

Assessment of Research Quality

Netherlands Institute of Ecology (NIOO-KNAW)

2012-2017



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Contents

	Page
1. Introduction	
1.1 Background	3
1.2 Members of the assessment committee	3
1.3 Procedures followed	3
1.4 Research unit under assessment: Netherlands Institute of Ecology (NIOO)	4
2. Assessment of NIOO research	
2.1 Summary of NIOO's strategy and targets	8
2.2 Research quality	9
2.3 Relevance to society	10
2.4 Viability	11
2.5 Summary in numerical scores	12
3. Assessment of PhD programme, research integrity policy, and diversity policy	
3.1 Quality and organisation of PhD programme	13
3.2 Research integrity and open science policy	14
3.3 Diversity and inclusiveness policy	14
4. Recommendations	
4.1 Quality, impact, and viability of NIOO	16
4.2 PhD programme	18
4.3 Research integrity and open science	19
4.4 Diversity and inclusiveness	19
Appendices	
1. Short CVs of the members of the assessment committee	20
2. Site visit programme	23
3. Quantitative data on NIOO's composition and financing	24
4. Explanation of the categories utilised	25

1. Introduction

1.1 Background

This report describes the assessment of the quality and relevance of research conducted at the Netherlands Institute of Ecology (NIOO) in the period 2012-2017. The assessment was performed by an external review committee using the Standard Evaluation Protocol (SEP) 2015-2021. The SEP was drawn up and adopted by the Royal Netherlands Academy of Arts and Sciences (KNAW), the Netherlands Organisation for Scientific Research (NWO), and Association of Universities in the Netherlands (VSNU). All research conducted at Dutch universities, University Medical Centres, and NWO or KNAW institutes is assessed once every six years in accordance with the SEP. The primary aim of SEP assessments is to evaluate the quality and relevance of academic research and to suggest improvements where necessary. SEP assessments focus on the strategic choices and future prospects of research groups.

Target groups that are served by this assessment include

- **NIOO's researchers and management** need to know how the quality of NIOO research, its societal relevance, and its strategy are perceived by independent experts and how these elements can be improved.
- **The Board of the KNAW** wishes to track the impact of its research policy.
- **The Dutch government** wants to know the outcomes of assessments in connection with the institution's accountability for expenditure and its own efforts to support an outstanding research system.
- **Society and the private sector** seek to solve a variety of problems using the knowledge that NIOO research delivers.

1.2 Members of the assessment committee

The Board of the KNAW has appointed as members of the assessment committee

- Professor Corné Pieterse, *chair* (Utrecht University, the Netherlands),
- Professor Sue Hartley (University of York, UK),
- Professor Josephine Pemberton (University of Edinburgh, UK),
- Professor Klement Tockner (FWF Austrian Science Fund, Austria),
- Professor Ian Head (Newcastle University, UK).

Dr Linda van den Berg (Washoe Life Science Communications) served as the secretary to the assessment committee. Short CVs of the committee members are provided in Appendix 1.

1.3 Procedure

The assessment committee evaluated NIOO research based on the institute's self-assessment report, interviews and on-site interactions with NIOO representatives (management, senior scientists, postdocs, PhD students, and technical support staff), and an interview with the chairman of NIOO's Scientific Advisory Board during a site visit in April 2018. The site visit programme is listed in

Appendix 2. Additional reference materials included the conclusions and recommendations of the previous peer review committee (2012), a bibliometric analysis performed by the Centre for Science and Technology Studies of Leiden University (CWTS), and the NIOO strategic plan 2017-2025. The committee took into account international trends and developments in science and society as it formed its judgement. In addition, the committee bore in mind NIOO's strategy as outlined in its strategic plan 2017-2025 in formulating its recommendations.

Qualitative and quantitative assessment of NIOO research

The assessment committee made a qualitative and quantitative judgement of NIOO based on three assessment criteria:

1. *research quality*, i.e., contribution to scientific knowledge and scale of research results (scientific publications, instruments, and infrastructure produced, and other contributions to science),
2. *relevance to society*, i.e., quality, scale, and relevance of contributions (advisory reports for policy, contributions to public debates, etc.) targeting groups that NIOO has itself designated as target groups (the general public, industry, non-governmental organisations, and the national & European government),
3. *viability*, i.e., the strategy that NIOO intends to pursue in the future and the extent to which it can meet its targets in research and society during this period, the governance and leadership skills of NIOO's management.

Assessment of NIOO's PhD programme

The assessment committee also considered the supervision and training of PhD candidates at NIOO. During the site visit, the committee interviewed eight PhD students, who were in different stages of the PhD track. The committee assumed that these individuals provided opinions that are representative of the group at large. The following topics were considered:

- institutional context of the PhD programme,
- programme content and structure,
- supervision and the effectiveness of programme plans and supervision plans,
- quality assurance,
- guidance of PhD candidates for the job market,
- duration, success rate, exit numbers, and career prospects.

Assessment of NIOO's research integrity and diversity policy

The committee also considered NIOO's policy on research integrity and the way in which violations of such integrity are prevented. This was discussed during the site visit. The committee was interested in how NIOO deals with research data, data management, and scientific integrity, and the extent to which a critical pursuit of science occurs at NIOO. In addition, the committee evaluated NIOO's efforts to ensure a diverse staff composition from the junior through the senior scientist level.

1.4 Research unit under assessment: Netherlands Institute of Ecology

The Netherlands Institute of Ecology is one of the 15 research institutes of the KNAW. It is rooted in three independent research centres that were founded by the KNAW in the 1950s: Centre for Limnology, Centre for Terrestrial Ecology, and Centre for Estuarine and Marine Ecology. These institutes joined forces in 1992. Limnology and Terrestrial Ecology moved to the present NIOO

building in Wageningen in 2011 and Estuarine and Marine Ecology merged with NWO's Royal Netherlands Institute for Sea Research (NIOZ) in 2012. At present, NIOO is home to the largest group of fundamental ecologists in the Netherlands, studying animal, plant, and microbial ecology in terrestrial and aquatic environments. NIOO's mission is to 1) generate fundamental knowledge on the ecology and functioning of natural systems, with the aim to uncover innovative ways to safeguard and strengthen biodiversity, sustainability, and climate resilience of natural and man-made ecosystems in the future, and 2) to be an important hub between ecological knowledge centres and stakeholders in society.

