

Evaluation of Natural Sciences 2022-2024

Evaluation report

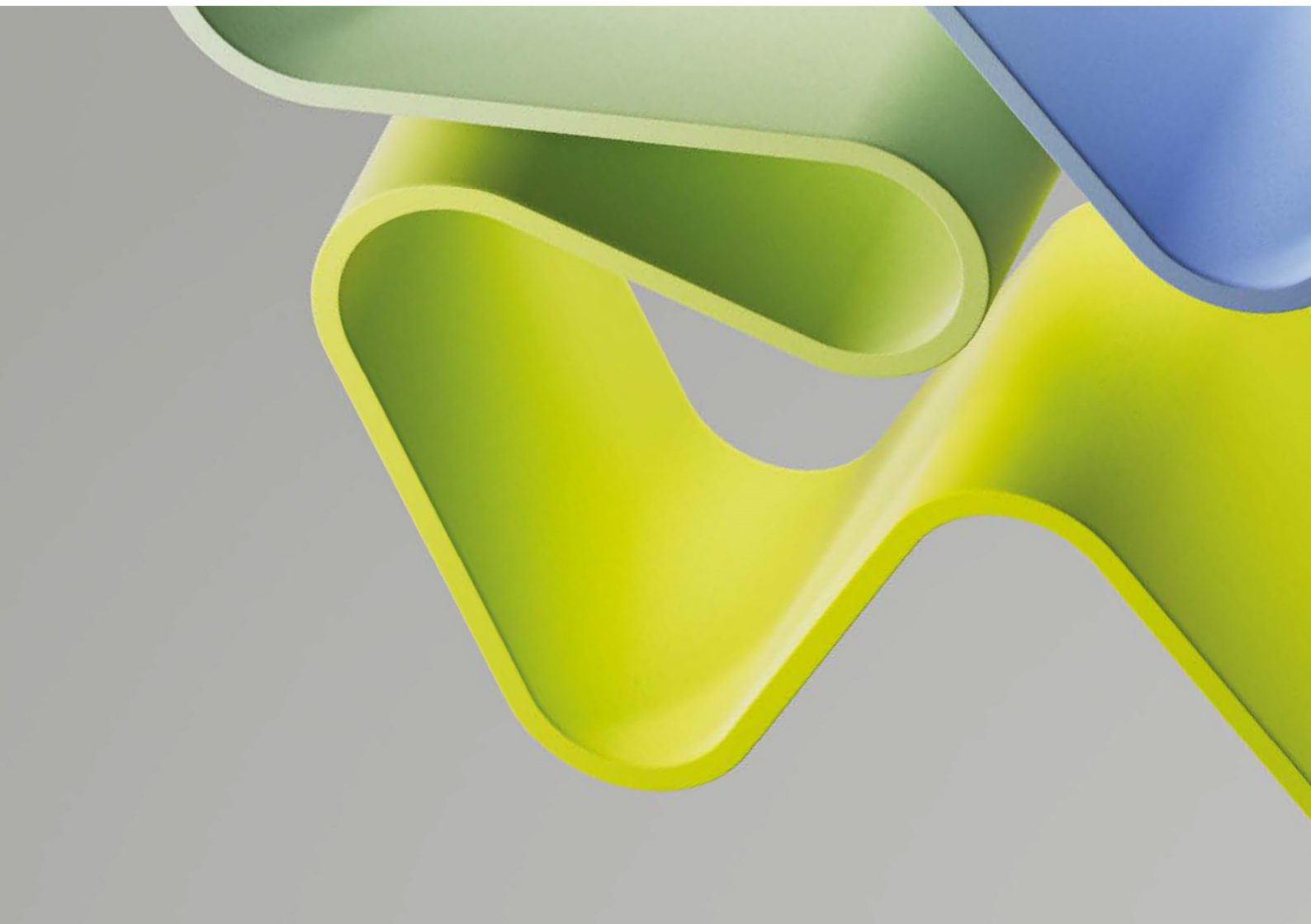
ADMIN UNIT

NGI - Norwegian Geotechnical Institute

INSTITUTION

NGI - Norwegian Geotechnical Institute

January 2024



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Statement from Evaluation Committee III – Institutes

The members of this Evaluation Committee have evaluated the following administrative units at the research institutes within natural sciences in 2022-2023 and submitted a report for each administrative units:

- NORSAR Foundation
- SINTEF Industry
- SINTEF Digital
- Norwegian Geotechnical Institute (NGI)
- Geological Survey of Norway (NGU)

The members of the Evaluation Committee are in collective agreement with the assessments, conclusions and recommendations presented in this report. None of the committee members has declared any conflict of interest.

