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INITIAL ACCREDITATION
ACADEMIC MASTER
ENVIRONMENTAL ENGINEERING
Delft University of Technology

FULL REPORT
21 March 2022

Content

1 Peer review

The Accreditation Organisation of the Netherlands and Flanders (NVAO) determines the quality of a new programme on the basis of a peer review. This initial accreditation procedure is required when an institution wishes to award a recognised degree after the successful completion of a study programme.

The procedure for new programmes differs slightly from the approach to existing programmes that have already been accredited. Initial accreditation is in fact an ex-ante assessment of a programme. Once accredited the new programme becomes subject to the regular review process.

The quality of a new programme is assessed by means of peer review. A panel of independent peers including a student reviews the plans during a site visit to the institution. A discussion amongst peer experts forms the basis for the panel's final judgement and the advisory report. The agenda for the panel visit and the documents reviewed are available from the NVAO office upon request.

The outcome of this peer review is based on the standards described and published in the limited NVAO Assessment framework for the higher education accreditation system of the Netherlands (Stcrt. 2019, nr. 3198). Each standard is judged on a three-point scale: meets, does not meet or partially meets the standard. The panel will reach a conclusion about the quality of the programme, also on a three-point scale: positive, conditionally positive or negative.

This report contains the findings, analysis and judgements of the panel resulting from the peer review. It also details the commendations as well as recommendations for follow-up actions. A summary report with the main outcomes of the peer review is also available.

NVAO takes an accreditation decision on the basis of the full report. The NVAO decision can be positive, conditionally positive or negative. Following a positive NVAO decision with or without conditions the institution can proceed to offer the new programme.

Both the full and summary reports of each peer review are published on NVAO's website www.nvao.net. There you can also find more information on NVAO and peer reviews of new programmes.

Because of COVID-19 temporary measures apply for this peer review.

2 New programme

2.1 General data

Institution	: Delft University of Technology
Programme	: Academic Master Environmental Engineering
Mode of study	: Full-time
Degree	: Master of Science
Tracks	: Water Resources Engineering, Resource and Waste Engineering, Atmospheric Environment Engineering
Location	: Delft
Study load	: 120 EC[1]
Field of study	: Technology

2.2 Profile

The MSc Environmental Engineering is a two-year full-time academic master programme, amounting to 120 EC, NLQF level 7, and is offered at Delft University of Technology. Given the international focus of the professional field and global societal context, the programme is offered in English. The expected student intake commencing the first year of study is approximately 150. The programme offers the education in three discipline profiles: Water Resources Engineering, Resource and Waste Engineering and Atmospheric Environmental Engineering.

The programme intends to train socially responsible environmental engineers who are able to understand, observe, predict and steer the effects of human interventions on the environment. The programme strives to meet future societal needs by delivering more engineers who can develop scientific approaches and sustainable engineering solutions for circular use of resources, conserving natural reserves, protecting the environment, and protecting the public from the risks of environmental hazards. The new programme is offered by the faculty of Civil Engineering and Geosciences and has been developed in close cooperation with the professional field in the domains of water resources, resource and waste and atmosphere.

2.3 Panel

Peer experts

1. Prof. dr. Wim Hafkamp (chair)
   Hoogleraar Milieukunde, Erasmus School of Social and Behavioral Sciences, Erasmus University Rotterdam
2. Prof. ir. Hans van Dijk
   Commissaris van NV Waterleidingbedrijf Limburg WML
3. Prof. dr. Paolo Burlando
   Professor of Hydrology and Water Resources Management, Swiss Federal Institute of Technology (ETH Zurich), Zurich, Switzerland
4. Ir. Wietske Rem
   Recently graduated Master Mechanical Engineering, University of Twente

Assisting staff

- Yulia Krijthe Ed.M., MA, secretary
- Lotte Ninaber van Eijben, NVAO policy advisor and process coordinator

Site visit (online)
Delft, 28 January 2022

[1] European Credits

3 Outcome

The NVAO approved panel reaches a positive conclusion regarding the quality of the academic master Environmental Engineering offered by Delft University of Technology (TU Delft).

The TU Delft MSc programme in Environmental Engineering (ENV) has evolved from the MSc tracks Water Management and Environmental Engineering offered in the current master programmes of Civil Engineering and Applied Earth Sciences. The programme clearly answers to a call from academia and industry for interdisciplinary engineers who can execute research in the field of environmental science and create sustainable solutions for problems related to environmental challenges. Representatives of the professional field whom the panel spoke to echoed this call. The panel ascertains that the ambition to educate adaptive and socially involved environmental engineers is a distinctive character of the programme. The panel advises the programme to refine its professional profile to tie it in with the programme's international orientation. The panel considers that the intended learning outcomes are sufficiently concrete and coherently formulated in line with the profile and orientation.