Organisation

The organisational structure of the institute is depicted in Figure 1 on page 7 of this report. NIOO has four scientific departments:

- The department of **Animal Ecology**, headed by Professor Marcel Visser, studies the evolutionary and population ecology of animals, with ecological consequences of climate change as its unique selling point.
- The department of **Aquatic Ecology**, headed by Professor Ellen van Donk, investigates how ecological mechanisms, eco-evolutionary processes, and abiotic factors govern the dynamics and structure of aquatic food webs, with trophic interactions in freshwater ecosystems as its unique selling point.
- The department of **Microbial Ecology**, headed by Professor Jos Raaijmakers, studies the ecology, diversity, and functions of microorganisms in natural and man-made ecosystems, including native plant habitats, agriculture, and aquaculture. It is leading in the field of soil microbiomes and their impact on ecosystem services.
- The department of **Terrestrial Ecology**, headed by Professor Wim van der Putten, investigates species, their interactions, and the consequences for community composition and ecosystem functioning in terrestrial ecosystems under global change, with aboveground-belowground multitrophic interactions as a unique selling point.

In addition to these scientific departments, the Dutch Centre for Avian Migration & Demography (*Vogeltrekstation*) is embedded in NIOO. It is jointly led by NIOO and the *Ringersvereniging*. Amongst other things, this centre facilitates scientific bird ringing in the Netherlands and manages the associated data. For five specific 'niches', NIOO has established research translation initiatives in collaboration with private partners and societal stakeholders: Microalgae Eco-Technological Solutions (METS), Aquatic Knowledge centre WAgeningen (AKWA), Tropical Microbial Ecology (TropME), Centre for Soil Ecology (CSE), and the Centre for Avian Population Studies (CAPS).

The NIOO management team consists of Professor Louise Vet (director since 1999), Dr Petra van den Berg (managing director since 2009), and the four department heads. The management team is advised by an external Scientific Advisory Board consisting of four international experts and chair Professor Rien Aerts. The institute also has an active works council, which engages with the management on behalf of all personnel. The operational management and support within NIOO is organised by Central Management & Services, which consists of a Financial Administration, HRM, ICT, Reception & Facilities, Technical Services, Library & Information Services, and PR & Science Communication.

Staff

In 2017, the NIOO research staff comprised approximately 92 full-time equivalents (FTE), consisting of 19 FTE senior scientific staff members, 30 FTE postdocs, and 43 FTE PhD students. In addition, the institute has 60 FTE technicians and other support staff members, as well as several visiting fellows. Further details about the NIOO staff are provided in Table 1 of Appendix 3.

Funding

NIOO has an annual budget of approximately 14 million euros (excluding housing). Around 60% of NIOO funding is direct funding by the Ministry of Education (through the KNAW). NIOO uses this budget to finance its permanent staff, general material costs, and research infrastructure. The remainder of the budget is acquired through external grants. NIOO uses this external funding to cover direct research project expenses as well as indirect costs. Further details about NIOO's funding are provided in Table 2 of Appendix 3.

Facilities

NIOO is located in one of the most sustainable buildings in the Netherlands, which serves as a showcase for its ecological research. The institute invests substantially in its research infrastructure. Facilities include molecular, microbial, chemical analytical, and aquatic laboratories, climate-controlled facilities for bird housing and experiments, a phytotron for all plant, soil, and insect research, greenhouses, and advanced aquatic experimental equipment (e.g., limnotrons and experimental ponds). An apparatus committee monitors NIOO's equipment and advises the NIOO management about the possibilities for shared use and new investments. NIOO has established a bioinformatics unit consisting of two persons that assist NIOO scientists in study design, data analysis, and data storage. Most omics analyses are outsourced because they require expensive equipment that rapidly becomes outdated (e.g., genomics, transcriptomics, and metabolomics).

Hub

NIOO acts as a national and international hub in the ecological research landscape and connects its research with ecology-related societal challenges through extensive outreach activities and collaborations with stakeholders. The institute attracts collaborators, visitors, and graduate students from all over the world. At the national level, the NIOO staff collaborates intensively with research groups at the Dutch universities, for instance through invited professorships in Wageningen, Utrecht, Leiden, Groningen, and Amsterdam. NIOO also contributes to MSc and PhD teaching programmes at these universities. NIOO researchers serve on national funding boards and programme committees, influencing the research agenda for the field of ecology. NIOO has played an active role in structuring and defining the nature- and ecology-related routes of the National Science Agenda, including Smart liveable cities, Circular economy and Resource efficiency, Sustainable food production, Environmental quality, and Water, and in particular the route 'The origin of life – on Earth and Elsewhere' and the virtual research centre that developed from this route (the Origins Centre). NIOO's position as a national hub in ecology is also illustrated by its leading role in several collaborative centres and networks, including CSE, CAPS, the Centre for Wetland Ecology, the platform for ecological restoration of lakes, the Netherlands Ecological Research Network, and the Netherlands Society for Evolutionary Biology.

At the international level, NIOO has extensive collaborations with universities, research centres, governmental organisations, companies, and other stakeholders. The institute participates in a variety of EU-funded research consortia, either as coordinator or as partner, including a Marie Curie Research Training Network on Plant Epigenetics, an EU-COST action on microbe-induced resistance to agricultural pests, and the Aquacosc and MANTEL projects funded by the Horizon2020 programme. NIOO has a prominent role in several global networks, e.g., the Global Lake Ecological Observatory Network, Global Soil Biodiversity Initiative, and NutNet.