The Evaluation Committee has consisted of the following members:

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Description of the administrative unit

Norwegian Geotechnical Institute (NGI) is an independent research institute in the field of geotechnical and geoscience engineering. NGI is organised in four market areas (Offshore Energy, Geotechnics and Environment, Natural Hazards, GeoData and Technology). In 2021 NGI had 294 employees from 39 different nationalities and 67% of these employees were male and 33% female,

Within NGI, six research groups are under evaluation as part of EVALNAT: Environmental Pollution, Sustainable Soil and Waste Management, Advanced Modelling, Offshore Geohazards, Climate Adaptation, Tsunamis.

The main strategic goal at NGI is to perform and promote research and innovation in the engineering geosciences to produce results that are relevant for, and used by, society. The current focus is towards the green shift related to offshore geotechnics. This includes advise on field development and operations such as site investigations, foundation engineering solutions, and geohazards and natural hazards risk assessment. NGI's self-assessment also refers to laboratory testing and investigations of mechanical and dynamic behaviour of geomaterials and instrumentation and monitoring of structures and facilities, as well as numerical modelling across a range of geosciences.

NGI's self-assessment identifies the following present strengths to enable in the future: (1) dedicated personnel; (2) research and research administration; (3) research support activities; (4) quick decision-making; (5) unique competence in areas of high relevance for societal challenges; (6) strong collaboration with industry, authorities, academia and other research institutions; (7) positions at Norwegian universities. The threats related to its weaknesses are listed as: (1) lack of research capacity; (2) lack of relevant calls for core activities like geotechnics; (3) researchers more likely to engage in consultancy projects than build careers as researchers; (4) industry partners often in a hurry to get results.

Under sector-specific impacts, NGI's self-assessment refers to a centre where research and development can create results in the form of new expertise, methods and technology, and continuous skills development and interaction for Norwegian academic communities. The examples mentioned in NGI's self-assessment are on providing the knowledge base to ensure a solid foundation for offshore wind parks, use nature-based science to prevent the consequences of natural hazards, and re-purpose waste from tunnel boring machines and concrete from demolition.

Overall assessment

The Norwegian Geotechnical Institute (NGI) is a renowned research institution specialising in geotechnical engineering and geosciences. Their research strategy is clear, cohesive and well-developed and has successfully supported their progress to date and their future strategic direction is convincing.

The unit is an internationally leading research institution on some specialised fields like offshore wind energy and has an excellent reputation for geoscience and especially geotechnical engineering in general. NGI is supporting high-quality research and is actively making its research and data open-access research. NGI's applied research and consulting activities are very often related to research commercialisation activities. Additionally, there are several activities documented of industry related innovations and cooperation, spin out companies etc.

The organisation demonstrates good composition in terms of gender diversity and skilled staff and the organisation of their research activities and the research infrastructure appropriately reflect and support their strategy and objectives. NGI's policies, processes and programmes to support further increase of diversity and equality, staff development and research integrity are appropriate and in good alignment with their institutional and sector-specific goals.

NGI has numerous and efficient collaborations both nationally and internationally, covering a diverse range of partnerships to address complex challenges. The self-assessment report indicates a breadth of collaborations with academic institutions, research organisations, industries, and government agencies, as well as a diverse portfolio of contracts and projects funded through competitive public funding. The high levels of international co-authorship in publications reflects this and NGI's successful efforts to improve internationally visibility. NGI has successfully secured funding from a range of sources, and the income is high relative to the size of the unit, mainly coming from national private or competitive funding. NGI acknowledges potential threats and identifies opportunities to improve their external funding, however, the lack of calls for geotechnical expertise poses challenges in securing funding, although their income primarily comes from the industry with a currently still small but increasing portion from EU funding.

Overall, NGI's activities align with their institutional goals and address sector-specific needs, demonstrating the relevance of their work to government, industries, and organisations involved in infrastructure development, environmental management, and hazard mitigation. Their work directly benefits society by ensuring the safety, sustainability, and resilience of infrastructure, protecting communities from geotechnical hazards, and promoting environmentally responsible practices in the field of geotechnical engineering and geosciences.

The administrative unit's areas of work are very relevant for the current societal and environmental challenges, and the impact case studies present a range of examples that demonstrate they have successfully been supporting tangible impacts in these areas. One major strength of NGI is that research activities and consulting for real projects walk hand-in-hand what enables the unit to focus on subjects being relevant for engineering practice and society.

Recommendations

The income from RCN and from EU is relatively low. The evaluation committee therefore recommends NGI intensify their applications for research funding from EU mainly but also from international sources. In this context NGI has already set goals to increase the income from competitive research and has a strategy towards Horizon Europe. These efforts might be followed up or even intensified.