The panel considers that the didactic approach is well developed and viable. The programme creates diverse opportunities for collaborative learning such as modules' practical assignments, cross-over modules and inter- and multidisciplinary projects. The problem- and project-based learning facilitates the integration and application of acquired knowledge, understanding and multidisciplinary skills in the context of environmental challenges. Students conclude the programme with a master thesis, which can be carried out at TU Delft, research institutes or companies in the Netherlands or abroad. The programme thus offers many opportunities for interaction with industry, academia and/or participation in the (inter)national R&D and engineering community.

The design and content of the programme are well thought through: modules address current and relevant issues, and the option to specialise in one of the three tracks befits the relatively broad influx of students. The panel concludes that the curriculum structure is coherent. The combination of core and electives modules, the flexibility through learning and inter- and multidisciplinary projects, overall, reflect the distinctive character of the ENV programme. The panel has established that the curriculum content adequately reflects the ENV vision and enables students fully to achieve a broad skill set of the envisioned graduate profile. The MSc ENV offers three specialisations or tracks intended to deepen the knowledge of students in a sub-field related to the domains of water resources, resource and waste and atmospheric sciences. The programme is supported by adequate facilities and elaborate student counselling services; they all create a conducive learning environment for students. The panel acknowledges that the staff have an array of broad educational and engineering expertise enabling them to realise the curriculum in the offered tracks; they are clearly committed to the success of the programme.

The ENV programme applies a varied mix of assessment forms and methods to evaluate students' academic knowledge, transferable skills, and professional attitude. However, it has remained uncertain how the programme guarantees assessment of the individual contribution through the portfolio aimed to facilitate a student's path to become an environmental engineer professional. The panel is positive about the provided assessment programme and the quality of assessments that are safeguarded by active and well-qualified committees in place.

The programme is proposed to have a duration of two years with the study load of 120 European Credits. The arguments of the programme management for this duration lie in the (inter)national engineering standards, as well as in the elaborate content of the curriculum with respect to required knowledge, skills, research, and engineering experience. The panel agrees that the qualifications graduates should have for them to be competitive in the (inter)national job market are unachievable in a programme of shorter than two years. The panel supports the programme management arguments and advises to grant the programme the right to offer a two-year master programme (120 EC).

In conclusion, the panel is convinced of the quality of the proposed programme and trusts the TU Delft MSc Environmental Engineering will be a robust, academically feasible programme.

Standard	**Judgement**
1 Intended learning outcomes	meets the standard
2 Teaching-learning environment	meets the standard
3 Student assessment	meets the standard
Conclusion	**positive**

4 Commendations

The programme is commended for the following features of good practice.

1. Professional vision and orientation – This TU Delft master programme has a novel orientation in Environmental Science and Technology towards training environmental engineers able to develop scientific approaches and sustainable engineering solutions for environmental challenges. The programme strives to educate adaptive and socially involved engineering professionals in this regard.

2. Nascent discipline profiles – The programme aspires to educate environmental engineers with well-developed, multidisciplinary practical skills, who can become specialists in the chosen nascent disciplinary profile attained through the education in Water Resources Engineering, Resource and Waste Engineering or Atmospheric Environmental Engineering.

3. Programme Learning Outcomes - The intended learning outcomes constitute a coherent set of learning outcomes that reflect the programme's ambitions for both scientific approaches and engineering solutions for environmental challenges and tie in with the TU Delft and Faculty CEG visions on education.

4. Rigorous curriculum structure - The curriculum is designed around clear and solid learning outcomes, which develop from consolidated academic strengths and incorporate project- and problem-based teamwork, with the purpose of broadening and enriching the students' learning experience as well as balancing disciplinary with inter-, multidisciplinary knowledge and skills.

5. Collaborative effort - The development of the programme is a truly collaborative effort by highly qualified teaching staff and programme management. The programme staff are committed to delivering a robust and academically feasible programme and have developed into a close-knit community that is very supportive of this master programme.

6. Student ownership of learning– The programme offers students a good degree of flexibility in shaping their individual learning trajectories and personal profiles of future environmental engineers. Students are trained to work in complex, inter- and multidisciplinary environments and have a generally varied elective programme enabling to expand their knowledge and skills through in-depth and cross-over modules, or study experience abroad or work placement.