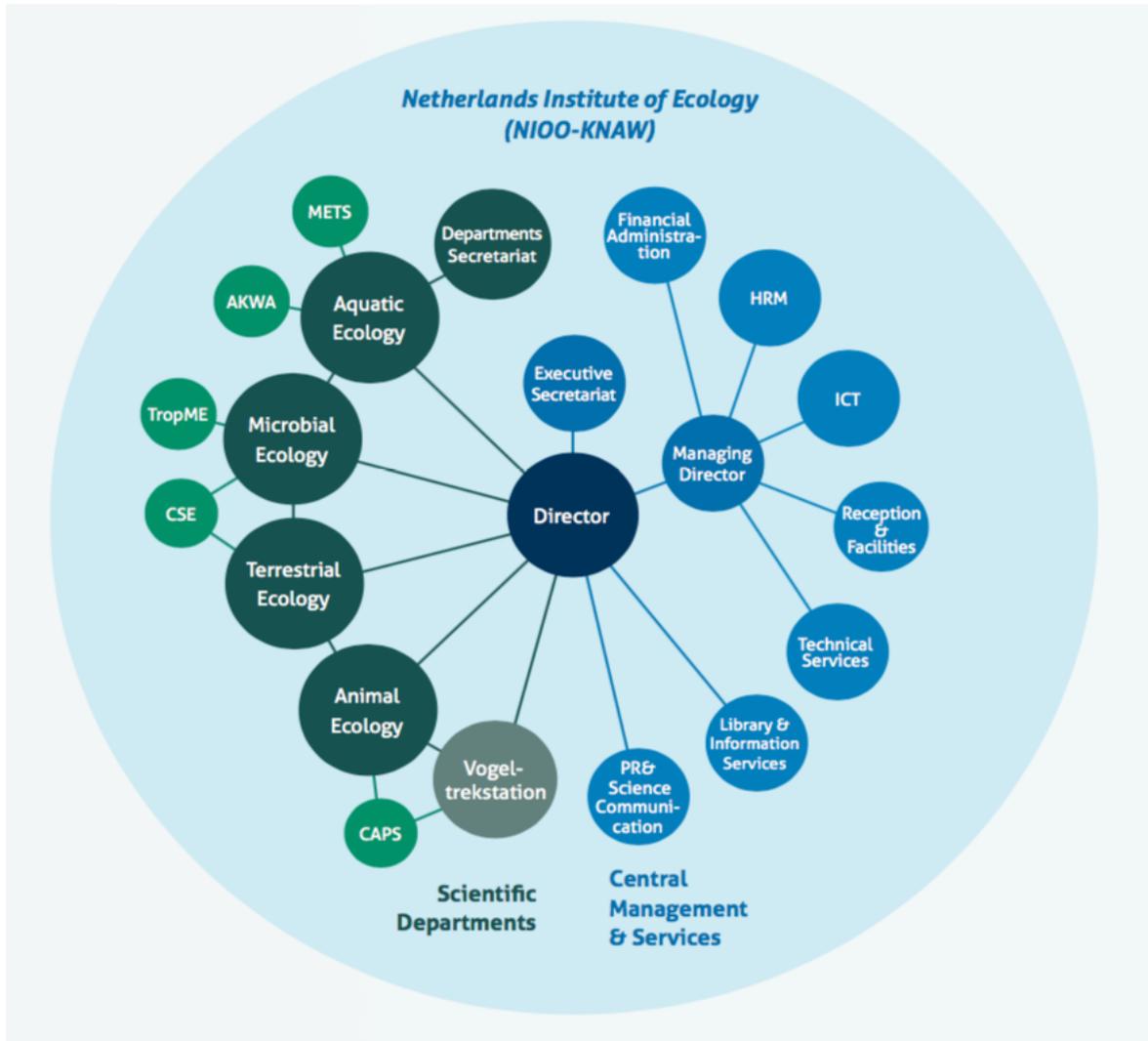


Figure 1: Organisational structure of NIOO in April 2018.

METS = Microalgae Eco-Technological Solutions
 AKWA = Aquatic Knowledge Centre Wageningen
 TropME = Tropical Microbial Ecology
 CSE = Centre for Soil Ecology
 CAPS = Centre for Avian Population Studies

2. Assessment of NIOO research

2.1 Summary of NIOO's strategy and targets

NIOO's mission is to carry out ground-breaking fundamental and strategic ecological research in terrestrial and aquatic ecosystems, and to make its ecological knowledge available to science and society. The institute aims to be an internationally leading institute in ecology and evolution, serve as a national and international hub for these fields, train future generations of nationally and internationally leading scientists in multidisciplinary research and outreach, and actively inform the global scientific community, stakeholders, end-users, and citizens about its research.

Research themes

In 2016, NIOO selected seven themes in which it aspires to play an internationally leading role: Global environmental change, Eco-evolutionary dynamics, Ecological epigenetics, Microbiomes, Chemical communication, Disease ecology, and Restoration ecology. The themes promote cross-departmental collaboration, act as a platform for knowledge and expertise exchange, and inspire new research projects. They are coordinated by senior researchers and the theme members meet every four to six weeks. Examples of current theme activities include jointly writing reviews and opinion papers, exchanging technical expertise, and organising symposia and workshops. NIOO allocates some of its strategic budget to explore promising new research lines within the themes.

Culture and organisation

NIOO fosters an inspiring, positive, and international atmosphere, in which people are encouraged to excel and collaborate. They organise weekly department meetings, weekly NIOO seminars where invited speakers highlight key scientific and societal developments in ecology, biannual NIOO Research Days for all NIOO scientists and technicians, and frequent social activities for all staff. During the period under evaluation, high-potential scientists were given greater responsibilities, including leading their own research group, seeking the most effective collaborations within the institute, and leading the seven research themes. NIOO uses a tenure-track system to evaluate the performance of scientists who aspire to permanent positions. Junior scientists can start their own junior research group when they meet certain criteria (e.g., successful grant applications in peer-reviewed funding calls and supervision of PhD students). NIOO values its technicians highly and benefits from maintaining a technician: researcher ratio of 1:3. The technicians play a crucial role in the labour-intensive development and standardisation of techniques and in the technical support of long-term studies and infrastructure, and they provide practical training and assistance to the postdocs and PhD students.

Funding

Since 2014, NIOO has strived to obtain approximately 5.25 million euros annually from external funding sources. The institute plans to continue along this line in the coming years by attracting funding from national and international research funders (e.g., NWO and the EU), public-private partnerships, direct collaborations with industry and other stakeholders, and charities. In 2017, the institute devised a novel external funding strategy to maintain a high level of external funding by diversifying its funding sources (i.e., European funding sources and public-private partnerships).

Strategy for the period 2017-2025

NIOO's strategic targets for the period 2017-2025 include:

- working on timely and interdisciplinary research themes in ecology and evolution that require a long-term approach, with the aim of becoming or remaining world-leading in these themes,
- having an outstanding output, as reflected in high-impact, high-quality publications,
- appointing excellent researchers, technicians, and support staff, creating and maintaining state-of-the-art facilities, and providing an open academic working environment,
- further developing NIOO as an (inter)national ecological hub by establishing special professorships at all Dutch universities with ecology in their curriculum, appointing top researchers as research fellows, forming a meeting place for top researchers, and playing an active and instrumental role in (inter)national research agendas,
- further developing NIOO's role as an international breeding ground for new talent, i.e., the place to be for young ecologists, allowing them to develop themselves to the full and move on to (inter)national top positions in science and society,
- broadly and actively disseminating NIOO's ecological knowledge to the global scientific community, stakeholders, end-users, and citizens, both NIOO-wide and through units tailored to specific stakeholders.

2.2 Research quality

The committee rates NIOO's overall research quality as **excellent**. NIOO researchers have published many high-impact papers over the last six years, in prestigious journals such as *Science*, *Nature*, *Nature* brand journals, *ISME Journal*, *PNAS*, and *TREE*. Several NIOO papers became landmarks in the science field during this period. A bibliographic analysis of the Centre for Science and Technology Studies of Leiden University revealed that NIOO's mean normalised citation score was 1.78 in the period 2009-2015/16, meaning that the impact of the publications of the current scientific staff is 1.78-fold the world average.