The evaluation committee consider the integration and complementarity of research activities and consulting to be an excellent precondition for ensuring NGI's applied research activities continue to

be relevant for engineering practice, risk assessment and society. Nevertheless, there seems to be potential for more fundamental research activities using NGI's excellent facilities, and competence for model tests and numerical simulations together with their existing excellence in geotechnical and environmental sciences. The evaluation committee therefore recommend NGI seek to support more fundamental research projects, probably by intensifying further the existing collaboration with universities. This would contribute to strengthening NGI's position as an outstanding research unit and for identifying future scientific and research opportunities for national and global relevance. Thus, NGI's research activities and international visibility could be strengthened further.

Besides that, NGI should continue to engage with stakeholders to understand needs and expectations of government, industries, and research organisations which will shape NGI's strategy to align with their requirements. NGI may further continue to evaluate and to adapt the strategy on the basis of clear performance indicators, the feedback of information from stakeholders and the evaluation of impact. It is further essential that NGI continues collaborations with industry to bridge research and practical applications as joint projects, knowledge sharing, and technology transfer validate research, promote commercialisation, and ensure relevance.

The unit focus on emerging trends and should in this context stay updated on geotechnical engineering and geosciences advancements, technological developments, policy changes, and societal demands. The strategy to address emerging areas to stay at the forefront of research and innovation should be continued, however could benefit from more detail or specificity in the research areas identified.

The unit is on a good way to embrace digital transformation by utilising digital technologies, data-driven approaches, modelling tools, big data analytics, and DL/ML techniques to enhance research, analysis, and decision-making processes; these activities should be further fortified.

It is relevant for NGI to continue to foster interdisciplinary collaboration. Collaboration between disciplines and research fields within NGI should be encouraged for innovation and global problem-solving.

NGI's efforts to develop researchers, engineers, and scientists through training, programs, and cutting-edge technologies should continue and could even be intensified. It is relevant for NGI's success to attract and retain top talents to foster excellence and innovation.

1. Strategy, resources, and organisation of research

NGI is an independent research institute in the field of geotechnical and geoscience engineering with a strong focus on applied sciences. The administrative unit is organised in four market areas (Offshore Energy, Geotechnics and Environment, Natural Hazards, GeoData and Technology). This structure reflects the main research subjects of the unit and at the same time addresses perfectly the current needs of industry and society concerning geotechnical engineering and engineering geosciences.

NGI has a cohesive and robust research strategy, covering a wide range of fundamental and mainly applied studies on national and international levels, which is closely aligned with its mission and vision. The strategy addresses a range of societally relevant issues, however, could benefit from more detail or specificity in the research areas identified.

NGI's unique position can be attributed to its capacity to combine research activities and industry consulting, enabling NGI to identify practice-relevant needs for future research activities which are relevant not only for geoscience but also the society and which provide benefits for the societal community.

The administrative unit is very active and shows excellent performance in identifying new research subjects and positioning itself as an internationally highly acknowledged research competence centre. NGI's research output is mainly very good or even excellent across the six evaluated Research

Groups and bibliometric analysis of their research outputs affirm the quality of their research to be high.

NGI also appears to be an attractive research-partner, and it is very active in collaborating with national and international partners from industry and consulting but also from science to foster interdisciplinary research and innovation.

For NGI the basic funding from RCN and other national grants is only a limited source of income of 8% whereas the main share of incoming results from national contract research, i.e. 63% from competitive national fundraising mainly from industry but also from ministries. About 71% of funding is based on national sources and 29% on competitive funding from international grants whereby the largest part comes from industry and only a small sum comes from the EU.

Under sector-specific impacts, NGI's self-assessment report refers to a centre where research and development can create results in the form of new expertise, methods and technology, and continuous skills development and interaction for Norwegian academic communities. The examples mentioned in NGI's self-assessment are providing the knowledge base to ensure a solid foundation for offshore wind parks, using nature-based science to prevent the consequences of natural hazards, and re-purpose waste from tunnel boring machines and concrete from demolition. Additional information provided during the panel interview proves that NGI is involved in many very attractive research projects and collaborations.

1.1 Research Strategy

The main strategic goal at NGI is to perform and promote research and innovation in the field of geotechnical engineering and the engineering geosciences to produce results that are relevant for, and used by society. NGI does not have a specific research strategy, but that research is integrated into the main strategy.

The administrative unit's unique position is due to NGI's main focus on applied sciences, combining research activities with consulting services and bridging academia with industry and the public sector. This enables NGI to identify practice-relevant needs for future research activities and identify areas of research with relevance to both geoscience and society more widely, allowing them to provide benefits for the societal community.