5 Recommendations

For further improvement to the programme, the panel recommends a number of follow-up actions.

1. Intake and selection procedure – Carefully reassess the criteria and prior knowledge background applied in the intake for the intended target groups and selection procedure for students who are not directly admissible to the programme.

2. International orientation – Refine the programme's ambitions in relation to the international orientation and incorporate them explicitly in the intended learning outcomes and curriculum.

3. Track Interconnectivity – Ensure that the interconnection between the three tracks is fully developed throughout the curriculum, teaching methods and assessment thus optimising student ownership of learning.

4. Curriculum Content - Secure that the latest know-how and new staff expertise keep finding their way into the curriculum, particularly in the nascent tracks of Resource and Waste Engineering and Atmospheric Environmental Engineering.

5. Portfolio Assessment – Bring into uniformity the assessment criteria and levels of attainment of the learning outcomes. Ensure rigor and alignment among teaching staff during the portfolio guidance.

6 Assessment

6.1 Standard 1: Intended learning outcomes

The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Judgement
Meets the standard.

Findings, analysis and considerations

The master programme of Environmental Engineering at TU Delft aims to educate a new type of engineers: environmental engineers focusing on the interaction between humans and their living environment, on protecting the public from the risk of environmental hazards and the sustainable use of resources. The programme aspires to teach students in understanding and executing research in the field of environmental science and delivering engineering solutions geared to reduce impact of human activity. In the process of creating these solutions students will integrate scientific methods from the fields of resource, soil, water, and atmosphere and apply the principles of resource circularity and sustainability. The proposed programme is built on the TU Delft's solidly established profile in Water Resources Management.

The programme intends to offer students three disciplinary profiles attained through following the education in three tracks, namely in Water Resources Engineering (WRE), Resource and Waste Engineering (R&WE) and Atmospheric Environmental Engineering (AEE). A student can also choose to study a double track (two tracks) within the programme of Environmental Engineering (ENV). The panel understands that the proposed programme prepares students for a range of professional positions in environmental engineering operating in both the public and private domains. They will be working in all sectors that plan, manage, operate or permit and supervise in the dedicated domains of water resources, resource and waste and atmosphere. The scope of employment providers extends to national and international engineering and consultancy firms, construction and technology providers, and diverse authorities (ministries, provinces, municipalities, NGOs, UN, WHO, WMO), research related institutes (e.g. RIVM, TNO, Deltares, KWR) and universities and institutes for higher (vocational) education (e.g. IHE Delft Institute for Water Education).

As the programme management explained, the broadened scope of this master programme responds to the wide variety of environmental challenges that societies are facing these days. Graduates of TU Delft's MSc Environmental Engineering will therefore enter the labour market as environmental engineers with well-developed, multidisciplinary practical skills and at the same time with in-depth expertise in the field of resource, soil, water, and atmosphere. This combination will enable them to master new knowledge throughout their professional life either in empirical research or in engineering applications. The panel is of the opinion that the context of environmental engineering befits the described demands of the (inter)national industry, responds to the societal need and meets the strategic ambitions of TU Delft in education of 'socially responsible engineers' working on the frontiers of the engineering science.

Upon reading the application file, the panel questioned to what extent environment engineering can be considered an established labour field, with a connection to industry stakeholders

that provides interaction, context, and community. The discussions with programme management and industry representatives assured the panel that graduates of this master ENV would secure their jobs in the respective domains. Moreover, the labour market has growing career perspectives at the intersections of the programme tracks, also for international alumni.

Gathered from the programme dossier, the panel got the impression that requirements from the professional field were considered in the process of the programme design. This impression was confirmed in the online discussion with the Advisory Board (AB) who were involved since the inception of the programme. This newly installed Board consists of industry representatives varying from managing directors to technology and research managers who operate in the domains of Environmental Engineering. The AB representatives the panel met with were highly supportive of this master programme and felt that the type of interdisciplinary graduate the programme envisioned was well-tailored to their expectations. The panel welcomes the programme's intention to foster insightful interaction with the Advisory Board and related professional associations to ensure the curriculum stays aligned with industry expectations and needs.

The profile of the programme has been translated into 12 intended learning outcomes (ILOs) based on seven areas of competence that characterise a technological university graduate in the Netherlands, referred as the Meijer's criteria for Academic Bachelor's and Master's curricula. The panel learned that the intended learning outcomes had been aligned with the requirements expressed by the representatives of the professional field. For example, the aptitudes associated with soft skills and digital literacy were emphasised in the intended learning outcomes upon recommendation by industry professionals. The panel has established that the ILOs are formulated in line with the Dublin Descriptors at master level and are tied in with the Dutch National Qualifications Framework (NLQF level 7).