In addition to the impressive publication record, the quality of NIOO research is illustrated by the prestigious personal grants, honours, invited professorships, and awards that NIOO researchers received during the evaluation period. These include Veni/Vidi/Vici grants, ERC Advanced grants, KNAW memberships, and an Honorary Membership of the British Ecological Society awarded to Professor Louise Vet. NIOO researchers frequently organise national and international meetings, are invited to give plenary and keynote lectures at major international conferences, are involved in editorial boards of scientific journals, and are members of boards of many national and international scientific organisations (e.g., EASAC-environmental steering panel, GSBI, NSF and ERC grant review panels, Finnish and Norwegian Academy review panels, NWO panels, DFG). In addition, NIOO hosts the office of the International Society for Microbial Ecology (ISME).

NIOO harbours a number of excellent, state-of-the-art research facilities that support the institute's outstanding research. The limnotrons, for example, constitute a unique facility that is available to collaborators (e.g., EU-funded project AQUACOSM), thus further contributing to the advancement of science. In addition, NIOO scientists have developed resources and shared these with scientists at other institutes, for instance R-packages (ClimWin), open-source software (Bioconda), genomic pipelines (<https://github.com/nioo-knaw/>), genome browsers for species that they have sequenced

(<https://genomes.bioinf.nioo.knaw.nl/>), computer models (PCLake), lab techniques, and valuable long-term datasets.

2.3 Relevance to society

NIOO's research is **highly relevant** to society. The institute generates fundamental knowledge about the Earth's ecosystems, which can be applied, among other issues, to improve the sustainability of food production, counteract biodiversity loss, and promote adaptation to climate change. Hence, the institute rightfully states that ecology is the science of the 21st century. NIOO is housed in a sustainable building, designed to make an ecological statement. The translation of NIOO's fundamental scientific discoveries into societal impact is a key component of the institute's mission and its importance is recognised by NIOO researchers at all levels, in particular by the younger researchers.

Examples of significant societal impact include the development of practical approaches for the discovery of new antibiotics and antimicrobial volatiles, the finding that soil inoculation can enhance ecosystem development (which is applied at more than 20 restoration sites in the Netherlands), and the establishment of a national surveillance network for arboviruses in wild birds (i.e., viruses that are transmitted by arthropods such as mosquitoes). In addition, they have developed an experimental on-site sanitation system that uses microbes and microalgae to harvest nutrients and use them as fertiliser.

Popularising ecology

NIOO has a highly professional PR & Science Communication unit that organises outreach activities to enhance the ecological literacy of the general public. Activities include open days, press releases, public lectures, film and game-building projects, public debates, social media, website news, stands at festivals, school projects, and citizen science projects. Notable examples include the 'Poop is gold' demonstration festival stand, the Climate Pursuit serious game, and the annual Soil Animal Days. In addition, the institute organises tours through the NIOO building, with an average of almost 900 tour participants per year in the period 2012-2017. The PR & Science Communication unit also organises communication training events and creates tools to help NIOO scientists engage with the general public.

Technology transfer

NIOO collaborates with companies and governmental and non-governmental stakeholders to ensure that its fundamental research results form the basis for translation in practical applications. NIOO has established five 'niche' initiatives in collaboration with academic and private partners and societal stakeholders (AKWA, CSE, TropME, METS, and CAPS). Coordinated by NIOO scientists, these initiatives aim to transfer NIOO knowledge to specific target groups, through collaborative research projects (e.g., AKWA and METS directly collaborate with water boards) and tailored events (e.g., CSE has organised a course for potato growers). In addition, NIOO runs multi-partner projects on nutrient cycle, wastewater treatment, roof vegetation, urban biodiversity development, and nature restoration (e.g., the Green Deal Green Roofs project with governmental organisations and ecosystem restoration practices with *Natuurmonumenten*). Examples of research in collaboration with companies include the nationwide BE-Basic programme, various STW/TTW projects (e.g., the

Back to the Roots STW Perspective programme), the PROMISE project funded by the Bill & Melinda Gates Foundation, and NWO projects financed from the Dutch government's Top sectors initiative (e.g., NWO-Groen). In 2016 and 2017, NIOO filed three new patent applications based on its discoveries. An earlier patent has led to the foundation of a spin-off company called Microlife Solutions BV.

Policy impact

NIOO scientists advise Dutch and European policy makers on environmental issues. For instance, Professor Louise Vet chairs the *Deltaplan Biodiversiteitsherstel*, a major national initiative on the recovery of biodiversity involving a wide variety of stakeholders. In addition, she participates in KNAW Science for Parliament meetings and lectures and the Environmental Steering Group of the European Academies' Science Advisory Council. A striking example of NIOO's impact on policy is the Light on Nature project, studying the long-term impact of artificial light at night on ecosystems. The project results have been implemented in national guidelines for illumination in and near natural areas in the Netherlands and in general guidelines for illumination of larger roads.

Taken together, the societal relevance of NIOO research is indisputable and the committee recognises the institute's efforts to reach out to societal stakeholders. However, the institute's activities to translate its fundamental research results into societal impact appear to be somewhat *ad hoc*. The committee suggests to develop a more cohesive strategic approach. We will elaborate on this in Chapter 4.

2.4 Viability

NIOO is an institute of great potential with **excellent** viability. The committee praises the strong leadership of Professor Louise Vet. She is a highly influential international ambassador for the field of ecology and an inspiration to female scientists. NIOO's four department heads appear to be highly skilled group leaders. The committee was impressed by NIOO's collegiate culture: the atmosphere at the institute is excellent and morale is high. The energetic and proactive attitude of NIOO's postdocs caught the committee's special attention. Indeed, NIOO can be proud of these young scientists. Regarding the financial viability of the institute, any institute that receives 60% of its funding as a lump sum from the KNAW should be considered as very viable, providing the KNAW is able to maintain this commitment. NIOO scientists have also demonstrated their capacity to obtain external funding during the evaluation period.

NIOO has a clear added value in the Dutch and international landscape. It constitutes the largest aggregation of fundamental ecologists in the Netherlands, generating valuable long-term datasets such as >100 years of bird ringing data, >60 years of songbird nest box data, and 20–40 years of natural succession & nature restoration data. It also provides a base for the Dutch Centre for Avian Migration & Demography (embedded in NIOO since the 1950s), which serves all Dutch bird ringers. NIOO acts as a national and international ecological hub, as illustrated by its leading role in several collaborative initiatives, centres, and networks. For instance, NIOO has been a major player in the National Science Agenda, the Netherlands Ecological Research Network, and the International Society for Microbial Ecology.

