictures by NIOZ

4. The BAS perspective on the proposed investments

Rothera station has many excellent facilities but it is the ambition of the British Antarctic Survey to continually develop and extend these so Rothera can maintain its reputation as an outstanding research station where world-class multi-disciplinary science is carried out.

The proposed Dutch investments in the new modular facility would be a major step forward in extending the facilities. At the very highest level the advantages would be:

- Significant opportunities for new science that complements very effectively existing research programme of the British Antarctic Survey
- Scientific collaboration with high quality scientists with complementary expertise.

4.1. Biological developments

For the past 50 years, the Antarctic marine ecosystem has been affected by climate change especially on the western side of the Peninsula, with its warming air and water, and declining sea-ice. There has been a decline in krill stocks in some areas, and a southward shift in the population of gelatinous salps. Also a decline in phytoplankton may reflect a decrease in iron input from the continental margin that is in turn related to a reduction in the formation of sea ice in this region and hence to climate change. All sea-ice related components of the pelagic Antarctic ecosystem are experiencing consequences of the regional decrease of sea ice west of the Antarctic Peninsula. For the bottom-inhabiting fauna, no evidence for impact of climate change exists but physiological experiments would suggest that major changes of biodiversity may occur.

BAS has a long history of carrying out research on the higher trophic levels, but the international community and BAS have very limited knowledge of bacteria and viruses in the Southern Ocean and around the Antarctic Peninsula. Bacteria constitute a very significant component of ocean productivity. Rates of bacterial production are determined mainly by the amount of decaying organic matter available. Phages, a group of highly species-specific viruses, are likely to be even more abundant than bacteria, and they have a critical role in regulating bacteria and phytoplankton abundance – here again little is known. Carbon cycling in the Antarctic system may not be simple; bacteria might dominate the uptake of nutrients, thereby reducing, not increasing, phytoplankton growth in the ocean, and hence limiting the potential food supply for zooplankton. These are critical issues.

The Rothera Oceanographic and Biological Time Series (RaTS) started in 1997. The ethos of RaTS is to make high-frequency, sustained observations with which to answer a number of scientific questions relating to the physical and biological marine environments, their evolution over time, and their interactions with the atmosphere and cryosphere.

The specific aims of RaTS include:

- To document the seasonal pattern of sea ice, temperature, salinity, chlorophyll, pH and macronutrients (N, P, Si) in the water column close to the Antarctic Peninsula
- To quantify the extent of interannual variability and long-term change in physical and biological oceanography close to the Peninsula, particularly in relation to large-scale forcing by factors such as El Niño and the Southern Annular Mode
- To relate seasonal and interannual variability in the feeding activity of selected benthic suspension feeders to variability in the physical environment
- To quantify interannual variability in the reproductive biology of selected marine invertebrates, and relate this where possible to variability in the environment.

4.2. Climate science

The Antarctic Peninsula is one of the most rapidly warming regions in the world and Rothera is extremely well situated for monitoring climate change and its effects. Rothera is already listed as a Global Atmospheric Watch (GAW) station making surface and upper air meteorological observations and monitoring stratospheric ozone. In addition, several other parameters are routinely measured, such as aerosols, radioactivity and GPS data to derive the amount of precipitable water.

In order to effectively provide the numerous research projects in the region with high-quality climatological background information, it is essential for the Rothera climate programme to be scaled up so that it achieved the international standards of a Baseline Surface Radiation Network (BSRN), a Global Upper Air Network (GUAN) station and develop atmospheric chemistry capability. Specific objectives include:

- Enhancing the radiosonde programme to GUAN standards
- Running an ozone-sonde programme
- Initiating a radiation measurement programme to BSRN standards

- Carbon balance, atmospheric greenhouse gases
- Isotopes in the water cycle for enhanced ice core interpretation
- Continuous monitoring of ^{14}C in air

The type of research that would be supported would include glaciological measurements, which contribute significantly to the rise in sea level.

The Dutch propose significant investments in the scientific infrastructure that would make Rothera a leading Antarctic climate monitoring site.