Additional information shared prior to the site visit provided the panel with a clear overview of how the programme positioned itself with respect to related national programmes addressing specific fields of Environmental Science and Technologies. In discussion with the programme management, the panel learned that the benchmark study also had helped the programme to sharpen its own profile. It was pleased to hear that the programme management sought to align their efforts with developments at other Dutch universities of technology. The panel was informed that the programme had involved the professional network of university partners, utilized staff industry experience, and incorporated feedback provided by students currently following the Environmental Engineering track within Civil Engineering (CE) and Applied Earth Sciences (AES) master programmes.

Students will study environmental challenges and develop engineering solutions in the fields of air quality, hydrology and water resources management, water technology and urban water infrastructure. Also, future challenges in recycling, long-term storage of waste, urban heat islands, air pollution and noise will be part of this programme. The panel values the thought process that went into defining the professional orientation as complementary to an academic orientation. Albeit broad involvement of stakeholders appeared on the national level, the panel has not received substantial evidence of the programme's international aspirations for the envisioned educational profile. In this regard, the panel recommends the programme

to define its ambitions in the field of internationalisation more clearly and ensure the programme curriculum and intended learning outcomes reflect the choices underlying the intended international orientation.

Based on the discussions with programme and industry representatives and the materials presented, the panel concludes that the profile of the programme is based on a conclusive and distinctive vision and is well-aligned with the expectations of the professional field. The panel supports the programme's multidisciplinary orientation and ambition to educate environmental engineers who will be able to work adaptively with the latest advances in Engineering Science and Technologies and deliver impactful engineering solutions to environmental issues and challenges. The panel recommends refining the present formulation of the ENV profile further to make it explicit in relation to the international orientation.
The panel ascertains that the programme's intended learning outcomes are formulated based on the rigorous criteria for academic master's curricula for universities of technology in the Netherlands and tie in with the Dublin Descriptors at master level. The panel therefore concludes that the intended programme meets standard 1.

6.2 Standard 2: Teaching-learning environment

The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Judgement
Meets the standard.

Findings, analysis and considerations

The education of the master programme in Environmental Engineering encompasses a full-time modular curriculum of 120 ECTS, divided into four semesters (eight quarters).
The programme consists of the compulsory part by offering general ENV subjects in the 'programme module' (9 EC) and general CEG subjects in the 'faculty module' (12 EC); both modules are seen as a 'master onboarding programme' aimed to provide students with a crucial toolkit to apply throughout their master's study ENV and further.

After this compulsory part, students make a choice between the three offered tracks: (1) Water Resources Engineering (WRE), (2) Resource and Waste Engineering (R&WE), or (3) Atmospheric Environment Engineering (AEE). Each track consists of a steppingstone (15 EC), followed by an A-module (9 EC) which is usually primarily focussed on theory and a B-module (15 EC) which is generally characterised by a more practical and empirical approach.

In the second year of this programme students are offered more flexibility and freedom of choice through following an in-depth track elective and a cross-over module or doing an internship or study abroad or undertaking a multi- or interdisciplinary project in the Netherlands or abroad. Following the presented curriculum structure, the panel observes that students are geared towards making a well-informed choice for a research topic for the thesis.

Gathered from the curriculum materials and received elaboration during the site visit, the panel determines that the programme offers students ample freedom to develop an individual

professional profile. During the discussion with the design team the panel came to understand that the programme considered it important that future environmental engineers would be trained to work in complex, inter-and multidisciplinary environments. Therefore, all ENV students, regardless of their elective programme, should complete a module with focus on multidisciplinary skills in their study plan. The panel considers this approach as a noteworthy feature of the programme and encourages collaborative attempts to continuously optimise the curriculum content in response to new societal challenges and industry (both national and international) and discipline-related evolutions. In this regard, the panel recommends that the programme structurally employs activating teaching methods (e.g. sustained inquiry- and project-based learning) leveraging students' outside-the-box thinking. The panel also supports the programme's aspiration to foster the TU Delft cross-domain learning communities and explore engagement options on the campus organization around the themes of sustainability and resource circularity.