The committee applauds the recent initiative to establish research themes, which developed from the bottom-up after their initial definition by the NIOO management. The themes were established only recently, but it is already evident that they promote cross-departmental collaboration and give rise to new research projects. The themes help define important focus areas where NIOO has sufficient critical mass and research quality. In addition, theme members learn from each other and jointly solve technical difficulties (e.g., in the Epigenetics theme). For junior researchers, the themes facilitate the interaction with senior scientists from other departments, broadening their horizons. The committee expects that the research themes will further boost the research quality and international visibility of NIOO, so is an important initiative for the future of the institute. Taken together, the committee is highly positive about NIOO's viability. However, the institute anticipates several challenges in the near future, and we offer recommendations to further improve the institute's long-term sustainability in Chapter 4.

2.5 Summary in numerical scores

In line with the qualitative judgements of NIOO research described above, the committee has assigned NIOO to a discrete category for each of the assessment criteria. The four possible categories are excellent (=1), very good (=2), good (=3), and unsatisfactory (=4). The scores are explained in more detail in Appendix 4 of this report.

	Research quality	Relevance to society	Viability
Assessment of NIOO research 2012-2017	1	1	1

3. Assessment of PhD programme, research integrity policy, and diversity policy

3.1 Quality and organisation of NIOO's PhD programme

Institutional context of the PhD programme

NIOO considers training the next generation of ecological researchers as one of its main functions. During the evaluation period, the number of PhD students significantly increased from 32.5 FTE in 2012 to 43.4 FTE in 2017 (see Appendix 3). The committee met eight of these students during the site visit. Overall, the PhD students at NIOO appear to be satisfied with the academic environment in which they operate. All PhD students are enrolled in a national graduate school (predominantly Experimental Plant Science or Production Ecology & Resource Conservation, both led by Wageningen University & Research). The NIOO PhD and postdoc platform facilitates exchanging knowledge and experiences. A party-planning committee organises social activities. NIOO regularly organises lunches where a number of PhDs and postdocs have lunch with the Director. The seven research themes have improved the embedding of the PhD students, promoting interactions with senior researchers from other departments.

Quality assurance and supervision

The committee learned that NIOO monitors the progress of its PhD students with a training and supervision plan. This plan addresses the student's progress in research and education on a yearly basis. In addition, the students' progress is formally evaluated within the first year, resulting in a go/no-go decision that is communicated to the KNAW. There seems to be some variation in the supervision arrangements, for example, some PhD students do not have an external supervisor. However, the above-mentioned graduate schools at Wageningen University have an adequate system to help students in case of problems between supervisor and PhD student.

Programme content and structure

NIOO offers its PhD students a EUR 1500 training budget to develop their professional and personal skills. They can apply for additional funding for specialised individual training (financed from the NIOO training budget). The students can enrol in specialised courses organised by the national graduate schools and general courses organised by the KNAW and other organisations. NIOO encourages its PhD students to actively participate in scientific discussions at the weekly NIOO seminars, present their work at (inter)national scientific meetings, interact with international experts, start publishing at an early stage, and engage in NIOO's outreach programme. Taken together, it is the committee's impression that the PhD candidates at NIOO are offered a broad educational programme.

Success rate, duration, exit numbers, and career prospects

NIOO PhD students receive EUR 450 if they complete their thesis within four years. Since 2008, nearly all PhD candidates graduated within four or five years, which is satisfactory in comparison with other research institutes in the Netherlands. Two candidates discontinued their PhD track in the period since 2008. The majority (96%) of NIOO PhD candidates find a job soon after completing their PhD, with 44% continuing as a scientist at an academic research institution outside the Netherlands,

26% at a Dutch academic research institution, 17% in the commercial sector, and 9% at (semi-) governmental or non-profit organisations.

3.2 Research integrity and open science policy

The assessment committee considered NIOO's research integrity policy and the way in which violations of such integrity are prevented or addressed. All of the committee's questions on this subject were adequately answered by NIOO's staff. Measures and procedures to safeguard research integrity can be found on the NIOO intranet, including:

- NIOO has adopted the code of conduct on scientific integrity as issued by the VSNU (Association of Dutch Universities), including topics such as honesty and scrupulousness, reliability, verifiability, impartiality, independence, and responsibility.
- NIOO's Research Integrity Advisory Board stimulates awareness of research integrity issues and researchers can consult members of this Board about compliance issues.
- The intranet lists confidential contact points, information about the complaint procedures of the KNAW and the Netherlands Board on Research Integrity.
- NIOO regularly organises workshops and seminars related to research integrity, as well as mandatory workshops for permanent staff, postdocs and PhDs, where dilemmas are discussed.

NIOO actively promotes the implementation of open science in ecology and evolution. Postdoc Dr Antica Culina coordinates a project on open science in ecology, has written publications on this matter, and has organised a symposium 'Opening doors to Open Science in ecology and evolution'. NIOO and the KNAW have invested in facilities to publish open access (Open Access Fund) and 52% of the papers that NIOO published in 2017 were open access. (Note that the KNAW strives for 100% of Academy publications to be made available open access within six months of their publication.) They have created their own data archive and are setting up an infrastructure to facilitate FAIR data storage (Findable, Accessible, Interoperable, Reusable). The two bioinformaticians at NIOO's central bioinformatics facility provide open data services in close collaboration with ICT and Library & Information Services.

3.3 Diversity and inclusiveness policy

NIOO endorses the diversity and inclusiveness policy of the KNAW, which states that diversity and inclusiveness lead to more creativity, multi- and interdisciplinary innovation, balanced decisions, and optimal use of people's capacities. The institute provides a welcoming environment for international researchers, for instance by assisting in finding housing and dealing with bureaucratic issues. Approximately 50% of NIOO researchers have a Dutch nationality, ~25% have a non-Dutch European nationality, and ~25% have a non-European nationality. The proportion of people with a Dutch nationality increases through the career stages from junior to senior scientist.

NIOO currently has a female director, female managing director, one female head of department, and a substantial number of female senior scientists. These women are inspiring role models for ambitious young female scientists. The proportion of female scientists decreases through the career stages from junior to senior level, so the institute is actively striving to improve the gender balance of its senior staff. A grant from the NWO Aspasia funding programme has provided an extra boost for the development of females of high potential. NIOO appears to foster a family-friendly environment,

for instance by allowing employees to work from home. One of the attention points of NIOO's works council is to promote the work-life balance for females and males alike.

4. Recommendations

4.1 Quality, impact, and viability of NIOO

1. *Added value*

As was discussed in section 2.4, NIOO has a distinct added value in the Dutch and international landscape, leading the ecology field in the Netherlands. However, it is recommended that NIOO performs an advanced benchmark analysis, comparing itself to similar institutes around the world and determining its unique selling point compared to these institutes. It is important to identify the characteristics that make NIOO a unique player. The committee recommends safeguarding the institute's emphasis on basic science as this is a key component of the institute's uniqueness. The committee encourages NIOO to lead novel research fields and pursue high-risk, high-gain projects, and to be thematically open-minded when it comes to recruiting new NIOO staff members.