NGI's research strategy is generally focused on green transition including all relevant aspects like renewable energies, sustainability, geological risks due to global warming etc. The probably most relevant current focus is towards the green shift related to offshore geotechnics. This includes advice on field development and operations such as site investigations, foundation engineering solutions, and geohazards and natural hazards risk assessment. NGI's self-assessment also refers to laboratory testing and investigations of mechanical and dynamic behaviour of geomaterials and instrumentation and monitoring of structures and facilities, as well as numerical modelling across a range of geosciences.

In the self-assessment, however, the main strategic goals for research are described in a relatively general manner by the administrative unit as "Research and consulting for societal security and the green transition". Green transition, sustainability, renewable energy etc. are all very relevant and current issues reflecting wider global challenges and needs, however, it would have been beneficial to name more specific research fields in the self-assessment and their strategic planning.

1.2 Organisation of research

NGI organises its research activities around four market areas, Offshore Energy, Geotechnics and Environment, Natural Hazards, and GeoData and Technology. The evaluation committee consider this to be a credible structure as it reflects their main fields of research and consulting activities.

The methods to discuss and assign public funds are described in the self-assessment and this is positive.

With branches in the USA and Australia NGI is also present in markets relevant e.g. for wind industry projects what might ease access to international industry-based research projects and scientific networks.

The SWOT analysis provided in the self-assessment report is quite short and some parts of it are relatively generic, however it does seem to identify the most relevant issues for the administrative unit. The evaluation committee therefore considered this to be credible.

NGI employs expert researchers, engineers, and scientists from approximately 40 nations who contribute to research projects and activities which is considered to be a great opportunity for research activities and international cooperation.

NGI utilises well-equipped labs and testing facilities for experiments, sample analysis, and research validation.

NGI also collaborates with academic institutions, research organisations, industries, and government agencies to access external expertise, funding, and resources, expanding their research scope and knowledge base.

1.3 Research funding

In general, the evaluation committee recognises that the administrative unit has a significant amount of funding for its relatively small size, and has a diverse range of national and international funding sources.

Around 71% of the administrative unit's funding comes from national sources, including 63% (346 MNOK) from competitive national fundraising mainly from industry (202 MNOK) and ministries (125 MNOK) and 8% from RCN (19 MNOK) and from other national grants (43 MNOK). The remaining 29% (161 MNOK) is raised from competitive international grants, most of which come from industry contracts (118 MNOK) and only a small sum comes from EU (17 MNOK).

As the proportion of research funding from RCN and especially the EU is relatively low, there is an opportunity for NGI to increase the income from these sources. In this context, NGI has set goals to increase their income from competitive research and has a strategy to increase their engagement with Horizon Europe. Information provided by NGI representatives during interview with the evaluation committee demonstrates that the administrative unit has an excellent European network and is quite active in identifying research opportunities on EU level.

Though the administrative unit acknowledged that the lack of calls for geotechnical expertise has made securing funding from these sources difficult in the past, hence their prior focus on securing industry funding, increasing the numbers of calls in these areas is a promising development. The threats and opportunities identified by the administrative unit in the self-assessment report address their approaches to improve their external funding, all of which appear to be appropriate.

NGI have a stated ambition to increase the amount of externally financed research, which the evaluation committee consider to be a reasonable aim considering the specific character of this unit and its focus on applied sciences. The organisational measures employed by NGI to reach this goal ("Boasting R&D at NGI") seem to be appropriate, however the self-assessment report does not

provide details and it is difficult to understand. It is therefore challenging to reach a conclusive assessment of their strategy and to reach their targets of increasing their external funding.

1.4 Use of infrastructures

NGI states that it has been – in partnership with NTNU, SINTEF, UNIC and the Norwegian Public Road Administration – in charge of the Norwegian Test Sites (NGTS), four national research facilities for geotechnical research located near Oslo and Trondheim. NGI provides access to these test sites to European users in the frame of the GeoLAB-project which is a reasonable approach for initiating further European collaboration.

Some of NGI's research projects seem to use this research infrastructure (e.g. NGTS) however it is difficult to assess the intensity of use based on the information provided for the evaluation.

The self-assessment report details NGI's participation in various ESA projects, mainly related to alpine avalanche forecasts, but does not document further participation in other international research organisations. Only two activities are noted in participation in European infrastructures (ESFRI).

1.5 National and international collaboration

Collaborative and industry-related research on a regional, national and international basis is a key feature of NGI and is correctly considered to be a fundamental success factor. The administrative unit considers itself correctly as a "bridge-builder between applied research, industry and the public sector". Based on the information provided as part of the self-assessment, the evaluation committee found this to be credible.