The integrated faculty module Modelling, Uncertainty and Data for Engineers (MUDE) focusses on engineering fundamentals and their applications to real engineering challenges and is also regarded as a 'landing zone' for the three Master programmes: Civil Engineering, Applied Earth Sciences and Environmental Engineering. Having studied the module description, the panel questioned whether the achievement of learning outcomes given a diverse student educational background had been carefully foreseen. The design team substituted their anticipation to bridge students' entry levels and previous knowledge by interlinking fundamental concepts with project work applications and inquiry-based learning. In the project part of the modules, students work at the interface areas where the various topics overlap; this approach creates opportunities for more integrated and increasingly complex applications in the broad field of environmental engineering, civil engineering and geosciences. In addition, the programme offers several online courses (MOOC) on computer programming skills. Even after further explanation by programme representatives, the panel was yet unable to fully see how the desired harmonisation and a higher level of in-depth knowledge of students from diverse disciplinary backgrounds are assured in the core programme and faculty modules. Thus, the panel recommends giving a closer look at the alignment of student entry levels, including international student intake.

From the reviewed module descriptions, the panel was not able to establish how exactly the concept of lifelong learning skills (Dublin Descriptor 5) had been embedded in the curriculum. During the site visit, the design team elucidated this point of concern by exemplifying that lifelong learning orientation already starts in the faculty module MUDE where students are facilitated to develop a growth mindset enabling them to see a wider application of their skill sets rather than only in the envisioned specific domain of expertise. Also, through the introduction of reflections on the metacognitive skills demonstrated in the portfolio, the programme aspires to make students active in their learning process. In addition, the programme intends to employ such teaching methods as inquiry-based, problem-based, and project-based which are seen complementary. The panel heard that 'learning on the job' is already being practised during the education, which is commendable.

From the curriculum material provided and discussions with the design team, the panel considers that the design of the ENV curriculum is coherent and adheres to the guiding principles underlying the TU Delft Framework for Future Master Education 2020-2030.
The curriculum structure is designed in line with the didactic concepts of constructive alignment. The programme has formulated modules' learning objectives and explicitly linked them

to the programme's ILOs. Upon reading the curriculum module information, the panel grasped that every module reflects an interlinked thematic cohesion; the structure and content of themes within a module is fixed. Students cannot interchange A-modules and B-modules. These limitations are considered necessary to safeguard the coherence of the programme and ensure full coverage of all ILOs in every possible individual programme. The panel understands the rational explanation for such limitations. However, the panel considers more interconnectivity between the programme tracks deem conducive for facilitating student-centred learning and for developing a student's personal graduate profile. This can be achieved through allowing more flexibility in the module choice between the programme tracks or introducing joint inter-and multidisciplinary projects within the tracks. The panel believes this approach viable through the elaborate student tutoring/coaching system intended in the ENV programme. The need for environmental engineers who are able to put forward interdisciplinary solutions has also been recognised by the professional field during the site visit.

Based on the curriculum information provided the panel was not able to identify a conclusive understanding of the ILOs attainment in relation to soft skills and the role of the portfolio in this regard. Also, the portfolio assessment, its constitutive elements as well as the associated role of the coach with respect to the portfolio were not fully clear. The provided elucidation as gained from intensive conferring with the programme representatives sufficed to demonstrate this adequately. However, the panel recommends bringing into uniformity the prime focus of portfolio and its embedding in the curriculum as well as securing rigour and alignment in coaching among diverse staff members involved. The panel welcomes the programme plans to provide respective training events and set up periodic calibration sessions for coaches.

The language of instruction is English. The programme management substantiates its choice by arguing that a significant part of professional field in which the ENV graduates find jobs is internationally oriented. Also, scientific research in the field of environmental engineering is executed primarily by international research groups, thus students aspiring a scientific career need to be fluent in English. In addition, international academic teaching staff, and diverse influx of non-Dutch students who will participate in the global research and engineering community necessitate an English-taught programme. The panel supports the programme's choice.

From the programme information related to admission, the panel has learned that bachelor students with various profiles may be admitted to the ENV programme, provided the applicant has sufficient 'engineering' competences. This includes a background in Mathematics, Chemistry and Physics (Fluid Mechanics). Previous knowledge in computer programming (Python, Matlab, C++) is also expected. Students can be directly admitted to the programme if they hold a Dutch bachelor's degree in Aerospace Engineering, Applied Physics, Civil Engineering, Marine Technology, Mechanical Engineering and Nanobiology. Students who do not fulfil the admission requirements or hold other Dutch bachelor's degrees in technical sciences may need to do a pre-master programme to obtain the required credentials or may be requested to follow a bridging programme. Since the programme is English-taught, applicants should demonstrate a strong command of the English language (C1 level, CEFR).