2. *Knowledge utilisation*

The societal relevance of NIOO research is indisputable and the committee recognises and applauds the institute's efforts to reach out to societal stakeholders, most notably the general public, industry, and policy makers. However, the institute's activities to stimulate and facilitate knowledge utilisation appear to be somewhat *ad hoc*. These activities should be fuelled by a clear **vision** on the institute's strategic relevance to society. In other words, there should be a more cohesive, strategic approach. This will also help the institute to avoid spreading its research translation efforts too thinly.

The committee advises the institute to improve this situation in the following ways:

- NIOO should develop a clear external narrative on the overarching, cross-departmental focus areas at which their societal impact is most evident. These focus areas should constitute grand societal challenges such as mitigating the impact of global change, rewilding/nature restoration, and sustainable agriculture. This should permeate and guide all NIOO's communication and dissemination activities. In other words, NIOO should strategically improve the branding of its societal relevance and focus and frame its translation activities along those lines.
- It would be very helpful to establish a Societal Relevance Advisory Board in addition to the Scientific Advisory Board. This Board could consist of members of global organisations such as those associated with the UN sustainable development goals.
- We suggest the five 'niche' initiatives (AKWA, CSE, TropME, METS, and CAPS) are renamed 'research translation units'. This will better clarify their function to the outside world.
- Although the committee thinks that it is very important to safeguard the institute's focus on fundamental research (see recommendation 1 above), the committee supports NIOO in its endeavour to also obtain funding for public-private collaborations. A way to stimulate new interactions with stakeholders is to organise a series of special 'Industrial/Societal Stakeholders Days' during which the potential for NIOO knowledge transfer in specific areas is advertised to interested parties.

3. *Structure and size*

The institute's current size is satisfactory. It is small enough to guarantee short lines of communications, yet large enough to ensure sufficient critical mass and support services. The separation from the Dutch sea researchers (working at NIOZ) seems to be a natural division of science fields, with NIOZ focusing on estuarine and marine ecology and NIOO on terrestrial and freshwater ecology. Although the committee considers the departmental structure somewhat rigid and outdated, the structure of departments, cross-departmental themes, and research translation units appears to work well for NIOO.

The committee applauds the establishment of the seven research themes, which effectively promote cross-departmental collaboration and provide a nursery for the development of new emerging themes in ecology. Since the themes had only existed for about 1.5 years at the time of the site visit, it is too early for the committee to evaluate their success. NIOO plans to evaluate the themes in a three-year cycle, with the potential to continue, discontinue, or merge existing themes and initiate new themes. The committee thinks that three years is rather short for a theme to flourish, but if the three-year cycle would be used for interim assessment of themes with potential, this system would be valuable. Criteria to evaluate the themes should mostly be process-related indicators (i.e., not based on output), such as the extent to which a theme results in new research topics, engagement (i.e., how many people are involved), and cross-departmental collaborative activities. The committee recommends increasing the importance of the themes in the future, so that they can become mature interdisciplinary cross-overs in the departmental organisation structure. A way to achieve this is to safeguard NIOO strategic budget for the maintenance of well-performing themes and the development of new ones when they emerge.

4. *Personnel planning*

The committee has several recommendations related to human resource management:

- Professor Louise Vet (NIOO's Director) will step down in 2020. The committee urges the KNAW to start the formal search for a new Director as soon as possible, preferably at least two years in advance, because this is a challenging position which will take considerable time to fill. In addition, the committee encourages NIOO to take a proactive role in speeding up the international recruitment process and use its extensive network to identify potential top candidates.
- Professor Ellen van Donk (Head of the Department of Aquatic Ecology) will retire in 2019. The committee recommends the institute to immediately start the formal search for her successor. We recommend NIOO be open-minded regarding the expertise of potential candidates and allow new research areas to be brought into the institute with a high-profile candidate. In other words, it is more important that the new Head of the Department of Aquatic Ecology is an international top scientist than that she or he seamlessly fits in the ongoing research lines of this department.
- In general, the committee agrees that the institute's personnel planning strategy seems to be rather rigid. For instance, the distribution of staff members over the departments is rather fixed at present. The institute could be more flexible and appoint on the basis of scientific excellence rather than specific expertise when vacancies arise.
- The committee anticipates that a bioinformatics facility consisting of only two people will be insufficient in the future. At present, NIOO uses project grants to appoint additional bioinformaticians within the departments to meet the challenges of data-intensive research. In

addition, the faculty of the bioinformatics facility teaches NIOO researchers to perform computational analyses. However, as the field of ecology is rapidly becoming more data-intensive, the committee expects that the institute will need to extend the capacity of the bioinformatics unit in the future. The institute may consider dedicating a technician position to this end (i.e., a data scientist/expert) as soon as a technician retires or leaves the institute.

5. *Financial policy*

The budget that NIOO receives from the KNAW has not kept up with increases in costs over the evaluation period. The committee anticipates that NIOO will experience a stronger incentive to apply for external money in the future. To ensure the long-term financial viability of NIOO, the committee recommends several measures:

- The committee learned that NIOO plans to diversify its funding strategy. The committee supports this ambition, but also recognises it as a potential danger if the diversification is not content-driven. In other words, the funding strategy should match the institute's mission. A stakeholder analysis may prove useful.
- NIOO should appoint a grant support officer (i.e., a research funding facilitator with ecological knowledge) devoted to assisting NIOO scientists in the preparation of large research grant applications. The committee learned that the KNAW has recently established a Knowledge Transfer Office which offers some grant support, but this is likely to be insufficient, particularly given NIOO's aim to diversify its funding and lead more large EU-funded projects (see below). Establishing such internal support for large grant applications will quickly pay off. The appointed person may interact with the KNAW's Knowledge Transfer Office. The institute may consider dedicating the budget of a technician position to this end as soon as a technician retires or leaves the institute.
- The committee supports the institute in its endeavour to lead and coordinate more international consortia such as large EU-funded projects.
- It is important to safeguard some strategic funding budget, not least to address NWO's new regulations for Vidi laureates (i.e., Vidi laureates should be offered permanent positions at their home institutes when the Vidi project ends). The committee suggests that NIOO establishes a solidarity funding principle, where senior scientists with large strategic grants or large personal grants (ERC, VICI) allocate a percentage of their resources to the strategic funding budget (e.g., by paying 30% of their own salary from the grant for the period of the grant, a principle that is functioning well at universities).