The self-assessment report of the administrative unit provides a very detailed overview of its intensive activities in collaboration with various research institutions as well as with private and public institutions and industrial partners. This provides a convincing demonstration that NGI succeeds in positioning itself as a well-acknowledged independent research institute, which collaborates when possible and competes when necessary.

With branches in the USA and Australia, NGI is also present in markets relevant e.g. for wind industry projects which provide access to international industry-based research projects and scientific networks.

1.6 Research staff

The evaluation committee find the staff composition to be adequate to meet the objectives set out in their research strategy for the administrative unit. In 2021 NGI had 294 employees (67% were male and 34% female), with a relatively high share of senior researchers and scientific experts, and very good levels of qualification levels across the administrative unit.

Though the share of women per category varies significantly, the overall average of around 34% of female employees is considered to be a quite good balance but also a share which has the potential to further increase.

The self-assessment report provides a very detailed description of policies to favour enrolment and integration in the research environment. NGI encourages employees to participate in internal research calls for basic funding, and has policies which favour fund raising. The self-assessment form states that employees are encouraged to participate in research but does not provide much detail about policies and measures taken to realise this.

NGI's self-assessment report states they actively encourage employees to take a PhDs over sabbaticals which is considered to be an important aspect. Yet the administrative unit needs to consider additional measures to further support ongoing training and education for its employees.

Mobility opportunities for employees seem to be limited to research projects and sabbaticals in the context of PhD education and therefore seem not to be very frequent. The evaluation committee finds the additional measures proposed by the administrative unit to increase the potential for further mobility options to be reasonable.

2. Research production, quality and integrity

NGI is an internationally well-known and acknowledged research institute in the field of geotechnical engineering and engineering geosciences. NGI's reputation in the key fields of geotechnical research (such as 'quick clay', geotechnics for offshore wind, risk assessment of natural hazards, and rock mechanics) is excellent. Further fields of excellence are in the development of new and advanced methods for soil and rock investigations both for onshore and offshore conditions and related lab testing. In these disciplines, NGI has contributed to advancing the state of the art, especially for offshore wind the administrative unit is internationally leading in research and consulting support.

Based on these key competencies, the self-assessment report indicated that NGI aims to orientate their scientific focus more towards the green transition and related societal security. Thus, research activities include geotechnical engineering, environmental geotechnics, geohazard assessments, rock technology, environmental technology and sustainability related to geosciences.

Of the six groups evaluated as part of EVALNAT, most have been considered from very good to excellent, with a very specialised sector for each. Some research groups perform well below the average apparently due to unfocused goals and strategy.

The unit has published a huge number of papers relative to their size, contributing to 5% of the Norwegian output. The citation rate is excellent, indicating their work to be of high quality and relevance to the wider research community. The papers also cover a wide range of research fields in geosciences, with a high proportion of interdisciplinary work.

Though the administrative unit does not yet have its own Open Access policy, its existing efforts and actions summarised in its self-assessment report are considered reasonable and sufficient at this stage. As a result, the share of open-access publications is very high, with 75% of publications available open access.

Many papers document interdisciplinary and international research collaborations. Most papers derive from international collaborative work, and many of them are with top-ranking institutions in the field and are very interdisciplinary. The bibliometric reports also demonstrate NGI's successful efforts to improve its international visibility.

NGI did not provide relevant details about their approach to ensuring research integrity in their self-assessment report. Though, aspects of research integrity are covered within NGI's Code of Conduct, which itself is in line with international best practices, and additional reasonable information was provided during the interview.

2.1 Research quality and integrity

Climate adaption and hydrodynamics - Overall Assessment

This seems like a good group doing quantitative climate adaptation work and earning good income from consultancy. The scale of their consultancy work and their international collaborations, e.g. through EU funding indicate their quality in the specific area they focus on. However, the account of outcomes and societal impact is disappointing. This makes it difficult to assess directly.

The group are focused on building on their international capability and engagement with stakeholders. It would be good to understand better the relationship between the research and consultancy. In particular, they should highlight their real-world outcomes by prioritising the information they provide to focus on giving more information about the wider range of their stakeholder funded/focussed reports.