In conversation with the programme management and teaching staff, it became clear that a varied cultural and national intake is preferred to enhance the students' learning experience

and to enable the achievement of the intended learning outcomes by providing optimal conditions to work in multidisciplinary teams and jointly acquire new knowledge.
Whilst the panel supports the programme's wish for a diverse student group, they still have concerns over whether the intake procedure is specific enough in relation to the intended three tracks. Simply expecting some students with a higher level of prior knowledge staying less engaged than others, as was mentioned during the site visit, does not seem to be a fail-safe and proactive approach. The intensive conferring with the programme representatives elucidated some of the choices made regarding the admission prerequisites and the range of bachelor's degrees eligible for admission to the ENV programme. However, the panel maintains that the student influx from the Chemical Engineering department and the Technology, Policy and Management faculty befits the programme profile and orientation. The panel, therefore, recommends reconsidering the admission matrix for the selection criteria, prior knowledge criteria (not limited to only a backround in Mathematics, Physics and Chemistry), and for bachelor's degrees that are not directly admissible.

During the online visit the panel has met the design team who were involved in the development of the ENV curriculum. This team has displayed a great collaborative spirit and a passion for the disciplines to be taught in the MSc Environmental Engineering. From the information dossier the panel acknowledges that teaching staff are systematically trained in the didactic and assessment skills through the University Teaching Qualification (UTQ). Gathered from the conversation with the teaching staff, the panel learned that the provision of extra professional schooling on enhancing team-based teaching, inquiry-based learning and modular curriculum design had also taken place with the faculty. In addition, periodic design team meetings were held in the development of the programme; the panel would encourage the teaching staff and programme management to continue these calibration meetings to ensure further alignment of the various curriculum components. Another commendable aspect in relation to the new curriculum and teaching-learning environment, acknowledged by the panel is that the faculty will soon be offering a training in student tutoring or coaching in relation to the portfolio building and assessment.

From the provided staff curricula vitae, it has become clear that all dedicated academic staff are well-established researchers who actively contribute to the development of Engineering Science and Technologies. The proposed lecturers are largely international and hold positions as assistant professors, associate professors, or full professors; they are supported by junior lecturers, PhD candidates and postdocs. From the discussion with the design team, the panel was convinced that the faculty had sufficient staff capacity and a broad spectrum of expertise enabling them to realise the curriculum in the less established tracks of Atmospheric Engineering and Resource and Waste Engineering; the panel welcomes the management's intention to employ more staff (vacancy worth 2 FTE) in this regard. The panel considers the programme management and teaching staff well-equipped to implement and coordinate the overall programme.

Furthermore, the panel has learned that throughout the programme students will be offered guidance, coaching and counselling on different levels, depending on the nature of the support that students require.
The programme will provide focussed guidance in the choice for a track students intend to follow. For instance, questions about professional development-related choices will be handled by the portfolio coach. Support regarding choices to be made within the chosen track (e.g., choosing an A- and a B-module) will be offered by the track manager. The track manager

will also support the student at the start of their graduation project. During this project, the student will be guided by a supervisor or a supervision team.

Since the site visit was conducted online, the panel was unable to have a tour of the facilities, yet it was elicited that the CEG Faculty has adapted or developed new facilities for the hybrid and online provision of education forced by the COVID pandemic. Also, student guidance has actively been facilitated by study buddies, study associations and mentor groups. Academic counsellors will pay extra attention to international students enrolled for the intended programme who appear to be extra vulnerable to pandemic measures.

In summary, the panel is of the opinion that the programme offers a conducive teaching-learning environment. The curriculum structure is overall coherent and viable; it presents an attractive combination of compulsory and elective modules and is primed for implementation by well-qualified staff. The programme content, with room for further development in the AEE and R&WE tracks, sufficiently reflects the distinctive profile of the proposed programme, albeit some module harmonisation of diverse student intake is desired. Strong elements encompass activating teaching methods based on the inquiry- and project-based learning that facilitate the development of students' multidisciplinary skills and student ownership for the design of their individual learning paths. All in all, the panel establishes that the curriculum, guidance services and facilities, and the quality of the teaching staff will enable incoming students to achieve the intended learning outcomes. The panel therefore judges standard 2 as met.

6.3 Standard 3: Student assessment

The programme has an adequate system of student assessment in place.

Judgement
Meets the standard.