4.2 PhD programme

NIOO provides a protected environment for its PhD students and the students appear to be very happy and comfortable. The committee encourages the institute to ensure that the students are well-prepared for the next steps in their careers, including preparing for alternatives to a career in science. In addition, it would be good to ensure that all PhD students have an external supervisor.

4.3 Research integrity and open science

In general, appropriate measures to safeguard research integrity are in place at NIOO. The postdocs seem to need more information on a trust person that they can approach in case of problems.

Regarding open science, NIOO actively promotes the implementation of open science in ecology and evolution, as it was discussed in section 3.2. The committee shares the institute's concerns about the increasing costs of facilitating open science (including open access publications and data storage) but does not have suggestions on how to solve this problem. The committee advises the KNAW to join the initiative of the Dutch universities to construct an agreement with major scientific publishers such as Elsevier and Springer to ensure free open access.

4.4 Diversity and inclusiveness

NIOO clearly takes diversity and inclusiveness seriously. To further increase the gender diversity among its staff, the institute should launch a mentoring scheme for female scientists.

Appendix 1. Short CVs of the members of the assessment committee

Professor C.M.J. Pieterse (chairman)

Corné Pieterse is Professor Plant-Microbe Interactions and Scientific Director of the Institute of Environmental Biology at Utrecht University (the Netherlands). His research group investigates how the plant immune system protects plants against microbial pathogens and insect herbivores and how beneficial microbes in the plant root microbiome stimulate plant growth and health. Pieterse received his MSc (Plant Breeding and Plant Molecular Biology, *cum laude*) in 1988 and his PhD (Phytopathology) in 1993, both from Wageningen Agricultural University (the Netherlands). In the period 1993-2004, he was a Postdoc and subsequently an Assistant Professor in Molecular Phytopathology at Utrecht University's Department of Biology. Pieterse was appointed as Professor Plant-Microbe Interactions in 2004 and as Scientific Director of the Institute of Environmental Biology in 2009. He has served as the Programme Leader of the 'Environmental Biology' MSc programme (2005-2015) and PhD programme (2009-2015) of the Utrecht Graduate School for Life Sciences. Pieterse was awarded a European ERC Advanced Investigator grant for innovative research in 2010, was elected member of the Royal Netherlands Academy of Arts and Sciences (KNAW) in 2013, and has been a Thomson Reuters Highly Cited Researcher (World's top-1% in the field) since 2014. In 2015, he was appointed as 'Distinguished Professor Faculty of Science'.

Professor S. Hartley

Sue Hartley is the Director of the York Environmental Sustainability Institute (YESI) and Research Theme Champion for environmental sustainability and resilience at the University of York (UK). Her research group aims to develop sustainable methods to increase crop resilience to climate change, fungal diseases, and insect pests. She has a particular interest in the use of plant silicon as a means to defend crops against both abiotic and biotic stresses. Hartley obtained her BSc (Biochemistry) from the University of Oxford in 1984 and her PhD (Ecology) from the University of York in 1987. She did a NERC Fellowship at the University of York in the period 1987-1990 and was based at the Centre for Ecology & Hydrology in Banchory (UK) in 1990-2000. In 2001, she moved to the University of Sussex' School of Life Sciences as a Reader in Ecology, before being appointed Professor in 2004 and Director of Research and Knowledge Exchange in 2009. Since 2010, Hartley has been Professor of Ecology at the Department of Biology at the University of York and Director of YESI. She was the Royal Institution's Christmas Lecturer in 2009 and received the BES award from the British Ecological Society in 2012. She is on numerous advisory boards, Chair of the Sustainable Agriculture Research Innovation Club, and an associate editor of *Global Change Biology*. In 2015, she became President of the British Ecological Society. In 2016, she was appointed to the Board of Trustees of the Royal Botanic Gardens at Kew and in 2017 to the Board of Natural England, the UK Government's advisory body for environmental protection and nature conservation in England.

Professor J.M. Pemberton

Josephine Pemberton is Professor of Molecular Ecology at the Institute of Evolutionary Biology of the University of Edinburgh (UK). Her group seeks to understand the causes of individual fitness differences and the causes of population differences in the distribution of genetic variation. Pemberton obtained her BA (Zoology) from the University of Oxford in 1975 and her PhD (population genetics of fallow deer) from the University of Reading in 1978. She was a Postdoctoral researcher at

University College London and the University of Cambridge. In the period 1991-1996, Pemberton was a SERC Senior Fellow in Cambridge and Edinburgh. In 1994, she was appointed Lecturer at the University of Edinburgh, where she has worked ever since. Pemberton was awarded the Molecular Ecology Prize in 2011 and EMBO Membership in 2014. She was elected a Fellow of the Royal Society in 2017.

Professor K. Tockner

Klement Tockner is President of the Austrian Science Fund FWF and Professor of Aquatic Ecology at the Free University Berlin (Germany). He is a world-renowned freshwater scientist, with a reputation in the fields of biodiversity, ecosystem science, and environmental management. Tockner received a PhD (Zoology and Botany) from the University of Vienna (Austria) in 1993 and then continued as a Postdoctoral fellow for several years. He was an Assistant Professor at Eidgenössische Technische Hochschule (ETH) Zürich (Switzerland) in 1996-1999 and a group leader at Eawag/ETH in Dübendorf (Switzerland) in 1999-2007. Tockner was Director of the Leibniz Institute of Freshwater Ecology and inland Fisheries in Berlin from 2007 to 2016. He received a Titulary Professorship at ETH in 2005 and was appointed a Professor at the Free University Berlin in 2007. He was elected as President of the Austrian Science Fund FWF in 2016. He is a member of several international scientific committees and advisory boards, Editor-in-Chief of the journal *Aquatic Science*, and elected member of the Austrian Academy of Sciences and the Germany Academy of Sciences, Leopoldina.

Professor I. Head

Ian Head is Professor of Environmental Microbiology at Newcastle University (UK). His research aims to unravel the microbial controls on biogeochemical processes in natural and engineered environments. He obtained his Bsc (Applied Microbiology, *with honours*) from the University of Strathclyde (Glasgow, UK) in 1986 and his PhD (Plasmid-encoded catabolism of the insecticide carbofuran) from the University of Newcastle upon Tyne in 1989. He conducted postdoctoral research on the ecology of ammonia-oxidizing bacteria and nitrification at the University of Liverpool from 1989 to 1992 and took up a faculty position in the Fossil Fuels and Environmental Geochemistry Postgraduate Institute at Newcastle University in 1992. In 2008, he was Visiting Professor of Geobiology in the Department of Geological and Planetary Sciences, Caltech. He has been a member of several steering committees and scientific advisory boards, including the Prokaryote Division Committee of the Society for General Microbiology, KNAW BE-BASIC Scientific Advisory Board, KNAW Ecogenomics Scientific Advisory Board, and the Deep Carbon Observatory Scientific Steering Committee (Deep Life). He is also an Elected Member of the European Academy of Microbiology, an elected fellow of the American Academy of Microbiology and The Royal Society of Biology. Head received a Young Investigator Award from the International Society for Microbial Ecology in 2004 and is currently Editor-in-Chief of the *ISME Journal*.