Tsunamis - Overall Assessment

Strengths:

- Highly complementary combination of research expertise, especially given the small group size, which enables a holistic approach to tsunami process and risk
- Outstanding evidence of research organisation, including clear alignment with the strategic goals of the institution and department
- Excellent track record of national and international funding, including roles in some large high-profile research projects and evidence of a diverse range of funding sources
- Clearly-defined international role and excellent collaborative networks
- Research outputs are consistently of high quality, including some world-leading publications
- Very considerable efforts to develop and apply the group's scientific research to economic, societal, and cultural development, with some clear evidence of innovation in their approach to impact

Weaknesses:

- Limited information on support, training, or mentoring opportunities for group staff. Given the small size of the group and the threats to sustainability outlined in the self-evaluation, it would be worth reflecting on how this could be strengthened
- Impact work by the group appears from the self-evaluation to follow an information deficit model, and there is limited evidence of involvement of stakeholders in the research process. As a result, it comes across as somewhat passive. It would be useful to provide evidence of how external partners are involved in the group's research, and how this enhances both the impact and the quality of the research

Environmental Chemistry and Toxicology - Overall Assessment

The group has a strong income stream and uses this to good effect for a range of end-users and in developing publications in academic journals as well as public facing reports. They operate in a key area of the environment enabling the understanding of pollutant fate and transport and potential remediation. Across this area they train and develop staff and students.

The main area of weakness is how the group links into the wider organisation and strategies and tactics related to ongoing and future threats around funding and staff development. The group may be limited by (access to) analytical infrastructure.

Sustainable Soil and Waste Management - Overall Assessment

The group offers relevant services within the portfolio of the host institution and appears well placed to supplement other activities at NGI. The group hosts a reasonable range of researchers, balancing both scientist seniority and gender. The group demonstrates ability to carry out and publish state-of-the-art research, engage in project work with external partners, and ensure research collaboration with academia. However, the scientific and societal impact of the group appears limited. The organisation itself does not appear to provide the needed conditions supporting excellent research, applied or not. The research production and impacts appear modest, and the societal impacts very

few. Overall, the group and host institution appear to lack clear goals regarding research and societal impacts, and the strategy to reach such goals.

Offshore Geohazards - Overall Assessment

The Offshore Geohazard research group at NGI demonstrates significant strengths in its scientific quality and societal contribution. The group's research is characterized by a diverse range of activities spanning from nationally or EU funded R&D projects to applied projects that demand new development or necessitate taking recent technologies into use. The group's collaboration with other research groups both within and outside NGI has enabled it to be at the forefront of interdisciplinary applied science, particularly in modelling landslide dynamics and the development of integrated, data-driven ground models. The societal contribution of the group's research has a significant impact on solving problems related to national infrastructure projects, seismic risks to hydropower reservoirs, and optimized geotechnical design of offshore wind turbines. The group has also made important contributions to international community efforts to quantify risk from natural hazards.

Strengths:

- Strong scientific expertise in offshore geohazard research.
- High-quality research output demonstrated by a strong publication record and participation in international research projects.
- Active involvement in industry collaborations and consulting activities.
- Interdisciplinary approach to research and development.
- Strong and flexible collaboration with the two other NGI groups, and a strong international network
- Development of innovative technologies and computational models
- Active involvement in MSc and PhD supervision and committee membership

Weaknesses:

- There is limited information available on support, training, and mentoring opportunities for staff. To address this, it may be valuable to reflect on potential strategies to strengthen these areas.
- Dependence on the availability of deep-water energy projects.
- Limited focus on certain areas of expertise, such as turbidity currents.
- Potential difficulty in attracting and retaining talented researchers due to competition from other international research groups.
- Very poor gender balance in the group at present.
- Knowledge transfer mechanisms were standard practice, and the impact of external partnerships was not strong in the evidence presented.

Advanced GeoModelling - Overall Assessment

Overall, the Advanced GeoModelling research unit at NGI has established itself as a leading centre for the numerical modelling of geomaterials. The group's research activities are characterized by a strong theoretical foundation, rigorous testing and validation, and a commitment to addressing important societal challenges related to the green transition, digitalisation, and knowledge development. However, there are some areas where the group could improve.

Strengths:

- Strong theoretical foundation
- Rigorous approach to testing and validation
- State-of-the-art physical testing, centrifuge testing, CT scanning, and element scale testing
- Exploration of new numerical modelling techniques

- Relevance of research to industry and society
- Active involvement in education and supervision of researchers at external institutes in Norway and internationally

Weaknesses:

- Lack of gender diversity in the group.
- There is limited information available on support, training, and mentoring opportunities for staff. To address this, it may be valuable to reflect on potential strategies to strengthen these areas.
- Limited involvement in outreach activities to engage with the broader public and stakeholders.

2.2. Open Science

NGI is well on the way to supporting open-access research. Open-access journal articles and accepted manuscripts are deposited in BRAGE (institutional open archive) and the specific and appropriate policy favouring open science is provided and FAIR principles are guaranteed. This point is excellent.