Findings, analysis and considerations

The master programme in Environmental Engineering has developed an assessment system that adheres to the principles and procedures for the design, organisation, administration, and evaluation of assessment as defined in the Faculty CEG Master Programmes Assessment Policy (2021) and Educational Vision Master Redesign, Faculty of CEG (2021). In line with the Faculty Assessment Policy, the programme has delivered the ENV assessment programme that provides an overview of summative assessments, and the assessment matrix that indicates which programme ILOs are assessed in which modules spread over the proposed duration of two years.

The programme employs a functional mix of assessment forms such as written assignments, presentations, reports and lab experiments. The assessment programme also includes test formats based on individual and group participation. Group work involves supervision of the process and assessment of individual contribution as well as peer feedback and evaluation of individual performance. Lecturers have been trained in the development of various assessment forms and formats.

From the discussion with the design team and the Board of Examiners, the panel assures that the programme maintains enough transparency regarding assessment per designed module.

From the reviewed samples of module descriptions and pertinent assessment material the panel can determine that assessments are based on the learning outcomes defined at module level; those are aligned with the ILOs at programme level.
The provided module descriptions and assessment rubrics outline the type and formats of assessment with evaluation criteria that correspond to the intended learning outcomes. The grade reflects the level of performance of the individual student. The panel has learned that reliability and validity are enhanced in various ways: examiners have to apply the 'four-eyes' principle in the process of designing summative assessments which are based on assessment matrices. Also, student deliverables under assessment are regularly evaluated by and discussed between colleagues within the teaching team. These evaluations can both result in adaptations in the assessments and in adaptations of the assessment rubrics and judgment guidelines. The panel is positive that these procedures safeguard a high quality in assessment.

Formative and summative evaluations alternate. For instance, portfolio assessments will provide both formative and summative opportunities for monitoring progress toward achieving identified learning outcomes. The panel learned that the number of assessments had been decreased to 25. The panel observed that almost all modules contained three to four types of summative assessment; most of them are written. The panel recommends the programme to further integrate the modular curriculum aiming to a minimum number of summative assessments along with active application of informal (community) learning, peer review and continual constructive feedback in the assessment cycle as well as strongly recommends including oral exams in a more integrated manner.

The focus on portfolio to integrate assessment and instruction and to promote meaningful learning (assessment for learning) has been detailed to the panel during the dialogue with the programme representatives. From the very start of the programme until the proposal for the thesis is submitted, the students work on developing their individual academic and professional profile through the portfolio by collecting evidence of their educational experiences. These educational experiences can be very diverse. For instance, they can include consecutive versions of a personal and professional development plan, reflections on economic, societal and/or ethical dilemmas, student-selected samples of work experiences, feedback of lecturers, peers and industry stakeholders. The student reflects on these experiences using the STARR method and linking the experiences to ILOs. The panel understood that the assessment of portfolio (a concrete assessment grid for evaluation activities/portfolio 'data points') had not yet been fully defined, thus the panel was not able to determine how the assessment of complex aspects, such as individual attitudes in a group process and student efficacy would be assessed efficiently and reliably. The panel welcomes further development of the portfolio in the assessment programme that would require the ongoing involvement of students in the creation and assessment process. The portfolio design should provide students with the opportunities to become more reflective about their own work while demonstrating their learning aptitude for achievement in the ENV modules and projects. The panel appreciates a detailed description of attainment of the learning outcomes specified in the portfolio assessment rubric. In addition, the panel recommends the programme to explore the principles of programmatic assessment in relation to the portfolio assessment.

The ENV programme concludes with a 30 EC graduation project that consists of a master thesis based on individually performed research. Students will complete the project in a graduation session where they present the objectives of the graduation project and discuss their results, conclusions, and recommendations. The graduation projects are assessed by a master

thesis graduation committee. The committee consists of at least two academic staff members of TU Delft, appointed as examiners. One member of the graduation committee will not be involved in supervising the student during the project. In addition, company representatives involved in graduation projects will provide their assessment advisory to the graduation committee. Having reviewed the ENV Graduation Manual and Master Thesis Grading Rubric, the panel considers the graduation programme to be rigorously developed and elaborate; it ensures the assessment of ENV programme learning outcomes at the master's level of attainment. The panel was pleased to hear about the introduction of the 'green-light meeting', which serves as a preliminary assessment held four weeks before the graduation session. This meeting is aimed at calibrating expectations of the student with the graduation committee members and preventing potential conflicts over the final thesis work.