Dr L. van den Berg

Linda van den Berg is an independent science writer and communications consultant with a background in the life sciences. She obtained a MSc (fundamental biomedical sciences, *cum laude*) in 2000 and a PhD (behavioural genetics) in 2006, both from Utrecht University (the Netherlands). In the period 2006-2012, she was a Postdoctoral Researcher at VU University Medical Center (the Netherlands), the Broad Institute of Harvard and MIT (USA), and Leiden University Medical Center (the Netherlands). Since 2012, she has worked as a professional science writer, with a special interest

in research quality and science & society. Her company Washoe Life Science Communications offers a variety of communication services to academic institutes, patient organisations, and companies. Since 2015, she has served as an independent secretary to several research assessment committees.

Appendix 2. NIOO site visit programme

Sunday 15 April 2018

Arrival committee in Wageningen. Hotel: De Wageningsche Berg

18:30 Committee kick-off dinner, hotel-restaurant De Wageningsche Berg
Wim van Saarloos (vice president of the KNAW) joined 18:30 – 19:00 to welcome the committee

Monday 16 April 2018

08:15 Pick-up at the hotel
08:30 Preparation: committee kick-off meeting
09:30 Presentation and interview Director NIOO-KNAW - Louise Vet
10:30 Interview Director Central Management and Services - Petra van den Berg
10:45 Interview Heads of the scientific departments - Ellen van Donk, Marcel Visser, Jos Raaijmakers, and Wim van der Putten
12:00 Lunch committee
13:15 Research theme session
15:15 Tour of the building and its facilities, including tea break and meeting with the technicians
16:30 Interview with the chair of NIOO's Scientific Advisory Board – Rien Aerts
17:00 Mixer with NIOO personnel
18:15 Taxi to the restaurant
18:45 Wrap-up day 1 committee
19:15 Dinner with NIOO Management Team

Tuesday 17 April 2018

08:15 Pick-up at the hotel
08:30 Interview senior scientists, including Tenure Trackers
09:05 Interview Postdocs
09:40 Interview PhD Students
10:25 Coffee Break committee
10:40 Interview AKWA, Vogeltrekstation, CAPS, CSE, METS, and TropME
11:15 Societal relevance, strategy and examples
12:15 Lunch + writing time/private final meeting Committee
14:30 Recap with NIOO's Management Team
15:00 Feedback to the whole NIOO – at tea time in the canteen
15:30 Closure / departure

Appendix 3. Quantitative data on NIOO's composition and financing

Table 1 Research and other staff

For research staff, numbers represent time dedicated to research: PhD students 85%, senior scientists, tenure trackers and postdocs 90%, heads of department 80%, director 70%. FTE input of technicians and support staff is based on 100% of their employment. For more details about the number of PhD students, see Table 9.

FTE	2012	2013	2014	2015	2016	2017
Scientific staff	16.70	19.00	22.20	21.18	22.58	18.75
Postdocs	38.80	34.80	41.60	31.57	33.66	30.00
PhD students	32.50	32.60	49.90	45.80	49.99	43.39
Total research staff	88.00	86.40	113.70	98.55	106.23	92.14
Technicians	31.50	29.70	32.65	31.81	36.14	29.16
Support staff	30.90	28.70	31.95	32.53	33.47	31.30
Visiting fellows	9.60	2.20	2.50	9.52	5.35	3.67
Total staff	160.00	147.00	180.80	172.41	181.19	156.27

Table 2a & 2b Funding: FTE & expenditure

Staff (in FTE) and expenditure (in k euros). FTEs and expenditure of personnel that is not employed at NIOO but works on a personal grant are excluded.

Table 2a	2012		2013		2014	
Funding	FTE	%	FTE	%	FTE	%
1 Direct funding (KNAW/NIOO)	38.43	43.70%	44.78	48.90%	45.34	40.60%
2 Research grants	26.54	30.20%	21.12	23.10%	28.01	25.10%
3 Contract research	21.29	24.20%	20.63	22.50%	31.45	28.20%
4 Other	1.64	1.90%	5.07	5.50%	6.85	6.10%
Total funding	87.9	100%	91.6	100%	111.65	100%

	2015		2016		2017	
Funding	FTE	%	FTE	%	FTE	%
1 Direct funding (KNAW/NIOO)	49.19	46.60%	51.81	44.80%	45.68	44.80%
2 Research grants	24.47	23.20%	32.99	28.50%	32.56	31.90%
3 Contract research	28.52	27.00%	26.85	23.20%	19.92	19.50%
4 Other	3.33	3.20%	3.95	3.40%	3.76	3.70%
Total funding	105.51	100%	115.6	100%	101.92	100%

Table 2b	2012		2013		2014	
Expenditure	k €	%	k €	%	k €	%
Personnel costs	8,468.60	71.90%	9,403.80	70.20%	10,281.30	65.80%
Other costs	3,310.30	28.10%	3,997.20	29.80%	5,338.30	34.20%
Total expenditure	11,778.90	100%	13,401.00	100%	15,619.60	100%

	2015		2016		2017	
Expenditure	k €	%	k €	%	k €	%
Personnel costs	10,056.70	72.70%	10,143.14	72.30%	10,346.33	73.00%
Other costs	3,774.20	27.30%	3,890.03	27.70%	3,818.20	27.00%
Total expenditure	13,830.90	100%	14,033.17	100%	14,164.53	100%

Appendix 4. Explanation of the categories utilised

Category	Meaning	Research quality	Relevance to society	Viability
1	World leading/ excellent	The research unit has been shown to be one of the few most influential research groups in the world in its particular field.	The research unit makes an outstanding contribution to society.	The research unit is excellently equipped for the future.
2	Very good	The research unit conducts very good, internationally recognised research.	The research unit makes a very good contribution to society.	The research unit is very well equipped for the future.
3	Good	The research unit conducts good research.	The research unit makes a good contribution to society.	The research unit makes responsible strategic decisions and is therefore well equipped for the future.
4	Unsatisfactory	The research unit does not achieve satisfactory results in its field.	The research unit does not make a satisfactory contribution to society.	The research unit is not adequately equipped for the future.

Source: Standard Evaluation Protocol 2015 – 2021 Amended version, 2016