As a result, in 2021 75% of all publications by NGI are available open access, 26% of which are available through gold open access and 49% available through green open access. The share of NGI's open access publications has also been increasing continuously from around 15% in 2013/14 to the current 75% in 2021. Thus, NGI has succeeded in increasing the share of open access publications significantly what is considered to be an excellent development.

According to their self-assessment report, NGI has endorsed the principles of Plan S however they do not currently have any further or additional institutional policies relating to Open Access publication. The self-assessment report does note NGI plans to develop such a policy in the near future. Nevertheless, the efforts and actions summarised in their self-assessment report are considered reasonable and sufficient at this stage.

NGI has provided open-source computing software on a web-page (EU ERIC) which also includes data sharing.

3. Diversity and equality

The evaluation committee finds NGI's actions against discrimination and for gender equality to be clear and convincing. The gender equality plans and strategies available are described in the self-assessment report and these align with international best practice. The administrative unit has a code of conduct and their perspective of diversity encompasses the representation of individuals from various gender, racial, ethnic, and cultural backgrounds, though with particular emphasis on gender equality.

Equal opportunities are ensured through fair treatment in hiring, promotion, training, and development. NGI promotes an inclusive workplace culture through programs and policies that foster respect and fairness. NGI's engagement in diversity and equality initiatives further demonstrates its commitment to fostering an inclusive environment.

4. Relevance to institutional and sectorial purposes

NGI is a technical-industrial research institute for applied research, contributing to societal and industrial transformations and sustainable development through its research and innovation activities. NGI's applied research and consulting activities are very often related to research

commercialisation activities. Additionally, there are several activities documented of industry related innovations and cooperation, spin out companies etc. The self-assessment report includes a range of credible and impressive examples relating to offshore wind energy, geo-safety evaluation and renewable energy use.

The subjects and strategy of NGI's research activities are very clear and are related to the current needs and to the benefit of geotechnical engineering and engineering geosciences in general but also to particular industry and society needs. This includes those involved in infrastructure development, environmental management, and hazard mitigation. This strategy is convincing, having been specified in detail in the self-assessment report and being successfully lived for decades.

For many of their areas and projects, NGI indicates they foresee a route to commercialisation, and provide specific policies in place to support. Examples of successful commercialisation of innovation are also well detailed and have a high impact.

Collaborative research is very well detailed and huge activity is reported in collaboration with various partners. Many of these are also with private partners. Numerous and efficient collaborations (national and international) demonstrate that NGI's research activities are very diverse.

NGI also make available their geotechnical data for various purposes, including wind parks or for analysing the impacts of natural hazards. NGI focuses on research innovation, technology transfer, industry collaboration, and commercialisation support. These efforts further help to drive innovation in the wider ecosystem, attract and foster industry collaboration, and support the application of research outcomes to market, advancing geotechnical engineering and geosciences more widely.

5. Relevance to society

NGI's focus is on subjects that are very relevant nationally (e.g. soft clay, wind energy) and they therefore have a high level of impact on the long-term societal development of Norway. The evaluation committee also considers their impact on societal challenges to be high as they work to address issues such as sustainability, climate adaptation towards natural hazards, renewable energies, etc. which are relevant both for national and international society and for addressing the UN Sustainable Development Goals (SDGs). The description of these activities provided in the self-assessment report is convincing.

According to NGI's self-assessment report, the SDGs are the "higher sky above all activities" and NGI aims to build knowledge relevant to reach these goals in all their activities. In its current long-term plan for research, NGI intends to contribute towards addressing SDGs through "Climate, environment and environmentally friendly energy" by providing the knowledge needed with research and consulting towards instrumentation and foundations for offshore wind constructions, CCS, circular economy and climate adaption towards natural hazards.

NGI's work directly benefits society through the development of innovative solutions ensuring the safety, sustainability, and resilience of infrastructure, protecting communities from geotechnical hazards, and promoting environmentally responsible practices in the field of geotechnical engineering and geosciences. This is reflected in the impact cases provided, as well as the breadth of their collaborations with government and industry partners, demonstrating high societal impact.

Comments to impact case 1: REDWIN project

The REDWIN project contributed to a significant improvement in state-of-the-art geotechnical modelling of the soil and foundation for Offshore Wind Turbines (OWTs). The key research issue was the scientific formulation and validation of foundation models for shallow (e.g. bucket foundations) and deep foundations (e.g. monopiles) to be used in time-domain dynamic analysis of OWTs. This

has contributed to a significant improvement in the state-of-the-art geotechnical modelling of the soil and foundation for OWTs.