The Board of Examiners (BoE) functions faculty wide and is responsible for the quality of assessments and safeguarding the competency standards of its programmes. The BoE monitors compliance with the TER, appoints examiners and handles fraud and complaints about examinations. The Board of Examiners periodically consults with the director of studies and programme managers on identified problems with assessment quality and provides advice on quality improvement. The BoE has three subcommittees; two of those operate with focus on quality assurance of assessment such as performing periodic screenings on validity, reliability, transparency and the 'four-eyes' principle applied to the assessment design throughout the CEG programmes and evaluating bachelor and master theses of all CEG programmes. Both subcommittees report to the BoE and provide feedback to examiners where necessary. The third subcommittee handles student individual requests regarding assessment issues.

During the online visit, the panel has received confirmation of the BoE involvement in the development of the ENV programme. They conducted a thorough screening of the ENV programme ensuring that the constructive alignment between the profile and the curriculum would be achieved. From the interviews with the assessment representatives, the panel can assert that the Board of Examiners and associated committees are instrumental in monitoring the quality of assessment with the proposed programme and safeguarding the quality of graduate assessment. The BoE formally appoints examiners according to the established programme requirements and ensures necessary onboarding related to the assessment process and assessment criteria of graduation assignments. The panel was informed about the BoE plans to conduct a thorough screening of the ENV master theses over the three tracks before the end of 2024. The panel has noticed that the communication with the BoE and teaching and management teams is sustained in mutual understanding and cohesion.

The panel concludes that the programme has a sound and transparent system of assessment in place. It is characterised by a range of assessment forms and provides sufficient insight into the relationship between the programme intended learning outcomes and learning objectives for a given module. Assessment constitutes an integral part of the educational process and adds to another learning opportunity for the student. The staff has showed a strong aspiration to further develop an assessment culture with a greater focus on active student participation, formative assessment, constructive feedback, coaching and guidance. The BoE plays an important role in ensuring assessment quality and has spent considerable efforts to create reliable procedures, resulting in consistent and efficient decision-making processes. Considering all of these, the panel concludes that the intended programme meets standard 3.

6.4 Degree and field of study

The panel advises awarding the following degree to the new programme: Master of Science. The panel supports the programme's preference for the following field of study: Technology.

6.5 Programme extension

The TU Delft academic master programme in Environmental Engineering has been proposed for the duration of two years (120 EC). The arguments of the programme management are tied in with the breadth and complexity of the programme, reflecting the multidisciplinary domains of environmental engineering endorsed by the professional field, and the international requirements of the programme. The panel has assessed the arguments, using the criteria put forward in the Protocol for programme extension of NVAO, published on 8 October 2003.

Findings, analysis and considerations

The panel is of the opinion that the range of specific disciplines, state-of-the-art technical knowledge, and transferrable skills enabling to work effectively in multidisciplinary environmental engineering domains are essential for the programme to optimally prepare students for their future careers. The panel strongly feels that the qualifications the graduates should demonstrate to stay competitive in the (inter)national job market cannot be achieved within a year- long programme. The panel considers the proposed design of the two-year master curriculum is primed to ensure the attainment of the ENV competences (intended learning outcomes). In addition, the panel notes that the benchmark study conducted by the programme management to be relevant and thorough and concludes that nearly all similar programmes in Engineering Science and Technologies in the Netherlands and alike abroad take two years (120 EC).

Conclusion

Given these strong arguments in favour of a two-year curriculum, the panel advises to grant TU Delft the right to offer a two-year master programme with the study load of 120 EC.

Abbreviations

AB	Advisory Board
AEE	Atmospheric Environment Engineering
AES	Applied Earth Sciences
BoE	Board of Examiners
CE	Civil Engineering
CEG	Civil Engineering and Geosciences
CEFR	Common European Framework of Reference for Languages
EC	European Credit
ENV	Environmental Engineering
ILO	Intended Learning Outcomes
KWR	Water Research Institute
MSc	Master of Science
NGO	Non-Governmental Organisation
NVAO	Netherlands Flanders Accreditation Organisation
PBL	Problem-Based Learning
RIVM	Rijksinstituut voor Volksgezondheid en Milieu / The National Institute for Public Health and the Environment
RWE	Resource and Waste Engineering
STARR	Situation, Task, Action, Result, Reflection
TER	Teaching Examinations Regulations
TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek/ the Netherlands Organisation for Applied Scientific Research
TU Delft	Technische Universiteit Delft / Delft University of Technology
UN	United Nations
UTQ	University Teaching Qualification
WHO	World Health Organisation
WM	Water Management
WMO	World Meteorological Organization
WRE	Water Resources Engineering

The full report was written at the request of NVAO and is the outcome of the peer review of the new programme academic master Environmental Engineering of Delft University of Technology

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NVAO

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