The most significant output of the project is a library of new soil-foundation models for time-domain dynamic analysis. These new models overcome several of the limitations in existing design tools and allow designers to adopt more accurate models in the OWT analyses used in OWT design and in lifetime extension evaluations. Using more accurate models reduces uncertainties in the predicted loads and in the estimated OWT lifetime, leading to reduced risk and lower costs in the design. Several large industry actors, including offshore wind developers, consultants, certifiers, and researchers, have implemented the models in their own OWT analyses tools.

In addition, this approach has removed barriers between structural and geotechnical engineers, facilitating the integration of the geotechnical discipline into the streamlined OWT design process. Further, it has improved the understanding of soil and foundation damping, and the contribution from the foundation to the overall energy dissipation in the OWT system.

Thus NGI's research has had a significant positive impact on the design of OWT, a very important renewable energy resource.

Comments to impact case 2: EVOKED-Project

The EVOKED project has facilitated and contributed to climate knowledge exchange, as a precondition for climate action, between scientists and climate adaptation practitioners at local municipalities and regional counties in Europe with case study sites in Norway, Sweden, Germany, and the Netherlands. The EVOKED project demonstrated the co-production of climate services to advance their application and uptake by end users to support climate adaptation strategies. NGI co-lead the collaboration across the projects funded under the European Research Area for Climate Services (ERA4CS) to leverage all project outputs and showcase the co-production of climate services at the European policy level. This project demonstrates that NGI's research activities have an environmental- and sustainability-relevant impact on society and the building industry.

Comments to impact case 3: GEOreCIRC project

Within the GEOreCIRC project NGI has helped develop methods that form the basis for increased recycling and utilisation of i) slightly contaminated waste products and surplus materials that are currently considered waste and ii) surplus materials that are considered clean and have potential for re-use. The focus of the project was on materials that arise in connection with construction projects and industrial activities, including surplus materials from road or railway infrastructure projects and building projects. This includes for example, geologically natural materials such as lightly contaminated soil, lime-cement-stabilised clay, and tunnel boring machine materials, as well concrete or demolition materials, waste from the mineral industry, and slag from mineral-producing industries. From the outset, there was high emphasis for the GEOreCIRC project to collaborate with relevant stakeholders such as local or national authorities, site/problem owners, entrepreneurs, waste handling companies, and consultants.

The GEOreCIRC project has contributed to a significant improvement of state-of-the-art practices relating to the reuse of industrial by-products for the remediation of contaminated soil. This is a prime example of how NGI has genuine, environmental- and sustainability-relevant impacts to society and to the construction industry.

List of administrative unit's research groups

Institution	Administrative Unit	Research Groups
Norway's Geotechnical Institute (NGI)	NGI	1. Environmental Pollution
		2. Sustainable Soil and Waste Management
		3. Advanced Modelling
		4. Offshore Geohazards
		5. Climate Adaptation
		6. Tsunamis

Methods and limitations

Methods

The evaluation is based on documentary evidence and online interviews with the representatives of Administrative Unit.

The documentary inputs to the evaluation were:

- Evaluation Protocol (see appendix 3 Evaluation Protocol) that guided the process
- Terms of Reference
- Administrative Unit's self-assessment report
- Administrative Unit's impact cases
- Administrative Unit's research groups evaluation reports
- Bibliometric data
- Personnel and funding data
- Data from Norwegian student and teacher surveys

After the documentary review, the Committee held a meeting and discussed an initial assessment against the assessment criteria and defined questions for the interview with the Administrative Unit. The Committee shared the interview questions with the Administrative Unit two weeks before the interview.

Following the documentary review, the Committee interviewed the Administrative Unit in an hour-long virtual meeting to fact-check the Committee's understanding and refine perceptions. The Administrative Unit presented answers to the Committee's questions and addressed other follow-up questions.

After the online interview, the Committee attended the final meeting to review the initial assessment in light of the interview and make any final adjustments.

A one-page summary of the Administrative Unit was developed based on the information from the self-assessment, the research group assessment, and the interview. The Administrative Unit had the opportunity to fact-check this summary. The Administrative Unit approved the summary with minor adjustments.

Limitations

The Committee judged that the Administrative Unit self-assessment report was insufficient to assess all evaluation criteria fully. However, the interview with the Administrative Unit filled gaps in the Committee's understanding, and the information was sufficient to complete the evaluation.

Appendices (link to website)

1. Description of the evaluation of natural sciences
2. Invitation to the evaluation including address list
3. Evaluation protocol (including ToR template)
4. Template Self-assessment administration unit
5. Grading scale for research groups

Website: <https://www.forskingsradet.no/tall-analyse/evalueringer/fag-tema/naturvitenskap/>

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